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Reflections in Soil: Multi-element analysis of later prehistoric and early historic house floors in Britian

George, Nebu

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Reflections in Soil

Multi-element analysis of later prehistoric and early historic house floors in Britain.

Nebu George

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‘Yr wyf drwy hyn yn datgan mai canlyniad fy ymchwil fy hun yw’r thesis hwn, ac eithrio lle nodir yn wahanol. Caiff ffynonellau eraill eu cydnabod gan droednodiadau yn rhoi cyfeiriadau eglur. Nid yw sylwedd y gwaith hwn wedi cael ei dderbyn o’r blaen ar gyfer unrhyw radd, ac nid yw’n cael ei gyflwyno ar yr un pryd mewn ymgeisiaeth am unrhyw radd oni bai ei fod, fel y cytunwyd gan y Brifysgol, am gymwysterau deuol cymeradwy.’

Rwy’n cadarnhau fy mod yn cyflwyno’r gwaith gyda chytundeb fy Ngrichwyliwr (Goruchwylwyr)’

‘I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. All other sources are acknowledged by bibliographic references. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree unless, as agreed by the University, for approved dual awards.’

I confirm that I am submitting the work with the agreement of my Supervisor(s)’

List of publications resulting from this research

George, N. 2021. It's elemental, my dear Watson! A geochemical study exploring chemical signatures for the use of space in houses. In R. Karl and J. Leskovar (eds) *Interpretierte Eisenzeiten 9. Studien zur Kulturgeschichte Oberösterreichs*. Linz: Oberösterreichisches Landesmuseum.

George, N. 2019. The Life in Phosphorus. A soil phosphorus study of the gatehouse at Meillionydd. In R. Karl and J. Leskovar (eds) *Interpretierte Eisenzeiten 8. Studien zur Kulturgeschichte Oberösterreichs*. Linz: Oberösterreichisches Landesmuseum.

List of Abbreviations

In this study, there are instances where abbreviations are employed for frequently repeated words and phrases. The list of these abbreviations is provided below.

Al: Aluminium

Ca: Calcium

Cl: Chlorine

Cr: Chromium

Cu: Copper

Fe: Iron

K: Potassium

Mn: Manganese

Ni: Nickel

P: Phosphorus

Pb: Lead

S: Sulphur

Ti: Titanium

Zn: Zinc

TXRF: Total X-ray fluorescence

pXRF: Portable X-ray fluorescence

ABSTRACT

The idea of domestic space and the concept of house and home in the distant past is at the core of this PhD research. The research takes as its main focus the analysis of mainly one kind of 'artefact' within ancient houses: the sediment, which makes up the anthropogenic occupation floors located inside the buildings. This doctoral thesis, therefore, explores the potential of multi-element analysis via TXRF-spectrometry in the study of archaeological house floors in Britain. The comprehensive deployment of multi-element analysis in the study of domestic space within British archaeology remains largely uncharted, and this is an issue that this research aims to address. Where traditional archaeological study relies on artefact distributions of houses (with occasional phosphate analysis), this study employs multi-element analyses to understand the chemical composition of the sediments that make up the house floor. This method, coupled with the study of architectural arrangements and features, and finds distributions (where available), from individual case studies, has produced significant insights about the use and organisation of domestic space in a range of prehistoric and early historical contexts.

Addressing several pivotal questions, the research sought to discern patterns in the use of the internal space within the houses examined. It also probes potential temporal and geographic variations in the use of domestic space, as reflected in the corresponding chemical signatures. Finally, the study assesses if observed patterns align with existing theoretical models of domestic space in British archaeological literature, focussing on the different time periods represented by the case studies.

Three well-preserved structures from western Britain, spanning later prehistoric and Early Medieval periods, serve as case studies in this thesis. They comprise of an Early-Middle Iron Age roundhouse at Meillionydd, a Late Iron Age cellular house at Orosaigh, South Uist and a Middle Norse longhouse at Bornais, also in South Uist. All three case studies were subjected to multi-element analysis using a Total X-ray fluorescence spectrometer at Environment Centre

Wales, Bangor University. The analysis uncovered previously undetected possible storage/sleeping areas, possible cooking areas, possible activity areas, possible destroyed hearths, and potential partitions. It also revealed that specific activities in the houses were marked by distinctive chemical signatures, represented by elevated levels of certain elements in the floor layers. Moreover, the study demonstrated the potential of developing universal chemical signatures for specific activities or features based on the comparison of similar activities across the three sites, as well as from other studies where similar chemical signatures have been identified. By incorporating insights from anthropology, the research presents a better understanding of the organisation of space in these buildings, but this has broader significance in our understanding of houses from a range of different periods of the distant past. This PhD thesis, thus, underscores the potential utility of multi-element analysis in archaeological investigations of domestic spaces.

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CHAPTER 1: INTRODUCTION

1.1 The Domestic Space

Social life can be viewed as a drama in which individuals are the actors, and the house is a theatre that provides the stage for the drama to play. This is based on the concept of 'dramaturgy' developed by Goffman (1959). Grahame (2000, 1), however, noted that this view is unsatisfactory when applied to archaeological material because it renders built space meaningless without occupants, i.e., the 'actors', which include people and materials. After the 'act', the actors may leave behind their props, which we often encounter in archaeology as artefacts. Furthermore, evidence for the acts and actors may be seen on the 'stage' and in the case of houses, this stage is the house floor. This thesis seeks to explore the use and organisation of 'domestic' space within house architectures from different periods of the past by focusing primarily on the relation and use of that important stage: the house floor and its geochemical signatures.

Houses and their floors can be seen as a type of material culture closely associated with the physical world and the socio-cultural environment of the people who construct and reside in/on them. The capacity of material culture to contain latent possibilities is unpredictable, as they can reflect past actions, meanings, and intentions while prompting new and unexpected reactions (adapted from Keane 2006, 199-201), and houses are similar. Chesson (2012, 45) considers the house a form of material culture that is dynamic in nature. The dynamic nature of the function of the house was recently experienced when the world was affected by the COVID-19 pandemic when it took on the meanings of a home, a place of work, a place of entertainment, a school, a place of isolation and containment, etc. Hence, just like material culture, to better understand houses and homes, it is imperative to understand how they were made, used, and lived in.

Archaeological studies of house floors have been enhanced considerably through the field of anthropology and ethnography. Bourdieu (1977), through his anthropological work, delved into the concept of *habitus*, which explores the ways in which people experience space and interact with the world around them. For instance, through his study of the Kabyle house, he found that the Kabyle house was structured based on the group's social and cultural beliefs, particularly those related to gender roles. Bourdieu's ideas impacted the work of several archaeologists and anthropologists. In the 1980s, Blier (1987) examined the meaning of architecture in the contemporary Batammaliba communities of Togo and the Benin Republic. She arrived at a conclusion similar to Bourdieu's, which posited that architecture was imbued with meaning through metaphors and that these meanings were reinforced by the ritualistic construction and use of domestic spaces (Blier 1987). Blier (1987, 10) gained a deep understanding of Batammaliba architecture by using various methods such as observing, comparing, documenting ceremonies and rituals, examining building processes and technology, and conducting interviews with the Batammaliba. Through this, she could comprehend the houses and the cosmology they reflected from the perspective of those who used and built them. One significant aspect of these studies was observing the architecture in action and conversing with the inhabitants to understand the use and symbolism of the architectural settings.

The idea of domestic space and the concept of house and home have been broadly studied in archaeology and anthropology. This has led to the development of various theoretical and practical tools for analysing these spaces being developed over time. Cieraad (2017, 1) noted that although work in the late 1970s started to consider the artefacts in the buildings and how they may indicate the organisation of domestic space into activity zones, the term 'domestic space' did not likely exist in academic discourse. Yet, the concept of the living area within an enclosed boundary of a house existed (Cieraad 2017, 1). Still, structural remains were often the focus rather than the organisation of the space within. For example, from the late 1970s onwards, D. L. Clarke (1972), based on the architecture and structural remains of houses and the artefacts within them, suggested that the organisation of buildings at the Iron Age site of

Glastonbury Lake Village was centred on gendered activities. One of his guiding ideas behind such a division based on gender was the presence or absence of artefacts associated with ‘female activities’ such as ‘querning,’ spinning, combing, leather and fur working, and so on (Clarke 1972, 817). Using a derivative of Clarke’s approach, Ann Ellison (1981) used the distribution of finds within Middle Bronze Age settlements to interpret the use of individual buildings, arguing that some were living huts whilst others were food production or craft huts or animal shelters. Another approach was access analysis, a direct application of the ideas developed in social anthropology by Hillier and Hanson (1984). Sally Foster (1989) strictly examined the plans of houses using access analysis in her study of Middle Iron Age settlements such as the brochs in Atlantic Scotland. This method depended on identifying thresholds differentiating each area/room from the other, and ideas of possible functions of those areas. This was used to help deduce the possible hierarchy of the rooms and, in turn, the occupants. Both access analysis and Ellison’s approach are rigid and simplistic in their application to studying domestic space. Access analysis, for instance, adopts a rather rigid approach to space, overlooking artefacts that may contribute to an enhanced comprehension of domestic space. Conversely, Ellison’s technique employs artefacts as a proxy for activity areas, which may not necessarily offer an accurate depiction of the nature of the space under consideration.

Parker Pearson and Richards (1994a) built upon two decades of research in their work ‘Architecture and Order: Approaches to Social Space’ by asserting that our relationship with the built environment is rooted in experience. Spaces, or places, are classified and named; they carry narratives, histories, experiences, and values, making them a ‘cultural artefact’ (Parker Pearson and Richards 1994c, 4-5). The authors present the house as a space where symbolism and function blend and unite (Parker Pearson and Richards 1994c, 6-7). Because ancient archaeological houses lack living occupants to interview to help us understand their practices, Parker Pearson and Richards (1994c, 4; 1994b, 41-53) use the distribution of finds, microscopic analysis, and the impact of architecture on movement to reconstruct the social space of the house and its attributed meaning. The construction of ancient houses was influenced by cultural or social customs that are distinct from those of the archaeologists examining them. It is, therefore, crucial for archaeologists to cross-examine the archaeological study of houses with anthropological literature to better comprehend domestic spaces in the past.

In archaeology, the distribution of artefacts within a structure has been frequently used to study and interpret the organisation of domestic space. This has led to the development of various models for the use of domestic space in structures, such as the sunwise model (Fitzpatrick 1994), the centre-periphery model (Hingley 1990), and so on (see a brief discussion of these models below). However, as stated above, this approach has faced criticism because of uncertainty in the temporality of the depositions (e.g., Webley 2007; Waddington 2014) and because the study of site formation processes has revealed the complex ways in which objects and materials enter the archaeological record. One approach that has proven fruitful is the geoarchaeological study of house floors. Soil micromorphology and multi-element analyses are techniques that are used to analyse microscopic remains and the chemical makeup of the sediments of house floors. Soil micromorphology has seen recent broader use in British archaeology in the study of domestic space (e.g., Milek 2006, Milek 2012, Munro and Milek 2020), but the cost of such analysis makes it restrictive to only a handful of samples being taken from specific locations on the house floor (for discussion, see Chapter 8). Furthermore, it is also dependent on floors being present *in situ*. However, when combined with the study of the spatial arrangements of architectures, finds, and features, the geoarchaeological study of the sediments of house floors can produce powerful results.

While chemical analysis of soils and sediments as a method used in archaeology is long established, its specific use for the investigation of domestic space began in the mid-1980s. The primary and dominant chemical analysis that was carried out initially was phosphate analysis (e.g., Conway 1983; Williams 1998a; 1998b). This is because of the useful properties of phosphorus. Phosphorus is present in varying amounts naturally in soils and sediments, but it can be enhanced or reduced due to human or animal activities. It can be introduced (or more accurately enriched) into settlement areas as human and animal faeces and urine, the burial of corpses and carcasses, organic building material such as daub of dung, refuse and as a result of food processing or storage. Phosphorus gets fixed in most soil and sediment types on deposition. Being relatively stable compared to other elements in the soil and sediments and mostly resistant to leaching, it is a suitable detector of past activities.

Phosphorus (P) is the most commonly used element in geochemical studies of archaeological sites. However, few studies (e.g., Wilson *et al.* 2005; 2006a; 2008; Smith and Marshall 2012) have explored other elements in conjunction with P to determine the chemical signatures of different activities. Researchers can now analyse a range of elements, including calcium (Ca), magnesium (Mg), potassium (K), carbon (C), nitrogen (N), copper (Cu), zinc (Zn), and sulphur (S), in order to identify different formation processes in sediments. This type of analysis has been widely used in ethnographical studies of contemporary non-industrial societies in the Americas, such as Mexico, Honduras, and Guatemala, to reveal connections between certain chemical elements associated with domestic activities (e.g., Barba and Bello 1978; Wells and Urban 2002; Terry *et al.* 2004). For example, high levels of Ca in areas around fireplaces, hearths, and ovens can suggest cooking activities. In contrast, high levels of sodium (Na), K, and Mg in areas with wood-ash residue indicate a kiln or hearth. Additionally, barium (Ba), manganese (Mn), and P may indicate organic waste disposal, while lead (Pb) and mercury (Hg) may indicate craft production (Holliday 2004, 303). Thus, multi-elemental analysis can help archaeologists determine the past use of areas in archaeological sites and the possible organisation of house floors (Holliday 2004, 303).

A limited number of studies have thus far conducted multi-element analyses on House floors in Britain (e.g., Wilson *et al.* 2005; Smith and Marshall 2012; Doonan and Lucquin 2019). However, most of these studies have not been focussed extensively on revealing the use of domestic space but appear in publications more as complementary and standalone studies lacking in-depth interpretation of the organisation of domestic space. Given the current context of such studies in Britain, one of the primary objectives of this doctoral research is to evaluate the feasibility of utilising multi-element analyses of sediments from house floors as a method for investigating the occupation of domestic spaces within the scope of British archaeology.

1.2 Sediments and Occupation Horizons

At the core of this PhD research is geoarchaeological analyses, which typically examine both soils and sediments. Hence, it is important to distinguish between soils and sediments as this is fundamental to this thesis. Sediments are not soils. Instead, they are a broader term covering all material seen as layered, unconsolidated materials of lithic and/or organic origin that have been removed from the place they were initially weathered from a rock and redeposited elsewhere by one or more processes; for example, deposits as a result of flooding, hillwash deposits, and wind deposits (Shackley 1975; cited in Banning 2000; Allison and Palmer 1980, 112; cited in Herz and Garrison 1998; Campbell *et al.* 2011, 27). People are also agents of deposition through activities such as terracing, building earthworks or levelling uneven surfaces. Although soils and sediments are a product of chemical and mechanical weathering of rocks and their minerals, sediments are the result of the breakdown of the lithic material and its subsequent redeposition, leading to sediment beds accumulating on top of one another while soils form in place (Garrison 2016, 56). In contrast, soils form through natural processes (see Figure 1.1)

In the history of sediments, i.e., the formation and consolidation of sediments, the four factors involved are the source, transport, depositional environment and post-depositional environment (Garrison 2016, 56). All sediments preserve several episodes of history, and hence, sediments are studied to reconstruct the landscape and understand how it changed over time, especially in archaeology. Anthropogenic sediments are sediments whose specific characteristics are a result of the enduring influence of past human activities.

Anthropogenic sediments are often composed of a mixture of materials, including artefacts, ecofacts, and other cultural remains. House floors are just one example. Archaeologists excavate these sediments to uncover evidence of past human activities. (O'Connor Evans 2013, 40). In the study of anthropogenic sediments, emphasis is directed towards the composition, deposition history, and subsequent alterations post-deposition, while duly considering the material ramifications resulting from human agency (Arroyo-Kalin

2014, 280). Most human activity in the past took place on land surfaces, and these land surfaces are subjected to different actions that alter their characteristics over time. If the modifications or inputs in the sediment as a result of the actions of people are preserved, they lead to detectable differences when compared to natural sediments, as even fairly simple human activities can produce a variety of debris (such as charcoal, bones, ash, pottery, lithic, phytoliths, slag, etc.). Sediments may also be subject to activities like excavation, heaping, winnowing etc. (Arroyo-Kalin 2014, 280). Sediments that remain unaltered but have been relocated by human intervention (such as those employed in platforms, agricultural raised fields, and materials like sand or clay extracted from quarries and transported to different locations), as well as sediments that have undergone modification by humans for the production of artefacts (e.g., clay deposits utilised in pottery, adobe, and mudbrick), among other instances, also warrant consideration within the category of anthropogenic sediments (Arroyo-Kalin 2014, 280).

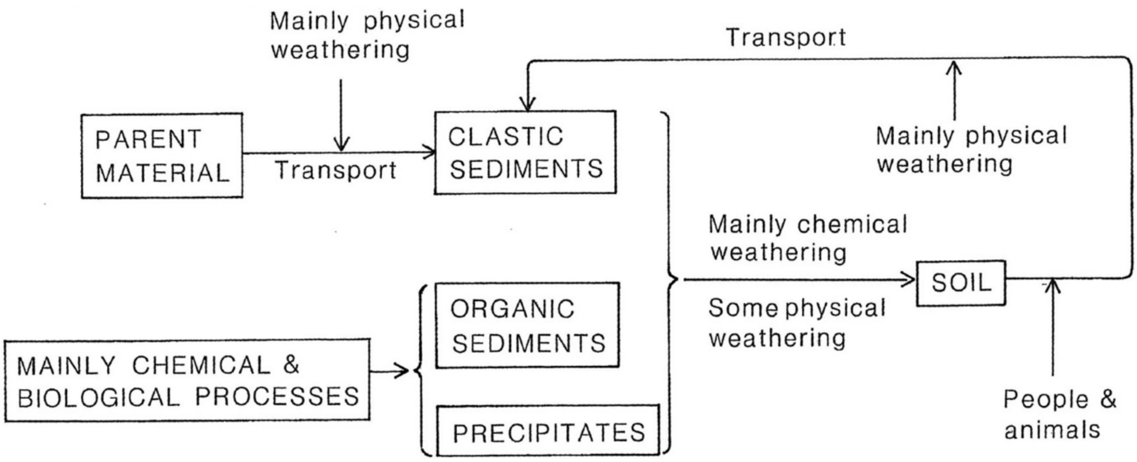

Figure 1.1: The general relationship between soil and different types of sediments (O'Connor and Evans 2013, fig 3.9).

This PhD thesis is concerned with occupation horizons (or layers) or floor layers within structures that are anthropogenic sediments. Occupation horizons, in this context, are a type of living surface. 'Living surface' or 'living floor' is a general term that includes a layer of occupation that suggests a surface indicating use as a house, shelter or camp area which shows signs of human activities such as cooking, sleeping, or working on household tasks. Such surfaces can be located in an open area, cave or inside a built structure (Kipfer 2021, 777;

Holliday 2017, 24-26). It is the living surface within structures such as houses where various daily activities are focussed. These activities make up the anthropogenic soils/sediments on which this PhD thesis is centred. The soil/sediment samples studied in each case study in this thesis come from occupation horizons. Considering this, it is crucial to understand the formation of occupation horizons and their subsequent transformations (until the time of recovery) as part of sampling for analysis.

There are various processes that lead to the formation of such living surfaces in the archaeological record, and it is essential to appreciate or at least acknowledge these processes. Several processes have acted upon these layers. They include all the processes that led to its formation, its use, and until the exact moment it was last in use. They also include the processes that have acted on it since its abandonment until the moment it was sampled for analysis. In his study of the archaeological record, which focused on material culture, i.e., artefacts, Schiffer (1996) studied various formation (and transformation) processes with the following idea:

'Regardless of how much evidence is present, the archaeologist cannot read behaviours and organisation directly from patterns discovered in the archaeological record. However, because formation processes themselves exhibit patterning, the distortions can be rectified by using appropriate analytic and inferential tools built upon our knowledge of the laws governing these processes' (Schiffer 1996, 10).

He identified two types of such formation processes, cultural (c-transforms) and environmental or non-cultural (n-transforms). However, Schiffer first established the various c-transforms and n-transforms that can cause different changes or 'traces', i.e., physical modifications to artefacts. He has categorised these modifications of artefacts under 'four dimensions of variability' (Schiffer 1996, 13-23).

Cultural formation processes

Cultural formation processes or c-transforms are the various processes influenced by humans by which material culture would (or would not) become part of the archaeological record. Equally, it can also be defined as the various processes influenced by humans that lead to the formation of anthropogenic soils and sediments. Schiffer (1987) has classified cultural formation processes into four categories: reuse processes, cultural deposition, reclamation processes and disturbance processes. I will not dwell on these processes here but will instead consider c-transforms which are explicitly relevant to the study of house floors, such as discard processes, primary and secondary refuse disposal, as well as trampling, abandonment etc.

Discard processes are means by which artefacts end up being selected for discarding. Schiffer (1987, 49) elaborates on some of the possible reasons why artefacts get discarded. The discard rate of an artefact can vary even when it is of the same type. Schiffer (1987, 49) uses the example of pottery, where pots employed for cooking tend to last in use for c. six months to a year, while large pottery used for water storage can last for decades and is discarded less frequently. Primary and secondary refuse disposal relates to the deposition location of artefacts in terms of use and abandonment. Artefacts discarded in the area of use are termed primary refuse, while those discarded in a place other than the area of use are termed secondary refuse. Secondary refuse also includes artefacts discarded in areas adjacent to the use location. However, Schiffer (1987, 58) suggests that the artefacts discarded in activity-related areas may also be included as primary refuse. Identifying artefacts as primary or secondary refuse is critical in understanding the artefacts and their contexts and is particularly crucial to the interpretation of house floors. Schiffer (1987, 59) also often refers to the fallacy made by archaeologists that in dealing with artefacts in occupation floors, the artefacts are considered primary refuse. This has led to the function of the area of the floor being defined by the artefacts found there.

Maintenance processes can have a significant effect on the location of the object and the interpretation of the artefacts. Maintenance processes and waste streams refer to an area's cleaning-up activity and the network of stages by which the artefacts end up in secondary refuse. Schiffer (1987, 49) distinguished maintenance processes as ad hoc and regular. While regular maintenance processes are scheduled, ad hoc ones are reactions to breakage or spillage events. The variability in the regularity of the maintenance process is dependent on the rate at which refuse is generated, the frequency of the use of the activity area and the variation in activities performed in that area. Maintenance processes clearly impact the formation of house floors, something which will be considered later in this thesis.

The attitudes towards refuse and their treatment, or different cleaning practices, can also vary from one community to the other. Schiffer (1987, 73-74) explains this, and he uses Hodder's (1982, 62-63; cited in Schiffer 1987) observation of Romany people to illustrate a key point. They keep the inner self symbolically more protected than the outside. With such a distinction between the inner body and the outside, they tend to keep the inside of the caravan, where cooking takes place, spotlessly clean while the outside is covered in litter and faeces. The point to stress here is that different cultures have different cleaning and maintenance practices in the house. Some of these practices might be visible archaeologically, especially when house floors are examined.

Abandonment processes are processes by which an area of activity, structure or a whole settlement is turned into an archaeological context. A de facto refuse deposition is a result of the abandonment process by which refuse such as tools, facilities, structures, and other cultural materials which are still usable are left behind (Schiffer 1972). Schiffer noted that there is marked variability in the de facto refuse. This is dependent on factors such as whether the abandonment was slow and planned, or rapid and unplanned, as well as the available means of transport, the season of abandonment, the distance of the next settlement (or occupation area), the needs for activities in the next settlement, the size of the population moving out and whether there is an intention of returning. Abandonment can also affect maintenance and discard processes. For example, in cases of anticipated abandonment in the immediate future, the occupant of a structure may relax their cleaning standards, and such activities may be undertaken less often or forgone altogether (Green 1961; cited in Schiffer 1987, 97). Equally, refuse may be discarded in areas that may not be the initially intended area for refuse (Stevenson 1982).

Disturbance processes in terms of cultural formation processes are the human-initiated activities by which an unintentional result is the modification or relocation of artefacts and deposits (adapted from Schiffer 1987, 121). These include earth-moving processes and surficial disturbances. Earth-moving processes include the construction of houses and other structures that require digging and relocation of soils and sediments. Along with artefacts, sediments from occupation horizons can get displaced. An example of surficial disturbance is trampling. Trampling is caused by people or animals walking within structures in the course of movement or performing various activities. Trampling results in the compaction of occupation horizons and the downward movement of artefacts and deposits. The downward movement is more pronounced in cases where the surface is softer and not rigid. Such objects trampled into the sediments can alter the chemical composition of the sediments. Furthermore, such trampling may be seen only in specific parts of an occupation horizon where there is a high movement by people (and animals). For instance, it has been observed that lateral displacement of artefacts occurs from heavy trampling areas to low trampling zones (Wilk and Schiffer 1979, Gifford-Gonzalez *et al.* 1985; cited in Schiffer 1987, 127). While Schiffer argues such displacement in the case of artefacts, it can also happen in the case of soils or sediments in the occupation horizon, especially if these horizons are directly walked upon as floors. As a result, it is likely that soils/sediments from an area used for one activity may also have some soils/sediments from an area for another activity. This is a theme that will be returned to later on in this thesis.

Another process that can affect the formation and preservation of house floors is the make-up or construction of a floor that involves an element of scavenging. While scavenging refers to the reclamation of discarded items from primary or secondary refuse for use, in the case of occupation horizons, it can refer to parts of an occupation horizon or the soil/sediments used to create a new horizon. For example, the Hohokam of Snaketown often built a hard floor for pithouses from a calcareous material called caliche which was often scavenged from abandoned houses (Schiffer 1987, 109). Another example of scavenging is the use of secondary refuse to make platforms of structures. For example, the Maya used secondary refuse as a platform for temples (Schiffer 1987, 109). Both examples of platforms made of scavenged material used for making floors will have significantly altered levels of various chemical elements than background levels even before its use. Hence, sediments from such a floor, in terms of chemical composition, would reflect the cumulative effect of activities in the house and the secondary refuse or the scavenged floor material. Similarly, in the instances of structures occupied for a long time, Schiffer (1987, 111) suggests that earthen floors may require frequent repair where nearby refuse deposits that also contain previously deposited artefacts may be used, leading to the relocation of artefacts. Such use of refuse deposits for repairs will also alter the chemical composition, as discussed above.

Another example of surficial disturbance is ploughing. Unlike trampling, ploughing is an activity that can affect artefacts and occupation horizons at any point after the abandonment of a site. Depending on the intensity of ploughing (or preparing the field for sowing), the impacts on archaeology can be varied. It has been found that ploughing can result in the vertical and lateral displacement of artefacts, causing severe problems with the contextualising of artefacts and spatial analysis (Schiffer 1987, 130-131). Depending on the ploughs' depth and the occupation horizon's location, ploughing can also have effects ranging from ephemeral surface scrapes to churning or vertical and lateral displacement of the occupation horizon.

This brief look at cultural transformation processes has shown that various activities, both ancient and modern, can change artefacts and occupation horizons within archaeological contexts. Let us now consider n-transforms which are perhaps more explicitly useful in the study of the formation processes of occupation horizons.

Environmental formation processes

N-transforms or environmental formation processes are environmental processes that alter the artefacts, site, or archaeology. Such environmental factors can have effects that cause an alteration in any chemical or physical characteristics of artefacts or sediments, including weight, shape, colour, surface texture, hardness, tensile strength, and chemical composition (Schiffer 1987, 143). Schiffer (1996) identified that three important environmental factors affect artefacts post-deposition. They are the nature of the environment, the agents of deterioration present in the environment, and the rates and cycles of deterioration. The nature of the environment refers to the location of the environment, such as urban, rural, forest, wetland, dryland, and so on. Each type of environment has its own characteristics that can lead to the preservation or deterioration of the artefact. The nature of the environment is also equally responsible for the preservation or deterioration of the various materials that make up occupation horizons.

Based on the mode of action, environmental agents of deterioration are classified as chemical, physical and biological agents (Schiffer 1996, 143-198). Chemical agents are ones that are responsible for initiating chemical reactions that can alter artefacts or soils/sediments. There are various chemical agents in the sediments that can cause them to be acidic or alkaline, depending on the location and atmosphere. Furthermore, the nature of the soil or sediment and environment in terms of dampness, temperature, and proximity to the coast can further accelerate or decelerate the chemical reactions. For example, acidic soils/sediments can dissolve bones, while highly alkaline soils/sediments degrade pollen substantially. Acidic soils/sediments also corrode metal considerably and organic materials. On the other hand, soils/sediments high in salt content (i.e., basic soils/sediments) slow down biological decay agents (Table 1.1, also see O'Connor and Evans 2013, Box 7.1). Yet, over time they can still lead to the deterioration of iron, silver, copper, ceramics, and stone. Thus, they can cause significant changes to the artefacts present in the soil/sediment. However, these same chemical agents can also affect occupation horizons. Along with the survival of any artefacts in the occupation horizon, the alteration of the chemical composition of the soil/sediment depending on the activities that took place on the horizon will depend on the pH level of the soil/sediment. Although chemical signatures of activities can be seen in varying pH levels of the soil/sediment, extreme acidity or highly basic soil/sediment can distort the chemical signatures (Sjöberg 1976, 449).

burial environment	*main soil and sediment types*	*some typical situations*	*environmental remains*
acid, pH usually <5.5, oxic	podzols and other leached soils	heathlands upland moors some river gravels	charcoal and other charred plant macrofossils pollen and spores phytoliths diatoms
basic, pH usually >7.0, oxic	rendzinas (but can be acid in the topsoil) lake marls tufa alluvium shell-sand	chalk and limestone areas valley bottoms karst machair	charcoal and other charred plant macrofossils mineral-replaced plant and insect remains[1] molluscs bones ostracods foraminifera parasite eggs[1] pollen and spores (rarely)
neutral to acid, pH 5.5–7, oxic	brown earths and gleys river gravels alluvium	clay vales and other lowland plains	charcoal and other charred plant macrofossils mineral-replaced plant and insect remains[1] bones molluscs parasite eggs[1] pollen and spores
acid to basic, anoxic (anoxic conditions can be patchy and unpredictable)	peats and organic deposits, eg lake sediments and alluvium gleys	some well sealed stratigraphy, including organic urban deposits wetlands river floodplains wells wet ditches upland moors	charcoal and other charred plant macrofossils waterlogged plan remains insects mineral-replaced plant and insect remains[1] molluscs bones ostracods foraminifera pollen and spores diatoms wood parasite eggs[1]

[1] *Parasite eggs and mineral-replaced plant and animal remains survive in a range of very local conditions that are difficult to predict.*

Table 1.1: Preservation conditions within soils at varying pH levels (Campbell *et al*. 2011). The reader may find this table helpful when the case studies are analysed in chapters 5-7.

Physical agents of deterioration are the ones that affect the formal properties of artefacts and soils/sediments, such as weight, shape, size, hardness, colour, and chemical composition (Schiffer 1996, 148-149). The physical agents include volcanoes, earthquakes, landslides, floods, and other natural disasters. Water in various forms is another physical agent that affects artefacts and occupation horizons. For example, drainage of rainwater in poor drainage areas can lead to erosion of artefacts and occupation horizons. Such erosion could lead to the deposition of sediments from one part of the horizon to the other or the complete removal of a part of that horizon (Schiffer 1996, 149). Furthermore, soil/sediment moisture can promote various decay processes in the soil/sediment. Another example of a physical agent is wind. It can lead to weathering of artefacts as well as occupation horizons. The weathering of exposed occupation horizons is a form of erosion. Sunlight is yet another physical agent, as it can cause cycles of short-term expansion and contraction on the surface of artefacts and occupation horizons alike. This can lead to cracks appearing that could lead to further weathering (Schiffer 1996, 148-149).

Biological agents are principally living entities that affect artefacts and occupation horizons. These include bacteria and fungi that can cause the decay of several organic artefacts in the soil/sediment (Schiffer 1996, 149-150). Most organic matter that form part of occupation horizons also undergo decay due to bacterial or fungal action. Plants of various kinds can have varying effects on most physical and chemical characteristics of artefacts and occupation horizons. Plant roots that grow and dig into sediments post-abandonment of a site can cause the movement of artefacts (and part of occupation horizon) from their original position in the archaeological context (Schiffer 1996, 149). Roots can also secrete humic acids that can affect susceptible artefacts. If completely decayed *in situ*, such artefacts can alter the chemical composition of the soil/sediments and lead to distortion in the interpretation of activities in the area if the artefact formed part of secondary refuse and this was not realised. Burrowing animals are another biological agent that Schiffer (1996, 150) describes as affecting artefacts, such that they cause various alterations to artefacts as well as the movement of artefacts and ecofacts between different soil horizons.

Any disturbance process that is caused by any species of the animal kingdom is called faunalturbation. Examples of these include burrowing animals such as rabbits and earthworms that can cause vertical movement of soil/sediment constituents as they churn the soil/sediment. Such disturbance can significantly drive the mixing of two different occupation layers and mainly cause the blurring of boundaries between two different layers. Suppose birds or animals use decaying houses or other buildings soon after their abandonment as nesting areas. In that case, this can introduce various organic matter in the floors in the form of food brought in or animal/bird droppings. Such organic matter can significantly alter the chemical composition of the sediment (for further reading, see Schiffer 1987, 207-210), and such abandonment processes should also be considered when house floors are analysed.

Floralturbation is another form of a non-cultural transformation process that is mainly the disturbance process that is primarily the result of the root action by living plants. The root of trees can cause various changes to the physical characteristics of an occupation layer by the pressure it can exert if it grows in such a layer. After the death of the tree, the root may decay entirely and leave a void in the occupation horizon, which could be filled by the downward displacement of the deposits. Plants, by root action, can also cause upward or downward movement of various chemical compounds in the soil/sediments, altering the composition. One such example is that of phosphates. Growing plants can intake phosphate from the soil/sediment through their roots, and on death and decay, such phosphate is returned to the soil/sediment but at a higher/surface level than the original occupation horizon underneath. This can lead to a vertical displacement of the total phosphorus in an occupation horizon, reducing the phosphorus level in the horizon (Bethell and Maté 1988; Brady 1974).

Another disturbance process that can affect an occupation horizon is the freeze-thaw action due to the seasonal temperatures of the local weather. This is called cryoturbation. Such a freeze-thaw action has been found to cause upward movement of artefacts and soil/sediment particles generally. However, in wetter soils, it has been observed to cause the downward movement of soil particles (Wood and Johnson 1978, 343; also cited in Schiffer 1987, 213). On the other hand, soils (also sediments) with high clay content have also been seen to show similar effects as cryoturbation due to the shrinkage and swelling of such soil/sediment and leading to the upward movement of larger particles like artefacts and stone in the movement between dry and wetter weather.

All the various processes discussed here are activities or phenomena that affect the formation of an occupation horizon during its use (i.e., leading to its formation) or since the exact moment of its abandonment. However, various geological processes lead to the formation of soils/sediments, which act as a parent material for anthropogenic soils, but it is beyond the scope of this thesis to explore.

Although Schiffer's (1987) ideas on the formation processes of the archaeological record have been heavily drawn upon, his focus has mainly been on artefacts and their survival. However, all the formation processes discussed by Schiffer (1996) that affect artefacts/material culture are also highly relevant to the study of house floors. This supports the idea that occupation horizons behave in a similar manner to material culture and hence could be considered a part of material culture within the discourse of archaeology.

Earlier in this chapter, occupation horizons were defined as a living surface or floor indicating use as a house, shelter or camp area which shows signs of human activities such as cooking, sleeping, or working on household tasks (Kipfer 2021, 777; Holliday 2017, 24-26). The various formation processes discussed here have highlighted the need for caution in drawing interpretations from house floors and their associated objects without accounting for the various factors that may have affected them. It is for these reasons that caution has been taken in selecting well-preserved houses with deeply stratified house floors for analysis within this doctoral research.

1.3 Aims and Research Methodology

The overarching goal of this doctoral research is to scrutinise the feasibility of implementing the technique of multi-element analysis as a tool for interpreting archaeological house floors derived from diverse structures in Britain. For this, three well-preserved buildings were targeted, spanning three different periods from western Britain (Early-Middle Iron Age, Late Iron Age and Middle Norse period). The research endeavours to address a number of critical inquiries, including whether discernible patterns in the use of internal space within excavated houses can be identified based on the multi-element analyses of the constituent sediments that comprise the floors; whether there are any temporal and/or geographic variations in the utilisation of domestic space and corresponding chemical signatures, evidenced by the observed patterns; whether it is feasible to develop a repository of chemical signatures that can be linked to specific functions within particular areas or features of the house floors; and, finally, whether the observed patterns conform to the existing theoretical models of domestic space documented within the extant British archaeological literature.

These questions were addressed by subjecting the samples collected from the house floors of the three case-study sites to multi-element analyses using a Total X-ray fluorescence spectrometer (TXRF) at Environment Centre Wales, Bangor University, with the guidance of Prof Davey Jones and Sarah Chesworth. For further details on the methodology employed, see Chapter 4.

1.4 Case Studies

The case studies chosen specifically for this study belong to a broad span of periods. This was mainly to check the applicability and versatility of geochemical analysis across different periods. Three houses from three sites in Atlantic Britain were chosen for their excellent survival of house floors. These include an Early-Middle Iron Age house at Meillionydd in Northwest Wales, the Late Iron Age (Scottish) cellular house from Orosaigh in South Uist, the Outer Hebrides in Scotland, and another Middle Norse longhouse from Bornais, also in South Uist, Outer Hebrides. The main criterion in choosing the sites was the excellent preservation of occupation layers inside the houses. Aside from Bornais, these sites allowed the author the opportunity to visit the sites and excavate and, where possible, collect samples directly, ensuring that sample collection was carried out precisely and using the techniques established by English Heritage (Historic England 2015; see Chapter 4). All three analyses were conducted during the post-excavation phase of various projects and prior to publication. It is hoped that the analyses presented here will be included in the forthcoming excavation monographs. I will now provide a slightly lengthy introduction to each case study to explain the rationale for choosing them.

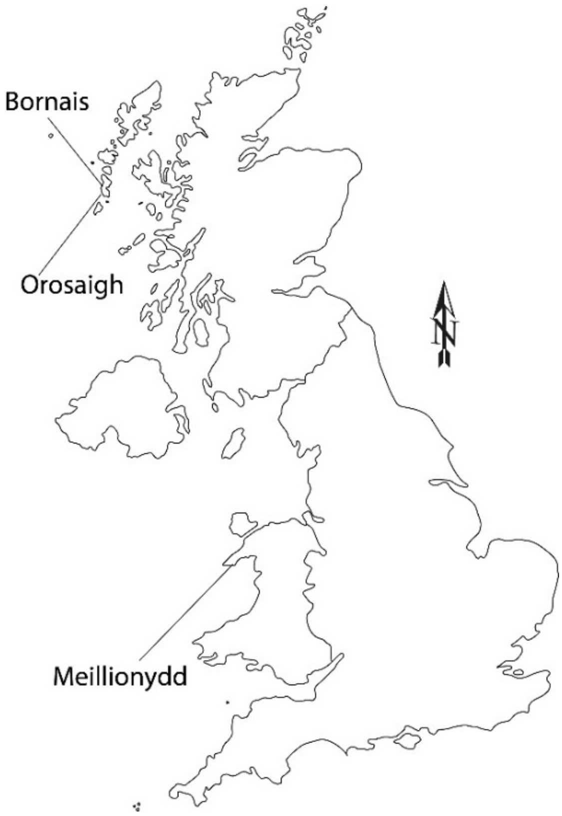

Figure 1.2: Location of the three case study sites. For higher-resolution location maps, see Figures 5.7, 6.7, and 7.5.

The first case study is a Middle Norse-period house at Bornais, South Uist, the Outer Hebrides, Scotland (see Chapter 5; see Figure 5.4 for a photograph of the house; Sharples and Davis 2020a). The rationale behind choosing a Norse period case study was that there are better ideas of the use of domestic space in Viking longhouses than in the other two case studies due to some ideas from the Viking sagas. Furthermore, Viking longhouses tend to be better studied and have been recorded to be rich in finds, at least in comparison to the previous case studies. While Norse houses are generally well-researched, the ones in Scotland are not well understood as the number of modern and complete published excavations is limited. Norse houses have complex histories, being frequently reconstructed and occupied in multiple phases. Additional structures, including outbuildings, byres, barns, and smithies, are also present, with some coastal sites featuring *nousts* or boathouses for easily accessing boats. The longhouse at Westness in Rousay, Orkney, is a prime example of this (Graham-Campbell and Batey 1998; Hall 2010, 20). However, the understanding of Viking-age houses in Scotland also remains limited due to several other factors, including poor preservation of some buildings constructed on acidic soils/sediments, which destroy archaeological assemblages. Nevertheless, Scotland's stone building tradition has helped preserve some structures, and excavations conducted on alkaline soils/sediments have yielded extensive assemblages from both floors and middens.

The domestic organisation of some longhouses in Scotland has been examined based on structural features present in the building and the distribution of artefacts within. One example is an early Norse house located in Jarlshof, Dunrossness, Mainland Shetland (Hamilton 1956). It is argued that the primary entrances separated the house into a living area and a kitchen area. Two rows of post holes divided the living area into three aisles, with benches indicating a sleeping or sitting area along the sides. The central aisle, which contained ash, may have served as a hearth. The kitchen area was elevated and had a central fireplace and an oven adjacent to the back wall. Another example of a Norse house that showed some signs of internal organisation is the house at Underhoull, Unst, Shetland, dating to the mid-eleventh century (Bond 2013). The east end, which had an entrance, was suggested to be a barn, while the central area was deemed a living space with indications of a hearth in the centre on a clay bed (Bond 2013, 159). A similar layout with a long central hearth and a living or sleeping area around it was observed in another Norse longhouse at Skaill, Deerness, Orkney (Buteux 1997). However, two longhouses at Cille Pheadair, near Bornais in South Uist, were studied using a geochemical study. Here the analysis combined assessment of the spatial distribution of phosphorus, structural layout, and the artefacts (Parker Pearson and Brennand 2018a; 2018b). Both houses (House 700 and House 500) offered a better understanding of the organisation of these houses (see Chapter 5).

House 2 at Bornais gave a unique opportunity to study a Middle Norse longhouse using multi-element analyses. House 2 was part of the settlement at Bornais, in South Uist, Outer Hebrides (Sharples 2020a). It was built between the 11th century AD with a semi-subterranean design and well-preserved quarried stone walls still standing up to 1.3 m high in certain places. It had a sub-rectangular shape and was over 19 m in length with a width that narrowed from

5.8 m to 3.8 m at the west end. The house had a short occupation period of up to 50 years and yielded an array of material culture (Sharples and Davis 2020a). Along with the rich finds assemblages, it had well-preserved floors. While spot samples for geochemical analyses were collected, the floor was also sampled for wet sieving along a 1 sq. m grid. These sediment samples were processed, and the coarse residues and flots provided a wealth of information relating to the floor's use, as revealed in the recently published excavation report (Sharples 2020a). However, the geochemical sediment samples were yet to be analysed, proving to be an ideal sample set to be analysed as part of this PhD. This case study not only presents and interprets the result of the geochemical analyses but also re-analyses the rich number of artefacts and the coarse residues and flots. This helped create a possible model for the internal organisation of this Norse house.

The second case study explored relates to the Early-Middle Iron Age stone roundhouse at Meillionydd, which is located on the Llŷn peninsula near Rhiw in Northwest Wales (see Chapter 6). During the excavation of this house in 2013, samples were taken from the entire floor on a 0.5 m grid for phosphate analysis. Initially, these samples were analysed for total phosphorus using a TXRF spectrometer as part of the author's MA thesis (George 2017). However, this research was later expanded on during doctoral research to include a multi-element analysis of the samples. The aim of this research was to test whether the approach could verify some of the spatial models which have been proposed for later prehistoric roundhouses.

Roundhouses in Britain, notably in southern Britain, have been studied extensively in terms of the internal organisation of domestic space. These structures are often interpreted as homes and as permanent residences suggesting a place of daily activity. However, it has also been suggested that later prehistoric roundhouses have symbolic significance and that the buildings were a physical analogy of wider cosmological schemes. Among the models proposed for the organisation of internal space are Hingley's (1990) centre-periphery division of internal space, and the Sunwise model, which is a cosmological model based on the movement of the sun around roundhouses with eastern and southeastern facing entrances (Fitzpatrick 1994; Parker Pearson 1999; see also Oswald 1991; 1997).

The primary data used to develop these models have often been the structural remains or the artefacts found within these houses and their location on the house floors. For example, the centre-periphery model suggested a distinction between the central and peripheral areas of the roundhouse such that the central area containing the hearth was used as an active area for daily activities while the peripheral area was for passive activities like sleeping. Hingley's (1990) idea for such a division was based on double-ringed roundhouses in southern Britain and stone roundhouses (brochs or wheelhouses) in northern Britain. Another example is the development of the sunwise model by Fitzpatrick (1994), which was mainly based on the distribution of finds within the roundhouse at an Iron Age settlement in Dunston Park, Berkshire. Fitzpatrick (1994) used the finds distributions to suggest a left-right distinction in the use of space, such that the left side was the living area, and the right was the sleeping area. Although structural evidence for hearths or any evidence for cooking activities is absent, the observation of spreads of burnt flint and fired clay was used to indicate a cooking area in the house. He further suggested that there is a structured social space within the roundhouse, which is based on the arguable left-right distinction observed. This apparently also incorporates a reference to cosmology if the orientations of the entrances of Iron Age roundhouses are also considered, which in this case was towards mid-winter sunrise, i.e., facing southeast (Parker Pearson 1999; Figure 1.3).

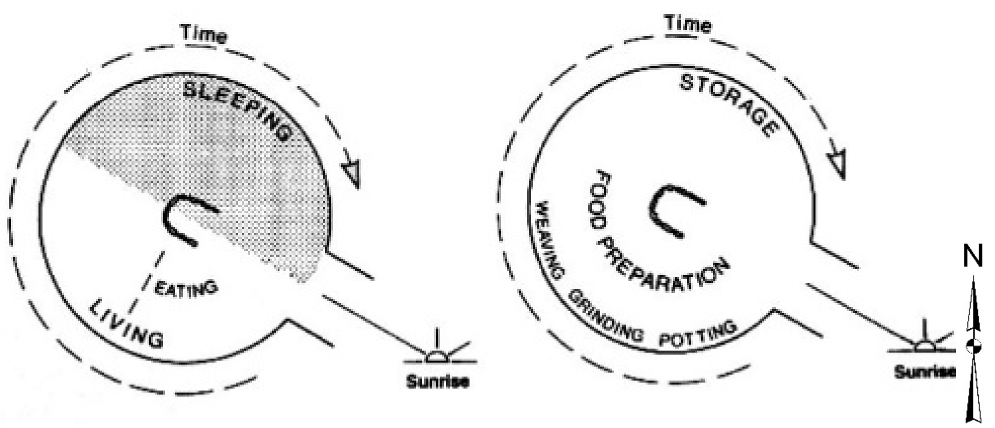

Figure: 1.3: The cosmological model based on interpretations suggested by Parker Pearson (1999) and Fitzpatrick (1994) (Pope 2007, fig. 1).

Although later prehistoric roundhouses and settlements have been studied in Wales (e.g., Ghey *et al.* 2007; Waddington 2013), very few studies have explicitly focused on investigating the internal spatial organisation of roundhouses. Roundhouses in Northwest Wales are not generally suited for depositional studies because of the deficiency of pottery and organic finds due to the Iron Age aceramic traditions and the acidic soils/sediments. However, several stone roundhouses in Northwest Wales, mainly in enclosed or elevated sites, tend to have well-preserved floors because they are built in terrace cuts which protect the floors. Such well-preserved floors make them ideal for geochemical studies, which help reveal information about the use of internal space and daily life within such roundhouses.

The roundhouse SO19 at Meillionydd proved to be an excellent candidate to test the application of multi-element analysis on its usefulness in the interpretation of the spatial organisation of roundhouse floors in Iron Age stone walled roundhouses in Northwest Wales. The house is located in Meillionydd, which is a double ringwork hilltop enclosure (also classified as a small hillfort) on the Llŷn peninsula in Northwest Wales. Roundhouse SO19 had preserved upstanding walls 0.4 m high and an internal diameter of 7 m and was termed a 'guardhouse' due to its location next to the outer bank entranceway (Figure 1.4). This house had a drainage system connecting most of its floor and an internal ring of postholes that likely supported a conical roof or possibly another floor. The occupation layer, which accommodated a hearth, was well preserved under an abandonment layer of silt and rubble which infilled the building. Based on the radiocarbon dates from the hearth, the occupation layer, and the drain, Waddington *et al.* (in prep) claim this floor and any associated features belong to the Early-Middle Iron Age (c. 470-350/300 cal BC).

Figure 1.4: Photograph of RH SO19 taken facing northeast showing the excellent preservation of the walls keeping the floor protected from ploughing.

The analysis of this house floor revealed patterns that suggested that particular areas may have been reserved for specific activities such as cooking, food processing, storage, sleeping, and daily activities. This study demonstrated the possible advantages of the multi-element study, which was tempered with the results of the previous study (George 2017). As a result, a new tentative model for the use of internal space in the Iron Age roundhouse has been created.

The final case study investigated the floor layers of a Late Iron Age stone-walled cellular house on the islet of Orosaigh in South Uist in the Outer Hebrides (see Chapter 7; see figure 7.7 for a photograph of the house). This case study gave a fortuitous opportunity to have multiple occupation layers lying on top of each other to be analysed. The house here was a three-celled cellular structure that had well-preserved floors that were protected by a rubble abandonment infill and upstanding walls that were c. 0.9 m in height in certain places (Sharples forthcoming). In the largest cell (Main Room A), two layers of occupation were detected, whereas three occupation layers were observed in the neighbouring middle cell (Cell B). Geochemical analysis was conducted on each floor layer using a grid measuring 0.5 m, while sediment samples were obtained from every other metre using a grid measuring 1 sq. m for the purpose of wet sieving. This case study was useful in understanding the use of domestic space in cellular structures in Scotland, as cellular structures are understudied in this context.

A prominent feature of the Iron Age roundhouses in Scotland is their monumental nature. This is seen in the brochs and wheelhouses which characterise Middle Iron Age Scottish architecture. Although it is still debated whether the shift away from such monumental structures began in the 2nd century AD (Henderson 2007, 161) or the 3rd and 4th centuries AD (Sharples 2012e, 19), a rise in the various forms of smaller cellular structures are seen to appear alongside a decline in the construction of brochs and wheelhouses. Cellular structures in Scotland are not only understudied in terms of their internal spatial organisation, but the structures as a whole are also under-researched. This is because they are often excavated as later phases of Middle Iron Age roundhouses, such as brochs, duns, and wheelhouses, particularly in the Outer Hebrides. According to Rennell (2015, 18), this is primarily due to the imposing and visually dominant nature of Middle Iron Age settlements, which often overshadow other aspects of Iron Age studies in the Outer Hebrides.

Initially, cellular structures had diverse plans and were limited by pre-existing architectural forms, such as cells with ancillary rooms filling circular interiors of brochs. Later, such structures were consolidated into characteristic free-standing buildings or independent settlement structures (Sharples 2012e, 19). Examples include Buckquoy (Ritchie 1977), Traigh Bostad (Neighbour and Burgess 1996), and the Udal (Crawford 1986; cited in Sharples 2012e, 19). Cellular structures (or houses) come in different shapes, but all have internal cell divisions. They are seen as successors to Atlantic roundhouses, such as wheelhouses and brochs, and their footprint can be similar to these structures. While there are no dedicated studies focusing on the use of internal space in cellular structures or any wider models developed for the use of such domestic space, some studies allude to models setting out the use of internal space in this structure. For example, the structure with a cellular layout at Eilean Olabhat in North Uist had a series of cells with a hearth off the centre. The largest cell here was suggested to be a living area, while the centre of the structure with the hearth was proposed to be used for metalworking (Armit 1996, 177). On the other hand, the cellular structure at Loch Na Beirgh was suggested to have a front/back division of space such that the central area of the largest cell was the focus of daily activities. The smaller/peripheral secondary cells seem to have been used for storage (Harding and Gilmour 2000). Parker Pearson (2012b, 417) noted the similarity of three-celled plans of the cellular structures at Dun Vulan, the Udal, and Bostadh that included a smaller 'guard cell' adjacent to the entrance that may have functioned as an access control point in these structures. This guard cell led to a circular or oval-shaped room with a central hearth, which then led to a circular backroom.

Due to the scarcity of studies focusing on the use of internal space in cellular structures, the cellular structure at Orosaigh proved to be an excellent case study to help fill the knowledge gap. This structure comprised one large L-shaped main cell (Main Room A) and two smaller cells (Cells B and C). The occupation layers in this house at the time of excavation showed excellent preservation. Unlike the other case studies, multiple levels of occupation layers were sampled for geochemical analysis. Among the internal features of this structure were two identified stone piers in Main Room A and a hearth in middle Cell B, yet no hearth was detected in Main Room A. The geochemical study, while possibly confirming the stone partitions' function, tentatively revealed additional possible partitions and the existence of another hearth, each in Main Room A and Cell B. The resulting interpretive (and tentative) model for the organisation of this house is the first comprehensive model for Late Iron Age cellular structures in Atlantic Scotland.

1.5 Structure of Thesis

The thesis begins with a chapter considering various anthropological and archaeological approaches to the study of domestic space in archaeology. In the case of anthropological examples, this is mainly focused on exploring the governing principles behind the organisation of domestic space in various cultures; for example, those based on social roles and norms, gender, or the idea of the house as a living entity. This chapter then explores the application of such concepts in archaeology. It concludes by suggesting that structured ways of organising space are often visible within houses, though the factors governing this can vary considerably, and they may be dynamic.

Chapter 3 provides an overview of the research context and literature related to geochemical analyses in archaeology. The chapter commences with an explanation of phosphorus and its use as an indicator of human activity in archaeological soils and sediments. It also explores the utility of multi-element analysis and delves into the history of their use in the study of past houses and settlements. This chapter also reviews selected cases where multi-element geochemical analyses have been carried out on house floors in Britain.

Chapter 4 provides a succinct overview of the methodology that was applied to each case study in this research. It outlines the step-by-step process followed, from the meticulous collection of sediment samples to the subsequent laboratory analysis and the presentation of findings in the form of clear and comprehensible distribution plans.

Chapters 5-7 each focus on a distinct case study: respectively, the Middle Norse House at Bornais, the Early-Middle Iron Age house at Meillionydd and the Late Iron Age cellular house at Orosaigh. The rationale for arranging the case studies in this sequence is to begin with Bornais, where we possess the most comprehensive information, including spatial analysis of artefacts and ecofacts, soil micromorphology, and other comparative studies concerning the organisation of Norse houses. Subsequently, we move to the Meillionydd roundhouse, which has ample comparative examples of studies on the organisation of roundhouses in Britain. Lastly, we explore the cellular house at Orosaigh, which is relatively less understood due to the scarcity of comparative studies on Late Iron Age cellular houses as such and their organisation. Each of these case studies is essentially an independent study that begins by contextualising the research area and providing a detailed account of the archaeological sequence of the house and its associated floors. Subsequently, spatial analysis of the chemical elements from the floors is conducted, and the findings are presented and discussed. Finally, an interpretive model of the internal organisation of space within each case study house is presented, drawing on the comprehensive analysis of geochemical data.

The discussion chapter (Chapter 8) has two primary objectives. Firstly, it examines and compares the interpretive models generated for each case study with the anthropological concepts explored in Chapter 4. Secondly, it presents tables displaying the levels of various elements associated with specific activities within each case study and analyses them to identify similar chemical signatures that potentially correspond to particular activities. In conclusion, the chapters provide a discussion of the study's implications regarding the successful application of multi-element analysis in house studies and the possibilities for future research. Chapter 9 is the concluding chapter of this thesis summarising the findings and implications of this PhD research.

CHAPTER 2: THE IDEAS OF HOUSE, HOME, AND DOMESTIC SPACE

2.1 Introduction

'Space is practice (our everyday actions); it is also symbol'

(Parker Pearson and Richards 1994c, 5).

A house and the space within can be described in many ways, and the definition can be subjective to its inhabitants. According to Le Corbusier, a house is a machine for living inside with subordinate material, design, and internal detail for that specific purpose (Le Corbusier 2007). The organisation of the interior space of the house can give ideas about the inhabitants and their social relations within and outside the house. Such an organisation is not just a docile background for social activity, but it is also active and interacts with the inhabitants producing and transforming social relations and structures. This is exemplified in Moore's (1996) description of Marakwet domestic life. According to her, the organisation of spaces results from enacted practices. Considering the nature of resources and power relations, the meaning of such organisations is open to negotiation and renegotiation (Moore 1996, x).

This doctoral study mainly focuses on the application of multi-element analysis to the floors of archaeological 'houses' in Briain, and despite the prevailing trend towards purely empirical conclusions in most published geochemical studies (as discussed in Chapter 3), it also seeks to provide an overview of domestic spaces and houses from various global perspectives, thus underscoring the need for interpretations that transcend the simple demarcation of functional zones within archaeological structures through geochemical analysis. Hence, the main objective of this chapter is to assess how people in different societies view and organise their houses by exploring how the houses are spatially organised while also considering the social reason for such organisations. This chapter will consider how some of the anthropological models or ideas have been applied to the archaeological evidence. Initially, a brief history of the application of ideas from anthropology and other disciplines in archaeological studies regarding the use of domestic space is touched upon. This is followed by an outline of the various ideas behind the concept of home and how it is conceptualised across different societies. To do this, several selected case studies from different societies will be presented to highlight their respective ideas of home and the organisation of internal space. Two recent examples of archaeological studies that have used ideas from anthropology and ethnography in order to suggest interpretations of houses, their use, and how they were conceptualised in these past societies will also be explored.

2.2 Domestic Space and Archaeology

The surge of interest in domestic architecture in archaeology emerged during the 1950s to 1970s, exemplified by seminal works such as those by Adams (1965), Chang (1968), Clarke (1972, 1977), Parsons (1972), and Ucko *et al.* (1972). Notably, Amos Rapoport (1969; 1976), a pivotal figure in the study of domestic architecture and space, contributed significantly, albeit initially from an architectural perspective. Rapoport's seminal work, 'The Meaning of the Built Environment' (1982), introduced the paradigm of 'Environment-Behaviour Studies', further elucidating the interplay between human culture and constructed space. His work in subsequent decades (e.g., Rapoport 1988, 1990a, 2002, 2005, 2006, 2008) has further enriched our understanding of the complexities inherent in human-environment dynamics.

In archaeology, before the 1980s, the construction methods of houses and interpretations of the general function of the structure were the focus, especially in the case of later prehistoric roundhouses. In the early 1980s, two key architectural analyses emerged: proxemics and access analysis, alongside household archaeology. Proxemics, rooted in semiotics, explores how people shape their surroundings and what it reveals about behaviour (Steadman 2015, 14). Notably, Rapoport (1982) extensively leveraged proxemics in the formulation of Environment-Behaviour Studies. Hillier and Hanson's (1984) work in access analysis integrated these fields, allowing archaeologists to decode cultural behaviours from architectural layouts, such as the importance of privacy, boundaries between dwellings, and territorial expressions in communities. The application of access analysis to archaeological house plans is exemplified in the key study of brochs and substantial roundhouses in Iron Age Atlantic Scotland by Sally Foster (1989). By the 1990s, the organisation of domestic space in archaeological buildings such as roundhouses and brochs received strong attention.

The influence of various theoretical stances that have their origins or applications in other disciplines such as sciences, philosophy or anthropology can be seen in archaeology. Since its rise to prominence in the 1960s, processual archaeology has been anchored by one of Binford's (1972; cited in Trigger 1996, 394-395) seminal concepts. This concept posits that alterations within cultural systems across various domains are primarily adaptive reactions to shifts in the natural environment, fluctuations in population pressure, and interplay with other cultural systems (Trigger 1996, 394-395). Consequently, this led to processual archaeology being described as functionalist, which is also typified in the processualist views of White (1959, 8), where material culture is described as 'man's extrasomatic mean of adaptation'. During this era, efforts were undertaken to align archaeology more closely with the natural sciences, resulting in a significant expansion of the scientific methodologies employed within the field of archaeology (Harris and Cipolla 2017, 19). Concurrently, there was a notable rise in the utilisation of geochemical analyses, particularly phosphate analysis (discussed in Chapter 3). Binford (1972) also perceived ethnoarchaeology as a methodological approach to elucidating past human behaviours. He contended that comparative ethnographic studies could unveil a significant degree of regularity in human behaviour. Subsequently, these identified regularities could be leveraged to infer various behavioural characteristics of prehistoric cultures (Trigger 1996, 399). Binford's (1978; 1983) seminal hearth-centred activity model with the debris drop-and-toss zones, based on his ethnographic work among the Nunamiut of north central Alaska, stands as a cornerstone example within the field.

While Lewis Binford led the movement in America, Colin Renfrew and David Clarke were the early advocates of processual archaeology in Britain (Harris and Cipolla 2017, 19). One of the early studies of houses or domestic space in terms of processual ideas can be seen in Clarke's approach (1972, 1979) to the re-evaluation of the site of the Middle Iron Age Glastonbury Lake Village. This was influenced by a theoretical framework that emphasises understanding past societies through the analysis of cultural processes, ecological relationships, and adaptive strategies. Clarke aimed to uncover the underlying dynamics and evolutionary trajectories of the Glastonbury Lake Village and its inhabitants. He re-evaluated 'the kinds of evidence that might be recovered from the spatial relationships involving the site, its artefacts, structure…' and so on, and thus developed an explanatory model for the understanding of this site. His study pushed a settlement model which suggested 14 functional types of space organised into compounds, where each compound was divided based on gendered identities.

However, this Iron Age village model was heavily criticised. The structures which were argued to be organised by activities or gender identities were not all contemporary (Coles and Minnitt 1995). Drawing upon a modified version of Clarke's methodological framework, Ann Ellison (1981) employed the pattern of artefact distribution within settlements from the Middle Bronze Age period to deduce the specific functions of discrete architectural structures. She suggested that 'major residential structures' were for male and female activities, while smaller 'ancillary structures' and 'weaving huts' were for female activities, suggesting a gendered division of those spaces (Ellison 1981). At the Middle Bronze Age settlement at Blackpatch in Sussex, a similar gendered division of structures was also proposed based on the distribution of finds within the houses (Drewett 1982). Although a 'chief's hut' and a 'wife hut' were interpreted, the analysis at this site concluded the settlement to be a 'joint family compound' (Drewett 1982, 342). However, this analysis was criticised as several houses initially analysed were later found to not all be contemporary (Russell 1996). It was also found that there was, more likely, a pairing of major and ancillary structures (Russell 1996).

Emerging in the 1980s as a critical response to processualism, postprocessualism constitutes a significant theoretical framework in archaeology, especially in the study of houses and domestic spaces. Postprocessualism challenged the scientific positivism, deterministic methodologies, and objective analytical techniques that are associated with processual archaeology. Postprocessualism emphasises the subjective nature of archaeological interpretation, the role of ideology, power, and discourse in shaping knowledge, and the importance of individual agency, reflexivity, and symbolic meaning in understanding past societies (Johnson 2020, 111-117; Trigger 1996, 444-452). In Britain, this movement emerged as a result of the work of Ian Hodder and his students in the 1980s (Trigger 1999, 450). Johnson (2020, 111) suggests that postprocessualism encompasses a 'great diversity of viewpoints and traditions'. This postprocessualist movement also saw the integration with other theoretical frameworks that originate from the disciplines of anthropology, sociology, and linguistics. These frameworks include structuralism, structuration theory, and post-structuralism (see below).

Structuralism originated in linguistics through the contributions of Swiss linguist Ferdinand de Saussure (1978; cited in Shanks and Tilley 1988, 99), who conceptualised language as a system of signs and symbols shaping human comprehension and societal interactions. Building on this notion, the French social anthropologist Lévi-Strauss (1968) proposed that each culture possesses an underlying structure or essence, governed by its distinct laws, which people might not consciously recognise. This structure ensures consistency in the cultural expressions emerging from it. Lévi-Strauss (1968) further posited that human cognition is structured by conceptual binaries or oppositions, such as culture:nature, male:female, day:night, and life:death. He contended that while the principle of opposition is a universal feature of the human psyche, each culture selects specific oppositions that can undergo significant variations in their interrelationships; yet the overall system remains consistent. Archaeologists, drawing inspiration from structuralism, propose that material objects found in the archaeological record serve as manifestations of broader human material culture (Johnson 2020, 100). Consequently, it is possible to elucidate and understand the culture from which it originates by identifying the underlying cognitive principles that shape that material culture. For houses, which are a form of material culture, such cognitive rules could also be uncovered in their organisation. In the analysis of historical dwellings, structuralism is exemplified in the survey and analysis of 18th-century vernacular houses of Goochland and Louisa counties, Virginia, USA, by Henry Glassie (1975). He suggested that these houses were designed using a set of fundamental spatial units, to which a system of grammatical rules was applied, resulting in various house layouts (also see Johnson 2020, 100).

While the decades between 1960 and 1980 were described as the 'age of structuralism' (Morris 1991, 402), the influence of structuralism in archaeology was most explicitly seen in the 1980s and onwards. One of the leading advocates of the structuralist approach in postprocessual archaeology was Ian Hodder. This is exemplified in his work examining the similarities in the layout of Neolithic tombs and houses in Europe, where he attempted to infer their symbolic meaning (Hodder 1984). One of the most pivotal studies employing a structuralist framework was also presented by Hodder (1990), where he explored the changing layouts and locations of European houses, settlements, enclosures, and tombs, as well as shifts in associated iconography from the Neolithic period to the Iron Age. He attempted to link the changing patterns to structural modifications in relations which were framed via a set of binary oppositions such as nature:culture, male:female, wild:domestic, outer:inner, front:back, light:dark, and life:death. At the core of this study was the concept of 'domestication of the wild', encapsulated by the term *domus*. Beyond merely denoting a physical dwelling, *domus* encompassed notions of home, familial units, social organisation, distinctions between 'inside' and 'outside' (the latter termed *agrios*), as well as life and death. The evidence suggests that the *domus* concept existed long before the advent of agriculture. Cultivating plants and domesticating animals may not have arisen solely from economic imperatives but stemmed from pre-existing conceptual frameworks. Consequently, there was no Neolithic revolution in the conventional sense; rather, it was a reinterpretation by communities of both familiar and unfamiliar environments (Hodder 1990). Similarly, the significance of the *domus* diminished, though it retained much of its traditional influence, during the later Neolithic period. The focus now shifted towards the periphery, the *agrios*. Spearheaded by individuals engaged in external activities like hunting and warfare, i.e. male-centred, the *domus* disintegrated into smaller residential entities, which eventually coalesced into recognisable nucleated villages, often demarcated by distinct boundaries (Hodder 1990).

An example of structuralist ideas in the study of domestic space in archaeology can be seen in Hingley's (1990) proposed centre-periphery model to differentiate between the central and peripheral zones of later prehistoric roundhouses. In this structuralist model, the central area, illuminated by both natural light and the hearth, served as the 'public' space for communal activities like eating, socialising, and entertainment. Conversely, the darker, more confined peripheral area was designated as the 'private' space for activities such as storage, sleeping, or possibly housing livestock (Hingley 1990, 132; see also Figure 6.20 in Chapter 6). Hingley (1990, 132-133) further posited that this spatial division reflected a broader conceptual binary division in Iron Age societies, encompassing contrasts like light:dark, day:night, culture:nature, cooked:raw, winter:summer, and male:female. The impact of structuralist ideas on the study of later prehistoric dwellings can also be seen in the studies of Oswald (1991; 1997), Fitzpatrick (1994) and Parker Pearson (1999; Parker Pearson and Richards 1994b). They suggested an explanation for the division of domestic space proposing various models/ideas. These have been briefly mentioned in Chapter 1 and are also explored further in Chapter 6. It was these works that led to the development and application of a sunwise 'cosmological model', which was also drawn from ethnographic analogy, and applied to the wheelhouses in Northwest Scotland (Parker Pearson 1999). This model suggested a sun-focused tradition/belief, based around the roundhouse, for about a millennium in later prehistoric Britain (Parker Pearson 1999; Giles and Parker Pearson 1999; Parker Pearson and Sharples 1999, see also Figure 6.19 in Chapter 6). The interior layout of the roundhouse was structured to associate the southern half with 'day' activities and the northern half with 'night' activities. As a result, the sequential flow of activities within the dwelling symbolically mirrored the sun's movement, with daytime tasks such as food preparation and craftwork allocated to the southern half, and nighttime activities, including sleeping and storage, situated in the northern segment (Giles and Parker Pearson 1999, 219). The above two examples exemplify the structuralist school of thought where an archaeologist influenced by structuralism would ask ‘what are the underlying rules governing this structure?... and what do those rules tell us about the way this culture sees the world?’ as noted by Johnson (2020, 100). In terms of the move away from mostly functional or processual ways of studying archaeology, Hodder and Hutson (2003, 72-73) suggest that with structuralism in archaeology, ‘we are no longer bound to the quantification of presences, but we are also drawn to the interpretation of absences’. However, they also acknowledged the missing ‘agent’ in the cultural and historical context in the structural interpretations of archaeology. It may be argued that structuralism often downplays individual agency in favour of structural determinism, where the individual is viewed as largely constrained by underlying social structure and patterns.

One of the seminal works that explores the relationship between architecture and social organisation in ancient societies is the edited volume ‘Architecture and Order: Approaches to Social Space’ by Parker Pearson and Richards (1994a). The book delves into various archaeological case studies to examine how different societies structured their built environments, from prehistoric villages to monumental architectural complexes. Employing interdisciplinary methodologies, the authors in the volume posit that architecture serves not only as a functional construct but also as a conduit for the embodiment and transmission of cultural and social significance within a given society. They critique the contemporary archaeological approaches that merely describe architectural remnants, advocating instead for a more profound comprehension necessitating an exploration of the embedded social and cultural meanings within architectural structures, which encompass elements such as cosmology and classification.

The pervasive influence of structuralism in the volume may be seen in the analysis of diverse examples spanning contemporary and historical societies, including discussions on house forms in the first two key introductory chapters (Parker Pearson and Richards 1994b; 1994c). They assert that architecture transcends mere utility, functioning also as a symbolic manifestation of societal values and power dynamics. The editors caution against deterministic interpretations of architecture, emphasising the limitations of directly inferring social processes from built forms. Still, also drawing upon Giddens’s (1984) structuration theory (discussed below), they highlight the dynamic role of spatial structures as mediators in the production and reproduction of social relations (Parker Pearson and Richards 1994c, 2; Lane 1994). The enduring impact of this key work on archaeology is profound in being a representation of a shift towards more nuanced and interdisciplinary approaches in the study of built forms of the past and social space in archaeology. Consequently, the book still plays an instrumental role in shaping theoretical discourses and serves as a crucial starting point for archaeologists wishing to develop an archaeology able to address questions of meaning, agency, and practice.

Almost as soon as archaeologists were invested in the ideas of structuralism, ideas of post-structuralism also emerged in archaeology. Harris and Cipolla (2017, 26) noted that the post-structuralist approach was a set of hugely diverse philosophical approaches that were influenced by figures such as Michel Foucault (1979), Roland Barthes (1975), Jacques Derrida (1976), alongside others. In the realm of archaeology, this emerged as a transformative notion suggesting that, instead of language (as in the case of structuralism), material culture could be more aptly metaphorised as text. This conceptual shift entailed two primary implications. Firstly, material culture could be interpreted as akin to textual analysis, and by scrutinising the relationships between objects and examining their contextual associations, one could reconstruct the underlying meanings embedded within them. This underscores the paramount significance attributed to context by postprocessual archaeologists in their pursuit to discern meaning from archaeological findings. Secondly, if material culture can be read like a text, then multiple readings are possible, i.e. a multiplicity of meanings or interpretations. Thus, in the post-structuralist framework, language (as seen by structuralists) is a site of struggle, contestation and power relations with meaning/s seen as contingent on context, being negotiated continuously. In the field of archaeology, post-structuralism has also encouraged theorists to examine power dynamics, both within the contemporary professional landscape and in depictions of historical contexts (Shanks and Tilley 1987; Tilley 1990; Leone and Preucel 1992; Shanks 2004). Furthermore, while structuralism tends to minimise human agency (in that human action is governed by social structure), post-structuralism emphasises multiple perspectives, voices, and experiences in archaeological interpretation, thereby acknowledging the role of human agency (which, in turn, affects social structure). However, Trigger (1999, 469) noted that the emergence of post-structuralism reintroduced a focus on structures and forces that may constrain and influence human behaviour and, thereby, countered an interest in agency. In this framework, the individual is perceived as being influenced by a multitude of fragmented structures rather than a singular underlying one (Bapty and Yates 2015, 2). In a similar vein, Bapty and Yates (2015, 6) note that 'post-structuralism is, in fact, heavily dependent upon structuralism, and it is not so much a move beyond as a move through its logic'. Similarly, Gardner (2008, 98) emphasised that post-structuralism introduced greater flexibility to the rules governing meaning, thereby further dispersing the individual and challenging the notion of stable personal identity within a conceptualisation of social life as a fluid discourse. Furthermore, he also suggests that, in both structuralist and post-structuralist approaches, the concept of agency is predominantly overlooked, if not entirely disregarded (Gardner 2008, 98).

It has been suggested that the role of agency has garnered more attention as the discipline of archaeology has moved from processualist ideas to the postprocessual theoretical frameworks of structuralism and post-structuralism. Nonetheless, one theme that is common to all of these is the fixation on the structure:agency dualism that often attempts to deal with them separately (see discussions in Whittle 2003, Chapter 1). Such a dichotomy is addressed and is replaced by a duality in the application of the ideas of structuration in archaeology. Structuration theory was primarily developed by British sociologist Anthony Giddens (1979, 1984). It offers a nuanced framework for the understanding of the interplay between agency and structure in social systems–which, as stated above, are key to structuralist and post-structuralist understandings. An essential tenet of structuration theory is the presumption of the 'duality of the structure'. This implies that all social actions presuppose the existence of structure, while concurrently, structure presupposes action, as 'structure' is contingent upon the regularities of human behaviour (Giddens and Sutton 2021, 192-193; Giddens 1984). Thus, structuration theory posits that social structures are both the medium and the outcome of human actions, continuously shaped and reshaped through daily practices and interactions (Giddens 1984, 25). This dual-structure approach with emphasis on the recursive relationship between social systems and individual actions (Hodder and Hutson 2003, 90), investigates how structures both enable and confine human agency. Additionally, it explores how human agency, in turn, reproduces and transforms these structures over time. In other words, as Baert (1998, 104) put it, 'structures, as rules and resources, are both the precondition and the unintended outcome of people's agency'. Taking this further and looking at the debate in prehistoric archaeology on the ideas of structure and agency, Whittle (2003, 13) says agency cannot be reduced only to individuals, as groups or 'collectives of people may act together' and the effects of their action are contextual. Nonetheless, 'in no situation is it really legitimate to separate agency and structure, since one does not exist without the other' (Whittle 2003, 13). According to Hodder and Hutson (2003, 90), structuration, in essence, is a theory of practice or social action. It must be noted that Giddens (1984) considered agencies and structures to be inherently specific to individual social groups, rather than being shaped by universally defined concepts of power or human capabilities.

Although Bourdieu (1977), who comes from an anthropological background, has had some influence on the structuralist framework in archaeology, his ideas outlining a 'theory of practice' also placed a strong emphasis on human agency. Based on his analysis of the ethnographic study of people's practices in relation to social structures, such as in the case of inhabiting domestic spaces (Bourdieu 1970), he developed the idea of the house as an *opus operatum* or as having or being a 'structuring structure' (Bourdieu 1977, 90). He noted that 'the house, an *opus operatum*, lends itself as such to a deciphering, but only to a deciphering which does not forget that the 'book' from which the children learn their vision of the world is read with the body, in and through the movements and displacements which make the space within which they are enacted as much as they are made by it' (Bourdieu 1977, 90). He attempted to unite structure and agency in a single framework of *habitus* (Bourdieu 1977, 1990). *Habitus* according to Bourdieu (1977, 72) is suggestive of the system of shared cultural dispositions, perceptions, and attitudes within a particular social group acquired through socialisation that shapes an individual's actions and practices. Akin to Giddens (1984), he endeavoured to elucidate, via the notion of *habitus*, how activities characterised as objectively 'regulated' and 'regular' are generated, yet without necessarily emanating from strict adherence to established rules (Bourdieu 1977, 72). In such a framework, individuals of the past, in the context of archaeology, are perceived as influential agents capable of constructing and shaping social structures, while simultaneously serving as manifestations or embodiments of those very structures (Barrett 2000, 65). In practice, agency serves to 'vitalise' structure, concurrently enabling the agent to negotiate the conditions they encounter from an informed standpoint (Barrett 2001, 150). However, the idea of *habitus* and structuration theory have also come under criticism in the context of archaeology. Buchli (1999, 8) has called the ideas as a form of structuralism 'merely replaced by higher-order structuration principles' which are 'just as deterministic and 'pre-wired' as any previous structuralist proposition'. Within this framework, individuals are perceived as creative and self-determining only within the confines of pre-established structuration principles.

An example which draws inspiration from Bourdieu's *habitus* is Alasdair Whittle's (2003, 134-143) exploration of *Linearbankeramik* (LBK) longhouses that unveils their intimate connections with material culture, social practices, and symbolic meanings in Neolithic LBK Europe. Departing from static interpretations, Whittle adopts a dynamic perspective to the house, contextualising longhouses within evolving social dynamics and historical contexts (Whittle 2003, 134-143). He examines the symbolic significance of longhouse orientations, suggesting they reflect broader cultural orientations towards concepts like origins (in terms of migration) or cosmological principles, challenging deterministic readings of house orientations (Whittle 2003, 138). He emphasises the fluidity and multiplicity of meanings inherent in architectural settings, as evidenced by the varying layouts and orientations found across LBK sites, such as those discussed at Bruchenbrücken, Friedberg (Whittle 2003, 136-138). Through analyses of individual longhouse biographies, such as those at Bruchenbrücken, Whittle (2003, 142) also illustrates how social dynamics and historical contingencies shaped the construction and reconstruction of longhouses, highlighting their role as central nodes in social networks, while also underscoring the performative nature of human agency which continually creates and recreates meaning and symbolism within architectural settings.

In thinking about home or house and the organisation of internal space in archaeology, however, there has sometimes been a functional/symbolic divide in the perception of the use of internal space which also has implications in the classification of a structure as 'ritual' or 'domestic'. Bradley (2005, 193-194) noted that such a division in the classification of structures as 'ritual' or 'domestic', which may have stemmed from the structuralist approaches of the 1970s and 1980s, ultimately put their definitions in direct opposition to each other. The predominance in interpretations of functional factors being responsible for the organisation of space stems from a 'common sense' approach towards archaeological data[i]. Although the application of functional approaches is largely due to a perceived 'familiarity' with the domestic record (Brück 1999, 323; Hill 1989), it has been criticised as it ignores the significance of symbolism which is usually embedded within architecture (Barrett 1989, 115; Pope 2003, 46). Symbolic and functional factors in the organisation of space are, in fact, interdependent, and one factor cannot be considered solely responsible for the determination of the organisation of space in past societies. Several societies studied anthropologically were found to integrate or not distinguish between the two factors (Brück 1999, 313, 326). Bradley (2005), through an exploration of several archaeological examples, demonstrates that 'rituals' or symbolisms in the past may very well have been a part or continuation of a 'domestic' sphere and, hence, are not separable from the functional realm. One of the ways he highlights the integration of functionality and symbolism is by suggesting that the 'daily' or functional activity of preparation or service of food may have engendered a repertoire of metaphors in prehistoric societies akin to those associated with the treatment of the dead (Bradley 2005, 207). There are several examples of such integration observed in anthropological studies of the home, and this is demonstrated in the following section, which explores a range of case studies spanning the continents of North and South America, Africa, Europe, Asia, and Australia.

2.3 Ideas of House and Domestic Space

Rapoport (2002) discussed the organisation of space as a fundamental aspect of human behaviour and societal structure. Human groups inherently designate specific areas and structure space differentially, asserting entitlements over segments of it, whether territories, sites, or pathways. This spatial organisation results in a mosaic of groups congregating at distinct locations on the Earth's surface (Rapoport 2002, 469). He noted that while resource utilisation and control may initially underpin spatial organisation, these structures may endure amidst ecological shifts. Hence, spatial organisation provides insights into status, power dynamics, group affiliations, and cultural significance expressed through myth, ritual, and symbolism (Rapoport 2002, 470). Furthermore, Rapoport argues that 'sacred' ideas originally legitimised spatial structures grounded in ecological and resource-based criteria. Rapoport (2002, 470) further suggests that systematic use of space embodies spatial organisation, governed by established rules, lifestyles, and cultural significances. This organisation categorises space, both culturally and socially. Thus, the built environment serves as a tangible manifestation of spatial organisation, rendering abstract concepts of space comprehensible.

As explored above, the organisation of space is not solely physical but also reflects cognitive schemata, which need not always be expressed physically. Spatial domains are characterised by specific nomenclature and established norms dictating roles, responsibilities, and inclusivity or exclusivity criteria. Such demarcations serve as mnemonic devices, reminding individuals of appropriate behavioural protocols (Rapoport 2002, 483). These ideas regarding the house and the organisation of domestic space can be seen manifested in several ethnographic studies discussed below.

While the previous section shows how the various theoretical frameworks have influenced archaeological thought when it comes to the interpretation of the use of domestic space in the houses of the past, it is also noteworthy that all the different ideas and models suggested for such domestic spaces have been also shaped by observations in anthropology (e.g., Parker Pearson 1996, 117; Pope 2007, 217). Although cautious of the use of such analogy in archaeology, Pope (2007, 209)[ii] underscores its importance by asserting that 'only through the use of analogy can we use material culture in the present to interpret human action in the past'. This material culture provides essential evidence, enabling deductions about social interactions, cognitive frameworks, symbolic meanings, and other behavioural facets to be made (e.g., Rapoport 1990b; cited in Rapoport 2022, 488).

Given that the principal material culture under scrutiny in this thesis are the floors of past houses, the subsequent section delves into various anthropological and ethnographic studies, focused on the conceptualisation of houses across diverse societies. In several instances, these studies have highlighted that the notion of a house and the internal organisation of its spaces transcends mere functional considerations. They are frequently shaped by socially constructed factors such as societal roles, norms, gender roles, religious beliefs, and cosmological perspectives. Below, a selection of ethnographic case studies are examined, with the ensuing discussions emphasising the predominant ideas governing the conception of houses and the organisation of internal spaces within them.[iii]

The organisation of house and domestic space, based on social roles, norms and cultural and religious beliefs.

One of the principal ways societies have been observed to organise houses and their internal space is based on their social beliefs and rituals dictated by their culture. Several studies have concluded that cultural beliefs, practices, social values, and traditions strongly correlate to domestic architecture (Kent 1990; Rapoport 1969; Richardson 1989; Staaci and Onder 2015). One of the ways in which social beliefs and values have been seen to manifest is in the roles and the associated status given to households and individuals. Even within a household of related individuals (i.e., a family) residing in a house, the house can be seen to reflect these individual social roles. Such a reflection is seen in the assignment of certain areas within the house for specific social roles. While in some cases it may be seen as a reflection of social roles or norms played out, in other cases, it may reflect the culture's worldview and in others, it is a combination of both. The following examples from Mongolia, northwest and southwest USA, Canada, Greece, Myanmar, China, Japan, Korea, Indonesia, and Mali (West Africa) highlight the division of space inside a range of houses and show how the various social norms dictating the settings in the house often survive the barriers of time, economic factors, environment, and the rise of new ideas from modernisation, in some form or other.

An example of ritualistic or social concerns dictating the organisation of space inside a house is observed in the organisation of the family dwelling called *ger* in Mongolia, which is a round felt tent (Figure 2.1). Until modern times, the family, while also being the main unit of ownership and production in herding, also organised life rigidly in a formal manner which was tied loosely to the old social conditions observed as early as the 13th century AD (Humphrey 1974, 273). In this tent, the floor space was divided into four areas. The entrance faced south. The area from the entrance to the central fireplace was the low-status part, while the area behind the fireplace to the back of the tent was viewed as the 'upper' part in terms of status. A gender-based division further intersected this organisation, whereby the left side of the tent (as one enters) was the ritually pure male side, while the right was the impure female side (Humphrey 1974, 273). These four sections were further divided along its inner perimeter into designated sections for sleeping for people in various social roles and storing various possessions and implements of the different family members. Furthermore, these objects held remarkably close identification to their possessors, and the movement/storage of these objects out of their designated area was considered a sin (Humphrey 1974, 273). While people could move about the tent, they were supposed to sleep, eat, and sit in their designated places. Humphrey (1974, 235) observed that such designation of space made the division between each social category very clear to all. Moreover, even after the socialist revolution took place in Mongolia and a radical change in the organisation of the society and the organisation of space in homes was expected, the old tradition of this rigid floor organisation seems to have continued in one form or the other (Humphrey 1974, 273). This is an excellent example of a structured division of a house that shows the fixed position of functions, ideas, and objects in the house. Such an idea is often seen applied in archaeology, where material culture is used to determine the activity that took place where the artefact was found (e.g., Hingley 1990, Fitzpatrick 1994, Pope 2003).

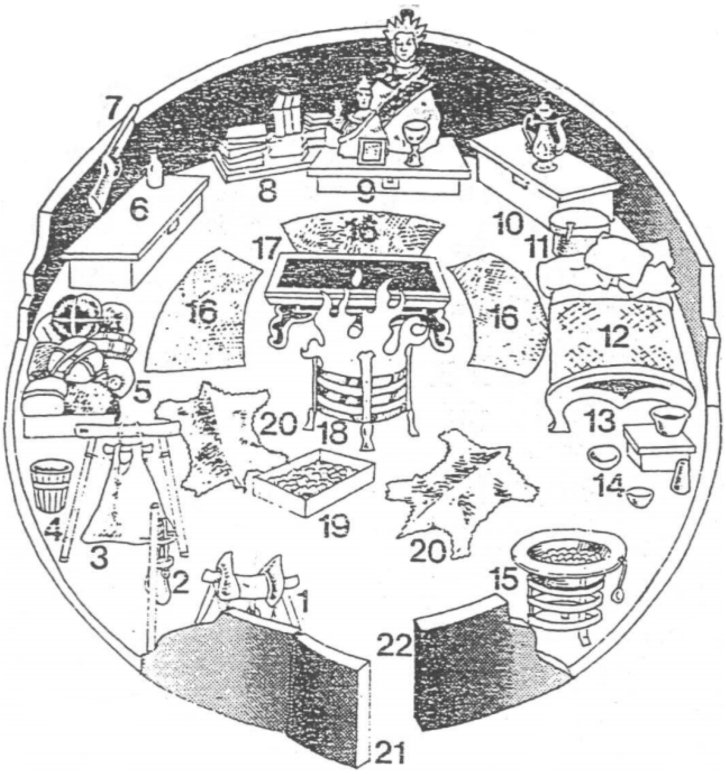

Figure 2.1: A traditional Mongol *ger* showing the fixed positions of various objects and the social roles and associated activities assigned to those positions. (1) saddle, lasso, hobbles; in winter this area might be used for young animals; at night time beggars, widows, old bachelors and ill people might be allowed to sleep here; (2) bridle, halter and other harness hanging on peg; (3) preparation of sour mare's milk in leather bag; (4) preparation of yoghurt; in front of this place sat 'clean' (i.e., having taken a vow of sexual abstinence) old men and women; (5) the place for storing felt, skins, blankets, bought foodstuffs; in front of this sat junior male guests towards the door and middling guests towards the *xoimor*; (6) one or two chests belonging to the male head of the household containing his clothes; footwear and other possessions; the more valuable things in chest towards *xoimor*, less valuable things and sometimes children's clothes in chest towards the door; honoured guests sat in front of these chests; (7) gun and other hunting equipment; (8) Mongol and Tibetan books; a distinguished lama would sit in front of this position; (9) this is the centre of the *xoimor*, which extends to numbers 8 and 10 on either side; the Buddhist altar, with paintings and statues of deities, prayer wheels, offerings, candles, lamps, perhaps holy books; in the chest under the altar were kept the most valuable things, like money, silk, jade snuffbottles, silver cups; (10) chest with valuable things of the wife; in front of this chest sat the male head of the household when receiving guests; his pipe, steel and flint, knife and a teapot might be kept here for him; (11) a box for hats; children of the family sat here; (12) the marital bed, made of wood or felt; at the lower end of it there might be a pen for very young children; this was the place of the mistress of the house; (13) the wife's saddle and bridle were sometimes put here; (14) wooden bowls, plates and stores of food; daughters of the house sat here; (15) cooking pot, brazier stand, ladle, cleaning rag and bunch of grass; the youngest daughter would sit here; (16) felt mats; (17) low wooden table for serving tea and other food; (18) brazier; (19) metal box for dried dung fuel; (20) skins on ground; (21) door, (22) this was the 'lowest' place in the tent and barely counted as being inside it; nothing was put here except perhaps women's boots or dirty underclothes; 'black people (i.e., people who had committed a sin, killed an animal, or were in some way polluted) sat here; dogs sat here if they were allowed into the tent at all (Humphreys 1973, fig 1).

Moving to an example from North America now, the Navajo houses – or *hogan* – in Navajoland, in northeastern Arizona, provide a comparable example. In this society, the *hogan* serves as the main dwelling, representing both a physical and symbolic nexus of the society's worldview (Oliver 1990, 155). Oliver (1990) found that the *hogan* is spatially differentiated through customs based on hierarchy, gender, ritual and symbolic associations (Figure 2.2). While the internal layout may appear undivided, it holds profound symbolic significance for the Navajo. The design elements of the *hogan* are emblematic: the slightly bowl-shaped floor symbolises the Earth, associated with femininity, while the gently concave roof represents the male-dominated sky. The roof is upheld by four posts anointed with sacred pollen. The eastern post venerates the Earth Woman deity, the western post honours the Water Woman of the Water World, while the northern and southern posts are dedicated to the Corn Woman and Mountain Woman deities, respectively. Despite the patriarchal head of the household, Navajo society is characterised by matrilineal and matrilocal traditions, reflected in the prominence of female deities (Oliver 1990, 155). Women's associated tools and implements, such as looms and cooking utensils, are traditionally kept on the southern side of the *hogan*. Storage is integrated into the structure, with belongings often hung on pegs, nestled in crevices, or placed on ledges. Central to the *hogan's* design is the hearth, situated at the centre of the dwelling, symbolising both the nadir and the centre of the world. The primary seat of honour within the *hogan* is to the west, reserved for the patriarch or matriarch of the family, and designated for visiting medicine men or *hosteen* (Oliver 1990, 156).

Upon entering the *hogan*, one circumambulates the hearth in a clockwise direction, or 'sunwise path', and exits to the north. For ceremonial occasions, such as the Beauty Way or Mountain Way Chant, a smooth sand floor is prepared in the *hogan's* centre, typically in the area of the hearth, where ritualistic dry-paintings known as *likaah* are created using coloured earths. Emphasising the centrality of this space, these ceremonies often span several days, culminating with an afflicted individual—often a child—sitting at the centre so that they can absorb the healing energies invoked from the Holy People (Oliver 1990, 156). Upon the death of an occupant, the body is ceremoniously removed through an opening in the north wall, after which the *hogan* is abandoned, eventually succumbing to decay. In death, both the spirit and material essence of the *hogan* are believed to reunite with the earth. Interestingly, Oliver (1990, 156) points out that similar spatial organisational principles can be found among other Native American nations and nomadic *yurt*-dwelling cultures of Asia, including the Turkomen, Uzbeks, Kirghiz of Afghanistan, Russian Kazaks, and various Mongolian tribes. The Mongolian *yurt*, known as a *ger*, is discussed above. The influence of the *hogan* in the development of the structuralist sunwise model for the use of space in British later prehistoric roundhouses can be seen in this example (Parker Pearson 1996).

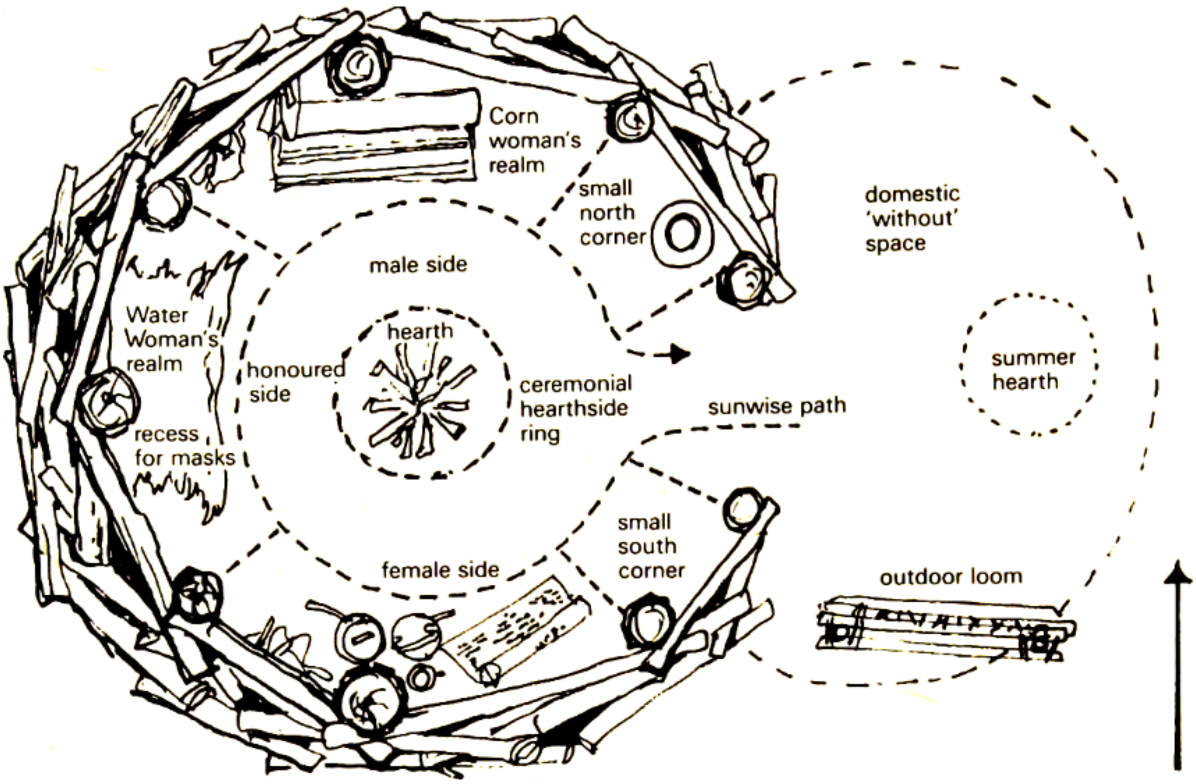

Figure 2.2: The spatial organisation of the *hogan* of the Navajo of North America (Oliver 1990, 160).

Another example of a community placing importance on cardinal directions in the organisation of space, albeit at a settlement level, is the Tewa community. Alfonso Ortiz's (1969) seminal work on the Tewa community of New Mexico in the North American Southwest illuminates the intricate interplay between spatiality and cultural ethos. Central to Tewa spatiality are the cardinal directions, each denoted by a sacred mountain crowned with an 'earth navel', symbolised by carefully arranged stones. The orientations of homes, villages, and shrines often align with or mark the cardinal directions and natural landmarks. The village's sacred centre, situated in the south plaza and demarcated by a circle of stones, further underscores the sacred geography as it represents another earth navel. The four shrines marking the cardinal directions are fashioned from stone piles or singular monoliths, while numerous shrines, including those positioned amidst refuse dumps, house ancestral spirits. The refuse dumps signify artefacts of the past which are considered sacred, linking them to the souls of the sacred past (Ortiz 1969, 20). Historically, the kiva, a communal ritual house, played a pivotal role, with the idea of the earth's navel often situated in the centre, epitomizing the intersection of spiritual and communal life (Ortiz 1969, 37). Such sacred spaces are governed by stringent cultural protocols and taboos, reflecting Tewa's emphasis on communal living and resource-sharing. The layout of villages and dwellings mirrors this communal ethos, fostering social cohesion and collective identity. Spatial arrangements and alignment with cardinal directions and natural features signify a harmonious rapport with the natural and spiritual realms, grounding Tewa spatial practices in a holistic understanding of existence, reflecting Tewa cosmology and worldview. A similar concern to reference cardinal directions and sacred landscape features, in the case of structures such as temples and, at times, houses, can be seen in Bali in the work of James (1973).

One of the ways in which social beliefs and values are expressed in society is through religion. An example of a traditional household intertwined with central religious practices, reinforcing community cohesion, and serving as a foundational element of cultural and religious identity, can be seen in Greece (Pavlides and Hesser 1989, 292). In both Eressos and Epidaurus, the entrance to Christian Greek houses serves as a focal point for ritual activity, embodying a symbolic threshold between the sanctuary and the protection of the household within from the potentially hostile external world (Pavlides and Hesser 1989, 288). Ritual practices at the entrance often include the placement of a smudged cross beneath the lintel, a wreath of dried flowers adorning the door, and the burning of incense, with the rising vertical column of smoke believed to act as a barrier against malevolent forces, ensuring constant spiritual protection for both the entrance and the interior of the house (Pavlides and Hesser

1989, 288). Within the Greek household, various objects are also strategically displayed to ward off the malevolent influence of the evil eye, a pervasive belief in Greek culture. Objects such as empty eggshells, sea urchins, snake skins, sea stars, blue beads, and strings of garlic heads are commonly employed for this purpose, hung on trees, walls, or above doors to safeguard the inhabitants, the house itself, or specific objects within the household (Pavlides and Hesser 1989, 290).

The spiritual significance of the house extends beyond mere ritual practices at the entrance. The construction process itself is heavily imbued with ritual activity to ensure the safety of both the construction workers and future occupants (Pavlides and Hesser 1989, 291). Furthermore, despite modernisations that have altered the materials, size, interior furnishings, and façade of Greek houses, the sanctity and ritualistic nature of the household persist (Pavlides and Hesser 1989, 291). This view is expressed in the perceived failures of modern house designs in Greece, which are sometimes criticised for a lack of consideration of religious beliefs and practices (Pavlides and Hesser 1989, 292). The Greek houses of Eressos and Epidaurus also serve as noteworthy illustrations of the concept wherein the house is perceived as a powerful entity which safeguards the occupants. Moreover, it underscores the notion that the items contained within the house, rather than merely signifying domestic activity, also serve as indicators of religious and cultural beliefs.

While Greek houses highlight an amalgamation of Christian beliefs and ritual practices within domestic architectures, the fusion of social norms rooted in Confucianism and the principles of *feng-shui* is evident in Korean household designs. *Feng-shui* and Confucianism jointly establish fundamental guidelines for architectural layouts that mirror domestic customs (Lee 1989, 305-312). Confucian ethics prioritise the separation of genders, hierarchical distinctions based on age, and the veneration of ancestors within family dynamics. The adherence to these norms is reflected in the organisation and design of household complexes. For instance, in compliance with gender segregation norms, inner chambers are predominantly allocated for females, while areas closer to the exterior are designated for males and household servants. On the contrary, Songju-nim, revered as the paramount deity in traditional residences, is typically positioned atop a ridge beam spanning the ceiling of the central living area, *maru*, within the house (Lee 1989, 311). Given that the main hall primarily pertains to men, particularly the head of the household, the deity is dedicated to this space. Consequently, both the room layout and the overall architectural plan are intertwined with Confucianism's social norms within the household *feng-shui* framework (Lee 1989, 305-312).

Some house organisations can be dictated by other social constructs and norms. For example, until 1885, Burma (Myanmar) was highly class-conscious, and the kinds of houses people were allowed to have (no matter how wealthy) were dictated by their class. For example, low-status houses were not allowed to have carved decorations on the doorjambs and window frames (Thanegi 2012, 91). Furthermore, with elephants being exclusively ridden by the nobility, non-noble houses would not have an open side on the outside platform, which would typically be used for stepping onto the elephant's back (Thanegi 2012, 91). However, apart from these rigid distinctions, the houses' layout was similar from nobility to low-status houses. The designs and functions were dictated by the religious and cultural norms of Burmese life. This included entertainment accompanying celebration, the importance of shrines, and beliefs about women's menstrual cycle (Thanegi 2012, 91). In nineteenth-century Burmese houses, the main rooms were a family room, shrine room, parlour and show-watching gallery, bedroom, birthing room, kitchen, strong room for cash and valuables, and storeroom. Servant's rooms and stables were under the house by the coolest corner with an attached groom's room (Thanegi 2012, 91).

The shrine room was the most important room in the house and displayed images of Buddha made from any of the various materials, such as gold, silver, bronze, marble, wood, or clay, with food offerings in front of it. However, in houses where a separate shrine room could not be afforded, an image and offerings were placed on a stand tacked high on the southern wall of the house. The show-watching and parlour rooms were two sides of a large room which could also be used as a large parlour. Family and guests would sit in the show-watching room to watch dance performances staged during family celebrations such as an engagement or wedding, the noviciation of sons, ear-borings of a daughter, commemorating a promotion etc.

(Thanegi 2012, 91). Gender was also observed to dictate the organisation of domestic space in some cases. For example, the birthing room was a room without windows and was off-limits to men (Thanegi 2012, 91). However, it is noteworthy that Burmese society is strongly matriarchal, and women hold prominent positions, such as heads of administration, and enjoy equal rights pertaining to inheritance and property division after divorce. The parlour would usually be used for family meals, with the oldest person or the head of the household being served first by the servants. The toilet was a bamboo or wooden hut over a deep hole in the ground at the far end of the backyard (Thanegi 2012, 93). Such traditional houses, although mainly prevalent in the nineteenth century, are still visible in rural areas. The difference in such houses today is that instead of being set on high platforms, they are built on stilts with a veranda that is called 'slipper-leaving space' reached by wooden stairs. The shrine occupied a place of pride inside the house, and just one room is walled to store bedding and private dressing. There is a bamboo or wooden platform under the house where casual visitors are received and used by the family to rest or do light work in the afternoon heat (Thanegi 2012, 93). This demonstrates how even with the passage of time, the traditional ideas of a structured division of internal space for various activities in Burmese society continue in one form or the other, highlighting the importance of social norms and the organisation of domestic space in such societies. This is also a good example of how the house's layout has certain universal components irrelevant to economic factors and new ideas.

Examining Chinese rural housing reveals a nuanced interplay of cultural, environmental, and social influences (Knapp 1986). Despite a shared architectural heritage influenced by cardinal directions and religious concepts, rural homes adapt to local landscapes and societal needs (Knapp 1986, 52). This adaptability results in a diverse range of dwelling types, reflecting China's vast territory and cultural diversity. Rural houses typically feature rectangular layouts, emphasising horizontal space even in multi-storey structures, with symmetrical front elevations (Knapp 1986, 51). These homes are built with an additive approach, guided by principles of hierarchy, shaping spatial organisation and social interactions. Thus, vernacular Chinese architecture serves as more than just shelter; it expresses shared cultural values.

The diversity of rural housing extends to various building plans, including rectangular, round, and U-shaped designs, as well as larger enclosures and cave dwellings. In northern China, homes typically adopt a one-storey rectangular layout, with an east-west orientation for optimal solar exposure. These dwellings, known as the 'one open, two closed' type, consist of three bays, featuring bedrooms flanking a central utility area with a symbolic brick stove (Knapp 1986, 29). Southern Chinese houses, on the other hand, vary in size, layout, and style to adapt to different landscapes and climates. In regions like Fujian, rectangular dwellings with three to five bays are common, often featuring second stories or additional side buildings. Enclosed within walls for protection, these homes maintain an open interior layout organised around a central courtyard, reflecting principles of spatial hierarchy (Knapp 1986, 51). Despite regional differences, a common layout focusing on a central area surrounded by functional rooms is evident across northern and southern Chinese homes. This layout, with local adaptations, is also observed in earth-sheltered dwellings of northwestern China, demonstrating how social considerations can shape architectural forms while functional needs vary by region (Knapp 1986, 31-39).

Socio-cultural norms reflected in the organisation of houses of East Asia are also visible in Japanese house plans. Japanese houses traditionally had straw-matted rooms called *tatami* and removable paper walls. These walls could be removed to make large and spacious rooms for special occasions. Generally, each room had a cupboard where a futon set could be put during the day. As a result, the rooms would be empty except for some chests of drawers making these rooms multi-purpose (Ozaki 2012, 118). In the early to mid-twentieth century, every house had a vestibule where one could remove one's footwear and store it in a cupboard for shoes. In this era, the most popular house type was the house that had a middle corridor that divided the house between areas for formal use and daily use and between areas for the family and servants. The family living room and the drawing room were on the sunny side of the house, facing the garden. The kitchen, sleeping room, bathroom, toilet, and room for the maid were on the opposite side of the corridor. The bathroom had a few smaller sections for undressing and bathing, while the toilet was separate. Although by the 1990s, *tatami* bedrooms had disappeared as Western-style bedrooms became popular in Japan, a *tatami* room is still seen next to the living room. This room is used as a drawing room for formal occasions or as a guest bedroom at night (Ozaki 2012, 119). It was also observed that, without exceptions, the bathroom and the toilet were kept separate. Furthermore, the bathroom always had two rooms. While one with the bathtub had a space for washing and rinsing oneself, the other was a washing-dressing room where clothes were taken off before entering the bathing area. This washing-dressing area was also the location of the washing machines. Such demarcation still defines the perceived pure and impure areas in the house. Ozaki's (2001) observation also exemplifies that placing the most defiled area, which is the toilet, next to the area reserved for purification, i.e., the bathroom, is inconceivable to the Japanese.

One of the governing norms for such organisation of activities/areas/rooms in a Japanese house is the idea of 'inside vs outside' and 'pure vs impure'. There are several Japanese rituals that keep the 'inside' and the 'outside' distinct. The 'inside' is linked to cleanliness, purity, safety, and intimacy, while the 'outside' is associated with impurity, dirt, and danger (Ozaki 2001, 337-357). Various daily rituals of hygiene are required to be performed to keep the inside of the house clean. For example, when one enters the house, one must remove one's footwear, wash hands, gargle, etc. Every morning people sweep and water the gate, vestibule, and the area between the two, where the inside meets outside. This area, acting as a demarcation between the outside and the inside, requires special care. Ozaki (2012, 117), while suggesting the importance of being clean and maintaining psychological boundaries in Japanese culture, also observed that dirt refers to conceptual and cultural dirt, and physical and visible dirt. Hence, the house must be kept clean to show the purity and the cleanliness of the family that lives inside. Similarly, he suggests that even though there have been considerable Western influences in Japan, houses with washing machines in the kitchen do not sell in Japan for the same purity concerns as the people in Japan do not like to mix 'clean' food and 'dirty' garments in the kitchen, especially as the kitchen is required to be the cleanest area in the house (Ozaki 2012, 119).

The Gerai apartments in longhouses in West Borneo, Indonesia (Helliwell 2006), provide an interesting deviation from the idea of the house or the household as a single entity that can be studied in isolation. Furthermore, it also introduces a different concept of 'inside' and 'outside' in the organisation of the houses, when compared to the Japanese houses discussed above. The Gerai Dayak community, nestled in the northeast region of the Ketapang sub-province in West Borneo, Indonesia, presents a fascinating case study of the intricate interplay between space and social relations within the context of their traditional longhouse architecture (Helliwell 2006, 45). While the longhouse is divided into several apartments, the architectural configuration of each apartment encompasses seven distinct levels (or areas), each delineated based on its *guno nar*, or 'true function'. While any level may serve various purposes at different junctures, the Gerai emphasise the intrinsic function of each level when describing a longhouse apartment (Helliwell 2006, 46, Figure 2.3).

Unlike other Dayak longhouses, the entirety of the Gerai structure, with its multiple apartments, is sheltered beneath a thatched roof, emphasising unity and interconnectedness within the community (Helliwell 2006, 46). Within each apartment, a wall extends from the floor to the roof, segregating the apartment into an 'inner' household area for cooking, eating, and sleeping, partitioned off from adjacent apartments (often inhabited by different family groups), and an 'outer' gallery area left unpartitioned. A door is embedded within this dividing wall made of solid sawn planks, facilitating access between sections of the apartment. The inner section, termed *lawang* (door), is alternatively referred to as *lem rumah* (inside of the apartment), while the outer section is designated as *ruang* (platform, space) or, more commonly, *sawah* (outside) (Helliwell 2006, 46).

While superficially this differentiation into the inner and outer sections resembles a dichotomy between 'private' and 'public' spaces from a Western perspective, closer inspection reveals a more nuanced interpretation. In Gerai, *lawang* and *sawah* do not denote an opposition between 'private' and 'public', but rather between 'inside' and 'outside'. Implicit in this inside/outside dichotomy is a division between the longhouse community (*lawang*) and the external world (*sawah*) i.e. between 'we' and 'other' (Helliwell 2006, 48; 1996, 135).

Furthermore, the association of the outer *sawah* with Malays among the Gerai Dayaks identifies it as a space for 'others', contrasting with the inner *lawang* perceived as 'our' space (i.e., the longhouse community space) (Helliwell 1996, 135). Although the outer area often facilitates community sociability, the 'true functions' of two of its four spaces primarily cater to Malay guests: the *sadau sawah* and the *paléper sawah* (the 'outside' equivalents of the *sadau* and *paléper*, respectively) essentially serve as sleeping and cooking areas for Malay visitors (Figure 2.3; Helliwell 1996, 135).

While the Gerai longhouse contains multiple individual apartments, it also constitutes a unified spatial entity traversable from end to end. Helliwell (1996, 137) notes that focusing solely on a single apartment and describing solely the relationships that unify its seven levels across the longhouse's width would neglect the relationships that unify individual apartments along its length. In spatial terms, these latter relationships are distinctly delineated: neither the seven spaces nor the wall between *sawah* and *lawang* terminate at any one apartment's edges but extend, in identical form, throughout the longhouse's length. Although cross-household ties might seem sustained primarily through casual interaction in the open *sawah* area, they are more frequently and intensely experienced within the enclosed *lawang* (Helliwell 1996, 137). This is because, in formal longhouse layout designs, this partition delineates each apartment's edge, signifying its independent and 'private' character. However, in practice, the partition is constructed of fragile materials such as bark, leaving gaps of varying sizes through which dogs, cats, and small children can enter, and enabling interpersonal communication across different spaces. Thus, this boundary is highly permeable, and it also facilitates an unimpeded flow of sound and light between all apartments constituting the longhouse (Helliwell 1996, 137-138). This continual movement reaffirms to individual households, their status as part of the longhouse and, by extension, the community of neighbours encapsulated within it. Thus, the partitions' flimsiness and permeability enable the creation of community in this manner, a fact of which the Gerai people are acutely aware (Helliwell 2006, 52).

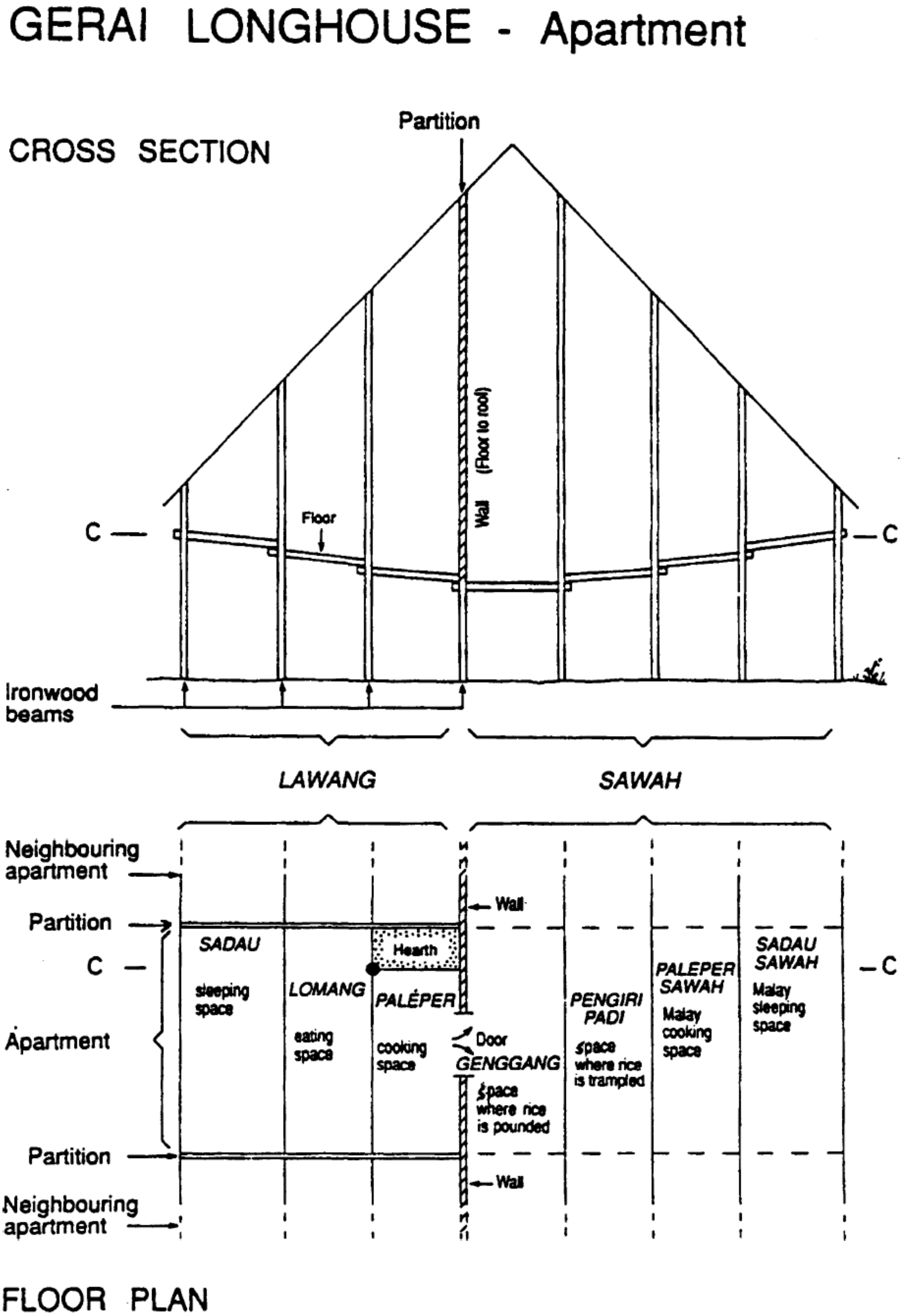

Figure 2.3: Cross-section (top) and floor plan (bottom) of Gerai longhouse-apartment (Helliwell 1996, 132).

The Nuu-chah-nulth (formerly called Nootka) of the Pacific Northwest Coast in Canada also live in multi-family rectangular houses. These large houses have an outwardly ragged makeshift appearance due to the unequal widths in the construction of the walls (Drucker 1951, 70). Near the centre of the house is a large shallow circular depression that serves as the fireplace on ceremonial occasions, and near the corners and along the sides were smaller hearths used by the families occupying the house for daily cooking (Drucker 1951, 71). There are sleeping platforms situated along the side of this longhouse. However, the hierarchy within the household is symbolically reflected in the allocation of living spaces. The titular 'owner' of the house, typically the chief of the lineage, occupies the rear right corner of the dwelling, with the subsequent ranking chief, often a close relative, situated in the opposite corner. Similarly, places of distinction are accorded to other prominent family members, with the corners adjacent to the entrance door, and the central locations along each side, referred to as 'middle places'. These designated areas, numbering four or six (depending on the household's size), are considered proprietary to their occupants, fostering a sense of permanence and familial identity (Drucker 1951, 71).

Conversely, intermediate spaces within the dwelling accommodate kin of lower status, who maintain more fluid affiliations with other lineages and frequently relocate between households (Drucker 1951, 72). Regardless of rank, each family within the communal dwelling possesses their own designated fireplace and sleeping arrangements, typically comprising of a few planks positioned against the wall. Personal belongings, including wooden containers, dishes, and baskets, are arranged around the sleeping platforms. The delineation of family spaces within the communal dwelling is sometimes facilitated by the placement of upright planks between sections or, more commonly, by the positioning of wooden storage chests at the ends of each family's area (Drucker 1951, 72).

Yet another example where multiple families reside in single longhouses comes from the non-agriculturalist society of the Haida. The Haida, a sedentary hunting and fishing community on the northwest coast of North America, represent one of the most socially hierarchical groups documented ethnographically among foraging societies (Whitelaw 1994).

They inhabited large village communities, inhabited throughout most of the year, with populations occasionally exceeding a thousand individuals. These villages consisted of numerous lineage houses, each functioning as a distinct cooperative subsistence unit. The social hierarchy was evident both within and between communities, with social affiliations such as clans integrating different houses into larger collectives (Whitelaw 1994, 234). Constructed primarily of timber and plank, these large houses accommodate up to a dozen or more families who collaborated in collective hunting, fishing, and food storage for consumption and ceremonial feasting. Village house alignments mirrored social rank, with prestigious chiefs' houses flanking either side of the house of the village chief, which occupies a central location in the row of houses.

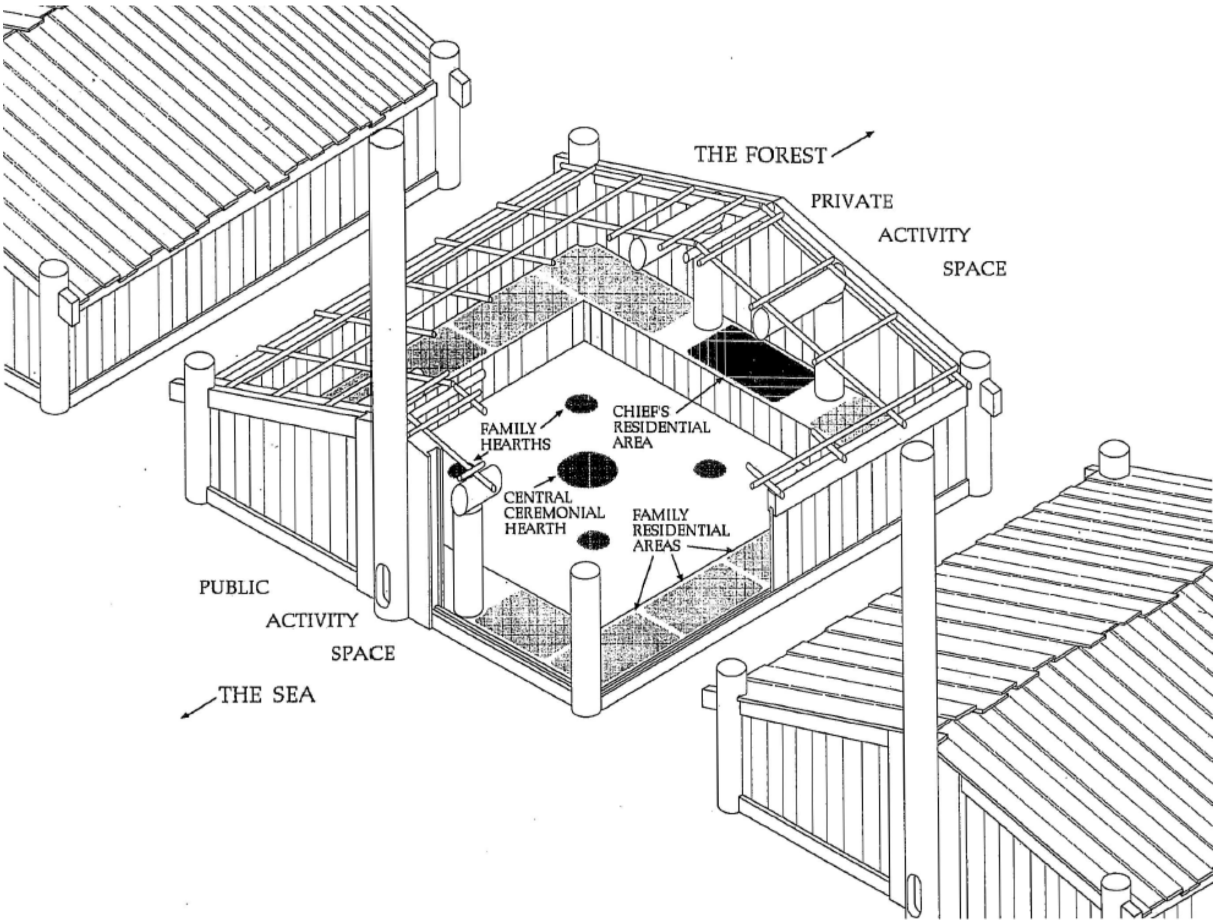

Figure 2.4: A normative model of spatial organisation in the Haida house (Whitelaw 1994, fig 11.9).

Within each house, individual domestic units possessed private spaces along the outer wall, while communal social and ceremonial activities unfolded in the central area (Figure 2.4). Spatial arrangements within the house were hierarchical, with the house chief typically situated at the rear centre, a position often serving as the focal point for ceremonial events (Whitelaw 1994, 234). Each house marked the symbolic centre of the world for its owners, connected by a middle-world line symbolising human dominance. This line intersected with the sea-facing houses, representing the underworld, with the forested hills behind symbolising the upper world. A separate axis ran through each house, connecting the sea and sky worlds, converging at the house pit, the lineage's ritual focal point (MacDonald 1989, 22).

The Haida house embodies both the living occupants and their ancestors. Ceremonial entry involved passing through the oval entrance doorway, symbolically entering the ancestor's body. Communication with ancestors and spirits occurred through offerings burnt in the central house fire, signifying the pivotal point of the world (MacDonald 1989, 22). The house, thus, epitomising the house lineage, marked a transition from the mundane to the spiritual realm.

A final example in this section looks at the domestic compounds of the Dogon of Mali in West Africa. The social and temporal organisation of space within Dogon architecture exhibits a complex interplay between cultural norms, familial structures, gender, and the developmental cycle of lineages. Situated within the Bandiagara escarpment and the Gondo Plain of eastern Mali, the Dogon people inhabit nucleated villages (Lane 1994, 199). These settlements, comprising clusters of compounds, display minimal physical differentiation. Each compound typically encloses between one to four houses which surround a central activity area, demarcated by drystone walls and sandstone boulders. Structures within these compounds include millet granaries, seating platforms, hencoops, weaving looms, and livestock pens. Notably, millet granaries and seating platforms are prevalent in compounds of lineage heads, reflecting the social status and responsibilities associated with these positions (Lane 1994, 202).

Despite general architectural uniformity, distinctions between compounds are delineated by the age, gender, and marital status of their inhabitants. Four primary categories of Dogon residence are recognised. The dwellings for lineage heads and their families are called *ginu na*, and those for other married individuals and their dependents are called *ginu sala*. The houses for widows and unmarried female agnates are called *yana peney dunoy* and the ones for unmarried adolescent males are termed *sagadara dunoy* (Lane 1994, 204). The nomenclature itself underscores the social and reproductive significance of each category, with terms like *ginu*, which means house, included in terms reserved for compounds of conjugal families, who contribute to lineage reproduction (Lane 1994, 205). Still, these residential categories are not static but evolve in tandem with individuals' life stages. The developmental cycle dictates transitions between compounds, with males typically progressing from *sagadara dunoy* (the house for unmarried adolescent males) to *ginu sala* (the house for married individuals and their dependents) upon marriage and potentially to *ginu na* (the house for lineage heads and their families) if assuming lineage headship. Females, following a similar trajectory until adolescence, reside with widowed women before joining their husband's compound. Post-marital residence occurs in the husband's home, often necessitating women's relocation outside their natal village (Lane 1994, 205-206).

Temporal considerations, as reflected in the lineage's developmental cycle, intricately govern spatial organisation. Recategorisation of dwelling spaces and individuals' moves within compounds occur periodically, reflecting shifts in familial roles and responsibilities. This spatial configuration underscores the nuanced interplay between social organisation, temporal dynamics, and spatial arrangements within Dogon architecture, reflecting the intricate fabric of Dogon society and its enduring traditions.

The above examples show how the organisational principles governing domestic spaces are frequently centred upon time-honoured socio-cultural and religious conventions. Nonetheless, they also underscore the persistence of these norms within domestic settings, notwithstanding the pervasive influence of exogenous ideologies and modernity. Moreover, while the examples demonstrate variances in social norms, roles, cultural customs, and even cosmological convictions as manifest in the spatial configuration of dwellings, a discernible uniformity persists in the idea of the house, and its central role serving as a symbol of cultural beliefs and values.

Domestic space organisation based on gender

One of the most prevalent social identities reflected in the organisation of domestic space, from tribal houses to plans of nineteenth-century western houses, is gender (Ardener 1981; Spain 1992). Even in cases where it is mainly the social norms and beliefs that dictate the organisation of space in the house, gender is also seen to play a role, as seen in some of the case studies above. While other factors governing the organisation in a house, such as social class, norms, beliefs, and tradition, seem to have an influence that is exerted and legitimised by the social contacts outside the house, gender within a household or family unit may be seen as an organising factor. This may be more evident when it is considered that domestic space can be a place to withdraw from relations with other external social groups. The differentiation in domestic space based on gender in some societies like the Marakwet can be seen as prevalent outside the house as well; however, the gendered division in Indian houses described below is seen in private areas of the domestic space. Nonetheless, in most cases, particular activities are associated with specific genders, such as the female gender and the activity of cooking. The following examples of houses from Algeria, Kenya, Colombia (Amazonia), Madagascar, Norway, Greece, India, Thailand, Timor, and Indonesia show different forms of house organisation where gender is subtly or overtly an influencing factor.

The seminal and widely cited work on the gendered division of space in houses is Bourdieu's (1970) examination of the Berber Kabyle houses of Algeria (also see Bourdieu 2003). Central to the arrangement of these houses is the orientation of the two doors, where the main door, situated to the east, symbolises the male domain, while its counterpart, the smaller female entrance, faces west. Such orientation demarcates gendered spaces within the house, with the wife's loom typically positioned against the west wall, reinforcing the association of this area with female activities (Figure 2.5; Bourdieu 2003, 99). The adjoining stable, characterised by its low light levels and association with primal aspects of existence such as sex, death, and birth, is also considered a female space (Bourdieu 2003, 99). In contrast, the elevated and well-lit living quarters represent the domain of the patrilineal household head, embodying notions of nobility and honour. This dichotomy underscores the overarching gendered division of space within the Kabyle house, where women predominantly inhabit the interior while men engage in activities outdoors and during daylight hours.

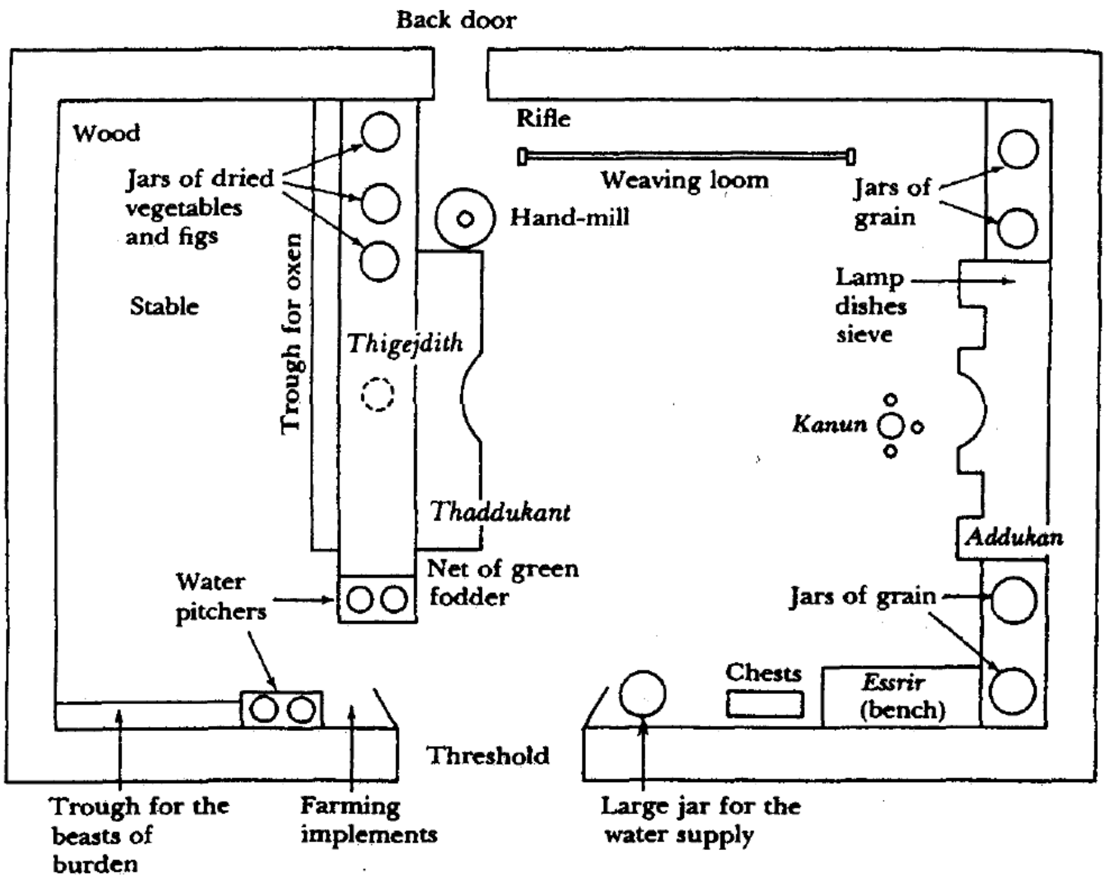

Figure 2.5: Plan of the Berber Kabyle House (Bourdieu 1979, fig 1).

Bourdieu (2003, 105, 110) further identifies a structural principle of reversal within the spatial organisation of these settings. Despite the conventional association of men with light and women with darkness in this society, the positioning of the loom against the western wall, which is actually illuminated by daylight through the opening of the eastern door, signifies a reversal of these gendered symbols (Bourdieu 2003, 99). Additionally, the internal designation of the eastern wall as being linked to light, despite the fact that it faces west is interesting, and this contrasts with the opposite western wall, termed the ‘wall of darkness’ (Bourdieu 2003, 99). Thus, the orientation of spaces within the house, which ultimately represents the realm of women, constitutes a reversal of the external world, which in turn is emblematic of male dominance. Through this analysis, Bourdieu illuminates how the organisation of the Berber

Kabyle house reflects, subverts, and perpetuates gendered roles and social hierarchies, underscoring the influence of cultural norms and symbolic meanings within Kabyle house designs.

The Marakwet of Kenya provides an example of social relations defined by gender. Here, male and female genders are seen as having a varied relationship with time and space, which can be seen reflected in language, household attitudes, ritual, clan responsibilities, and domestic space organisation (Moore 1996, xi). Furthermore, such organisation of space is experienced differently by boys and girls, men and women, old and young, and new wives and widows (Moore 1996, xii). The Marakwet Endo houses in the Kerio valley in western Kenya are sub-circular with one entrance and an occasional window (Moore 1996, 48). The organisation of Marakwet houses is based on its division into three areas. They are *kowerir* (bed area), *kapkoschio* (cooking area) *and kuti ya tobot* (area under the entrance to the roof store). Considering that to the Marakwet, the bed is the most private area, the bed should always be located behind the door (Figure 2.6). The fireplace/cooking area is always found just behind and to the one side of the centre post. The entrance to the roof store is always on the opposite side of the house from the bed, as it is not allowed to be over the cooking or sleeping area (Moore 1996, 51). According to Moore (1996, 51), the internal division in these houses is based on a system of cardinal points whose positions are relative to each other, even if certain things, such as the centre post or fireplace, are missing or displaced. However, in the Marakwet Endo compound, which may be made up of more than one house, there is a differentiation based on gender (Figure 2.7). In a compound with two houses, while one would be for a man, the other is for his wife (Moore 1996, 51). However, in recent times such a division is expressed as a house for cooking and the other for sleeping or entertaining. A gender-based division is still present in this case based on the strong identification of women with hearth, cooking activities and home (Moore 1996, 52). Moore (1996, 52) noted that traditionally, a family in a compound would have two stores. One store is for the husband and the other for the wife, with more stores if there are additional wives. However, at the time of their study, she noted that it was more common to find stores differentiated by use or items within. She also observed that the provision for such stores is significantly dependent on the associated construction costs, and in the case of shared storage areas, a man's grain and that of his wife are still separated (Moore 1996, 53). Furthermore, no matter the number of stores, the position in a compound is always the central back area. While some level of difference between men and women is seen in the organisation of space by the Marakwet, this differentiation is emphasised in their daily lives beyond the structural space. For example, the Marakwet link the sun to men as it is believed to have permanence, while the women are associated with the moon and its impermanence. It is also based on this link that they also have a gendered view of time. Furthermore, such links are associated with objects as well. For example, iron awl, and specifically iron, is linked to boys' permanent association with the clan. At the same time, a wooden cooking stick/wood is associated with the future links Marakwet girls have with the hearth and cooking (Moore 1996, 63).

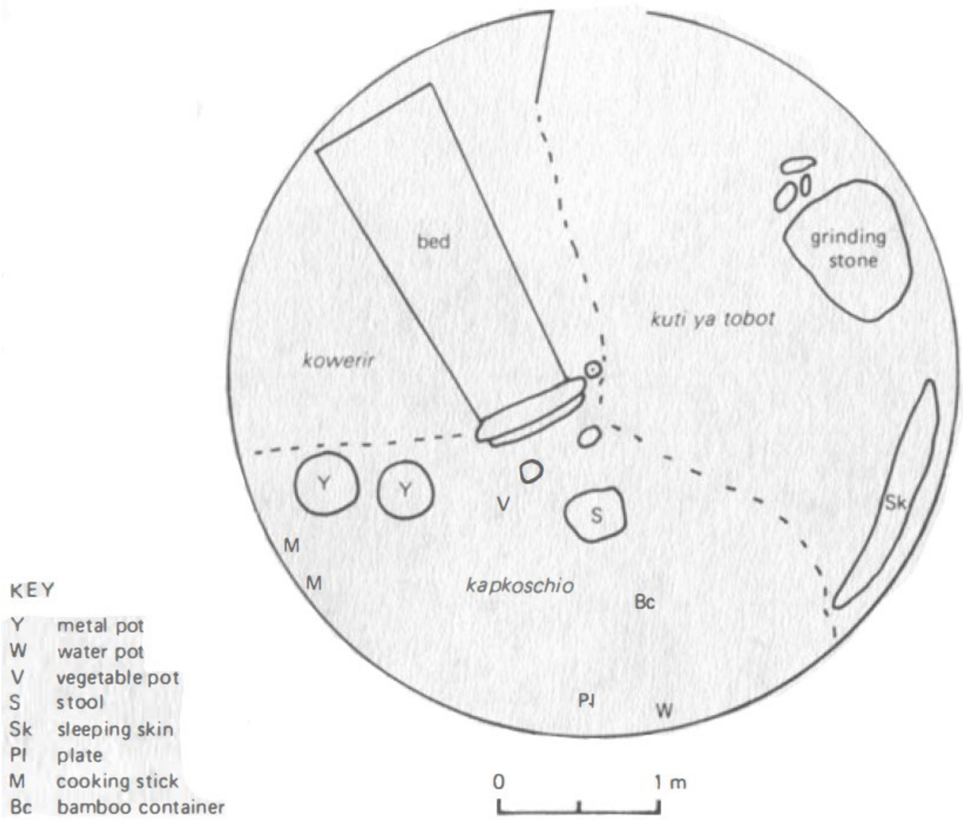

Figure 2.6: Plan of the interior of a traditional Endo house (Moore 1996, fig 18).

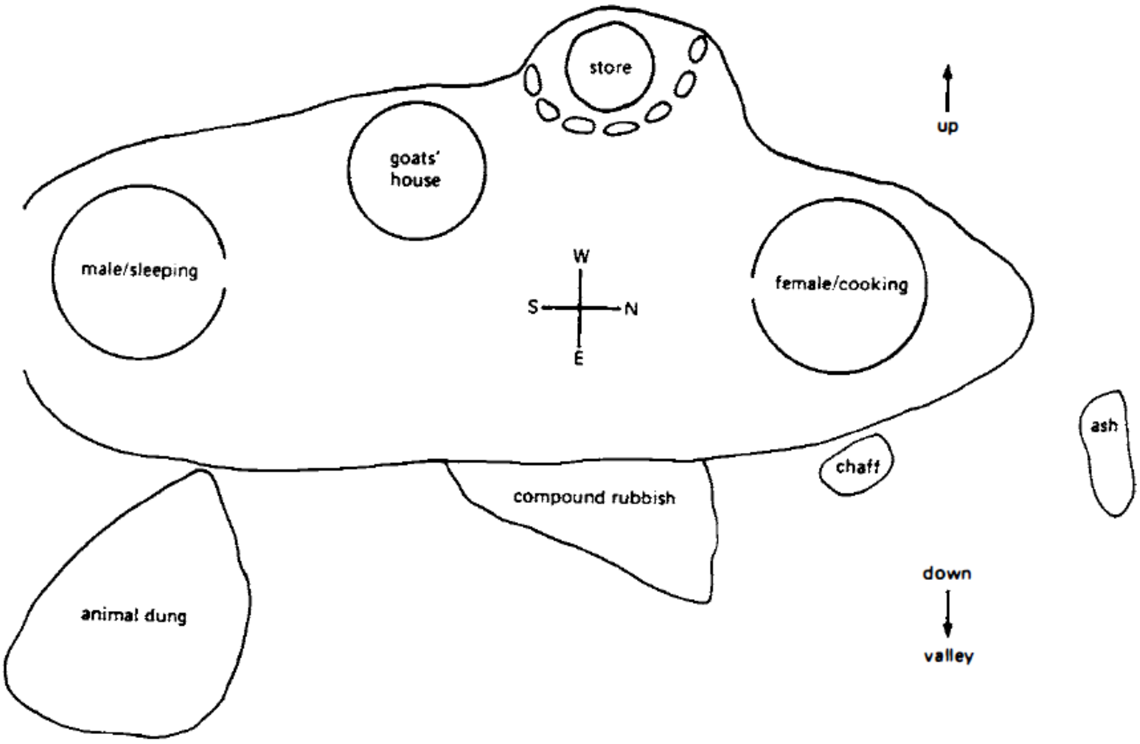

Figure 2.7: A typical Endo-Marakwet compound (Moore 1996, fig 17).

While observing the significant gendered settlements of the Marakwet, Moore (1996, 53) argues in her research that the organisation of space comes to have meanings, and they seem to be maintained through social interaction rather than meanings being encoded in the organisation of space. This is especially evident in the cases where she observed that economic factors dictated the structure built even though the 'gendered division of structures' would have dictated the creation of separate buildings for men and women (Moore 1996, 53).

While the Marakwet do not clearly distinguish between public and private, an example of a gendered organisation of space based on the public-private distinction can be found in nineteenth-century northern India. Giving some leeway for communities, castes and regions, most houses in this period in India were mainly divided into outer and inner quarters (Chauduri 2012, 353). The outer quarters were reserved for men of the house, male guests, and business. Conversely, it was the inner quarters of the dwelling that were designated for the use of female occupants. The general structure of these dwellings would reflect gender differentiation such that women would rarely enter the front room or offices where men would be sitting (*Ibid*). However, Chauduri (2012, 353) notes that the implementation of such demarcations was contingent upon the financial status of the household, as it was only in houses that were big enough that such separation was possible. She also suggests that such separations, when possible, in those times, provided a level of freedom and privacy, which were internalised to be a norm of virtuous conduct (Chauduri 2012, 353).

A caste from southern India that clearly differentiates domestic space based on gender is the Nattukottai Chettiyars or Nakarattars of Tamil Nadu, India. This is an excellent example of a sharp division of public and private space as well. All Nakarattar houses have three main divisions, i.e., the front 'male' section, a ceremonial central section, and a back 'female' section (Figures 2.8; 2.9). The elaborate vernacular architecture of the Nakarattar houses was for the inhabitation of not just single families. Instead, it was for several related conjugal families living in a joint-family system. The front male section of the house consisted of the veranda for the visitors, which also led towards the main entrance, which was the main men's entrance (Area 1 in Figure 2.8). The central ceremonial area of the house consisted of the main courtyard, a sitting area on a raised platform called *melpati, an* aisle surrounding the courtyard, several rooms for conjugal families and, behind them, rooms for valuable storage and a shrine area for worship/*puja*. This central section of the house is usually open to both sexes (Areas 2-7 in Figure 2.8). The back female section consists of a second courtyard for processing and preparing food, the kitchen, a veranda, a small room for menstruating women and girls during their coming-of-age ceremony, a veranda followed by an open garden that may have a well (Areas 8-12 in Figure 2.8) (Rudner 1994, 158). The schematic floor plan of such a Nakarattar house is shown below (Figure 2.8). However, since the last quarter of the nineteenth century, while still maintaining the primary division, the Nakarattar houses, with colonial influence, grew more elaborate with extra rooms around the central area and the use of several colonial motifs that ranged from towers with Mughal influence to niches with statues of Queen Victoria (Rudner 1994, 158). The floor plan in Figure 2.9 shows such elaborate houses called *nattukottai*, meaning 'country forts'.

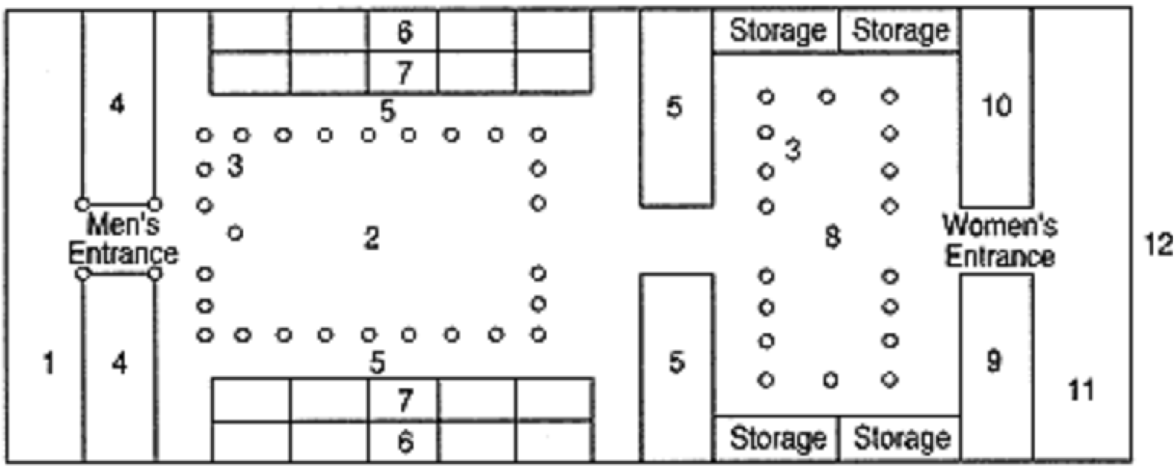

Figure 2.8: Plan of the ground floor of a simple Nakarattar House with the number denoting the following. Front male section: 1. Veranda. Central Section: 2. *Hal vitu or vitu*: first courtyard, 3. *Tontu*: columns, 4. *Melpati, tinnai*: a raised platform on which people sit, 5. *Valavu*: aisle or corridor surrounding the central courtyard, 6. *Ull arai*: *pulli*'s inner room for *puja* and storage, 7. *Veli arai*: *pulli*'s outer, 'conjugal' room. Back Female Section of House: 8. *Kattu*: second courtyard, 9. *Samayal arai*: kitchen, 10. *Kutchin*: a small room for women during menstruation and for girls during coming of age, 11. Veranda, 12. *Pin kattu*: open garden space with or without a well (Rudner 1994, Plate 9).

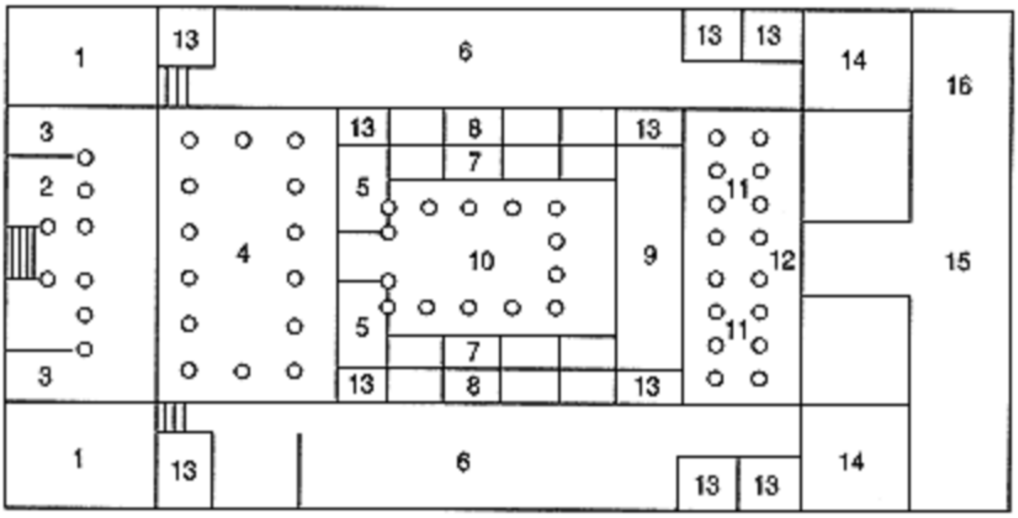

Figure 2.9: Plan of the ground floor of an elaborate Nakarattar house with the number denoting the following. Front (Male) Section of House: 1. *Munn arai*: front room, 2. *Murram*: courtyard, 3. *Talvaram*: corridor. Central Section of House: 4. *Kalyana Kottakai*: marriage hall, 5. *Patakasalai, tinnai*: the 'public' room in a house, 6. *Bhojana salai*: dining hall, 7. *Veliarai*: outer room, 8. *Ullarai*: inner room, 9. *Irantam maiya arai*: second central hall, 10. *Murram*: courtyard, roofed or covered with grillwork. Back (Female) Section of House: 11. *Murram*: courtyard, roofed or covered with grillwork, 12. *Talvaram*: corridor, 13. *Kalanjiyam*: storeroom, 14. *Samayal arai*: kitchen, 15. *Pin kattu*: backyard 16. *Keni*: well (Rudner 1994, Plate 10).

The preceding example does not explicitly demonstrate overt subordination of the female gender and associated activities; however, among the Namboodiri Brahmins of Kerala, India, a strict gendered division of domestic space with women assuming subordinate roles is observed. Prior to the mid-21st century, the Namboodiri Brahmins of Kerala reserved specific areas and rooms of their large houses, known as *illam*, strictly for women and men (Nilayamgode 2012). The secluded back areas of the house, including the kitchen, were exclusively designated for women, and had separate entrances. The house had minimal areas for interactions between men and women, and women were almost never allowed to interact with men (Nilayamgode 2012). The title given to the wives of the Namboodiri Brahmins, *antharjanam*, epitomises the secluded nature of the organisation of domestic space for women. The word *antharjanam* in Malayalam (the most spoken language in Kerala) is a combination of '*anthar*' meaning 'inner' or 'inside' and '*janam*' meaning 'person' or 'individual'. Additionally, '*anthar*' in the context of '*antharjanam*' also connotes darkness, *anthadha*, which together suggests the confinement of women to the innermost dark, secluded areas of the house (Jayanthi Suresh pers. comm.).

Christine Hugh-Jones' (1979) seminal study of the Barasana people of the eastern Amazon Basin, in the Vaupés Department of Colombia, South America, offers profound insights into the intricate organisation and symbolism of longhouse dwellings in this society. At the heart of Barasana house organisation lies a confluence of multiple principles, prominently influenced by gender roles. The Barasana longhouses are strategically constructed near rivers or streams, standing on sandy plazas adorned with kitchen gardens, containing both magical and edible plants (Hugh-Jones 1979, 43). These longhouses are primarily defined by an expansive roof which almost reaches the ground along the side walls (Hugh-Jones 1979, 46). Interestingly, the orientation of this roof aligns with a male-female axis (Figure 2.10).

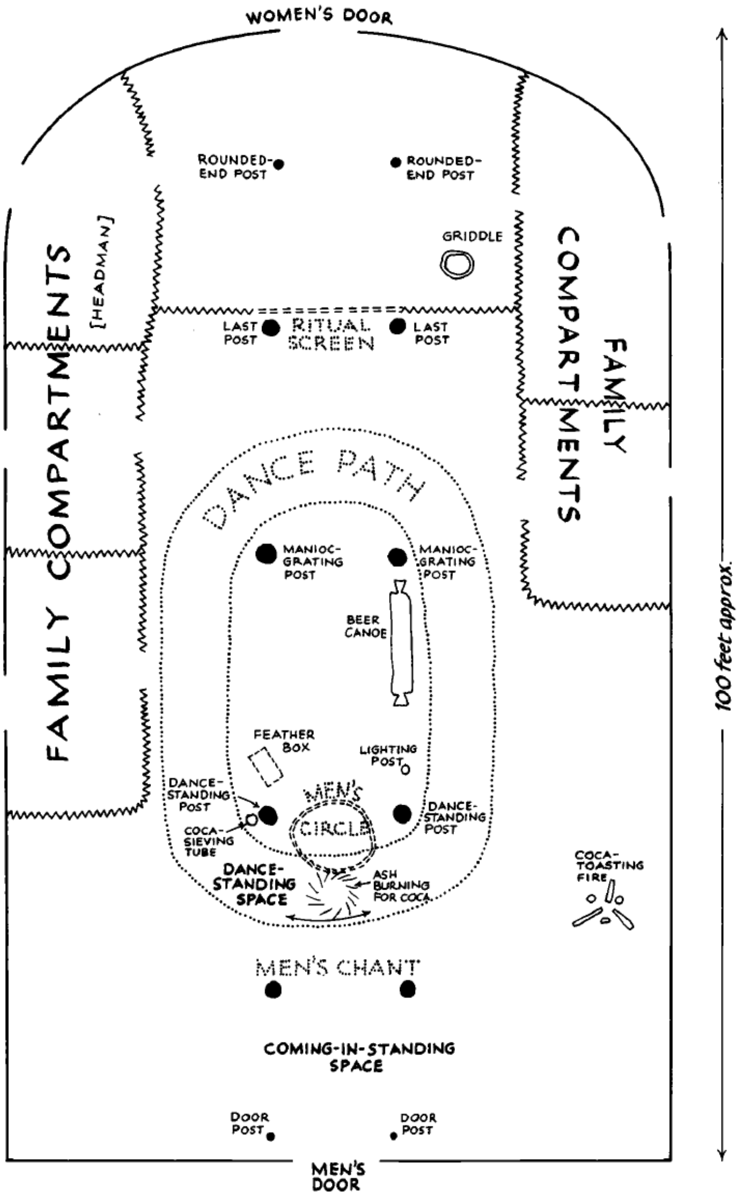

Figure 2.10: Ground plan of Barasana longhouse interior (Hugh-Jones 1979, fig 5).

The internal layout of the longhouse is marked by spatial demarcations that reflect both gender and familial roles (Figure 2.10). The men predominantly enter through a front door facing east, representing the ancestral journey of the anaconda up the Milk River (the Amazon). In contrast, women access the house through a rear door. Family compartments, typically accommodating nuclear families, are aligned along the side walls towards the female end (Hugh-Jones 1979, 48; see Figure 2.10). Each compartment houses a married couple and their children, centred around a hearth for cooking and preserving food. Social dynamics within the longhouse are nuanced, with communal and private spaces intricately intertwined. Men often engage in communal activities, sharing daily use and symbolic goods, while women's activities tend to be more private, centred around domestic chores and family responsibilities (Hugh-Jones 1979, 49). In this way, there exists a linear male-female axis extending between the two doors, coupled with a concentric pattern where the periphery signifies private and familial life, and the centre denotes public and communal activities (Hugh-Jones 1979, 246). These organisational principles are evident from the fixed locations of the male and female doors, the position of the family compartments, and the daily and ceremonial utilisation of the spaces. However, these spatial divisions become more pronounced during formal occasions or with the presence of visitors, highlighting the flexibility and adaptability of Barasana spatial organisation (Hugh-Jones 1979, 49).

Another distinctive feature of the Barasana longhouse is its conceptualisation as a living entity, resembling a mythical bird with the male end symbolising its head and the female end its anus (Hugh-Jones 1979, 249). The roof's sides are equated with its rib cage, and the main river is metaphorically perceived as the universe's gut, i.e., symbolising the whole interior of the house, mirroring the house's universe-like significance. This representation extends to the house's cleanliness and maintenance, with the front equated to the face, and the plaza outside the women's door reserved for intimate family activities. Furthermore, these longhouses are also conceptualised in the form of the womb, where the house as a womb likens the men's door to the vagina, symbolising the transition from the internal space to the external world (Hugh-Jones 1979, 249). This aligns with the men's door serving as both an entrance and exit for travels between longhouse communities. In contrast, the women's door serves as an 'internal' pathway leading to the manioc gardens, which are a source of sustenance for the community within the home (Hugh-Jones 1979, 249). Interestingly, in noting similarities between the Navajo *hogan* (discussed above) and the Barasana longhouses of Amazonia, Bradley (2012, 39) observed that whilst both these houses represent a model of the wider cultural cosmos, the Navajo *hogan* also conceptualises the house as a human body, which has a life, with the 'death' of the *hogan* happening when an inhabitant dies (and it is left to collapse). Overall, the Barasana longhouse embodies a harmonious blend of astronomic, cosmogonic, and social structuring principles, illustrating the profound interconnectedness of Barasana culture, space, and symbolism.

Gendered divisions of space can also be seen in the most northern parts of Europe. The Saami *kåhte*, traditional tents used by the Saami people in Norway, provide a striking illustration of gendered spatial divisions, comprising three principal areas subdivided into nine distinct social zones (Yates 1989, 251). The central area, referred to as *arran*, accommodated the hearth, serving as the nucleus of the tent. Adjacent to the hearth, the space between the door and the hearth was termed *uksa*, while the area beyond the hearth was known as *påssjo*. Flanking the hearth on either side, from front to back, were the *luoito* areas, which were further subdivided, into *arran-luoito* or *kaske-kåhte* near the hearth, and zones marked with the suffix *-gaecce* extending outward (Yates 1989, 251; Figure 2.11). The physical layout of the *kåhte* underscores gender differences. Characterised by two entrances—a larger fore-door and a smaller back door—the tent symbolised gendered access rights. While men enjoyed passage through both doors, women were confined to the fore-door, with access to the area near the hearth known as *kitta* (Yates 1989, 251). The intervening space, termed *loide*, functioned as a common area yet remained segregated by gender (Yates 1989, 252).

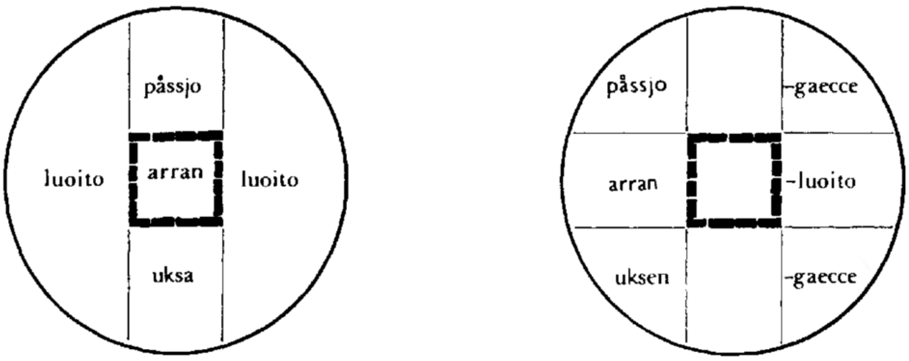

Figure 2.11: Saami names for areas of the *kåhte* (Yates 1989, fig 20.1).

This spatial arrangement also mirrored familial hierarchies, with the separation of husband and wife often demarcated by the *akka-kerrke* or housewife's stone in certain Saami communities (Yates 1989, 252). Parents and children occupied opposing sides of the tent, while servants were positioned near the entrance. Furthermore, the hearth also symbolised a vertical division between generations, with parents and young children on one side and older children on the other (Yates 1989, 253). The *kåhte* also transcended its physical dimensions, embodying the cosmic order. The hearth, akin to *Peive*—the central deity in Saami cosmology—symbolised life, fertility, and the nexus between the terrestrial and divine realms (Yates 1989, 254). *Sarakka*, the goddess of birth, was believed to reside beneath the hearth, representing the interface between the living and the dead. In summary, the spatial organisation of the *kåhte* mirrored celestial divisions, and concepts of life and death, along with ideas of gendered identities and division (Yates 1989, 255).

The houses of the Bara of Madagascar are relevant to this discussion. The Bara are an indigenous ethnic group inhabiting the southern regions of Madagascar (Huntington 1988, 4-6). Within Bara society, social organisation revolves around clans and lineages, with kinship structures serving as pivotal elements of society and its organisation. Gender demarcations represent fundamental categorisations within the Bara worldview, wherein gender characterises the primary division of a physical, moral, and social humanity (Huntington 1988, 16).

Architecturally, Bara dwellings assume a rectangular configuration, aligned north to south, with the entrance situated at the southern end of the western wall. Typically, both the eastern and western walls lack windows. Symbolic connotations permeate the cardinal orientations, with the east evoking ancestral associations, particularly pertaining to Bara origin myths. Conversely, the west symbolises femininity and affinity, contrasting with the patriarchal lineage of ancestors. The northern orientation conveys notions of superiority, light, and warmth, while the southern aspect embodies inferiority and coldness (Huntington 1988, 49). This symbolism extends to northern solar trajectories and southern wet and windy weather patterns, guiding seating arrangements within the dwelling. Senior male members occupy positions along the eastern wall in descending order of seniority, with the eldest situated to the north. Younger males align along the southern wall, with the eldest positioned toward the east. Women and children typically occupy the northern and western walls, although spatial constraints often result in a disorderly arrangement, particularly near the entrance and fire pit. Nonetheless, elder women tend to gravitate towards the northern periphery.

The Bara also design their dwellings as symbolic representations of individual personalities, based on birthdates. For example, each of the twelve zodiac signs correlates with specific positions within the interior of the houses. These astrological affiliations imbue distinct qualities or fortunes upon individuals. Another important aspect of the Bara house is the unimpressive nature of Bara dwellings, which is underscored by minimalist architectural designs, which is also emphasised by a dearth of any decoration, both internally and externally (Huntington 1988, 54). Such architectural minimalism reflects inherent Bara values: an affinity for natural elements, a penchant for abstract representation of values, and a passive disposition towards the external world. This modesty in design serves as a protective device, averting undue attention from supernatural forces, thereby mitigating against potential misfortune for the occupants (Huntington, 1988, 55).

The above examples are cases of a gendered division of domestic space, which to a certain extent, are androcentric. Furthermore, the ideas from structuralism, such as binary oppositions, can be seen as pervasive throughout these examples. However, a gynocentric creation/division of space is observed in Yerania houses in Greece. Although initially built as single-storeyed houses designed as a residence for single families, the houses have been subdivided over time. Hirschon (2012, 186) observed that such subdivisions resulted from social, historical, and political factors, with the most significant being the dowry for a daughter's wedding. Among the Yerania of Greece, separate living quarters in the parent's house are given as dowry. Furthermore, these living quarters were also accompanied by the creation of a separate kitchen which is considered the housewife's realm (Hirschon 2012, 187). Houses, in this way, tend to be shared by several households related through women, yet the separate kitchens maintain each conjugal family's independence. The significance of the kitchen among the Yerania, despite its minimal size in most cases, is further evident considering that food is exclusively handled and prepared by women and rarely do men even buy food supplies. Furthermore, culinary ability is so highly valued among the Yerania that it is one of the main criteria for assessing a woman's worth (Hirschon 2012, 188).

Many of the examples explored also portray ideas of subordination associated with women and the areas assigned to them in all examples when looked at through Western eyes. A different perspective in such gender-based division of space is observed in Southeast Asian contexts where gender is not seen as a way of separation or opposition but as complementarity of the male and female. Similarly, as in the above examples, the sphere of public and domestic/private is not seen through the lens of superior and inferior. This can be seen in Southeast Asia among the Northern Thai, Acehnese, Minangkabau, Toraja, Ema of Central Timor, Atoni of western Timor and Savu of eastern Indonesia (Cunningham 1964, Kana 1980, Waterson 2009). Among these societies, the economy is organised around the household as the main unit of production and consumption, and women play a significant role in agriculture and control the household produce. Furthermore, the house units play a vital role in traditional kinship and ritual systems and political processes, suggesting that the 'house' is not beyond such spheres. Rather than having a 'front-back' division of space, an inner and outer division is observed, with women being linked to the inner portion of the house. The kitchen or hearth was often located at the centre of these houses, thus strongly associated with life, fertility, and nourishment. It is also important to note that women are seen as house owners among the Acehnese, Minangkabau and Toraja. In the study of the Acehnese house, Dall (1982, 53) notes that the house is essentially the woman's domain and that the man is little more than a guest. In this case, where there might be a front-back division of space, it is the men who are confined to the front of the house rather than women being confined to the back (Waterson 2009).

The examples of gender-based division that have been looked at suggest that overall, there is some proclivity for women being associated with 'inner', 'back', 'sub-ordinate' or one half of the house that tends to be associated with cooking and storage activities in the darker parts of the house. However, the idea of a superior front/male/public area and subordinate back/female/private area is not universal. Wherever such a division may be observed, scrutiny is required to mitigate the bias caused by looking at them with a Western lens.

House as an entity with agency

The idea of a house being seen as an entity and, in some instances, with sentience is observed in some cultures. Ingold (2012) has offered an insight into the conceptualisation of the house as a living organism such as a tree. Although there is a basic difference between the tree as the dwelling of the fox and a house as that of humans, Ingold (2012, 34), using Uexküll's (1957, 5-80) oak tree analogy, also suggests that both have several inhabitants that bring about changes to them. For example, the tree, along with the fox, also shelters ants, owls, squirrels, birds and countless others, and these organisms, over many years, influence the form and characteristics the tree ends up assuming. Similarly, the house has many diverse human and animal inhabitants. Provisions such as stables, kennels, dovecotes etc., tend to be accommodated for such inhabitants. Along with this, human inhabitants keep the house under repair, decorate it and also structurally alter them from time to time, thus, contributing to the evolving form of the house (Ingold 2012, 34). Ingold, in this way, suggests that the house, like a tree, is a living organism as well to the extent that the house remains so only until the human and non-human components/inhabitants of the house prevail, and after its abandonment, it becomes a ruin. This also alludes to the fluidity of the house like an organism rather than a rigid structure. Thus, the house is not exactly a finished artefact, but the moment of abandonment is a moment in the life of that house. Furthermore, when the house is matched with a human purpose, i.e., the house serving as a family home or serving as a feasting place or a workspace for daily activity, it is just a fleeting moment in its life (Ingold 2012, 34).

This notion of organic living houses is interesting, and it can certainly be identified in the anthropological literature. Houses are considered in several societies of the Southeast Asian archipelago as possessing their own vitality, which is intertwined with the vitality of their occupants (Waterson 2009, 116). This is mainly observed among the Sakuddei of Siberut in the Mentawai archipelago (Schefold 1982). This vitality is seen expressed in Schefold's (1982) experience of the houses. During his fieldwork visiting and sketching a few of the Sakuddei's longhouses, he had fallen ill from a malaria attack. This attack was attributed to the houses being annoyed at Schefold's prolonged measurement, touching and wonderment at these houses, and a healing ceremony had to be enacted for reconciliation (Schefold 1982, 126). Here, the belief that the house was a life force with agency is apparent. Waterson (2009) observed that similar ideas are prevalent in several other societies of the islands of Southeast Asia. These include the Jorai of the southern Vietnamese highlands, the Minangkabau, the Sa'dan Toraja and the Malays (Waterson 2009, 118). Howe (1983), writing about Bali, noted that the houses are considered alive. The idea of houses being alive is reinforced by the processes by which life (vital force) is believed to enter the buildings. These include converting forest trees (that have their own vital force) into timber, the process (ritual) of construction itself, carving or decorations of the timber, or the various rituals carried out during the construction process. For example, several rituals are focused on the house posts among the Malays, Toraja, Bugis and the Sakuddei of the Indonesian archipelago (Waterson 2009, 122-23). Among the Bugis, the main house post is considered to be anchoring the vital force of the house. The centre post of the Malay house is regarded as the guardian or strength of the house. Several offerings are also made during the planting of these posts to appease the local earth spirits and to protect the posts and the house, indicating that the house is, in essence, 'alive'.

Following on from the idea of the house having vitality, the conception of the house having a body or as a body is also observed, reinforcing the idea of the house as 'living'. This is observed in the anthropomorphic or zoomorphic imagery and body symbolism relating to houses seen in several cases in Bali, Sumba, and Tetum of Timor (Howe 1983, 149; Forth 1981, 29; Hicks 1976, 56–66). The house may also be seen as a representation of a human body. The idea of house and body being interwoven or comparable has been observed in several cultures (Blier 1987; Carsten and Hugh-Jones 1995; Wilson 1988). Wilson (1988, 67), in his study of human evolution from the perspective of built environments, observed that there are instances where the house is thought of as a body, and it might be organised on the layout of a human body, and conversely, the human body might also be perceived as a house as well.

There are examples of the classification of the house using the body in Southeast Asian societies as well. For instance, in Savu, the house is considered to have a head, neck, cheeks, ribs and chest and an area through which it breathes (Kana 1980, 228). According to the Tetum of Timor, the house has a body with a face, eyes, head, backbone, legs, anus, womb, vagina, and bones. Their houses also have buffalo horn gable finials, which suggests that the house symbolises the body of a woman and a female buffalo, according to Hicks (1976, 56). The Balinese observe their family shrine as the head, the sleeping area and the social parlour as the arms, the courtyard as the navel, the gate as the sexual organs, the kitchen and granary as the legs and feet and the refuse pit in the backyard is suggested to be the anus (Covarrubias 1937, 88). Again, this demonstrates an organisation of space based on activity areas, but the overriding associations with those spaces are symbolic. Furthermore, a more vital link with the house is also observed by the use of the owner's body measurements for the measurement of various parts of the house (Waterson 2009, 129). This is evident in the Balinese case, where proportions are taken from the male householder, but the Sasak use the wife's measurements as she is most often in the house working (Howe 1983, 139; Gunawan Alif 1985, 61; cited in Waterson 2009, 129). Such a custom is also seen among the Malays, and the Donggo and Bima of Subawa, although in these cases, it is the carpenter or the woman of the house whose measurements are used (Waterson 2009, 129).

Although it may be suggested that the idea of the house as a body is just a convenient way of classifying and ordering domestic space, Waterson (2009, 129) suggests a link between images of the body and the vitality of the house. This is observed when considering that an increment to all body measurements is deemed essential to the house to have life in Bali. This increment is the act of infusion of the soul, i.e., *jiwa ukuran* (soul of the measure) (Howe 1983, 149). A custom of the need for association with uneven numbers (after totalling) when adding increments to measurements is also seen. Such additions symbolise life as a continuing process (Howe 1983, 144-5). Howe (1983, 145) also suggests that, like the Acehnese and Buginese of the southeast Asian archipelago, the Balinese link mystical influences entering a building through its corners as the corners are associated with odd numbers, joints and orifices of the body, space (such as seashore, crossroads, and bridges) and dusk time. It is believed that when there is a disruption in the flow of substances (including spiritual essence) in and out of the body/house, the house is blocked. Similarly, a dead body is described as 'blocked' (Howe 1983, 144-146, Covarrubias 1937, 373, 378). In this way, the house can be seen as having vitality. These examples demonstrate how particular beliefs about the living qualities of houses can be highly influential in the design and construction of the buildings, as well as their usage.

Such vitality in the house is also seen in societies that perceive or represent the house as an animal. For example, the house is seen as a buffalo's body among the Tetum of Timore and the Kara, Toba, and Simalungun Batak of Sumatra, and among the Northern Thai (Waterson 2009, 131). The vitality or agency of such a house is particularly evident in the case of the old chief's house in the village of Lingga, which Waterson (2009, 131) visited in 1986. This house had a buffalo head on the front gable, and around its neck, a small pot filled with water and lemon juice was hung. It was intended as a drink for the buffalo as it was believed that if it became thirsty, instead of protecting the house inhabitants, it could suck their blood (Waterson 2009, 131). In comparison with an animal body or body in general, Waterson (2009, 131) suggests that the house is perceived to form a protective outer skin outside of the inhabitant of the house, and the house is, thus, a secure and well-defined area where people feel at ease. This is especially evident among the Bugis who perceive a threat as penetration from outside, and a person could deflect such threat with concentration and awareness, developing a powerful *sumnage*[iv] (Errington 1979; 1983, 562). Similarly, rather than being impenetrable, the 'house body' is penetrable through the aperture and joints. By the concentration of its own *sumnage*, it offers protection leaving the inhabitant free to relax (Errington 1983, 562). The Acehnese had similar concepts of the house, and they regarded it as shelter from forces of evil and their influence rather than protection from sun and rain (Dall 1982, 50). Several instances can be thus seen here of the use of house-body metaphors to convey the idea of the perception of the house as an extension of its inhabitants. Another idea that exemplifies the house as an animate entity is the 'death' of the house. This is observed in the example of Toraja, where a village fire destroyed fourteen out of twenty-four houses, along with two noble houses. On this occasion, a small buffalo was sacrificed as a funeral offering as food for the afterlife of the house (Waterson 2009, 135).

In the case of the Māori people of New Zealand, the concept of the house as a living entity is particularly apparent. For the Māori, the concept of a house transcends mere physical structure; it embodies the ancestral spirit itself (Linzey 1989, 317). The carved house, known as *whare whakairo*, is directly integrated into tribal ceremonies and public gatherings, underscoring its profound significance as a living entity within Māori culture (Linzey 1989, 318). The apex of the gable typically features a carved headpiece, or *koruru*, towards which speeches are directed. Internally, the house is adorned with intricately carved *poupou* or side posts, as well as rafters adorned with traditional patterns. The central posts supporting the ridge beam, along with the ridge beam itself, are also intricately carved with human and mythological figures.

In Māori culture, this carved timber serves more than a decorative purpose. It symbolically represents the essence of a specific ancestor (Linzey 1989, 320). Often, the entire house is named after a particular ancestor and is viewed as the tangible embodiment of that individual. The ridge beam symbolises the ancestor's spine, the rafters represent the ribs, the internal space signifies the belly, and the outstretched bargeboards, known as *raparapa*, symbolise arms with fingers extended in greeting. Similarly, Māori meeting houses also bear the name of a tribal ancestor and are ceremonially addressed by this name in various contexts (Linzey 1989, 331). Linzey (1989, 325) observed that when speaking to the house, the Māori perceive it as possessing the living presence of the ancestor, emphasising the house's role as a dynamic and spiritually imbued entity within Māori cultural practices.

Another distinctive perspective on houses is evident among the Kalauna people of Goodenough Island, located in the D'Entrecasteaux Group at the eastern end of Papua New Guinea. The dwellings, known as *manua*, display a consistent architectural simplicity, but they are closely associated with ancestral spirits. Modern Kalauna houses are characterised by rectangular structures topped with evenly gabled roofs (Young 2006, 188). Elevated on piles ranging from 3 to 4 feet in height, access to these houses is facilitated by a single doorway, often accompanied by a step or notched log. Small 'windows' or peepholes are occasionally incorporated into one or two walls (Young 2006, 188). Internally, the houses are partitioned into multiple rooms, with a supplementary annexe often serving as a kitchen. Cooking is conducted on open fires positioned atop beds of sand and ashes, with vessels supported by three hearthstones. Typically, nuclear families cohabit in a single room, which also functions as the primary daytime living and dining space (Young 2006, 188).

Few Kalauna houses extend beyond two rooms. Given that adolescents usually vacate the family home, a single bedroom suffices for a couple and their young children. Those adolescents who remain in the house typically utilise the kitchen-cum-dining area as their sleeping quarters, unrolling sleeping mats on the floor at night wherever space permits. Young (2006, 192) observes that Kalauna houses lack specific orientations, gender-specific divisions, or conceptually significant oppositions like high and low or above and below. Consequently, the social space within these houses remains relatively unmarked and undifferentiated. Despite this, the interior of the house, known as *vetawana*, holds symbolic significance as a concealed domain of 'inside-ness' or 'within-ness' (Young 2006, 192). As the focal point of social activity, the house's interior encompasses essential features such as a cooking hearth, a storage area for yams, and a shelf or platform (*ubudoka*) situated at the rear of the roof, typically above the bedroom. These shelves or platforms predominantly serve as repositories for secrets, housing locked boxes containing shell valuables, heirlooms, bone relics, yam stones, and various magical paraphernalia (*yiba)* (Young 2006, 192).

Kalauna houses incorporate small black stones hidden in shadowy corners, believed to harbour ancestral spirits called *inainala*, protecting the dwelling and the items within from theft. Significant architectural elements, like the ridge pole and walls, are sometimes believed to host these protective spirits (Young, 2006, 192). Young (2006, 193) notes that the belief that houses contain their owners' *inainala* spirits represents the only context in which the Kalauna perceive houses as animated or 'alive'. Moreover, this is also emphasised by the fact that the house doorway (*awana*) also signifies the 'mouth', and windows are referred to as 'eyes' (*matana*), suggesting anthropomorphic analogies of the house (Young 2006, 193).

The Kalauna concept of a house also extends beyond its physical structure to encompass broader cultural and spiritual dimensions. The house serves as a focal point for rituals associated with *manumanua*, which broadly refers to rites or myths aimed at fostering prosperity. In these ceremonies, the stability and immobility of the house are symbolically transferred to agricultural yields and the community's inhabitants. Additionally, the housepost, particularly the central post or *owola*, stands as a potent symbol of anchored strength and enduring stability, representing the foundational stability and rootedness of the inhabitants within their community. It is noteworthy that in Kalauna houses, while elements like the black stones for protection and the central post for stability convey the personal agency of the house, these features might not be immediately noticeable due to the undifferentiated layout of the interior space.

In this study of some of the ethnographical ideas regarding houses, that range from central, east, south, and southeast Asia, north and southeastern Europe, the Indian Ocean area, Northwest and Southwest North America, South America (Amazonia), Africa, and Oceania (New Zealand and Papua New Guinea), it can be seen that houses are conceptualised and organised in different ways across cultures. It is evident that the design and layout of these houses, even down to the measurements used, often reflect the wider cosmological beliefs of the people constructing and inhabiting them. In these examples, it is also clear that there are rules for the uses of spaces through which the built environment is given meaning (see also Whitelaw 1994, 229). These may manifest as a representation of ideal familial dynamics between genders, generations, or the connections between inhabitants and their ancestors. Additionally, spatial layout may serve as a paradigm of social dynamics or hierarchies within a given societal framework. Finally, the organisation of domestic space may be construed as a microcosm reflecting the ordered structure of the universe itself. The next section will look at how such ideas have seen application in archaeology.

2.4 Archaeological Interpretations of Houses and Domestic Space Influenced by Anthropological Ideas

While the above discussion explored examples of ideas of the house as having an anthropomorphic or zoomorphic body in current cultures, similar ideas have been applied to the understanding of houses in archaeology. If houses reflect the beliefs, views, and understanding of the cosmos by the current inhabitants, then the excavated houses can be used to understand the beliefs and views of their past inhabitants. Such an idea has seen application in archaeology, where the idea of the house as a living entity from anthropology was used to study Viking Age houses in Scandinavia.

In such a study of Viking Age houses, Eriksen (2016) proposed an idea of houses as having 'life' and 'body', being an entity on its own, and calling it a 'house-body'. Following on from this, Bjorvand and Lindeman (2007) studied the etymology of Old Norse words for elements of construction. They found Old Norse words for window, gable and roof-supporting posts suggested eyes, head (or skull) and footprint, respectively (Bjorvand and Lindeman 2007, 1311; 348-49; 1046-47). Some suggestions have been found to indicate anthropomorphic qualities based on the etymology of some words. However, Eriksen (2016, 486) suggests that the idea must be transcended that Scandinavian Iron Age and Viking Age houses were just representations of the body. She draws on Alberti and Marshall's (2009, 353) idea of anthropomorphic pottery of north-western Argentina of the 1st millennium AD, termed 'body-pots' that are entities with an agency rather than a mere representation of bodies. Alberti and Marshall (2009, 353) argue that the 'body-pot' is an intertwined entity different from a thing, person, or concept. Using this same idea, Eriksen (2016, 487) suggests that the house-bodies may be like the body-pots. She also proposed that the Scandinavian longhouses, along with being a cognate of bodies, were also an embodiment of agential meshworks. These meshworks consisted of elements such as:

- the inhabitants who own and dwell in the house, including biological kin, guests, foster children, animals, workers, dependants, concubines, and slaves;

- the materiality of the structure with its physical properties and capacities;
- memories and practices, various types of artefacts and several other elements (Eriksen 2016, 487).

To further elaborate on the idea of a meshwork of agencies and the house-body, Eriksen (2016, 488) looks at the lifecycle of a Scandinavian longhouse in Jarlsberg, Norway. Based on the artefacts recovered, she suggests various social practices took place in the house. They include cultivating fields, slaughtering animals, food preparation by the hearth, consumption as a community, tending livestock and social interactions (Eriksen 2016, 488). Moreover, based on the beads found in the house, Eriksen suggests practices of ornamenting the body took place here. She further adds that the beads indicate travel or networks to places of their origin. Considering that some of these houses, when buried, had human remains, it implied commemorating the dead as well. Such a meshwork of so many practices knitted together the various social relations in the household (Eriksen 2016, 488; Jones 2007). This also included the relational line of movement to the place, people, and things in the form of craftsmen, material, trade, allies, kin, and landscapes. However, all this was not restricted to one generation of people in the house but to around three to four generations as the house stood that long. This suggests that the house transcended time, having several births, weddings, and deaths take place within, along with the decades of various domestic practices happening, and the use of numerous artefacts and the countless number of memories created within (Eriksen 2016, 488). When such a house is buried, Eriksen (2016, 488) states that it is actually the commemoration of this agential entity. She also emphasises the point of house-body by highlighting the house's lifecycle through the following stages:

1. before construction: 'Conception;'
2. construction: 'Birth;'
3. use, curation, and rebuilding: 'Life;'
4. abandonment, in decay or the dismantling: 'Death;'
5. post-abandonment/burial: burial rites/commemoration (Eriksen 2016, 485).

It was recorded that not all of the buried longhouses studied had human remains in them. Based on this, Eriksen (2016, 491-492) proposed that the human remains and other artefacts found in some of the longhouses may have been offerings to the grave of the houses rather than the house being the grave of the people found associated with it.

This survey of houses and ideas in anthropology in this chapter suggests that houses serve as more than just a place for shelter. They can be living entities or even considered a part of the community just as people, highlighting how intertwined houses and people are in all societies. They can also serve as a place for connection with ancestors in the afterlife. This is observed in several societies of Southeast Asia. The Roti bury the dead under the floor while their spirits, called *nitu,* are believed to reside in the loft. They also bury babies under house stairs to enable the easy return of their spirits into new bodies (Waterson 2009, 221). Among the Toraja, the dead may not be necessarily buried in the house they lived in during their lifetime, but instead, they may be buried in a clan house that may be already in use and has several other burials in it already and thereby accumulating ritual power (Wetering 1923, 479; cited in Waterson 2009, 221; Fox 1987). Such ideas of incorporating the dead in houses and daily life are also observed in Southeast Asia among the Sumba, Akha, Lisa, Hmong, Tanimbarese and the Ma'anyan (Waterson 2009, 224-228). Along with communicating with the dead, such practices are believed to offer great protection, power, and knowledge, as in the case of Ma'anyan (McKinnon 1983, 143; cited in Waterson 2009, 223). These various examples provide archaeologists with interesting analogies for the interpretation of houses of the distant past and the varied depositional practices which take place within them.

Lindsey Büster, in the study of Later Iron Age houses that have had several phases of construction/reconstruction at Broxmouth, southeast Scotland, used a biographical approach to suggest that such houses, as well as creating a bond between the living and the dead, served as a conduit of legacies and memories for generations of inhabitants. According to her, the houses at this site blurred the divide between houses and memorial monuments (Büster 2021). The hillfort at Broxmouth was occupied over 32 generations between 600 BC-200 AD and had six phases of occupation (Büster 2021, 5). Based on the truncation of features progressively from phases 1 to 6, Büster (2021, 5) suggests that the inhabitants of phase 6 houses had frequent encounters with past materials. While burials within the settlement interior seem to have been observed over several phases, successive constructions or reconstructions seem to respect and protect the past burials. Phase 6 roundhouses were recorded to have started life as timber or partially timber roundhouses with earth floors encased by a stone wall and paved floors (Büster 2021, 5). According to Büster's observations, the enhancements made did not entail any structural indispensability, as the preexisting walls or floors were left intact, and instead, new walls or floors were constructed in front of the old ones, and in the case of the paved floors, atop them. Such modification required significant investments in terms of labour and material as the old fabric was not reused. Furthermore, such construction methods lead to the reduction of usable space within the house interior. This was exemplified in the case of House 4, which went through five rebuilds and led to having its internal area almost halved (Figure 2.12). According to Büster (2021, 8), such restructuring was an important way of negotiating and communicating new identities at significant times, such as a death or an addition of a new household member. Thus, these houses may have represented the history of lineages manifested in material form, i.e., serving as epitaphs or mnemonics for previous generations that called it home. In this way, houses like House 4 at Broxmouth also served as a conceptual and physical bridge between the past and the present and between the living and the dead ancestors (Büster 2021, 8).

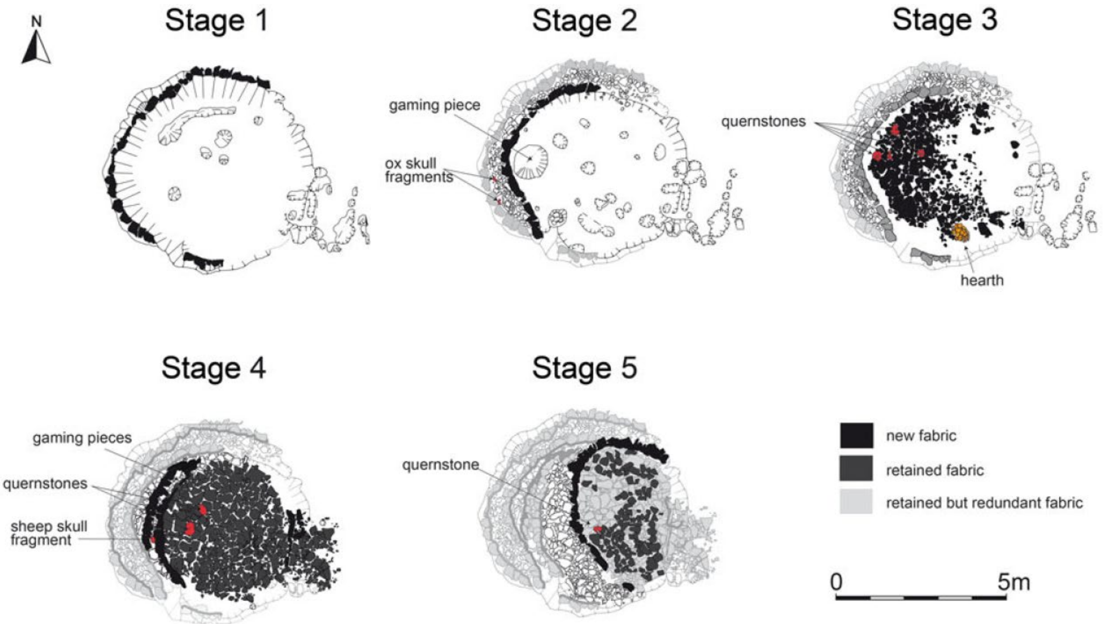

Figure 2.12: House 4 at Broxmouth, southeast Scotland, showing different stages of rebuilding (Büster 2021, fig 5).

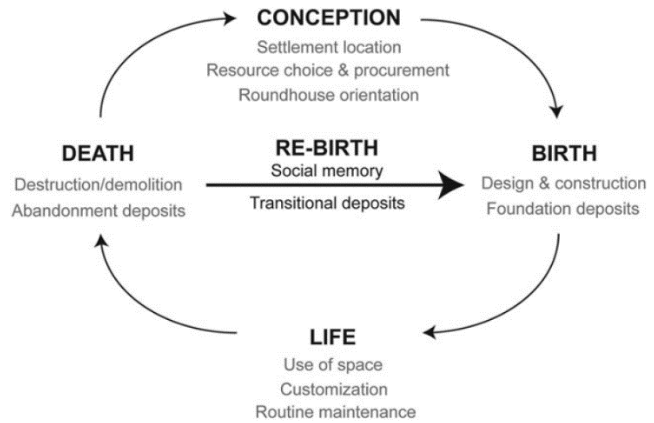

Figure 2.13: The cyclical nature of roundhouse biographies, with increasing layers of social memory added with the completion of each successive cycle. (Büster 2021, fig 2).

While Eriksen (2016) suggested a linear biographical approach to the understanding of houses having a linear lifecycle, Büster (2021) suggested a ‘nested’ or ‘cyclical’ approach. This is based on the idea that an inhabitant of a house such as House 4 at Broxmouth may draw on the temporal and spatial references in forming their own identity (Büster 2021, 2). Each instance of reconstruction, and the preservation of the associated burial within such reconstruction, entails more than the commemoration or remembrance of the deceased individual; it also serves as a means of preserving the memory of the household unit, the wider settlement community, and the surrounding landscape. Furthermore, she proposes a cyclical nature for the lifecycle or the biography of the house, where the house is reborn during each subsequent rebuilding and a new layer of social memory is added, as demonstrated in Figure 2.13. While this lifecycle of the house is quite different from that of an individual, it may be analogous to the family's lifecycle that survives several generations as a close-knit group. This is a good example of ideas from anthropology being developed further and used to good effect within archaeological interpretations of houses. The case studies explored in this chapter highlight that houses tend to have functions beyond the obvious ones that are usually associated with them, such as shelter from elements, protection or even as a showcase for status or wealth.

2.5 Conclusion

In archaeology, often a built structure that appears as a dwelling is interpreted as a house, but rarely is it presented as a vital building where a society's norms, beliefs and values were embedded. Perhaps a divide lies in the interpretation or description of a house compared to a home. While a house is a physically built dwelling in a static location, a home suggests a space, idea, or feeling that is not necessarily bound to a fixed place. This is exemplified in the ideas of the house suggested by Smyth and Croft (2006, 93). According to them, while protection from elements remains the primary function of the house/dwelling, it would be long after the house has been built that it became the stage for more complex human practices. It is such practices of the house that would provide the intricate ideas of the concept of home. This is well elaborated by Mary Douglas (2012) as she tries to explain the meaning of home. She observed that a home could not be defined by the functions that happen within, as alternative places can do the same function in the same way or even better. For example, a hotel or a health farm would be more efficient in providing primary care for bodies than a home. Similarly, a school or even an orphanage, arguably, would be more efficient than a home for children's education (Douglas 2012, 51). Home is an embryonic community and a place for the realisation of ideas of such a community.

The case studies and examples throughout this chapter reveal how a physically built structure such as the house manifests itself as a home through the performance of daily life and the realisation of the ideas of the community or inhabitants. It also highlights that looking at the domestic space based mainly on its function, and trying to draw ideas of the inhabitants and culture based exclusively on that, can be a myopic way of studying it and lead to inaccurate interpretations. However, in each of the examples above, the interdependency of function and ritual/belief/traditional ideas within the house architecture and house organisation is often seen. The case studies across different parts of the world suggest that a division of internal space within houses is usually quite structured, rather than fluid and changing. In other words, the various areas within a house tend to have a particular purpose or symbolic significance, suggesting the organisation of the internal space of houses tends to be rigid in terms of function or meanings associated with it, though it can have multiple functions and meanings too. However, fluidity does lie in the number of divisions in the house, which may be dictated by economic or environmental factors and social factors (e.g., marriage). Furthermore, even if economic or environmental factors dictate the most basic form of houses, it is observable that certain ideas or divisions survive in some form or the other, depending on the ideas that are central to the belief system of the specific society.

These ideas and understandings are important to this thesis as they highlight that house floors are indeed usually associated with particular activities and social values. Some of this structured organisation of space can be detected archaeologically. However, most importantly, this exploration demonstrates that it is unhelpful to apply modern Western ways of interpreting houses to the archaeological evidence, as it merely leads to a simplification of the evidence and, indeed, a misunderstanding of that evidence. Thus, the exclusive reliance on empirical data and modern Western understandings of houses (e.g., geochemical and spatial analyses) creates a potential gap in the interpretation of houses in the archaeological record. The value of anthropology and ethnography in the study of houses of the distant past should not be overlooked.

[i] Another example of this approach is environmental determinism, which suggests that human actions in the past were determined by certain universal laws, implementing the 'primacy of material base' (Pope 2003, 46)

[ii] Pope (2007, 223) argues that individuals responsible for designing roundhouses were influenced by both structural and spatial considerations, and that the ordering of the space within roundhouses tends to reproduce the architecture itself. While the architectural design of roundhouses facilitates the potential for a centre/periphery organisational principle within internal spaces, Pope (2007, 223) further posits that the perceived front/back division, as identified in her study, arises from a more subconscious mechanism associated with the desire for light and considerations of contact and privacy. Additionally, drawing on Brück's observations (1999a, 158; cited in Pope 2007, 223) regarding significant variability in the use of space within Middle Bronze Age houses in Britain, Pope underscores the adaptability inherent in such use of domestic space. This critique of the structuralist cosmological model for the use of space in roundhouses (discussed above; Parker Pearson 1999; Giles and Parker Pearson 1999; Fitzpatrick 1994), enables Pope (2007, 223) to argue that while structuralism seemingly endeavours to elucidate historical meaning by supplanting conventional functionalist or 'common sense' interpretations, it ultimately reconfigures many elements of processual methodology while persistently overlooking the individual from the past. Furthermore, the diverse approaches introduced by post-structuralism in archaeology have arguably served to obfuscate rather than clarify conceptual definitions and substantive content (Pope 2007, 222). She also emphasises that meaning is entirely contextual and that there cannot be a single reading (hence interpretation) of the past.

[iii] While this compilation of examples does not encompass a comprehensive survey of all ethnographic studies concerning houses and the use of domestic space, it endeavours to illustrate the conceptualisations of houses and internal spaces across diverse cultures from different parts of the world, through examples from all six historically inhabited continents. Moreover, the examples considered predominantly focus on cultures where houses have been scrutinised by anthropologists and exhibit some form of spatial and architectural order. This emphasis may reflect a bias by the author and also in anthropological studies, as there is a tendency to concentrate on houses characterised by order. This observation is corroborated by Parker Pearson and Richards (1994b, 65), who note that 'there are hundreds of ethnographies with no analysis of cosmology and architecture, either because those societies lacked such structures or because the anthropologists were uninterested in such matters'. Nevertheless, it is clear that human societies have a strong preference for spatial organisation within their houses and this often relates to ideas about how the wider society and world is symbolically organised and perceived.

[iv] *Sumnage* refers to the vitality or life force.

CHAPTER 3: CHEMISTRY, ARCHAEOLOGICAL SEDIMENTS, AND SPACE

3.1 Introduction

Archaeological soils/sediments hold a plethora of information regarding past human activities, and the chemical changes resulting from these activities are reflected in the preserved chemicals within the soil. Phosphate and multi-element analyses are useful methods for uncovering these chemical changes. This chapter provides an overview of the research context of the thesis and a general overview of the use of soil chemical analysis in archaeology while also reviewing extant literature on phosphate and multi-element analysis in archaeology. It begins by discussing phosphorus (P), an element with an atomic number of 15 that is highly reactive and commonly found in the form of phosphate compounds in soil. P is considered a reliable indicator of human activity in archaeological soils. While the primary focus of this doctoral research is on multi-element analyses, which fall under the category of geochemical analyses, it is important to recognise that delving into the history of geochemical analyses in archaeology inevitably entails a discussion of the historical development of phosphate analyses in archaeology as this is the traditional, more common method of geochemical analysis. Consequently, the chapter includes an examination of the evolution of phosphate analyses in the field of archaeology, along with multi-element analyses. As the focus of the thesis is the use of space in structures, the chapter also reviews a few available examples of the application of P and multi-element analyses in house structures in Britain.

3.2 The Phosphorus Cycle and the Archaeological Record

Human activities change the chemical content of the soil on which the activities occur. The chemical contents of archaeological soil reflect past human activities in the form of function, intensity, and duration (Eidt 1984; Cresser *et al.* 1993; Leonardi *et al.* 1999, 346). However, the rate of such chemical change in the soil depends on the retention or fixation power of the chemical elements in the soil and the features of the soil and climate. The identification of such changes in the soil is particularly useful when traditional archaeological materials such as definite features and artefacts are absent.

Phosphorus (P) is present in varying amounts naturally in the soil, but it can be enhanced or reduced due to human or animal activities. The main source of natural P in soils is the rocks that lie underneath the soils as parent material (Cook and Heizer 1965; Provan 1971; Eidt 1977, 1984; Leonardi *et al.* 1999, 346). In comparison to other macronutrients of the soil, P, once deposited, remains fixed to the initial deposition area in most soils due to its negligible vertical or horizontal migration and because it is not lost in gaseous form. This makes P the most reliable of the chemical elements linked to ancient human activities.

Most likely, the initial or natural quantity of P in the soil varies from place to place and from soil to soil. Hence, ideally, the natural or 'native' amount of P in the study area must be established. Organic and, to a certain extent, inorganic P are present in plants. Plants remove available P[v] (as orthophosphate ions in solution) at a certain depth from the soil surface through their roots (Bethell and Maté 1989; Brady 1974). The loss of P is permanent from the system in the case of crops when removed by them. However, in the case of naturally growing plants, P content in their tissue is returned back mainly as organic P to the soil when they die. Although the organic P redeposited becomes available again to growing plants, in the long term, the organic P tends to be transformed into inorganic P (Provan 1971). Thus, there is no net loss in a natural system consisting of plants.

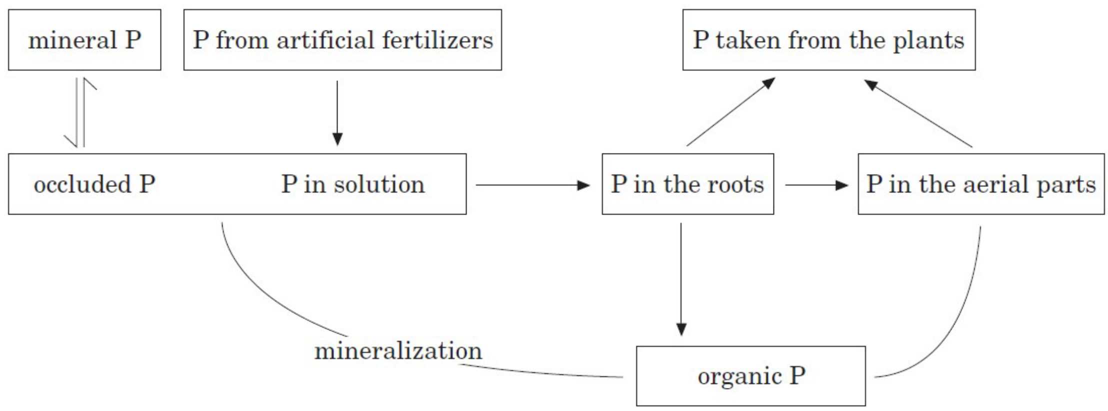

Figure 3.1: The Phosphorus cycle (Leonardi *et al.* 1999, fig 6)

Animals living in an area supply the soil with P through their waste and remove it when they graze. Hence, the change in soil P content due to naturally growing plants and animals is a case of movement and transformation of P rather than accumulation and depletion (Cook and Heizer 1965, Leonardi *et al.* 1999, 347). The schematic diagram of the P cycle in Figure 3.1 explains the movement of P in a system. The amount of P in non-human-affected systems remains stable. In a system that has not been affected by human intervention, leaching and erosion are the two significant pathways for a net loss of P. In general, however, such a system's total amount of P is relatively stable. Any significant change to the level of P in a system is usually a result of human activities (Bethell and Maté 1989).

The effects of human activities/intervention, such as farming, in the P cycle can lead to the following:

- In the most primitive forms of farming that lacked deliberate fertilisation, the crops displace the level of P to a lower than natural level. This is also the case in an intensely cleaned area (Luzzadder-Beach *et al.* 2011).
- Farm animals can displace the level of P from the natural level to a higher level in any area if they are tethered or confined to that area.

However, waste from wild animals and natural botanical waste are left in a landscape in a predetermined pattern. Hence, such wastes from wild animals and plants are not considered to add significantly to the soil's natural phosphate level. A site occupied by humans in a landscape will show detectably higher levels of phosphates than unoccupied sites, but remarkably high concentrations throughout the landscape can be tentatively identified as areas of organic waste disposal (Luzzadder-Beach *et al.* 2011) as it probably indicates deliberate deposition of organic material in a particular area. However, the raw data (absolute amounts of P in each sample location) from one site/landscape may not be used for comparisons with the other sites/landscapes as the natural level of P in each landscape is likely to be different. The distribution pattern observed, however, is comparable between sites even if they do not share the same level of natural P in the soil (Eidt and Woods 1974, 47). Therefore, any analysis of the P content of archaeological soils benefits from being set against the amount of naturally occurring P on any given site.

3.3 History of Geochemistry in Archaeology

Human activities have a significant impact on the levels of certain elements in the soil, such as nitrogen (N), potassium (K), calcium (Ca), magnesium (Mg), sulphur (S), and phosphorus (P) (Cook and Heizer 1965; Leonardi *et al.* 1999). The analysis of phosphate has become a common practice in identifying cultural features and activity areas pre-dating the Industrial Revolution, as demonstrated by various studies (e.g., Cook and Heizer 1965; Leonardi *et al.* 1999; Middleton and Price 1996; Parnell *et al.* 2002a; 2002b; Wells *et al.* 2000; Lippi 1988; Terry *et al.* 2000; 2004). Agronomist F. Hughes first introduced the application of soil geochemistry in archaeology in 1911 through the observation of phosphate enrichment at archaeological sites in Egypt (Herz and Garrison 1998). The field experienced significant progress in the 1920s and 1930s with the work of Olaf Arrhenius (1931; 1934), who conducted a systematic investigation examining the correlation between increased soil phosphate levels and historical human settlements in Sweden. He conducted an extensive mapping of a vast agricultural area in Skåne, southern Sweden, and published his archaeological findings from the late 1920s onwards, detailing a close correlation between phosphate anomalies and pre-modern settlements of various ages. For example, he observed that concentrations of phosphorus were higher in areas near churches compared to other unoccupied areas, and claimed that it would be possible to find past areas of occupation by testing the soil for levels of P. Through his extensive studies in Sweden, Arrhenius (1931; 1934) also pointed out that P content was usually high in the soil of old village sites (some of which pre-dated the Early Bronze Age). Such a relation was also supported by the premise that traditionally produced food, either plant or animal based, is relatively high in phosphorus, and all the organic refuse remained, at least, near the villages (Arrhenius 1931; 1934). It was also noted that whether an occupation site was modern or ancient could be determined by the difference found in the level of phosphates when compared to natural unoccupied locations (Arrhenius 1931). These Swedish data remain valuable to date, and a recent study by Thurston (2010) utilised them, together with new large-scale phosphate surveys in Denmark, to provide a comprehensive analysis of the evolving political geography of the region, spanning the Iron Age to Medieval times. The method by Arrhenius was adopted and modified in other locations, such as by Walter Lorch (1940) in Germany. Despite initial sluggish adoption, by the 1960s, studies from Europe and the USA proliferated (Cook and Heizer 1965).

There was an expansion in the 1950s in the range of trace elements that were being examined in soils (Rimmington 1998). Lutz's (1951) brief study conducted an analysis of soil samples from ancient settlements at Russian River and Auke village sites, as well as comparable forest stands in Alaska, for P, N, Ca, and K. The results indicated that human occupancy of the village sites led to a substantial increase in soil P content, ranging from 50 to 175-fold, along with a corresponding increase in soil N content by 3-7 fold and a 4-6 fold increase in P content. Moreover, there was a 2 to 12-fold increase in Ca when compared to the forest stands. These findings demonstrated that the soil had been enriched with various elements due to human occupation when compared to unoccupied forest areas in the study. However, the sample size was limited (just three samples from each site), and the spacing between samples was 50 feet in an attempt to reduce time and costs, as noted by Cannell (2016, 24). The work of Sokoloff and Carter (1952) revealed that middens in Florida were enriched in copper (Cu) and zinc (Zn), and this finding was attributed to the deposition of human refuse.

However, Cornwall (1958) expounds that while numerous wet chemistry techniques were accessible for identifying single-element concentrations at this time, many were either qualitative, labour-intensive, or both. Phosphorus (P) was preferred in this period because phosphate analysis was primarily qualitative, fast, and cost-effective. Unlike other elements associated with human activity, it provided a single element capable of capturing a wide range of activities with consistent success (Holliday and Gartner 2007). However, using phosphate analysis alone also meant that the task of identifying anything beyond a human habitation area or soil exposure to significant P-rich organic content remained speculative.

With the development of radiocarbon techniques and with the importance laid on understanding the interaction between humans and the environment in order to understand cultural change (Childe 1957), it was during the 1960s that there was a significant change within approaches to archaeology, with the push towards scientific archaeological techniques that emerged with the advent of processual archaeology. This phase of development led to a closer integration of archaeology and science. This was, in turn, reflected in geoarchaeology which eventually led to geochemical analysis becoming more efficient in the 1970s, enabling its comfortable application in research (Eidt 1977; Woods 1977; Bethell and Maté 1989). Over time, there was an improvement in the understanding of the factors influencing phosphate retention in soils and the methods employed for its analysis. Cook and Heizer's (1965) comprehensive article, based on numerous sites in North America, employed sampling on various scales and diverse soils to correlate the vertical and horizontal retention of phosphate in soils with archaeological evidence. In several case studies, the quantification of organic content and various elements, such as phosphorus (P), calcium (Ca), nitrogen (N), and carbon (C), was emphasised, highlighting the interconnection between these factors, different elements, and soil properties (Cook and Heizer 1965). These findings suggest that measuring only one variable, such as phosphate, could lead to misinterpretation.

However, the focus still remained on phosphate analysis in the 1970s, and as a consequence, there were several studies in the development and application of multiple phosphate analysis techniques. Eidt's (1977) brief article on phosphate spot testing is widely cited, as the method they employed was a rapid, qualitative test for soils using inexpensive reagents (hydrochloric acid, ammonium molybdate) and an ascorbic acid reducing agent in a two-step process. This method offered an alternative to the previously widespread use of ammonium sulphate as a reagent (Cannell 2016, 25). One of the seminal works that defined the application of phosphate analyses in archaeological practice was Sjöberg's study (1976). It was identified in the early 1970s that phosphate analysis could be used not just for delimiting sites as part of archaeological prospection but also in interpreting intra-site relationships (Sjöberg 1976). He highlighted the significance of phosphorus in soil systems and its archaeological importance. According to Sjöberg (1976, 449), phosphates can be classified into three forms depending on their availability to plants as nutrients, namely readily available phosphates, slowly available phosphates, and very slowly available phosphates, with the latter making up the majority of phosphates in soil (80 to 90 per cent of total phosphate in soil). The very slowly available phosphates result from past anthropogenic activities and can serve as indicators of previous human activity (Sjöberg 1976, 449). He also noted that the fixation of phosphates in the soil depends on the particle size, with clay soils having a higher fixation power than coarse-grained soils. Additionally, the retention capacity of soils is influenced by pH values, which can affect the fixation of phosphates if they are extremely high or low (Sjöberg 1976, 449). However, Shackley (1975, 68) observed that while organic phosphates are dominant in the topsoil, the inorganic phosphates of archaeological interest are located in the subsoil and remain relatively undisturbed over time. Shackley's (1975, 68) observation was also a critique against the widespread use of soil samples from the topsoil for archaeological prospection. Moreover, P is resistant to percolation and tends to form complex and insoluble compounds (Sjöberg 1976, 449; Cook and Heizer 1965). Several examples of the usefulness of phosphate analysis in archaeological research have been cited by Sjöberg (1976), including Cruxent (1962), Mulvaney and Joyce (1965), Rosenfield (1966), and Davidson (1973). Nonetheless, Sjöberg (1976) also noted that phosphate analysis is best employed systematically within a single site or structure rather than as part of large surveys for prospection purposes. It is worth highlighting that during Sjöberg's publication in 1976, phosphate analysis was predominantly employed as a means of large-scale surveys within sites, as opposed to individual structures. However, the field application of P analyses had moved from the early days of analysis of just a handful of samples from each site to a much larger grid-based sampling strategy for archaeological prospection.

Eidt and Woods (1974) further developed field and laboratory methods for soil analysis, specifically for settlement sites. Their work emphasised the usefulness of techniques such as phosphate analysis, micro-separation of soils, and palynology in settlement analysis within archaeology. Additionally, they provided detailed information on the methodology and specific conditions required for phosphate analysis (Eidt and Woods 1974). One of the methods they developed enabled the differentiation of normal phosphate forms from the phosphates added to the soil by human settlement activities (Eidt and Woods 1974, 74). Although determining the exact quantity of phosphates added by human activity can be challenging, this could be resolved by comparing the phosphorus levels in the settlement site to those in nearby areas not influenced by human activities. Eidt and Woods (1974, 62) also suggested ways of interpreting the levels of phosphate observed from laboratory results. For instance, a low phosphate reading in a settlement area may indicate possible ceremonial or defence zones deliberately set aside from daily activities. They also proposed that identifying ceremonial or habitation areas within a settlement was previously limited to the presence or absence of artefacts. However, with the advent of phosphate analysis, it became possible to differentiate between these areas through the levels of phosphate. Eidt's (1977) work further improved the method and offered both qualitative and quantitative approaches for enhanced results and specifically addressed the use of phosphate testing in archaeology.

In his work on the applicability of phosphate testing on anthropogenic soils, Eidt (1984) details the fixation of P in soils and the likely sources of P on human-occupied sites. For example, he observed that living areas in prehistoric sites usually have higher concentrations of P because of disposal practices. In contrast, agricultural areas may contain lower concentrations where fertilisers were not used. Furthermore, he also suggested that in cases where the slash and burn technique was used, the agricultural areas may have levels of P lower than natural levels due to the removal of crops without fertilisation (Eidt 1984).

By the 1980s, techniques of phosphate analysis had undergone substantial research and refinement, leading to an abundance of extraction and analytical methods being applied to archaeological sites. The array of approaches, encompassing rapid, *in situ* spot tests (Bakkevig 1980) to Conway's (1983; also discussed later in this chapter) quantitative total extraction, primarily originates from uncertainties concerning the phosphate cycle and its relation in archaeological samples under varied environmental condition. Lippi's (1988) strategic coring as a technique for sample collection for phosphate analysis of a buried forest site in Ecuador, where he emphasised the non-invasive nature of his method, is another example of the growing body of research in phosphate analysis in the 1980s. Craddock *et al.* (1985) employed phosphate analysis to understand its efficacy as a means of locating and interpreting archaeological sites along with other techniques such as field walking, aerial photography, magnetometer survey and magnetic susceptibility surveys at multiple East Anglian sites at Fengate (Peterborough) and Maxey Quarry (Cambridgeshire). While they used multiple sampling techniques (such as coring for sampling archaeological layers and sampling of topsoil), their study revealed that the sampling of topsoil in the study area was sufficient in the prospection of archaeological sites. However, aerial photography was better equipped and efficient as a locational technique (Craddock *et al.* 1985, 372). Phosphate analysis was proposed to be of maximum value as a prospection technique for specific features within sites (Craddock *et al.* 1985, 373), especially where other non-invasive prospection techniques have been applied.

A comprehensive analysis of advances in phosphate analyses in the 1980s by Bethell and Maté (1989) remains highly relevant within the realm of geochemical archaeology and continues to be widely cited (Linderholm 2007; Oonk *et al.* 2009; Cannell 2016). Numerous issues are identified in their critique of the extant application of phosphate analysis then, such as the absence of temporality in phosphate mapping results, especially when employed as a topsoil prospection technique, and aspects of a site from its different phases become obscured or indistinct. However, later research has attempted to associate the relative proportion of available and unavailable phosphate with chronological changes (Beach 1998). Additionally, despite the prevailing theory that organic phosphates rapidly mineralise and become 'fixed' in soil, substantial evidence suggests that mobility poses a challenge under specific environmental conditions (Crowther 1997; Craddock 1989; Cannell 2016). Furthermore, Cannell (2016, 26), in her brief review of the state of archaeological geochemistry, noted that Bethell and Maté's (1989) seminal paper might be perceived as somewhat antiquated, contingent upon the belief that multi-element analysis has surpassed single-element analysis, yet it is still relevant today as phosphate analysis persists in the realm of archaeology, both in commercial and research undertakings, contributing to the ongoing expansion of applied analytical methodologies. A good example of such use of phosphate study in the late 1990s-early 2000s can be seen at the Iron Age site of Wardy Hill Ringwork, Coveney, Ely (Evans 2003). Here, site-wide phosphate distributions were used to identify the presence of organic waste. It was found that the phosphate levels complemented pottery and bone distributions in front of two main roundhouses here (Evans 2003, 203-206). There are several recent examples too where archaeological geochemistry is studied by using phosphorus alone (e.g., Migliavacca *et al.* 2013, Parker Pearson *et al.* 2021a).

Despite the challenge of employing various analytical methods to investigate soil elements other than phosphorus, certain studies in the 1980s adopted a multi-elemental approach to soil analyses. In 1981, Griffith (1981) attempted to establish discrete functional areas within the Benson site, a 17th-century Huron (Wendat) village site in Canada, by identifying middens based on their high levels of magnesium (Mg), calcium (Ca), potassium (K) and phosphorus (P). In 1988, Ottaway and Mathews (1988) analysed levels of zinc (Zn), copper (Cu), manganese (Mn), calcium (Ca) and magnesium (Mg) in a 6 m deep sondage site in Gomolava, Serbia, where they found stratigraphy ranging from the Neolithic to Medieval period. They highlighted the importance of phosphorus in interpreting the levels of other elements analysed. Bethell and Smith (1989) published a multi-elemental approach using a single method and instrument based on work at Sutton Hoo burial in 1987. This study directly addressed key questions in archaeological geochemistry, such as background sampling, sampling methods, elemental mobility, the influence of local environmental conditions, and inter-site comparability. Additionally, due to its early application of Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES), the paper also included a discussion of suitable extraction techniques for sample preparation.

Although Bethell and Smith's (1989) study at Sutton Hoo was not the first multi-elemental application employing a single instrument in archaeology (e.g., Keeley *et al.* 1977), it remains an exemplary case for integrated, planned sampling within an archaeological excavation strategy. Since the publication of this study, the use of ICP, particularly ICP-MS (Inductively Coupled Plasma Mass Spectroscopy), has grown, becoming the most common instrument for multi-elemental approaches. The number of published studies using these techniques increased in the 1990s (Linderholm and Lundberg, 1994; Middleton and Price 1996; Entwistle and Abrahams 1997; Aston *et al.* 1998; Entwistle *et al.* 1998; Pierce *et al.* 1998; Rimmington 1998; Terry *et al.* 2000; Wells *et al.* 2000), and this expansion persists today. For example, Aston *et al.* (1998) conducted an extensive landscape study across the single parish of Shapwick in southwest England, involving a surface survey, widespread shovel-pit testing and excavations, and selected sites analysed for soil trace element chemistry. The investigation unveiled the identification of formations in the soils that were correlated with structures linked to indicative field names and detected through geophysics (Aston *et al.* 1998). They were found to be associated with elevated concentrations of lead (Pb), zinc (Zn), and cadmium (Cd). Furthermore, an enclosure exhibiting an enhanced concentration of Pb was also observed (Aston *et al.* 1998). In their study, they also found that a Roman villa they investigated exhibited enhanced levels of nickel (Ni), cobalt (Co), manganese (Mn), and Pb, and a High Medieval surface pottery concentration was linked to Zn and Pb. These elevated elements were attributed to human and animal refuse and body waste (Aston *et al.* 1998). Still, the use of ICP for multi-element analysis was not universally adopted in this decade. For example, da Costa and Kern (1999) in their archaeological prospection of occurrences of black soils (that show aspects of human occupation such as ceramic and lithic artefacts, coal, and, in places, shells) called *Terra Preta Arqueológica* or archaeological black earth, in the Amazon area of Brazil, used a multitude of chemical analysis methods which found a correlation of P, Mg, Ca, Sr, barium (Ba), chlorine (Cl), Mn, Zn, and Cu with anthropogenic activity.

Wells *et al.* (2000) found that phosphate analysis could also help determine the use of middens for the disposal of kitchen wastes or otherwise. However, they emphasised that in areas with a concentration of other elements, such as heavy metals, it could be an indicator of a workshop, craft or ceremonial area (Wells *et al.* 2000, 459; similar observation in Terry *et al.* 2000). In this way, they pointed out the use of a multi-element analysis being a complementary aid to phosphate analyses to identifying the use of specific areas within structures and sites. Entwistle *et al.* (1998, 2000a) investigated soil enrichment in Scotland, revealing crucial concerns for soil geochemistry application in archaeology. The study found elevated levels of various trace elements, such as barium (Ba), Rare Earth Elements, potassium (K), caesium (Cs), thorium (Th), and rubidium (Rb), at an abandoned settlement on Skye. Conversely, elements commonly associated with habitation, such as Co, Zn, Pb, Ni, Magnesium (Mg), and Copper (Cu), showed no increase. While certain element sources could be identified, others remained ambiguous. For example, high phosphate levels in yard areas were attributed to manure piles, while low levels in the fields were due to depletion from plant harvesting. Cu and Zn's lack of increase was attributed to mobility in acidic soils and low initial input levels. Most studies in the 1990s tended to use a targeted sampling method. This led Entwistle *et al.* (1998) in their study to caution against spatially limited sampling, suggesting a network of spot samples instead.

Concurrent with the modest yet increasing number of published studies, comprehension of differential retention mechanisms within soil also advanced in the 1990s. Specific elements were consistently observed to be enriched in archaeological contexts, including Ca, K, Mg, and P (Middleton and Price 1996; Entwistle *et al.* 2000a). Linderholm and Lundberg (1994; also see Linderholm 2007) undertook a study which involved a multi-elemental analysis of several excavated sites in Sweden. Their findings revealed that Cu, Pb, P, Mn, Zn, and Ca were frequently observed to be elevated in settlement features. Moreover, strontium (Sr) was especially linked with food preparation, in conjunction with P and Ca (Middleton and Price 1996; also seen in Milek and Roberts 2013), while hearths were associated with these elements as well as Zn, K, and Mg. Studies in the 2000s showed that Cu, Pb, barium (Ba), iron (Fe), aluminium (Al), and sodium (Na) seem to function as less universal and more site-specific indicators (Knudson *et al.* 2004; Wilson *et al.* 2008; 2009; Vyncke *et al.* 2011; Milek and Roberts 2013).

The past two decades have seen a flurry of studies that have taken the approach of analysing soils for multiple elements. In 2004, Haslam and Tibbett (2004) offered an overview of progress in this field so far. They pointed out that the number of elements that are used as indicators of human activity has continually increased. Burials, food waste, and animal excretion caused enhanced P and Ca; wood ash elevated magnesium (Mg); the production and use of coins, jewellery, and pigments raised Cu and Pb; plant and animal waste showed high levels of elements such as boron (B), Cu, Mg, Mn, Ni, P, selenium (Se) and Zn; and copper metallurgy raised Cu, Pb and Mn. Multi-element analyses also continued to be applied in the field of ethnoarchaeology. Middleton (2004, 56), based on ethnoarchaeological studies from ten sites in Mexico, Colombia, Guatemala, Turkey, and China, concluded that *in situ* burning mainly showed very high levels of P, K, Ca, and Fe but also high levels of other elements. Wood ash was characterised by remarkably high levels of P, K, and Ca, and food preparation areas by fairly high P and Ca levels (Middleton 2004, 56). Middleton (2004, 56-59) found the findings from the ethnoarchaeological sites applicable in the analysis of the multi-elemental study of the archaeological site of Çatalhöyük, Turkey. Cook *et al.*'s (2005) investigation of an excavated Roman house complex in the town of Silchester, England, to identify traces of onsite metalworking found that while the elevated Pb, Zn, and Cu contents in the soil coincided with hearths and burnt areas, those for gold and silver did not. Furthermore, the later study of this site suggested that significantly high levels of Cu seen in relation to the hearths were linked to probable working of copper alloys (Cook *et al.* 2010). They also noted that in the absence of any '*prima facie* evidence for metal-working' at a Roman site, the higher levels of Pb seen in hearth areas may be linked to the use of lead vessels for cooking rather than metal working (Cook *et al.* 2010, 879). Hutson and Terry (2006) in their study of Mesoamerican plaster floors at the ancient Chunchucmil, Yucatan, Mexico, dating to 300-600 AD, analysed phosphorus and trace metals such as barium, cadmium, Cu, Fe, mercury, Mn, Pb, strontium (Sr), and Zn. Structure 22 which was analysed in this study had three rooms, and it was found that the two smaller back rooms had higher phosphorus levels than the front room and the entrance, suggesting that the front room was kept clean for visitors (Hutson and Terry 2006, 397). Furthermore, they identified that food storage areas tend to show higher phosphate readings, especially in the nooks of such rooms (Hutson and Terry 2006, 398). They also found that possible oven-like furniture in a room showed similar patterns of Cu, Sr, and Pb distribution along with elevated levels of P (Hutson and Terry 2006, 398). They suggested that high levels of various elements along the edges of a room are the result of debris swept in that direction (Hutson and Terry 2006, 401).

Davidson *et al.* (2007) conducted a comparative study of abandoned rural sites in remote regions in mainland Scotland and the more recently abandoned island of St. Kilda. The study focused on Pb, Zn, Cu, and P, which are widely recognised as elements indicative of habitation. These elements were found to be enriched in settlement areas, with decreasing levels observed while moving from house hearths to midden heaps, yards for vegetable gardens, infields (intensively managed and arable), and outfields (less intensively managed). Wilson *et al.* (2009) conducted a comprehensive review of studies from around the world on the use of soil elements as indicators of functional areas within and around archaeological settlements. While elements such as P, Pb, Ca, Zn, and Cu were identified as indicative of past habitation, the authors acknowledged that simple models could not be universally applied and that site-specific factors such as human use of space, land use, climate, and soil variation must be analysed (Wilson *et al.* 2009). On the other hand, the general review of archaeological soil geochemistry by Oonk *et al.* (2009) revealed a common finding of anomalous levels of Ca, Cu, Pb, Mg, K, Sodium (Na), P, and Zn in past settlement deposits. However, the review also highlighted the challenge of defining an accurate baseline for naturally occurring elements in associated soils and clearly identifying the source of any specific enhancement.

The past decade has seen some applications of multi-element analysis in house floors, yet it remains largely as feature-targeted testing in most cases. Furthermore, its application remains rare in Britain. In 2011, Vyncke *et al.* (2011) applied soil chemistry to floors at the excavated settlement of Düzen Tepe, located near Sagalassos in Turkey, intending to replicate the findings obtained worldwide since 2000 in identifying different uses of space in past settlements. The authors used the associations of K, Mg, Fe, P, and Sr to identify a hearth/cooking zone, a portable fire recipient, a toilet area, a door area, and a zone of high traffic (Vyncke *et al.* 2011). However, a combination of feature-targeted and prospection use sampling methods was also seen to be used in the case of the study of the Preclassic site of Xtobo, Yucatan. Here, samples were collected on a 25 m grid site-wide and on a 10m grid within structures. The study noted that the overlap of concentrations of P, Fe, Cu, Mn and Pb is suggestive of mixed household and workshop midden deposits (Anderson *et al.* 2012, 373). As noted earlier, ICP-AES or, more so, ICP-MS continued to be the predominant method used in soil chemistry in archaeology. However, Derham *et al.* (2013) employed an innovative technique of soil geochemistry of portable X-ray fluorescence (pXRF) spectrometer to examine various contexts in the ancient city of Sicyon, identified through the surface survey and geophysics. This method enabled field-based soil analysis, which did not require much sample preparation before analysis like other methods (e.g., ICP-MS), which they suggested would eliminate the need for time-consuming and expensive laboratory testing. The findings showed the interiors of house blocks exhibited elevated levels of P, K, Zn, Cu, Na, and S. In order to test the accuracy and efficacy of pXRF against ICP and other prevalent spectrometry methods, auger samples collected from a house, an outer fortification ditch, areas in the settlement's centre, and a potential workshop of an Early Bronze Age settlement of Fidvár, Vráble, Slovakia, were subjected to geochemical studies using these methods (Gauss *et al.* 2013). The study found that pXRF had good accuracy in the detection of elements such as Ca, P, and Sr linked to human occupation. Furthermore, the success of the study was also underscored by the pXRF study that suggested the absence of the potential workshop, which was confirmed by targeted excavations of the area by Gauss *et al.* (2013). Hayes (2013) employed pXRF to test its viability in archaeological site prospection at Reaume Fort Site, Central Minnesota, USA, using a 2 m grid. The study helped in identifying certain sub-surface features within 5 cm of surface level, such as chimney bases, bone beds (sedimentary deposits that contain bones), and wall trenches of charred wood that showed high levels of P and Ca. She also noted that higher Fe and Ca values were linked to some extent with chimney pile features (Hayes 2013, 3206). Considering that the features at this site were identified on sediments that were 5 cm above the archaeological layer, it does raise the question of the extent to which contexts lying on top of each other have an effect on each other's chemical properties. A similar use with pXRF was undertaken by Cannell (2016) in her study of three Viking Age sites in Norway to examine archaeological geochemistry as a technique for enhancing comprehension of spatial and temporal fluctuations in occupation deposits. However, her sampling strategy involved coring to understand spatial and temporal variation in study areas.

Coronel *et al.* (2014) in their study of the central plaza (that accommodated a marketplace) of Telchaquillo, a contemporary village in Yucatan, Mexico, used pXRF to identify trace metal concentrations on the site and found that, along with P, iron (Fe), copper (Cu), zinc (Zn), and manganese (Mn) were linked to remnants of blood from butchered animals near butchering posts. At another Mexican site of Area D of Chunchucmil, Yucatan peninsula, Hutson *et al.* (2017) pXRF to identify a possible marketplace. However, this site was previously studied by Dahlin *et al.* (2007). Dahlin *et al.* (2007), based on their study of P, Zn, Sr, Ba, and Fe along with a study of a modern marketplace in Antigua, found that areas of food preparation/processing tend to show higher levels of P and Zn suggesting that these areas had food, and probably a host of other utilitarian objects, that were regularly prepared, vended and spilt here. They also found that interlaced areas that showed high levels of Ba and Sr, but low levels of P, Fe, and Zn, indicated areas of heavy traffic (Dahlin *et al.* 2007, 380). The pXRF study detailed by Hutson *et al.* (2017, 253-258) also corroborated the findings of Dahlin *et al.*

(2007) that marketplaces or food processing areas tended to show high levels of P and Zn. Interestingly, they noted that the area of contemporary butchering and meat sale activities in the marketplace in the village of Telchaquillo, Mexico, in Coronel *et al.*'s (2014) study, which showed high levels of P, Cu, Zn and Fe, were next to a limestone outcrop and similarly high levels of P, Zn, and Fe were also seen at Area D at Chunchucmil that was adjacent to a limestone outcrop (Hutson *et al.* 2017, 256). Hutson *et al.* (2017), hence, drew caution in attributing this elevation in levels to any butchering or meat sale activities as the area was not within the limits of the marketplace, insinuating the role of the limestone outcrop in raising the level of P, Zn, and Fe at Chunchucmil and Telchaquillo.

Simniškytė-Strimaitienė *et al.* (2017) conducted a study at a later prehistoric hillfort in Lithuania by taking samples from archaeological features and subsoils while controlling for local soil effects and identifying the likely sources of anomalous elements. In the soil chemistry study, they used the technique of X-ray fluorescence spectrometer, which is similar in principle to pXRF except for the TXRF requiring sample preparation in a lab and higher accuracy. The study revealed a context of human waste disposal where no artefacts were found. With elevated levels of P, Mn, and Zn here, they suggested these as markers of ash, possibly in connection with metallurgy. At the same time, aluminium, Fe, K, Na, and Sr were associated with infill from clay daub and clay-plastered poles. Save *et al.* (2020) reported on the use of pXRF equipment to perform field-based analysis of archaeological sediments, especially on developer-funded projects, which allowed routine analysis. Their review of results from multiple sites identified specific elemental enhancements, with Ca, P, and Sr linked to organic material and K associated with domestic and agricultural activities. They also emphasised that internal site patterning and its elemental associations, rather than absolute values, are essential for tracking anthropogenic influence due to varying soil properties, post-depositional changes, and a wide range of human activities carried out at different locations within past settlements (Save *et al.* 2020). A pilot study for southern African archaeological sites in terms of the use of pXRF was also carried out in the 'Stone Walled Sites' dating to the 1800s at Seoke in southeast Botswana, which found varying chemical signatures for communal middens and individual household middens (Biagetti *et al.* 2021). This variation in chemical signatures was suggested to be linked to their differential depositions. Interestingly, they found a correlation between areas with pottery, such as vessel storage areas, and zirconium (Zr), relating it to the higher levels of Zr seen in clay.

The difficulty in interpreting raised levels of different elements remains a problem. For example, Scott (2020) conducted soil chemical sampling at the Bronze Age site of Kaymakçi in Turkey and found that Cu and Pb elevation was primarily due to metallurgy rather than organic sedimentary components. However, in a recent study by Holdridge *et al.* (2021) on the Roman-Islamic city of Jerash in Jordan, elevated levels of Cu and Pb found in soil samples were attributed to the cumulative buildup of secondary waste deposits from artisanal and domestic activities, rather than local mining or associated workshops. Furthermore, Bintliff and Degryse (2022) suggest that such an elevation of copper and lead could also be because of household waste.

Archaeological geochemistry has been used for several decades to prospect and elucidate settlement morphology, with a range of extraction and instrumental approaches employed. Despite progress, knowledge gaps, technological concerns, wider applications, and challenges remain with respect to using elemental concentrations in the soil to investigate past human activity. Multi-element analyses have been applied to diverse environmental conditions and time periods, with ethnographic and experimental approaches used to connect observed activities to elemental enhancement. Studies have focused on the use of space, with houses being internally sampled to understand their use. Nonetheless, the absence of uniformity in the sampling methodologies and the preponderance of research focusing on recognised archaeological features within structures highlight a necessity to enhance the precision of soil chemical analysis implementation. Furthermore, open areas, courtyards, plazas, and field systems have also been studied in conjunction with artefact distribution and geophysical prospection. However, the sampling area often becomes an issue of convenience, access, and motivation. Multi-element analysis has hardly seen a systematic grid-based application on well-preserved house floors, especially in Britain. Furthermore, still being a young field of analysis, the behaviour of various elements in association with archaeological features under varying levels of pH remains understudied. While the preservation of various artefacts and ecofacts is highly contingent on the pH level of the soil in which they are deposited, the decayed artefacts or ecofacts would tend to remain in the soil in the form of the changed chemical composition of the soil, which can be detected by the elevation of various chemical elements associated with artefacts or ecofacts. A good example of decayed material being reflected in the geochemical analysis of the soil is the study of the burial at Sutton Hoo by Bethell and Smith (1989).

In recent decades, there has been a gradual yet measured advancement in the integration and development of geochemical methodologies within the field of archaeology. This progress has resulted in the identification of associations between diverse archaeological features and activities with distinct chemical elements, as evidenced by numerous studies. To systematically examine the recurrence of chemical elements in relation to activities across disparate archaeological sites and studies, a table encompassing archaeological sites, features, and associated element enrichments in their respective archaeological soils was generated (see Table 3.1). This table serves as a tool for discerning patterns in the elemental composition linked to specific activities across varied archaeological contexts. Although certain variations in the elemental composition associated with particular features are discernible, there are also noteworthy recurrences of specific elements in connection with these activities/features. The structure of this table is based on a similar table by Oonk *et al.* (2009; also cited in Bintliff and Degryse 2022). Notably, Table 3.1 presented here, not only incorporates the findings of Oonk *et al.* (2009) but also integrates insights derived from additional studies considered within the framework of this literature review. However, the differences in the combination of elements associated with the same activity/feature seen in different studies may be the result of factors such as different chemical analysis techniques and differences in the sites and geologies of the sites.

Archaeological Feature	Elements	Reference
Midden	Mg, Ca, K, P	Griffith 1981
	P	Wells *et al.* 2000; Terry *et al.* 2000
	P, K	Chaya 1996; Fernández *et al.* 2002; Wells *et al.* 2000; Parnell *et al.* 2001 (cited in Oonk *et al.* 2009)
Midden (from household/ workshop)	P, Fe, Cu, Mn, Pb	Anderson *et al.* 2012
Plant/animal waste	Boron, Cu, Mg, Mn, Ni, P, Se, Zn	Haslam and Tibbett 2004
Structure	P, Pb, Zn, Cd	Aston *et al.* 1998
Structure-house interior	P, K, Zn, Cu, Na, S	Derham *et al.* 2013
Houses (linked to farms)	P, Ca, Mg, Fe, S, Th, Rb, Cs, Pb, Zn, Sr, Ba	Zimmerman *et al.* 1992; Chaya 1996; Manzanilla 1996; Fernández *et al.* 2002; Entwistle *et al.* 2000a; 2000b; Wells *et al.* 2000; Parnell *et al.* 2001; Wilson *et al.* 2005, 2006a (cited in Oonk *et al.* 2009)
Painted building	Heavy metals	Wells *et al.* 2000 (cited in Oonk *et al.* 2009)
Roman villa (human/animal waste)	Ni, Co, Mn, Pb	Aston *et al.* 1998
High Medieval Surface Pottery concentration area	Zn, Pb	Aston *et al.* 1998
Workshop/craft/ceremonial area	P+ heavy metals	Wells *et al.* 2000; Terry *et al.* 2000; Holliday 2004
Food preparation	P, Ca (relatively high), Sr	Middleton 2004
	Sr, P, Cu	Middleton and Price 1996; Milek and Roberts 2013
Meat preparation	Sr, Zn, P	Vyncke *et al.* 2011
Hearth	Sr, P, Cu, Zn, K, Mg	Middleton and Price 1996; Milek and Roberts 2013
Hearth/burnt area	P, K, Mg	Cook and Heizer 1965; Parsons 1962; Keeley 1981; Bethell and Smith,1989 (cited in Oonk *et al.* 2009)
	Pb, Zn, Cu	Cook *et al.* 2005
Hearth/*in situ* burning	P, K, Ca, Fe	Middleton 2004
Hearth/ burning	P, Pb, Zn, Ca, Cu, Mn	Aston *et al.* 1998

Archaeological Feature	Elements	Reference
Oven	Cu, Sr, Pb, P	Hutson and Terry 2006
Ash and other burnt material (such as turf or dung)	P, Mn, Zn along with slight enrichment of K, Fe, and Al	Simniškytė-Strimaitienė *et al.* 2017
Wood ash	Mg	Haslam and Tibbett 2004
	K	Steenari *et al.* 1999
	K, P, Ca	Middleton 2004
	K, Sodium (Na)	Dempsey and Mandel 2017
	K, Ca (to some extent)	Hjulström and Isaksson 2009
Burial/food waste/ animal excretion	P, Ca	Haslam and Tibbett 2004
Burial/graves	P, Cu, Mn, Ca	Cook and Heizer 1965; Parsons 1962; Keeley 1981; Bethell and Smith 1989 (cited in Oonk *et al.* 2009)
Production, use of coin, jewellery, pigment	Cu, Pb	Haslam and Tibbett 2004
Copper metallurgy	Cu, Pb, Mn	Haslam and Tibbett 2004
Mining, smelting, production sites	Cu, Pb, Mn	Jenkins 1989; Maskall and Thornton 1998; Hong *et al.* 1994; Pyatt *et al.* 2002; Monna *et al.* 2004 (cited in Oonk *et al.* 2009
Food storage	High P in corners of the room	Hutson and Terry 2006
Presence of pottery or areas of vessel storage	Zirconium (Zr)	Save *et al.* 2020; Biagetti *et al.* 2021
Sleeping area (arguable)	Generally low levels of most/all elements	Vyncke *et al.* 2011
Sleeping areas, areas around and under beds	low levels of P	Pingarrón 2014

Table 3.1: Elements associated with various features/activities in archaeological sites, seen in various geochemical studies (adapted from Oonk *et al.* 2009).

Several factors affect the study of archaeological sites using geochemical analysis. Linderholm and Lundberg (1994, 313) in their study insinuated the importance of knowing the taphonomy of archaeological sites and their deposits as otherwise the enrichment of levels of various elements seen in conjunction with activities of people in the past can only be speculated upon. In other words, in the interpretation of data acquired from such geochemical studies, it is important to determine the chemical composition of the geological bedrock and the subsoil from which the samples are collected in order to understand what elements can be expected to be elevated. Bintliff and Degryse (2022, 6), in their review of geochemical studies, noted that the enhancement of various elements seen in the soil can be affected by a number of factors such as: the local geology and the character of the natural soil and associated spatial variation; the different changes to levels and form of different elements post-deposition; external interventions such as ploughing, terracing, erosion and deposition, animal and crop uptake; anthropogenic influence/inputs in the settlement and the surrounding exploited environment; and also long distance influences such as that of atmospheric pollution from urban and industrial centres. Bintliff and Degryse (2022, 2,6) noted that geology, especially, can play a major role in elements present on a site. For example, Vyncke *et al.* (2011; cited in Bintliff and Degryse 2022, 4) noted that Mg along with K, Fe, P and Sr were associated with a hearth/cooking area, portable fire recipient, toilet area, a door area, and high traffic zones at the settlement of Düzen Tepe, Turkey. However, they also found that Mg along with Cr, Ni, Pb and Titanium elevations were linked to the geology of the site (Vyncke *et al.* 2011; cited in Bintliff and Degryse 2022, 4). It is also worth pointing out a key observation by Bintliff and Degryse (2022, 2; also cf. Wilson *et al.* 2009) that even sites exhibiting similarities in geology, geography, chronology, and function can manifest distinct patterns of soil enrichment. This raises the point of equifinality.

Equifinality, in the case of geochemical studies, would suggest that for every element potentially indicative of a particular form of human behaviour, multiple alternative causes can be claimed, some of which are not necessarily the result of anthropogenic action (Bintliff and Degryse 2022, 6). Considering the above points in conjunction, it is important to emphasise that while it may be easy to attribute the elevation of levels of various elements in archaeological sites to anthropogenic factors (as observed in Table 3.1), to make interpretations or inferences that go beyond mere speculation, it is vital to lay out other natural and anthropogenic processes that may cause the same elevation in elements. According to the assertions posited by Bintliff and Degryse (2022, 6), a concerted examination of the internal patterning of elements within an area is needed alongside a comprehensive consideration of the diverse processes (including geological) that may contribute to those same patterns.

3.4 Application of Geochemical Analysis in Archaeological Floors in Britain

While various examples exist of the use of phosphate analyses in archaeology as a tool for locating areas of human occupation and for locating specific areas such as middens or byres, wide application of this method within structures in Britain is limited. Furthermore, multi-element analysis, specifically of structures, only happened occasionally in the mid-to-late 80s, 90s and 2000s. With a majority of studies focusing on phosphate analysis, the following section explores a few examples of its application within houses or enclosures. These examples were chosen specifically as these are among the few examples of geochemical soil analyses which have been used to interpret the use of space within structures, specifically houses. Case studies will focus on phosphate analysis first, followed by case studies using multi-element analyses. As I discuss each site, I will highlight the ways in which methods differ, highlighting that there has not always been a consistent approach in geochemical analyses of structures. Various houses are explained, and the publication of data in each case study is scrutinised. It is important to stress that this is not a discussion of all geochemical analyses in house floors in Britain. The results of some key analyses are discussed in later chapters where they are specifically relevant to the case studies explored in this PhD.

3.4.1 Barnhouse, Orkney

Barnhouse is a Late Neolithic settlement complex that consisted of several stone houses laid out in a concentric arrangement (Figure 3.2). Seven houses were excavated forming an inner ring, and five houses formed the outer ring. Due to the fairly well-preserved nature of some house floors, some of them were subject to phosphate analyses with samples collected on a 0.5 m grid, which are discussed below.

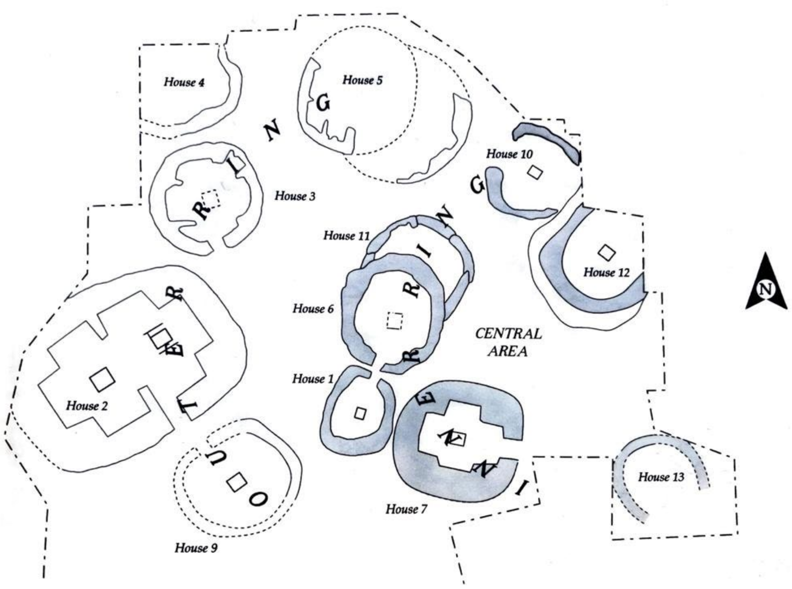

Figure 3.2: Concentric organisation of houses at Barnhouse, Orkney (Jones and Richards 2005, fig 3.31).

House 3

House 3 was a Late Neolithic building that formed a part of the outer ring of houses. It was 6.9 m long and 6.6 m wide and oval in shape. It had an entrance orientated southeast and at least five major phases of activity that involved re-flooring, with the accumulation of associated deposits or reconstruction of internal furniture. The third floor was built up during the third phase and was subjected to phosphate and magnetic susceptibility surveys. During this phase, a fireplace is seen to be set beneath the rear 'dresser'. This 'dresser' was a cavity created in the northern circuit of the wall that contained three stone pillars (Figure 3.3). The dresser in earlier phases has been suggested to have effectively functioned as a cupboard (Downes and Richards 2005, 65). The north area of this house was also recorded to contain an ash heap that also contained burnt bone (Downes and Richards 2005, 67). The phosphate survey showed high levels on either side of the 'dresser'/ fireplace and the rear cell, indicating that it was the locus of activities (Downes and Richards 2005, 69; Figure 3.3). However, it is also likely that the northeast ash heap may have contributed to the elevated level of P there.

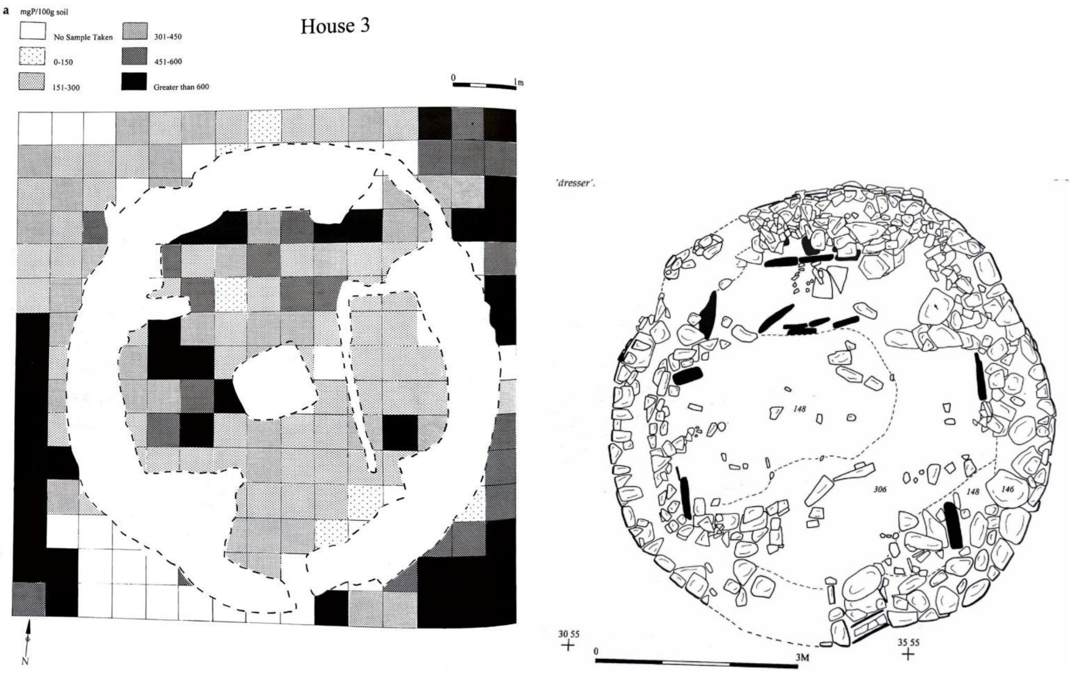

Figure 3.3: Phosphate analysis of the third floor of House 3 (left) and plan of House 3 in period 3 (Downes and Richards 2005, figs 4.11 and 4.19).

House 6

House 6, located in the inner ring of houses, is another Late Neolithic house that was subjected to phosphate analysis. It had an entrance facing southwest. It consisted of a central hearth and a covered drain running north of the hearth (Downes and Richards 2005, 94). The phosphate analysis revealed slightly higher levels on the western side (Figure 3.4). This has been attributed to an ashy spread radiating from the hearth. Downes and Richards (2005, 98) suggest that the high levels of phosphates indicate ash being raked out of the western side and that food preparation occurred here. Based on the recovery of pumice and flint, specific craft activities have been suggested for this house along with its use as a dwelling; however, a specific area for the craft activities has not been suggested (Downes and Richards 2005, 98).

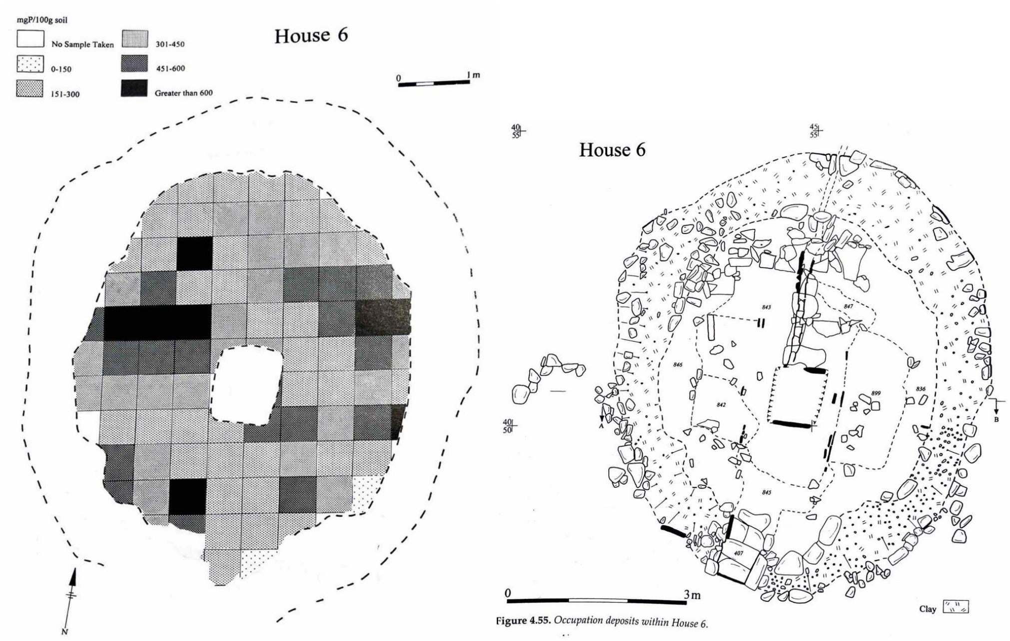

Figure 3.4: Phosphate analysis of House 6 (left) and plan of House 6 (right) (Downes and Richards 2005, figs 4.60 and 4.55).

House 10

This house was part of the inner ring and lay north of the open central area within the settlement. It had an entrance that was suspected to be aligned northwest (Downes and Richards 2005, 98). It had recesses on either side of its central hearth (Figure 3.5). The floor was not well preserved. However, it has been suggested that it had no laid clay floor and the natural clay till was used instead. A spread of ash was seen to be distributed fairly evenly around the central hearth. Higher levels of phosphate seem to concur with the ash distribution around the hearth (Figure 3.5). However, higher levels were observed to the north of the hearth which has been associated with domestic activities (Downes and Richards 2005, 105).

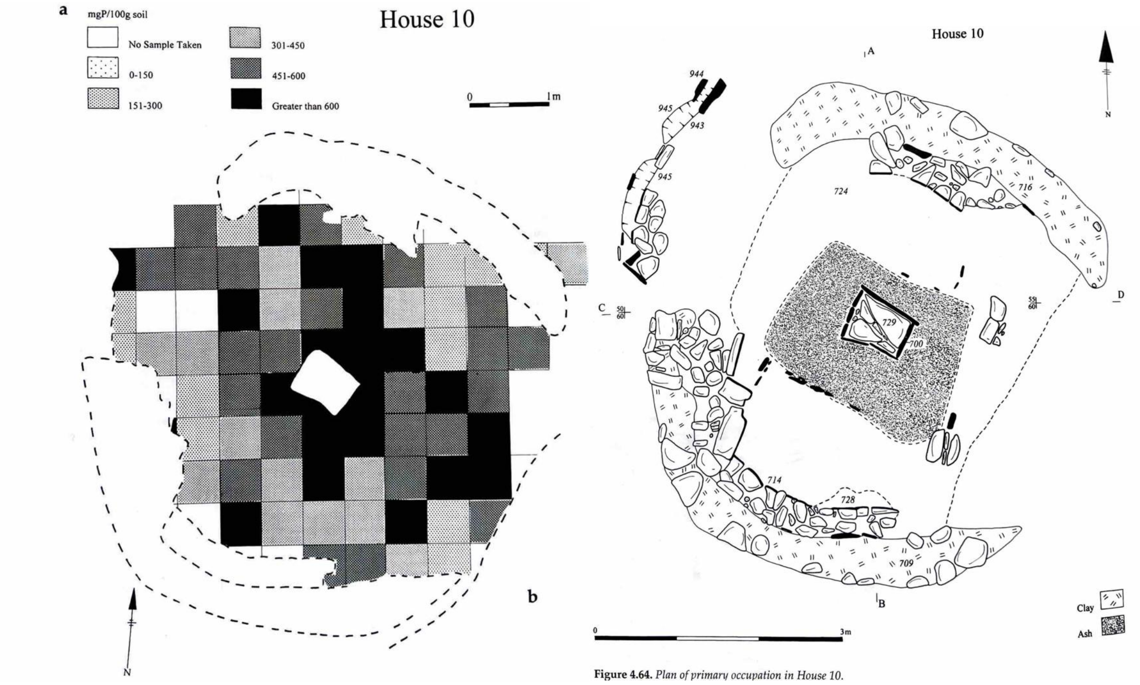

Figure 3.5: Phosphate analysis of House 10 (left) and plan of House 10 (right) (Downes and Richards 2005, figs 4.68 and 4.64).

House 1

Forming a part of the inner ring of houses, this building was one of the smaller houses in the settlement. It contained a central hearth and two clay floors (Figure 3.6). The secondary floor was subjected to phosphate analysis, and it showed generally low levels of P in the house. Although a layer of ashy soil of up to 0.5 m thick was recorded on top of the secondary floor around the hearth, it seems to have not affected this floor in increasing the level of P. This ashy deposit has been linked to the end of the habitation of the house. Based on the significant amount of pumice recovered in the northern part of the house, hide working was suggested in the northern part of the house (Downes and Richards 2005, 110-111). However, this activity was likely linked to the primary floor and is not highlighted in the phosphate analysis of the secondary floor. The phosphate study at this site is a good example of a sound sampling strategy which incorporated the location of artefacts into the interpretation of the potential activities taking place in the houses. The visualisation of the results may have been enhanced had it been presented following statistical analysis rather than being shown as a grid. However, this was a typical strategy in the early 2000s.

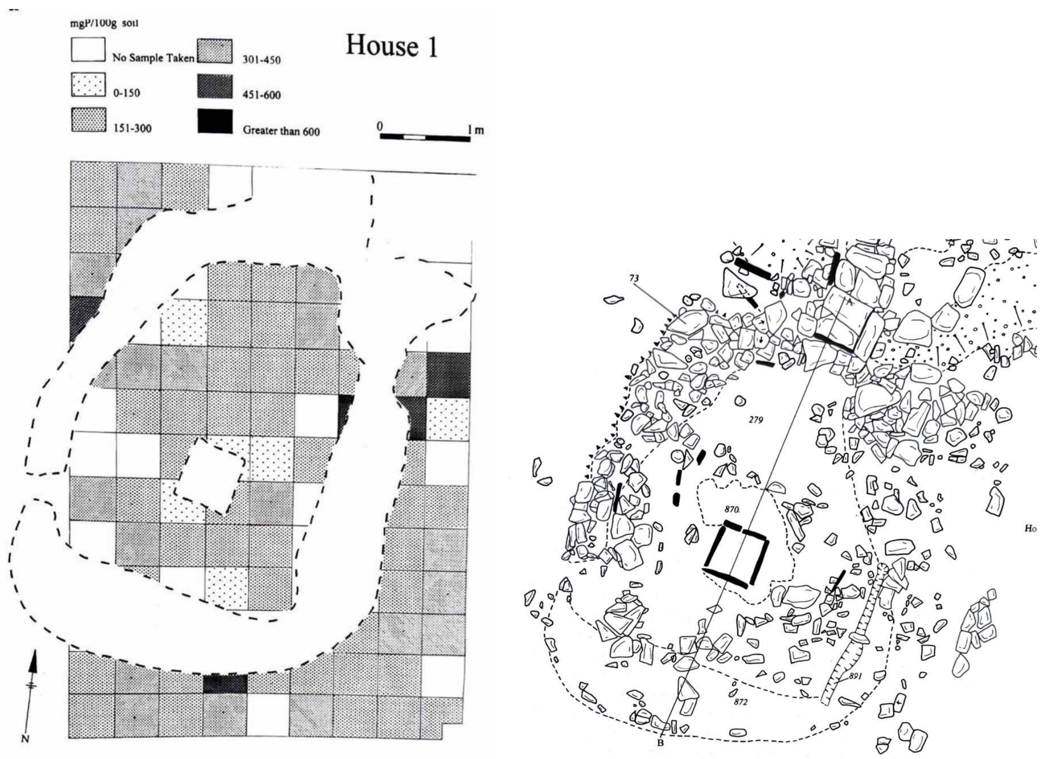

Figure 3.6: Phosphate analysis of House 1 (left) and plan of House 1 (right) (Downes and Richards 2005, figs 4.79 and 4.72).

3.4.2 Stonehall Knoll, House 3

Situated several miles west of Crossiecrown on Mainland Orkney, the Stonehall settlement represents a significant archaeological site dating back to the fourth millennium BC. The Neolithic occupation at Stonehall persisted into the third millennium BC, aligning with the observed patterns of nucleation evident at other Neolithic settlement sites in the Orkney region (Richards *et al.* 2016, 101). Beneath Pictish Iron Age constructions at this site, three Neolithic structures were identified. Among the Neolithic houses, House 3, dating to the 4th millennium cal BC, was subject to a phosphate study (Figure 3.7). The house had an entrance facing to the southeast and its interior was divided by internal lateral divisions created by orthostats projecting from the inner wall face (Richards *et al.* 2016, 101). Two clay floor layers were recorded internally, and it was suggested that they represent two long phases of occupation. The central area contained a stone-built hearth. The phosphate study showed that there was a discrete patch of high levels of P on the east of the hearth. Richards *et al.* (2016,

106) noted that these high levels of P spread to the western side of the hearth with decreasing value. The higher values (albeit lower than on the east) on the western side of the hearth are concurrent with an ash spread that was also observed on this side of the hearth. Generally higher P levels were observed in the central area around the hearth. This is concurrent with the suggestion made by Richards *et al.* (2016, 106) that a concentration of activities was focused around the hearth. Interestingly, raised magnetic susceptibility values were also seen in the areas showing higher levels of P (Richards *et al.* 2016, 107; Figure 3.7). Another area of high P levels and high magnetic susceptibility values was also observed in the area closer to the entrance on the east side, suggesting another area of activity. Based on the presence of stone tools such as three smoothers and a grinding slab, processing and manufacturing activities were suggested to have taken place in this house. However, the presence of these artefacts here was also attributed to the possible storage of the tools (Richards *et al.* 2016, 109). Another similar house that showed a fairly similar distribution of P levels around the hearth comes from House 3, Stonehall Meadow. However, this study is not discussed here as only a 2 m wide strip across the house was analysed for phosphates (Figure 3.8). The phosphate study at this site showed three broad areas of high levels of phosphates which were focused around the hearth (Richards *et al.* 2016, 118). Similar to House 3 at Stonehall Knoll, it was suggested that activities were focused around the hearth (Richards *et al.* 2016, 118).

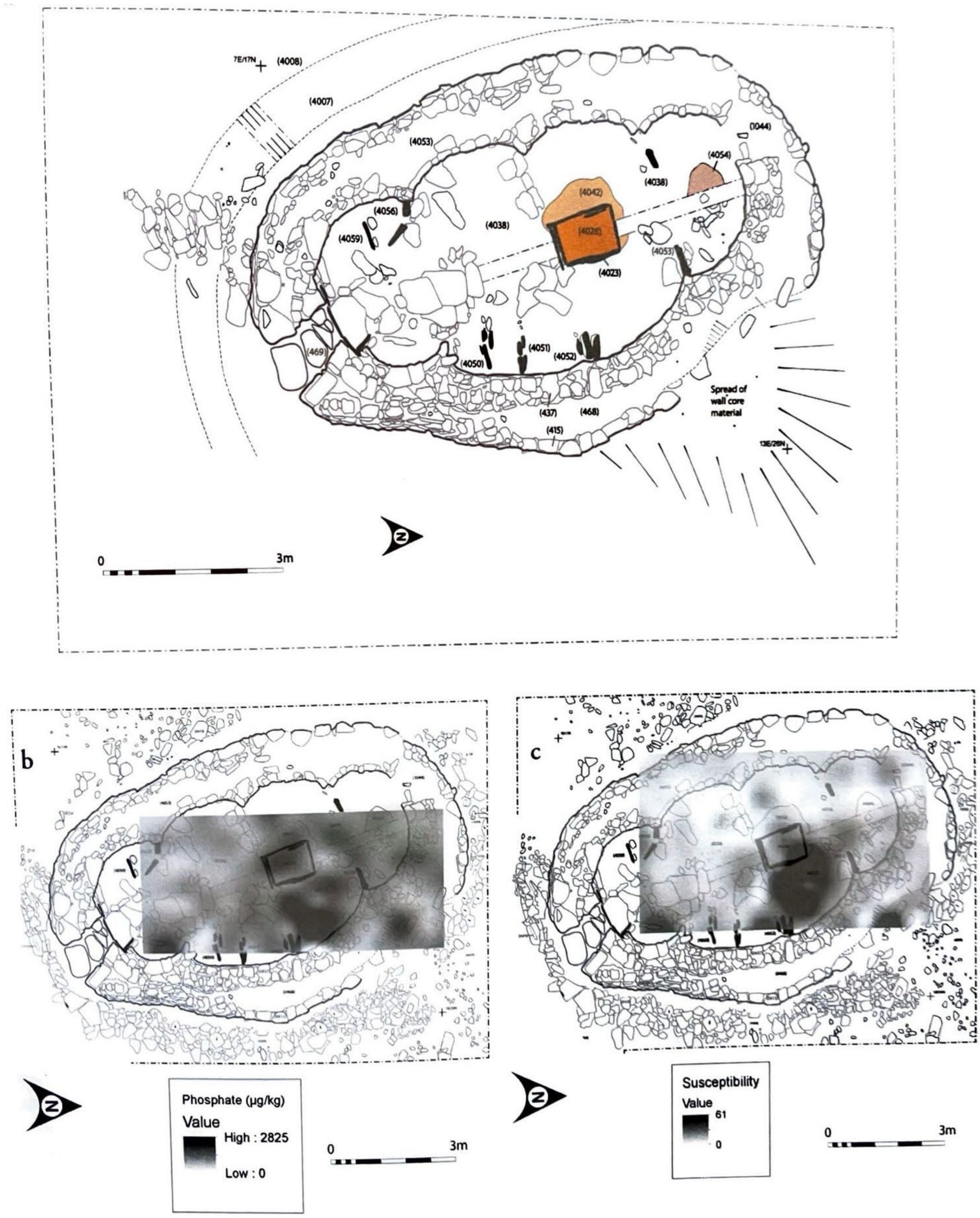

Figure 3.7: Plan of House 3, Stonehall Knoll (top), phosphate analysis of House 3 (bottom left) and magnetic susceptibility of House 3 (bottom right) (Richards *et al*. 2016, fig 5.19).

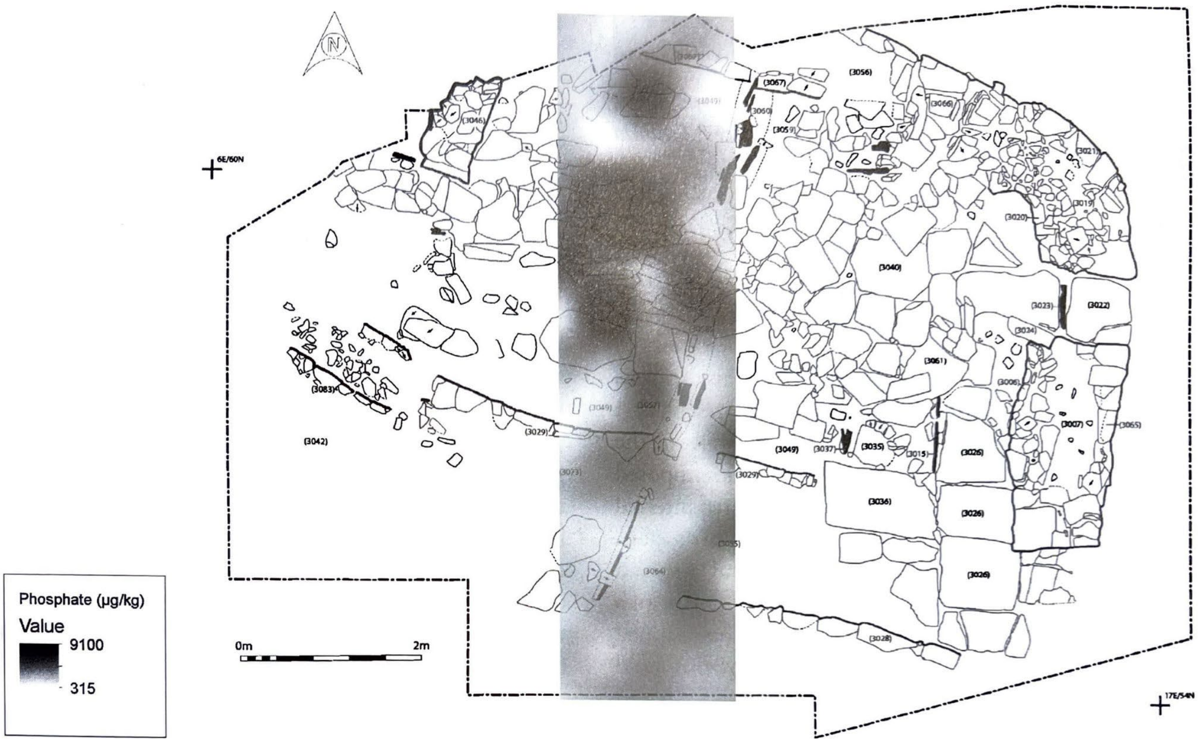

Figure 3.8: Phosphate analysis of House 3, Stonehall Meadow (Richards *et al.* 2016, fig 5.45).

3.4.3 Cladh Hallan, South Uist, Outer Hebrides

Cladh Hallan is a roundhouse settlement with a long occupation sequence stretching from the Late Bronze Age to the Iron Age. Several structures from this site were subject to a multi-faceted study involving sampling on a 0.5 m grid for floatation, magnetic susceptibility, and geochemical analyses, along with soil micromorphological analyses (Parker Pearson *et al.* 2021a). This study is an excellent example of a modern spatial study of structures incorporating multiple studies of different components and finds per house. The advantage of such a combination of multiple studies is that it can help reinforce or discredit interpretations of each house. For example, magnetic susceptibility can help identify areas of magnetic enhancement produced via burning and cooking, which could also be reflected in phosphate distributions. Furthermore, it is rare for a study to explore multiple houses with multiple floors preserved well enough to be studied extensively. Such a setting helps in the cross-comparison of phosphate studies between structures which have the added benefit of all being located on the same geology. The spatial studies at this site were able to identify the presence of domestic as well as non-domestic structures. The houses in the following section are discussed in chronological order, where possible.

House 2835

The Late Bronze Age House 2835 was a U-shaped or boat-shaped structure, with a southeast entrance, which is dated to 1380-1175 cal BC. It was built of exterior walls of wooden posts. Only the floor layers in the south and east survived; hence, the phosphate analysis and magnetic susceptibility study were restricted to this area of the house interior (Parker Pearson *et al.* 2021b, 52-54). The area around the hearth exhibited the highest phosphorus and magnetic susceptibility values (Smith *et al.* 2021a, 57; Figure 3.9). Based on a concave-face pumice rubber from the southeast floor area and seven unworked pieces of pumice from the Late Bronze Age plough soil directly above, the southeast quadrant has been suggested to be a place for working wood, bone or hide (Smith *et al.* 2021a, 57). Possible pottery manufacture or clay storage inside this house has been proposed based on two small pieces of raw clay, one of which was from the hearth area. Generally, most artefacts and animal bones were found primarily on the eastern end of the floor. This has been interpreted as a possible result of rubbish discarded towards the entrance with fewer residues in the west seen after the clearing out or sweeping of the hearth area. Alternatively, the concentration of indoor activities may have been focussed in the more well-lit (by sunlight) part of the house (Smith *et al.* 2021b, 62). Based on the high densities of pottery on either side of the entrance, cooking and food preparation have been suggested to have taken place in the east end of the house. A sleeping area has been hypothesised behind the hearth in the western third of the house, while a working and sitting space is proposed near the door (Smith *et al.* 2021b, 62).

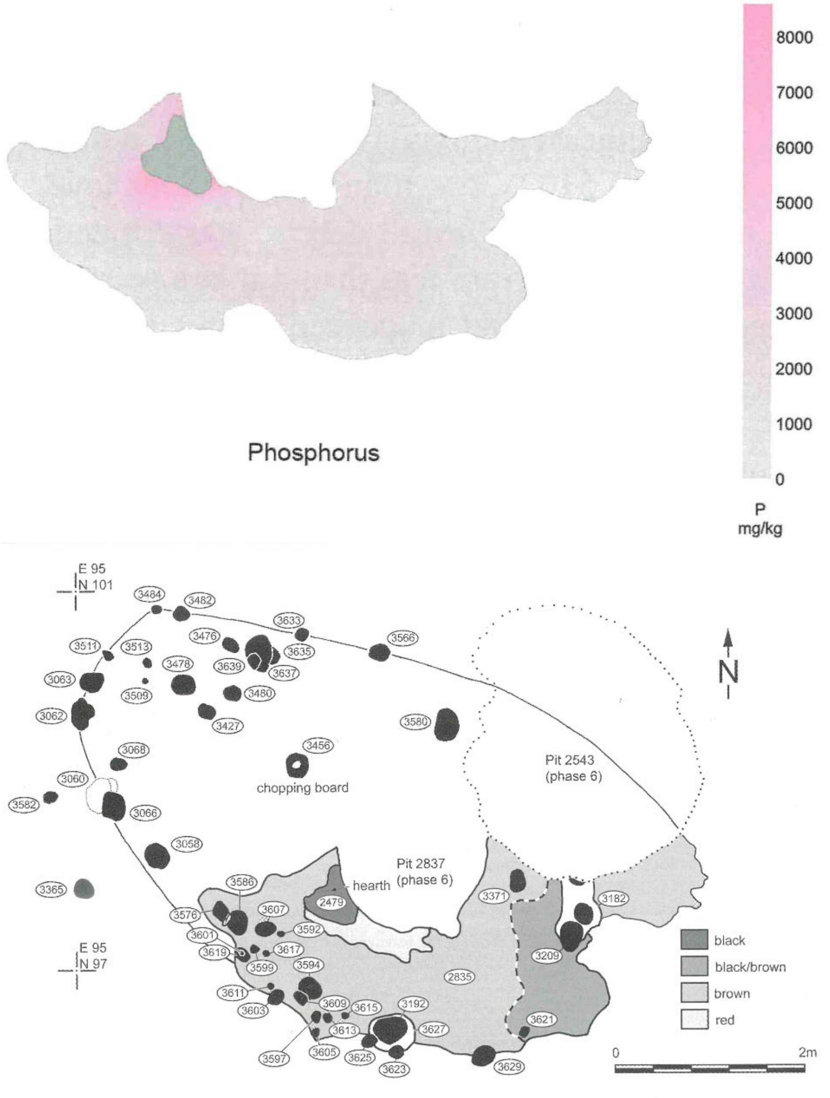

Figure 3.9: Phosphate analysis of floor of House 2835 (top) and plan of House 2835 showing floor layers that survived, the off-centre hearth and postholes (bottom) (Parker Pearson *et al.* 2021b, fig 3.7, 3.4).

House 801 (Floor 1150)

Floor 1150 of House 801 in Area A represented the occupation of a sub-rectangular Late Bronze Age house with an entrance facing east and a 2 m long passage. The interior of the house consisted of an earthen bank and stone niche on the southern side, a hearth in the centre, and an area of dark sand mottled with white machair sand in the northwest corner. It was dated to 1075-920 cal BC (at 95% confidence). The floor of the house was wholly intact except at its west end, albeit it was a thick layer of dark clayey sand (Parker Pearson *et al.* 2021c, 122; Figure 3.10). It had a central hearth that was highlighted by the highest values for magnetic susceptibility and phosphorus levels (Smith *et al.* 2021c, 128). The highest values of phosphorus were mainly observed around the central hearth, with some higher levels seen towards the northeast quadrant and on a sleeping platform in the northwest. The sleeping platform was identified here based on the observation of the floor being slightly raised in the northwest corner of the house. Higher values of P were also seen in the northeast quadrant, which was clear of artefacts (Smith *et al.* 2021d, 132). However, the northeast quadrant had higher levels of charred grain, spirorbis (a genus of small, tube-building marine annelid worms commonly found in both modern and ancient marine environments) and fish otoliths that correspond to the high levels of phosphorus seen here (Smith *et al.* 2021d, 133-134). A northeast-southwest line of six stones was suggested to direct movement into the house to the left along a 1.5 m long stretch of trampled floor. This line also seems to be the limit of the high values seen around the hearth in the southeast quadrant. Based on clay fragments, pottery-making activity was suggested in the southeast. On the other hand, based on the concentration of bone points, cut bone, antler, whalebone, flint and pumice in the southwest quadrant, craft activities associated with hide working, bone and antler were suggested in the southeast (Smith *et al.* 2021c, 128). Burnt and unburnt food observed around the hearth was suggested to indicate the use of the central area as an eating area around the fire, with a toss zone for food remains to the west (from people sitting facing the entrance and their backs to the west) (Smith *et al.* 2021d, 134). This is also observable in the high levels of P seen around the hearth and in the northwest quadrant where correspondingly higher amounts of butchered and gnawed bones were seen (Smith *et al.* 2021d, 134-135). To some extent, the phosphorus distribution seems to correspond with activities linked to floor 1150.

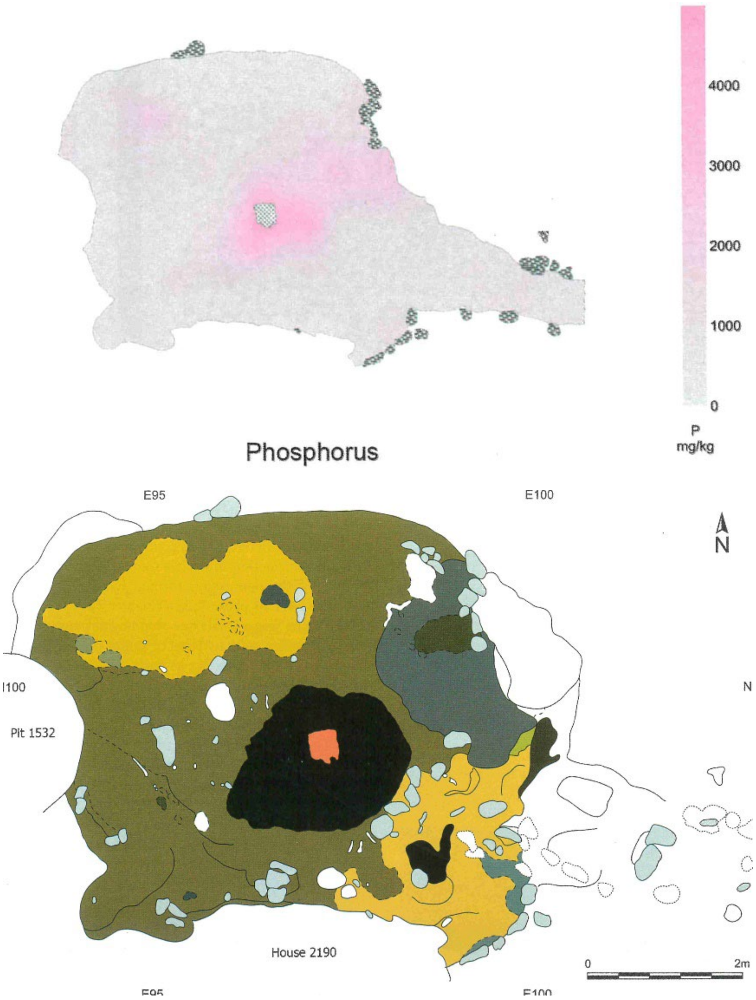

Figure 3.10: Distribution of phosphorus in floor 1150 of House 801 (top) and plan of House 801 with the central hearth in orange (bottom) (Parker Pearson *et al*. 2021c, figs 5.10, 5.6).

House 401

House 401 was a sub-rectangular roundhouse that had an eastern entrance. It had a central hearth and a cellar on the south side. This structure had five phases of occupation that are represented by floors 1311, 655, 595 and 465.

Floor 1311

Floor 1311 represented two sub-phases as a stratigraphic separation could not be made (Parker Pearson *et al.* 2021c, 137). Magnetic susceptibility showed the highest values around the hearth extending towards the west and northwest (Smith *et al.* 2021e, 154). Phosphorus values, on the other hand, were seen as a few clusters of high values in the northwest and northeast quadrants. Peripheral areas seem to show lower values (Figure 3.11). Based on the recovery of most of the pottery in the southeast it was suggested that this area was the main cooking and ceramic storage area (Smith *et al*. 2021f, 154). Craft-related and food-processing activities were also claimed as possible activities here. On the other hand, the southwest quadrant had the most craft-related artefacts and debris, indicating the location of craft activities here as well (Smith *et al*. 2021f, 154-157). The northwest quadrant was suggested to be the sleeping area with the sleeping platform against the wall and the recovery of deciduous human teeth (Parker Pearson *et al*. 2021c, 145; Smith *et al*. 2021f, 162). The slight elevation of P seen along the sleeping platform may be linked to the decayed machair turf that was found here (Parker Pearson *et al*. 2021c, 145-146). The northeast quadrant had high densities of carbonised grain. This quadrant of the house was also suggested to have special spiritual status as a burial was found under the floor, and copper-alloy blades were found on the floor. A crescent-shaped distribution of bone debris of various kinds was found to be concentrated in the western half, with the hearth as its centre forming a drop and toss zone (by people sitting around the hearth and tossing stuff behind them towards the sleeping area, while facing the doorway to the east). The high P values seem to follow this pattern (Figure 3.11).

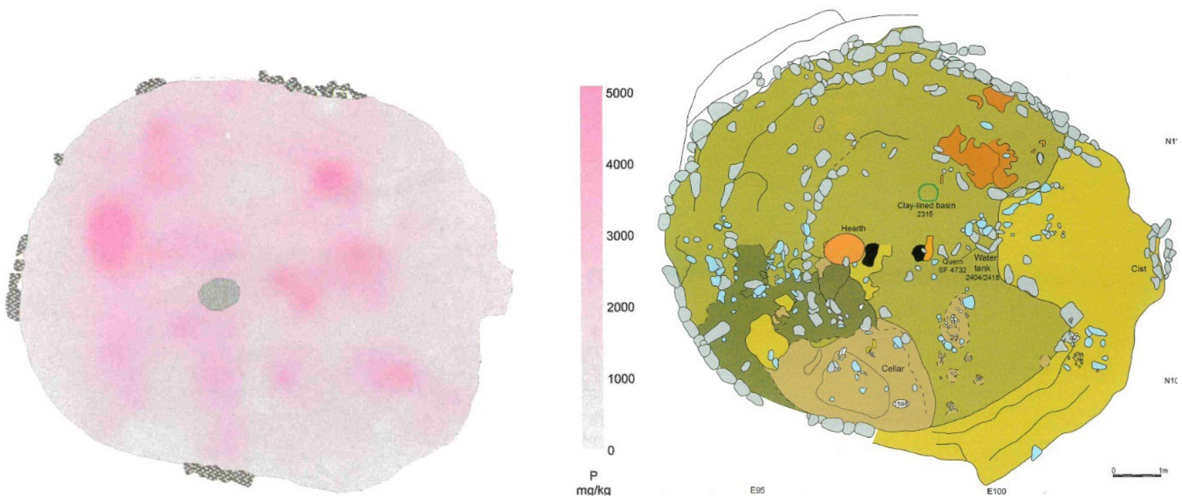

Figure 3.11: Distribution of phosphorus in floor 1311 of House 401 (left) and plan of House 401 with the central hearth in orange (right) (Parker Pearson *et al*. 2021c, figs 5.45, 5.20).

Floor 655

The third phase of the occupation of House 401 was represented by floor layer 655 (Figure 3.12). The phosphate study of this floor showed that the highest values of phosphorus (P) were in the northern half of the house. The northwest quadrant was interpreted as the sleeping area. This quadrant's eastern half and the area around it showed high levels of P. (Smith *et al.* 2021g, 264; Figure 3.12). The northwest quadrant contained a raised area that was 5 m long and 2.2 m wide that was interpreted as a sleeping platform based on its size, soft surface, and paucity of evidence for finds (Parker Pearson *et al.* 2021d, 259). However, the overall levels of P in the sleeping platform area were not significantly high (Figure 3.12). Some elevation of P levels seen here may be attributed to the machair turf that formed part of the soft surface of the platform (Parker Pearson *et al.* 2021d, 259). The house had a central hearth, and another fireplace was identified to the north-northeast of the central hearth, located against the wall (Parker Pearson *et al.* 2021d, 261). This hearth had the highest density of carbonised grain (Smith *et al.* 2021h, 272). Based on the distribution patterns of the various artefacts, cooking and food preparation were claimed to be located in the southeast quadrant. It was also suggested that the southwest quadrant was used for cooking activities because of the presence of small pottery sherd fragments. The west area of the floor was suggested to be for hide-working activities (among other craft-related activities) based on the recovery of pumice and bone points here (Smith *et al.* 2021h, 272). Although mammal bones appeared to be spread out across the floor, a concentration was recorded west of the hearth. This was suggested to be created by a sitting area where people sat down to eat to the west of the hearth (while facing the entrance to the east). Such a distribution of mammal bones is somewhat perceptible, in the elevated levels of P observed in the areas situated to the west and northwest of the central hearth.

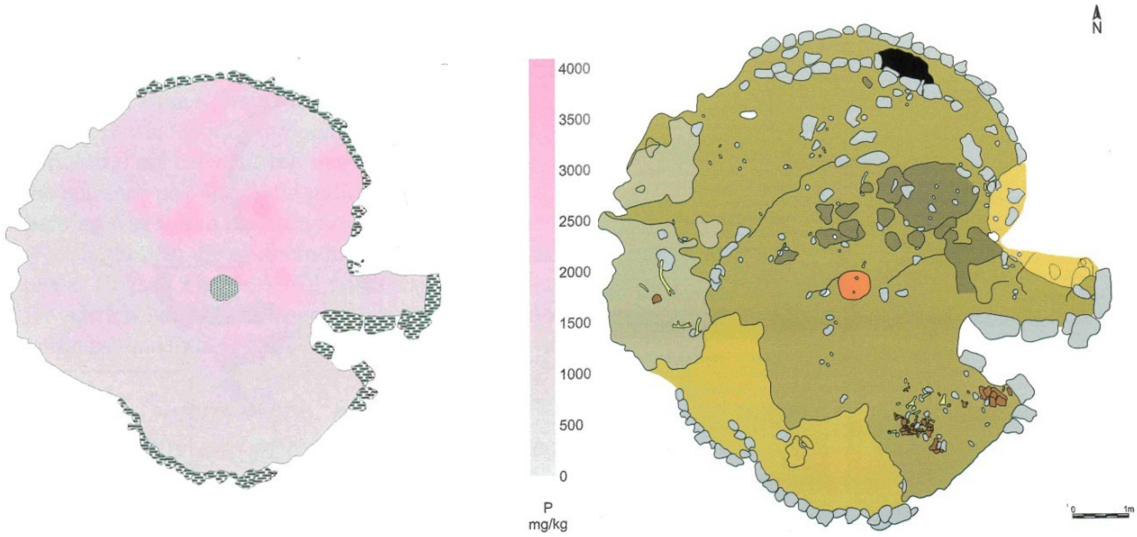

Figure 3.12: Distribution of phosphorus in floor 655 of House 401 (left) and plan of House 401 with the central hearth in orange and the ash and charcoal spread indicating a fireplace in black (right) (Parker Pearson *et al*. 2021d, figs 7.26, 7.6).

Floor 595

The fourth phase of occupation of House 401 in the Bronze-Iron Age transition is represented by floor 595 (Parker Pearson *et al.* 2021e, 292; Figure 3.13). This layer was a generally homogeneous layer, barring the light brown sand with dark mottling and red/black patches of peat ash close to the southeast wall. Only the northwest and the southeast quadrants were sampled on a 0.5 m grid. Hence, a significant amount of data is missing for this floor. However, from the two quadrants analysed, high P values were seen to lie to the northwest of the central hearth (Smith *et al.* 2021i, 296; Figure 3.13). This corresponded with concentrations of charcoal in the same area and within some parts of the southeast quadrant. Food processing and cooking were suggested to have taken place in the southeast, where the highest quantities of pottery sherds were found, while hide-working, potting, and other craft activities, such as spinning, were in the southwest quadrant. The northwest quadrant, containing three hollows, has been interpreted as a place where people likely slept (Smith *et al.* 2021j, 296). Along with the observation of a concentration of mammal bone in the northwest, it was suggested that food waste was discarded/tossed towards this direction (i.e. the northwest/west side of the hearth) from people sitting here facing the doorway in the east

(Smith *et al.* 2021j, 303). This is also corroborated by the higher levels of P seen in the northwest quadrant.

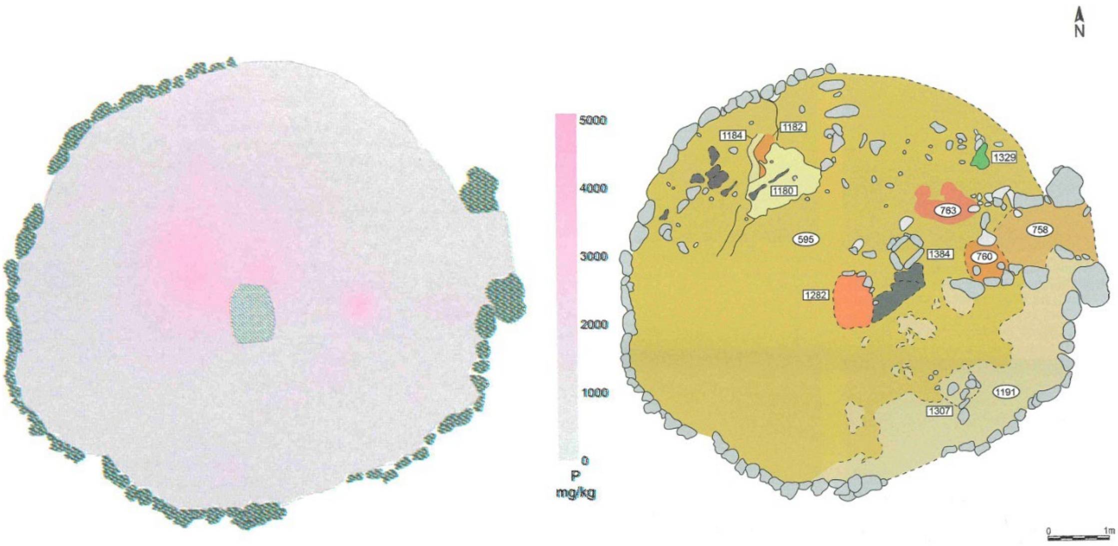

Figure 3.13: Distribution of phosphorus in floor 595 of House 401 (left) and plan of House 401 with the central hearth in orange (right) (Parker Pearson *et al.* 2021f, figs 8.32, 8.10).

Floor 465

Floor 465 represented the fifth phase of House 401. Phosphorus levels were seen to be high in the north and east, with some elevations seen to the northwest and southeast of the central hearth (Smith *et al.* 2021k, 320; Figure 3.14). Based on the quantities of pottery found in the southeast quadrant, it was suggested that this area was used for food preparation and cooking. The southwest quadrant was presumably used for storing food items and materials related to cooking (Parker Pearson *et al.* 2021f, 318). The western half was suggested to be used for activities linked to craftworking, hide-working and potting. This was based on the clusters of flint, antler, pumice, and clay here, with the bone tools seen widely distributed across the western half (Smith *et al.* 2021l, 327). The low quantity of ceramics found in this phase of the house was proposed to indicate that food preparation and cooking were not significant activities in this phase. Based on the high levels of mammal bone observed in the southeast quadrant, it was suggested that it was likely produced by people sitting around the hearth (with their backs to the entrance dropping some bones around them and tossing the rest behind them). The northwest quadrant, based on the presence of a large hollow, was proposed to be likely used as a sleeping area (Parker Pearson *et al.* 2021f, 318). Overall, it is interesting to note that P levels around the hearth are not as raised as seen in other phases, perhaps, also indicating the diminished significance of food preparation and cooking in this phase. Smith *et al.* (2021l, 328) have equated the function of the house during this phase to an ancillary building such as in floor 2211 of House 1370 (discussed above) due to the similar patterns of artefacts and P distribution observed.

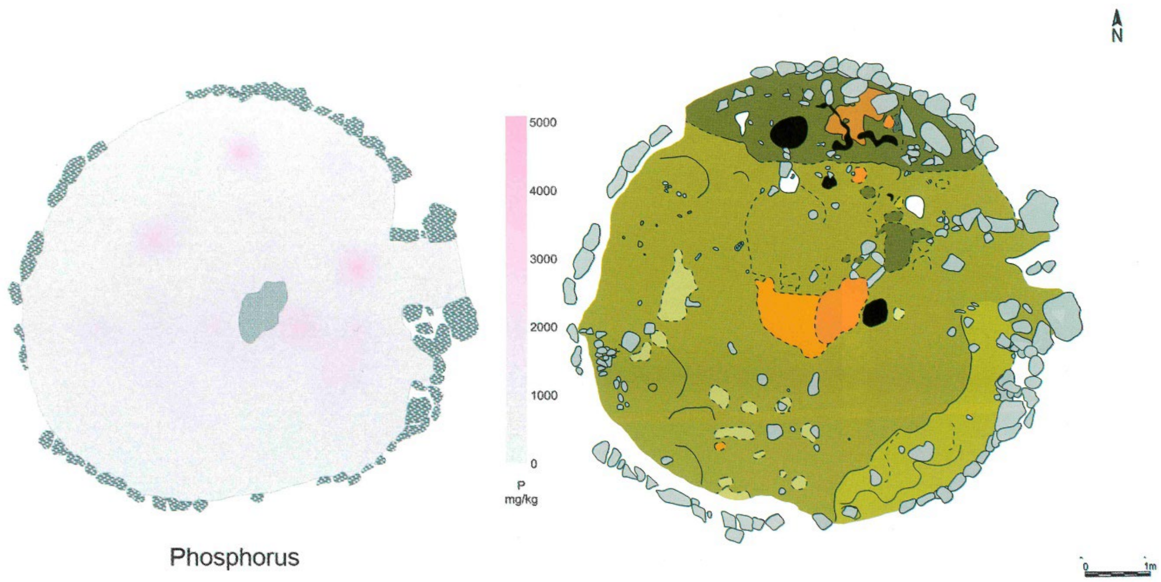

Figure 3.14: Distribution of phosphorus in floor 465 of House 401 (left) and plan of House 401 with the central hearth in dark orange (right) (Parker Pearson *et al.* 2021f, figs 9.18, 9.8).

House 1370

House 1370 was a sub-rectangular roundhouse with an east-facing doorway and a central hearth (Parker Pearson *et al.* 2021c, 165). Two floors representing two different phases of the house were studied using phosphate analyses.

Floor 2211

Floor 2211 represented the Late Bronze occupation phase (Parker Pearson *et al.* 2021c, 165-167; Figure 3.15). Based on the spatial distribution of artefacts, and the observation of herbivore dung accumulations, along with the dispersed distribution of higher values of P, within the floor, the house was suggested to be more likely an ancillary building, such as an outhouse, rather than a domestic residence (Smith *et al.* 2021n, 176). However, it had a machair-turf area in the northwest that was suggested to be a sleeping area (Smith *et al.* 2021m, 175). Based on the concentration of pottery sherds and potting clay in the southeast, cooking and pottery making was suggested to be located in the southeast. However, based on the distance from the hearth and the presence of an unfired pot, it is also suggested that vessels and/or pots were stacked here (Smith *et al.* 2021m, 175). The rest of the artefacts, while fewer in number compared to houses 401 and 801, were mainly randomly distributed across the floor. However, worked bone, antler, whalebone, and coarse stone tools were recorded mainly south of the hearth. Overall, it was inferred that floor 2211 of House 1370 was generally kept clear, perhaps with debris being swept to the edges (Smith *et al.* 2021m, 176).

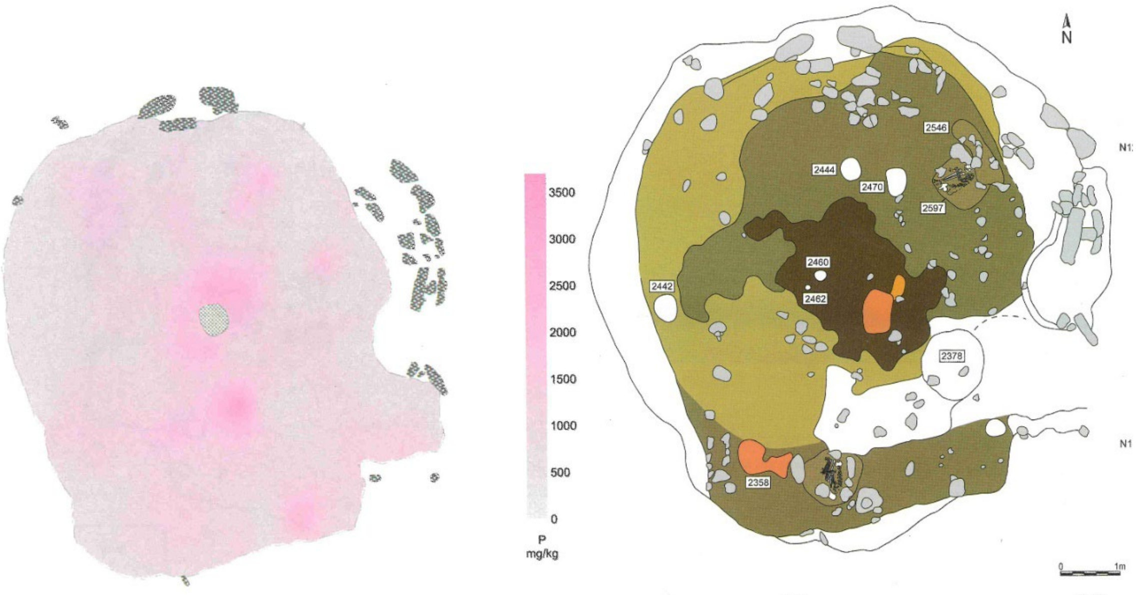

Figure 3.15: Distribution of phosphorus in floor 2211 of House 1370 (left) and plan of House 401 with the central hearth in orange (right) (Parker Pearson *et al.* 2021c, figs 5.75, 5.54).

Floor 1369

Floor 1369 represented the second floor of House 1370, which lay on top of floor 2211 (Parker Pearson *et al.* 2021c, 167-170, Figure 3.16). Magnetic susceptibility and phosphorus levels were seen to be highest around the central hearth, especially on the west side and to the southeast of it (Smith *et al.* 2021o, 176; Figure 3.16). A majority of the artefacts were recorded in the northwest quadrant of this floor. This area was suggested to have been used for activities such as hide working (based on the recovery of bone points, polishing stones, and pumice), with some amount of cooking and possible potting north of the hearth. Based on the distribution of mammal bone around the hearth (forming a crescent-shaped distribution pattern to the north and west of it), this area around the hearth is claimed to be a sitting and eating area facing the entrance (Smith *et al.* 2021p, 183). Based on soil micromorphological observation of herbivore dung, it is suggested that cattle or sheep over-wintered here. The negligible values of P in the northwest quadrant are claimed to indicate that the craftworking area was roped off from other areas, especially if the rest of the floor was used for the over-wintering of sheep and cattle (Smith *et al.* 2021p, 183). Metalworking in the form of bronze-casting and mould-breaking north of the hearth was also suggested here based on soil micromorphology analysis. Overall, floor 1369 of this house has shown evidence of limited or sporadic activities, indicating that it was an ancillary building (Smith *et al.* 2021p, 183).

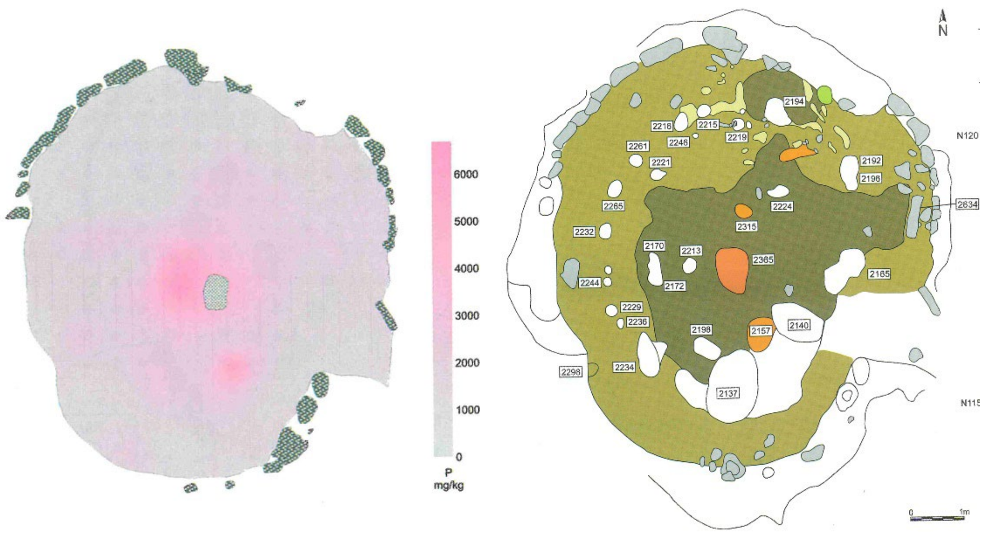

Figure 3.16: Distribution of phosphorus in floor 1369 of House 1370 (left) and plan of House 401 with the central hearth in orange (right) (Parker Pearson *et al.* 2021c, figs 5.79, 5.62).

The front yard of the settlement

The Late Bronze Age front yard, starting from the entrances of Houses 401, 801 and 1370 and extending eastwards, was represented by surface 1680 (Parker Pearson *et al.* 2021c, 183-184; Figure 3.17). This surface was also studied using phosphate analysis and magnetic susceptibility study. It was found that there was a lack of foci for high values of P and magnetic susceptibility in the front yard (Smith *et al.* 2021q, 184). However, higher values were observed in front of House 1370 of magnetic susceptibility, and this was attributed to a possible Early Bronze Age cremation platform and debris buried here (Smith *et al.* 2021q, 184). The northern part of the front year nearer 1370 showed consistently raised values of P. This was attributed to the sheep and cattle congregation in front of House 1370 (Smith *et al.* 2021q, 184). This interpretation was reinforced with the suggestion that cattle and sheep were sheltered in that roundhouse, as discussed above on floor 1369. Furthermore, based on the low number of artefacts in this outdoor area, it was suggested that it was not used for cooking, eating or craft working activities (Smith *et al.* 2021q, 184).

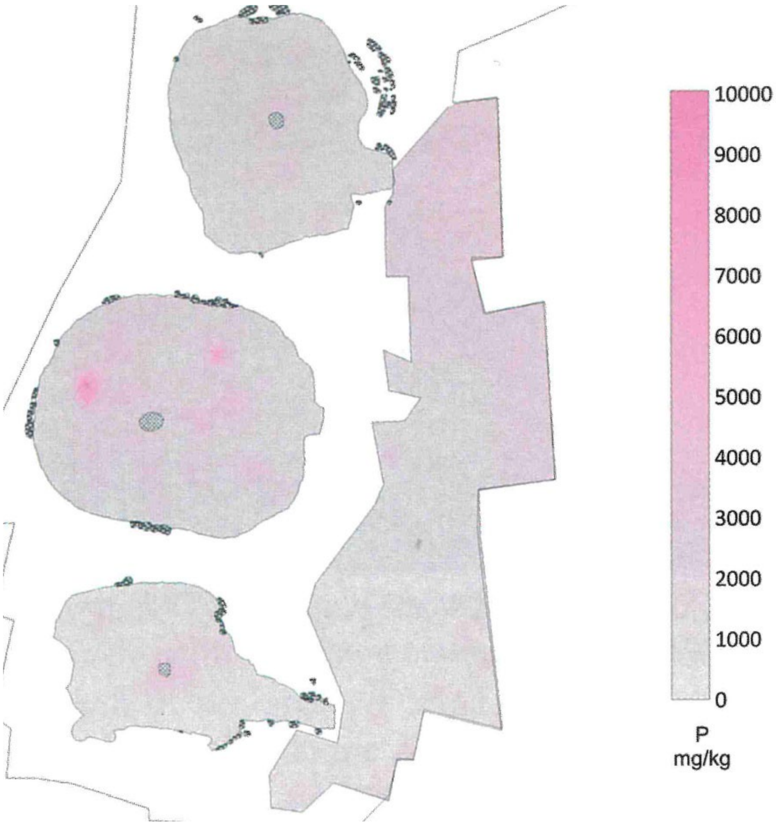

Figure 3.17: Distribution of phosphorus in layer 1680 lying across the front yard of House 1370 to the north, House 401 in the middle and House 801 in the south (Parker Pearson *et al.* 2021c, fig 5.88).

House 640

House 640 was described as a double roundhouse with an entrance facing east and a hearth in the east room (Parker Pearson *et al.* 2021g, 379). The west room had a large niche at the west end, a smaller one in the northwest corner and a flat slab in the centre (Parker Pearson *et al.* 2021g, 379). The phosphorus values in this house are not particularly significant. It is interesting to note that the phosphorus levels around the hearth were also unremarkable, although some slight elevations here can be seen (Rhodes *et al*. 2021, 385; Figures 3.18 and 3.19). The south side of the east room was claimed to be an area for food consumption and preparation based on the presence of mammal bones, marine shells, and a group of burnt cobbles. Based on the lack of any sleeping platforms or turfed areas, it was suggested that it lacked evidence for sleeping and that House 640 was a special-purpose building rather than a dwelling. The west room was suggested to have had a different purpose than the east room (Smith *et al*. 2021r, 389). One suggestion is that the house served as a smokery, with food consumption being a sporadic minor activity (Parker Pearson 2021g, 391). The lower level of P observed in this house overall agrees with this interpretation.

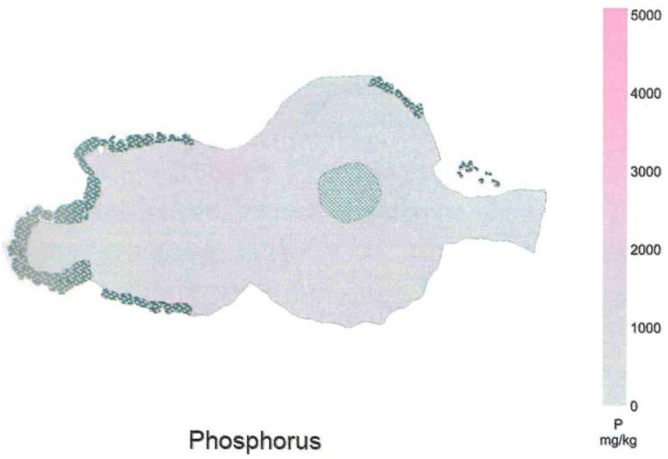

Figure 3.18: Distribution of phosphorus on the floor of House 640 (Parker Pearson *et al*. 2021g, fig 12.12).

House 640

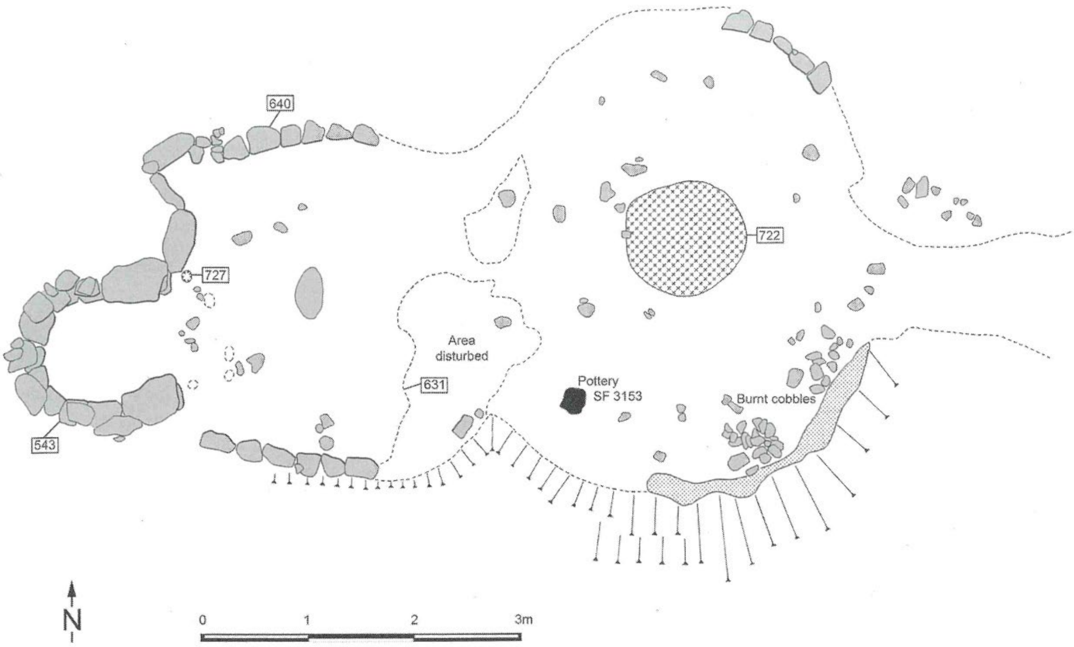

Figure 3.19: Plan of House 640 (Parker Pearson *et al.* 2021g, fig 12.2).

The study of the spatial organisation of multiple structures at Cladh Hallan provides an excellent example of the value of combined artefact studies, phosphorus studies, magnetic susceptibility studies and soil micromorphology. In several cases, phosphate study has helped archaeologists better understand the distribution of finds and patterns of use. For example, on several floors, phosphorus distributions in domestic structures confirmed the distribution of artefacts such as mammal bones that suggested the location of toss and drop zones. Another finding from the various studies at Cladh Hallan is that although multiple floors over multiple periods were analysed (as in the cases of House 801 and 401), the P patterns were distinguishable enough to suggest differential use of the buildings in different phases.

3.4.4 HAD V, Fenland

HAD V, located in Fenland, Cambridgeshire, was one of four Middle/later Iron Age enclosures that were investigated within the Fenland Survey project, conducted from 1981 to 1987. The floor surfaces of Buildings 4 and 6 were subject to phosphate analysis due to their remarkable preservation. Building 4, a roundhouse positioned in the western section of the enclosure, featured a distinct eavesdrip gully measuring 14 m in diameter (Evans and Hodder 2006, 118; Figure 3.20). An entrance on the eastern side, marked by substantial posts, was identified. The central floor contained a circular pit with intensely scorched upper edges, possibly functioning as a flat hearth (Evans and Hodder 2006, 118). The presence of charcoal and ash, predominantly on the southern side, suggested that the building had been destroyed by fire (Evans and Hodder 2006, 119). The detection of internal arrangements of postholes supported the inference of interior partitions. Building 6, a later construction, partially overlapped with the western half of Building 4. It was a roundhouse defined by a sub-circular wall trench measuring 7.3 m in diameter. An entrance was proposed on the eastern side, marked by major post holes forming a 2 m wide porch projecting for 1.4 m (Evans and Hodder 2006, 122; Figure 3.20). Building 6's central floor area featured clay-lined hearths and ovens, with the floor surface of Building 4 serving as an informal courtyard during its use (Evans and Hodder 2006, 123).

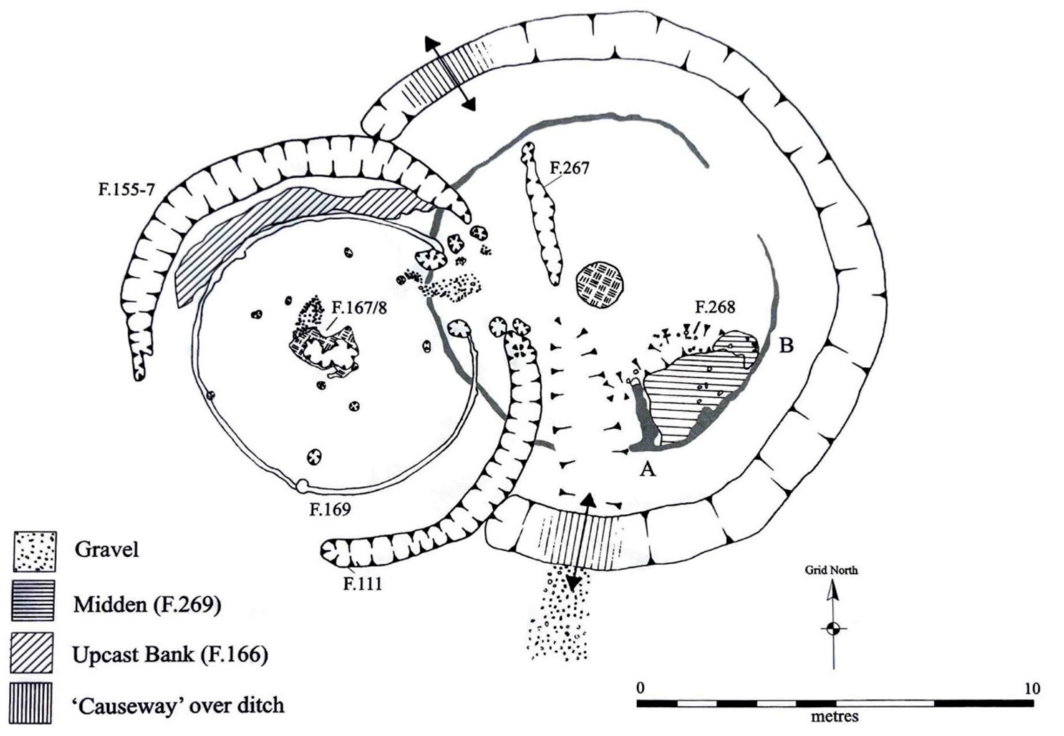

Figure 3.20: Plan of Building 6 with the floor of Building 4 used as a yard (Evans and Hodder 2006, fig 5.3).

Phosphate analysis on a 2 m sample grid revealed generally low and minimally varying phosphorus levels across the floors of Buildings 4 and 6 (Evans and Hodder 2006, 145; Figure 3.21). However, isolated high points were identified in the northern part of Building 6 and on either side of the doorway. Significantly, a cluster of elevated phosphorus levels extended from the middle of Building 4 to the northern section of Building 6, with higher levels in the northern half of Building 4. This was postulated to be influenced by the possible presence of reeds, which, if used as bedding, could have contributed organically to the observed phosphorus levels (Evans and Hodder 2006, 145). The heightened phosphorus concentration from the central region of Building 4 to the northern section of Building 6 was associated with sweeping activities emanating from the hearth of Building 4 and the entrance of Building 6. Furthermore, increased phosphate levels in the northern half of Building 6 were also linked to activities generating organic residues, potentially related to processes such as food processing and, to some extent, animal penning (Evans and Hodder 2006, 145). An alternative interpretation proposed that the suboptimal structure of Building 6's floor might have facilitated the incorporation of animal excreta, deposited along the underlying 'hoof pathway', through contact or mixing (Evans and Hodder 2006, 145).

While samples from Buildings 4 and 6 were collected on a 2 m grid, the enclosure was sampled on a 5 m grid. It was found that there were generally higher phosphate levels in the eastern back interior of the compound. This was proposed to indicate the dumping of organic refuse along the inner side of the bank. Localised high readings observed in the northwest area of the enclosure were suggested to indicate possible penning of animals (Evans and Hodder 2006, 107). Overall, this study revealed the strong association of phosphorus with the accumulation of organic waste or refuse. Although phosphorus levels in both houses were broadly characterised as low, with occasional localised elevations, it is possible that the locations of elevated spots were missed due to the use of a considerably broader 2-metre sampling grid rather than a 1 m or a 0.5 m grid.

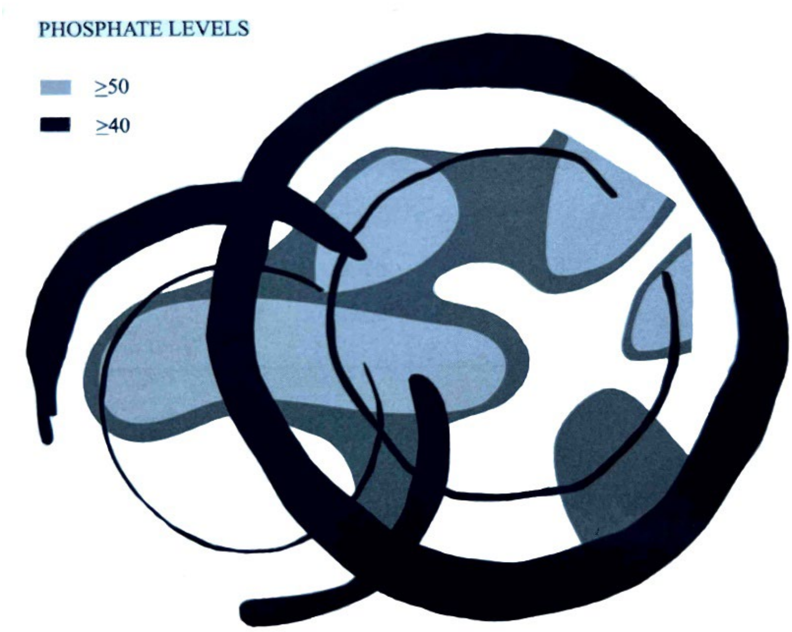

Figure 3.21: Distribution of phosphates in Buildings 4 and 6 at HAD, Fenland (Evans and Hodder 2006, fig 5.53).

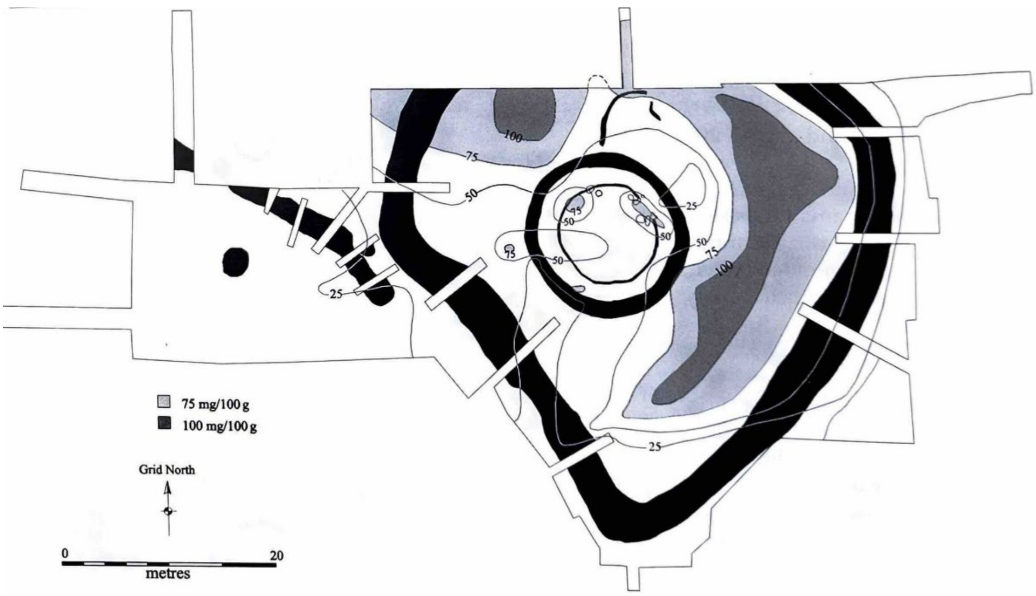

Figure 3.22: Distribution of phosphates at HAD V Iron Age enclosure (Evans and Hodder 2006, fig 5.5).

3.4.5 Dan-y-Coed, Llawhaden, Dyfed, Pembrokeshire

Dan-y-Coed is a roughly horseshoe-shaped Middle to late Iron Age enclosure excavated at Llawhaden, in Pembrokeshire (Figure 3.24; Williams 1998a). As a portion of a limited programme of soil analysis, a phosphate survey was performed in the eastern part of the enclosure, which incorporated roundhouses V and IV (Figure 3.26). The samples were collected on a 1m grid, and the total phosphorus in each sample was determined.

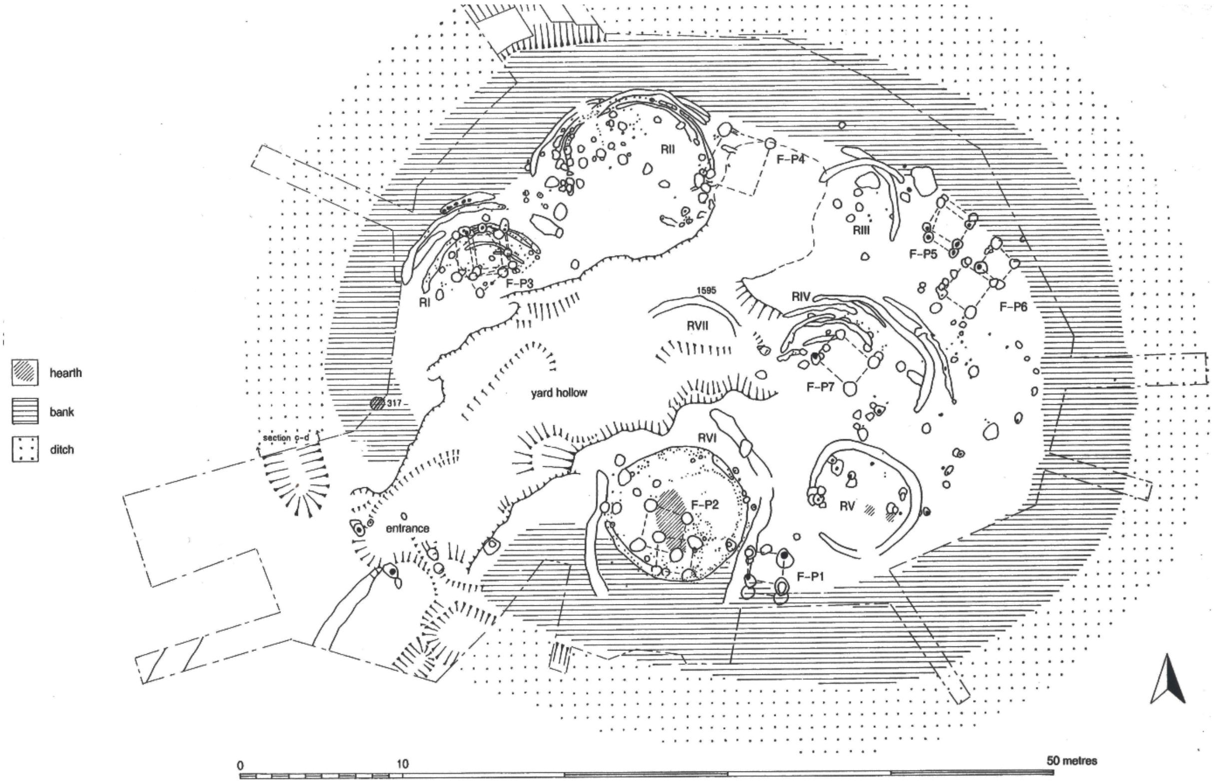

Figure 3.24: Dan-y-Coed, composite plan of Periods 1, 1A and 1B. Roundhouse V can be seen in the southeast corner (Williams 1998a, fig 27).

Roundhouse V

Roundhouse V is situated in the southeastern corner of the site (Figure 3.25) in an area that pertains to period 1 and encompasses 5 phases (A to E). Although no coherent structures were identified between Phases A to C, several features such as a hollow, postholes, stake holes (some of which were substantial), and an occupation surface were present. Phase D marks a period of abandonment accompanied by the deposition of rubbish, rampart decay, and colluvium accumulation (Williams 1998a, 36). The construction of Roundhouse V took place during Phase E, and it was characterised by a complete sub-square gully that might have served as a wall gully for the house (Williams 1998a, 36). The diameter of this structure is roughly 6.3 meters, and the entrance is located in the west/west-southwest direction. At the northern entrance terminal, a sequence of postholes was observed, although it is unclear if all of them were contemporary with the structure (Williams 1998a, 36). Two small hearths, designated as 1141 and 1086, were situated on the right side of the house in the southwest quarter, with 1086 positioned closer to the centre of the house. Although internal flooring areas have also been noted, their precise location was not indicated by Williams (1998a, 38) on the house plan (Figure 3.25). Within the rubbish deposits related to Phase D of this house, a small penannular brooch belonging to the Fowler D type was discovered, suggesting a possible Romano-British period for the house (Williams 1998a, 37). The charred plant remains were concentrated primarily near the house's centre and left side, with some concentration observed in the wall gully at the back and the northern gully terminal. Charred remains were also recovered near the 1086 hearth (Caseldine and Holden 1998, 114).

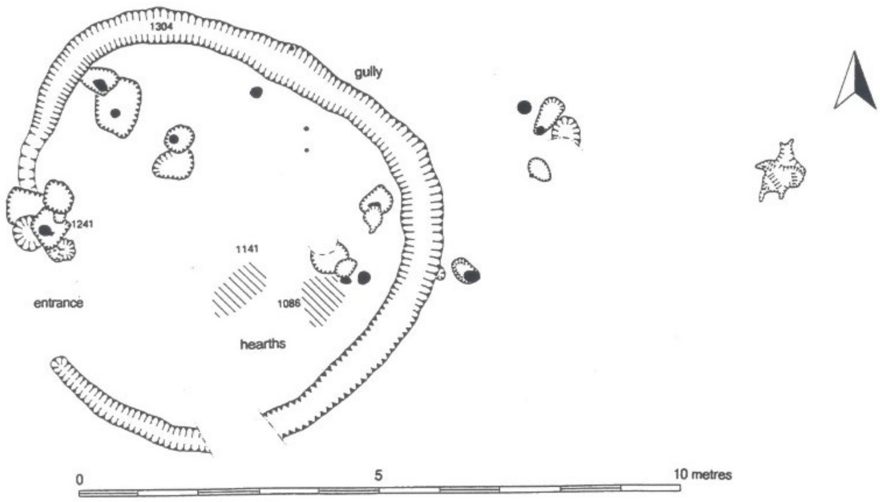

Figure 3.25: Plan of Roundhouse V at Dan-y-Coed (Williams 1998a, fig 32).

The phosphate survey results suggest that the highest levels of total P are found in the front area and just outside of Roundhouse V, with relatively higher levels in the left side of the house. It is also faintly noticeable that there is P enrichment in samples that have been taken from spots closest to the two hearths (lying in the category 3.50-3.49 mg/g), and the two samples lying between the area of the two hearths show enrichment that is lower (in the category 1.50-2.49 mg/g). The overall lowest levels of P observed were in the northern area of Roundhouse V, closer to the wall gully. However, based on the presentation of the results in this study and the sampling strategy using a metre grid, it is difficult to discern any possible and significant differences in the use of internal space in the house.

Figure 3.26: Total P distribution at Dan-y-Coed (Crowther 1998, fig 74).

Roundhouse IV

Roundhouse IV was a multiphase house terraced into the hillside. It had many of its features truncated, and the southern part was mostly destroyed (Figure 3.27; Williams 1998a, 36). Based on the number of probable wall gullies, drainage gullies and a scatter of stakeholes, four successive wall-built roundhouses were suggested to be built on the location of Roundhouse IV (Williams 1998a, 36). The earliest phase roundhouse had an entrance on the west, marked by a pair of postholes, while the later phases had entrances on the southeast. Four large postholes have been suggested to form a four-poster in the northern half of the house (Williams 1998a, 36). Based on the wall gullies in the plan, it can be speculated that the roundhouses here were probably 6-8 meters in diameter (Figure 3.27). A fine spindle whorl was recovered from the largest (probably drainage) gully in the area (Williams 1998a, 36). Most charred plant remains recovered seem to be from the northern half of the house close to the wall gully and the four-poster (Caseldine and Holden 1998, 114).

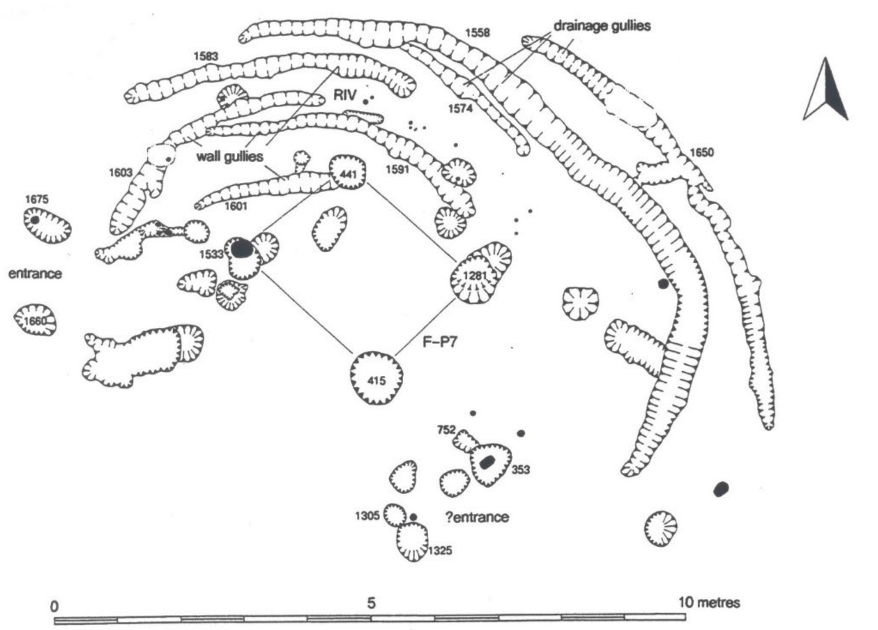

Figure 3.27: Plan of Roundhouse IV at Dan-y-Coed (Williams 1998a, fig 32).

In terms of phosphorus (P) enrichment, the northern half of the site and samples obtained from locations proximal to the wall and drainage gullies exhibit elevated P levels. However, significant P enrichment is also evident in the vicinity of the eastern and western areas outside the house, with a similar pattern observed in Roundhouse V (see above). Crowther (1998, 118) posits that this phenomenon may be due to midden deposition immediately outside the structures, particularly in the eastern region of roundhouses IV and V, which are closer to the enclosure's lower regions. The observed P enrichment was suggested as likely a result of the downslope movement of debris and soil from the eroded rampart by surface wash and soil creep, as well as the differential loss of topsoil and subsoil from the higher parts of the site due to ploughing (Crowther 1998, 118). Additionally, the high P levels observed in the eastern area of Roundhouse IV were attributed to the presence of a later rectangular longhouse (Structure IX), which is potentially Romano-British, according to Crowther (1998, 118).

The results of the phosphate survey conducted at Dan-y-Coed provide limited insights into any discernible patterns that may indicate differential use of space or exposure/contact with organic matter. The sampling strategy employed in this study would have been more effective as a pre-excavation survey. The 1m grid utilised at the site is not ideally suited for identifying differential space use within structures, as is evidenced by the limited number of samples collected from known features such as the hearth. In the case of Roundhouse V (Figure 3.25), for instance, only one sample (1141) appears to have been taken from the edge of the hearth, whereas a 0.5m grid would have facilitated the collection of at least four samples, thereby offering a clearer representation of the distribution pattern. Additionally, no samples were obtained from the hearth (1086), indicating that the observed distribution of P enrichment in both houses may not fully indicate the overall distribution of P within the structures.

The distribution of total P has been depicted by classifying the amount of total P into five groups based on large amounts of P: 0.5-1.49 mg/g (value of control samples), 1.50-2.49 mg/g, 2.50-3.49 mg/g, 3.50-4.49 mg/g, and >=4.50 mg/g (Figure 3.26). However, this classification system is overly broad. It may pose challenges in identifying potential areas of P enrichment, particularly when the difference in the level of P between two areas is not substantial. Additionally, this classification strategy may not be well-suited for detecting subtle differences between areas within structures, if any exist.

3.4.6 Woodside Camp, Llawhaden, Dyfed, Pembrokeshire

A similar phosphate survey was carried out at the Iron Age enclosure of Woodside Camp (Williams 1998b). However, unlike Dan-y-Coed, the samples were collected on a 2m grid (Crowther 1998, 118). Woodside Camp is a univallate hillslope D-shaped enclosure with an entrance on the west. The site was very truncated by ploughing (Williams 1998b, 8). While a majority of the enclosure features are Early to Late Iron Age, a few Early Bronze Age features were found sealed under pre-enclosure soils (Williams 1998b, 16). However, significant occupation in the interior of the camp is seen in the Late Iron Age/Romano-British period. On the northern part of the interior was a series of multiphase roundhouses (Roundhouses I, II, and III). There were four-posters within the enclosure in two phases, and a series of rebuilt four-posters was recorded in the southwestern part of the interior, revealing the storage of grain. The southern side of the interior was mostly empty until the late stage when a series of conjoined roundhouses (Roundhouses IV, V, VI) were built (Figure 3.28; Williams 1998b, 21).

The results of the phosphate survey conducted at Woodside Camp revealed a lower level of phosphorus in comparison to Dan-y-Coed (Figures 3.26 and 3.29; Crowther 1998, 118), suggesting a shorter period of occupation at the former site according to Crowther (1998, 118). However, it is important to note that the geology of the soils at Dan-y-Coed and Woodside Camp are not mentioned (whether similar or not), rendering it difficult to conclusively attribute the observed difference in overall levels of P to differences in the length of occupation. Additionally, higher levels of P were detected progressively towards the lower, southern parts of the site, a phenomenon that Crowther (1998, 118) has attributed to the general downward movement of debris along the slope and the differential loss in higher areas relative to lower areas due to ploughing. Nonetheless, the collection and presentation of results at this site pose challenges for drawing meaningful interpretations of the phosphate survey. The 2 m grid used for sample collection resulted in only approximately 20 to 25 samples being obtained from roundhouses that were as large as 9-10 m in diameter. Furthermore, the lack of discussion on the contexts from which the samples were taken is a significant flaw in the survey strategy, particularly within structures, which suggest multiple floors/layers. It is highly likely that the samples collected could be from contexts of different phases, as there is no mention of the state of preservation of the floor layers or whether the floors analysed were contemporary. As such, the results of the phosphate survey at these two sites are of limited use in identifying differential use of space within structures.

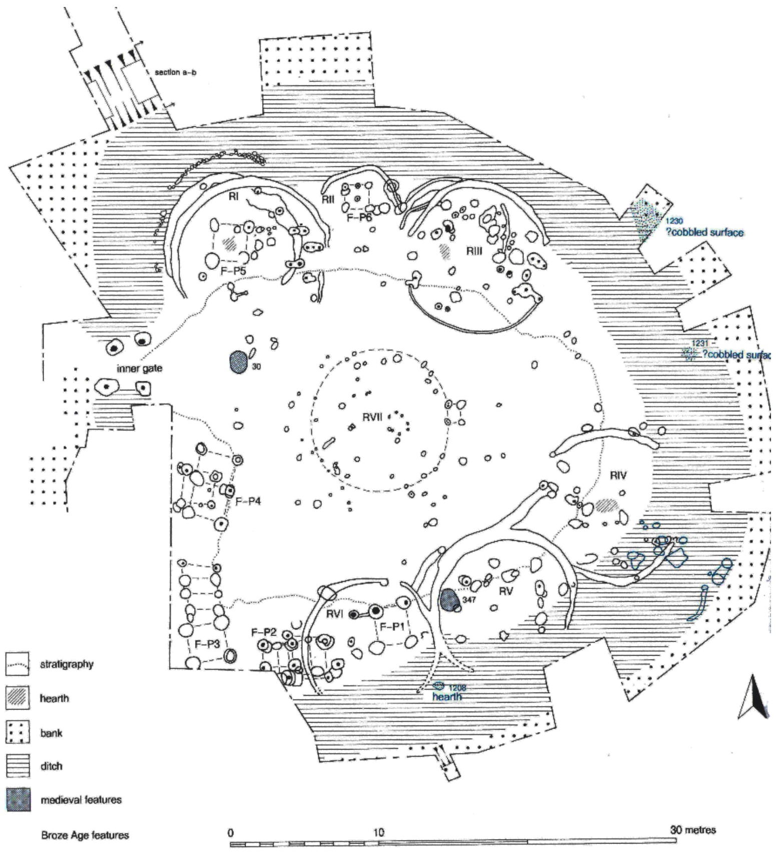

Figure 3.28: General plan of all phases at Woodside Camp (Williams 1998b, fig 17).

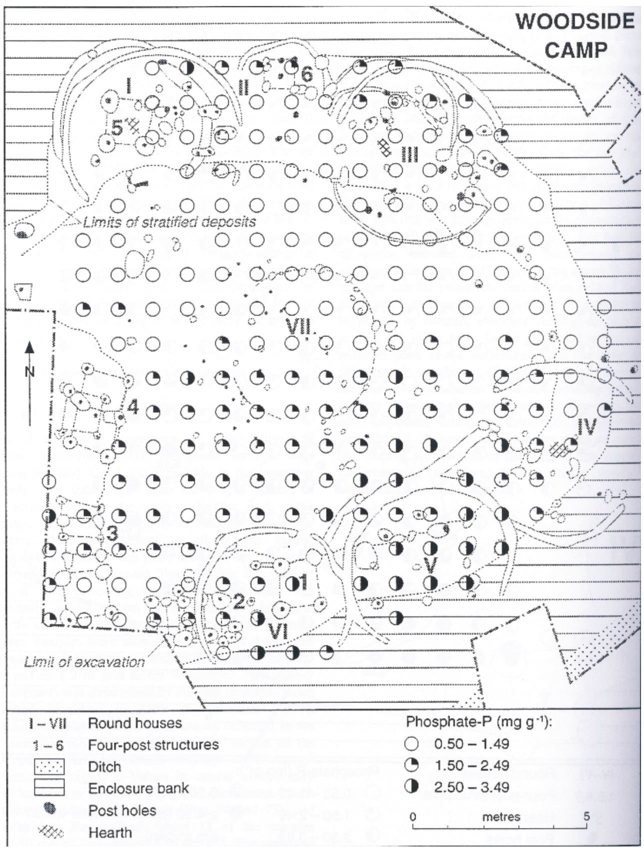

Figure 3.29: Total P distribution at Woodside Camp (Crowther 1998, fig 75).

3.4.7 Cefn Graeanog II, Gwynedd

Cefn Graeanog II is a stone-built enclosed settlement in North Wales dating to the Romao-British period, with several phases of occupation and reconstruction (Fasham and Mason 1998). At its height of contemporary use, the site consisted of three domestic roundhouses and a range of rectangular structures/out-buildings attached to the enclosure's substantial wall (Figure 3.30; Fasham and Mason 1998, 9-29). The enclosure also had a courtyard and a possible garden area (Fasham and Mason 1998, 9-29). The entrance to this site was through a double barn (Fasham and Mason 1998, 9-12, Conway 1983, 118). A phosphate study was carried out as part of the rescue excavation at this site. Hut C, Hut G and Building F were sampled on a 1m grid and analysed for levels of total and extractable phosphorus.

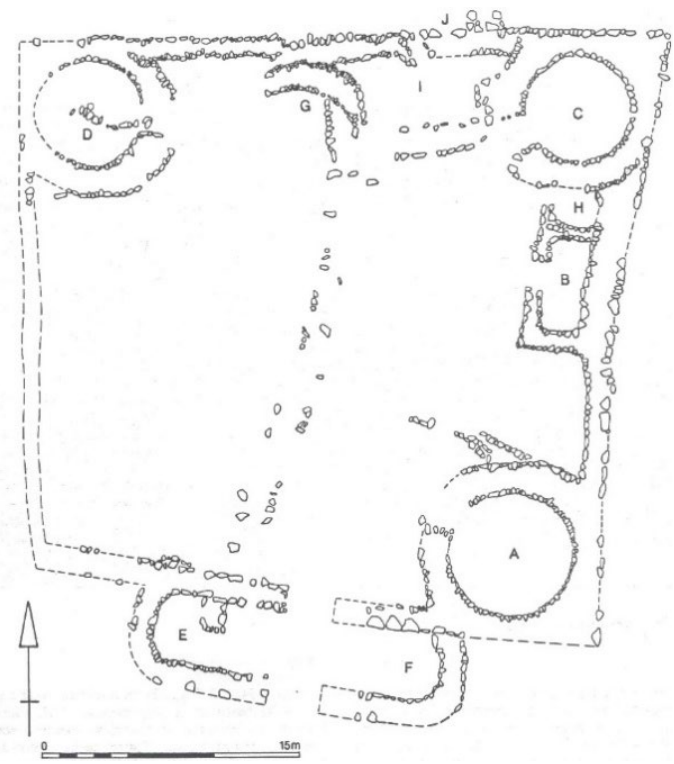

Figure 3.30: Plan showing the maximum extent of Cefn Graeanog II (Fasham and Mason 1998, fig 13).

Hut C

This circular hut consisted of several features that included a hearth, two pits, and a slab-covered drain, along with an occupation deposit that contained pottery sherds and charred plant remains that included cereals (Figure 3.31f; Conway 1983, 121). It was well preserved and unaffected by post-abandonment activities (Fasham and Mason 1998, 21; Conway 1983, 121). This round hut had an internal diameter of about 6.2 m (Fasham and Mason 1998, 21). Inside the house, two areas of possible burning (110 and 111) were recorded and based on the charcoal analysis, it was suggested that burning might have occurred in context 110 (Thompson 1998, 72). An earlier phase hearth (135) was recorded close to the hut wall and the entrance (Fasham and Mason 1998, 21). The entrance of this hut faced west/west-southwest towards the entrance of another hut G. The finds from Hut C include a small perforated lead weight, red and black-burnished coarsewares, a samian ware sherd, a socketed sickle, some slag, and perforated slate (Fasham and Mason 1998, 22). Charred plant remains analysed from the floor, the drain, the hearth, and the area of burning (110) showed that all (except context 110) had cereals in them. A majority of the cereal fragments were observed in the sample taken from hearth 135 (Fasham and Mason 1998, 22).

Thirty-three samples were taken from the floor level of the hut on a 1 m grid (Conway 1983, 121). The distribution pattern of total P revealed generally higher levels adjacent to the walls and high levels on either side of the entrance (Conway 1983, 121). Trend Surface Analysis (TSA)[vi] was used to understand the significance of irregularities in the distribution of total phosphorus. According to Conway (1983, 123), the general pattern of higher values adjacent to the walls is best explained by the erosion of the built floor made of dung-tempered clay or some similar material and the presence of patches of fine materials close to the walls. He also suggests that higher values observed close to walls could be the result of sloping or the presence of structures such as bed platforms or benches adjacent to the walls (Conway 1983, 123). In other words, the peripheral areas in the interior of the house were inaccessible due to furniture and hence difficult to clean. However, a drain was recorded on the right side of the hut adjacent to the wall. This drain most likely caused the higher level of P observed on the right-side peripheral area of the hut compared to the left side (Figure 3.31). The high P levels in the front right and left side of the interior correspond to features that contained burnt clay and charcoal spreads, as in the case of (110) and (135) (Conway 1983, 123). This was most likely the result of the fixation of P onto iron oxides formed at high temperatures or longer exposure or contact with organic material at these locations (Conway 1983, 123). This phosphorus study also revealed through TSA that there was a distinction between features 110, 135 and 111. Furthermore, the phosphate analysis, along with the statistical analyses, helped confirm that (135) was a well-defined hearth and (110) was a pit (Conway 1983, 121; Figure 3.31). This also conforms with the archaeological evidence that context 135 was a hearth with a considerable spread of charcoal, and context 110 contained charcoal with no *in situ* burning and pottery. Context 111, on the other hand, had no artefacts.

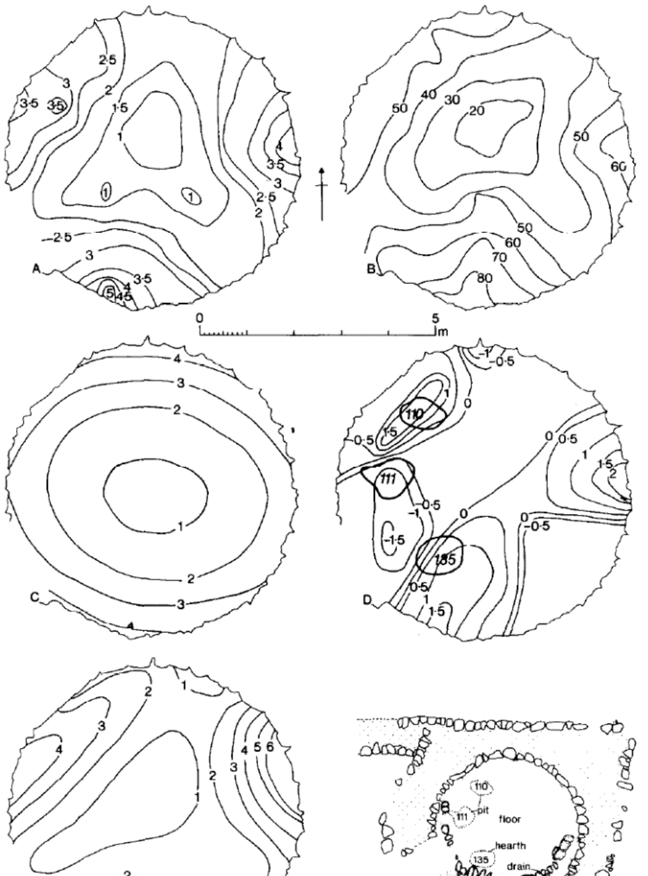

Figure 3.31: Hut C (a) Total P distribution map. (b) Extractable P distribution map (c) Total P second-order trend surface (d) residuals from second-order trend surface (e) Fifth-order trend surface (f) Plan of Hut C (bottom left) (Conway 1983, fig 2).

Hut G

This circular building was built during Phase III (AD 50-150) of the site and later demolished in either Phase IV (after AD 150) or just after. It was recorded that a third of its wall had not survived, but it was easily traceable in the ground (Fasham and Mason 1998, 18). The hut was 7 metres in diameter internally, and it had an entrance facing east. The internal features include a drain that was cut into the floor and went along the internal perimeter of the house closer to the wall and a second drain (possibly joining the first one) that ran under the entrance paving, which joined another drain outside the hut (Fasham and Mason 1998, 18; Figure 3.33). While stone slabs covered the internal drain, the second drain was covered by the wall of the house. Closer to the centre of the house, a clay-lined hearth (89) was recorded, which contained some flat fire-cracked stones (Fasham and Mason 1998, 18). A heavy spread of charcoal around the hearth was also recorded. Conway (1983, 124), in an earlier report, noted that there was another hearth (124) in Hut G. The floor was partly covered with a spread of stones which appeared to be uniform with the wall collapse, and it sealed floor 74. Among the finds from the floor, drain and wall of Hut G, were black-burnished and Samian wares, a part of a 1st century AD decorated glass bracelet, worked stones (including whetstones), an unperforated roughly circular, possibly worked slate, that was perhaps used as a pot lid, and some slag (Fasham and Mason 1998, 18). The only mortar found on the site was also recorded in this hut set in the floor to the north of the hearth (Fasham and Mason 1998, 18; Figure 3.33).

Forty-eight phosphate samples were collected on a 1m grid from an area that covered a significant part of Hut G, its adjacent courtyard (this is the area from within the hut that was at a later phase incorporated into the courtyard in front of Hut D) and the midden area in the northwestern/western area just outside the hut (Conway 1998, 71; Figure 3.33). The distribution of total phosphorus shows the highest enhancement above 3000 ppm (or mg/kg) at the location of the midden area and a division marked by an isoline[vii] of 2000 ppm between the courtyard and the floor deposit (Figure 3.32; Conway 1983, 125). The locations of the two hearths are evident in the high values observed within the hut. High total P values were observed in the part of the floor that had remained undisturbed under the layer of stone spread (Figures 3.32 and 3.33). Conway (1983, 126) has used this to suggest that it indicates the whole floor area had P enhancement. He also claims that the later erosion in the area incorporated into the courtyard caused the lower observed total P (Conway 1983, 126). An obvious distribution pattern was not visible in Hut G when compared to what was observed in Hut C. Conway argues that this is because of the compacted soil or gravel floor in Hut G as opposed to the clay floor in Hut C, which has better retention of P (Conway 1983, 126). Conway (1983, 126) also suggested that the difference in distribution patterns observed between Hut C and Hut G could result from a difference in their usage.

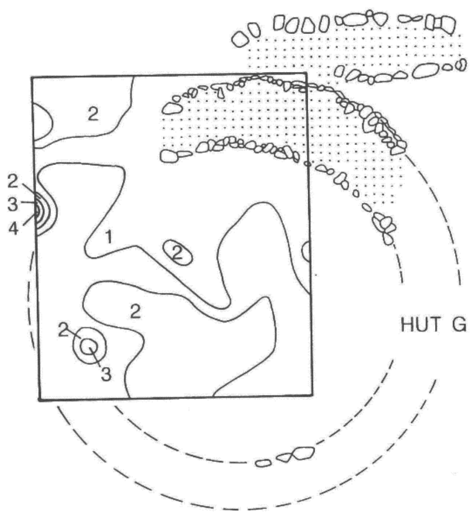

Figure 3.32: Total P distribution (in ppm) on the plan of Hut G (Conway 1998, fig 29).

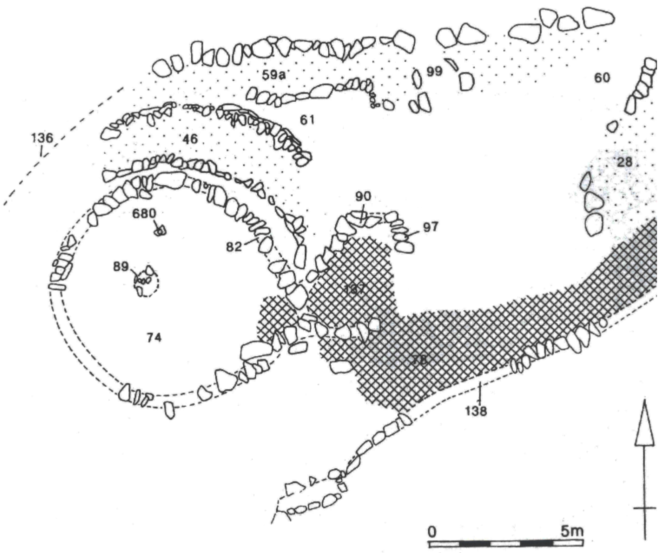

Figure 3.33: Interpretive plan of Hut G (Fasham and Mason 1998, fig 8).

Considering that only a portion of Hut G was sampled on a grid of 1m, a comparison between Hut C and Hut G to suggest differential use of internal space may not be appropriate.

This is made more challenging by the fact that most of the floor of Hut G had eroded due to its later use as part of the courtyard. This makes the P distribution pattern incomparable to each other. Conway (1983, 126) claimed the higher level of total P observed from samples where the floor was preserved was indicative that the whole floor would have had higher levels of P had it survived. However, this is highly debatable. This is because any areas within the hut that had limited contact with organic matter could show P values equivalent to or closer to that of control samples, i.e., the samples taken from natural soils, which were between 400-900 ppm (Conway 1998, 71). The highest levels of total P in the Hut G area are observed closer to the hearths, especially hearth 89, and overall lower levels are observed along the drain except in the easternmost samples. The mortar found set in the northern part of the interior of the house and closer to the hearth 89 could indicate that the area was a food preparation area. However, the lack of proper comparative total P data from other parts of the interior of the house makes suggesting the limits of the food preparation area challenging.

Building F

The southern part of the enclosure had buildings E and F. These structures, while not physically connected, were spatially arranged to form a rectangular shape that functioned as the gateway to the enclosure. Buildings E and F mirrored each other and were about 7 m x 4 m each internally (Fasham and Mason 1998, 27; Figure 3.34). Building F had an arc wall that ran south and west off the enclosure wall, while Building E was partially divided by a short stub wall (Fasham and Mason 1998, 27). A cobbled pathway ran between the two buildings (Fasham and Mason 1998, 27). Building E was most likely used for grain storage, according to Conway (1983, 123). This assertion is further substantiated by the findings of the botanical investigation, which reveals that Building E contained the highest quantities of charred cereals compared to all other contexts on the site, with wheat chaff fragments being the most prevalent (Fasham and Mason 1998, 27).

Building F had only a few internal features in the form of a posthole located midway across the building and a drain that passed under the south wall and emptied outside the enclosure

(Figure 3.34; Fasham and Mason 1998, 27). Environmental samples collected from it had high levels of chaff and the largest number of straw nodes on site which was suggested to indicate that the area was likely used for livestock stalling (Fasham and Mason 1998, 28).

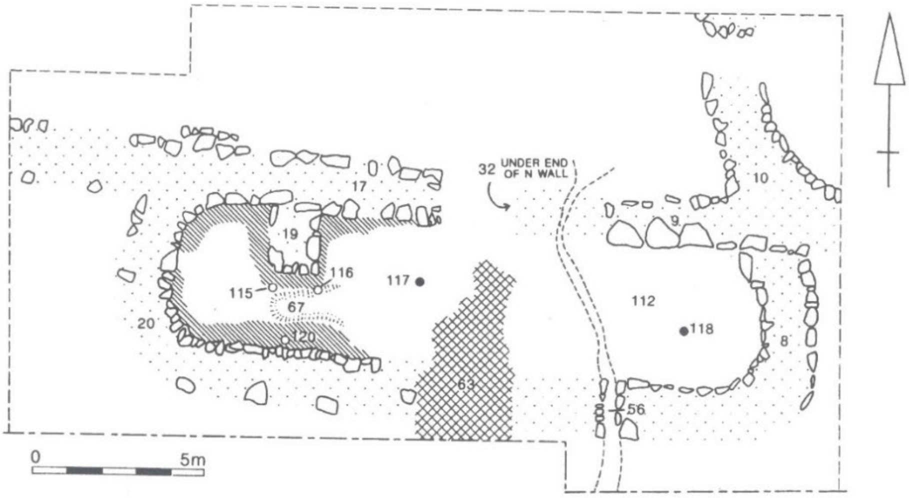

Figure 3.34: Interpretive plan of Building E (left) and F (right) (Fasham and Mason 1998, fig 17).

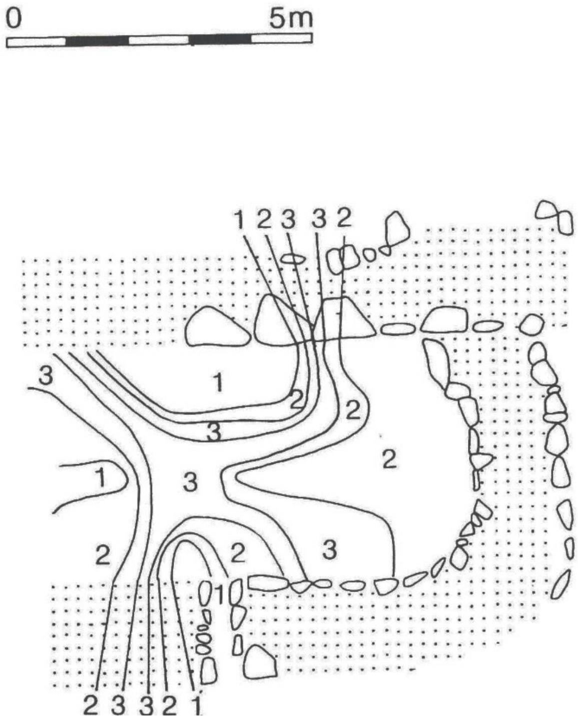

Figure 3.35: Total P levels (in ppm) in Building F (Conway 1998, fig 29).

Twenty-nine samples were taken from floor 112 of Building F for phosphate analysis (Conway 1983, 123). The total P distribution pattern suggests that the floor can be divided into three distinct areas. They include an area of low values up to 1800 ppm in the west and extending down the centre of the building, an area of high total P values above 2000 ppm across the middle, and another area of low values in the eastern part of the building that merges on to the cobbled path (Conway 1983, 123; Figures 3.34 and 3.35). Considering that the highest values were observed along the drain and closer to it, Conway (1983, 124; 1998, 71) suggests that the simplest explanation for the distribution pattern is that there was a single longitudinal division by the post that stood in posthole 118, which divided the structure into two animal stalls. The drain that ran across likely served as a channel for animal faeces and urine, producing high total P values (Conway 1998, 71; 1983, 124). The low levels of P observed at the west end of the building were claimed to indicate the presence of a manger or a similar feature that prevented the animals from trampling the soil in that area (Conway 1998, 71; 1983, 124). Phosphate analysis at this site, thus, helped identify the splitting of the building into grain storage/processing area and animal corralling area.

The phosphate survey carried out at Cefn Graeanog II has revealed the successful application (to a certain extent) of this technique and sampling strategy of contemporary contexts in two of the three structures analysed for total P. In the case of Hut C, although a metre grid used for sample collection revealed a significant pattern, it is likely that the extent of those areas is exaggerated or underrepresented. However, in the case of Building F, with its (most likely) singular function and very few internal features, a metre grid was sufficient in identifying the potential use of the building and its internal organisation. Hut G, on the other hand, demonstrated the limitation of the phosphate analysis technique in showing any significant pattern. This was mainly because a significant portion of the floor had not survived. This study is also notable for showing that the phosphorus from the initial use of the floor can still survive over a very long time as the floor survived under the wall collapse. In terms of interpretations, the study does not incorporate the finds and their location (wherever the data is available) into the interpretations. Such incorporation could have given more insights into the potential use of space in the structures.

Based on all these case studies so far explored in this subsection, it can be observed that there was no standardisation in the methods used in the 1980s and 1990s. Furthermore, the studies above and most extant literature on P analysis in Britain appear to be carried out by specialists who present their results as independent from the overall archaeological evidence and finds distributions though studies at Cladh Hallan are an exception to this. Differences in sampling strategies adopted at various sites can also be highlighted. Such a difference means that the results from different independent studies cannot be used to compare with each other.

Studies using multi-element analysis, as discussed earlier, have been significantly less extensive in archaeological explorations of houses. This discrepancy is particularly pronounced within the context of British archaeological research. Nevertheless, there is a growing trend among archaeologists to adopt this methodology. What follows below is an exploration of a selection of well-published multi-element studies at archaeological sites. They are organised in chronological order of the sites dating from the Neolithic to the modern period. Later chapters go on to explore additional examples of published geochemical analyses, so this is not an exhaustive list (see Chapters 5-7).

3.4.8 Multi-element study of Late Neolithic House in Crossiecrown, Orkney

A Late Neolithic house at Crossiecrown on Mainland Orkney has been the focus of a good multi-element study. Although the occupation of this site began in the mid-late 4th-millennium cal BC (Card *et al.* 2016, 162), the most substantial and coherent structures at this settlement were the Grey House and House 1 (referred to as Red House in Card *et al.* 2016) (Card *et al.* 2016, 163). The floor of House 1 was subject to a multi-element and magnetic susceptibility study based on samples obtained on a 0.6 m grid. House 1 was a large circular structure with double skin walls and a large central hearth (Jones *et al.* 2010, 33) belonging to the Late Neolithic. The house had a recess to the left of the entrance as one enters, a cell-like feature, a stone-lined drain, four stone-lined boxes set in the floor, a small pit, and orthostats

(Jones *et al.* 2010, 33). Magnetic susceptibility was found to be high in the hearth area, while high levels of phosphates were seen in areas beyond the hearth towards the southeast. Interestingly, the range of P values and magnetic susceptibility values were observed to be similar within and outside the house. The multi-element study at this house found that the spatial distribution of certain clusters of elements was suggestive of anthropogenic activities such as the use of the hearth, drain and other daily activities. P, Ca, Sr, and Zn were found in high concentrations around the drain. It was also observed that, despite their high levels, these concentrations exhibited varying degrees of enhancement. Particularly noteworthy was the marked elevation of P, whereas Zn showed the least pronounced increase in levels (Jones *et al.* 2010, 44; Figure 3.36). This has been linked to generalised midden deposits that are a mix of ash, charcoal, decomposed bone, and excrement. P, Cu and Ba were high in the entrance area. Ca and P were high close to the hearth and the area behind the hearth was highlighted by raised levels (though not uniformly raised) of P, Ca, and Sr. However, Jones *et al.* (2010, 44) also noted that while Ca levels peaked in the south corner of the hearth, it was not the case for P and Sr. Iron (Fe) seemed to be higher in a wide area behind the hearth, with peaks near the east wall (Jones *et al.* 2010, 37, 44), though it was not convincing that it was related to the rake out from the hearth (Jones *et al.* 2010, 45). Raised concentrations of Pb were seen in discreet areas, especially around the recess area.

A significant number of stone tools were also found in the eastern part of the house. This coincides with the elevation of levels of some elements (as discussed above) (Jones *et al.* 2010, 46). According to Jones *et al.* (2010, 43-44), this study highlighted that there were distinct patterns in the distribution of the several elements studied. Furthermore, the locations of raised concentrations of many elements were in spatially or functionally defined areas such as around the hearth, recess, drain, etc. (Jones *et al.* 2010, 43), suggesting that these distributions are a result of human activities. They also noted that some individual elements show a distribution that is not seen in other element distribution patterns, suggesting that some elements can act independently of others.

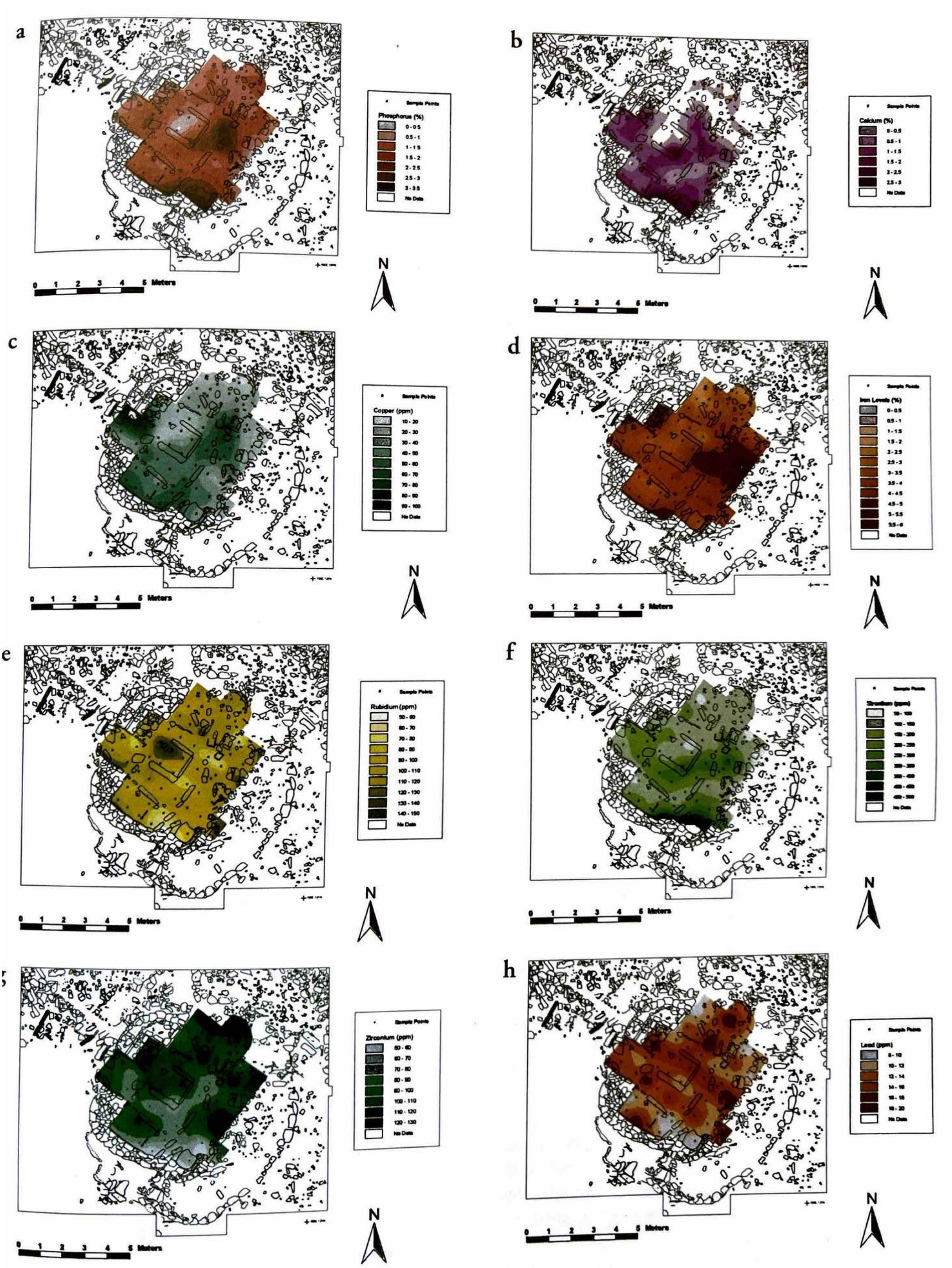

Figure 3.36: Distribution of (a) phosphorus, (b) calcium, (c) copper, (d) iron, (e) rubidium, (f) strontium, (g) zirconium and (h) lead across the interior of House 1 at Crossiecrown, Orkney (Card *et al.* 2016).

3.4.9 Late Neolithic Structure 14 at Ness of Brodgar, Orkney

Ness of Brodgar is a Late Neolithic settlement complex of monumental stone structures on Mainland Orkney. Structure 14 at this site was subject to a geochemical study using multi-element analysis. This stone building was sub-rectangular in shape with two sets of slightly tapered opposing piers and two buttresses in the corner at the east end that divided it internally. Such a division facilitated the creation of recesses and smaller spaces like niches which, according to Pike and Shinsato (2020, 167), likely had particular functions. The internal space was divided into eastern and western halves by a central orthostatic feature. Both these halves had a hearth each. Structure 14 also had two entrances, which were both located in the eastern half of the building (Pike and Shinsato 2020, 167).

The building had three distinct occupation phases. The first phase B was linked to a rammed earth flooring, and the second phase C was recorded as a deposition of yellow clay floor along with the reconfiguration of internal spaces. The final phase, D, represents the phase just before the dismantling of the building: it was badly preserved with several robbing cuts (Pike and Shinsato 2020, 167).

Although the 19 elements were analysed from each sample collected using pXRF on a 0.5 m grid, only phosphorus (P), potassium (K), manganese (Mn) and bromine (Br) have been presented in the study. In phase B, K was found to be in higher levels in the western half of the building but not as high in the northwest recess or the niche to the north of the hearth (Pike and Shinsato 2020, 172; Figures 3.40 and 3.38). In the same phase, Mn was highest immediately below the eastern hearth and northwest recess. Although P is also seen in the same areas, it is also seen higher around the western hearth (Figure 3.39). Pike and Shinsato (2020, 172) have associated Br with salt and suggest that Br behaves in a similar manner to chlorine (Cl) in chloride salts such as sodium chloride. Br was found to be higher by the south door area and the northwest recess in all three phases. This has been interpreted to suggest that areas within this house were used to store or prepare marine resources (Pike and Shinsato 2020, 172).

In phase C, Mn was found to be in higher levels in the western hearth, appearing to trail northward towards the pier (Pike and Shinsato 2020, 169; Figure 3.37). The eastern half of the building in this phase showed lower levels of Mn. K, on the other hand, showed a relatively even distribution in the area around the western hearth throughout the building (Pike and Shinsato 2020, 172; Figure 3.39). In terms of P, the distribution is similar to that of Phase B, except in the northwest recess. In all three phases, low levels of P were observed in the niche to the north of the western hearth. However, higher levels of P observed to the south of both hearths (excluding the doorways) are suggested to indicate that organic matter was stored in the southeast recess (Pike and Shinsato 2020, 172). Phase D, with fewer samples compared to other phases overall, was claimed to show a similar pattern of K and Mn distribution to that of Phase C (Pike and Shinsato 2020, 171-172). However, it was also suggested that this could be an artefact of inadequate data (Pike and Shinsato 2020, 172). On the other hand, P distribution in Phase D was found to be homogeneous and unremarkable.

This study has shown the advantages of a multi-element study in a multiphase house. Similar to the case of P studies in structures at Cladh Hallan (discussed above), it has shown the difference in the patterns of the distribution of various elements across different floors of the same building, suggesting the different uses of the various areas of the house in different phases.

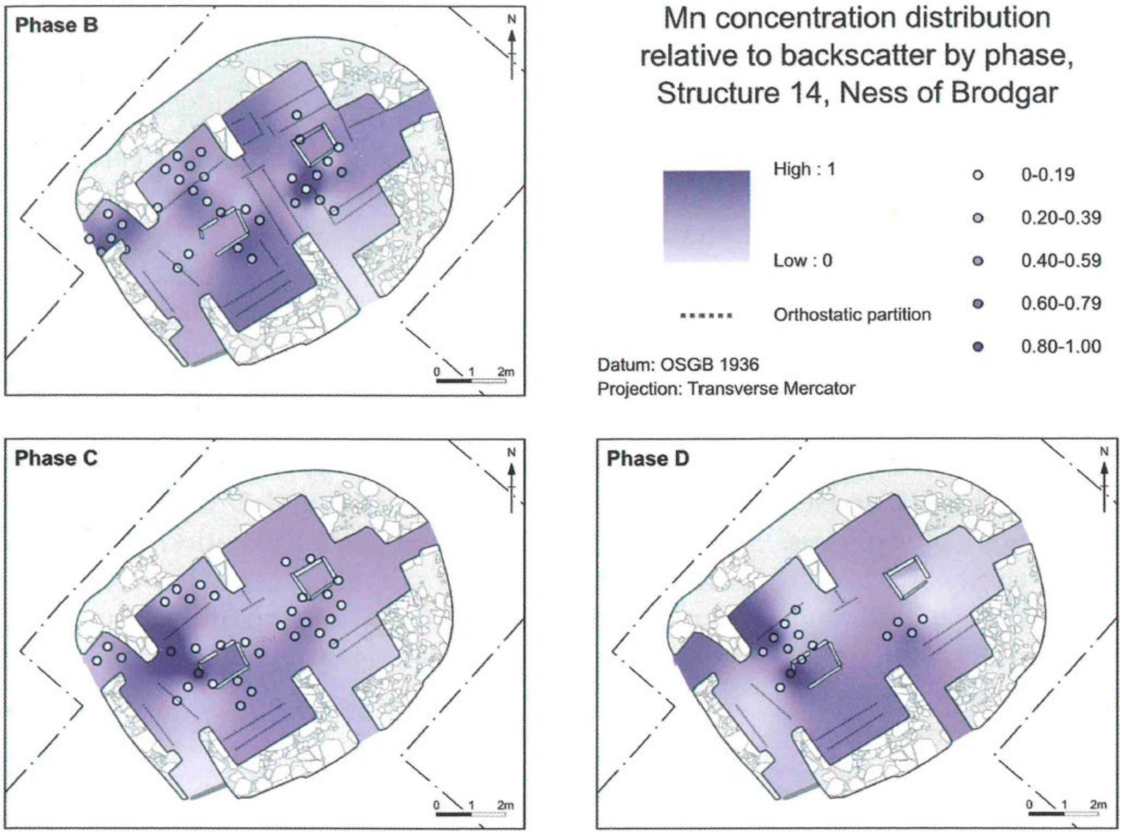

Figure 3.37: Distribution of manganese across the floor of Structure 14 in the three phases (Pike and Shinsato 2020, fig 13.4).

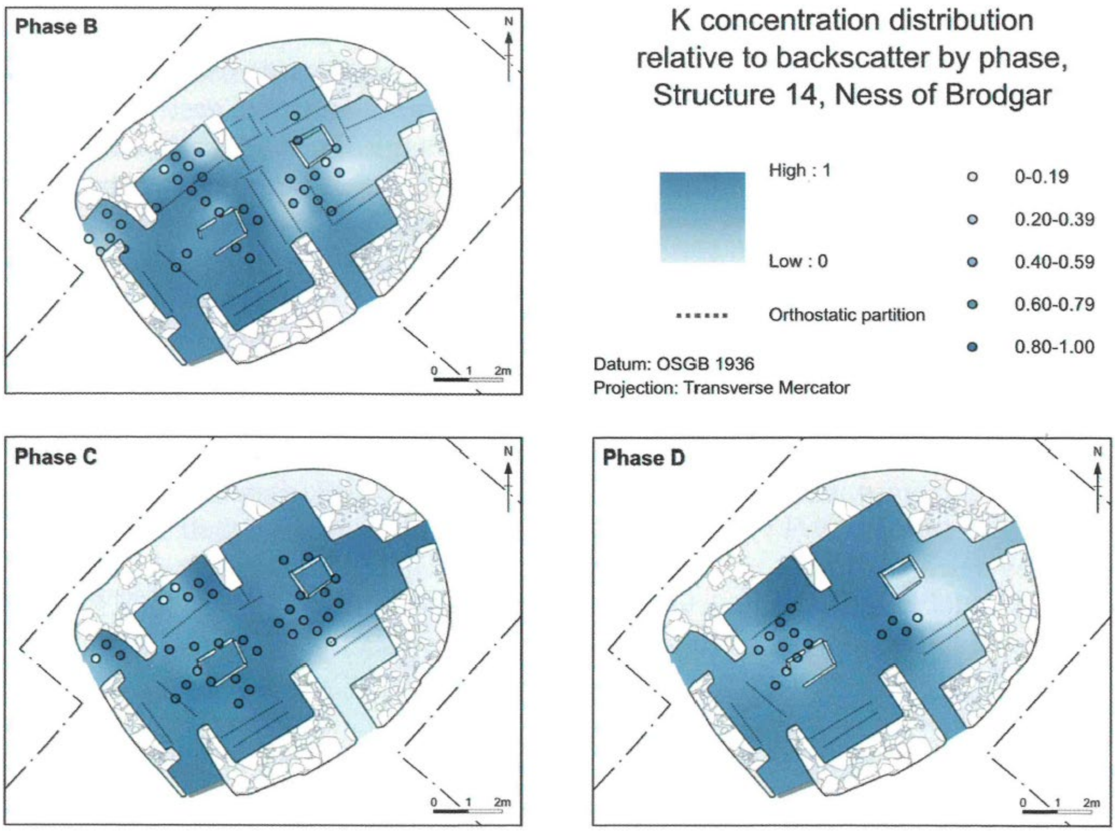

Figure 3.38: Distribution of potassium across the floor of Structure 14 in the three phases (Pike and Shinsato 2020, fig 13.5).

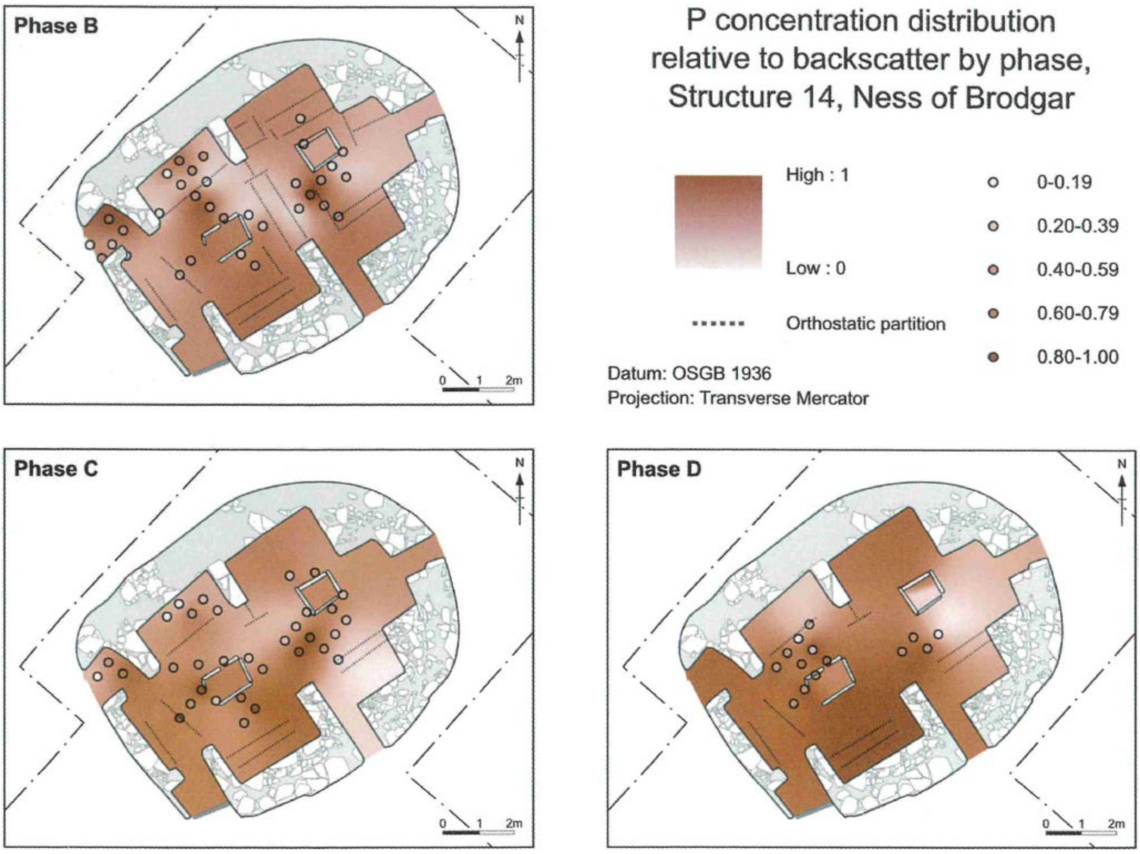

Figure 3.39: Distribution of phosphorus across the floor of Structure 14 in the three phases (Pike and Shinsato 2020, fig 13.6).

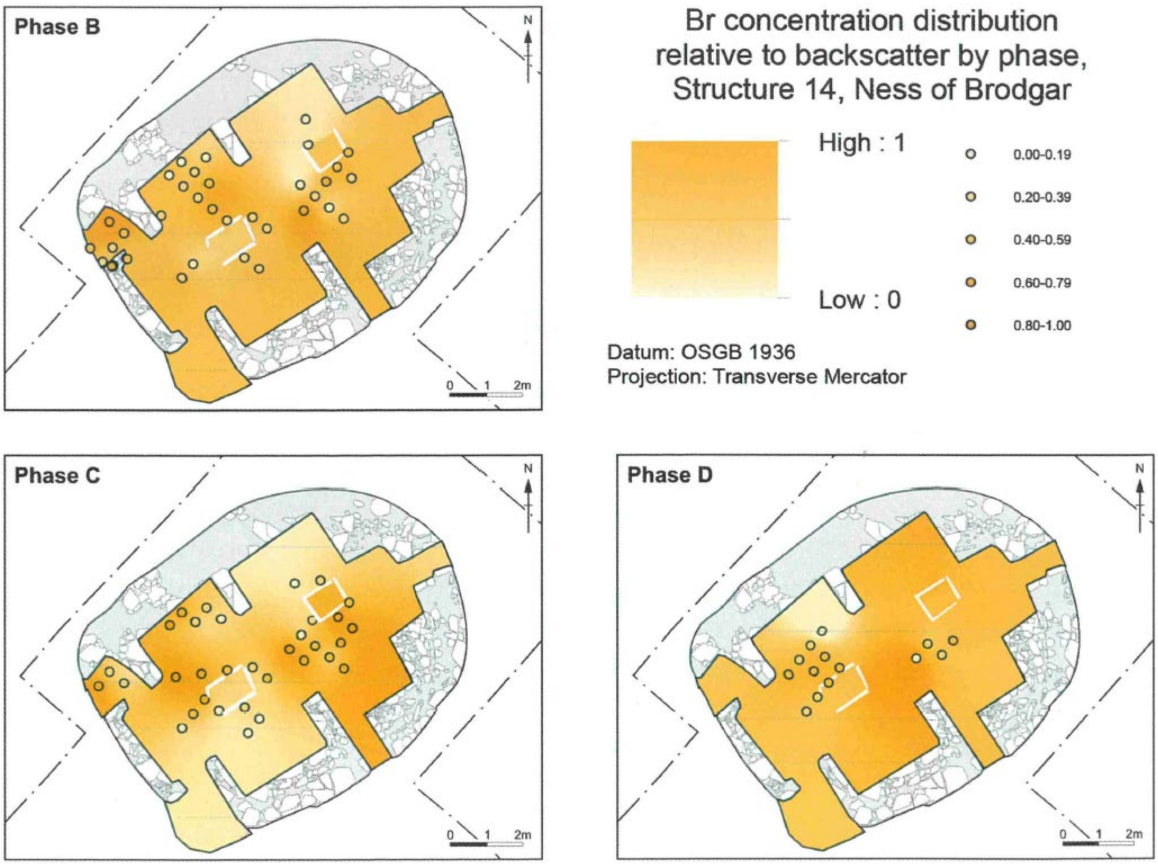

Figure 3.40: Distribution of bromine across the floor of Structure 14 in the three phases (Pike and Shinsato 2020, fig 13.7).

3.4.10 The multi-element analysis of a Late Iron Age house, mound 1, Bornais, South Uist, Outer Hebrides

The Late Iron Age stone-walled house on Mound 1 at Bornais in South Uist, Outer Hebrides, gave evidence of being burnt down and rebuilt at least once, and it was subsequently almost entirely robbed of its structural parts after it was abandoned (Sharples 2012b, 42). Among the surviving structures include two groups of stones that define the inner wall face, two piers that project from the inner wall face, a group of stones forming an arc joining the pier ends, two hearths and two rows of low-lying stones that may have been entrance thresholds (Sharples 2012b, 42). Due to the presence of two hearths and two thresholds, Sharples (2012b, 42) has therefore interpreted it as a house that was reconstructed at least once. Some of the structural remains of the primary phase may have been reused as it was evident on excavation that the east wall remained in place for both phases. Based on the change in the location of the hearth and the presence of two possible thresholds, Sharples (2012b, 42) claims that the western end was radically altered between the two phases. What follows is an analysis of the phosphate samples taken from the house floors and analysed by multi-element analysis. First, I shall briefly characterise the deposits and structural remains associated with each phase.

Houses 1 and 2

House 1 has been interpreted as the remains of a possible Late Iron Age wheelhouse, with the visible walls and piers on the east side still *in situ*. The excavators observed a distinction between the internal core and external peripheral areas of the house, divided by stone piers. This was based on the observation that piers 3 and 4 were joined at their inner ends by a line of five small upright stones, and similar stones appeared sporadically in other areas while still following a roughly oval line that was 3.8 m by 3.4 m (Figure 3.41, Sharples 2012b, 43). The hearth was in the centre of this oval area (Sharples 2012b, 43). As occupational deposits, this house had fairly complex stratigraphy that comprised vestigial remains of the original floor layer and a thick layer of charcoal-rich material (457) that contained a lot of carbonised timbers (Sharples 2012b, 45). Sharples suggests that the carbonised timbers are most likely the result of the roof collapse when the house was burnt down (Sharples 2012b, 49-50). This charcoal layer was covered by the secondary occupation floor, demonstrating that the house was reoccupied (this is named House 2, below). Four radiocarbon dates obtained from the charcoal layer have given the calibrated dates of AD 420-590, AD 400-560, AD 430-490 and AD 500-690, all at 95% confidence (Sharples 2012b, 47). Wheelhouses are more typically associated with Middle Iron Age Atlantic Scotland, and so this appears to be an unusually late example (see Chapter 7).

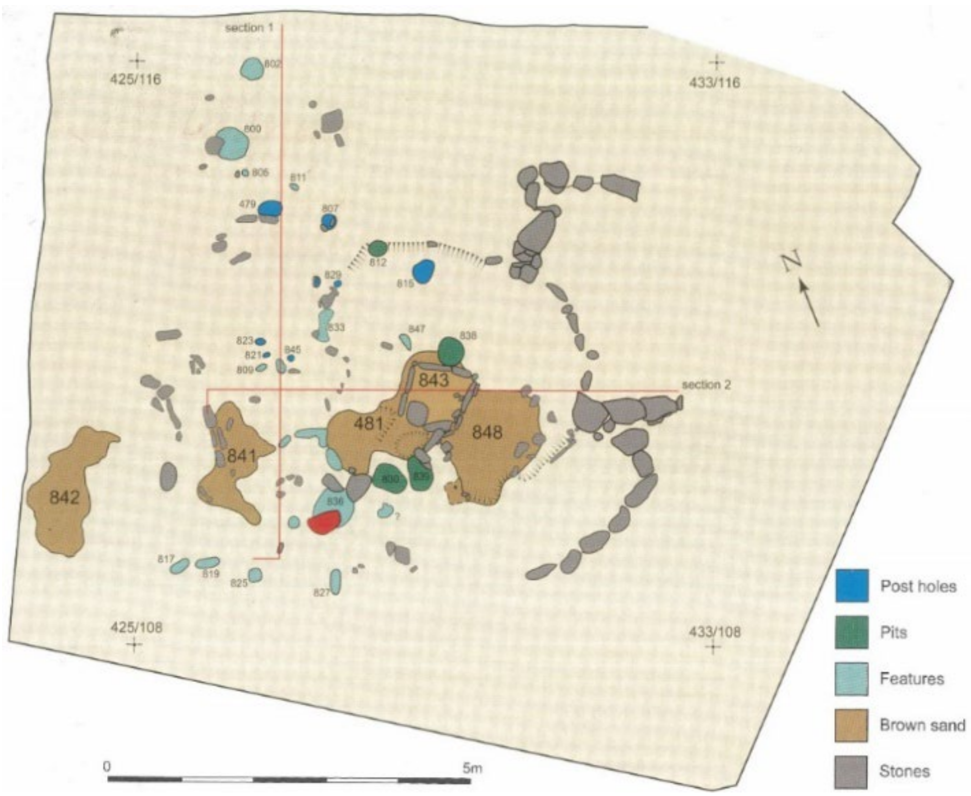

Figure 3.41: Structural remains of House 1 (Sharples 2012b, fig 23).

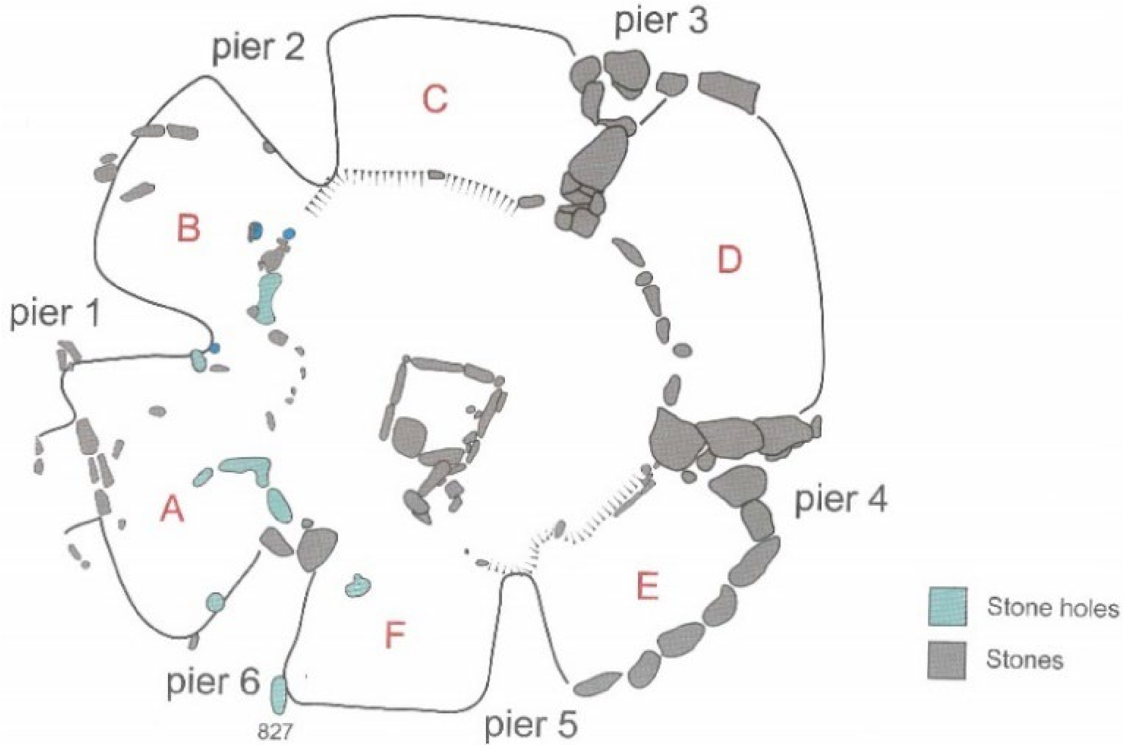

Figure 3.42: Interpretive plan of House 1 as wheelhouse (Sharples 2012b, fig 33).

The reoccupation and partial reconstruction of House 1 involved the reuse and retainment of the south and the east arc of the wall and at least piers 3 and 4. In this phase, a hearth was built to the west of the original hearth and just inside the original entrance of House 1. This hearth was recorded to be trapezoidal, being 0.55-0.75 m wide and 1-1.11 m long. A new entrance for this phase was recorded to the south of the new hearth (Sharples 2012b, 50-51). The main occupation layer linked to the occupation of this house was an orange-black compact sand layer (397/306) which was recorded as patchy and difficult to separate from the underlying charcoal layer (457) due to the considerable mixing of these layers (Sharples 2012, 53). Sharples (2012b, 53) claims that such mixing reflects the problem with the reoccupation of a building that was burnt down, with the burnt horizon being reused to create a new floor surface. This is an excellent example of a c-transform, such as recycling, affecting the site. Two calibrated dates of AD 400-560 and AD 420-600 were obtained from this floor at 95% confidence (Sharples 2012b, 54).

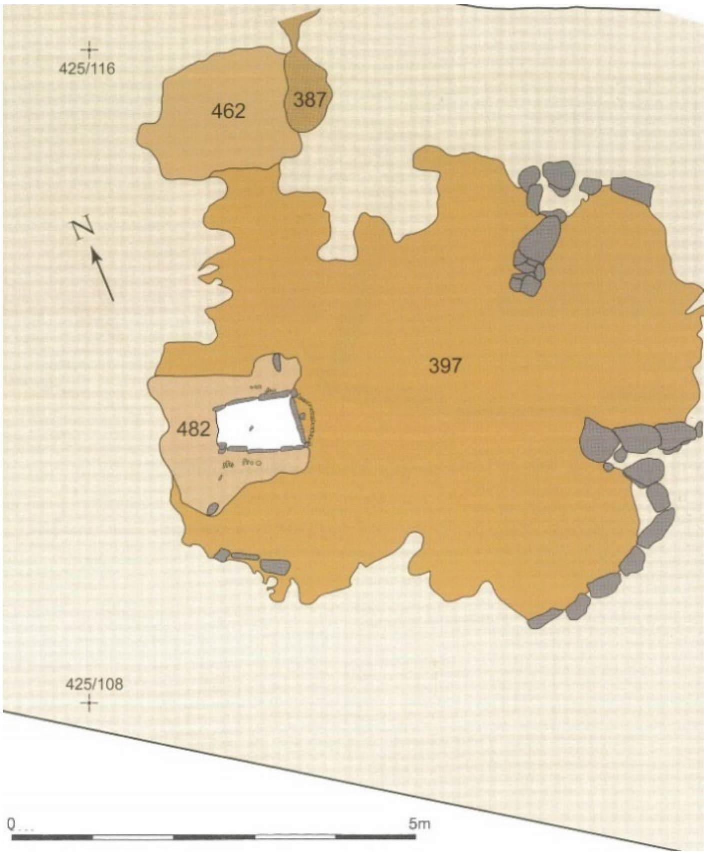

Figure 3.43: Plan of House 2 showing the extent of floor 397 (Sharples 2012b, fig 36).

Based on the observation of two discrete patches of compact brown sand (462) and orange-black sand (466), directly in line with the hearth and in the northern area of the house, Sharples (2012b, 54) argues that a new entrance was positioned here. The west side of this house was badly damaged by recent erosion, and as the structure's north side was irregularly preserved, it was a challenge to determine a precise shape and size for this house, like House 1 (Sharples 2012b, 54). However, Sharples (2012b, 54) argues that the house was not a standard wheelhouse and may well have been similar in shape to the hearth, with a rounded east end, a straight west end and two straight sides. If this is the case, with two piers still surviving in this phase, it is likely that the area between piers 3 and 4 was a chamber (Figure 3.43).

Multi-element analysis was performed on soil samples taken from the surface of the floor of House 2 (397). The samples were taken at 0.5 m intervals. Each sample was analysed for various elements as well as magnetic susceptibility (Smith and Marshall 2012, 69-76). Based on the distribution of the readings, the results have enabled the house to be split into three areas (Figures 3.44 and 3.45).

Hearth

The distribution patterns for most of the analysed elements found within the soil, as well as the magnetic enhancements, appear to have certain similarities (Figures 3.44 and 3.45). Smith and Marshall (2012, 73) have noted that the elements present with enhanced levels include phosphorus (P), magnesium (Mg), zinc (Zn), nickel (Ni), manganese (Mn) and lead (Pb), and copper (Cu) to a lesser extent. In most cases, the highest values seemed to focus around the perimeters of the stone surrounding the hearth, especially along the northern edge and at the western and eastern ends. While similar patterning was observed for P, Mg, and Zn, the highest concentration seemed to be at the west end of the hearth and the opening of the stone kerbs of the hearth. Smith and Marshall (2012, 73) have suggested that this indicates the location of particular activities, such as cooking or cleaning the hearth, as well as highlighting an accumulation of food and fuel waste from such activity. Mn was observed to be highest within the hearth, particularly in the northeastern area. Similarly, lead (Pb) levels also demonstrated their peak values within the hearth. Potassium (K), on the other hand, was observed to be in a high concentration in two samples taken from the east of the hearth (Figure 3.45; Smith and Marshall 2012, 73).

Chromium (Cr) and copper (Cu) were noted as being highest along the stone surrounding the hearth. One isolated sample each, with high values for copper, was noted on the southern edge of the hearth and about 1 metre east of the hearth (Figure 3.44). Smith and Marshall (2012, 73) have suggested this to be a result of the isolated loss of artefacts.

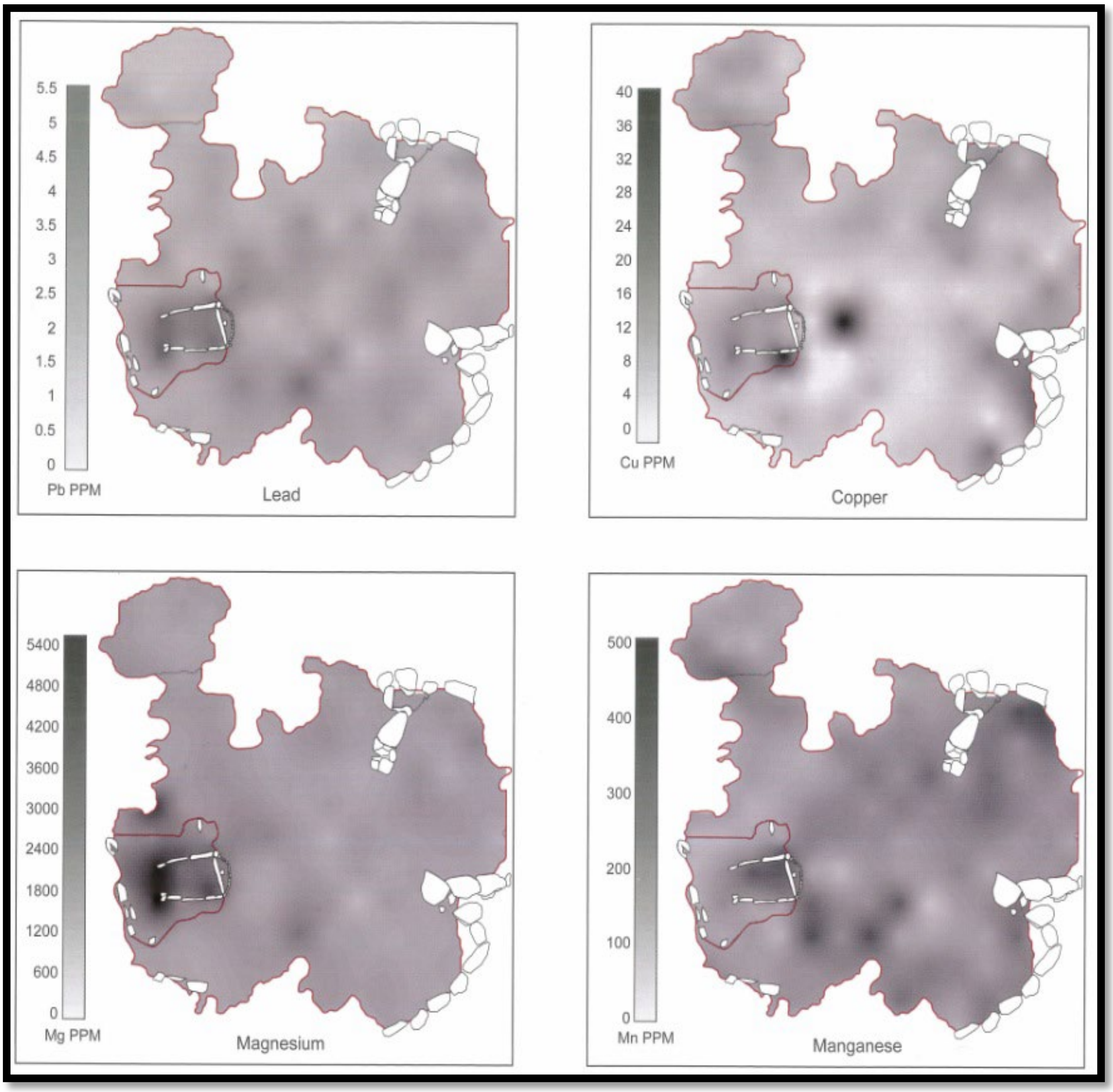

Figure 3.44: The distribution of lead, copper, magnesium, and manganese (Marshall and Smith 2012, fig 51b).

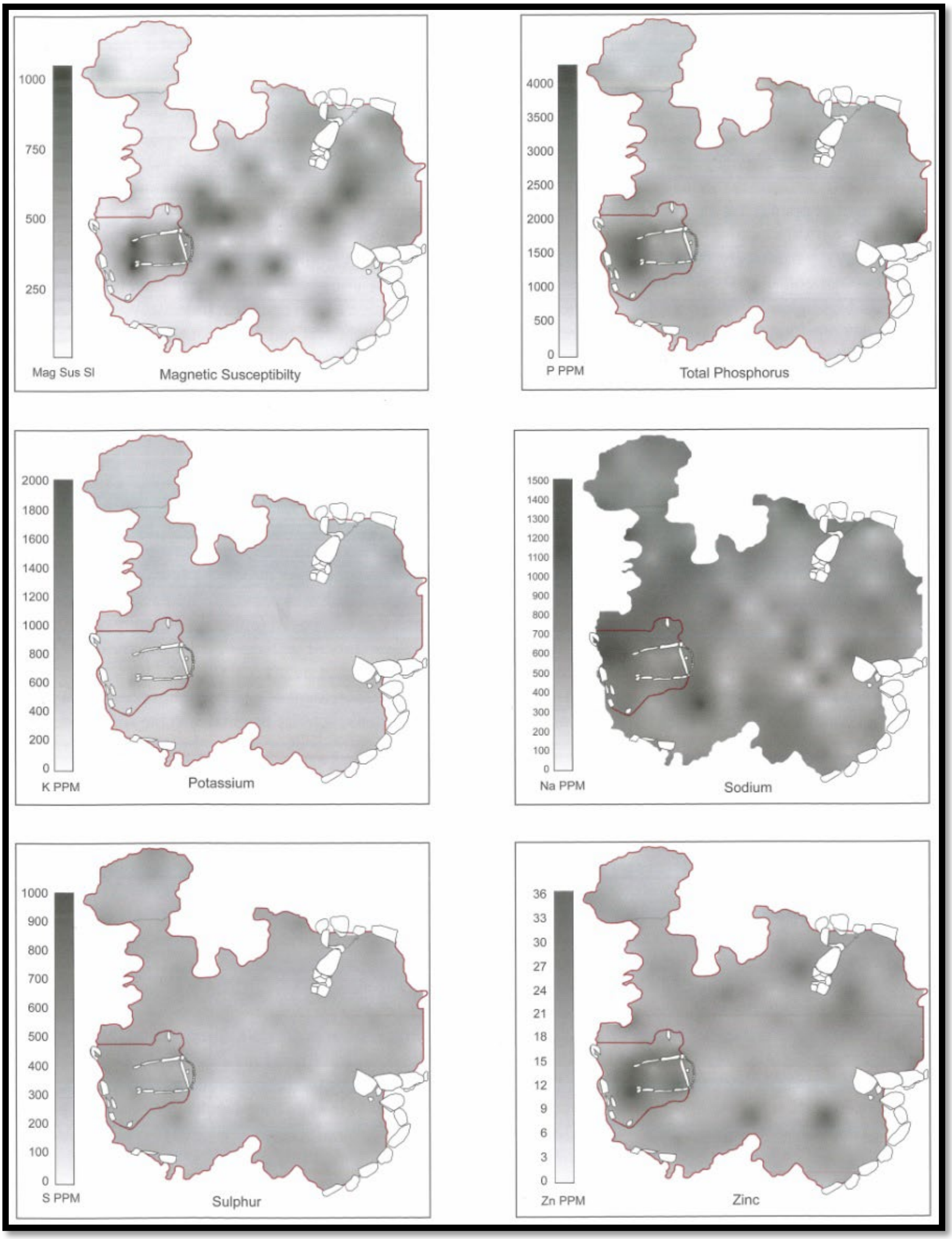

Figure 3.45: The distribution of magnetic susceptibility, total phosphorus, potassium, sodium, sulphur, and zinc (Marshall and Smith 2012, fig 51a).

The area between and around piers 3 and 4

Another area producing high concentrations of several elements is noted within and around the cell and between stone piers 3 and 4 on the east side of the house. A high concentration of P was also noted in an area just to the north of pier 4, where it meets the inner wall and in the area lying west of pier 3 (Figure 3.45). A conspicuous buildup of manganese (Mn) was also detected along the southern periphery of pier 3 and exhibited a curving pattern alongside the outer wall. Slightly augmented levels of Mn were also detected within the cell's floor, proximate to pier 3, as indicated (Figure 3.45; Smith and Marshall 2012, 73).

Other areas

Marked concentrations of sodium (Na) formed a diagonal band running from the northwestern edge of the hearth to the northeast (Figure 3.45, Smith and Marshall 2012, 73). To the southeast of the hearth, higher levels of Mn were observed to form a small arc. Sulphur (S) was found to have higher values towards the outer edges of the house interior and in the cell on the eastern side of the house (Figure 3.45; Smith and Marshall 2012). Interpretations of the significance of such concentrations, particularly of Na, Mn, or S, were not discussed further in the publication.

Analysis

One of the drawbacks of this study seems to be the fairly limited amount of interpretation offered for the various distributions and concentrations of particular elements and magnetic enhancement within the soil. The only interpretation provided for the patterns identified was that the hearth was used for cooking activities (Smith and Marshall 2012, 73). Moreover, the results of the multi-element study and the analysis of the finds distributions and the coarse residues deriving from the soil samples (Sharples 2012a) have not been combined to improve the interpretation of the spatial organisation of the house. For example, the spatial distributions of coarse residues from soil samples which were taken from the house floor on a 0.5 m grid show the highest amount of coprolite recorded in the area between piers 3 and 4

(Figure 3.46). Elevated P levels can also be observed in this area, particularly in the eastern corner against the wall (Figure 3.45). Evidently, the reason for the high levels of P in this area is the density of coprolites found here. If coprolites are located here, the high levels of P may also relate to the presence of urine. The soil micromorphology study of a sample from this area indicates that the coprolite was a carnivore coprolite, most likely from a dog and that it was trampled into the surface of the floor (Milek 2012, 61). A sand layer that was recorded as covering the coprolites was suggested as an indication of it being deliberately dumped to bury the faeces and to maintain the cleanliness of the floor (Milek 2012, 56, 61).

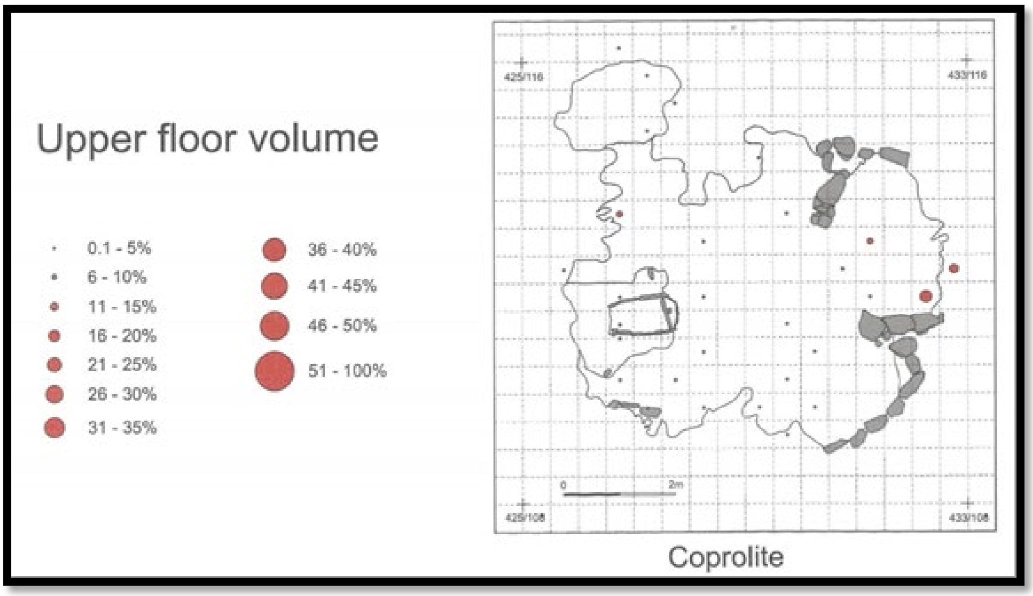

Figure 3.46: Distribution of coprolite residue in House 2 (Sharples and Norris 2012, fig 50).

A layer of coprolite was recorded in House 1 in the same area where it was recorded in House 2 (Sharples 2012c, 322). According to Sharples (2012c, 322), this coprolite layer in House 1 results from a dog being restrained in the area. This area was most likely used as a storage area, with the idea being that items were stored hanging from the roof of this chamber. A similar use has not been suggested in the same area in House 2. However, based on the P levels and coprolite layer discussed above, this cell/chamber in House 2 was most likely used in the same manner as House 1. Moreover, the high concentration of P adjacent to pier 4 recorded (Figure 3.45) was possibly the result of the dog urinating against the wall in the eastern corner. This is because urine has higher levels of P than faeces. The high levels of P overall correspond fairly well with the distribution of coprolite in House 2 (Figures 3.45 and 3.46), yet the absence of coprolite in that same eastern corner raises the possibility that the high level of P here is a result of exposure to urine. This further emphasises that the dog was possibly restrained there rather than the defecation being an isolated event.

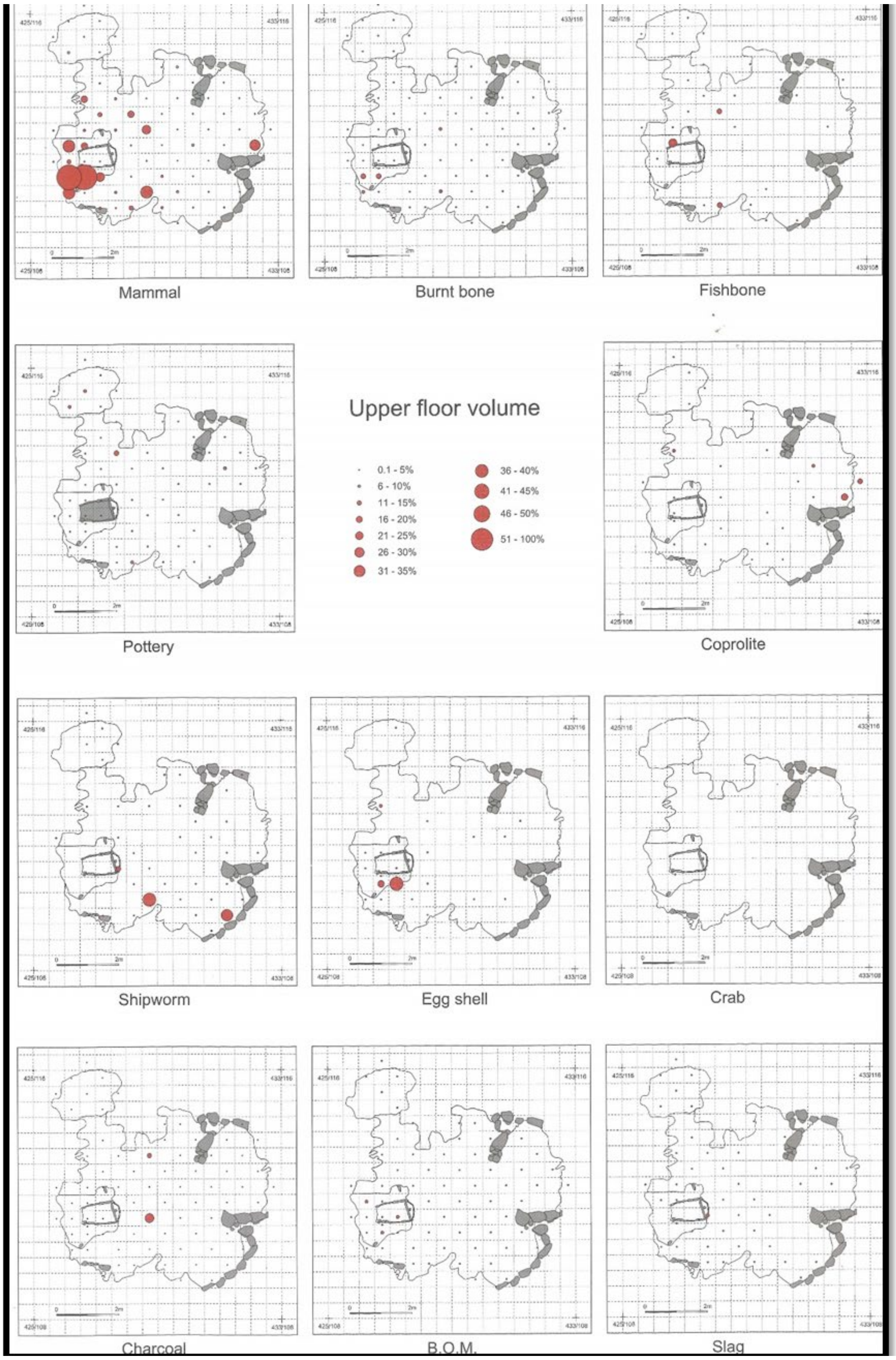

Figure 3.47: Distribution of material recovered from below 10mm in floor layer 397 (Sharples and Norris 2012, fig 50).

Interpretations for the low concentrations of P in the southern half of the house, particularly in the cell between piers 2 and 3, are also not explored anywhere in the publication. These low readings are consistent with the low densities of coarse residues taken from the house floor (Figures 3.45 and 3.47). Likewise, in terms of the distribution of small finds, these were low in number in this area, being mainly concentrated in the central area of the house and to the east of the hearth. The small finds recovered from the central area include a bead, a couple of bone pins and antler finger rings, while bone points, handles, and a bone waster for object production were found in more peripheral areas (Sharples 2012c, 323). Based on the spatial patterning of small finds, it is stated in the publication that this might indicate a distinction between the central area and peripheral area, as is the case in other wheelhouses. It must, however, be noted that the number of finds recovered was too few to suggest this as an emphatic division (Sharples 2012c, 323). However, when compared with the P levels, it does indeed seem likely that the southern area was, at least, kept cleaner or had much less exposure to day-to-day activities in comparison to the working/cooking central area.

According to Smith and Marshall (2012, 73), it has been suggested that peat may have been the fuel employed in the house, as it is often associated with moderate levels of copper (Cu). Nevertheless, this interpretation overlooks the distribution patterns of potassium (K) within the floor. The claim that peat constituted the principal fuel becomes considerably more robust when the absence of elevated K levels in the hearth area and the area where food and fuel waste accumulated to the west is considered (Figure 3.45). This absence is significant because peat ash is notably deficient in potassium when compared to wood ash (Steenari *et al.* 1999, 249-258). Moreover, Sharples (2012d, 65) highlighted a noteworthy disparity in the quantity of charcoal derived from coarse residues between the floor of House 2 and the charcoal layer 457. He proposes that this disparity likely resulted from the regular use of peat as a domestic fuel (Sharples 2012d, 65). Once again, this finding lends further support to the contention that peat was the primary fuel employed.

Although a magnetic susceptibility survey was carried out, and Pb concentrations were also analysed, the apparent similarities in the spatial patterning of magnetic enhancements along with Pb have not been stressed in the analysis (Marshall and Smith 2012 73; Figure 3.44 and 3.45). Such a pattern could indicate the peat ash being deposited or trampled into the floor in those areas, as Pb is a component of peat and wood ash. Furthermore, micromorphological soil analyses on samples taken from an area lying immediately to the east side of the hearth contained mainly peat ash, which had evidently been dumped and trampled on the floor surface (Milek 2012, 61). Based on all these observations published in the volume, it may be suggested that peat was likely the primary domestic fuel used at the site.

A note on methodology used at Mound 1, South Uist

In the context of the geochemical study, it is worth noting that the reference soil samples (if obtained) from the site's natural deposits have not been analysed. This aspect assumes significance if one intends to propose that the elevated levels of certain elements in the house floor are a consequence of human activity rather than being indicative of naturally occurring concentrations in the soil. In this study, however, the archaeological evidence unambiguously establishes that the high phosphorus levels are attributable to human occupation activities, as they are observed to be co-located with the house floors. Still, it is advisable to analyse the natural soils at the site during any phosphate or multi-element study of archaeological soils. Such an approach can aid in minimising the likelihood of erroneous interpretations. The method of data representation used at this site is an excellent example of the benefit of GIS distribution maps in geochemical floor analyses (See Figure 3.44-3.45).

3.4.11 Multi-element analysis of six abandoned farms in Britain

Wilson *et al.* (2005; 2008) applied multi-element analytical techniques to six abandoned farms in Britain which were abandoned between AD 1890 and 1940. These all had modern land use, which was limited to recreation and rough grazing (Wilson *et al.* 2005, 1095). These sites include Olligarth and Papa Stour in Shetland, Auchindrain in Argyll, Grumby in Sutherland, Far House in North Yorkshire, Balnreich in Perthshire and Cwm Eunant in Powys; thus, representing a range of sites spread out in Britain (Figure 3.48). The samples were collected from the hearths, houses (kitchen), gardens, middens, arable fields, grazed outfields, byres and reference soils from off-site areas where present. They were collected using augers from topsoil in buildings and fields using a 1 m grid (Wilson *et al.* 2008, 414).

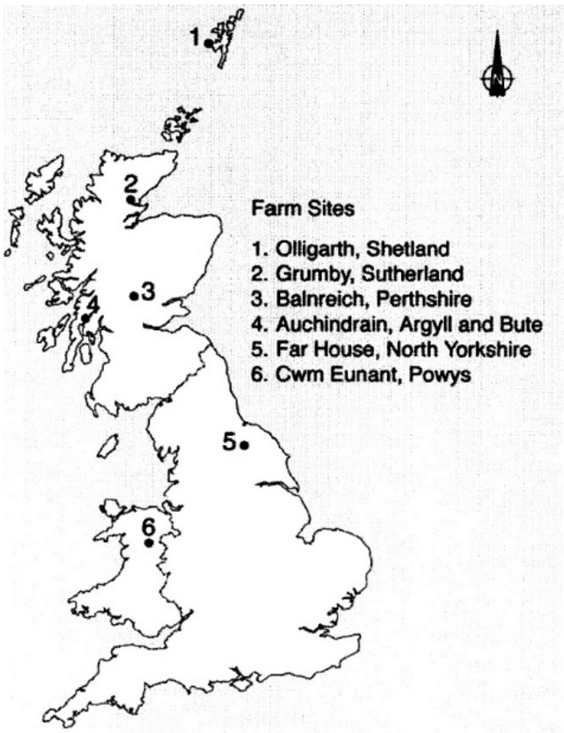

Figure 3.48: Location map of farm sites (Wilson *et al.* 2005; fig 1).

In this current study, Wilson *et al.* (2008) have used the previous data from their preliminary work (Wilson *et al.* 2005) along with the addition of analyses of reference materials such as charcoal, bone, heather, peat, turf, wood, bracken, and dung from farm sites in order provide an interpretation of the results, with a higher degree of confidence. The reference materials were collected locally from around each site. The multi-element analyses of reference materials helped in identifying the potential inputs in different activities that caused the enrichment of a specific group of elements. A summary of the site's characteristics and history is provided in Table 3.2. This is a useful case study to explore as it can help facilitate the interpretation of multi-elemental analyses on other archaeological sites and houses.

Summary of site characteristics and history

	Auchindrain	Balnreich	Cwm Eunant	Far House	Grumby	Olligarth
	Argyll	Perthshire	Powys	N. Yorkshire	Sutherland	Shetland
Geology	Schist	Mica schist and gabbro	Shale and slate	Oolite and sands	Gneiss	Rhyolite
Soils	Peaty gley, podzol, humic iron podzol	Peaty gley, podzol, humic iron podzol	Peat, iron stagno-podzol	Peat, pelo-stagnogley, humic iron podzol	Peat, humic iron podzol	Brown forest soil, skeletal humic soil
Date last inhabited	Late 19th century	Late 19th century	1917	1938	1940	1940
Settlement type	Township	Township	Tenanted farm	Tenanted farm	Croft	Croft
Layout	Byre house?	Byre house	Courtyard	Courtyard	Linear	Linear
Construction	Clay mortar	Clay mortar	Lime mortar and plaster in house	Lime mortar in house and byre, plaster in house	Clay mortar, fireplace and walls patched with lime	Clay mortar internal shell based plaster
Main fuels	Peat and coal	Peat and coal	Peat and wood	Peat, wood and coal	Peat	Turf and coal
Agriculture	Mixed; oats, bere, cattle, sheep, poultry and communal pig, potatoes, kale and turnips	Mixed; bere, oats, potatoes, turnips, peas, lint, cattle, sheep, pigs and poultry	Mixed; wheat, barley and oats, potatoes and turnips, Molinia and bracken cut as fodder; sheep, cattle, pigs and poultry	Mixed; wheat, barley, oats, potatoes and turnips, cattle, sheep, pigs and poultry	Mixed, oats and bear, potatoes and turnips, cattle and sheep, also pigs and poultry	Mixed, bere, oats, kale and potatoes, few turnips, cows, sheep, poultry and pigs, spade cultivation
Manure	Byre and domestic waste, commercial fertiliser and lime	Byre waste, domestic waste, turf and lime	Byre waste particularly bracken bedding, and lime	Byre waste and lime	Byre and domestic waste, and commercial fertiliser	Byre waste, domestic waste, turf, seaweed, fish waste
Modern use	Museum, fields cultivated	Grazing, organic for last 5 years	Grazing, possibly limited liming	Grazing, no fertiliser or reseeding in last 10 years.	Rough grazing, no intervention	Grazing, no intervention

Table 3.2: Summary of characteristics and history of the six farm sites (Wilson *et al*. 2008, table 1).

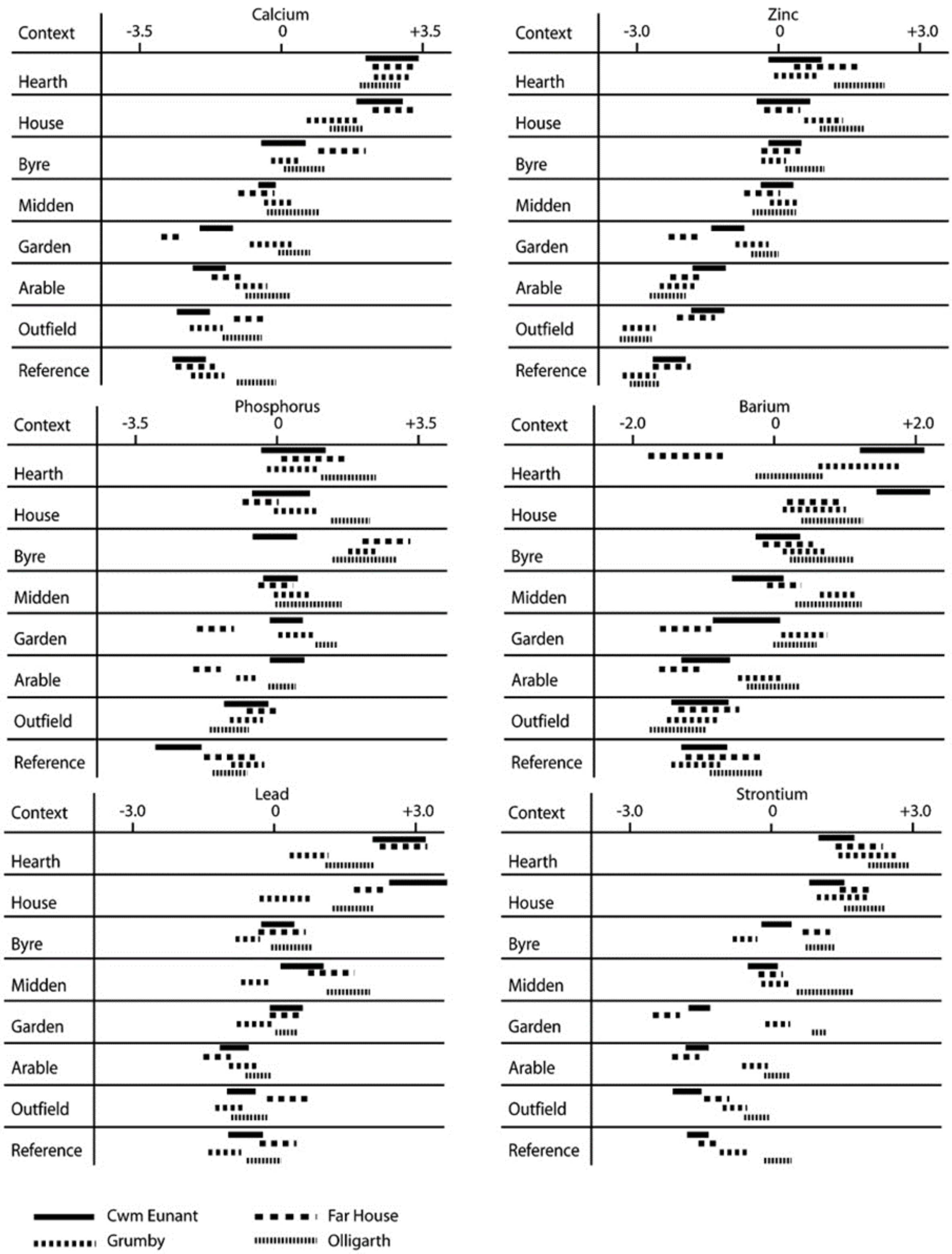

Figure 3.49: Comparison of the site and functional area differences with graphs showing intervals normalised against Cwn Eunant byre samples at 95% confidence (Wilson *et al.* 2008, fig 1).

The analysis was done using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) (Wilson *et al.* 2008, 414). The results portrayed significant differences (if any) in concentration levels of elements between the functional areas at all sites (Figure 3.49). Although there was a general enhancement of element concentrations within and around buildings compared to other regions, such as the arable field and grazed outfields, a generalised pattern in the distribution of various elements was also observed (Wilson *et al.* 2008, 416).

Calcium (Ca) showed the highest concentrations near the hearths and marginally lower levels in the houses. There was little overall enhancement in concentrations in the arable fields and garden when compared to the outfields and reference samples (Wilson *et al.* 2008, 416; Figure 3.49). A similar pattern of high levels near the hearths and slightly lower in the houses was also recorded for Barium (Ba) and Strontium (Sr) (Wilson *et al.* 2008, 416; Figure 3.49).

Lead (Pb) showed no significant enhancements in the arable fields. However, its highest concentrations were observed in the hearth and the house. Enhancement of Pb levels was also found within midden, byre, and garden samples (Wilson *et al.* 2008, 416; Figure 3.49). The highest levels of Zinc (Zn) were found in hearths, houses, byres, and middens and, to some extent, in the gardens. Grumby is an exception to this trend, where Zn showed the highest enhancement in the house than elsewhere (Wilson *et al.* 2008, 416; Figure 3.49). However, the lowest concentration of Zn was recorded in the reference samples, but moderate enhancement in Zn was observed in arable fields. This likely suggests the plants/ grain as a source of Zn. Phosphorus (P) was recorded to be the highest in byres. However, the concentrations were also significantly higher in the hearth, house and middens compared to the outfield and reference soils (Wilson *et al.* 2008, 416; Figure 3.49).

This study successfully points out that there lacks a correlation between the background concentrations of various elements and the enhancement of concentrations of those elements within buildings at the six sites analysed. This suggests anthropogenic factors rather than background geology as the prime cause for the enhancements in elevated levels and distribution patterns of various elements in buildings; however, Pb is an exception to this (Wilson *et al.* 2008, 419). Areas with former domestic function are highly noticeable in the concentrations of Ca, P, Ba, Pb, Cu (Copper), Sr, and Zn despite the sites having different geology and being from distant areas within the UK (Figure 3.49). Based on this study, it can be suggested that on farm sites, a high concentration of an extensive suite of elements, with P showing medium levels of elevation, is an indicator of the hearth. A similar series of elements show enhancements in areas associated with house floors, although at a slightly lower level compared to the hearths. A similar marginally lower level for the similar elements (Ca, P, Ba, Pb, Cu, Sr, and Zn) was also noticed in byres, with the notable exception that P concentrations are the highest in these contexts (Figure 3.49). Based on these observations, Wilson *et al.* (2008, 421) suggest that in cases where there exist known analogues or reference materials, interpretation of the use of space based solely on soil multi-element concentrations may be possible. Multi-element soil analysis from structures can be used to identify activities or features in the structures if specific chemical signatures associated with specific activities/features could be identified based on studies of several sites. This can serve as a vital tool in archaeological prospection and interpretation as well (Wilson *et al.* 2008, 423).

As mentioned above, various reference materials were selected from the sites and analysed for multiple elements in their composition in this study. These include bone fragments, bracken, charcoal, coal, dung, heather, mortar, peat, rush, turf, and wood (Wilson *et al.* 2008, 414). It was found that in the case of the chemical elemental composition of reference materials, the differences were small for similar materials from different sites. It was observed that charcoal that was extracted manually from the soil was a vital source of Sr, Cu, Pb, P, Ca, Zn, and Ba. However, a charcoal sample from Cwm Eunant had much weaker concentrations of Ba, Zn, and Pb compared to samples from other sites. This anomaly is attributed to fresh charcoal being extracted from Cwm Eunant and old charcoal from other sites (Wilson *et al.* 2008, 421). Based on this, Wilson *et al.* (2008, 421) emphasise the post-depositional uptake and concentrations of Ba, Zn, and Pb in charcoal. Cwm Eunant (abandoned in 1918) is an older site in comparison to Far House (abandoned in 1938), and Grumby and Olligarth (both abandoned in the 1940s) (Wilson *et al.* 2008, 414). This brings into question the strategy involved in the extraction of fresh charcoal from Cwm Eunant as opposed to old charcoal perhaps available on site.

Transformation of material post-deposition, similar to that of charcoal, has also been suggested for bones in the retainment of Zn and Cu. This was based on the results of a separate microprobe analysis on charcoal and bone (fish in this case) (Wilson *et al.* 2008, 421). Such a finding has been supported by the post-depositional enhancement of bone with Cu and Zn in the soils of the previously inhabited island of St Kilda, Scotland (Davidson *et al.* 2007). Based on all of these findings, Wilson *et al.* (2008, 421) suggest that high concentrations of P in byre and midden could be linked to high P concentration in dung. While this is true, it is highly likely that very high levels of P in byres could be a result of urine or a mixture of urine and dung rather than dung alone, as urine has much higher concentrations of P than faeces and urine is barely noticeable, if at all, in the soil. Wilson *et al.* (2008, 421) also claim that the high concentration of a suite of elements observed in hearths reflects the wide range of elements present in fuel sources such as turf, peat and coal. This is concentrated in the hearth due to the combustion process and may be aided by the retention of elements linked to higher cation exchange capabilities at higher temperatures[viii] and the presence of charcoal. It must be noted here that Wilson *et al.* (2008, 421) have not mentioned element concentrations in the hearth that are associated with higher cation exchange capacities.

Elements such as Ca and Sr observed at Cwm Eunant, Far House and to a smaller extent in Grumby and Olligarth are linked to the lime-based local construction methods (Wilson *et al.* 2008, 421). A distribution plan, had it been drawn, based on the concentration of Ca and Sr in samples from within the buildings and surrounding areas would have identified the presence of former structures such as walls in the house. This is based on the observation of high levels of Ca and Sr recorded in the house and mortar analysed as reference material (Figures 3.49 and 3.50). Thus, the analysis of reference materials seems to point to the input material for the elevated levels of various elements in different areas to a certain extent.

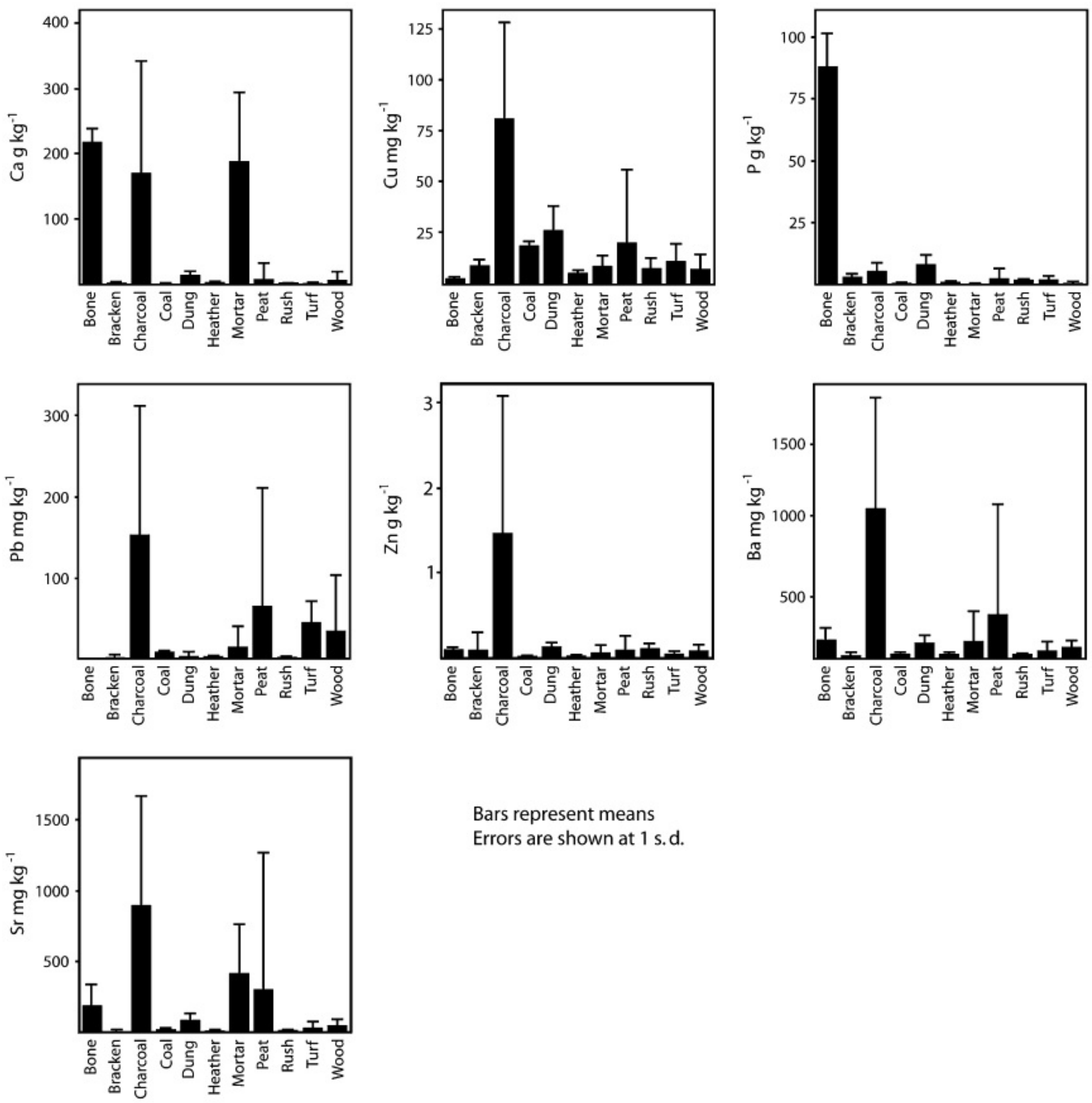

Figure 3.50: Mean element concentrations from selected reference materials (Wilson *et al*. 2008, fig 2).

Although eleven reference materials have been analysed by Wilson *et al.* (2008, 418-423; Figure 3.50), only bone, charcoal and, to a lesser extent, mortar seem to be discussed in this study in terms of elemental compositions. Dung seems to show enhancements in concentrations of Cu, P, and, to a lesser extent, Ba, Zn, and Sr. However, it has deficient levels of lead (Pb). Low levels of lead were also noted in the samples analysed in the byre (Figure 3.49). Peat, turf, and wood seem to have similar elemental compositions, although varying in levels of each element. Peat shows high levels of Pb, Cu, and Ba in comparison to most reference materials analysed (Figure 3.50). Peat can be differentiated from wood and turf as a fuel source at the sites based on the level of concentration observed of Sr and Ba, as they are at least four times the levels seen in turf and wood (Figure 3.50). A Pb isotope study (Wilson *et al.* 2006b), done to understand the movement of material on site, highlighted that the fuel material was an important source of Pb at the abandoned croft at Olligarth (Wilson *et al.* 2006). Based on this observation, Wilson *et al.* (2008, 423) have suggested that the high multi-element concentrations observed in hearths in all the six sites of the study seem to indicate ash as an important factor in the observation of concentration of the suite of elements in hearths.

This study was mainly successful in identifying certain functional areas, especially across six sites that vary in geology. This suggests that particular areas with former specific use can be linked to specific elemental concentration signatures, such as in the case of houses, hearths, or byres. However, this study has used the mean values of all samples taken from specific functional areas. While this is useful in generally identifying a functional area as an aid to archaeological prospection before excavation, it would have been helpful in the detailed interpretation of the use of specific areas had the individual concentrations of elements in individual samples been discussed in association with those areas. For example, in the case of a house, if the concentration of various elements were laid as a distribution map, then hotspots (if any) could have been identified, and it would have helped in associating various internal activities linked to the different areas within the house. Furthermore, a distribution map of the concentration of the multiple elements across the six farm sites, overlying the corresponding plans of the farm sites, could have helped identify other areas of interest on site. This would have also highlighted similarities and differences in concentrations of various elements between sites and assisted in a more detailed interpretation of the site areas.

3.5 Conclusion

Looking at a majority of published studies of geochemical analysis, several discernible patterns have emerged. The study of multiple structures or multiple phases of the same structure from the same site has a significant advantage in developing understandings of houses. Moreover, when finds distributions are explored alongside phosphorus, soil micromorphology, and magnetic susceptibility, as demonstrated at Cladh Hallan, interpretations of individual structures can be dramatically refined. Such studies, if combined with multi-element analyses would help further in the interpretation process. This is mainly because P studies mainly measure contact with organic matter while a growing number of multi-element studies provide suggestions for specific activities or features.

Despite the considerable advantages inherent in multi-element studies for the examination of structures, wherein they can elucidate distinct patterns of soil enrichment corresponding to various features and activities, it is imperative to underscore that numerous cultural and natural processes may contribute to heightened chemical properties in archaeological soils. Instances of specific chemical enhancements linked to features and human activities are shown in Table 3.1, and this table will be referred to in the case studies in this PhD thesis. However, it is crucial to acknowledge a salient point articulated by Bintliff and Degryse (2022, 2) regarding the interpretation of multi-element distribution patterns, who emphasise that 'even sites which are comparable in geology, geography, chronology, and function can be seen to produce different specific patterns of soil enrichment'.

Another pattern seen across different geochemical studies is that there is an understandable disjunction between archaeologists responsible for penning excavation reports and archaeological scientists who analyse soil for its chemical constituents. In cases where site investigations comprise a report on the chemical analysis of soil pertaining to structures, the amalgamation of interpretations derived from geochemical examinations into the comprehensive understanding of structures or floors, founded upon the scrutiny of artefacts and architectural remains, is markedly deficient. Similarly, the converse is also observed.

While the majority of phosphate studies, frequently incorporated within excavation reports, do make mention of features and artefacts found within structures, the disconnect between excavation reports and analysis is exacerbated in the context of multi-element analyses. This phenomenon may be attributable to the concern raised by Cannell (2016, 31), which suggests that single-element analysis, such as phosphate analysis, proves inadequate for pinpointing specific activities, as it mandates copious supplementary data to contextualise findings. Moreover, within the majority of investigations employing geochemical analyses to offer interpretations, there exists a notable deficiency in contrasting the structure under examination and its associated interpretations with similar structures or studies conducted in other locations in order to refine and bolster the interpretations presented.

An additional pattern discernible within the majority of these studies is that the drawn conclusions are primarily restricted to the empirical domain. It is worth noting that economic and social inferences are proposed, albeit with minimal references to their broader ramifications (beyond the mere explanation of functional events that transpired within the confines of the structure). Such an approach, in its endeavour to define the events that occurred, frequently neglects to address the issues such as preconceived notions held by archaeologists and archaeological scientists when selecting the area to be sampled—an example of which is evidenced by the assortment of sampling strategies employed. Staying on the point of social inferences, spatial analysis of artefacts and features has seen a wide variety of collaborative work in the application of ideas from other disciplines, such as anthropology, in order to get a better understanding of the past society. Such an application is often found wanting in the study of spaces within structures using geochemical analysis. However, geochemical research in archaeology by archaeological scientists is predominantly focused on utilising archaeological soil/sediments, a ubiquitous medium in archaeological contexts, to glean insights into the past use of space. Hence, the interpretations are frequently constrained to the extent of archaeological soils or sediments. Typically, such interpretations are reached through spatial statistics, distribution maps, or analogous graphic depictions that are sometimes correlated with known or excavated archaeological phenomena. Hence, it is appropriate to also turn to the anthropological literature (as discussed in Chapter 2) to understand the multiple ways in which house floors might be perceived and organised in human societies, as this is another important avenue to explore, which can facilitate the interpretation of houses and their organisation in the more distant past.

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[v] Available P is P in the soil mostly in organic form that can be extracted from the soil by plants for nutrition.

[vi] TSA is a mathematical tool that effectively separates map data into two components that are signal (which is regional in nature) and noise (which is local in nature) and reveals the hidden causative factors (Davis 2002; Hota 2014)

[vii] An isoline is a contour line of constant value on a contour map.

[viii] The number of cations that can be retained on the surface of soil particles is the cation-exchange capacity of that soil (Brady and Weil 2008). Negative charges on the surface of soil particles form bonds with cations (positively charged atoms or molecules) in the soil, but they also allow these exchanges with other positively charged particles in the surrounding soil water (Birkeland 1999).

CHAPTER 4: METHODOLOGY

4.1 Introduction

This chapter provides a summary of the field and laboratory methodologies employed in the current study, along with a justification for their use. Although each case study explored in the following chapters (Chapters 5, 6 and 7) encompasses a brief methodology section outlining the site-specific techniques, this concise chapter serves to consolidate the consistent methods employed across all case studies and the rationale behind their adoption. The next section of this thesis explores the archaeological case studies analysed through multi-element analysis, starting with the Middle Norse longhouse at Bornais, Outer Hebrides (Chapter 5).

4.2 Sourcing of samples and data

Bornais

The sampling of the occupation horizon within the Middle Norse period longhouse at Bornais, Mound 2, was carried out during the excavation in two phases, as east and west halves, between 1994 and 2004 by Niall Sharples and his colleagues. The samples collected were transported to Cardiff University and stored there until analysis by the author at Environment Centre Wales, Bangor University.

Meillionydd

The occupation horizon of the Early-Middle Iron Age roundhouse, RHSO19, at Meillionydd, was sampled by Raimund Karl, Kate Waddington and their colleagues at the time of excavation in 2013 and stored at Bangor University. These samples were analysed for phosphorus (P) as part of a phosphate study for the author's MA thesis (George 2017) using a TXRF (total reflection X-ray fluorescence) spectrometer. This is the same spectrometer used to analyse samples from other case studies in this thesis. Consequently, the device produced the results for all other elements analysed in this thesis along with P. In the investigation for this PhD research, the raw analysis data from 2017 was re-examined for fifteen elements, including phosphorus, and incorporated into this thesis. In addition, litmus testing of a range of soil/sediment samples was carried out in order to gauge the pH level of the soil, which, up until now, was unknown (see Chapter 6).

Orosaigh

The occupation horizons within the Late Iron Age cellular structure at Orosaigh, South Uist, were sampled by Niall Sharples, his colleagues and the author over two seasons. The samples collected were transported to Cardiff University for storage until the analysis was conducted by the author at Environment Centre Wales, Bangor University.

The samples from Bornais and Orosaigh were initially intended for phosphate analysis alone. However, considering the preservation of the occupation horizon and the fact that the sampling strategy followed was also suitable for the multi-element study, they were included in this PhD research.

4.3 Field methods

Surface samples were collected using stainless steel spoons or pointing trowels which were wiped clean thoroughly between each sample collection to avoid cross-contamination and stored in marked small single-use plastic bags. All samples were collected by site directors or under the supervision of the site directors at each site. The sediment samples from Meillionydd and Orosaigh were collected on a 0.5 m grid following the steps recommended by English Heritage for phosphate analysis (Historic England 2015). However, at the time of the early season of excavations in the mid-1990s, the sampling strategy adopted at Bornais was that of using a 1 m grid. While a 0.5 m grid may be better suited to defining the limits of possible functional areas identified with the house floors (also discussed in Chapter 3), it is clear that a 1 m grid can be useful for sampling internal floors within structures (French 2015).

In the case of the samples from Meillionydd, each spot from where the samples were collected was surveyed using Leica GPS 1205 Smart Pole. At Orosaigh and Bornais, the location of each sample collection spot was recorded on the drawn plans of the structures, which also incorporated the grid laid. At the time of sampling, meticulous attention was given to ensure consistency and quality in selecting each sample point. Furthermore, any sample points identified to be located within archaeological features, such as the upper fills of postholes, were intentionally omitted from the sample collection process. This decision was made to understand better the nature and spatial distribution of occupation within the chosen area without contamination with other feature fills, which are stratigraphically later. Nonetheless, samples obtained from hearth layers were still incorporated in the analysis, provided they were obtainable. Once collected in labelled small single-use plastic bags, the samples were placed in boxes for safekeeping until further analysis.

Control samples

During the excavation projects at Bornais and Orosaigh, the excavators did not collect control soil/sediment samples. The author intended to retrieve control samples from these sites at a later date. However, this plan was impeded by the COVID-19 pandemic restrictions, which disrupted the sampling and data collection phases of the PhD research. Despite the absence of control samples from Orosaigh and Bornais, the observed patterns in the concentration of various elements were significantly strong enough to deduce a possible use of internal space. Furthermore, the chemical composition of the local geology was also identified in each of the study sites by accessing the information from the British Geological Survey website (https://www.bgs.ac.uk/). This was compared with the patterns of elevation and depletion in the chemical elements seen in the sediment samples in order to assess the impact of the local geology on the various elements.

In the case of Meillionydd, however, the author obtained control samples from the site in 2017 following the 2017 excavation season prior to research for the MA dissertation (George 2017). The samples were acquired from five 0.2 m x 0.2 m test pits located within the yellowish-orange natural layer at Meillionydd. The selection of the locations for the test pits was random, but great care was taken to ensure that they were located 150 to 180 meters away from the visible outer ringwork of Meillionydd. The samples were meticulously collected in marked small plastic bags using a trowel, with every effort made to prevent any mixing between the topsoil and subsoil. The location of every pit was also recorded using a Leica GPS 1205 Smart Pole.

Once collected, all the samples in each case study were subsequently placed in boxes for safekeeping until further analysis. The boxes were kept under cool and dark storage conditions. Although the author's ability to conduct field sampling was confined to a solitary occupational horizon (specifically, the surface of context 230 at Orosaigh in 2018), this thesis has incorporated the aforementioned sites and their structures as case studies. The decision to do so was motivated by their exceptional state of preservation of the occupation horizons and the thorough sampling and storage procedures that were meticulously employed at each location.

4.4 Laboratory methods

Principal instrument

The soil samples collected were analysed using TXRF spectrometer model S2 PICOFOX manufactured by Bruker. S2 PICOFOX, hereafter denoted as the TXRF spectrometer, is a portable benchtop spectrometer that facilitates the quantitative and semi-quantitative analysis of multiple elements in liquids, suspensions, solids, and impurities. This device functions on the principle of total reflection X-ray fluorescence spectroscopy (TXRF), which renders it highly adept at detecting trace elements. (Brucker n.d.). For the analysis, each sample is prepared as a thin film on a flat, highly polished reflector, which is then irradiated at a very low angle of incidence to achieve total reflection. This involves utilising the primary X-rays' interaction with materials (sample) to produce distinctive X-rays and subsequently examining these characteristic X-rays in order to quantify the level of various elements in the material (Yang *et al.* 2020). The reason for choosing this device for analysis at Bangor University was primarily the device's successful use for the author's MA research in phosphate analysis at Meillionydd (George 2017; also discussed below). Another notable feature of the TXRF spectrometer is its superior accuracy for multi-element analysis and ability to detect trace elements in the parts per billion range, as opposed to the parts per million range of conventional XRF (X-ray fluorescence spectrometer) spectrometers (Yang *et al.* 2020), including portable variants known as pXRF (portable X-ray fluorescence spectrometer), which have gained increasing popularity in archaeological research (Derham *et al.* 2013; Cannell 2016; Save *et al.* 2020)

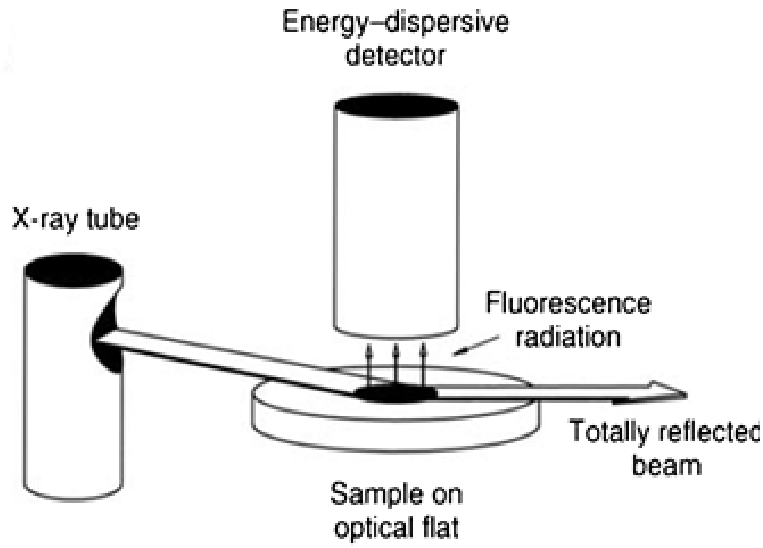

Figure 4.1: Schematic diagrams showing the principle of TXRF spectrometry (Yang *et al.* 2020, figure 3).

Figure 4.2: Brucker S2 PICOFOX used for analysis in this PhD research.

The author was trained in geochemical analysis and in the use of the above instrument by Prof Davey Jones and Sarah Chesworth at Environment Centre Wales, Bangor University, where all the laboratory work was carried out. To ensure the reliability and precision of the analytical results, the processes described below were devised through a combination of guidelines recommended by the manufacturer of the TXRF spectrometer and the protocols established by the Environment Centre Wales (ECW), Bangor University, for soil analysis. Some tweaks were implemented by the author, with the advice of Sarah Chesworth, to optimise the accuracy of the results.

Sample preparation

After obtaining each sample, approximately 10 grams were carefully transferred into appropriately labelled glass vials or small ceramic bowls. The samples were then dried in an oven, maintained at 40°C, for approximately 24 hours. This was then followed by sieving the sub-sample through a 1 mm sieve. In order to eliminate potential cross-contamination, the sieve was thoroughly rinsed with water and dried using compressed air after each use. Using a ball mill, they were milled to a fine powder with a maximum grain thickness of 70 µm. To prevent cross-contamination between samples, the container and ball of the mill were washed with a brush and water and dried, followed by wiping with acetone after every milling session.

Any transfer process between containers in the above steps or any steps below was conducted using plastic or metal equipment such as a small spatula. Such equipment was either designated for single-use or thoroughly wiped clean using acetone between transfers.

Before introduction into the TXRF spectrometer, the further preparation of the samples entailed placing approximately 20 mg (ranging from 19 to 21 mg) of oven-dried and ground samples into labelled 1.5 ml centrifuge tubes. The weight of each sample was recorded with precision up to 0.01 mg. Subsequently, 1 ml of TritonX solution 1% volume by volume was added to each tube, followed by 5 µl of 1000 mg/l selenium standard, which was thoroughly mixed for approximately 15 seconds with a vortex mixer. Before the suspension could settle, 10 µl of the mixture was pipetted onto the centre of a siliconised quartz disc, which was then dried on a hotplate for 15 minutes at 50 °C, forming a thin film on the disc. Duplicate samples were also prepared for each sample, and a batch of 22-24 samples, including duplicates, was analysed at a time.

Analysis

Before each batch of samples prepared on the quartz discs was inserted into the TXRF spectrometer, the spectrometer was run with a single disc of soil standard to check for accuracy. After this, 22-24 discs were placed on a cassette with a record kept of each disc's sample number. These details, along with the exact weight of the sample in each 1.5 ml centrifuge tube, were then inserted into the associated spreadsheet provided in the software supplied by the manufacturer of the TXRF spectrometer so that it can calculate the quantity of each element in the soil samples in mg/kg.

The analysis process for a batch of samples required approximately 4 hours to complete and produce results. The analysis time for each sample was set at 600 seconds in the case of Bornais and Orosaigh according to the protocols for analysis using the TXRF spectrometer set by ECW. Nonetheless, in the instance of assessing the Meillionydd samples during the MA research, the laboratory protocols dictated a reduced analysis time frame of 400 seconds. To ascertain whether this deviation of 200 seconds substantially influenced the outcomes, control experiments were conducted, examining the same samples for both the 400 seconds and 600 seconds durations. The comparative analysis found that the variation in time did not contribute to significant discrepancies in the resultant data.

Once the analysis was completed, the cassette containing the discs with the irradiated samples was removed and cleaned following the procedures suggested by the instrument manufacturer (Bruker n.d.).

Data handling and visualisation

Analysing and disseminating large geochemical data sets can prove to be a complex and multi-step procedure. The various steps involved are also complicated by the methods used for data acquisition and the limitations of data sets and extreme outliers. The transformation of extensive geochemical data sets into meaningful and usable representations of archaeology is often achieved by subjecting the data to various statistical analyses. Some approaches for this task involve kriging techniques (Carey *et al.* 2014; Fleisher and Sulas 2015), cluster analysis (Vyncke *et al.* 2011, Dirix *et al.* 2013), and principal component analysis (Cannell 2016). What follows is a description of how the raw data acquired from the TXRF analysis was compiled into a dataset and further subjected to statistical analysis.

Following the analysis of each sample using the instrument, a spreadsheet was generated displaying the levels of each element in milligrams per kilogram (mg/kg) for each disc containing the sample. All the results from the different samples in separate spreadsheets were subsequently consolidated into a single spreadsheet. In this combined spreadsheet, the values for each element from the duplicate samples were merged by calculating the mean value of the two measurements. Doonan and Lucquin (2019) note that the level of any chemical element, particularly those that are exceptionally high or low, assumes significance if a minimum of three comparable values can be discerned within the sample set. Occasionally, extreme outliers of low or high values were encountered in isolated samples When these anomalies arose, the respective samples were excluded from the ensuing analysis. These steps were followed to enhance the accuracy of the overall analysis. In the case of Meillionydd, location data for each sample was available readily in the form of eastings and northings. However, in the case of Orosaigh and Bornais, this data was unavailable as the locations were directly recorded on the plan of the corresponding structures, so a different approach was taken. Four GPS survey points were available on the plans of the structures at Orosaigh and Bornais, acquired from Niall Sharples of Cardiff University. These plans were tied onto the respective points in ArcMap 10.7.1 using the default coordinate system of WGS84 Web Mercator. Once projected, the coordinate points for each sample location were noted and added to the spreadsheet.

Following this, a plan of the house in each case was made so that the results from the analysis could be overlain using Adobe Illustrator (2020-2023) and Adobe Photoshop (2020-2023). Next, in ArcMap 10.7.1, the newly compiled Microsoft Excel spreadsheet with mean values of each element and the location coordinates as eastings and northings were added to the plan of the house where eastings formed the x-coordinate and northings the y-coordinate. The z-coordinate was reserved for the actual levels of each element in each sample.

Afterwards, ArcMap 10.7.1 was employed to carry out spatial geoprocessing and statistical analysis using 'interpolation'. Specifically, an inverse distance weighted (IDW) technique was used for interpolation, as this technique is known to produce visual surfaces that are not significantly impacted by any outliers that may be present in the dataset. Next, the 2.5 standard deviation values of each element in every sample were utilised to present the resultant surface. This approach was implemented to minimise further the influence of extreme outlier values on the presentation of the outcomes compared to employing the actual values. The data visualised in such a manner was found to aid in identifying any patterns across the various elements and in comparing the levels of each element in different areas within the houses. Although the scatter map used for phosphate analysis of RHSO19 at Meillionydd was considered, the aforementioned technique was ultimately favoured due to its substantial benefits in terms of facilitating enhanced data visualisation.

Pattern identification and interpretation

In each case study, the patterns for each chemical element are evaluated by identifying areas on the house floors where they are either elevated or depleted. This assessment is conducted by analysing visualised data presented in GIS-based distribution maps, which employ a colour scheme. In these maps, low values are represented by blue areas, medium values by predominantly yellow areas, medium-high values by a mix of yellow and red, and high-value areas by red shading. Additionally, consideration is given to the actual value ranges indicating enrichment or depletion of the chemical element, facilitating comparison between areas within the same house floor. The areas exhibiting elevated levels of one or more chemical elements are subsequently cross-referenced with Table 3.1 (found in Chapter 3) to identify potential activity areas or features on the house floor. The next three chapters of this thesis explore the three case studies that form the core of this PhD research, where the application of the above methods can be seen.

CHAPTER 5: MIDDLE NORSE HOUSE, BORNAIS, SOUTH UIST

5.1 Introduction

Between 1994 and 2004, the settlement at Bornais underwent excavation under the supervision of Niall Sharples and his team. This site serves as an ideal case study for the present thesis, as it comprised a large, stone-walled, Viking, sub-rectangular house dating back to the 11th-century cal AD, featuring well-preserved floors and artefact assemblages within its interior. Although a few instances exist in Scotland where the organisation of domestic space has been hypothesised based on the architectural layout and internal features of the buildings, a comprehensive understanding of the organisation of space in Viking houses in Scotland remains limited. This knowledge gap was recently addressed through the complete excavation and publication of House 2 at Bornais in the Outer Hebrides in 2020 (Sharples 2020a), and the case study is an ideal opportunity to explore a well-excavated Viking house through multi-element analysis.

The chapter first sets out the Norse context of Scotland, followed by a succinct introduction to the Norse archaeological sequence at Mound 2 at Bornais, where House 2 is situated. An introduction to Bornais, in terms of its location and underlying geology, is then provided which is followed by an overview of House 2's archaeological sequence. The ensuing section outlines the methodology employed for sample collection. After this is a summary of the stratigraphy of the occupation layers, which is followed by descriptions of the analysed archaeological context. The chapter then presents the outcomes of the multi-element analysis in the form of distribution plans superimposed on House 2's plan and a cursory account of the results predicated on the division of the house into four primary quarters, with each quarter further divided into northern and southern sub-quarters. The published distributions of finds, flots, and coarse residues (Sharples 2020b, 166-193; Sharples *et al.* 2020, 193-221; Summers and Bond 2020, 221-226) are analysed as per the division of the house into sub-quarters so that a complete picture can be provided for the use of the floor. Based on the patterns from the geochemical analysis results and the distribution patterns of finds, flots, and coarse residues, the functions of various areas within House 2 are suggested in the final part of this chapter. This is further discussed by juxtaposing these findings with those of comparable Norse period houses. By integrating the multi-element analysis and the finds distributions from this floor, it has been possible to determine the specific functions of individual spaces of the house.

5.2 Norse Context of Scotland

Norse contact with Scotland initially manifested as acts of raiding within the Northern and Western Isles of Scotland, subsequently leading to the establishment of settlements. Such settlements have been identified in Caithness and Buckquoy in the northeast and the Udal in the west, among many other sites (Graham-Campbell and Batey 1998). It is argued that the earliest Norse houses were constructed by immigrant farmers who likely engaged in raiding activities to supplement their income (Graham-Campbell and Batey 1998). However, there exists a contention regarding this matter, with several debates on whether the early settlements were 'pirate settlements' consisting of Viking farmers who raided Ireland and the Northern and Western Isles, if they resulted from peaceful integration, or if the settlers/raiders in the Hebrides and Northern Isles travelled from Ireland (Griffiths 2019a; Graham-Campbell and Batey 1998, 54). The early Norse/Viking structures are rectangular, and they have been termed halls in the literature. They are distinctive from the native Late Iron Age buildings that were circular or oval in shape in Scotland. The earliest historical record of Viking raids in Scotland is in 794 AD in the *Annals of Ulster*. The earliest record for Western Scotland is in 795 AD when the monastery of Iona off Mull (Inner Hebrides) was sacked (Graham-Campbell and Batey 1998, 2). However, there is no record or strong evidence of raids in eastern or northern Scotland, the Northern Isles, and the Outer Hebrides (Griffiths 2019a, 470). However, the

Pictish monastery at Portmahomack arguably shows the best evidence of a Viking raid in the late eighth/early ninth century AD (Carver *et al.* 2016, 105-260).

Still, a sudden takeover by the Vikings has been suggested in the Outer Hebrides by Graham-Campbell and Batey (1998, 173). This is particularly noted in North Uist, where flourishing native settlements were settled upon violently by the Vikings (Graham-Campbell and Batey 1998, 173). The native settlement had structures characterised by figure-of-eight buildings (often seen as later forms of cellular structures such as the one explored in Chapter 7). Some of their parts were incorporated into Norse sub-rectangular buildings.

Viking Age houses average around 20 metres in length and 6 metres in width, and good examples have been recorded at Jarlshof, Sumburgh Head and Dunrossness in Mainland Shetland (Graham-Campbell 1980). Some Viking houses were bow-walled in shape. These houses are generally well-built with coursed inner-faced and outer-faced walls of dressed stones with turf or earth cores, which help with stability and keep the houses warm. The entrances of these houses often appear in opposing pairs and are generally located off the centre in the long walls (Graham-Campbell and Batey 1998, 156-178; Hall 2010, 19). Other features of these houses include hearths that are stone-lined and run axially and set into the earth floor with slabs that are placed along the edges of the long walls, which have been suggested to be benches used for sitting during feasts and meetings, as well as potentially for sleeping (Sharples 2020a, 14). Although the Outer Hebrides also exhibit a prevalence of similar internal features and layout in the tenth and eleventh-century bow-walled longhouses, as evidenced by the archaeological sites of Bornais and Cille Pheadair in South Uist, it appears that a discernible regional pattern had emerged for other buildings that were constructed slightly later (Parker Pearson and Sharples 1999; Parker Pearson *et al.* 2004a; 2004b)

Understanding of Norse houses in Scotland is limited due to the degree of modern, complete excavations that have been conducted and fully published. These buildings have complex histories and often multiple phases of construction and occupation. These structures are also observed to have outbuildings, byres, barns, and smithies and, in coastal sites, are occasionally accompanied by a *noust* or a boathouse where boats could be drawn up easily. One such example is at Westness, Rousay, Orkney (Graham-Campbell and Batey 1998, 135; Hall 2010, 20). Some have also been recorded to incorporate byres within the main house structure, such as at East Mound, Bay of Skaill (Griffiths *et al.* 2019). The limited understanding is also exacerbated by the poor preservation of some buildings built on acidic soils, which destroys archaeological assemblages. However, the stone building tradition in Scotland has helped with the preservation of structures. On alkaline soils, large assemblages have been excavated from associated floors and middens. They include antler or bone items such as awls, combs, and pins, spindle whorls, beads, lamps (some of which are made of stone), line-sinkers used for fishing and large bowls, which are often made of soapstone or steatite, which was quarried in Shetland. Although less frequently, pins and other personal adornment items made of bronze/copper alloys, iron knife blades, sickles, fishhooks, strike-a-lights, and glass beads are also recorded at these sites. On the other hand, pottery is recorded to be less common, perhaps due to the preference for durable and repairable soapstone vessels (Barrett 2008, 411-427; Hall 2010, 21). However, a distinctive tradition of pottery-making and use in the Outer Hebrides emerged, in contrast to mainland Scotland and the Northern Isles (Lane 2005). This implies a perpetuation of a pre-Viking pottery-making tradition into the Viking period within the Hebrides, which ultimately manifested the form of a new style of pottery comprising open bowls/platters and small cups (Lane 2005). Overall, Viking Scotland suggests temporal and geographical variations in material culture and building.

Some ideas of the layout of Viking houses are still discernible from the previous studies. For example, the 18.4-metre-long bow-walled Underhoull house comprises three sections: a potential barn, a central living area with wooden floors, and a cold store with paved stone flooring (Bond 2013; also discussed below). Though no *in situ* hearth was discovered, a central hearth on a clay bed is hypothesised (Sharples 2020c, 14).

The early Norse house at Jarlshof, Mainland Shetland, contained three entrances, a living area, and a kitchen area (Hamilton 1956). The living area was subdivided into three aisles with an implied sleeping/sitting area. The kitchen area here accommodated a fireplace and oven

(Hamilton 1956; also discussed below). On the other hand, the well-preserved bow-walled house at Skaill, Orkney, was split into two sections by a central entrance. The southern half had a large hearth, paving stones, and a kerb, suggesting a kitchen and possible sitting area. The northern half is considered the living area, with benches delineated by slabs along the edges. A similar layout around a hearth with benches indicating sitting and sleeping areas within a bow-walled structure was also observed in the Phase 3 longhouse at East Mound, Bay of Skaill (Griffiths *et al.* 2019). However, this house did not show a formal hearth with kerb stones but rather a series of informal ones that were used and repositioned along the central area (Griffiths 2019b, 312). House 2 at Bornais, which is the focus of this chapter, is a bow-walled structure that was occupied, presumably during the era of established Viking settlement that ensued after the period of Viking raids.

5.3 The Study Site: Mound 2, Bornais, South Uist

The settlement at Bornais is a complex of various mounds that rise as protrusions on the machair plain (that is relatively flat) on the west coast of South Uist, Outer Hebrides (Figure 5.1). The earliest settlement on the machair appears from the Beaker period, and the machair was in continuous and intensive occupation from the Late Bronze Age until the end of the Norse period (Sharples 2004; Sharples 2020d, 1). The construction of House 1 at Bornais, mound 2, was the earliest activity in the Norse period on this mound and was followed by the construction and occupation of House 2. This latter house forms the basis for analysis in this chapter.

Angus (1994; cited in Rennert and Hermann 2020) described machair as a gently sloping coastal dune plain arising from the aeolian deposition of calcareous sand. The machair plain situated along the west coast of South Uist is characterised by the presence of calcareous shell-rich, wind-blown sand, exhibiting elevated pH levels, typically ranging between 6.5 and 7.5 in topsoils and 7.5 to 8.0 in subsoils (Hudson 1991; cited in Smith and Colledge 2018, 527). Similarly, Sharples (2020d, 1) has described the sand as being made up of 'relic glacial material and large quantities of comminuted shell from the ancient storm-washed shoreline’. The organic content within this region is notably minimal, commonly falling below 10%, as documented by Dickinson (1977). The machair landscapes have a topography that encompasses a mosaic of dunes proximate to the sea and a grassland featuring low-intensity agriculture. Inland, it transitions into wetland, loch, and blackland — a blend of sand and peat (Angus 1994; cited in Rennert and Hermann 2020). However, adjacent to the coastal dune system, in South Uist, lies an undulating, well-drained plain to the east, characterised by a water table consistently below the soil profile. The sandy soils in this region, owing to their low organic content and high permeability, tend to be arid and susceptible to nutrient leaching, specifically of phosphates, nitrates, potassium, copper, and manganese (Owen *et al.* 1996; cited in Smith and Colledge 2018, 527). Referred to as the ‘dry machair’ (Boyd and Boyd 1990; cited in Smith and Colledge 2018, 527), this area fosters the development of brown calcareous soil and calcareous regosols, as noted by Hudson (1991; cited in Smith and Colledge 2018, 527).

As discussed previously, the natural soils at Bornais were not analysed as part of this study due to the unavailability of the samples. However, as a proxy for such a study, the available information on the chemical composition of the machair soils on the northern Isle of Harris is set out here. Rennert and Hermann (2020) studied the geochemical composition of soil samples on the machair in the Isle of Harris and the elements identified that are relevant to this PhD thesis include potassium (K), calcium (Ca), aluminium (Al), iron (Fe), manganese (Mn), phosphorus (P), strontium (Sr), and titanium (Ti). The ranges of the elements seen in the soils and the rock are shown in Table 5.1. The machair soils of Harris exhibit lower levels of most elements compared to the house floor sediments of House 2 at Bornais. However, notable elevations are observed in the natural machair levels of K, Al, and Sr, and might influence the levels at Bornais. It is pertinent to highlight that K levels at Bornais (between 2095-5609 mg/kg, also discussed below) are markedly lower than even the natural machair levels at Harris (8700-9400 mg/kg; Table 5.1), this is interesting as the bedrock gneisses of South Uist also show lower levels than the bedrock gneisses of Harris (Fettes *et al.* 1992, 19; discussed below).

Considering insights from Rennert and Hermann (2020), variations in machair soil properties are discernible with coastal-inland transition. This is evident in pH decrease (8 to 6.5), particle size reduction, and increasing soil organic matter content (Randall 2006; cited in Rennert and Hermann 2020). Rennert and Hermann's study, conducted on samples from the southwest coast of Harris, underscores the impact of parent material and seawater spray on soil variation. Notably, the authors concluded that the soil composition reflects a distinct imprint of the local bedrock (Rennert and Hermann 2020, 9). This is intriguing given the peltic gneisses, which are sodium-potassium rich, constituting the bedrock in southwest Harris, where the study samples originated (Baba 1997, 122-123). In contrast, Bornais, located inland in South Uist, features a mixture of banded biotite gneisses and biotite-hornblende gneisses as bedrock (discussed below). Consequently, the chemical composition of machair soils in southwest Harris may not accurately represent those of Bornais. This may explain the significantly lower levels of potassium (K) seen in house floor sediments at Bornais (2095-5609 mg/kg) compared to the natural levels in the machair soils of Harris (Table 5.1).

Element	**Level in soil (mg/kg)**
Potassium (K)	8700-9400
Calcium (Ca)	40300-73300
Aluminium (Al)	58800-70400
Iron (Fe)	25500-36800
Manganese (Mn)	578-843
Phosphorus (P)	878-1383
Strontium (Sr)	513-2098
Titanium (Ti)	1661-2843

Table 5.1: Geochemical composition of machair soils from sites in Harris (after Rennert and Hermann 2020, table 4).

The South Uist bedrock is made up of a mixture of banded biotite gneisses and biotite-hornblende gneisses with a variable number of pink pegmatitic lits (Fettes *et al.* 1992, 14). Although there is a lack of extensive study on the gneisses of South Uist or the Outer Hebrides in general, a geochemical study involving five analyses of samples from South Uist shows the main composition of the gneisses consist of 67.1% silica (SiO_2), 15.48% aluminium oxide (Al_2O_3), 4.81% calcium oxide (CaO), 4.62% sodium oxide (Na_2O), 2.38% iron oxide (FeO), 1.5% potassium oxide (K_2O), 1.44% magnesium oxide (MgO), 1.26% ferric oxide (Fe_2O_3) and 0.34%

and titanium oxide (TiO_2) (Fettes *et al.* 1992, 14) and other individual elements as seen in Table 5.2.

Component	**percentage**	**Trace element**	**mg/kg**
SiO_2	67.1	Ba (barium)	809
TiO_2	0.34	Co (cobalt)	66
Al_2O_3	15.48	Cr (chromium)	26
Fe_2O_3	1.26	Cu (copper)	25
FeO	2.38	Ga (gallium)	15
MnO	0.05	La (lanthanum)	43
MgO	1.44	Li (lithium)	22
CaO	4.81	Ni (nickel)	23
Na_2O	4.62	Pb (lead)	6
K_2O	1.5	Rb (rubidium)	41
		Sr (strontium)	370
		Y (yttrium)	11
		Zn (zinc)	35
		Zr (zirconium)	185

Table 5.2: Geochemical composition of gneisses in South Uist in mg/kg (after Fettes *et al.* 1992, table 3).

While gneisses are generally made up of 62-75% silica (SiO_2) and 1 to 6% K_2O, the gneisses in Harris are richer in SiO_2 and K_2O. On the other hand, the gneisses in the Uists are poorer in K_2O but richer in FeO, MgO, and CaO (Fettes *et al.* 1992, 19). Considering the gneisses are the bedrock that also contributes towards the machair soils, the reliability of the composition of machair soils of Harris as a proxy for that of South Uist must be seen with caution. This is especially the case for K, Ca, and Fe, where K is likely to be lower in Uists and, on the other hand, Ca and Fe are likely to be higher in the Uists than in gneisses of Harris (Fettes *et al.* 1992, 19). This could also explain further the stark difference seen in K levels in the machair soils of Harris in comparison to the house floor sediments in House 2 at Bornais. It is also noteworthy that the study of K in house floors of the Norse stone longhouse, House 700, at Cille Pheadair (which has a similar geology to Bornais) showed levels of K that were around 2250 mg/kg at its highest close to the hearth (Parker Pearson *et al.* 2018b, 79-78), which is also within the range seen at Bornais. This could further suggest that natural levels of some elements in the machair soils of South Uist may be different to those in Harris.

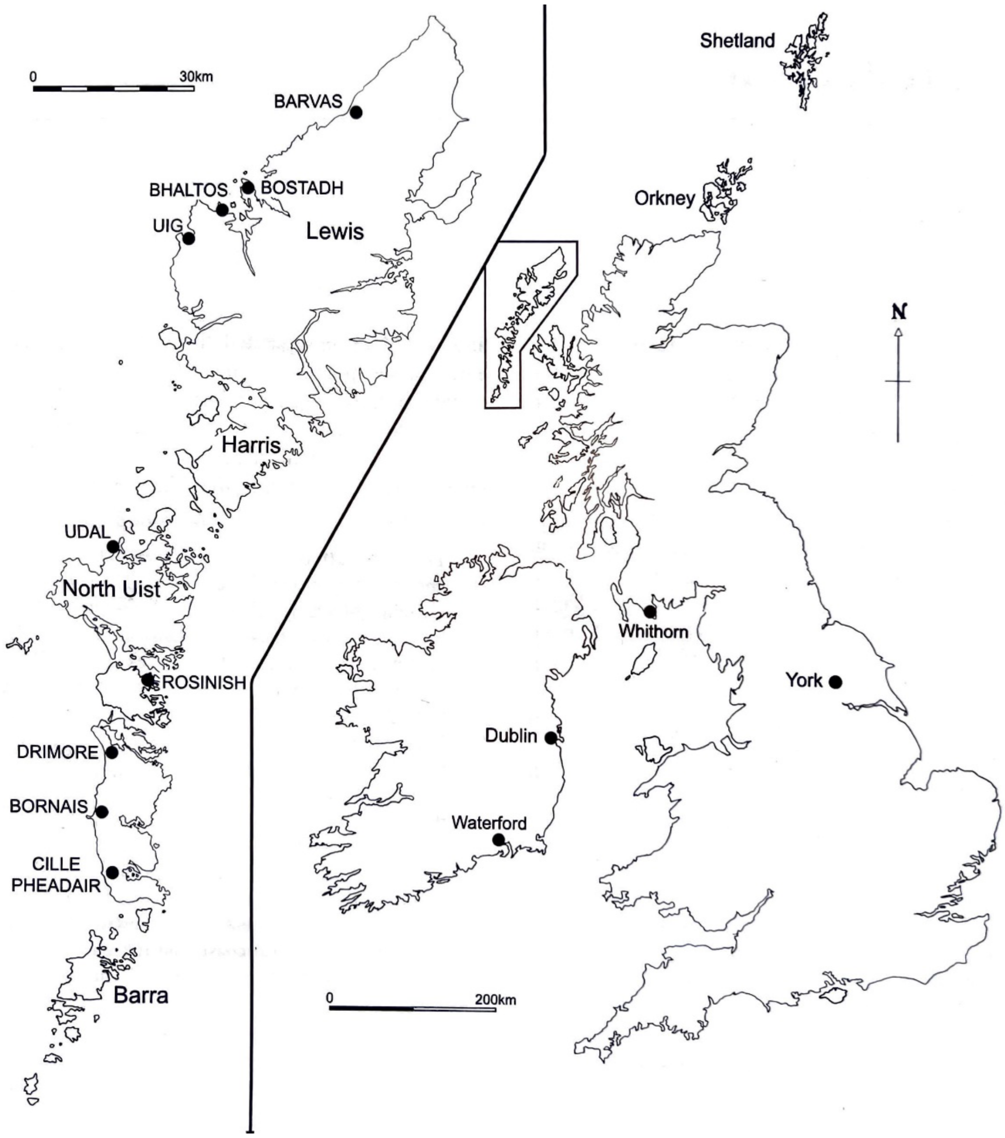

Figure 5.1: Location of Outer Hebrides in the British Isles with inset showing the location of Bornais in South Uist (Sharples 2005, fig 1).

House 1

The first Norse structure on Mound 2 was House 1, which consisted of an Early Norse period house (Figure 5.2). It was a bow-walled hall, over 23 m long, and lay directly under House 2 (Sharples 2020e, 94). The earliest occupation of this house has been dated to cal AD 900 –1010 (95% confidence) or cal AD 940-990 (68% confidence) (Sharples 2020e, 94). This house was estimated to have been abandoned in the eleventh century AD. The stone wall of this house was robbed to build House 2 (Sharples 2020e, 60). However, two stones from the base of the north wall of House 1 were observed to be forming a part of the north wall of House

2 (Figure 5.2; Sharples 2020e, 60). This suggests the incorporation of parts of the pre-existing house into new construction. This, apparently, was a recurrent feature of the sequence of constructions at Bornais, and it was also observed at the nearby site of Cille Pheadair (Sharples 2020e, 60; Parker Pearson *et al.* 2018a). Based on the size and structure of this house, Sharples (2020e, 96) suggested that a high-status individual occupied it; however, he also points out that very few finds are clearly high-status to support this interpretation.

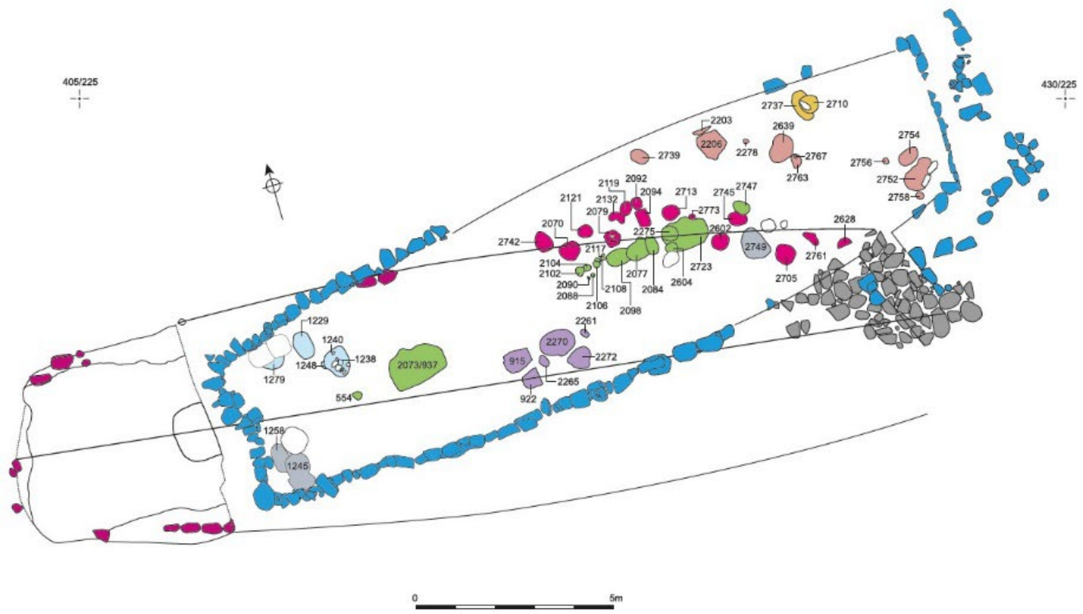

Figure 5.2: Plan of House 1 shown by following the lines along the pink-coloured features (Sharples and Davis 2020a, fig 107).

House 2

House 2 was built in cal AD 1055-1100 (68% confidence) (Sharples and Davis 2020a, 137), following the abandonment of House 1. It was a semi-subterranean house that was exceptionally well preserved, consisting of quarried stone walls surviving over a metre in height. It was sub-rectangular in shape and bow-walled – being over 19 m in length and with a 5.8 m width in the centre that contracted to 3.8 m at the west end (Figures 5.3, 5.4; Sharples and Davis 2020a, 145). The radiocarbon dates and finds suggest that this house probably had a relatively short occupation period of up to 50 years (Sharples and Davis 2020a, 137). The material culture recovered from this Middle Norse House included significant assemblages of iron, antler and bone ornaments, bone tools, glass beads, coins, and unusual items such as an antler-cylinder with a decoration of a Ringerike-style beast, a piece of green porphyry from the Mediterranean and an enigmatic amber fragment.

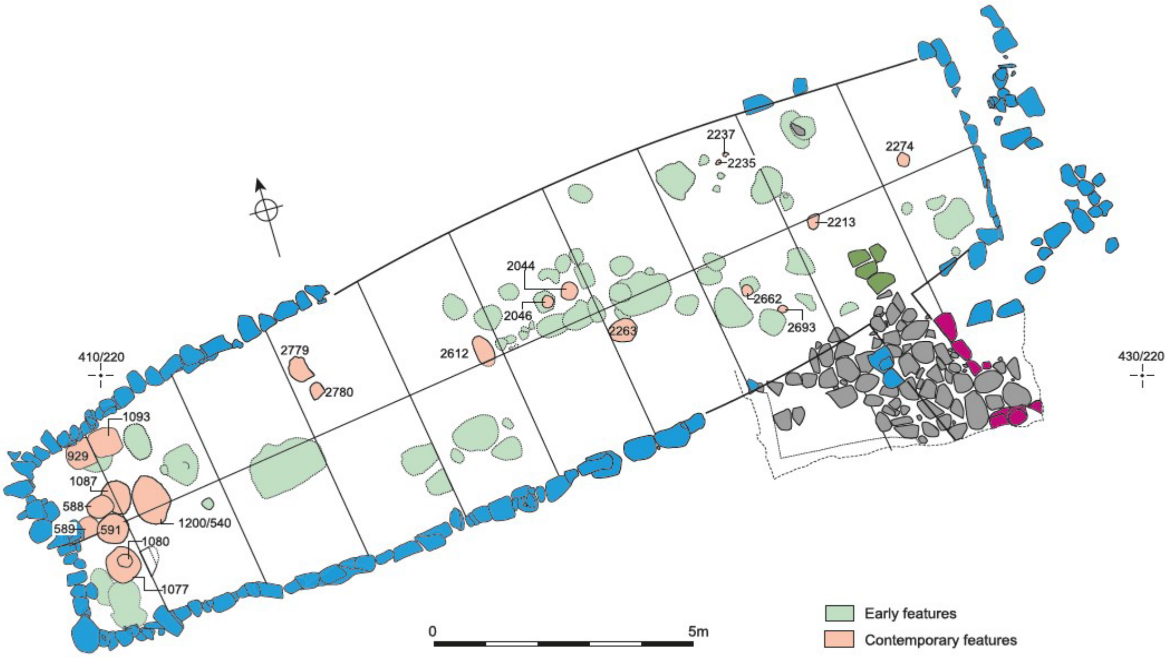

Figure 5.3: Plan of House 2 at mound 2, Bornais (Sharples and Davis 2020a, fig 107).

House 2: foundation and construction

A significant number of cut features were associated with the construction or use of House 2. Eighteen cut features ran along the central axis of House 2: some consisted of post holes, but the rest were pits. Hearth deposits from House 2 were recorded within some of these pits, suggesting that the pits predated the occupation phase of House 2. Based on the alignment of these cut features and the hearth deposits recorded within these cuts, it is suggested that these cut features held timber posts associated with the construction of House 2 and were probably removed before the occupation (Sharples and Davis 2020a, 137).

Of the north and south walls that survived, those on the western end survived much better than those at the eastern end, which had been almost entirely removed following abandonment. The western gable survived in a collapsed manner and hence was significantly distorted, with most of its stones pitching inwards (Sharples and Davis 2020a, 145). The best-preserved part of the southern wall consisted of eight courses and was 1.3 m in height. Most of the western wall had survived with at least six courses. In contrast, only a few isolated stones survived in the eastern half, apart from a section where two courses survived. The entrance to House 2 was identified by paving stones that formed the entrance passage into the house. This entrance was located at the eastern end of the south wall (Figure 5.3). The entrance was recorded as about 1 m wide and 2 m long (Sharples and Davis 2020a, 145).

Figure 5.4: A view of House 2, from East to West, mid-excavation in 2004 (Sharples and Davis 2020a, fig 181).

Sitting above the abandonment layers of House 1 and associated with the construction of House 2 were sand layers located at the west end of the structure. Two radiocarbon dates were recorded from this sand sequence. One was from a pig metatarsal dated to cal AD 980-1170 (at

95% confidence), and the other from carbonised rye was dated to cal AD 1020-1190 (at 95% confidence) (Sharples and Davis 2020a, 148).

House 2 occupation

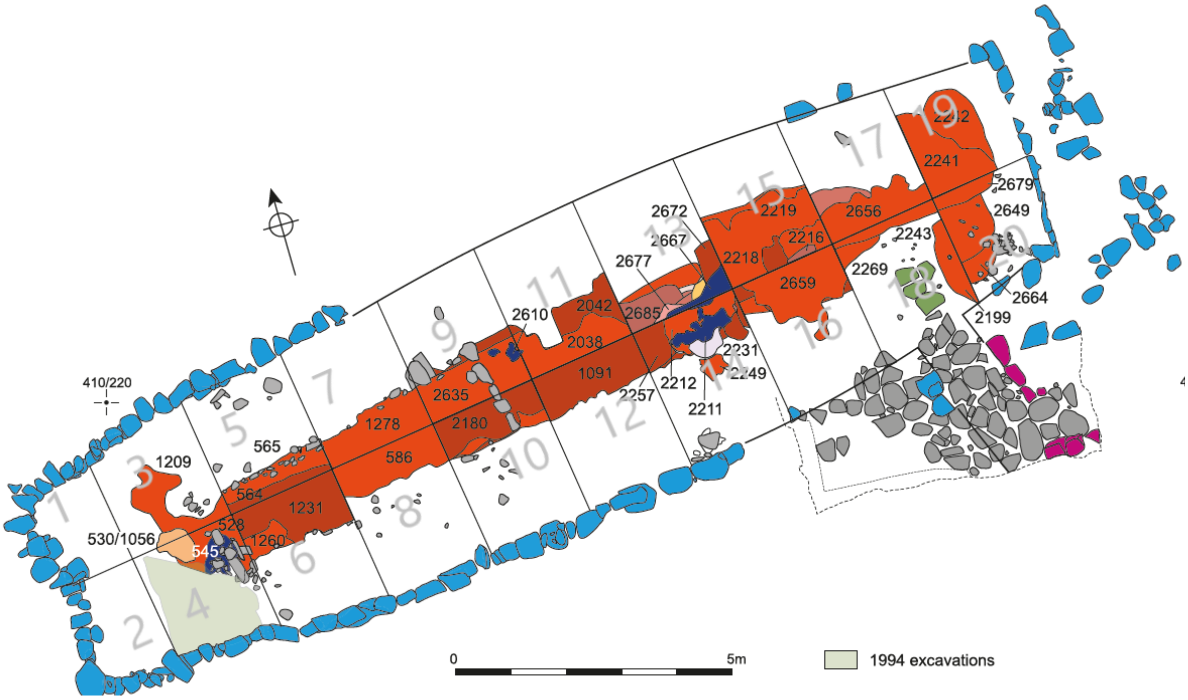

Figure 5.5: Plan of House 2 showing the extent of ash spread in the occupation layer and quad numbers in grey (adapted from Sharples and Davis 2020a, fig 119).

Based on the stratigraphy, the excavators argue that a 'primary floor' accumulated over 80 years and that this was formed by layers about 0.6 m thick (Sharples and Davis 2020a, 152). Ash layers ran throughout the central length of the house, measuring about 1.5m in width and 16.5 m in length. This deposit was thickest in the house's centre, especially from quads 9 and 15 (Sharples and Davis 2020a, 152). Based on these ash layers' laminated nature, it was suggested that these deposits resulted from the spreading of the ash left by domestic fires burnt within the house, which had subsequently formed a hard surface through trampling. It was also suggested that certain areas along the centre were favoured for hearths based on the different intensities of burning observed within the deposits. These ash spreads were compacted through trampling, which has been suggested to result from the central area being used as the principal route through the house (Sharples and Davis 2020a, 152). Still, an ill-defined hearth was recorded with slabs at either ends and an insubstantial kerb of small stones

(Sharples 2020f, 605; Figure 5.5). Although not defined by such stones, a significant place for a hearth or fire was noted from the stratigraphic report in the central hearth aisle in the adjacent areas of quads 13, 14, 15 and 16 (also discussed below).

The sandy layers in the peripheral aisles of the house were less compact, which, according to Sharples and Davis (2020a, 152), resulted from fewer footfalls, possibly suggesting the presence of a timber floor. Around the west end of the house, it was observed that the upper floor layers were thicker and richer in finds and darker in colour. This suggests that the west end area had an intense occupation (Sharples and Davis 2020a, 152).

The comprehensive extent of a house was revealed in 2004, with associated floor layers investigated during various years (1994, 1999, 2000, and 2004) due to the complex and intermittent history of excavations. The floor was systematically excavated using a 2-metre grid system, with identified layers further subdivided into one-metre squares. However, challenges had arisen in maintaining consistency across the excavations, as contiguous quadrants were excavated non-sequentially, and excavation personnel composition varied. This resulted in each quadrant bearing unique context numbers and a multitude of contexts, making it difficult to establish a coherent stratigraphy (Sharples and Davis 2020a, 152).

Sharples and Davis (2020a, 152) also noted that weather conditions had further impacted the ability to discern between layers, with dry conditions causing rapid drying and minimal colour variations, while wet conditions allowed for easier detection of subtle distinctions. This led to adjacent quadrants displaying varying layer numbers due to contrasting weather conditions during excavation. The central hearth area was noted as particularly challenging to excavate, as it comprised numerous fine ash layers, some less than a centimetre thick, characterised by unique colour and texture. In some areas, major distinctions were observed, while in others, arbitrary demarcations were established to discern temporal depositional differences (Sharples and Davis 2020a, 152). Furthermore, they also observed that the excavation approach varied among excavators, with some segregating layers and others combining them into loosely defined contexts (Sharples and Davis 2020a, 152). Hence, what follows is a summary of the complex stratigraphy of the occupation layers using the different context numbers in different quads (as in Figure 5.5) published in the report (Sharples and Davis 2020a, 152-156). In accordance with the published report, the occupation layers have been described distinguishing them as hearth layers and floor layers with further bifurcation into north and south.

Northside-hearth layers

The base of the hearth primarily consisted of several small patches of yellow ash distributed along the central axis of the house. These deposits were identified as 2680 and 2668 (quad 9), 2043 (quad 11), and 2699 (quad 13). Notably, deposit 2699 (quad 13) was situated above 2718, a red-brown lower hearth trample layer that may have developed due to interactions between the hearth above and the infilling deposits underneath (Sharples and Davis 2020a, 152-153). The primary hearth deposit, comprising multiple layers of multi-coloured ash, enveloped these ash spreads. In quad 1, it manifested as a thin trample layer that thickened and became interspersed with ash lenses toward the house's centre. This layer was divided into 549 (quad 1), 1209 (quad 3), 565 (quad 5), 1278 (quad 7), 2660 and 2635 (quad 9), 2042 (quad 11), and 2697 (quad 13). The thick portion of the hearth terminated within quad 13 at this level, encircled by hearth trample layer 2258 (quad 15). The hearth continued into quad 15, where it thickened again and was designated as 2259 (quad 15) and 2661 (quad 17) (Sharples and Davis 2020a, 153).

A final hearth layer, characterised by pink-red sand, overlay the main hearth material in select quads, including 1056 (quad 3), 564 (quad 5), 2038 (quad 11), and 2685 (quad 13). The absence of this layer in certain quads was attributed to its possible removal alongside the primary hearth deposit. A thin layer of fine grey sand, 2036 (quad 11) and 2684 (quad 13) covered the hearth deposits in quads 11 and 13, seemingly forming a stabilisation layer between the lower hearth material and three brightly coloured burnt deposits situated above. These deposits, 2677, 2674, and 2667 (quad 13), were collectively removed as 2291 in quad 15, spreading into quad 15's corner, where they ended abruptly, encircled by 2258. 2258 was the trample layer from hearth area 2259. Sharples and Davis (2020a, 154) noted that there is a possibility that 2258 represents the fill of an undetected pit or cut. Finally, an orange hearth layer, 2652 (quad 13), 2217 and 2218 (quad 15), and 2656 (quad 17), overlaid the last of these deposits, 2667 in quad 13 and 2259 in quad 15.

Southside hearth layers

Like the north side, the primary hearth layer on the south side consisted of a dense, multi-lensed deposit (refer to the detailed description above). In quad 2, this layer appeared as a trample layer within the floor deposit, thickening and containing more compacted ash lenses as it extended eastward. This layer was designated as 1010 (quad 2), 528 (quad 4), 1267 (quad 6), and 586 (quad 8), along with four comparable red-orange-brown layers 2289, 2255, 2222, and 2232 (quad 10), 1095 (quad 12), 2287 (quad 14), and 2682 (quad 16). In quad 18, the main hearth deposit (2243) thinned out and was present only as an associated trample layer (2649) in quad 20.

In quad 14, the main hearth deposit (2287) was covered by a thin layer of loose ash (2284), separating the hearth beneath from the three distinct burnt deposits above, as observed in quad 13. The overlying hearth layers were 2277, 2253, and 2250. Layer 2277, a pink-orange deposit, was primarily situated in the western part of the quad and was likely contemporaneous with the upper hearth deposit (2091) in quad 12. Layers 2253 and 2250 were located in the eastern part of the quad, with 2253 being clayey yellow sand and 2250, a black charcoal-rich clayey sand. In this quad, these hearth deposits were restricted to the eastern corner and appeared to terminate abruptly, as seen in quad 15. Sharples and Davis (2020a, 155) suggest that these burnt deposits might have been truncated, potentially by a cut for a second hearth area in the eastern part of the quad.

In quad 16, the main hearth layers enveloped a discrete yellow-orange clay-like burnt deposit in the northwest section, likely equivalent to 2253 (quad 14) as it was surrounded by trample (2683) from the separate hearth area (2682) within quad 16. A final red-orange hearth deposit overlay the main hearth layer in the eastern end of the house, identified as 2671 (quad

16), 2269 (quad 18), and 2645 (quad 20). In the western end, this overlying layer consisted of a dark brown-red deposit which was 545 and 546 in quad 4 and 1231 in quad 6.

Northside floor layers

The main deposit associated with the use of the house in quad 5 was a dark brown sand (557) that accumulated against the wall, appearing to be equivalent to 2113 (quad 7) and 2637 (quad 9). These layers were situated at similar levels within their respective quads, comprising dark brown, fairly compact material containing numerous small finds. In quad 1, the occupation layer 546 was partially covered by an orange yellow red ash layer (548), which formed a discrete deposit continuing east-west across the centre of the quad. A layer of yellow sand, numbered 1009 (quad 1), 1220 (quad 3), 550 (quad 5), and 1314 (quad 7), covered this deposit and was overlain by a final compact dark brown floor deposit (182).

In the eastern half of the house, additional floor layers underlay the main hearth deposit, including 2707 and 2653 (quad 17) and 2260, 2267, 2297, and 2607 (quad 19). These layers were equivalent to 2712, 2715, 2716, 2717, and 2731 (quad 20), constituting a mid-brown compact layer covering most of the quad. According to Sharples and Davis (2020a, 154), this layer might have been contemporaneous with the main hearth deposits in quad 15 (2258) and formed before the use of this area as a fireplace. A final light grey-brown compact floor layer underlay the final floor deposit in the eastern end of the house, primarily located within the northern half of each quad. This layer formed an occupation layer that was level with the main hearth deposits and extended from the east of quad 9 to quad 19. It was numbered 2636 (quad 9), 2036 (quad 11), 2673 and 2657 (quad 13), 2221 (quad 15), 2648 (quad 17), and 2230 (quad 19).

The last deposit associated with the occupation of the house was a dark brown compact layer covering most of the interior, including the central hearth (130 and 132). The layer's colour was darker in the west up to quad 11, becoming gradually lighter toward the east with fewer small finds. Despite covering the central hearth, several quads exhibited highly coloured ash layers, indicating that the hearth area was not entirely abandoned. For instance, red-orange hearth material 1056 was contained within 1049 in quad 3. The final occupation layer in the western part of the house was 182 (quad 1), 1049 (quad 3), 182 (quad 5), and 1234 (quad 7).

In quad 9, the final occupation deposits thickened and formed several dark brown, compact sand layers containing numerous small finds. The top two layers, 2627 and 2617, were similar and formed the final floor deposit together. These dark brown, compact sand layers were not present in quads 11 or 13, but an equivalent layer appeared in quad 15 as a firm red-brown deposit containing fewer small finds. This layer was numbered 2190 (quad 15), 2646 (quad 17), and 2220 (quad 19).

Ash trample layers in quads 9, 13, and 15 connected the central hearth with contemporary floor deposits, running east to west through the house adjacent to the hearth. Sharples and Davis (2020, 155) suggest that these layers likely formed due to occupants moving between the hearth and the peripheral area near the house's north wall. The earliest ash trample spread was a red-brown layer associated with the primary use of the hearth, numbered 2681 and 2699 (quad 9), 2708 (quad 13), and 2258 (quad 15). The overlying trample formed a mottled red-brown layer located within quads 13 (2672) and 15 (2219), associated with the final hearth deposits. Sharples and Davis (2020a, 155) noted that these layers had been truncated by the 2000 excavation within quad 11, making them difficult to identify. This trample was absent in quad 7, and the hearth and floor deposits were found divided by two large stones positioned between the two.

Southside floor layers

The main occupation deposit in quads 4 and 6 consisted of a light grey-brown sand (552 and 1260), occupying the eastern side of quad 4 and forming a strip adjacent to the upper hearth deposit (1231) in quad 6. This deposit contained minimal evidence of trampled ash from the main hearth, suggesting it was intentionally placed to maintain a clean floor. The lowest floor in quad 6 was a grey-brown sand (1603), overlain by a dark brown-black sand limited to quads 4 and 6 (551 and 1219).

In the eastern section of the house, the primary floor layer within quads 12 to 20 was a dark brown sand containing a significant amount of occupational debris, which decreased toward the east. This layer was numbered 1005 and 1008 (quad 12), 2286 (quad 14), 2692 (quad 16), 2283 (quad 18), and 2701 (quad 20). It was situated below the hearth in quads 18 and 20 and appeared contemporaneous with the primary use of the thick hearth in quad 16. In quad 10, the primary floor deposit (2225) was contemporary with a bright red peat ash dump (2226) against the southern wall, followed by two successive dark brown compact sands (2192 and 2181). In quad 14, deposits between the primary and final floor layers included two loose sands (2204 and 2200) adjacent to the southern wall in the western part of the quad, appearing to be a build-up of material in a hollow against the wall.

In most quads, excluding 10 and 14, the final dark brown compact floor deposit directly overlays the primary occupation layer. The final dark brown compact sand contained a substantial amount of burnt material, indicating continued hearth usage. Sharples and Davis (2020a, 155) suggest that it was likely altered by post-depositional processes, as it was the final layer in the abandoned house exposed to the elements, and soil formation processes could have caused the hearth and surrounding floor layers to become more homogeneous. This layer was numbered 1010 (quad 2), 182 (quad 4), 1057 (quad 6), 581 (quad 8), 2177 (quad 10), 1005 and 1008 (quad 12), 2188 (quad 14), and 2647 (quad 16). In quads 18 and 20, the last floor deposits, 2194 (quad 18) and 2686 (quad 20) did not overlie the central hearth. This compact dark brown sand occupied the entirety of quad 18 in the southern section. Sharples and Davis (2020a, 156) suggest that although it is plausible that this layer was contemporaneous with the primary hearth deposits located in the northern part of the quadrant, it yielded minimal small finds. The final deposit, red-brown sand, was restricted to the junction between quads 18 and 20, numbered 2199 (quad 18) and 2664 (quad 20), representing a discrete deposit of occupational material.

Sharples (2020f, 606) noted that, based on the complexity and depth of the deposits that formed the central hearth area and related floors, it is possible that this house was occupied for a long period of time, but this may not have been more than a couple of generations, as suggested by the radiocarbon dates. He also observed that the 'primary floor' of House 2 was likely 'patched up and renovated on a piecemeal basis throughout the occupation'. This is because there is no evidence to suggest that during the occupation of the house, the floor was replaced in its entirety, which is in stark contrast to the floors belonging to later phase houses, such as House 3 (Sharples 2020f, 606).

Several pits and post holes were also notable features of the occupation of House 2. While the earliest pits were shallow scoops cutting the earliest hearth layers, the later pits tended to be steep-sided and deeper (Figure 5.3). It was noted that these deeper pits (shown in Figure 5.3 as contemporary features), mostly in the western half of the house, were dug before the final floor's accumulation, suggesting they were dug after the house had been occupied for some time (Sharples and Davis 2020a, 156). It was also recorded that the more substantial pits were concentrated at the west end of the house (Figure 5.3, Sharples and Davis 2020a, 156). According to Sharples and Davis (2020a, 156), these pits, characterised by flat bottoms and steeply sloping or vertical sides, may have been cavities or basins which held timber barrels or containers. Thus, these pits mark out the west end of House 2 as being different from the rest of the house. The only pit in the rest of the house comparable to the pits of the west end was 2263 in quad 14 in the central region of the house (Figure 5.3). On the other hand, the central and eastern areas of the house had several postholes that were suggested to be either structural features of the house or internal divisions. Going from west to east these include 2779, 2780, 2612, 2244, 2044, 2046, 2263, 2213 and 2274 (Sharples and Davis 2020a, 156).

5.4 Methodology

From the occupation layer (the accumulated primary floor, also described above), samples were collected on a 1 m grid during the excavation of House 2. The samples were mainly from the final floor and hearth layers of the house. The specific contexts from which the samples were collected are listed with descriptions in Table 5.3. The descriptions of the contexts in this table are based on all the information available from the context sheet descriptions and the stratigraphic report in the publication. In instances where conflicting information was observed in the stratigraphic report, the information presented for individual contexts in the stratigraphic report was given preference. However, in some cases, only the basic information such as the colour and type of sediment was available. The number of samples collected from the west end of the house was comparatively fewer than the rest of the house (Figure 5.6). This was done mainly to avoid sample collection from the pits in the west end (Niall Sharples pers. comm.). At the time of the early season of excavations in the mid-1990s, the sampling strategy adopted only sampled the floor on a 1 m grid, which is different to the more recent sampling strategies adopted at Orosaigh and Meillionydd, which used a 0.5 m grid as recommended by Historic England (Historic England 2015, 31). The sampling and analysis were carried out following the methods described in Chapter 4. Not all samples were found to be lying exactly 1 m apart from each other, as the samples were collected over several seasons of the house being excavated (Figure 5.6). Four samples were collected from construction or pre-house layers as these were the only samples available from these locations. These samples were not observed to distort the results and hence were included in the analysis presented here. All the remaining samples were from adjacent occupation layers, which were 'the primary floor' that was repaired or patched up on a piecemeal basis. However, see below for a discussion of context 182 from the west end of the house which may not be contemporary with the rest of the house floor. The subsequent section describes the contexts sampled for the analysis presented here, by grouping them in different quarters of House 2, as depicted in Figure 5.7 (see below).

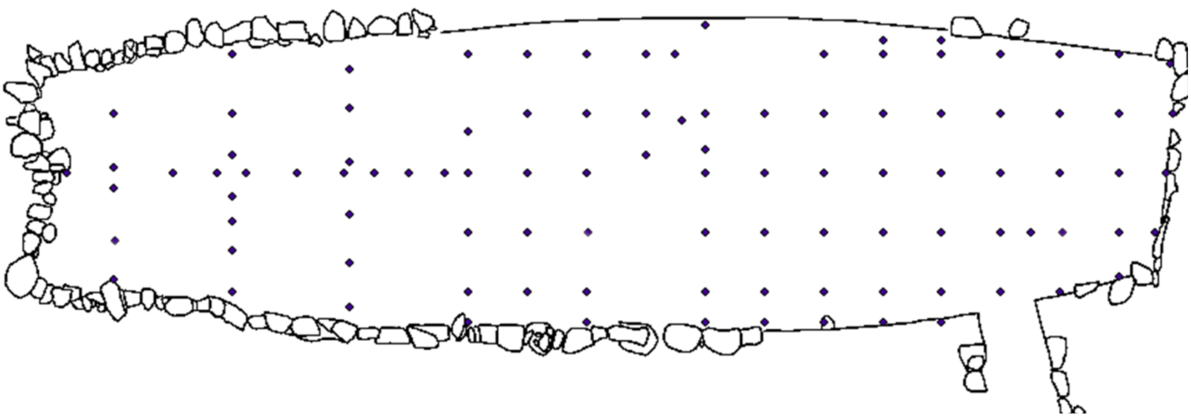

Figure 5.6: Plan of House 2, at mound 2, Bornais, showing the spot sample locations.

As mentioned earlier, this case study is different from the other case studies in this PhD thesis, such that spatial distribution of small finds and coarse residues from wet-sieving was available at the time of writing this chapter (Sharples and Davis 2020a). Within the publication, a spatial analysis predicated on the finds and coarse residue distributions is provided in conjunction with a model for the organisation of the house (Sharples 2020f, 602-608). Nevertheless, to avoid bias in the author's understanding of the multi-element analysis, a conscious decision was taken to abstain from considering the published interpretations in the final discussion chapter of the volume (Sharples 2020f, 602-608) during the time of the writing this chapter. Still, it is reassuring to note that the model for House 2 proposed by Sharples (2020f, 602-608) is compatible with the ones presented in this chapter.

Based on the observed distribution patterns of various elements, it seemed appropriate to segment the house floor into four quarters: West End, West Central, East Central, and East End, with each quarter further subdivided into north and south sub-quarters. The house was thus divided into eight areas for analysing the levels of chemical elements and finds, facilitating more effective comparison and contrast between different areas of the floor. It must be noted that the East End area in this chapter refers to quads 15-20. However, the East End area in the published report of House 2 (Sharples and Davis 2020a) refers to quads 17-20. This difference has been appropriately mitigated in this chapter, and any reference to the East End (and East Central as a result) in the chapter follows strictly the quad numbers and quarters set for this chapter and not the published report.

The distribution patterns of the various elements, as illustrated in Figures 5.8-5.11, rely on quantitative data. However, discerning patterns among these elements across a large floor area ultimately depends on a qualitative visual examination of the coloured distribution maps. To compare observable clusters of finds within the house floor to observable peaks and troughs in element distributions, both need to be presented in a comparable table or graph form. Pie charts were initially considered but deemed unsuitable for representing the levels of elements, as they would depict the entirety of items available in the house as percentages. For instance, while the total number of recovered pins can be ascertained, a similar total cannot be obtained for any element without analysing every sediment grain from the occupation layer, and it would also include the amount of naturally occurring elements in the sediment. Moreover, the suggestion of whether the levels of a particular element are high or low levels is relative to the range for that particular element observed through multi-element analysis. Consequently, a non-conservative approach employing bar graphs with relative levels of each element was deemed the most appropriate method (Figure 5.12).

Bar graphs were utilised to represent high and low levels of various elements in each sub-quarter of House 2 (see Figure 5.7). A numbering system was devised according to the GIS distribution plans, which display the level for each element across the floor (refer to Figures 5.8-5.12). The colour scale for each distribution plan indicates the range of values for each element, transitioning from the lowest (blue) to the highest (red). The assignment of numbers 1-4 for the bar charts is based on the colour scale, with 1 being predominantly blue sub-quarters (low), 2 being a mixture of blue and yellow (medium), 3 being a mixture of yellow and red (medium-high) and 4 being mainly red sub-quarters (high) (also discussed in Chapter 8). This method is applied to each element's distribution plan, allowing for the comparison of different element levels in a sub-quarter that would otherwise be impossible due to their disparate value ranges. For example, the average level of potassium (K) is lowest in the West End south and highest in the West Central north of House 2. Thus, the bar chart for West End South (Figure 5.12) assigns level 1 to K, while the bar chart for the West Central north sub-quarter (Figure 5.12) assigns level 4 to K. Similarly, the distribution of lead (Pb) on the plan reveals that the West Central north quarter has the second-highest level on average, resulting in an assignment of level 3 to Pb here, while the West Central south has the highest level of Pb and is assigned level 4 (Figure 5.12). In this manner, the bar charts visually represent the levels of various elements within each sub-quarter. Bar graphs are also used to show the amount of each particular type of small finds recovered within each sub-quarter, making the levels of various elements and small finds comparable.

5.5 Multi-element Analysis: Contexts

This section gives a brief summary of the type of contexts from which samples were collected. The contexts are grouped depending on their location in the house into four quarters of the house, as shown in Figure 5.6.

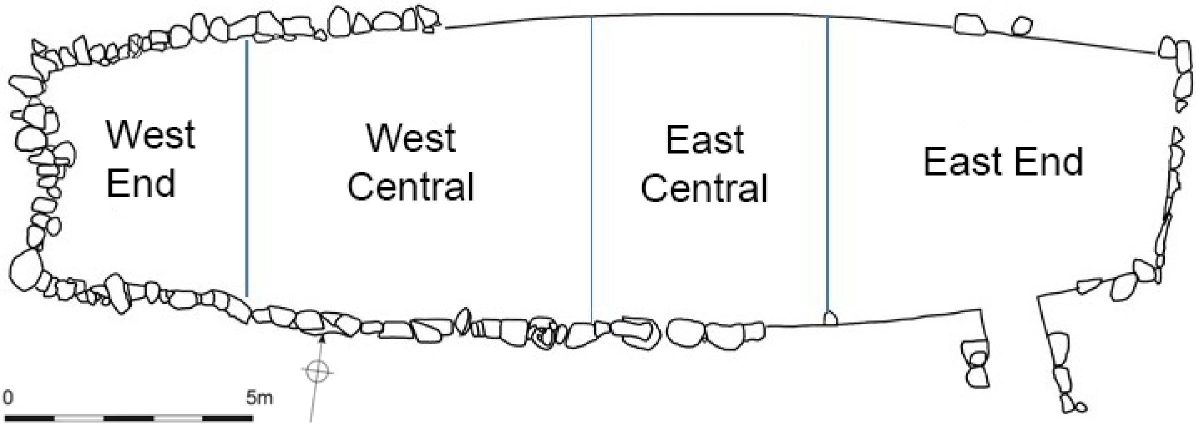

Figure 5.7: Plan of House 2 showing the division of the house into four quarters for easier analysis.

The samples collected from West End were all from context 182. This context was initially suspected to be an abandonment layer as it was the top fill of the occupation horizon. Based on soil micromorphological study of a sample, it was calcareous sand with a relatively small amount of fine material. It had a few inclusions of charred amorphous organic material, charred plant, and charred seaweed. Based on the lack of floor deposits and relatively small inclusion, Munro and Milek (2020, 166) suggested that this context was likely an abandonment horizon.

The samples collected from West Central were mostly from hearth layers that may have been part of the ash spread of the house. However, some samples were also collected from the occupation layers closer to the walls of the house. Almost all the samples collected from East Central were from the hearth layers or the ash spreads in the northern part of this quarter. However, all samples in the southern sub-quarter were from the primary floor level.

Most of the samples collected from the northern part of East End were from the hearth layers. The samples collected from the southern part were entirely from the occupation floor layer. The dominance of the ash spread/hearth samples collected from this house for geochemical analysis shows the high amount of ash that was spread in the house.

Context numbers	Description	Quad numbers	Quarter
182	Dark brown compact sand containing substantial amount of burnt material.	1 to 7	West End
518	Dark brown sand.	7,8,	West Central
564	Hearth layer composed of Pink/red Sand	5,6,7	West Central
581	Dark brown compact sand containing substantial amount of burnt material.	6,7,8	West Central
587	Dark brown sand.	5,7	West Central
2128	Dark brown sand.	11,13	East Central
2192	Dark brown compact sand with charcoal.	9,10,11	West Central, East Central
2194	Mottled dark brown floor deposit with very few finds.	18	East End
2215	Grey brown sand.	15,17	East End
2217	Orange hearth layer.	15	East End
2219	Mottled orange brown trample layer with charcoal.	15,17	East End
2221	Thick dark grey brown compact sand.	15	East End
2241	Dark brown sand-trample layer.	19	East End
2242	Red brown sand-trample layer.	19	East End
2254	Brown sand.	19	East End
2260	Dark brown black compact sand-floor layer.	19	East End
2286	Dark brown sand with large amount of occupational debris.	14	East Central
2637	Dark brown medium compact sand with large number of finds.	9	West Central
2651	Pale brown sand-possible construction layer.	19	West Central, East Central
2656	Orange hearth layer.	17	East End
2668	Yellow ash.	9	West Central
2669	Red-orange compact sand-hearth layer.	18	West Central, East Central
2677	Brightly coloured cream/pink burnt deposit.	13	East Central
2685	Pink/red sand-hearth layer.	13	East Central
2686	Mottled dark brown red compact sand floor layer.	20	East End
2691	Brown red compact sand.	13	East Central
2692	Grey brown sand with large amount of occupational debris.	16	East End
2703	Grey ash.	13	East Central
2707	Dark brown compact sand-floor layer.	17	East End
2708	Red/brown mottled sand-ash trample spread.	13	East Central

Table 5.3: Contexts from House 2, Bornais, analysed using multi-element analysis.

5.6 Multi-element Analysis: Results

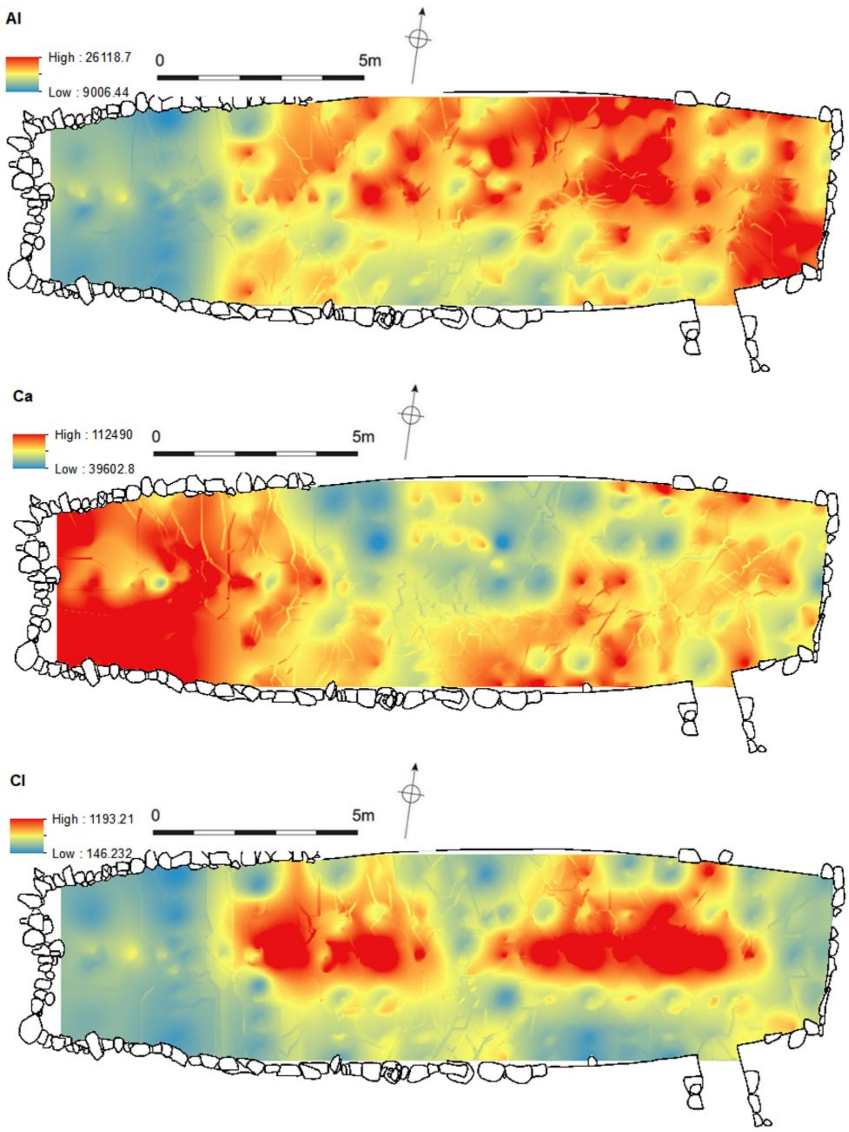

Figure 5.8: Distribution patterns of aluminium, calcium, and chlorine in mg/kg (from top to bottom) in House 2, Bornais.

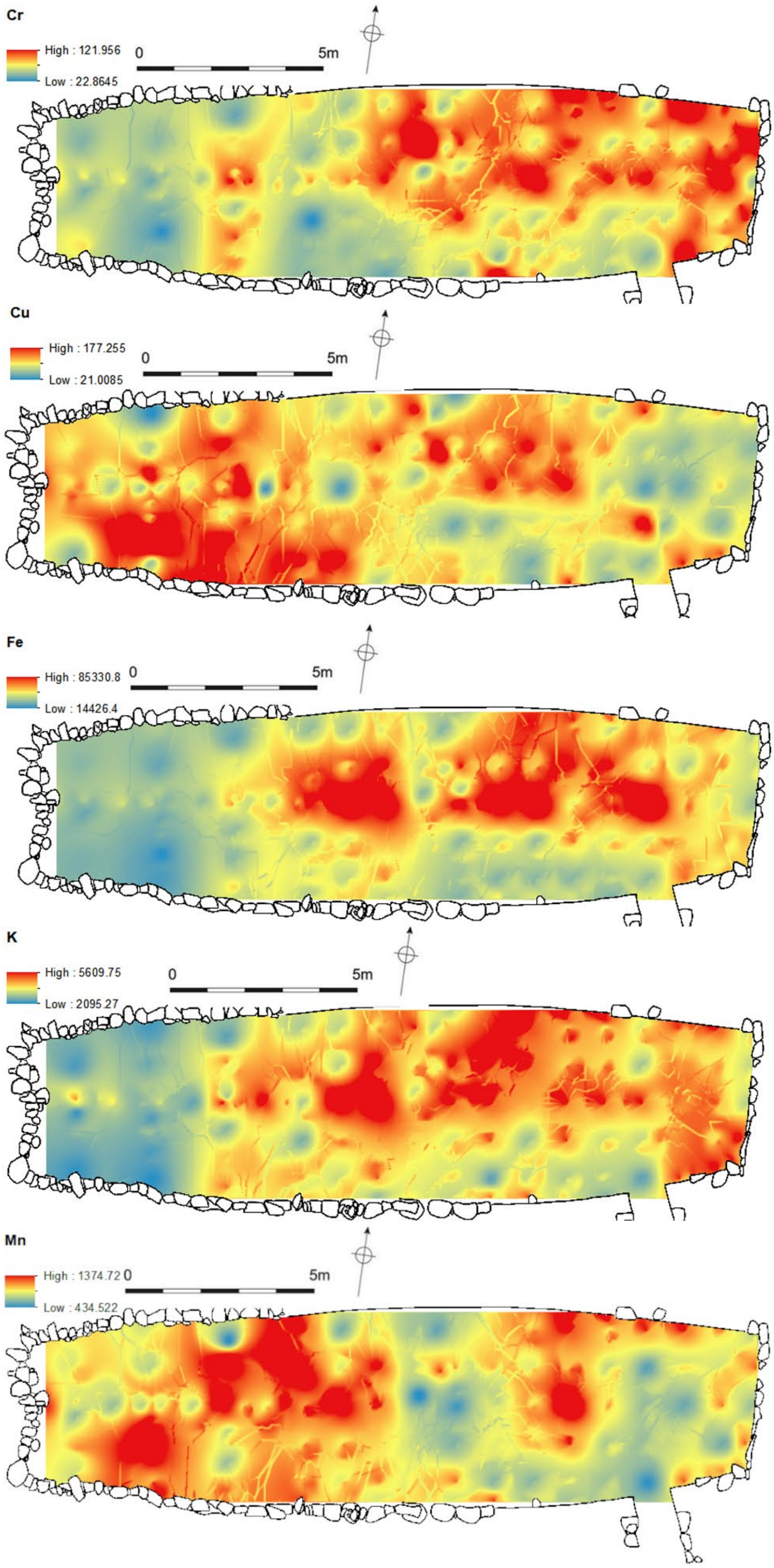

Figure 5.9: Distribution patterns of chromium, calcium, iron, potassium, and manganese in mg/kg (from top to bottom) in House 2, Bornais.

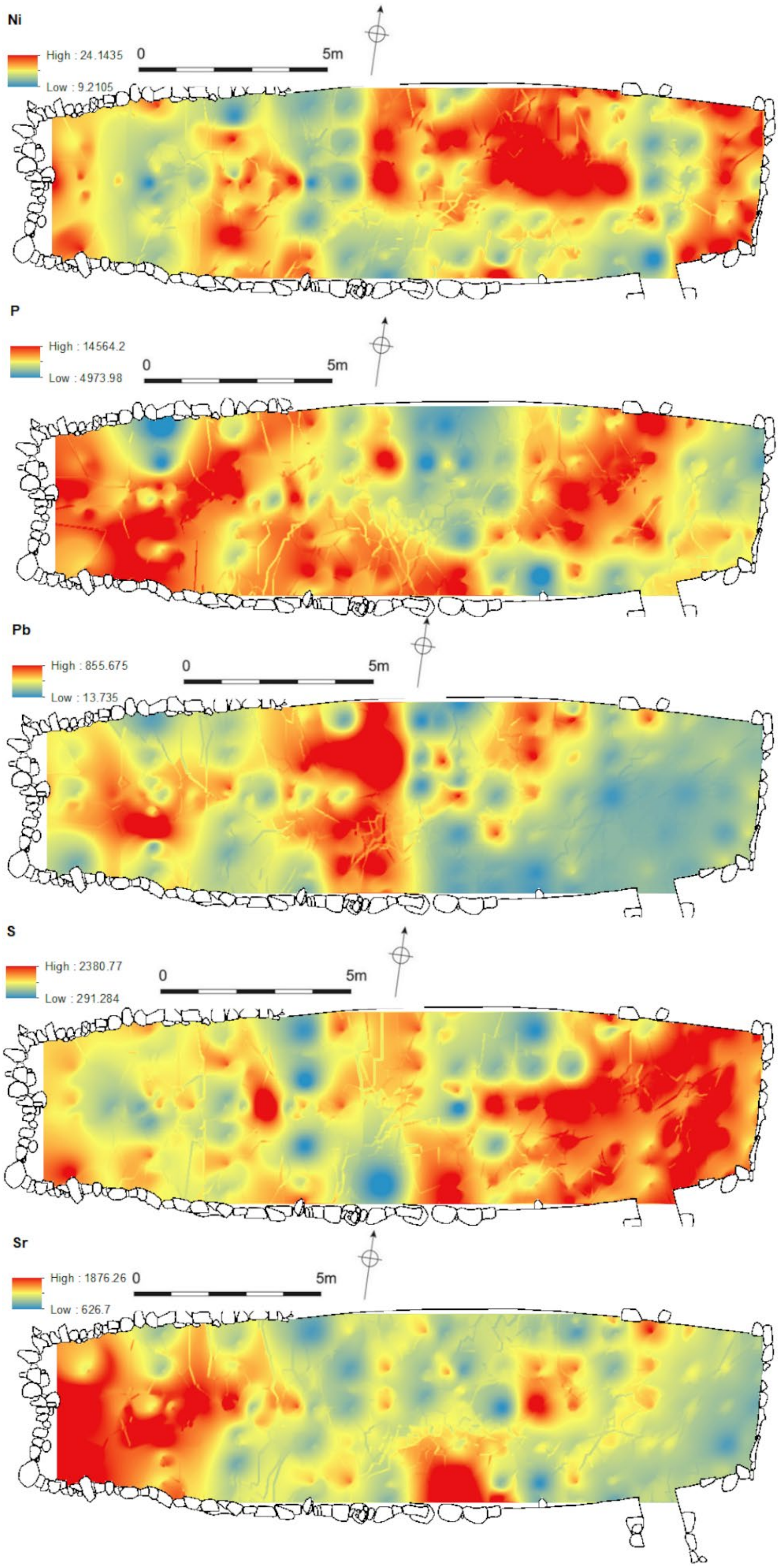

Figure 5.10: Distribution patterns of nickel, phosphorus, lead, sulphur, and strontium in mg/kg (from top to bottom) in House 2, Bornais.

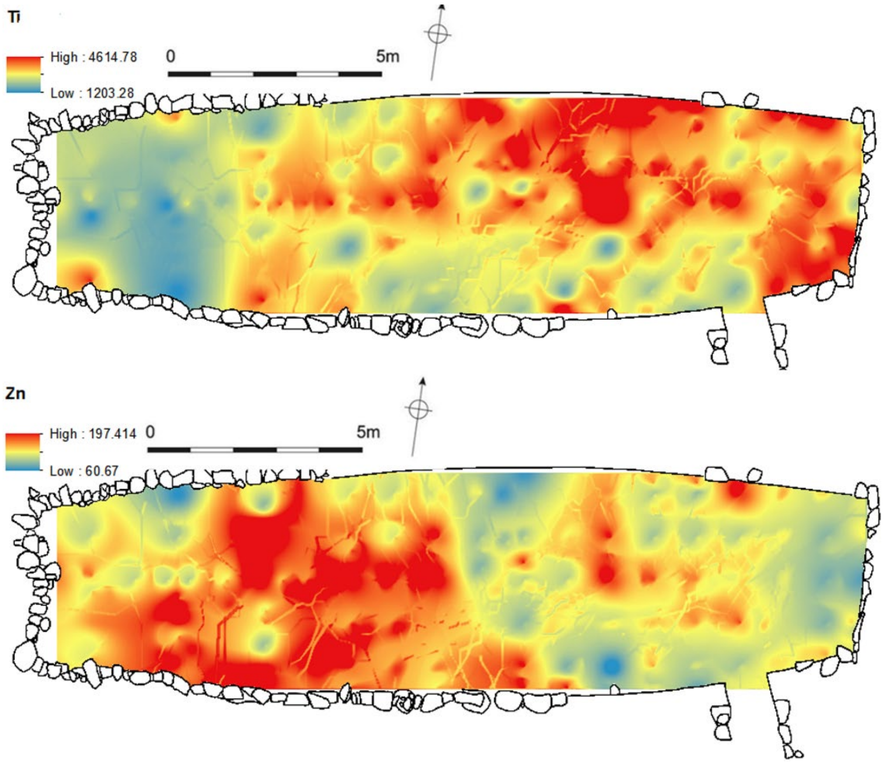

Figure 5.11: Distribution patterns of titanium (top) and zinc (bottom) in mg/kg in House 2, Bornais.

The multi-elemental analysis revealed several patterns in the accumulation of floor deposits in House 2. There were notable concentrations of certain elements in particular areas within the house floor. This could be an indication of certain areas being allocated for certain activities. What follows is a bar graph representation of the level of various elements in the different sub-quarters of House 2 (Figure 5.12).

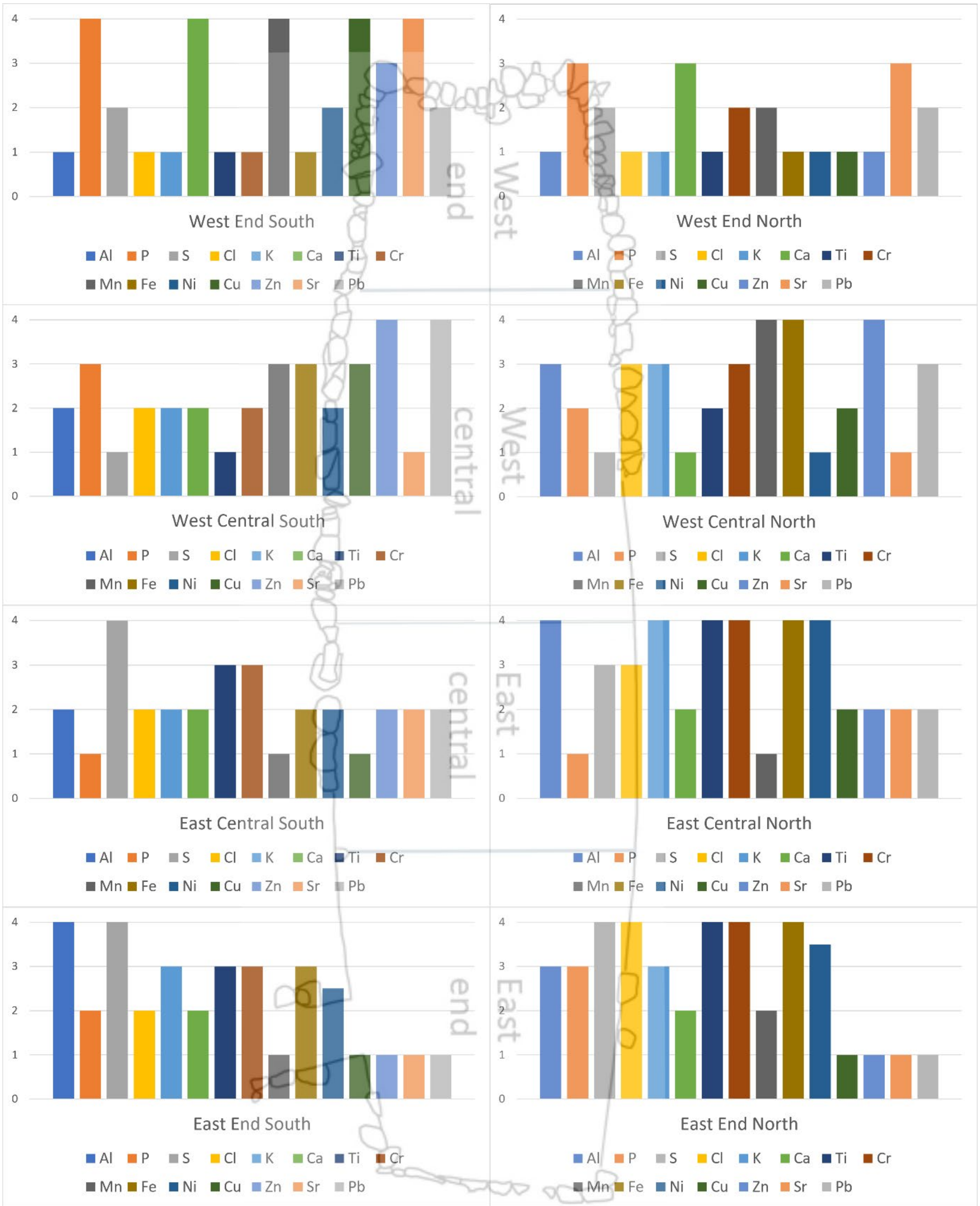

Figure 5.12: Levels of various elements in each sub-quarter of House 2 with the plan of House 2 overlaid to correspond to the graphs roughly.

West End

The West End quarter, especially the south sub-quarter, showed the highest levels of phosphorus (P), calcium (Ca), manganese (Mn), and strontium (Sr), and medium-high levels of Cu and Zinc (Zn) (Figures 5.8-5.12). The distribution pattern of almost all elements in this quarter towards the eastern limit sees a sharp decline or sharp rise in their levels. However, such a sharp decline cannot be seen towards the central aisle. This suggests that this quarter of the house was significantly different to the adjacent quarter. However, it cannot be ruled out this is a result of the fewer samples taken from the west half of the house to avoid pit features which is also a result of the 1 m grid used. The northern sub-quarter showed medium-high levels of P, Ca, and Sr, suggesting a similar pattern, albeit slightly lower. Copper (Cu) and zinc (Zn), together, can be seen to be high in the southern sub-quarter. However, this is overall slightly lower than what is seen in the adjacent quarter (Figures 5.9, 5.11 and 5.12). While the higher levels of P, Ca, and Sr could suggest exposure to organic matter, it is pertinent to underscore that the samples taken in this quarter were from context 182 which was identified as an abandonment horizon made up of calcareous sand (as per the soil micromorphology). Hence the elevation in the levels of Ca and Sr may be a result of the natural variation of Ca and Sr in the machair soils. This will be explored in more detail below.

West Central

Looking at the distribution pattern of the levels of elements in the West Central quarter, it seems likely that there was a significant difference between the West End quarter and the West Central quarter, as mentioned above. This is evident because of the distribution patterns of aluminium (Al), Ca, chlorine (Cl), chromium (Cr), iron (Fe), potassium (K), lead (Pb), nickel (Ni), and Ti, showing a significant rise in levels. The northern sub-quarter of the West Central region showed the highest levels of Mn, Fe, Zn, and Pb, with significantly high levels of Cl and medium-high levels of Al, K, and P. The levels of Al and K, when compared to the natural levels in the machair soils of Harris, are lower here and hence there is a possibility that these may be the natural levels. The southern sub-quarter showed the highest Zn and Pb levels with medium-high levels of P, Mn, Fe, and Cu. Based on the distribution of P, it is mainly the southern sub-quarter which possibly had higher exposure to organic matter. Furthermore, the suite of elements with high levels within the same area may be the result of the hearth layers/ash spread in the central area of this quarter (Table 3.1).

East Central

This quarter seems to show a significant difference in the levels between the northern and the southern sub-quarters. The northern sub-quarter had the highest levels of Al, K, Ti, Cr, Fe and Ni. It also showed high to medium-high levels of sulphur (S), Cu, and Cl. On the other hand, the southern sub-quarter only showed medium-high levels of S and Sr towards the wall. Apart from S, Sr, and Pb, all elements show a significant elevation in levels towards the central aisle, especially closer to the eastern limits of this quarter, which may be suggestive of a strong association with an activity in the East End quarter. This quarter also showed significantly low levels of Ca in the north sub-quarter and P in the north and south sub-quarters towards the walls of the house, possibly suggestive of low exposure to organic matter. Although Sr follows a similar pattern like P, a high outlier in one sample was observed in the southern sub-quarter. Nonetheless, the levels of Al, K, and Sr are lower than or within the range of their levels seen in the machair soils of Harris (Table 5.1) and while natural levels in the machair soils of South Uist remain unknown, there is a likelihood that the levels of Al, K, Ca, and Sr seen in this quarter are a result of the natural levels in the sediments that contain the machair sands.

East End

This quarter overall shows the elevation of most elements towards the centre and closer to the western limits of this quarter. The northern sub-quarter towards the west showed the highest levels of Al, Cl, S, Cr, Ti, and Fe and medium-high levels of P, Cu, K, Mn, and Ni. The southern sub-quarter had the highest levels of Al (closer to the entrance) and Cl and medium-high levels of K, Ti, Cr, Fe, and a medium level of Ni. Although not showing significant levels overall in this quarter, Zn is raised towards the central west. The high levels of various elements such as Fe, K, Cr, P, Zn, Cu, and Mn (and to some extent Sr in the centre) may be suggestive of a possible area of burning, as seen in other studies (Middleton 2004; Aston *et al.* 1998; see

Table 3.1). This is especially seen towards the centre-west area of this quarter. However, it is worth highlighting the sample collected towards the centre of this quarter belonged to hearth layers possibly affecting the distribution pattern. It is notable that the eastern part of this quarter towards the eastern wall showed declining levels of Cl, Cu, Fe, Pb (lowest), Mn, P, Sr, and Zn. This may be suggestive that the area towards the eastern wall was possibly reserved for separate unrelated activities. A sharp decline in the levels of Al, Mn, Cl, Ni, Cu, P, Sr, and Zn can also be seen along a north-south line along the entrance of the house. While this could suggest a possible partition was here, this is not clear in the case of the distributions of Ca, Cr, K, S, and Ti, and so this is a tentative suggestion. Nonetheless, a posthole (2274) identified here was suggested to be part of a structural setting or an internal division (Sharples and Davis 2020a, 156). This posthole lies on the border of the sharp decline seen in this area, perhaps raising the possibility of an internal division.

Summary

Overall, it can be observed that the areas closer to or encompassing the possible central hearth aisle positions are highlighted by the P distribution. A possible second major hearth that lies between quads 15, 16, 17, and 18 (or slightly in East Central and mostly East End quarter) is highlighted by the higher levels of almost all elements. Overall, the central aisle of the house with the ash spreads and the hearth is visibly highlighted in the distribution maps. The distribution pattern of K is, interestingly, roughly similar to the extent of ash spread in the house (Figures 5.5 and 5.8). This may be an indication of a fuel rich in K, such as wood (or its derivative, such as charcoal), also being used as a source of the ash along with the peat that is easily available here as peat is deficient in K (Steenari *et al.* 1999, 249-258). It is also noteworthy that higher levels of K are observed towards the eastern half of the house, which may be suggestive of wood ash being more prevalent in the eastern half than the western half (Figure 5.9).

5.7 Spatial Distribution of Material Recovered from House 2

The distribution of flots and coarse residue from wet sieving

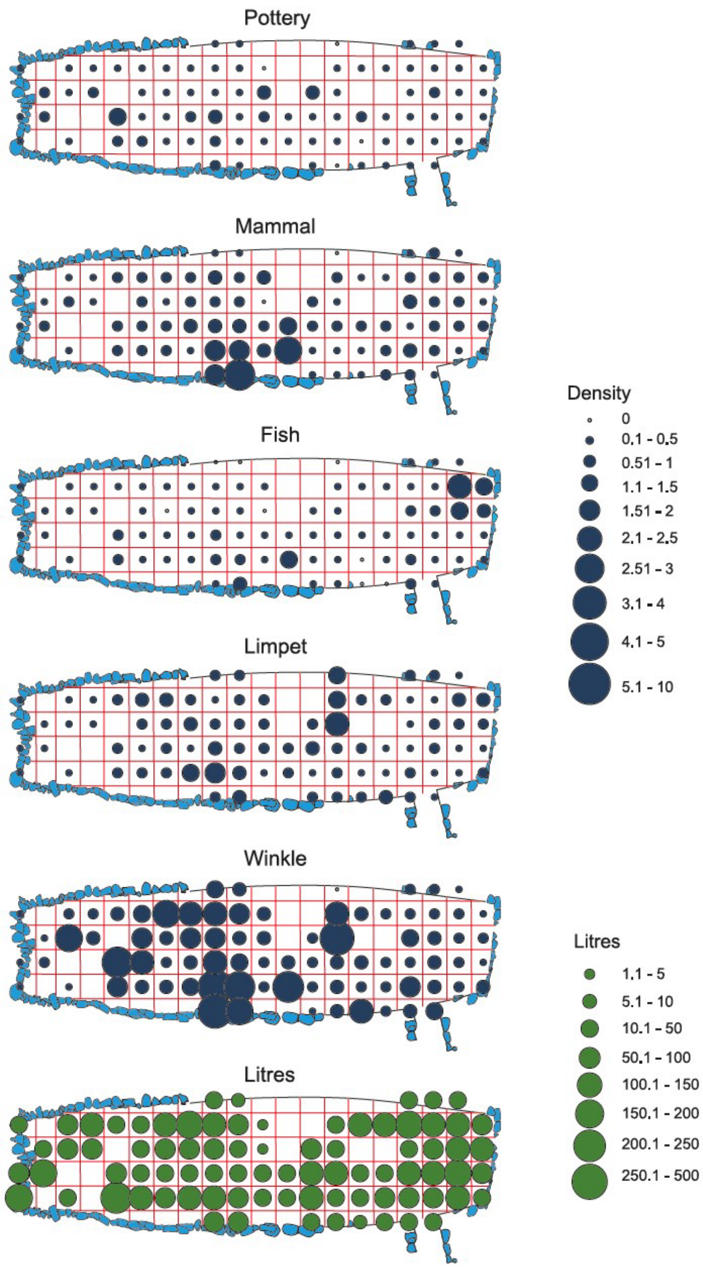

Figure 5.13: The distribution of materials from above 10mm residues from floor and abandonment layers in House 2 (Sharples 2020b, fig 129).

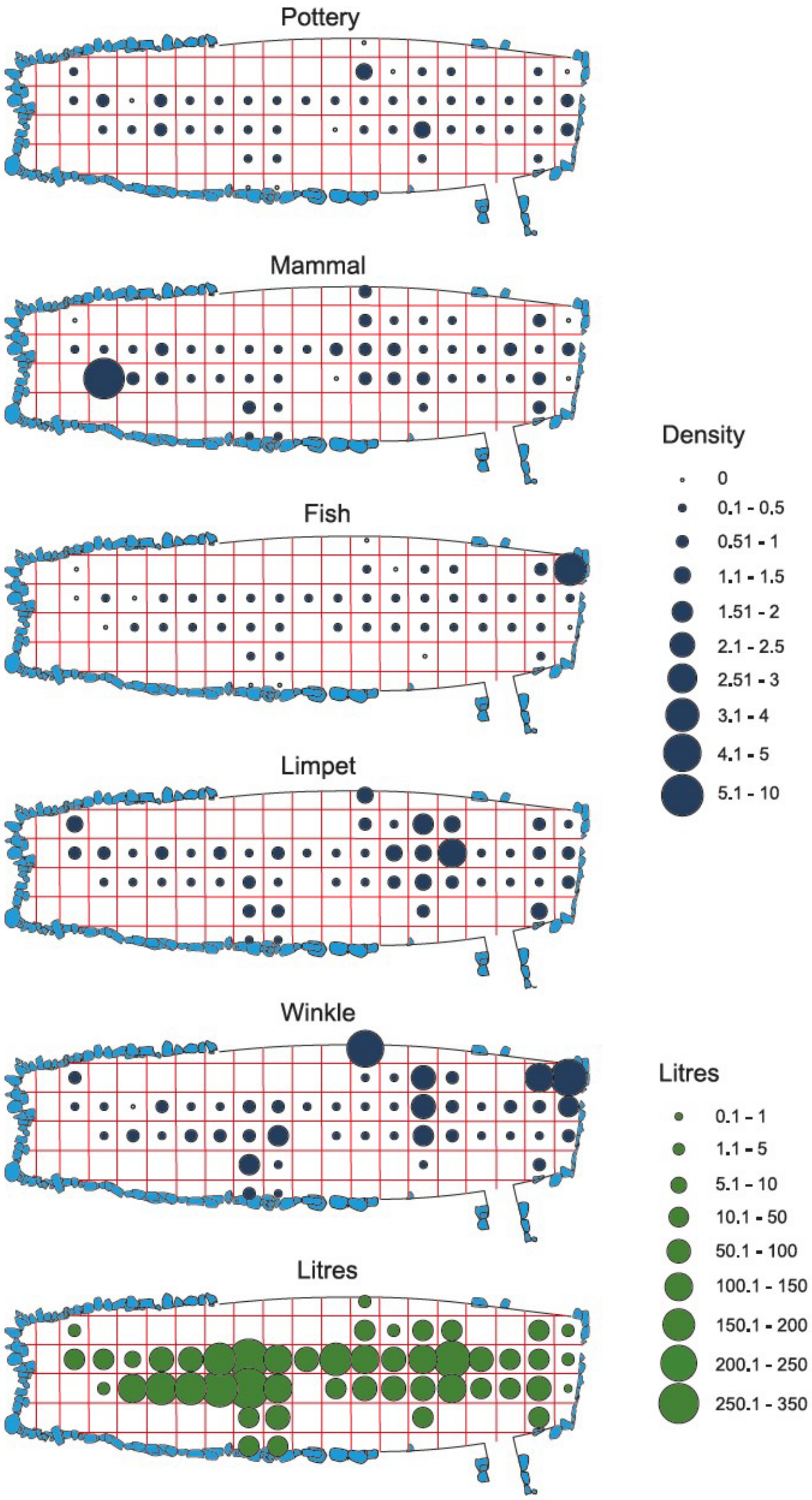

Figure 5.14: The distribution of materials from above 10mm residues from hearth layers in House 2 (Sharples 2020b, fig 130).

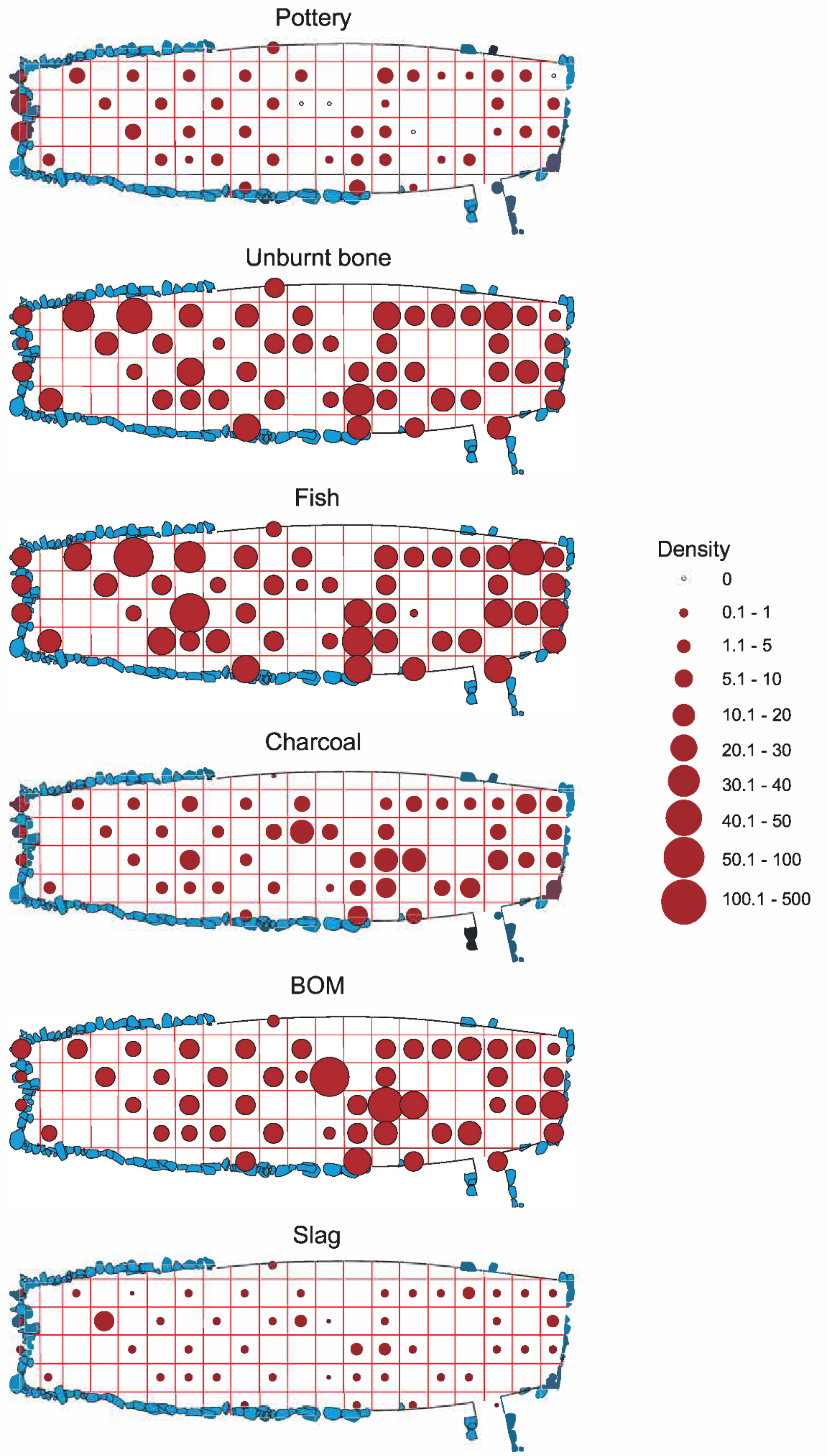

Figure 5.15: The distribution of material from 2-10 mm residues from the floor and abandonment layers in House 2 in frag/litre (Sharples 2020b, fig 134).

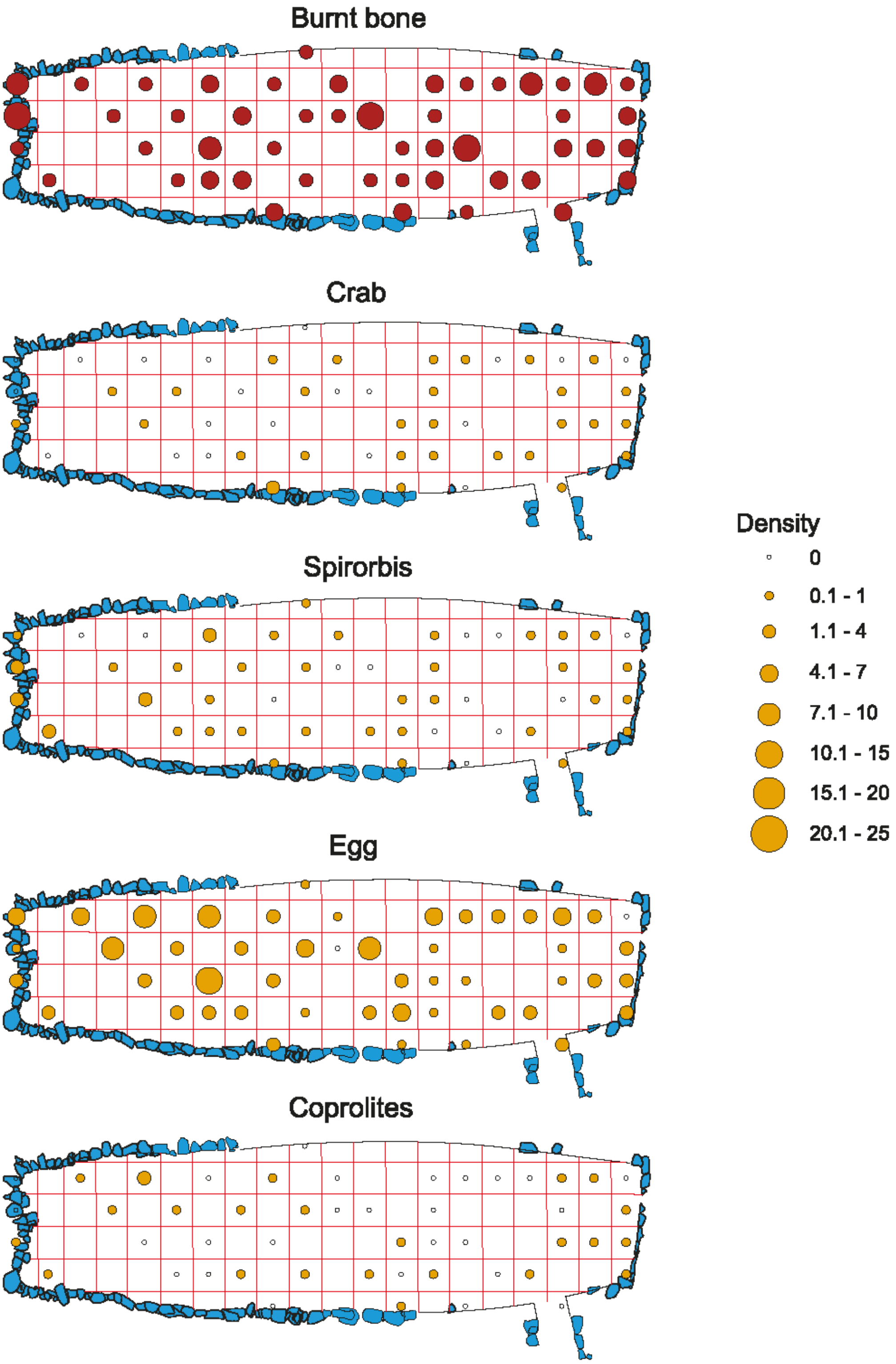

Figure 5.16: The distribution of material from 2-10 mm residues from the floor and abandonment layers in House 2 in frag/litre (Sharples 2020b, fig 134).

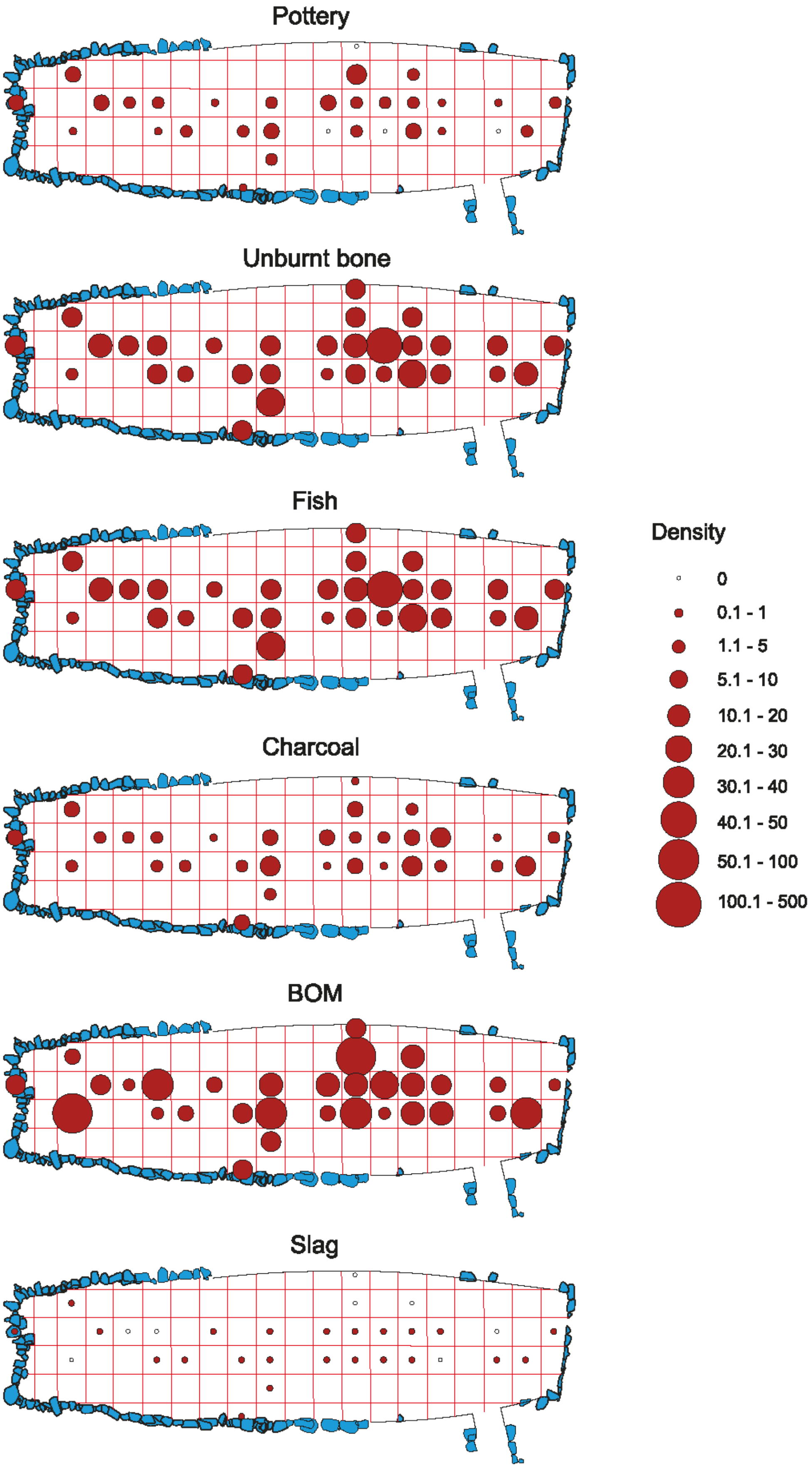

Figure 5.17: The distribution of material from 2-10 mm residues from the hearth layers in House 2 in frag/litre (Sharples 2020b, fig 135).

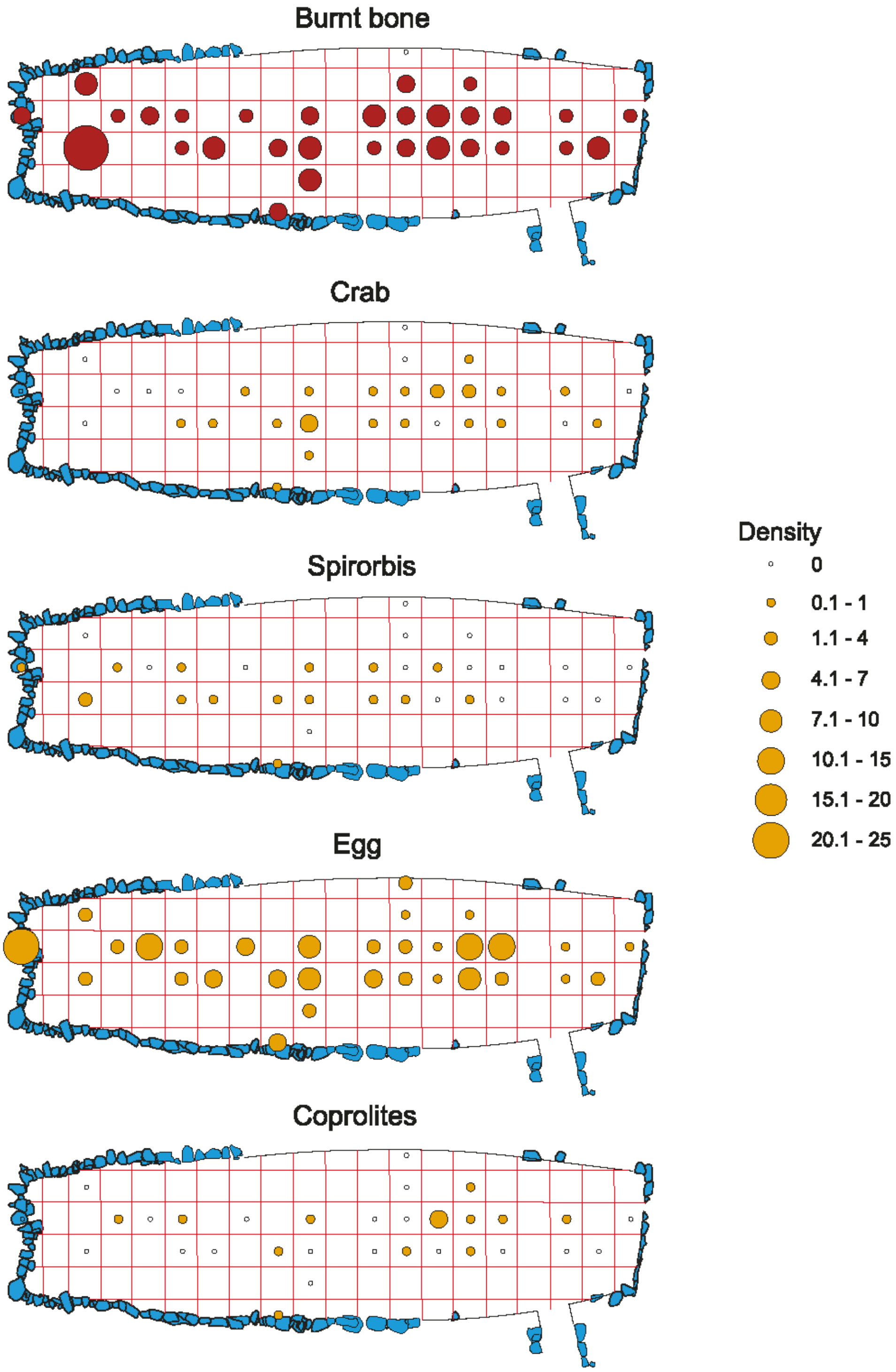

Figure 5.18: The distribution of material from 2-10 mm residues from the hearth layers in House 2 in frag/litre (Sharples 2020b, fig 135).

The processing strategy for wet sieving adopted by Sharples (2020b, 167) divided the residues into two: 2-10 mm residues, which include the flots, and above 10 mm residues, which are mainly from coarse residues. The 2-10 mm residues were sieved and sorted from 178 samples (Sharples 2020b, 167). Sharples noted that when it was realised that samples and material from the occupation and abandonment layers gave complete coverage of House 2, the data from the occupation and abandonment layers were amalgamated to provide a complete picture of the house (Sharples 2020b, 166-186). The main categories of material recovered from residues of the occupation/abandonment layers that were above 10 mm in size were fish bone, mammal bone, winkles, limpets, and pot (see Figures 5.13 and 5.14). High quantities of most materials were found to be in the central area of the house, particularly in the West Central south area. Occasional high densities of pottery are visible in other areas of the house. High quantities of fish bone were recovered from the East End north area. Limpet and winkle were in higher numbers compared to other areas in the West Central south sub-quarter. The densities of material from hearth samples were much lower than that of the occupation/abandonment layers. However, a striking quantity of fishbone is still visible in the East End north area. A consistent pattern of elevated amounts of most materials was observed in the adjacent areas of East Central north, East End north and south (Figures 5.13 and 5.14).

From 2 to 10 mm residues, it was found that pot was most common in the West End and declined towards the East End in the floor layers (Figure 5.15). Unburnt bone was found to be in slightly higher densities in the East End north and East Central north areas in the hearth layers (Figure 5.17). However, in the floor layers, they were slightly higher in the East End north and East Central north (Figure 5.15). Fish bone, although it had higher densities in the eastern half of House 2, was unevenly distributed in the hearth layers (Sharples 2020b, 177). Higher densities of fish bones can be seen in the West Central and East End north areas in the floor layer (Figure 5.15). Sharples observed that burnt organic material, which suggests an association with burning, was higher in the eastern half of the house (Sharples 2020b, 177; Figures 5.15 and 5.17). A cluster of high-density samples was observed in the east-central area (Sharples 2020b, 177; Figures 5.15 and 5.17). Higher densities of burnt organic material can also be seen in East End south area close to the central aisle adjacent to the East Central area. Sharples (2020b, 177) noted that although charcoal showed a similar pattern to burnt organic material, there were no significantly high densities. From the hearth layers, mammal and fish bones were the highest in the east-central area. Similarly, high levels were also observed for pottery in the East Central area (Figures 5.17; Sharples 2020b, 181). Burnt organic material and charcoal distribution in hearth layers also showed a similar pattern where higher densities can be seen in the East Central area. It is also noteworthy that burnt organic material here also shows elevation toward the east in this quarter (Figures 5.15 and 5.17), indicating proximity to a hearth.

Pottery

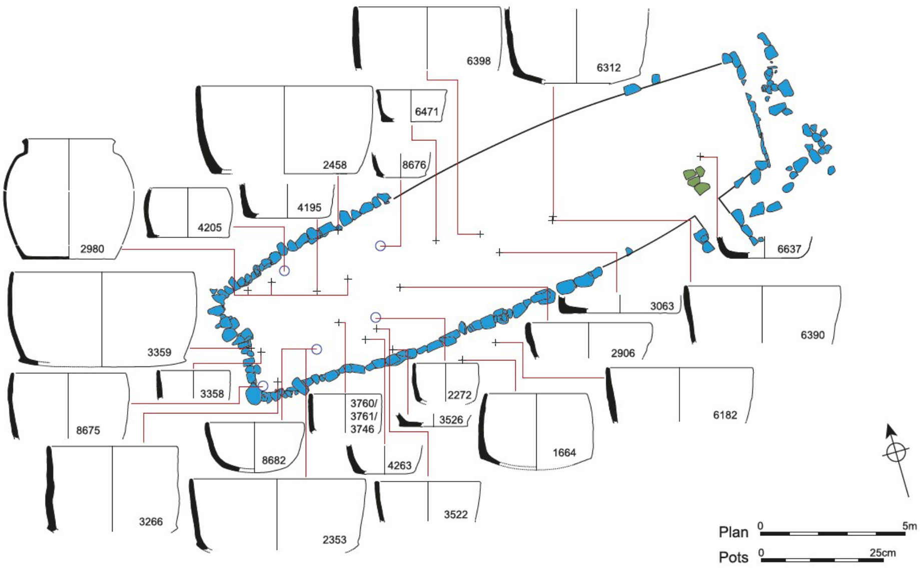

Figure 5.19: The distribution pattern of better-preserved pots from the floor of House 2 (Harding and Sharples 2020, fig 141).

Of the pottery recovered, 94 per cent by weight came from the occupation layers. The West End of the house had large pottery spreads that could be refitted to form almost complete vessels (Harding and Sharples 2020, 181). However, a cluster of sherds was recorded in the East End South sub-quarter of the house too. Although a few sherds from fine ware and platters were recovered, the assemblage was dominated by simple bowls. Most of the platters recovered were from the East End area, although some were observed in the West End quarter (Harding and Sharples 2020, 186). The distribution pattern of the pots that were better preserved

(Figure 5.19) suggests that the food storage area and main consumption area may have been in the western half of the house, with storage more likely in the West End area of the house.

Artefacts

689 objects and 664 pieces of flint were recovered from the hearth and occupation layers. The assemblage of finds includes forty bone and eight copper alloy pins, sixty-six comb fragments (mostly antler but a few are bone), spindle whorls (eight bone, three ceramic, two stone and three lead), nine needles, nine iron knives, one sickle blade, whetstones, cobble tools, stone fishing weights, two iron arrowheads, two silver coins (a cut farthing of Æthelred II who reigned between 978-1016 and a coin fragment of Olaf Kyrre who reigned in Norway 1067-1093), eight glass beads, three rings (one each of stone, copper alloy and iron), pearl and lead pendants, six antler tines, 74 nails, 36 roves, 19 holdfasts etc. One of the most significant objects to be found was an antler cylinder with a Ringerike-style animal (Sharples 2004, 203). Based on the distribution of finds (Figure 5.20), it was observed that there is a decline in the number of artefacts from west to east. There is a lack of finds in the East Central north area. According to Sharples *et al.* (2020, 213), this was due to the later disturbance here due to the north wall being robbed for the later structure built. The linear area along the centre of the floor, which coincides with the ash layers, produced very few finds. This could be due to the lack of deposition towards the hearth or was a result of trampling caused by people moving through the building (Sharples *et al.* 2020, 213). Clusters of finds were also observed in the northern halves of the West End and West Central areas and the opposing southern halves. With the lack of finds along the centre in the adjacent areas of the West End and West Central quarters, it is likely that there was a hearth area with prolonged usage here. This is further emphasised by the fact that the localised cluster of finds easily differentiated ash layers in the West-Central north sub-quarter (Sharples *et al.* 2020, 213). The above-published data was used to find the quantity of each artefact category in each sub-quarter of the house and are shown as bar graphs below to help in easier comparison with the results from geochemical

analyses dividing them into the four quarter (and sub-quarter) as shown for geochemical analysis results (Figures 5.21-5.27).

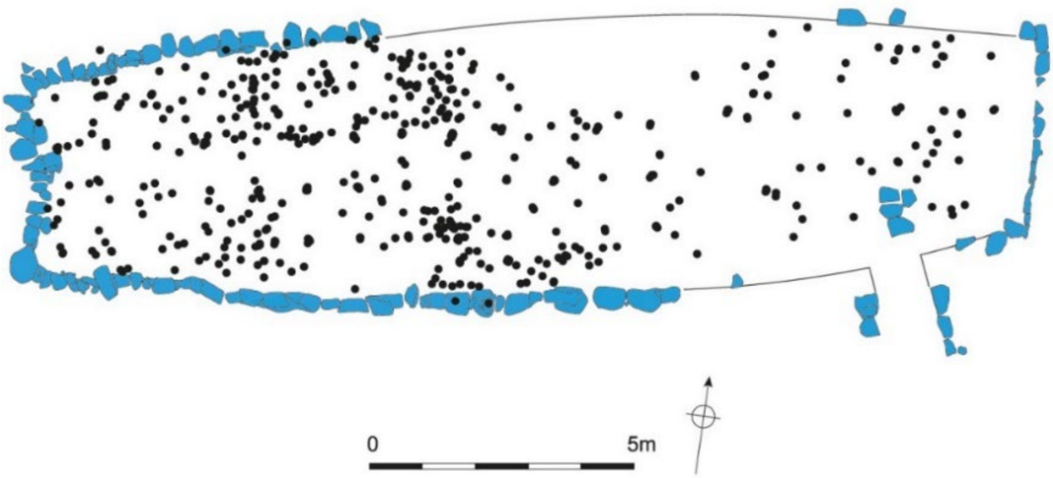

Figure 5.20: The distribution of finds from the floor of House 2 (Sharples and Davis 2020a, fig 159).

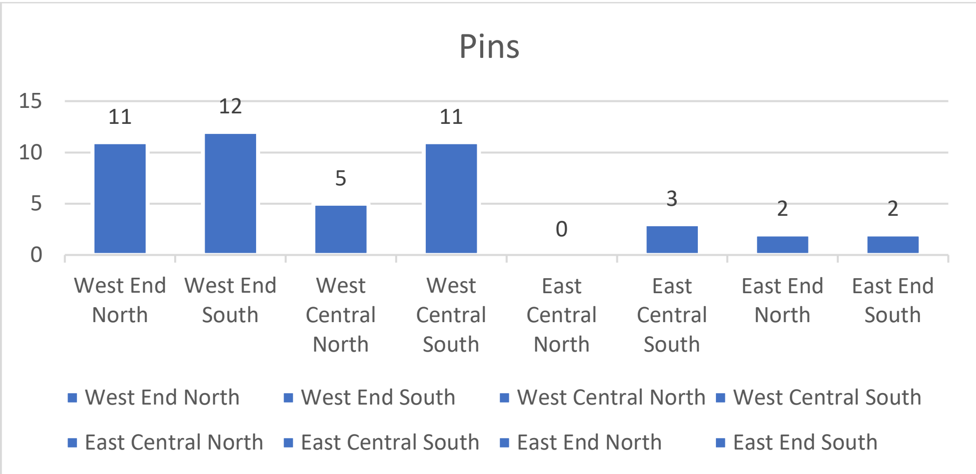

Figure 5.21: Bar graph showing all types of pins together in each sub-quarter of the house.

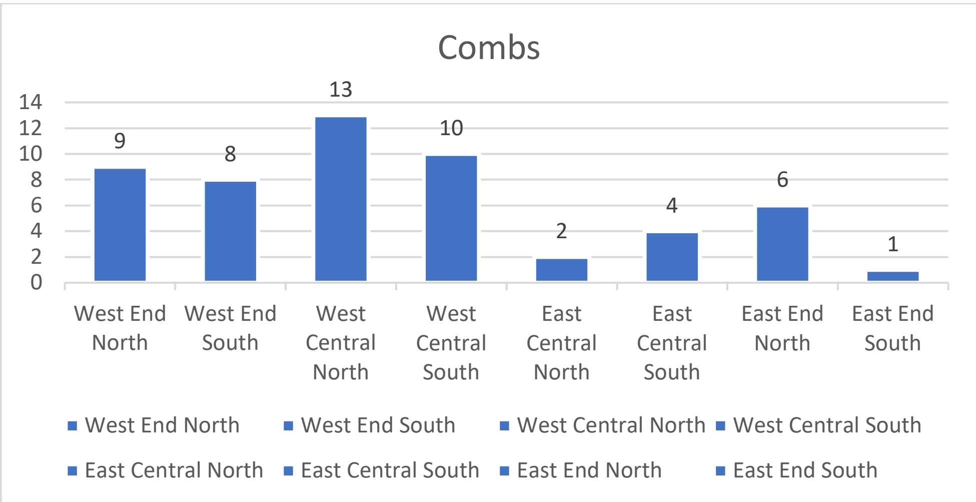

Figure 5.22: Bar graph showing bone and antler combs in each sub-quarter of the house.

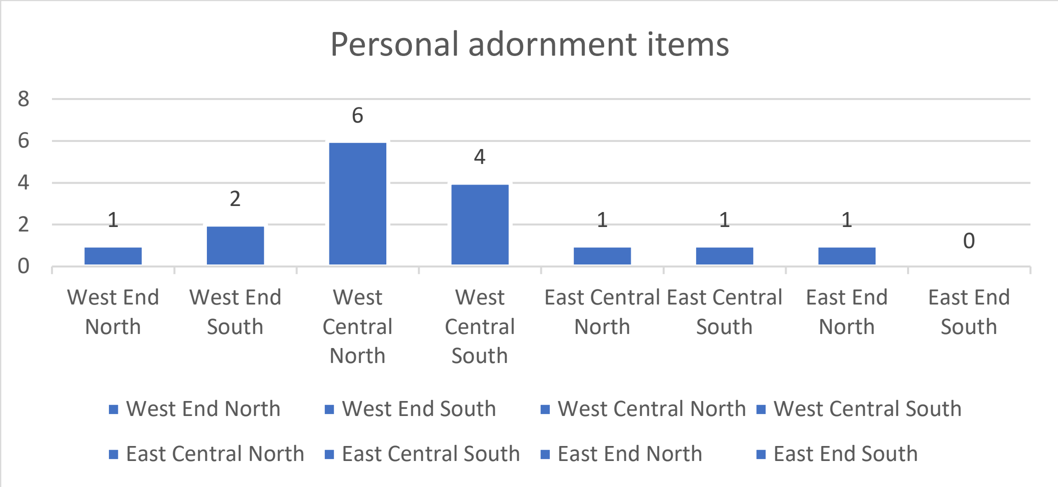

Figure 5.23: Bar graph showing personal adornment items that include rings, glass beads, pearl, lead pendant, stone bead, silver coins, amber object, and stone green porphyry in each sub-quarter of the house.

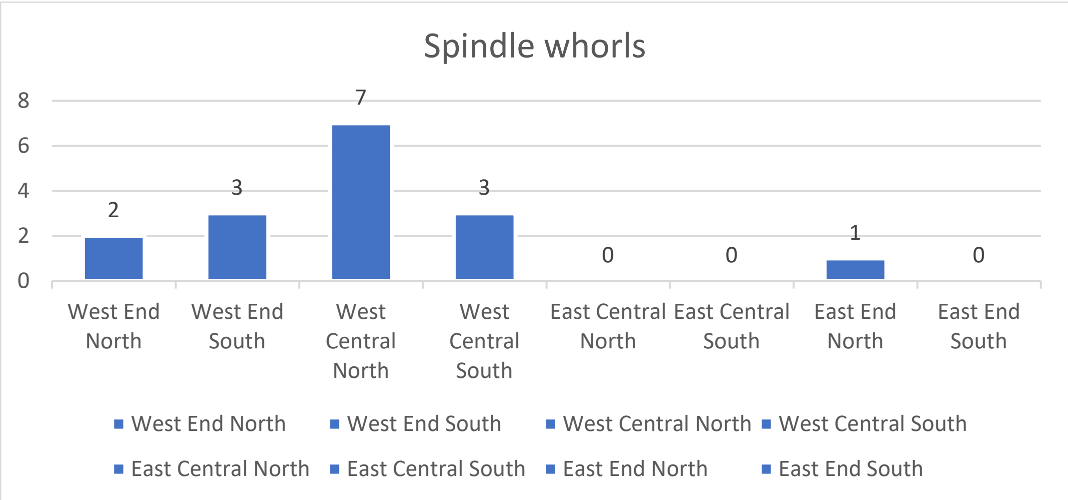

Figure 5.24: Bar graph showing spindle whorls in each sub-quarter of the house.

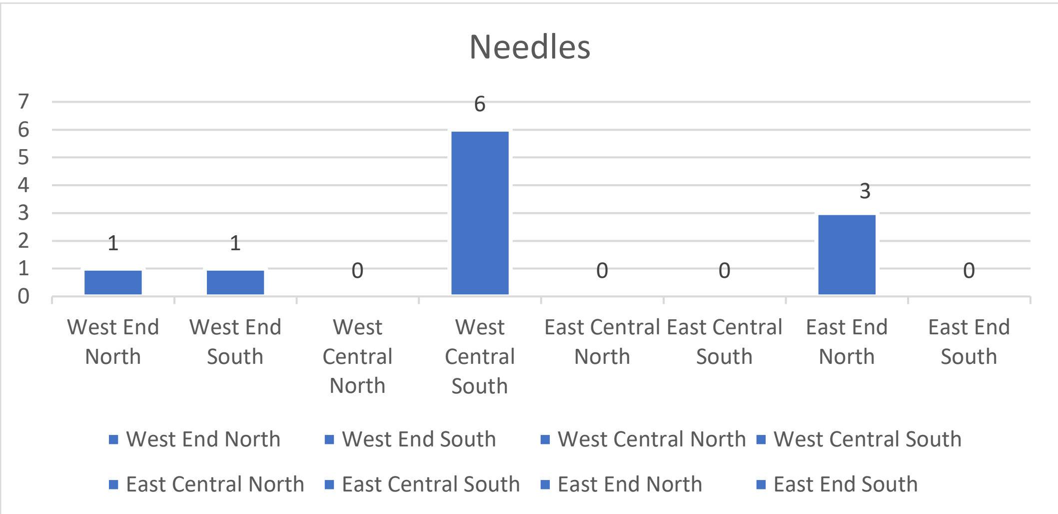

Figure 5.25: Bar graph showing needles in each sub-quarter of the house.

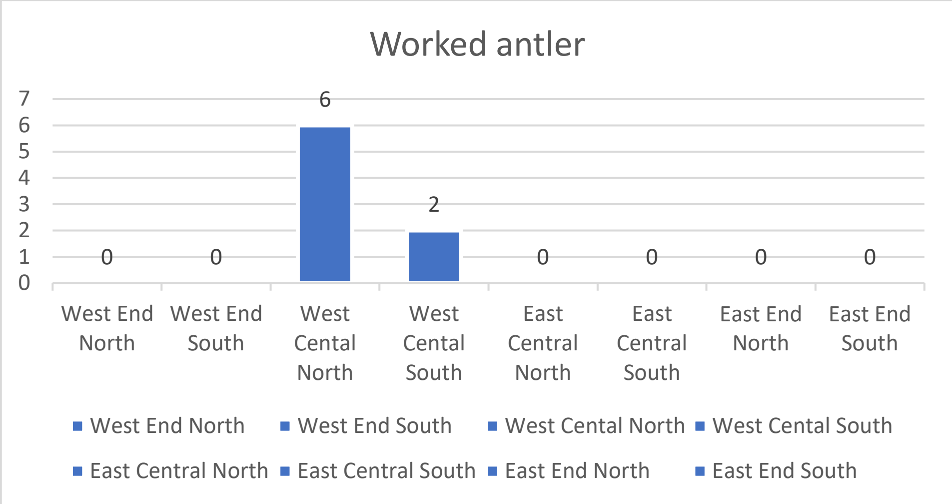

Figure 5.26: Bar graph showing decorated tines, gaming piece and Ringerike cylinder in each sub-quarter of the house.

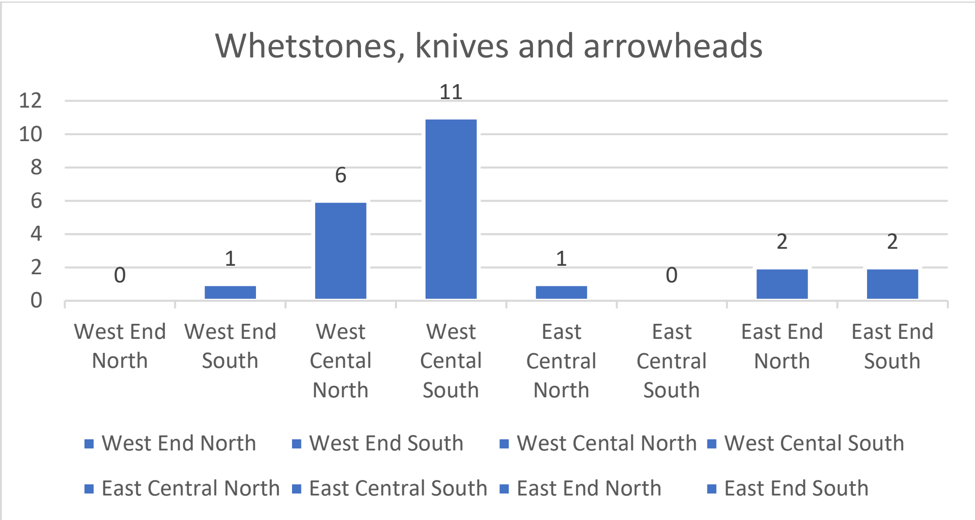

Figure 5.27: Bar graph showing whetstones, knives, and arrowheads in each sub-quarter of the house.

Based on the distribution of spindle whorls in the West Central north and West End areas (Figure 5.24) and the needles in the West Central South and East End areas (Figure 5.25), wool production in the northern parts and western parts and fabric stitching in the southern side and East End was suggested (Sharples *et al*. 2020, 214). Whetstones and knives were found to be close to each other in the West Central north and south areas (Figure 5.27). Two arrowheads were also located in the trampled ash layers closer to the centre (Sharples *et al*. 2020, 216).

Decorated tines possibly associated with drinking and eating were clustered in the West Central north area (Figure 5.26). The antler cylinder decorated in Ringerike style lay at the centre of this cluster. Alluding to the possibility of the decorated tines being the finials of drinking horns, Sharples *et al.* (2020, 216) suggest that this area may have been the seating area of an important individual, such as the head of the household. The distribution of pins and combs seems to be higher in the East Central quarter than in the rest of the house, and there are fewer numbers in the eastern half of the house (Figures 5.21 and 5.22). The West Central area's importance is also emphasised by the cluster of exotic items/personal adornment items such as two silver coins, amber cross fragment, and lead axe-shaped pendants (Figure 5.23; Sharples *et al.* 2020, 216).

Carbonised plant remains

Thirty-nine samples with carbonised plant remains were analysed from the occupation deposits. The linear hearth area along the centre of the house, running west to east, is highlighted by the distribution of barley, flax, and wild seeds (Summers and Bond 2020, 224). However, oats and rye were evenly distributed with slightly higher quantities in the West Central area. Barley was found higher in the central area of the house compared to the rest. Flax, like barley and oats, was the highest in the West central area. These clusters of carbonised plant remains in the West Central area indicate the presence of a hearth in this area that may have been primarily associated with cooking. However, Summers and Bond (2020, 225) note that the large number of charred flax seeds found indicates possible linseed oil preparation and its waste material being burnt rather than its use for food or fibre.

5.8 Spatial Analysis Combining All the Studies

At this point, it is essential to discuss each area of House 2, considering the observations made through the separate and various studies in the sections above. They are discussed cohesively below by grouping them into different quarters.

West End

The West End, overall, produced twelve pins, a cauldron handle, and three spindle whorls, and it also had significant numbers of pottery, mammal bone and burnt bones. The West End north had eleven pins, a cauldron handle, two spindle whorls and high numbers of pottery sherds, unburnt bone, fish bones, unburnt bones, and the highest levels of eggshells. Sharples (2020f, 605) noted that along with the large spreads of complete pottery here, this quarter also contained a concentration of small pits with vertical sides that were likely used throughout the occupation of the house. It was also suggested that these pits could indicate the presence of wooden barrels and other wooden furniture that were embedded in the floor and would have contained water and other liquids. Furthermore, the highest densities of the carbonised plant remains were also noted in this pitted area (Sharples 2020f, 605). It is pertinent, however, to highlight that the distribution of artefacts and the micro-debris throughout the house does not distinguish between the occupation layers and possible abandonment layers within the house.

Overall, if the patterns are taken at face value, the West End quarter of the house could indicate that food handling, storage or processing were the likely activities in this area. It is possible that West End South functioned as a food (especially meat) processing area. This is because it showed high levels of P, Cu, and Sr, which indicates food preparation involving meat, based on other geochemical studies (Middleton and Price 1996; Milek and Roberts, 2013; Table 3.1). The high level of Ca observed in this quarter could be a result of the significantly high number of eggshells here.

Nonetheless, these results and interpretations need to be set in the context of the problem of this abandonment layer (182), as discussed earlier. Based on the soil micromorphology study from a single sample (soil micromorphology sample number 9676) from this context, it was observed that evidence was absent for any floor deposits here. Considering this, it was suggested that 182 is an abandonment horizon and not a secondary occupation deposit (Milek and Munro 2020, 166). In the publication, it is noted that 182, the final occupation layer, is called an abandonment layer 'as shorthand reference and should not prejudice its final interpretation' (Sharples and Davis 2020a, 154). Although 182 is stratigraphically positioned above floor layers that are contemporary with the rest of the house, and this layer also partially covers the central hearth area (Figure 5.28), still, in a number of places in the hearth area, highly coloured ash layers were seen in context 182 (Sharples and Davis 2020a, 154). As such, Sharples and Davis (2020a, 154) suggest that this indicates that the hearth area was still used in some capacity when this horizon formed. For example, red-orange hearth material (1056) was contained within context 1049=182 (Sharples and Davis 2020a, 154). Furthermore, this final occupation or abandonment layer is described as 'a dark brown compact layer that covered the majority of the house' (Sharples and Davis 2020a, 154). It was also noted that this layer had a darker colour in the western part of the house and gradually turned lighter as one moved east, where there were significantly fewer small finds (Sharples and Davis 2020a, 154). However, they also suggest that it was likely transformed by post-depositional processes, as it was the final layer in the abandoned house exposed to the elements, and soil formation processes could have caused the hearth and surrounding floor layers to become more homogeneous.

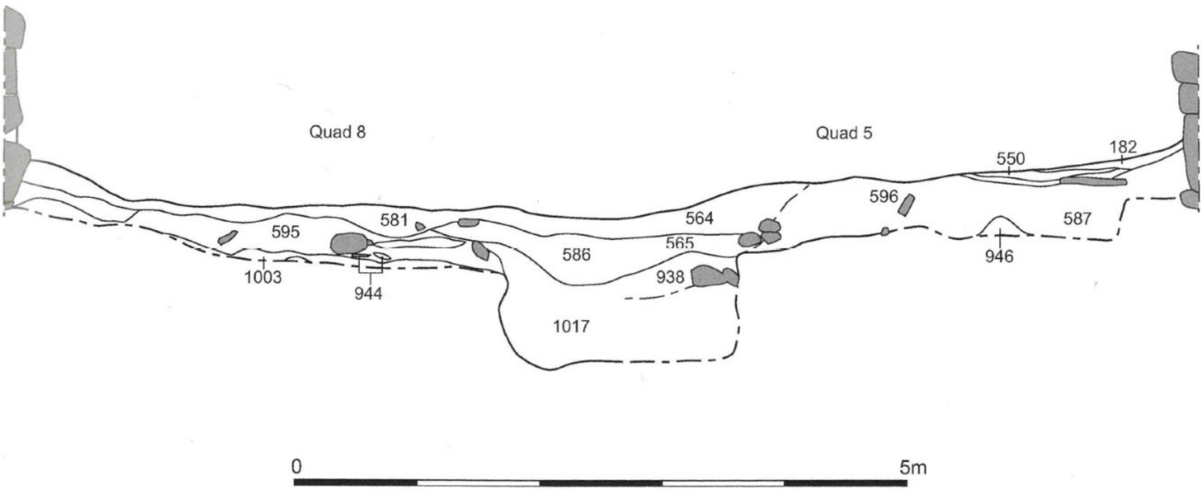

Figure 5.28: East-facing section through edges of quads 5 (or edge of quad 7) and quad 8 (or edge of quad 6) (Sharples and Davis 2020a, fig 116). Context 182 can be seen at the very top of the sequence of floor deposits.

Context 182, based on the multi-element analysis, showed that this quarter, especially towards the south end, showed the highest levels of phosphorus (P), calcium (Ca), manganese (Mn) and strontium (Sr) and medium-high levels of Zinc (Zn) (Figures 5.8-5.12). The soil micromorphology study described it as calcareous sand with some fine material (Munro and Milek 2020, 166). Calcareous sand will show elevated levels of Ca and Sr (Rennert and Hermann 2020, table 4; Table 5.1), and it is therefore noteworthy that the levels seen in this quarter are generally higher than in other areas of the house, which suggests the influence of natural sand accumulations forming part of this possible abandonment layer. Furthermore, Al, Cl, Cr, Fe, and K show uniformly diminished levels here compared to the rest of the house floor, further suggesting that this layer is significantly different to the rest of the sediments in other areas of the house floor.

It is, however, not unlikely that this layer may have been associated with a possible occupation phase, considering the presence of occupation material in the form of the red-orange hearth material, alongside the darker coloured deposits, raised phosphorus and higher number of small finds seen towards the western end of this quarter. Nevertheless, its higher position in the stratigraphic sequence must be acknowledged (see Figure 5.28), and based on the soil micromorphology study and the possibility that it was affected by post-depositional formation processes, it cannot be considered to be contemporary with the rest of the floor, and this cannot be incorporated within the final spatial model.

West Central

The West Central north and south sub-quarters had high levels of pottery, mammal bones and winkle shells. The northern sub-quarter demonstrated elevated concentrations of Mn, Fe, Zn, and Pb, along with significantly increased levels of Cl and moderate to high levels of aluminium (Al), potassium (K), and phosphorus (P). Comparatively, the southern sub-quarter exhibited high levels of Zn and Pb and moderate to high concentrations of P, Mn, Fe, and copper (Cu). The high levels of a suite of elements such as these could be indicative of a hearth or a midden (see Table 3.1 for the elements which are typically raised in these features). However, the presence of a hearth is underscored by the recording of an ‘ill-defined hearth’ that only had an insubstantial kerb of small stones, as noted by Sharples (2020f, 605). Overall, the West Central area shows indications of a hearth in its central area used for cooking.

The West Central area may be interpreted as accommodating a cooking area. This area's interpretation is further emphasised by the observation of charred remains of oat, barley, and rye in this area. Around this cooking area, there must have been a sitting/food consumption area, which is supported by the range and the number of elaborate personal small finds, which included sixteen pins, six cauldron handles/sheet fragments, ten spindle whorls, ten personal adornment items, six decorated tines, one gaming piece, eight whetstones and seven iron knives, two arrowheads and the Ringerike-style decorated cylinder. This emphasises the use of this area as a cooking/eating and social area. Furthermore, the soil micromorphology study of the sediments here suggested its use as an area for 'the processing and/or the consumption of food (shellfish/meat/fish)' with a focus on the southern sub-quarter (Munro and Milek 2020, 164). Perhaps, it is for this reason that elevated levels of P, Cu, and Zn are seen throughout this quarter, especially on the southern side (also see Table 3.1). Additionally, the presence of spindle whorls in the north sub-quarter was suggested to indicate a wool production area (Sharples *et al.* 2020, 214). Moreover, the southern sub-quarter, where the largest number of needles were retrieved, was postulated by Sharples *et al.* (2020, 214) to have served as a fabric-stitching location.

Based on the study of carbonised plant remains, it can also be implied that the hearth in this area was a cooking hearth (Summer and Bond 2020, 221-226). The importance of the sitting area around this hearth is emphasised by the iron knives and whetstones that were recovered in pairs, and based on the location of the Ringerike-style cylinder to the north of the hearth area, Sharples *et al.* (2020, 219) suggested that it was likely that this was the sitting area of an important figure such as the head of the household. Furthermore, with this primary cooking hearth here, it can now be suggested that West Central area accommodated the 'kitchen' of House 2.

Sharples (2020f, 605-606), in his spatial analysis of the western half of House 2, has suggested that an area of 5.6 m long can be identified as the primary focus of the hearth. This area was characterised by the placement of slabs at both ends and the presence of short upright stones along the edge of the central aisle. Furthermore, Sharples (2020f, 606) also posits that this region may have served as a communal space, accommodating most of the indoor activities undertaken by the occupants. Such an interpretation is further supportive of the idea that the West Central area accommodated the primary cooking hearth and sitting area/social space.

The central area (towards its eastern end) also showed the highest levels of Pb in the house, and this area also showed a concentration of lead material, mainly in the form of sheets and fragments as well as lead nodules. Therefore, it may be argued that this central area may have also been used as a lead-working area (not smelting but perhaps a form of processing that involved heating and reshaping). Such an interpretation is also supported by Sharples's suggestion that these finds likely indicate recycling and processing on the settlement, if not in the house (Sharples *et al.* 2020, 198).

East Central

Based on geochemical analysis results, this area may have been part of a sleeping/storage area on either side of the central aisle of the house, especially closer to the walls. This is mainly because of the generally low levels of P observed. A similar interpretation has been suggested by Sharples (2020f, 606), although he also notes that the identification of an obvious activity area was difficult. Nonetheless, with a possible hearth lying nearby (East End; discussed below) and the generally low levels of P in both the north and southern part of this quarter, it is possible that this area was subject to more cleaning rather than lower exposure to organic matter. The cleaning of this area may also be evident based on the low number of small finds recorded. The north sub-quarter had the least number of finds compared to any other area of the house. However, this has been attributed to the later disturbance caused by the robbing of the north wall for the building of the later structure, House 3 (Sharples *et al.* 2020, 212).

The suggested close proximity of this quarter to a hearth is based on the high amounts of burnt organic matter and burnt bone in the floor contexts here, along with the assemblages of pottery, unburnt bone, fish bones, and eggshells recovered during wet sieving (Figures 5.13-5.18) from the ash spreads in this quarter, which were all located close to the central aisle of the house. Coincidentally, this also coincides with the high levels of Al, K, Ti, Cu, Cl, Cr, Fe, and Ni, and medium-high levels of S and Zn towards the centre, indicating that this area was most likely exposed to ash and heat (Table 3.1). Furthermore, a similar pattern of high levels of P and Ca closer to the central aisle may be suggestive of proximity to a hearth. Nonetheless, it is worth reiterating that the levels of Al, K, and Ca may also be a result of natural levels seen in machair soils (Table 5.2; Rennert and Hermann 2020).

East End

Overall, the East End quarter indicates a multi-functional area that includes a (possibly destroyed or moved) secondary hearth, hearth-related activities and a textile-working area. The evidence for burning is observed from the material recovered in this quarter from wet-sieving, which includes the highest amounts of burnt organic matter observed found in the house. From unburnt and burnt bone, fish bone, charcoal, and eggshells recovered from the ash spread towards the central aisle of the house, it can be suggested that a secondary cooking area might have been here. Although not immediately close, a quern stone was recovered from the southern area of this quarter, hinting at this area's use for cooking/food processing activities. The high levels of P in this quarter possibly highlight the hearth and its fallout in the north sub-quarter. The hearth is also highlighted by the high to medium-high levels of elements in the north and the south sub-quarter collectively closer to the central aisle by Al, Cl, K, S, Cr, Ti, Fe, Mn, Ni, and Zn.

Posthole 2274 was interpreted in this quarter as part of a possible internal structural setting or internal division. Hence, a partition going north-south to the right-hand side of the entrance of the house may have existed here. Concurrently, distribution patterns of elements such as Al, Mn, Cl, Ni, Cu, P, Fe, Sr, and Zn could imply the presence of a boundary between two separate functional areas of the house. Furthermore, the alignment of low levels of Ni following the same line as the possible partition from the north wall to posthole 2274 perhaps also indicates the place where a partition was positioned (Figure 5.10). However, the wider sampling grid of 1 m used in this area of the house may have created an artificial pattern here: such a large grid may have missed spots showing intermediary levels of elements, and so the pattern may not, in reality, be as neat. As such, the provisional interpretation that a partition stood here must be viewed with caution. Sharples (2020f, 606) suggests that the East End area was a place where rubbish was allowed to accumulate. However, the level of P is not accordingly high as would be expected from a waste accumulation area. This is suggestive that the samples collected from this area for geochemical analysis may have been from a phase during which this area was used for something else. While the levels of Ni, Cr, S, and Ti are high in this area, it is not conclusive of a specific function. However, a textile-working area in the form of fabric-stitching, as suggested by Sharples *et al.* (2020, 214) in the northern part of this area cannot be ruled out as it had the second-highest number of needles than other sub-quarters of the house. This may be seen as consistent with the low levels of P seen here.

Hearths

While a central hearth aisle existed in this longhouse encompassing significant ash spreads, two areas showed a higher possibility of accommodating major fireplaces. High levels of a suite of elements were identified in the central areas of the West Central and East End quarters of the house, as discussed above. These hearths have, however, shown a significant difference in the levels of potassium (K). The level of K is lower in the hearth area in the West Central quarter when compared to the fireplace of the East End quarter. Moreover, the high levels of K in the house seem to follow a pattern similar to the ash spread in the house (Figures 5.5 and 5.9). Notably, the K levels peak in the areas close to the second possible major fireplace of the house, and it seems to peter out towards the western end of the house, especially towards and beyond the other major hearth in the western half of the house.

It is possible that such a disparity in the K levels in the two hearths could have resulted from the differences in the use of the primary fuel here. Based on the soil micromorphological study of samples from the western hearth, it was suggested that the primary fuel used was peat, with wood being used as secondary fuel (Munro and Milek 2020, 160). However, while there could be multiple reasons for this pattern, the fireplace in the East End quarter (showing high

K levels) could be a result of the greater use of wood here as a fuel. This is because wood or wood ash is rich in K compared to peat/peat ash (Steenari *et al.* 1999, 249-258). Considering the K levels in the central hearth aisle/ ash spread, it is likely that wood was used more in the minor/secondary fireplaces towards the East End, and peat was used towards the western end. Alternatively, it could also represent that the ash spread in the central aisle consisted more of wood ash as one moved from west to east.

The slightly unusual position of the hearth in the rear enclosed western half of the house is commented on by Sharples (2020f, 605). He points out that it is plausible that the peat hearths discovered at Bornais were utilised in a distinct manner from those that were employed for burning timber in other Norse houses. Peat fires are notably simpler to regulate and sustain, and it is conceivable that ad hoc fires were ignited at irregular intervals throughout the hearth aisle in House 2 as the need arose. However, any indications of such activity would have been promptly eradicated by trampling (Sharples 2020f, 605). Perhaps this eastern fireplace (closer to the entrance where wood was significantly used) was one such fireplace lost by trampling. Furthermore, the eastern fireplace would have reached higher temperatures compared to the hearth in the western half of the house. With lead-working (not smelting) being suggested as a possibility in this house, it is possible that wood was used as fuel to produce higher temperatures compared to peat for such activities. Furthermore, the presence of a secondary major fireplace could have been verified by other studies such as magnetic susceptibility, pH level analyses and soil micromorphology (had a sample been taken from this area). For instance, areas of burning would have been highlighted by the magnetic susceptibility study. Similarly, the hearth areas (if confirmed) would have shown higher pH levels compared to the rest of the floor (see Pingarrón 2014, 2807; see Chapter 8 for an exploration of this).

While various interpretations have been offered for the different areas of the house, these interpretations must be viewed with some caution. This is because the reality of equifinality must be considered for the formation of these sediments, where-for every raised element which is present and regarded as potentially indicative of a particular human activity–multiple alternative causes may be at work, some of which are not necessarily anthropogenic (Bintliff and Degryse 2022, 6). In the case of context 182 in the West End, it has been demonstrated that the high levels of Ca and Sr in this area could well be a result of the naturally high levels of these elements in the calcareous sand sediments here. Likewise, while Cu, Pb, and Sr can be observed to be at much higher levels in parts of the house floor when compared to their natural levels in the underlying gneiss rock, it does not mean that the elevations are necessarily a result of anthropogenic activities. Furthermore, the Sr levels seen in House 2 are within the range of levels of Sr seen naturally in the machair sites of Harris and this range is meaningful and reveals the extent to which the underlying geology could affect the chemical composition of house floors. This can be used to cast doubt on those interpretations offered above which identify food preparation areas on the house floor, where the elevation of Sr levels has been used as evidence. While the raised P levels may be attributed to exposure to organic matter, there are several post-depositional n-transforms (for example, faunal-turbation) that can also contribute to the higher levels seen here. This may especially be the case in context 182, where the excavators suggest a possibility that it was affected by post-depositional formation processes as it was part of the final layers that were left exposed to the elements when the house was abandoned (Sharples and Davis 2022a, 155-156). Considering the notable concentration of pottery, particularly large spreads of intact ones, and the prominence of pits possibly designed for the accommodation of barrels or wooden furniture, which could have stored water and other liquids (Sharples 2020f, 605; Figure 5.3), it is plausible that this space served as a storage area related to the cooking area nearby. It is important to highlight that this interpretation is not based on the results of the multi-element analysis.

In the case of the West Central area, the levels of Al, Mn, Fe, Cl, and K are seen as significantly elevated relative to the rest of the house floor. This distribution is not necessarily meaningful, as the levels of these elements are within the range of the natural levels seen in the machair sampled on neighbouring Harris. However, on the other hand, the levels of some of these elements observed in certain parts of the floor are lower than the natural levels seen on Harris, such as in the case of K, Mn, Fe, and Ti–and this might reveal some subtle variations in the chemical composition of the machair on South Uist. Perhaps, this could be an indication of the potassium poorness of South Uist gneisses as noted by Fettes *et al.* (1992, 19). In the case of the relatively high Ni levels observed in the East Central and East End quarters, when compared to the rest of the floor, it should be stressed that it is not much higher than the natural levels of Ni seen in gneiss bedrock. Thus, any interpretations drawn based on levels of Ni here may not be conclusive. Another issue that could cause interpretive problems is that the published studies involving artefacts do not distinguish between floor layers and abandonment layers (i.e., layer 182). Nonetheless, when we consider the multi-element analysis alongside the observations from the distribution of artefacts, flots, and coarse residues from wet-sieving, the patterns identified are notably strengthened and an interpretive plan of the organisation of the house floor can be proposed, and this is shown in Figure 5.29. By exploring other Viking houses excavated, these interpretations from House 2 can be further examined and verified, and the following discussion will explore these ideas in more detail.

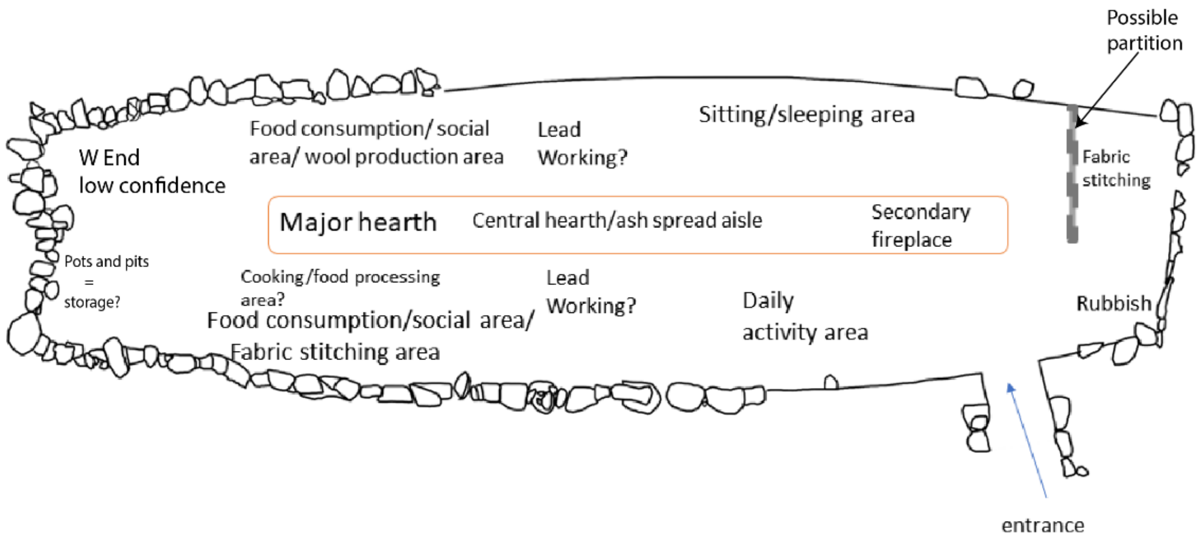

Figure 5.29: Interpretive plan of House 2, Bornais. The West End has low confidence as it was a likely abandonment layer that was analysed. The suggestion of a possible storage area here is based on the recovery of intact pots, and pits that may have held barrels and other wooden furniture for storing water and other liquids (as per Sharples 2020f, 605).

5.9 Comparisons with Other Norse Houses

The understanding of Norse houses in Scotland is limited due to the degree of modern, complete excavations that have been conducted and fully published, and the direct comparison of similar studies of Norse houses (such as the one at House 2) in Scotland is challenging. Still, this section aims to explore examples of Norse houses and take account of the interpretations of the organisation of space within these structures. By comparing and contrasting various studies, it may be possible to have a better idea of the organisation of space in House 2.

An example of a Viking house which has been studied based on its structure is that of an early Norse house (House 1) from Jarlshof, Dunrossness, in Mainland Shetland (Hamilton 1956). The house was a rectangular structure of 21 m in length and 6 m wide and orientated east-southeast and west-northwest. It had three entrances. A pair of these were opposing entrances in the western half, and another was a subsidiary entrance in the east gable (Figure 5.30). The main entrances divided the house into a living area covering two-thirds at the east end and a kitchen area suggested at the west end (Hamilton 1956, 107). Two lines of parallel post holes divided the living area into three aisles. A sleeping/sitting area was suggested along the sides based on the recording of small upright stone indicating benches (Hamilton 1956, 107). While a spread of ash was recorded in the central aisle here, a hearth was not observed. At the west end, the kitchen area was on a slightly raised platform with a fireplace in the centre and an oven running from the centre and abutting the back wall (Hamilton 1956, 106-109).

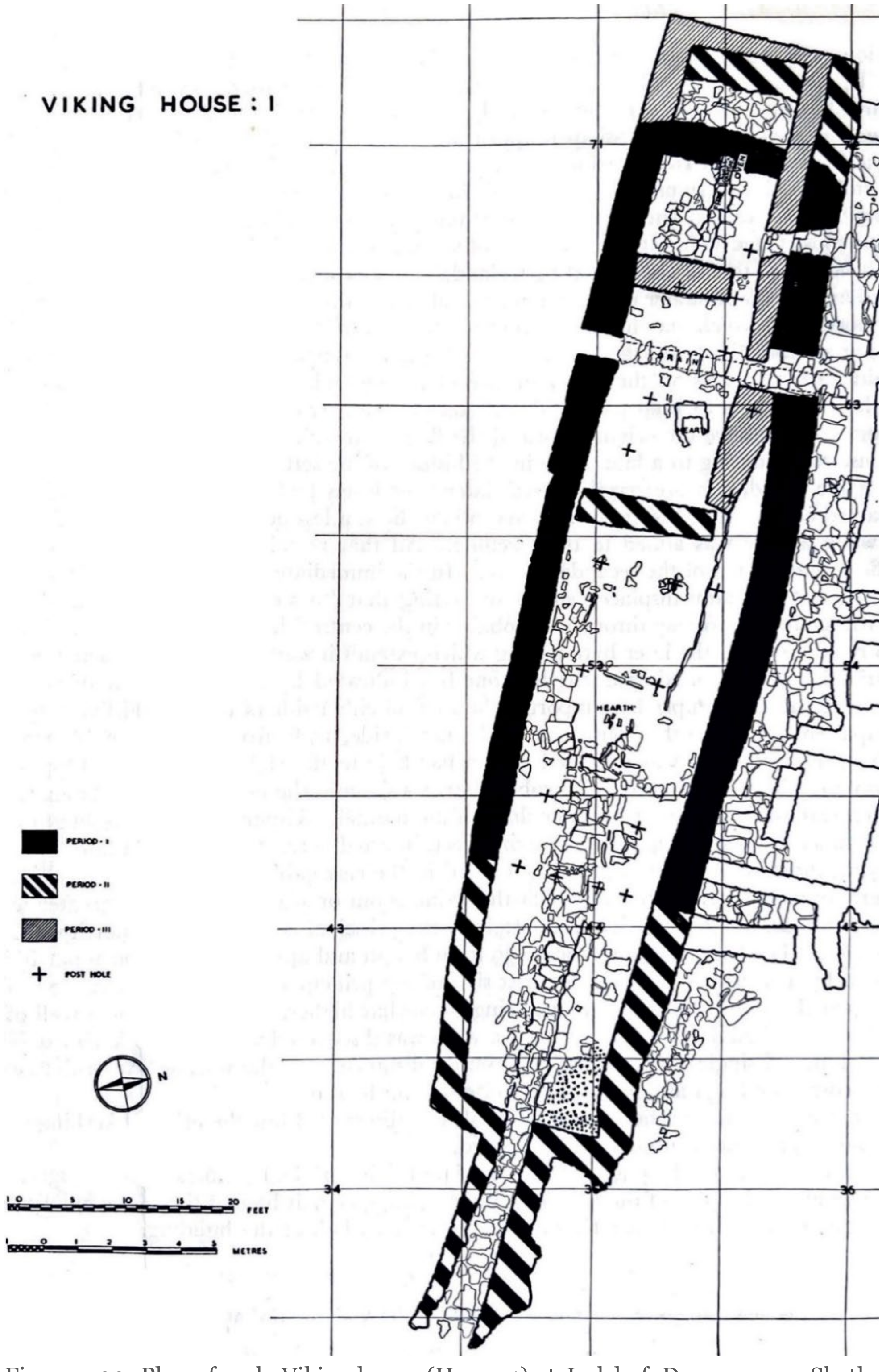

Figure 5.30: Plan of early Viking house (House 1) at Jarlshof, Dunrossness, Shetland (Hamilton 1956, fig 52).

While this site has been studied based on structural remains and an interpretation of its use has been suggested, it lacks a detailed study of the use of internal space. A similarity to House 2 at Bornais, however, can be seen. Among the striking similarities are the central aisle of the house with ash spread, two major hearths, an allocated kitchen area, and a sleeping/sitting area along the sides of the central living area of the house.

Another example of a Norse structure with ideas of use of internal space is a house at Underhoull based on the study of structural features and artefacts. This house was bow-walled, 18.4 m in length and 4.5 m wide (Figure 5.31). It was dated to the middle of the eleventh century. This house was divided into three rooms. The east end near the entrance was interpreted as a barn (not conclusively), while the west end with paved stone flooring was suggested to be a cold store which contained fragments of steatite and ceramics (Bond 2013; cited in Sharples 2020c, 14). The central room was suggested to have wooden floors and hence indicates a living area. Although ash deposits were observed in this area, they were not enough to indicate an *in situ* hearth (Bond 2013, 159; cited in Sharples 2020c, 14). However, it has been suggested that the central living area had wooden floors, and a long central hearth may have existed on a clay bed.

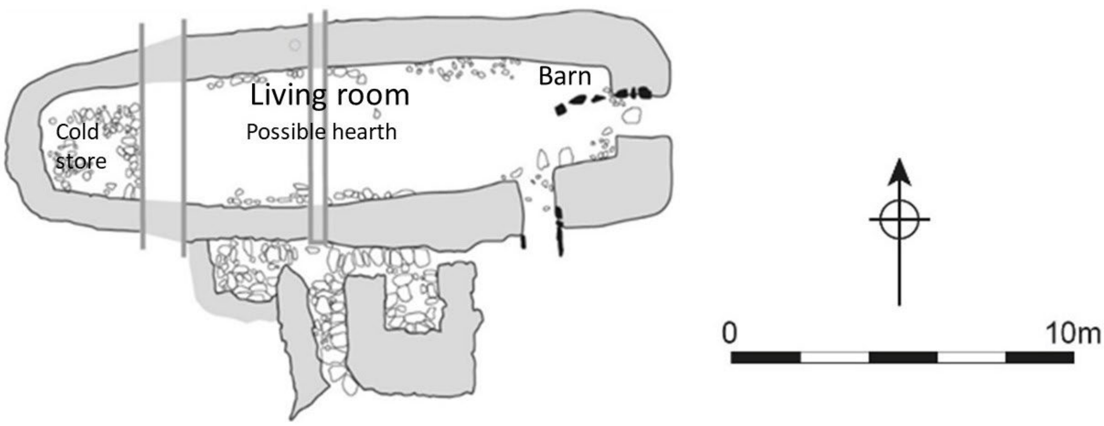

Figure 5.31: Simplified plan of early Viking house at Underhoull, Unst, Shetland (adapted from Sharples 2020c, fig 17 B).

This house at Underhoull, like House 2, at Bornais, has a possible long central hearth and living area, and storage area at one end. At the Underhoull house, with a hearth in the central living area, cooking may have taken place in the same place as the living/daily activity area. This is similar to the case at House 2 at Bornais, where hearths identified overlap with the central living area of the house.

A well-preserved Norse bow-walled house was also recorded at Skaill, Orkney (Buteux 1997; cited in Sharples 2020c, 14; Figure 5.32). This house was 18.9 m in length and 4.6 m wide. Internally, it was divided into two along its entrance in the centre of the western wall. Another entrance was likely to have existed through the southern gable wall. The southern half had a large rectangular hearth with paving stones and a kerb, indicating that this area was the kitchen. A sitting area along either side of the hearth was also suggested to be likely based on the vertically set slabs along the walls that may have held wooden benches (Buteux 1997; cited in Sharples 2020c, 14). The northern half was suggested to be the living area. This area had benches defined by slabs set along the edges on both sides of the central part of this living area (Figure 5.32). Almost all finds from this house were recorded from middens just outside the house, which did not help discern the use of internal space any further (Buteux 1997; cited in Sharples 2020c, 14).

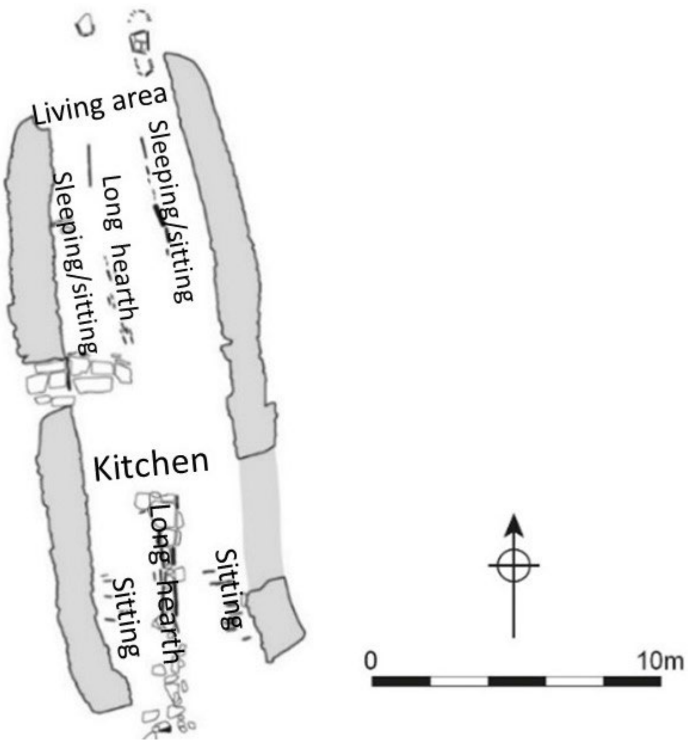

Figure 5.32: Simplified plan of early Viking house at Skaill, Deerness, Orkney (adapted from Sharples 2020c, fig 17 B).

The discussion of this house has highlighted some similarities with House 2, at Bornais, in having a sitting/sleeping area on either side of the central area of the living area. A sleeping or sitting area may have also overlapped with the kitchen area based on the idea of the possible wooden benches on either side of the hearth. These examples from Scotland interpret the use of internal space based mostly on the structural remains with limited analysis based on finds. This is mainly because of the poor survival of finds, finds not being studied in relation to their locations or simply because there were no finds inside the house, such as in the case of Skaill. A few examples from Scotland have adopted a multidisciplinary approach to the study of the use of internal space in Norse houses by incorporating geochemical studies and spatial analysis of finds. The following examples summarise the use of internal space in these structures.

A good example of a Norse house from the Outer Hebrides is House 700 at Cille Pheadair, which is near Bornais on South Uist (Figure 5.33). This small house was 8.4 m long and 4 m wide internally. It was aligned north-south. It dated to cal AD 1030-1095 (95% probability) and cal AD 1040-1075 (68% probability) and was slightly earlier than or contemporary with House 2, Bornais. The house had an entrance at the southern end of the eastern side (Parker Pearson and Brennand 2018a, 75). There was a long hearth that ran along the centre of the house. However, cooking and food preparation activities were suggested to be focussed in the northern part of the house near the north end of the hearth. Thus, the northern end of House 700 was the kitchen of the house (Parker Pearson *et al.* 2018b, 79). The evidence for the kitchen was based on the high amounts of pottery, iron artefacts and fragments, burnt fish and mammal bones and spirorbis, which is similar to the case at House 2, Bornais. Sleeping areas, similar to Bornais, have been suggested along the east wall. However, higher P levels recorded here were attributed to the infants wetting the bed (Pearson *et al.* 2018a, 79).

The southern end was suggested to be a woodworking area or an area where footwear and clothing would have been removed on entering the house. Due to the poor preservation of House 700, much of the activities that took place inside could not be inferred. House 700, however, has shown a similar layout when compared to House 2, Bornais.

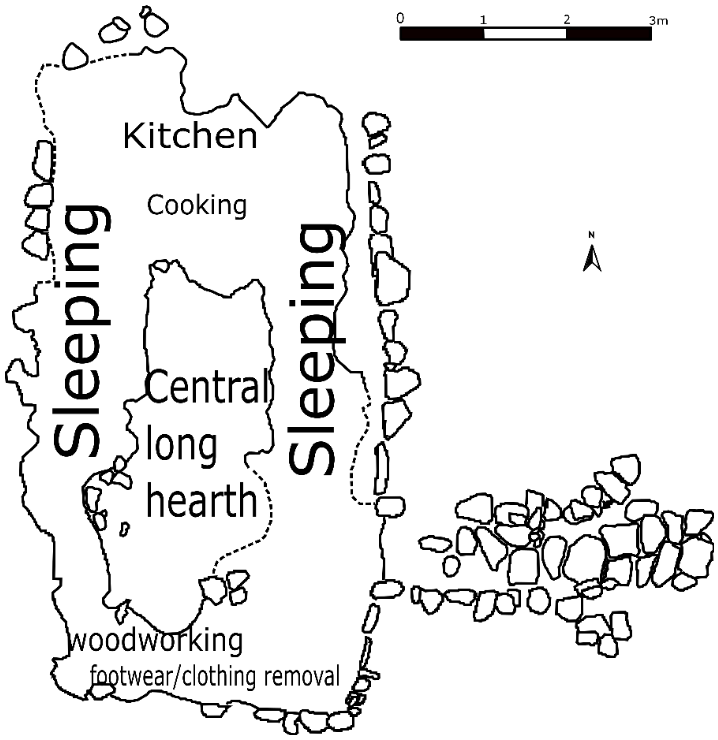

Figure 5.33: Interpretive plan of House 700, Cille Pheadair (After Parker Pearson and Brennand 2018a, fig 5.2).

House 500 at Cille Pheadair, was constructed using the dismantled stone of House 700, and it had an ancillary room. This longhouse was constructed in cal AD 1060-1110 (95% probability) (Parker Pearson 2018, 142), which is broadly contemporary to House 2, Bornais. However, it is only the main room that is considered here for comparison with House 2, Bornais. House 500 was aligned north to south, and its main room was 10.3 m long and over 7 m wide. It was connected to the ancillary room at the northern end by a small passage. It had a paved entrance at the southern end of the east wall. The main room was only slightly bow-walled with rounded corners, unlike House 2, Bornais. Like House 700, Cille Pheadair, and House 2, Bornais, House 500 had a long central hearth. The northern and north-eastern ends of the hearth and the house were the focus of cooking activities (Figure 5.34). The northern end of the house was also likely used for activities such as storage, weaving and spinning (Parker Pearson and Brennand 2018b, 109).

The west side of the house, on the other side of the hearth, was on a raised bank and presumed to be part of a sleeping and sitting area. Based on the distribution of combs and pins on either side of the half in the northern area, dressing and grooming activities have been suggested. While an animal byre is alluded to as a possibility based on soil micromorphology, it is not conclusive (Ellis 2018, 132). This corner also showed higher levels of phosphorus (P), burnt fish bones and fuel ash slag (Parker Pearson *et al.* 2018c, 117). Parker Pearson claims that the level of P in this corner is not suggestive of its use as an animal byre (Parker Pearson 2018, 142).

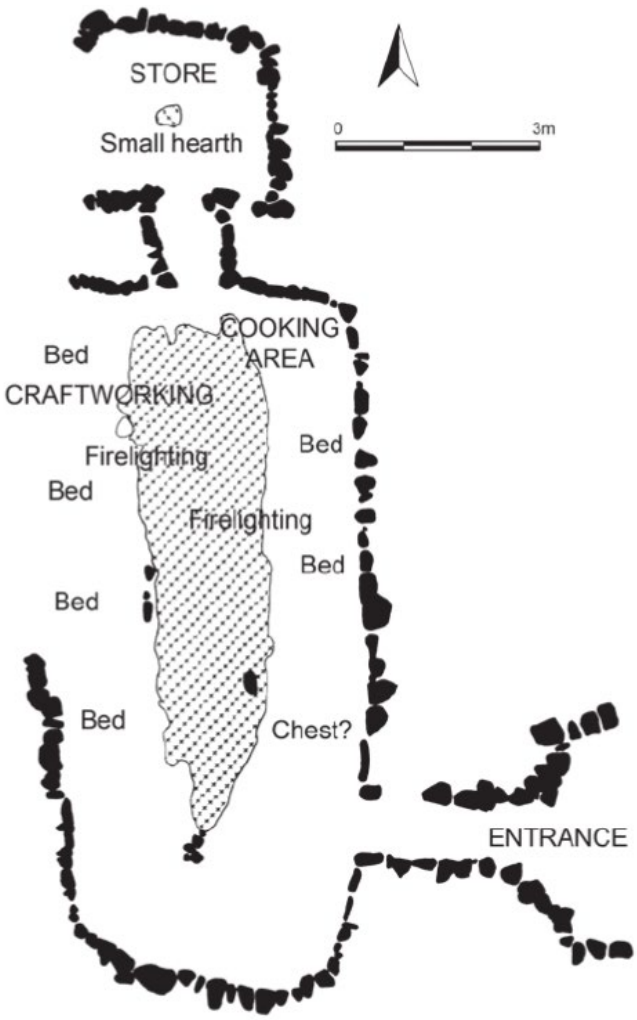

Figure 5.34: Interpretive plan of House 500, Cille Pheadair (Parker Pearson 2018b, figure 6.29).

House 500 is slightly different in layout from that of House 2, Bornais, yet its long main room has shown some significant similarities to the layout of activities from that of House 2, Bornais. These are the long central hearth, the sleeping areas on either side of this hearth, the main cooking area and the craft-working (or daily activity) area closer to the end of the hearth that is away from the entrance.

The recently published report on the excavation at East Mound, Bay of Skaill in Orkney, details the spatial layout of a bow-walled Viking longhouse over two phases (Phases 3 and Phase 5) (Griffiths *et al.* 2019). However, the developed phase of the longhouse (Phase 5) is of particular interest here as this structure had some samples taken from within the house which were analysed by multi-element analyses (Figure 5.35). This longhouse was 26.3 m long and 5 m wide. It had an entrance in the south wall towards the west end, which was 1.2 m and led into a 'T junction' that divided the house into an eastern byre and workshop area, and the western/western central living quarter, which further led to the west end annexe that was as a work area and as a cooking area. The eastern area was paved and led to another entrance in the east wall. The western living area had side benches along the north and south walls for sitting/sleeping, and at its centre was a small central hearth that was used for cooking, heating, and some ferrous metalworking inside the house, with a sunken stone-lined quenching box next to it (Griffiths 2019b, 313). Griffiths (2019b, 313) suggests that this living area functioned as a social space, cooking, and sleeping area. While metalworking activity in this area has been suggested, Griffiths notes that it may have been few restricted episodes of metalworking as it would have made living inside unpleasant (Griffiths 2019b, 313). To the west of the living quarters in the west annexe were much wider side benches along the wall which were suggested for sleeping, sitting and storage. These wider benches made the central area between the side benches narrow. In this central area, a cooking hearth that showed evidence of prolonged use was also identified (Griffiths 2019b, 314).

The multi-element analysis at this house looked at P, Cu, Zn, Pb and Fe. However, the sampling strategy was not a grid-based system as followed at Bornais. Instead, it was targeted spot sampling, usually in association with identified features. Yet, an elevation in the level of P close to and around cooking, eating and animal stalling areas was observed (Doonan and Lucquin 2019, 137). Such elevation of P was particularly noted in the cooking and food consumption areas suggested for both the hearth areas (Figure 5.35). Doonan and Lucquin

(2019, 137) also noted a high level of P and Pb in the living area and the western annexe, which is suggestive of a possible relation to social activities centred on the maintenance of fires and cooking. However, they also note that although the upper ranges of the Pb levels seen at this site are comparable to heavy metal enhancement associated with human activity, it is still not significantly high enough to suggest lead-working (Doonan and Lucquin 2019, 137).

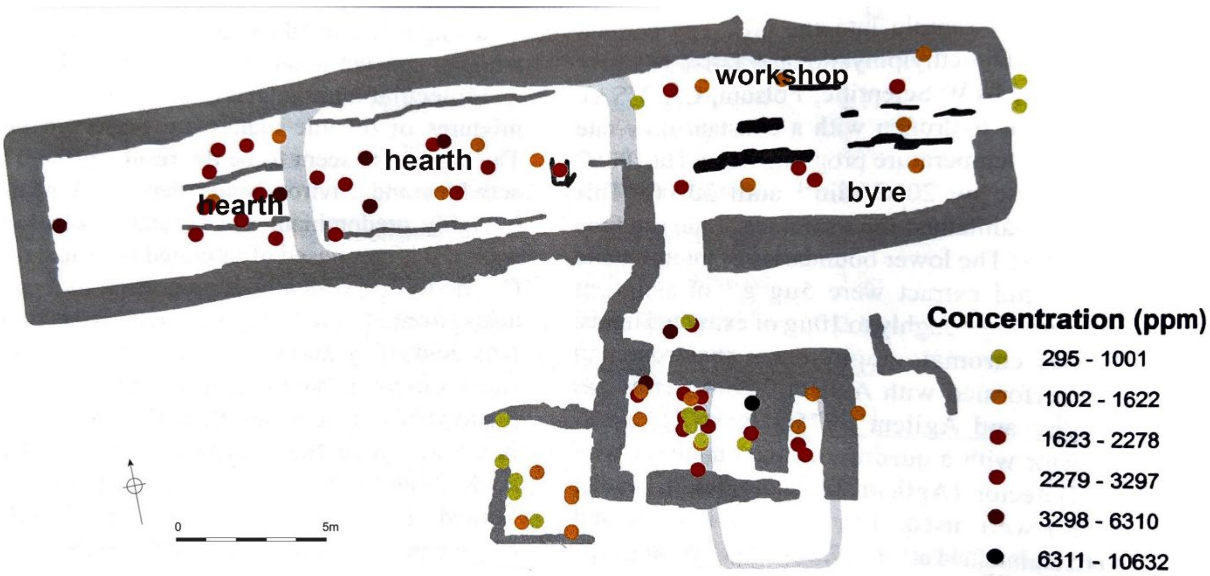

Figure 5.35: Simplified plan of Phase 5 East Mound longhouse showing P level (adapted from Doonan and Lucquin 2019, figure 7.1).

This Orcadian house at East Mound seems to show some similarity with House 2 at Bornais, such that it has two major hearths, an allocated kitchen area, and a sleeping/sitting area along the sides of the central living area of the house. A secondary kitchen area, as seen at East Mound, has been alluded to from the multi-element analysis at Bornais. However, the layouts of these structures are still significantly different. The higher ranges of the level of Pb (c. 300-800 mg/kg; also see Figure 5.10) found at Bornais are suggestive of the possible association with lead-working as it is considerably higher at House 2, Bornais, in comparison to higher ranges of levels at East Mound (c. 60 mg/kg). This helps in giving more confidence to the interpretation of possible lead-working at Bornais within the house.

In his overview of Scottish Early to Middle Norse houses, Sharples (2020c, 16) observed that the majority of these houses featured an asymmetrically situated entrance positioned at one end of a lateral wall. However, a trifurcated internal layout with a central living space governed by a hearth was scarcely found. Predominantly, these Scottish Early and Middle Norse have been interpreted as having a bifurcated division, with a benched living area situated at one extremity of the house, as exemplified by Jarlshof and Skaill (see above). Substantial hearths were rarely found in these living areas and were instead typically located in separate kitchen spaces. To obtain a more precise understanding of the characteristics of sizeable bow-walled longhouses, such as the one at Bornais, Sharples (2020c, 16) examined other regions in the North Atlantic where the archaeological record provides greater insight.

He referred to Milek's (2006; cited in Sharples 2020c, 16) research, which posited that early Norse dwellings exhibit a specific form and spatial organisation. Although most houses were traditional bow-shaped longhouses, some examples exhibited minimal expansion in the central region, such as Snjálleifartóttir and Herjólfsdalur V, which could be compared to the early house at Jarlshof. The primary entrance was typically situated near the end of one of the elongated walls; however, additional secondary entrances were also prevalent, often positioned on the same wall as the main entrance. There were attached annexes—small rooms constructed on the sides or ends of the house, accessible from the main house. Annexes with direct external access were far less common. Distinct 'pit houses' were also frequently observed (Milek 2006; cited in Sharples 2020c, 16).

The interior of these Icelandic houses was generally partitioned into three distinct spaces: a central living room and two smaller gable rooms located at either ends of the house (Milek 2006, 98; cited in Sharples 2020c, 16). Although these rooms were likely separated by timber partition walls, this feature is often challenging to identify. The living room was divided into three aisles; the central aisle housed a large hearth with a stone kerb and paving, which frequently accumulated ash that seemed to have been intentionally spread to produce a dry surface. In contrast, the side aisles displayed minimal deposits, suggesting they were protected by wooden floors and could have functioned as low-benched areas (Milek 2006, 98; cited in

Sharples 2020c, 16). The house at Aðalstræti serves as an exemplary case, with Milek and Roberts (2013; see below) conducting a thorough analysis of its internal occupation. Sharples also acknowledged similar patterns identified by Myre in his assessment of artefact distribution at Oma, Norway (Myre 1982; cited in Sharples 2020f, 606) and by Einarsson in his report on the Granastaðir excavations in Iceland (Einarsson 1995; cited in Sharples 2020f, 606). However, it is worth noting that Milek and Robert's (2013) study encompassed a geochemical analysis in addition to a spatial examination of the discovered artefacts and internal features. Hence, what follows is a synopsis of the study of the bow-walled longhouse at Aðalstræti, Iceland, and draws comparisons to House 2 at Bornais.

Aðalstræti 16, although in Iceland, is an example of a comparable house similar to the one at Bornais, South Uist. This bow-walled house is at Aðalstræti 16, in central Reykjavik, and dates to the late ninth to tenth century AD (Milek and Roberts 2013, 1850; Figure 5.36). This house had an entrance closer to the northern end of the East long wall and another narrow entrance in the southwestern corner of the house. Partitions were identified based on the alignment of postholes. There was a large central hearth lined with kerbstones. Based on the series of postholes running parallel to the long walls, it was suggested that the large central space was divided into three aisles. The thin and patchy deposits in the western side aisle were argued to indicate that this area was likely covered by a wooden platform (Milek and Roberts 2013, 1852). Based on the distribution of artefacts, a central work area around the hearth was suggested. The eastern aisle was proposed to be a working/sitting area, and an upright loom was suggested at the southern part of the western aisle based on the location of four loom weights there.

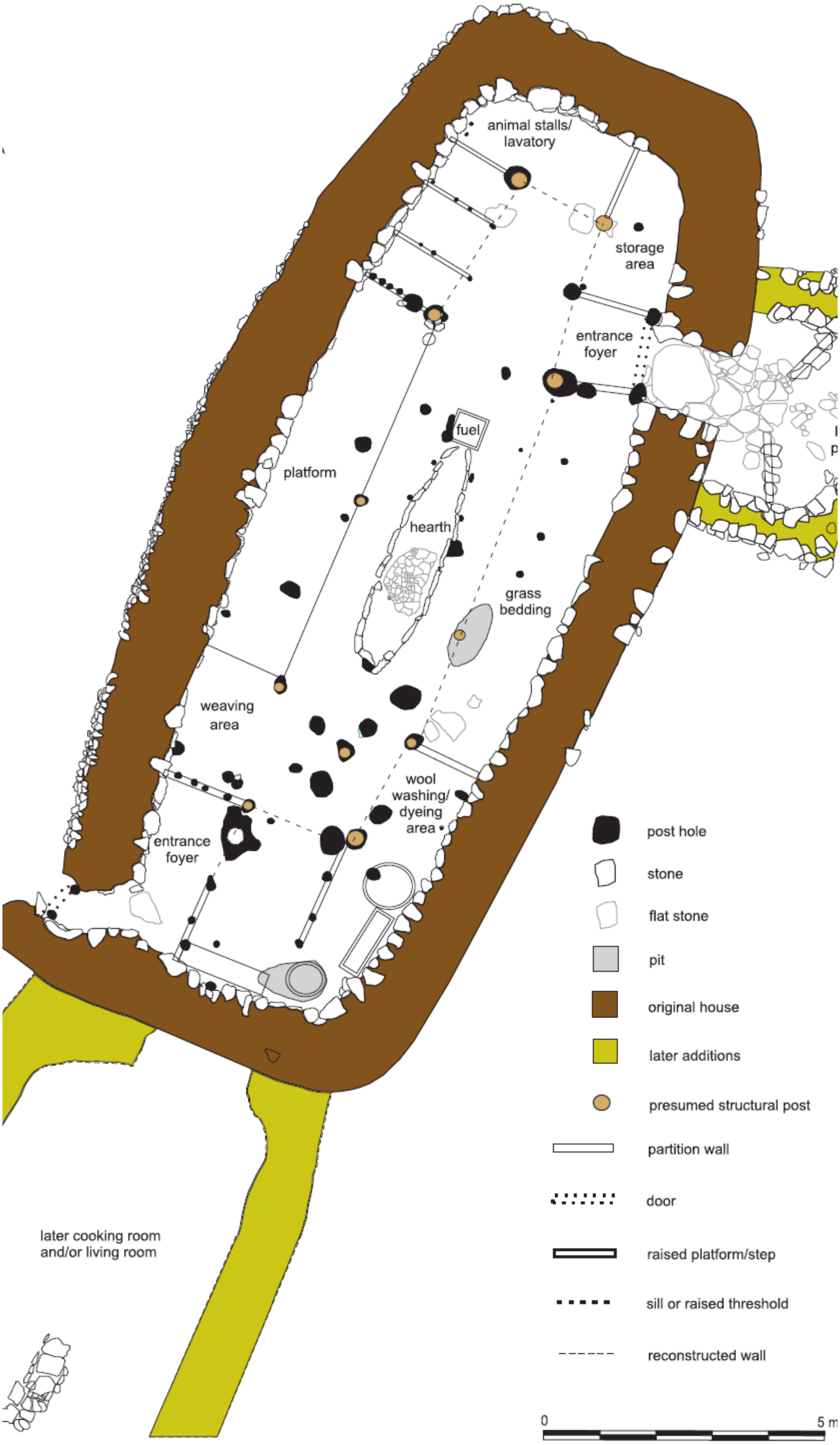

Figure 5.36: Interpretive plan of Viking house at Aðalstræti 16, Reykjavik, Iceland (Milek and Roberts 2013, fig 10).

Based on the study of geochemical analysis (that was focused on the study of elements that included aluminium (Al), barium (Ba), calcium (Ca), copper (Cu), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), phosphorus (P), sulphur (S), strontium (Sr) and zinc (Zn), several functional areas were identified. Since the central hearth was the primary source of light, it may have been the focus of winter or evening cooking, eating, handicrafts and social activities (Milek and Roberts 2013, 1861). Milek and Roberts (2013, 1861) observe that the main fuel source was probably birch wood or peat, but dung may have also been used. On the aisles on either side of the central hearth, there was most likely a sleeping or sitting area, with that in the western aisle most likely being on a raised platform which is also suggested by the low levels of P observed here. There may have been a loom next to or on this platform. Based on finds such as pumice, a spindle whorl and a knife, the eastern side may have been an area of everyday craftwork. The north-western corner of the house was suggested to be used as an occasional animal stalling area or a lavatory. The southeast corner of the house was rich in salts seen in the form of high levels of Mg, Ca, K, Na, and Cl, suggesting the use or storage of sea salts/seaweed in this corner or perhaps it was a place used for washing and dyeing wool (Milek and Roberts 2013, 1861).

This house at Aðalstræti 16 has shown several similarities to the house at Bornais, reaffirming the interpretation made for House 2, Bornais. These include a long central hearth and sitting/sleeping areas on either side of it, a cooking and work area that also was part of this central space, a storage area at one end, a textile-working area adjacent to the central area of the house and the existence of transverse partitions. While these examples are not exactly similar to the Norse house in South Uist, they still provide an excellent way to compare the relative accuracy of the interpretations made for House 2 at Bornais. It can now be suggested with more confidence that the Bornais house did, in fact, have a central hearth aisle, but unlike the other houses compared, it had a primary hearth and a secondary fireplace (Figure 5.27). The house may also have been divided into a central living area and a storage area/meat processing area in the west alcove, and a fabric-stitching/rubbish area in the east end. The central living area was also probably divided into three aisles. These were the central aisle, which had the hearths, and the two side aisles. The northern aisle was most likely used as a sitting or a sleeping area. This aisle may have also accommodated a wool-working area next to the sitting area. The southern aisle, closer to the western hearth, accommodated the primary cooking and food consumption area, which suggests a focus on social activities. Next to this was a likely lead-working area that may have accommodated another sleeping/sitting area closer to the walls. The area closer to a secondary hearth toward the eastern part of the house may have been used for occasional cooking. This hearth likely had a function requiring higher temperatures as wood was frequently used as fuel in this hearth. Perhaps this was associated with lead-working. Sharples (2020f, 608), in his comparison of the hearth locations in Aðalstræti and Granastaðir, found that cooking activities in the house took place in the public areas of the house either closer or roughly closer to the entrance. Although the main cooking area with the primary hearth at House 2, Bornais, is in the private western half of the house (in that it is located from the entrance, and does not have a second entrance near the hearth as seen at Aðalstræti), the secondary hearth observed closer to the entrance in this study may offer some parallels to the hearth/cooking areas in the public areas seen at Aðalstræti and Granastaðir.

5.10 Conclusion

The geochemical analysis of the floor of this house not only unveiled the activities conducted within it but also showed two other things that could have been overlooked had this study not been undertaken. Firstly, the significant use of wood as fuel in the fireplace in the eastern half of the house deviates from the inferences drawn from the soil micromorphological analysis of the western hearth, where peat is the dominant fuel and wood is observed as an important yet minor fuel. Secondly, the floor samples collected from the West End of the floor were from context 182, which was suspected to be an abandonment layer, based on the soil micromorphology analysis and its higher position within the stratigraphic sequence. While it is likely that this horizon is indeed an abandonment layer, a possibility remains that this layer may have been the focus for some occupation activities or that it was affected by some post-depositional formation processes, it is clear, however, that this layer is not contemporary with the rest of the house floor. The stark contrast seen in the levels of most elements in this layer compared to the rest of the floor of the house confirms this interpretation.

Additionally, multi-element analysis has helped in revealing the organisation of space inside House 2 at Bornais, as the distributions have been combined with the artefacts and residues recovered. Interestingly, the interpretation of the house at Bornais is similar to that for houses in Iceland, which perhaps suggests a widespread cultural ideal in the use of space within these buildings. This, however, would need to be investigated further by conducting such extensive studies at other Viking houses as done at Bornais. The implication of this research will be further explored in the final chapter.

Chapter 6: The Early-Middle Iron Age Roundhouse, Meillionydd, Northwest Wales

6.1 Introduction

This chapter will analyse the geochemical signatures from the floor deposits of a roundhouse in the settlement at Meillionydd, located on the Llŷn peninsula near Rhiw in northwest Wales. This double ringwork enclosed settlement falling under the classification of a hillfort was partially excavated by Raimund Karl, Kate Waddington, Katharina Möeller, the author, and their colleagues between 2010 and 2017. This was an excellent case study for this thesis as it consisted of a stone-walled roundhouse dating to the Early Iron Age-Middle Iron Age with reasonably well-preserved floor deposits. The floor was sampled for a phosphate analysis on a 0.5 m grid at the time of excavation in 2013. These samples were analysed for total phosphorus using a TXRF spectrometer as part of the author's MA thesis (George 2017). However, this study was reworked and expanded during doctoral research to include a multi-element analysis of the floor. Considering that this site generally had a relatively low finds assemblage (although the standard for the region in this period), it proved to be a good case study to evaluate the utility of geochemical analyses in studying its internal space. The multi-element analysis carried out on the floor of roundhouse RH SO19 at this site hints at a possible structured division for the use of internal space.

For this study, a brief description of roundhouse studies in Britain is first set out. After this, is a concise description of roundhouse studies in northwest Wales, and a brief description of hillforts, as Meillionydd falls under the classification of a small hillfort. This is followed by a discussion of the archaeological evidence of RH SO19 and its geochemical analyses of the internal floor deposits. The discussion compares the results with other roundhouse studies, which includes the spatial analysis of features and finds and the phosphate studies of roundhouses which exist elsewhere in Wales.

6.2 Roundhouses and the Research Context in Northwest Wales

The roundhouse

The archaeological record of the British Isles features a striking characteristic unparalleled in continental Europe—the widespread appearance of circular houses in the Middle Bronze Age (c. 1500 BC) (Sharples 2006, 285). The nomenclature of these structures has been broadly applied, and the term roundhouse is frequently used to refer to circular structures distinguished typically by stone tumble, gullies, stake holes and postholes, walling, hearths, and other internal occupation features. In some cases, even sub-circular and slightly polygonal structures have been called 'roundhouses' (Ghey *et al.* 2007). Thus, the term roundhouse serves as a broad umbrella term that encompasses circular, sub-circular, or oval-shaped structures, including those that display close gradations, which differ significantly from their rectangular counterparts of the same period on the European continent.

Roundhouses have been observed to be either made of stone or timber. Harding (2009, 57) notes that the main circle of principal weight-bearing timber was the primary element of a timber roundhouse. Thus, timber roundhouses may be identified by a ring or concentric rings of postholes and stake holes observed in the archaeological record. These roundhouses also seemed to have porched entrances defined by a four-post setting. This is a significant feature of the roundhouses in Wessex (Harding 2009, 60). Harding suggests that a double-ringed plan is possibly the standard layout of timber roundhouses (Harding 2009, 63). Stake-wall roundhouses (Harding 2009, 69), ring-groove roundhouses (Harding 2009, 70) and ring-ditch roundhouses are among the common types based on construction techniques (Harding 2009, 76). However, in the case of stone roundhouses, although the design and layout remain similar to timber ones, stone is mainly used to build external walls, with timber posts being used internally to support the roof (Harding 2009, 91). Other forms of stone roundhouses are also observed, such as brochs and wheelhouses found in Scotland, which vary in design and layout compared to timber roundhouses but maintain the basic principles (Harding 2009, 91-116). A transition in the types of roundhouses can be observed in many sites. For instance, Kelly (1990) noted a shift from timber roundhouses of the mid-first millennium BC, which were larger, to stone houses that were smaller in size by the later Iron Age in northwest Wales. A good example of such a transition can be observed in Moel y Gerddi (Kelly *et al.* 1988; discussed below) and is also visible at Meillionydd in Trench 3 (Waddington 2013, chapter 4).

Sharples (2010, 177) suggested that while the house was a place for essential daily activities, it also had a symbolic significance and was a physical analogy of the existing society built on social relationships and established by routine activities. He thus emphasises that the concept of roundhouse and space is vital in the conceptualisation of society in the past. The interest and ideas on the social importance of prehistoric roundhouses stemmed from Clarke's ideas of Iron Age society based on Glastonbury Lake Village (Clarke 1979). While this work has been criticised (e.g., Barrett 1987, 421; Coles and Minnitt 1995), it laid the foundation for a school of thought that married societal and social significance in the past of roundhouses with observations from field archaeology. This led to several works over the years investigating roundhouses leading to suggestions of models for the use of houses. These include Ann Ellison's model for the use of Middle Bronze Age settlement roundhouses (e.g. main dwelling versus subsidiary structures; Ellison 1981), Hingley's model (1990) for the centre-periphery division of internal space, Oswald's model for the orientation of roundhouse entrances in Britain (Oswald 1991, 1997), and the sunwise model which privileges a cosmological use of space based on the movement of the sun around roundhouses that have entrances orientated towards easterly directions (Fitzpatrick 1994; Parker Pearson 1996, 1999). Webley's critique of such a sunwise model and their alternate suggestions, and Pope's model (2003, 2007) that combines front-back and central-peripheral division of internal space, have taken these understandings forward.

These cosmological models to understand roundhouses and the society that dwelled in them were based on the architectural arrangements of well-preserved roundhouses and the location of finds and features within them. For example, the substantial timber Late Bronze Age/Early Iron Age house at Longbridge Deverill Cow Down, Wiltshire, was partly used to form the basis for the sunwise model suggested by Fitzpatrick (1994) and Parker Pearson (1996) (Figure 6.17). House 3 at Longbridge Deverill Cow Down had an entrance facing southeast and an inner ring of post holes forming a circle of 11.6 m in diameter that was suggested to hold posts supporting the roof (Figure 6.1). An outer ring of postholes was also recorded, forming a circle of 15.5 m in diameter. However, Chadwick Hawkes (1994; cited in Sharples 2010) argued that the inner post ring, in fact, formed part of the outer wall, and the second ring was more likely a screen that separated an area for storage or byre under the eaves of the roof. Although no hearth was observed, it was suggested to be at the centre, and it was likely destroyed by ploughing. Based on the arrangement of postholes within, it was argued that a gallery or a platform in the back half of the house existed. A large amount of pottery was found to cover the area from the entrance and around the southern third of the floor. Based on the observation of two large postholes and the distribution of pottery sherds, Chadwick Hawkes (1994, 68) suggested the presence of fixed furniture such as an earth-fast table or dresser where the 'leading family's table service and a festal meal would be displayed on grand occasions'. Loom weights were found in the southwest area of the floor. Two spindle whorls and a bone gouge were recorded directly opposite the main doorway. These finds and features have been used as evidence to show a split within the house such that the right side, with the absence of occupation debris, was suggested as the sleeping and storage area. In contrast, the left side, with the layer of occupational debris, was the daily activity area. This example, along with a number of others, has been used to suggest the overall organisation and use of internal space in roundhouses of the first millennium BC.

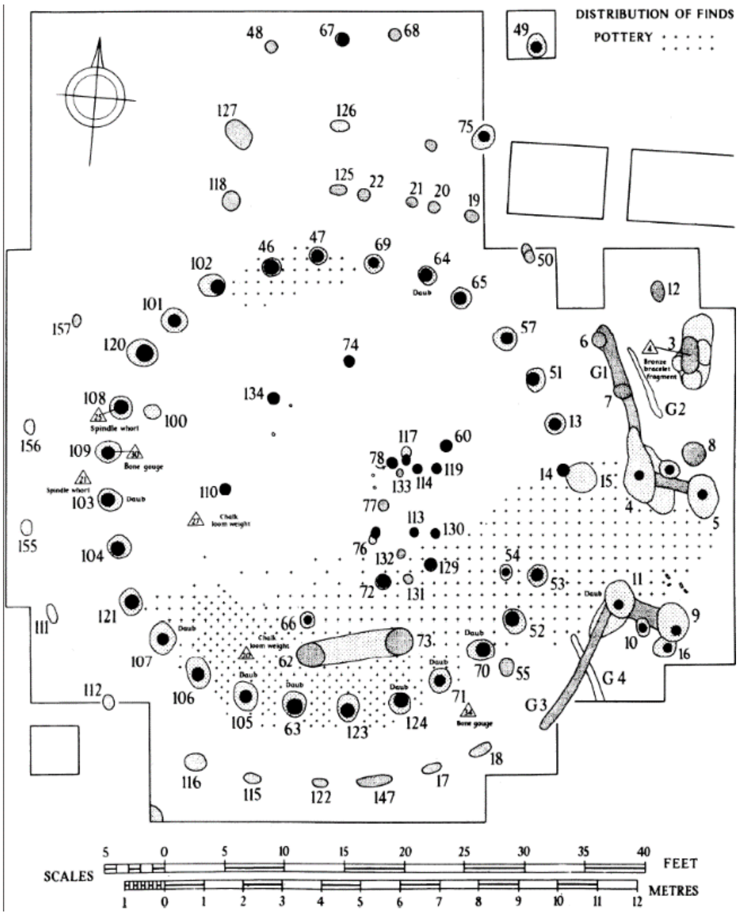

Figure 6.1: Plan of House 3, Longbridge Deverill Cow Down showing pottery distribution (Chadwick Hawkes 1994, fig 4).

Based on double-ringed roundhouses in southern Britain and stone roundhouses in northern Britain, Hingley (1990, 130) alternatively suggested a distinction between the central and peripheral areas of roundhouse floors (Hingley 1990, 130, Figure 6.18, also discussed below). An example of such a substantial roundhouse that helped formulate Hingley's idea was the Middle Iron Age broch in the Howe, Orkney (Early Phase 7 of the site sequence). The broch was actually located on top of an earlier substantial roundhouse (Phases 5 and 6). Its walls were 5.5 m thick, with an entrance passage in the southeast. The central area containing the hearth was partitioned from the peripheral area by upright stone slabs, creating a central area which was 4 m in diameter. To the right of the entrance passage and surrounding the central area was a passage/curving room that was 2 m wide, encompassing the eastern and northern peripheral areas of the broch. This area also provided access to the souterrain. There were three small bays in the south and southwest peripheral areas (Balin Smith 1994, 47, cited in

Waddington 2014; Figure 6.2). These partitions within the house differentiated the floor into the central hearth area and the peripheral areas. A similar layout was observed at Bu, an Early Iron Age substantial roundhouse in Orkney (Armit 2003, 42-43). At Bu, the roundhouse was divided into the central living area with a large hearth, a cooking tank and a slab-built cupboard, and the peripheral area, which had three small cubicles partitioned by stone slabs on the left side of the house (Figure 6.3). The right-side peripheral area of the house had a small, paved room followed by a longer paved chamber following the arc of the house (similar to the broch at Howe), suggested to be an animal stalling area (Armit 2003, 43). Thus, such divisions in houses inspired the model of a centre-periphery use of space, which was argued to be part of a widespread practice by Hingley (1990) throughout the British Isles.

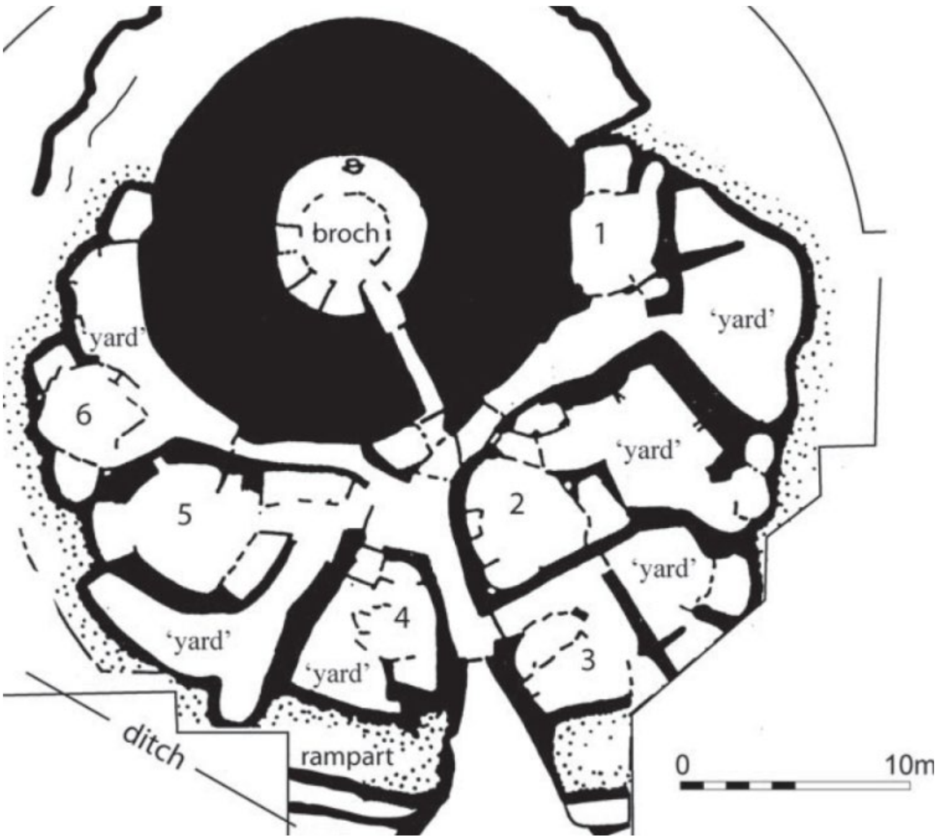

Figure 6.2: Schematic plan showing the broch in phase 7, at Howe, Orkney (Waddington 2014, illus 5).

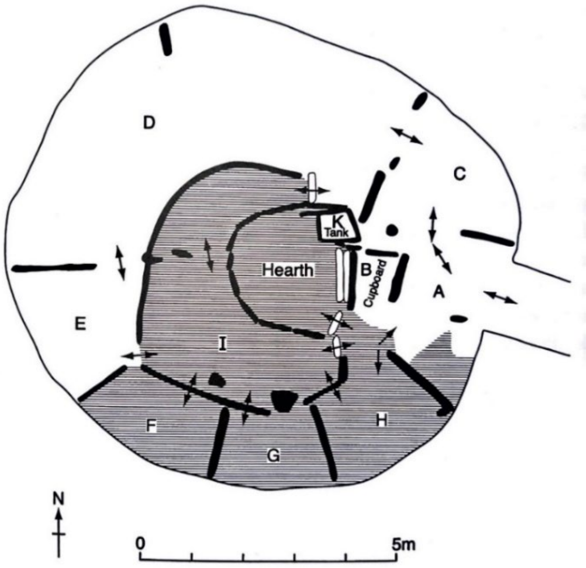

Figure 6.3: Simplified floor plan of Bu roundhouse. The unshaded areas are paved (Armit 2003, fig 17).

As mentioned before, the above examples also showcase that the models for the use of space within roundhouses have been proposed based on the architectural settings, the location of finds and occupation features in such settings. While both Hingley (1990) and Pope (2007) have used roundhouses where phosphate analyses (which are discussed later in this chapter) were performed to reinforce the validity of their models, no study has yet to date assessed all the above models using the multi-element analysis of a house floor. Hence, the multi-element analysis carried out at the stone-walled Meillionydd roundhouse is an excellent example which can be used to assess the validity of these models in a region where Iron Age finds assemblages are more restricted than the case studies discussed in Wessex and Atlantic Scotland.

Roundhouses in northwest Wales

While roundhouses and roundhouse settlements have been studied in Wales, few publications have focused explicitly on depositional studies in order to examine the use of space within roundhouses. In her broader study of roundhouses in northern and central Britain, Pope (2003; 2007) also looked at the ones from north Wales. Her analysis in terms of the use of domestic space in roundhouses was based on the location of features and artefacts within them. Her suggestion for northwest Wales in terms of roundhouses was that the peripheral areas of the houses were used either for livestock stalling or storage or sleeping. This was based on chordal bed arrangements observed for some roundhouses in North Wales (Pope 2007, 219). However, these interpretations are based on reference to ideas from phosphorus studies of roundhouses at sites such as Moel y Gerddi and Erw-wen (Pope 2007, 219). The Welsh Roundhouse Project was another study that included some detailed research on roundhouses from northwest Wales (Ghey *et al.* 2007). Several issues were highlighted in terms of the study of the occupation and use of the roundhouse floor in Wales. These include the rarity of *in situ* floor deposits, the lower proportion of houses with features such as hearth, flooring and drains, and the dominance of roundhouses with incredibly low to no recorded finds. Furthermore, this study only looked at houses that were radiocarbon dated, which excluded a lot of houses (Ghey *et al.* 2007). The only site where a detailed depositional study has been carried out in northwest Wales is at the later Iron Age enclosed settlement of Bryn Eryr (Longley *et al.* 1998; discussed below). Roundhouses have also been looked at in terms of settlement contexts by Kate Waddington (2013) in her study of the later prehistoric settlements in northwest Wales. However, she has also briefly looked at the spatial analysis of roundhouses in terms of internal features such as internal stone settings and hearths. She observed the recurrence of stone settings suggesting an area for sleeping or sitting in the peripheral back areas of the houses, such as in stone roundhouses at enclosed settlements of Caerau I, Pant y Saer, Cae'r Mynydd I and at Braich y Dinas (Waddington 2013, 113). However, the use of domestic space in roundhouses is conventionally approached via depositional studies of finds, and such studies are lacking for the region of northwest Wales. While this could result from a lack of extensive interest in such studies in this region, it is certainly exacerbated by the overall sparsity of finds in Iron Age settlements in northwest Wales. This can be attributed to the aceramic nature of the pre-Roman Iron Age in Wales and the acidic soils and sediments of most areas, where the survival of any organic artefacts is unlikely.

Northwest Wales, containing the modern counties of Anglesey and Gwynedd, contains a remarkably well-preserved number of later prehistoric roundhouse settlements, some of which have been the focus of extensive excavations in modern times. Quite a few of these settlements still stand today as stone-walled structures. While there is a wide range of settlement types in this region, they are mainly categorised into enclosed settlements, unenclosed settlements, and hillforts. A large number of the enclosed and unenclosed roundhouse settlements have been subjected to research-led and developer-funded excavations, and hence these are better understood than the contemporary hillforts (Waddington 2013). In terms of roundhouse construction, timber, stone, and clay-walled roundhouses are the typical construction techniques used by Iron Age communities in this area.

Moel y Gerddi provides a good example of a site with timber and stone roundhouses (Kelly *et al.* 1988). In its first phase, it was a roughly circular timber palisaded enclosure with a substantial timber roundhouse located at its centre, which was later rebuilt in stone (Figure 6.4). The central timber roundhouse had a wall slot of 9.4 m in diameter internally, with gaps in the east and west for the entrances. Twelve postholes forming an internal ring were also recorded, though not all of them may have been contemporary to each other (Kelly *et al.* 1988, 111). Several intercutting shallow pits or scoops were also recorded in the central area of the house. During the stone phase of the site, the central roundhouse had the addition of a low stone wall on the outside of the wall slot from the timber phase. Kelly *et al.* (1988, 133) note that apart from this addition, the structure remained unaltered. However, the west entrance gap was blocked, thus leaving a single entrance in the east (Figure 6.4). The internal occupation layer of this roundhouse had good preservation and hence was subjected to phosphate analysis as a result (discussed below).

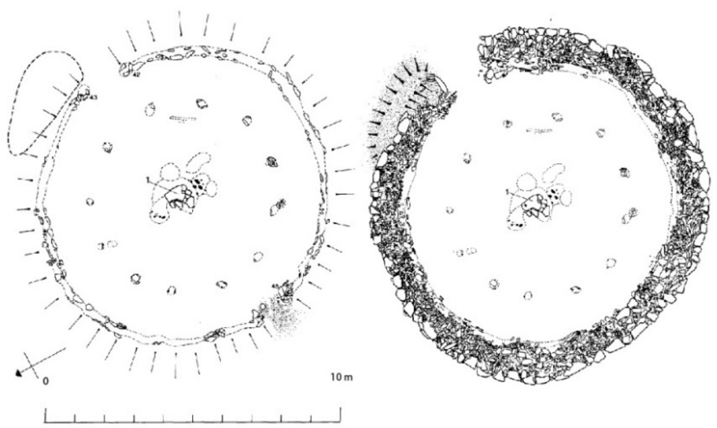

Figure 6.4: Moel y Gerddi timber phase roundhouse (left) and stone phase roundhouse (right) (adapted from Kelly *et al.* 1988, figs 6 and 8).

An example of a clay-walled roundhouse was recorded at the Iron Age enclosed settlement at Bryn Eryr, Anglesey (Longley *et al.* 1998; Figure 6.5). House A, dating to the Middle Iron Age, was the largest of the roundhouses found here. Although it originally stood alone, in phase 2 (Later Iron Age), another house (B) was added alongside House A to the south with its wall abutting the original structure. Longley *et al.* (1998, 228) noted that these houses were, in fact, occupied at the same time, as they both used the same external drain. House A had an internal diameter of 8.5 m with clay walls that were 2 m thick. The entrance was orientated to the east, and the house had a stone-capped drain on the western side of its floor. This house also had an internal ring of postholes concentric to the wall. No central hearth was recorded in these houses. Two mortar-like querns were recorded from the northern part of the house floor and set in the occupation surface (Longley *et al.* 1998, 230). House B, which was added in phase 2, had an internal diameter of 7 m, and its wall was 1.25 m in thickness. Stone-capped drains, and a central hearth, were recorded in this house. Two quern stones were also recorded set into the ground in the northern part of the floor. In phase 3, which dates to the Romano-British period, House C was added to the south of House B. House C was the smallest of three roundhouses with a diameter of 4.8m. Although this house had walls with poor survival, Longley *et al.* suggest it had an entrance facing east (Longley *et al.* 1998, 230). This house also was observed to have drains and a central hearth (Figure 6.6). The hearth seems to have two phases, where it was moved south slightly in its second phase (Figure 6.6). House C also showed the survival of its floor in the form of a clay floor. Overall, these houses at Bryn Eryr had very few finds apart from a few quern stones and flint artefacts (Longley *et al.* 1998). However, using conventional spatial analysis based on artefact locations, it may be suggested that the quern stone indicates an activity area, such as food processing, in the northern part of the floor.

Roundhouses in northwest Wales are not particularly suited for Iron Age settlement depositional studies due to the relative scarcity of finds. However, a number of stone roundhouses in northwest Wales, mainly in enclosed or elevated positions, tend to have well-preserved floors due to being protected from ploughing. Such well-preserved floors provide a contrast to the badly ploughed-out sites of southern England, and this makes them good candidates for geochemical studies, which can help to reveal additional information about the internal use of space within such roundhouses.

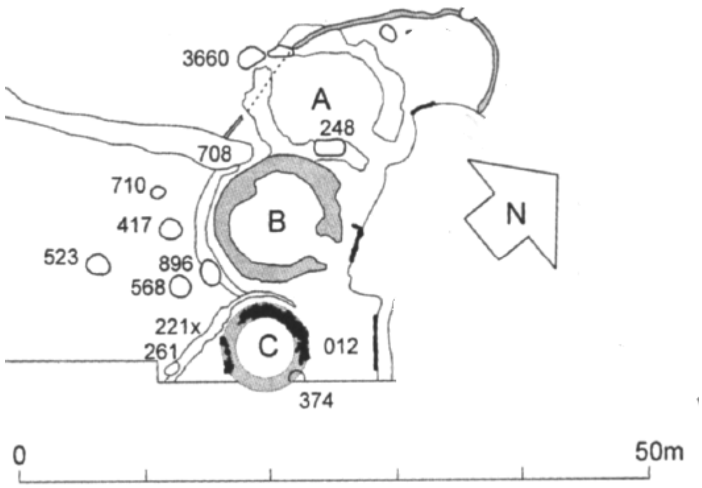

Figure 6.5: Phase 3 at Bryn Eryr showing houses A, B and C, Bryn Eryr (adapted from Longley *et al.* 1998, fig 9).

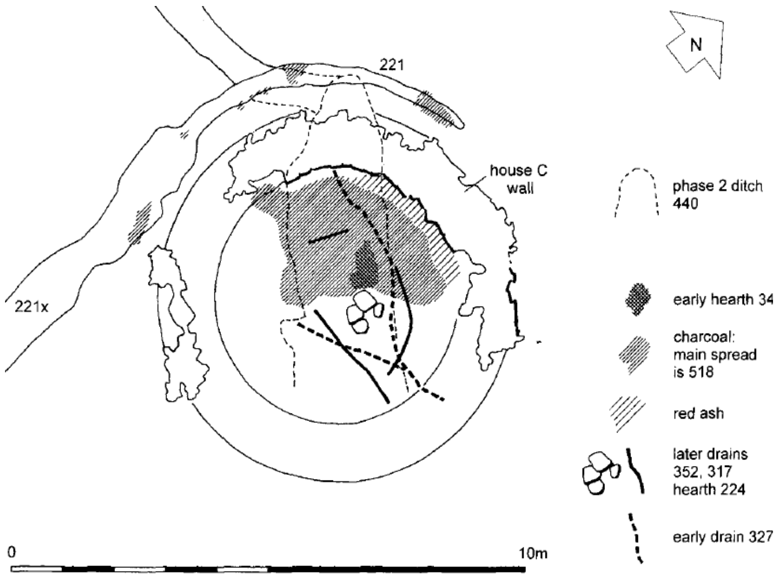

Figure 6.6: General plan of House C, Bryn Eryr (Longley *et al.* 1998, fig 10).

Hillforts in northwest Wales

Meillionydd, where RH SO19 is located, is an example of a small hillfort. Hillforts are monumental roundhouse settlements that are enclosed and located in prominent places in the landscapes. They have impressive walls or embankments that enclose roundhouses and structures for food storage. The larger, impressive, stone-walled hillforts in the region are significantly different to the smaller ones. Examples include Conway Mountain, Garn Boduan and Tre'r Ceiri, and Braich y Dinas (Waddington 2013). Tre'r Ceiri, Llŷn peninsula, is a spectacular large stone-walled hillfort with seventy stone roundhouses and eighty rectangular buildings, of which a few were occupied in the Romano-British period (Waddington 2013, 220-223). Such larger enclosures that were densely occupied are suggested to belong to a developed phase of hillfort construction that may have commenced in the Middle Iron Age, as seen in other parts of Britain from c. 400 BC (Waddington *et al.* in prep.).

While they appear in varying sizes and forms, small hillforts (under 1.2 hectares in size) are dominant in northwest Wales. There are about one hundred in this region, although their boundaries are generally less elaborate than their counterparts in the Welsh Marches and South England (Waddington *et al.* in prep.). Double ringwork enclosures are classified as small hillforts that have circular double ramparts that are placed concentrically with internal roundhouses (Waddington *et al.* in prep.). They are mainly found on the Llŷn peninsula. Castell Odo, dated to the Late Bronze Age-Iron Age, is one such double ringwork enclosure, located only 3 km from another double ringwork enclosure, that of Meillionydd. Both had two main settlement phases. In the first main phase, a settlement with timber roundhouses enclosed by a ditch or wooden palisade was occupied: this dates to the first half of the first millennium BC. In the second main phase, dating to the Iron Age, the settlements became bivallate stone-faced embanked enclosures within which there were stone roundhouses found overlying the timber ones of the previous phase (Waddington *et al.* in prep.). Other examples nearby include Castell Caeron and Conion (Waddington *et al.* in prep.). Double ringworks usually date from the Late Bronze Age to the Middle-Late Iron Age, such as 800-100 BC in the case of Castell Odo and Meillionydd. They are also characterised by intensive occupation, often observed in the form of multiple roundhouses overlapping one another. The presence of some well-preserved stone-walled roundhouses in these enclosures provides a good opportunity for some detailed analysis of the use of space within them. The roundhouse from Meillionydd, which is analysed here, was positioned within a 0.70 m deep quarry hollow located in front of the outer bank, providing spectacular preservation conditions for this structure.

6.3 The Study Site: Meillionydd, Llŷn Peninsula.

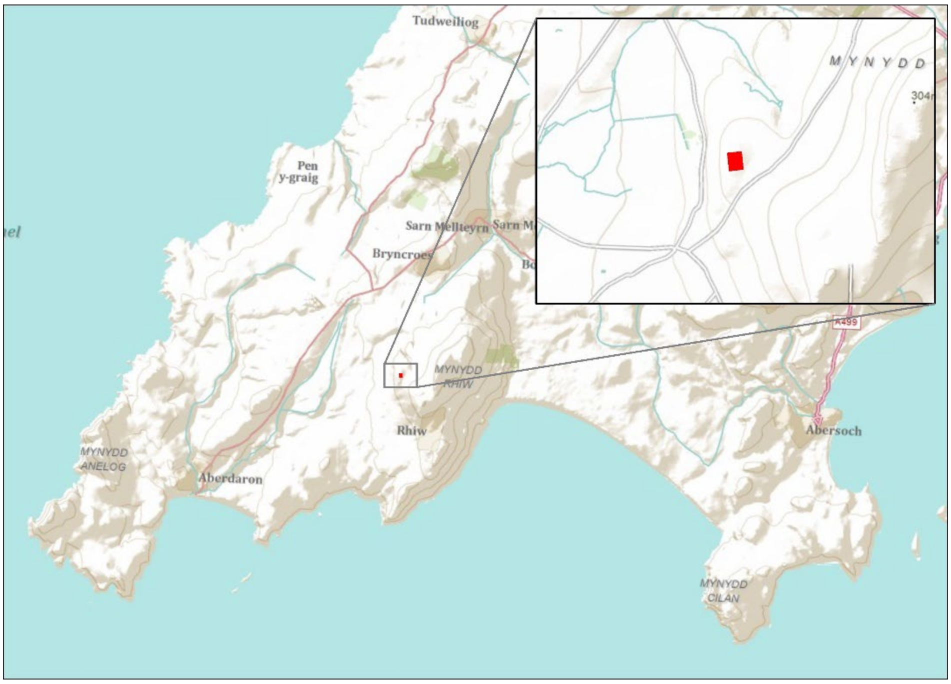

Figure 6.7: Location of Meillionydd on the map of Llŷn peninsula with inset showing location close to Mynydd Rhiw (Waddington *et al*. in prep.).

Meillionydd is a double ringwork hilltop enclosure located on the southwestern end of the Llŷn peninsula in northwest Wales (Figure 6.7). It is positioned atop a gently rounded hilltop that forms the western end of a spur projecting from Mynydd Rhiw. The underlying geology at this site, which contributes to the formation of the soils and sediments at Meillionydd, are the Sarn Complexes which are made up of mostly metamorphic rocks. The exposed Sarn Complex lithologies 'range from diorites through to granites', and locally show repetitive layering as typically seen in metamorphic rock (Gibbons and McCarroll 1993, 14). The exact levels of various chemical elements within the bedrock in Meillionydd are unavailable. However, a study by Gibbons and McCarroll (1993, 19-21) identified the composition of the bedrock in terms of the chemical compounds seen in samples collected near and around the western tip of the Llŷn peninsula, which includes samples c. 400 m from Meillionydd.

The Sarn Complex is mainly made up of silica (SiO_2) ranging from 46% to 79% (Gibbons and McCarroll 1993, 19). The next major components after silica are aluminium oxide (Al_2O_3)

at 12.9-17.38%, ferric oxide (Fe_2O_3) at 1.13-13.8%, calcium oxide (CaO) or quick lime at 0.10-8.01%, magnesium oxide (MgO) at 0.15-7.91%, sodium oxide (Na_2O) at 1.26-3.39%, potassium oxide (K_2O) at 0.79-4.36%, titanium oxide (TiO_2) 0.15-3.21%, phosphorus pentoxide (P_2O_5) at 0.0-1.45% and manganese oxide (MnO) at 0.01-0.25% (Gibbons and McCarroll 1993, 19-21; Table 6.1). While other trace elements were analysed, the element of interest here is Sr, which has shown levels of 61-275 mg/kg, as the Sr levels seen in some areas of the house floor layers at Meillionydd are lower than that in the bedrock falling with the range of 15-157 mg/kg. Unfortunately, the levels of individual elements such as aluminium (Al), iron (Fe), calcium (Ca), manganese (Mn), phosphorus (P), potassium (K), and titanium (Ti) are not available. However, the Sarn Complex appears to have high levels of Al and Fe. The levels of Ca are considerably varying, as seen in Table 6.1 (in CaO percentages). While potassium (K) was generally observed to be low (Gibbons and McCarroll 1993, 20), the levels of phosphorus (P) and manganese (Mn) were even lower than K.

Given that the bedrock at Meillionydd was never reached in the excavations, the depth of the glacial till in this location is currently unknown. The natural subsoil upon which the site was established is primarily constituted by glacial till, comprising of light yellow-reddish sands and gravels, which offers highly well-drained soils, thereby making it favourable for settlement, pasture, and agriculture (Waddington *et al.* in prep.). The natural subsoils and archaeological sediments on this site are acidic and measure between pH 5-5.5 (see Appendix I). This natural subsoil at this site was analysed as control samples in order to understand the levels of various elements and this is discussed below in section 6.6.

Wt % oxides	1	2	3	4	5	6	7	8
SiO_2	80.41	79.14	73.47	64.55	61.02	51.26	49.20	52.5
Al_2O_3	12.90	12.92	14.45	17.38	14.38	13.03	15.25	16.8
TiO_2	0.29	0.15	0.49	0.68	0.39	1.60	3.21	0.9
Fe_2O_3	1.56	1.13	3.07	4.62	4.20	11.93	13.80	8.9
MnO	0.01	0.02	0.07	0.10	0.09	0.20	0.25	0.1
MgO	0.22	0.15	0.77	1.94	2.62	7.91	4.77	6.6
CaO	0.11	0.10	0.25	1.64	11.52	8.01	5.92	7.4
Na_2O	3.39	2.64	2.10	3.54	1.26	1.30	2.45	2.4
K_2O	0.79	4.36	3.44	1.75	2.31	1.59	1.25	0.8
P_2O_5	0.02	0.02	0.07	0.21	0.12	1.16	1.45	0.0
LOI	0.71	0.65	1.64	1.75	2.02	1.74	1.85	2.7
Total	100.40	101.28	99.72	98.14	99.92	98.73	99.40	99.5
ppm								
Rb	45	173	120	66	74	48	43	35
Sr	92	61	204	412	79	119	275	275
Ba	408	901	701	625	323	327	276	115
Zr	408	327	247	318	110	124	176	61
Nb	31	27	20	12	10	14	3	3
Y	84	92	39	36	46	42	34	26
Hf	9.6	—	6.7	7.6	—	—	5.8	2.0
Sc	6.3	—	8.8	11.7	—	—	31	35.2
Ta	1.24	—	1.04	0.61	—	—	0.46	0.2
Th	14.5	—	15.1	5.09	—	—	3.21	0.4
U	2.02	—	1.99	0.89	—	—	0.73	0.1
La	61.40	67.90	46.80	33.60	39.2	—	19.20	8.2
Ce	132.20	123.40	99.60	68.80	78.9	—	46.70	19.8
Pr	17.00	19.63	12.75	9.40	10.59	—	8.42	8.2
Nd	60.10	69.60	41.60	32.80	37.70	—	31.60	12.9
Sm	11.50	14.10	8.08	6.25	7.93	—	7.29	3.2
Eu	2.37	1.94	1.61	2.28	1.15	—	2.72	1.0
Gd	10.69	13.35	7.47	6.25	7.95	—	8.98	4.1
Dy	9.81	11.71	5.54	5.29	7.46	—	7.02	4.1
Ho	2.05	2.42	1.23	1.12	1.54	—	1.45	0.8
Er	6.54	7.78	3.94	3.68	4.97	—	4.99	2.9
Yb	5.50	6.63	3.31	3.12	3.97	—	3.19	2.3
Lu	0.84	1.02	0.55	0.50	0.61	—	0.50	0.3

1 Sarn Granite; disused quarry [221 339]
2 Sarn Granite; disused quarry [221 339]
3 Sarn Granite; roadcutting near Pen y gopa [2234 3178]
4 Granodiorite; disused quarry, Carrog Farm [2176 3302]
5 Tonalite; ridge east of Mellionedd Farm [2176 3302]
6 Diorite; Llangwnnadl stream [2100 3293]
7 Diorite; Carrog Farm [2172 3304]
8 Gabbro; quarry, Graig Fael [2175 3040]

LOI = Loss on ignition

Table 6.1: Chemical composition of the Sarn Complex on the Llŷn peninsula in the general area around Meillionydd (Gibbons and McCarroll 1993, table 1).

The archaeological site at Meillionydd was recorded first by the Royal Commission as a 'weak double ringwork' (RCAHMW 1964, lxxiii). It has been investigated as a part of the 'Early Celtic Societies in North Wales' project that is focused on the investigation of hillforts and settlements in northwest Wales from the Late Bronze Age to the Early Medieval period (around 1150 BC-AD 1150) (Waddington 2013).

Meillionydd was excavated between 2010 and 2017. A ground-penetrating radar survey undertaken in 2012 identified a large number of roundhouses on the site. The occupation at this site began at least around 650 cal BC as a timber-built settlement with post-built and plank-built roundhouses (Waddington *et al.* in prep.). This was enclosed by two ditches and timber palisades in the earlier Iron Age (Phase 2), followed by a double-banked enclosure with stone roundhouses in the Early to Middle Iron Age between c. 470 cal BC and 300 cal BC (Phase 3a). In a later phase dating to the second-first century cal BC (Phase 3b), roundhouses were built on top of the inner bank on the eastern side of the site, with quite a few focused on the inner entranceway through the original inner bank. The roundhouses identified, which appeared to be constructed using different methods and materials, had a strong stratigraphic sequence suggesting long and different building phases at this site (Waddington and Karl 2010). Excavations also revealed that stone roundhouses were deliberately infilled on abandonment. This was first revealed in the stone roundhouses of Trench 1 and Trench 3, which were infilled with dense deposits of burnt stones on abandonment (Waddington and Karl 2010). Radiocarbon dating of a charcoal sample from the hearth of a timber roundhouse that lay partially sealed under a stone roundhouse wall from trench 3 suggested an Early Iron Age date (753-410 cal BC 2 sigma) while a Middle Iron Age date (384-203 cal. BC 2 sigma) was suggested by the dating of a sample from a pit in the floor of the overlying stone roundhouse (Waddington and Karl 2015a, 31).

The finds from this site include hammer stones, smoothing stones, a fragment of a jet bracelet, glass beads, whetstones, saddle-quern stones, and stone, clay, and lead spindle whorls. The absence of ceramics on this site is attributed to the aceramic nature of the Iron Age period in Wales (Waddington and Karl 2015b). In the later seasons of excavations, it was revealed that the site went through at least eight main construction phases with a few sub-phases. Although a single roundhouse (RH SO19) is the focus of this chapter, a brief description is offered below of the stratigraphic sequence of RH SO19 and its associated features, such as the outer bank and quarry hollow in which it was constructed.

The outer enclosure and quarry hollow

The settlement boundaries at Meillionydd were reconstructed in the later Early Iron Age to make two circular concentric banks with stone facings in phase 3a (Figure 6.8). Based on the radiocarbon dates, it was found that the outer enclosure was probably constructed in c. 5th century cal BC (dated to the end of the earlier Iron Age radiocarbon plateau) (Waddington *et al.* in prep.), and it was among the earliest features of the phase 3 settlement. This bank was constructed alongside an inner quarry hollow (155). The inner quarry hollow was 7.5-9 m wide and around 0.6-0.7 m in depth. The creation of such a wide quarry hollow also, essentially, enabled the construction of a levelled area on the inner side of the outer bank, which was set apart for the location of the entrance roundhouse (RH SO19). A shallow quarry scoop located outside the bank is far narrower than the inner one at 1.3-2.4 m in width and about 0.15-0.2 m deep. After the construction of the quarry hollow (155), drainage gullies were found to be built in the terminal areas of the quarry hollow and the entrance gap of the outer bank. Some of these gullies also formed part of the drains of RH SO19, with one of the main gullies running from the interior of the house floor and under the outer bank and finally terminating in the south of the entrance area on the outer side of the outer bank (Waddington *et al.* in prep.). This reveals that the roundhouse was contemporary with the construction of the outer bank and deliberately placed to oversee the main entrance-passage of the enclosure (Figure 6.8).

The outer bank had an earth and rubble core, and its inner and outer facing were made of large stone blocks. The entrance through this enclosure was marked by a 2 m-wide gap orientated to the east. The southwestern bank terminal was built such that it curved around RH SO19, extending for an extra 2.5-3 m from the roundhouse, creating a simple entrance gap. This bank terminal also further juts out for 1 m by 1.5 m creating a wall terminal for the north-facing entrance of the roundhouse. This highlights again that the bank and the roundhouse are contemporary. As soon as the outer bank was built, a metalled surface was constructed that ran through the entrance gap of the outer bank and in front of the roundhouse entrance. This created a hard standing for the passage of people and animals into the enclosure, which could be easily monitored by the occupants of the roundhouse (Waddington *et al.* in prep.).

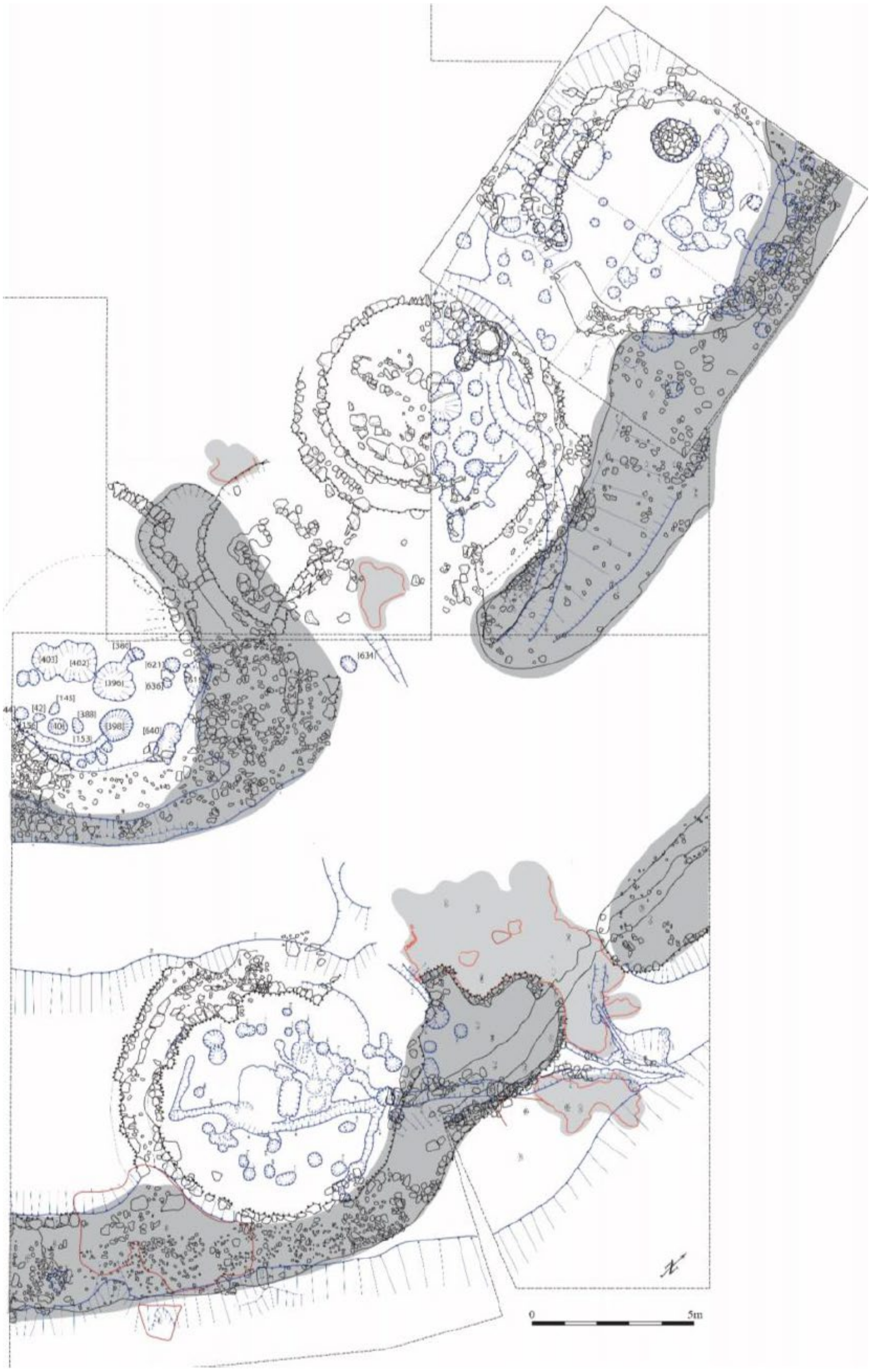

Figure 6.8: Plan of the settlement at Meillionydd in Phase 3 showing the outer and inner bank, associated roundhouses, and quarry hollow (Waddington *et al.* in prep. fig 2).

Roundhouse RH SO19

Roundhouse RH SO19 was circular with an internal diameter of 7 metres and an entrance facing north (Figures 6.9, 6.10). Being located at the southern terminal of the outer bank, it also provided direct access to the internal passageway to the site. Because of its position, Waddington *et al.* (in prep., Chapter 3) have classified this roundhouse as an 'entrance-house' or a 'guard-house'. However, caution is suggested for the use of the latter term due to its military connotations. It was likely that the people living in this house 'managed' access to the inside of the enclosure and, thus, played a significant role in the community living at Meillionydd. Based on radiocarbon dates (discussed below), it was found that the house had a long history of occupation with two phases. The earliest phase is suggested to lie in the earlier Iron Age radiocarbon plateau, probably around the fifth to early fourth century cal. BC. The second phase belongs to the beginning of the Middle Iron Age (Waddington *et al.* in prep., Chapter 3).

Figure 6.9: Photograph of RH SO19 taken facing northeast. The entrance is visible in the background facing north as a gap in the wall, and the dark grey brown silt (843) is visible in the centre of the roundhouse next to the capping stones of the drain.

Construction of RH SO19

The house was built within a cut 338 at the terminal of the quarry hollow (Figure 6.10). The house was fairly well preserved, with its walls still standing at the time of excavation, consisting of four courses of stones reaching a height of 0.4 m on all sides, barring the north entrance, which had a width of 1.2 m. The wall was constructed of well-built inner and outer facing stones and a core of dark silt and smaller stones that was 0.6 m wide. In places where the wall of the house was built into the outer bank, the body of the bank was used as its wall core. The entranceway was subjected more to later disturbances than the other parts of the house. Here, the cut of the roundhouse floor sloped downwards into the interior of the house.

A second external wall of three courses of stones was also recorded following the outer wall facing on the southern side of the house. This external wall extended for about 4 m from the edge of the cut of the quarry hollow. It was interpreted as a support or repair wall for the house (Waddington *et al.* in prep., Chapter 3).

RH SO19 occupation and construction features

Among the earliest features of this house was a drainage system that consisted of a main gully that ran north-south across the floor of the house. The drain had several branches running east and west, connecting most of the house floor. A gully also extended underneath the wall of the house in the northeastern quarter of the house floor and continued under the outer bank, terminating at the entranceway of the outer bank (Figure 6.10). Such a layout of the drains also confirmed that the roundhouse was contemporary with the construction of the bank.

The drains (891 =1057) had capping stones along most of their length, and they connected to a rather shallow working hollow in the central area of the house. Two radiocarbon dates from two different charred hazel twigs were produced from the dark grey silt that formed the fill of the drain. These gave the earliest occupation dates for the house: 791-545 cal BC (OxA-37209; 2519 ± 24 BP) and 728-402 cal BC (OxA-37210; 2405 ± 25 BP). They are argued to lie towards the end of the earlier Iron Age radiocarbon plateau because the Phase 2 timber palisade enclosure also dates to the earlier Iron Age radiocarbon plateau, probably in the 7th-6th centuries cal BC (the fills of the earlier U-shaped ditch belonging to the Phase 2 enclosure are actually truncated by the Phase 3a quarry hollow and are partially sealed by this roundhouse). Another drain (911), roughly Y-shaped and unconnected to the main drainage system, was also recorded at the eastern edge of the roundhouse entranceway. This drain terminated in two circular scoops. Finally, the house also had another drainage gully in the roundhouse entrance lying beneath the edge of the metalled surface of the roundhouse entranceway (1047), which lay next to sinkhole 1092 (Figure 6.10). The significance of these drains in this roundhouse will be discussed later.

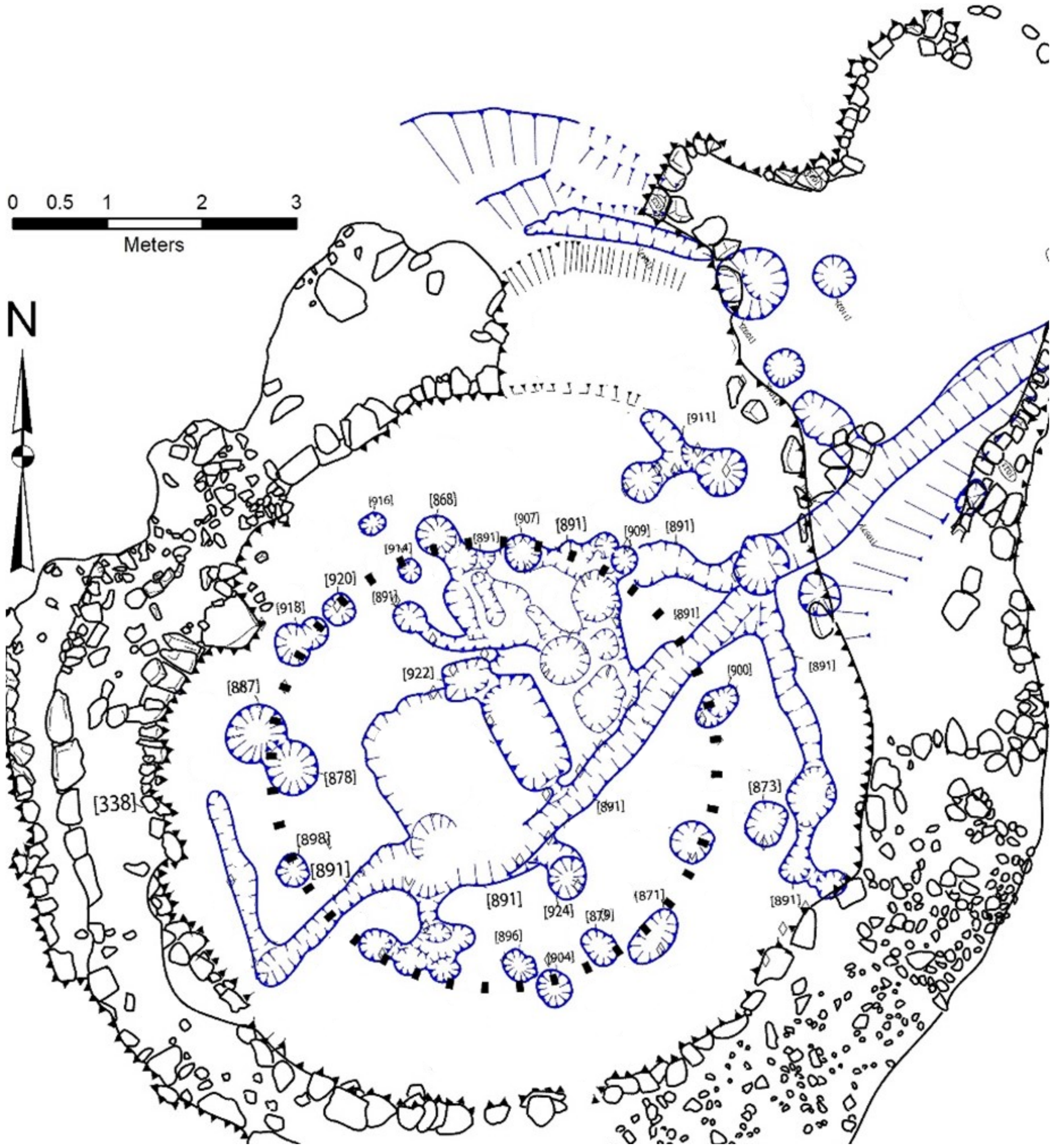

Figure 6.10: Plan of roundhouse RH SO19 incorporated into the outer bank on its east side and the inner ring of postholes shown by the dotted circle.

The shallow working hollow, located in the centre of the house floor, was bordered by a post-ring formed by seventeen postholes. This post-ring had a diameter of 5 m with a layout that was concentric with the walls of the house. Such a post-ring quite likely served as an infrastructure supporting a conical roof or another floor above. Within the shallow working hollow were two hearth pits (923 and 922) that were rectangular in shape and located centrally on the house floor. The smaller pit (922) measured 26 cm by 20 cm and was 40-50 cm deep. It had a fill rich in ash and charcoal deposits in a brown silty soil. The fill appeared much darker than the other hearth pit, and hence there remains an ambiguity whether this pit was a hearth pit or an ash pit. Two radiocarbon dates were obtained from the dating of two hazel twigs. They are 728-402 cal BC (OxA-37214; 2406 ± 25 BP) and 516-392 cal BC (OxA-37215; 2370 ± 25 BP). This suggests an Early Iron Age use which is contemporary with the underlying drains and the floor deposits recorded.

Some features were recognised as cutting through the floor of the roundhouse and were associated with the occupation of the house. On the northwestern side of the post-ring were two scoops (914 and 916) that were positioned around 0.4 m apart and proposed to be the foundation of an internal setting, perhaps for a screen or a piece of furniture (Waddington *et al.* in prep., Chapter 3; see Figure 6.10). Feature 914 was 0.15 m in diameter and 0.13 m deep, and it was filled with a dark brown, stony silt (913), while feature 916 was 0.18 m in diameter and 0.09 m deep and filled with a dark brown silt (915). Close to the wall on the northeastern side of the house were shallow circular scoops 63 and 65, which were both around 0.4 m wide. 63 contained reddish-brown silt with charcoal flecks and 65 had a charcoal-rich dark grey silt that contained large chunks of charcoal (these features are not shown in Figure 6.10)[ix]. There was another shallow scoop (873), 0.45 m in diameter, on the eastern side of the house just outside the post-ring. This scoop contained a dark grey-brown silt with large amounts of charcoal fragments (833). This deposit was suggested to be a dump of hearth material (Waddington *et al.* in prep., Chapter 3).

Floor deposits were found to be preserved *in situ* (albeit thin in some areas) and they were sampled for geochemical analysis. These include the dark grey brown silt (843) that was recorded as a linear spread running centrally in the house and covering most of the drainage gully running north-south, partially infilling the upper part of the working hollow, and petering out to the peripheral areas of the house floor. Along with many charred plant remains, this layer produced two separate hazel twigs dated to 741-405 cal. BC (OxA-37212; 2424 ± 25 BP), and 537-396 cal. BC (OxA-37211; 2380 ± 25 BP). The western side of the house had a mid-brown silty soil (853) and a layer of yellow brown sandy gravel (325). A large spread of compact sandy light-brown loam (318) was found on the eastern side. This layer had frequent inclusions of small stones and heat-affected stones. Broadly equivalent to these occupation layers and covering the entrance way and sitting partially on top of (853) was a dark grey clayey soil (827). These floor deposits were suggested to be contemporary with each other, and their differing characteristics indicate distinct activity areas in the house (Waddington *et al.* in prep., Chapter 3). Based on the radiocarbon dates from the ash pit 922, layer 843, and drain 891, and the Bayesian analysis of the radiocarbon dates, Waddington *et al.* (in prep., Chapter 3) claim this floor and any associated features belong to the Early Iron Age and the early Middle Iron Age (c. 600-400 cal BC).

The central area also encompassed another hearth pit (923), which lay pretty central to the house and connected to the smaller hearth pit (922). This was 1.4 m in length, 0.6 m wide and 0.4 m. On its eastern side, it was also connected to (likely truncated) the main drainage gully (891). From the fill (894) of this pit, two radiocarbon dates from two separate hazel twigs were obtained. One was dated to 749-407 cal BC (OxA-37298; 2434 ± 26 BP), falling in a similar date range as the other layers discussed above and suggesting an Early Iron Age use. However, the other twig was dated to 358-170 cal BC (OxA-37213; 2176 ± 24 BP), suggesting a Middle Iron Age date. This has been suggested to indicate that the hearth was recut and reused in the Middle Iron Age, indicating two phases for the use of this hearth and occupation (Waddington *et al.* in prep., Chapter 3).

Some discrete spreads of charcoal and ash material in the peripheral area of the floor, and close to the eastern wall of the house, were unfortunately excavated in 2010 before the sampling was carried out and hence were not included in the analysis (Figure 6.11). This was because, during this trial excavation season, it was not immediately clear that the deposits related to a roundhouse floor, as it was assumed that these were deposits which had built up against the inner face of the outer bank in the small trial trench opened (Waddington *et al.* in prep., Chapter 3). The deposits include a layer of dark grey-brown silty loam (67) that was thin and covered the capping stones of the drain. Layer 67 was relatively rich in charcoal, ash and reddened burnt clayey material. Overlying this was a mottled reddish brown loam (61) which had frequent charcoal flecks – likely also part of the roundhouse floor. Another thin layer (828) described as 'dark grey soil containing a lot of charcoal and ashy material' (Waddington *et al.* in prep., Chapter 3) was also removed from the eastern edge of the house floor in 2012 due to over-cleaning of the floor by trowelling, and before it could be sampled as such. However, thin remnants of the floor were still present at the time of sampling in 2013. The excavators suggest that these discrete deposits could be a result of sweeping activities originating from the hearth and 'perhaps accumulating beneath wooden benches on this side of the house' (Waddington *et al.* in prep., Chapter 3). The removal of these deposits in the earlier part of the excavations has probably had an impact on the multi-element analysis of these peripheral areas (see below).

In terms of the occupation layers from the second phase, several layers overlying the primary floor deposits were thin and discrete. An area of around 30 cm in width of floor deposits was removed in 2010 in trench 2 (which was the eastern periphery of the house) before it was realised that a roundhouse was located here. Initially, these deposits were assumed to be a build-up of occupation material against the inner facing of the outer bank. As a result, these were not sampled for any geochemical analysis, although the underlying natural sandy gravel was (which was the original roundhouse floor). These floor deposits include a small patch of compact yellowish brown sand (context 60, which covered primary floor deposit 61), which was under a spread of mottled dark brown ash-rich silt (58). This ash-rich silt was greasy in texture and had frequent charcoal flecks and reddened clay. It is now suggested to be a build-up of ashy floor sweepings in the peripheral area of the house. These layers were likely contemporary with a floor deposit on the eastern side that included a thin spread sandy light brown deposit (314). This layer covered the entirety of the eastern side of the house. Layer 314 also had a patch of charcoal-rich dark clayey soil in the southeastern part of the floor (312). Another patch of dark clayey soil on the northeast side (313) was also recorded immediately in front of layer 60. Waddington *et al.* (in prep., Chapter 3) propose that these are secondary floor layers which were contemporary with the recut of the central hearth, which dates to the Middle Iron Age. These layers were not sampled for phosphate analysis during the excavations and are therefore not included in this chapter.

Abandonment of RH SO19

On abandonment, the roundhouse was infilled with relatively sterile mid-brown silt and rubble layers. Among these abandonment infills, various utilised stone tools were retrieved. Most stone roundhouses of Phase 3 at this site mainly had stony infills. However, RH SO19's abandonment fills were mostly rich in silt, with the lower spread consisting of rubble possibly deriving from wall tumble. Waddington *et al.* (in prep., Chapter 3) suggested that this was evidence that this roundhouse was subjected to different abandonment activities or closing rites compared to the other stone roundhouses of this phase.

Being built in a 0.7 m deep quarry hollow and then being covered with deep abandonment silts and rubble and derived bank deposits, the floor deposits of RH SO19 were, on the whole, exceptionally preserved (taking into consideration earlier archaeological disturbance of the edges of the floor in the 2010 and 2012 excavations). The preservation of such floor deposits here is in stark contrast to the ploughed-out timber roundhouses in southern England. This gave a good opportunity to explore the chemical signatures of *in situ* floor deposits.

Finds from RH SO19

RH S019 yielded a total of 42 finds, predominantly consisting of stone artefacts (27 finds). Notable among these were 15 utilised stone tools, one potentially crafted stone lamp or mortar stone, two knapped flint flakes, and various imported or curated stones along with burnt cobbles (Waddington *et al.* in prep., Chapter 3). Unfortunately, the coordinates of most of these stone finds (especially the utilised stone tools) from this house were not recorded, with a number of utilised stone tools only being identified during finds washing. Additionally, seven pieces of fired clay and a deposit of unburnt clay were recovered from the structure, along with corroded iron fragments and a small bone fragment from the ash pit 922. 13 small finds were recovered from the primary occupation layers of the roundhouse. The central layer, context 843, of the floor was particularly productive, yielding items such as a stone working slab (which is a find which was also found in each roundhouse platform at Meillionydd; Waddington *et al.* in prep., Chapter 3). This floor deposit also contained some burnt stones, two fragments of smoothed fired clay which were likely for lining cut features, and three possible corroded iron fragments. The entrance-way floor deposit (context 304) included a stone abrader (SF 311) and a possible corroded iron fragment. Features cutting the roundhouse floor generally lacked finds, but one drain fill contained a possible stone lamp or mortar stone, and the fill of a shallow scoop produced a single flint flake (Waddington *et al.* in prep., Chapter 3).

In contrast, secondary occupation floors yielded fewer finds and comprised a stone hammer, a utilised pebble, and a deposit of unfired clay fragments (Waddington *et al.* in prep., Chapter 3). Additional domestic material found within the external repair wall and the silty core of this wall included a probable stone lamp or mortar stone, a flaked lump of Mynydd Rhiw stone used as a pounder or hammer, and two fragments of fired clay, likely daub (Waddington *et al.* in prep., Chapter 3).

A significant portion (51%) of the total finds assemblage from this building originated from primary and secondary abandonment infills of the house, particularly the primary rubble infill, which contained a stone polisher, pounder, and hammer stones, as well as a cup-marked stone, and stone abraders, burnt stone, and partially burnt fired clay (Waddington *et al.* in prep., Chapter 3). The abandonment infill was suggested to be the result of intentional levelling of the structure, possibly post-roof collapse or dismantling of the building, with items either potentially sitting on top of the final occupation floor (see also Parker Pearson *et al.* 2021c, 137) or deriving from settlement middens which were used to level the structure. Secondary abandonment layers exhibited a mixed stony and silty character, with stone abraders, smoother/hammer stone, fired clay (likely daub), and burnt stone. Post-abandonment layers primarily contained burnt stone, except for a lead spindlewhorl found just outside the house, associated with the final stages of occupation in Phase 3b at Meillionydd (Waddington *et al.* in prep., Chapter 3).

6.4 Methodology

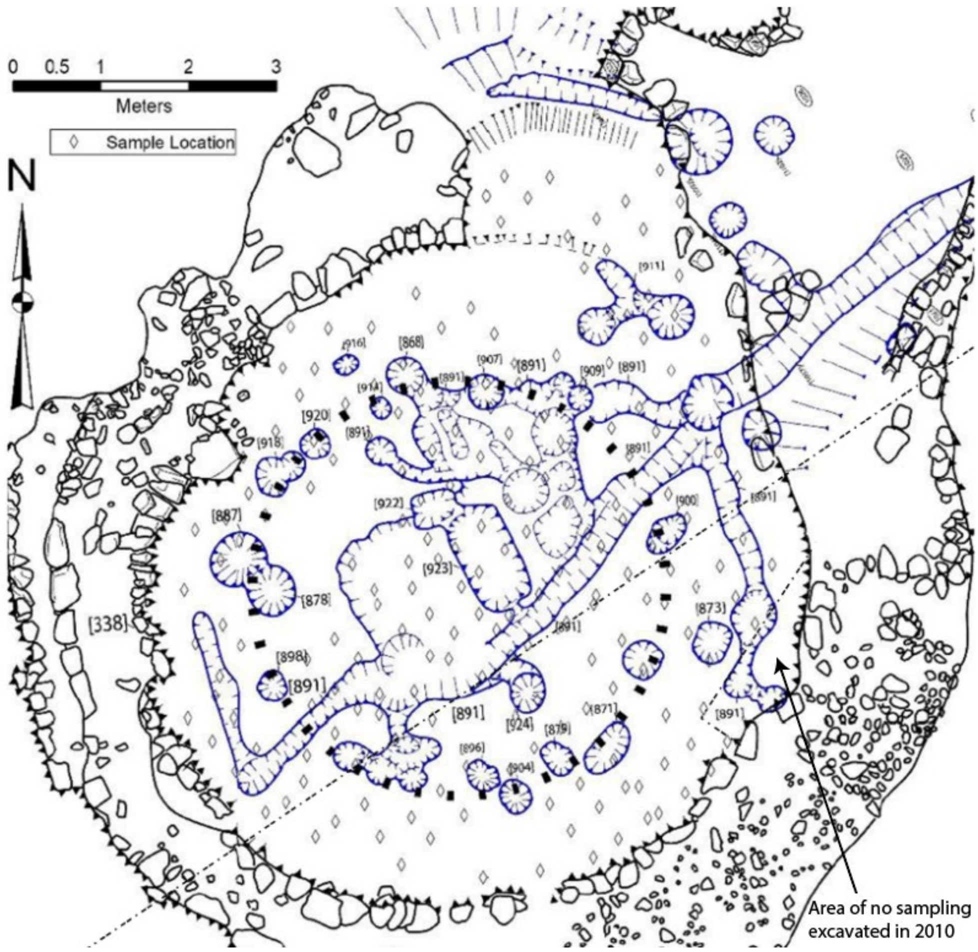

Figure 6.11: Location of sample collection spots from the house floor layers of RH SO19 shown against the post-excavation plan of features in the roundhouse, and the limit of the 2010-2011 trenches that included the southeastern portion of the house floor (shown by dash-dot lines). The east corner shows the limits of the 2010 trench where the floor deposits were removed in 2010.

Spot sediment samples for phosphate analysis were collected on a 0.5 m grid during the excavation of the primary floor deposit of RH SO19 in 2013. The contexts 843 (along the centre), 318 (on the east), 853 and 325 (both on the west side) and 827 (at the entrance area) were sampled and analysed for this chapter. One hundred and ninety-four samples were collected and analysed using the methods described in Chapter 4. Samples from context 318 were initially mislabelled and assigned as context 11, which is actually the context number assigned to ‘natural sandy gravel’ in this trench (the same misnumbering appears in George 2017, 2019 and 2022). This mistake was rectified during post-excavation in 2022, and all the sample numbers were relabelled as 318. To establish the level of each of the fifteen chemical elements in natural subsoil layers, five control samples were also collected via test pits, at random, from 150 to 180 metres away from any archaeological layer or feature within the enclosure. These samples were analysed in the same way as the archaeological samples, and they provided a baseline for analysis.

6.5 Multi-element Analysis: The Contexts

This section gives a brief summary of contexts from which samples were collected (see Table 6.2). The samples collected from the central area were mainly from context 843. This context was initially suspected to be an occupation layer that may have been an area of intensive activity because of its dark colour. It runs in a linear fashion across the centre of the roundhouse floor. This area also included fill 894 of hearth 923 and possibly fill 921 from the early phase of hearth 922 (although not differentiated from 843 at the time of sampling).

The samples collected from the west side were primarily from context 853, with very few samples from 843 and 318 in the south-southwestern area. All the samples collected from the southern side were exclusively from layer 318. The survival of this context at the time of sample collection in 2013 was a little patchy in the southeastern area. This was because it was partially overdug during a previous excavation season when part of the roundhouse floor was opened in 2011. However, this was not regarded as a major problem given that the natural surface in this structure was originally the floor surface of the house.

All samples from the eastern side were also collected from layer 318. The samples collected from the north quarter and the entrance area of the house came from four different contexts. These were: 853 to the west, 325 in the centre west, 843 to the east and 827 in the north. 827 covered the whole entrance area of the roundhouse. The separation between 853 and 325 was not very distinct, and hence it is indicated by dotted lines in the plan (Figure 6.12).

Context	Description
318	Compact orange loam with frequent heat-affected stones and small stones.
325	Yellow brown sandy gravel (was excavated in 2011 when much of the floor deposits were removed so part of the layer sampled might contain some of the underlying natural).
827	Dark grey clayey soil.
843	Dark grey brown silt with frequent charcoal and organic inclusions and burnt organic matter.
853	Mid-brown silty soil.
894	Compressed and partially burnt clayey deposit with reddish brown and orange lenses.
921	Dark brown silty soil filled with very frequent ash and charcoal.

Table 6.2: Occupation contexts from which samples were collected.

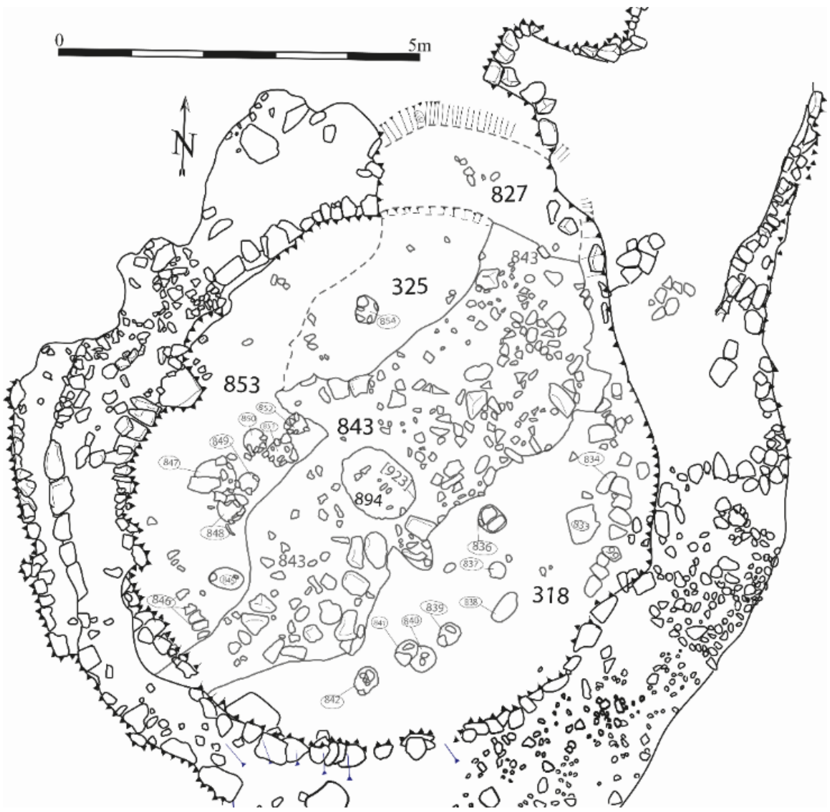

Figure 6.12: Plan of RH SO19 showing occupation layers sampled for this study.

6.6 Multi-element Analysis Results

Table 6.3 presents the levels for each element in the control samples (representing the base levels), which demonstrate the range of values (lowest-highest) in milligrams per kilogram (mg/kg) across all samples analysed for each element. Although not all control sample values are the lowest or below those observed in samples collected from the house, the range of values for each element in the control samples is considerably lower (approximately three to four times) than the highest values detected in the house samples. Moreover, the range is significantly below the mean values and the mid-range values for each element in the house samples (for exact values of control samples see Appendix I). These findings reveal an increase in the level of various elements in the house samples due to the activities which had taken place in the structure during the Iron Age. When the results were analysed, care was taken to check the levels against the test pit samples (control samples) to ensure that any naturally raised elements present in the natural soils on this site were not skewing the results.

Element	Range of the values in mg/kg
Al	20232.06 – 33198.27
P	201.32 – 406.8135
S	45.9945 – 86.816
Cl	27.603 – 46.2395
K	5075.933 – 6582.181
Ca	659.1985 – 719.37
Ti	1888.7705 – 2302.766
Cr	34.5095 – 63.3365
Mn	191.1575 – 463.21
Fe	11288.03 – 16620.29
Ni	11.23 – 14.81
Cu	7.298 – 7.912
Zn	33.971 – 44.4185
Sr	28.054 – 38.673
Pb	14.931 – 17.0445

Table 6.3: Range of the total amount of each element from the test samples.

The levels of various elements represented in the control samples are significantly different to the levels of elements which characterise the bedrock at Meillionydd (see above). The levels of Ca (calcium), Mn (manganese), and Sr (strontium) in the natural subsoil are low and may be comparable to the lower percentages of CaO, MnO, and Sr seen in the geology of the Sarn Granite rather than the higher ones seen in tonalite and diorite geologies (Table 6.1). Direct comparison between both the control samples and the chemical analysis of the geological samples is possible only in the case of Sr, as unfortunately the other chemical elements from the geological samples discussed by Gibbons and McCarroll (1993) are shown in their oxide forms. The levels of Sr seen in the natural subsoil were significantly lower than the levels in the geological samples of the Sarn Complex. It is possible that any elevation in the levels of Al, Ti, Fe, Mn, Ca, and K (found to be raised in the bedrock) in archaeological layers at Meillionydd may be the result of the influence of the underlying natural geology. P, on the other hand, was found to be significantly low, both in the natural subsoil and the bedrock, and so where this element is found to be raised in the roundhouse floor, this appears to be a meaningful pattern.

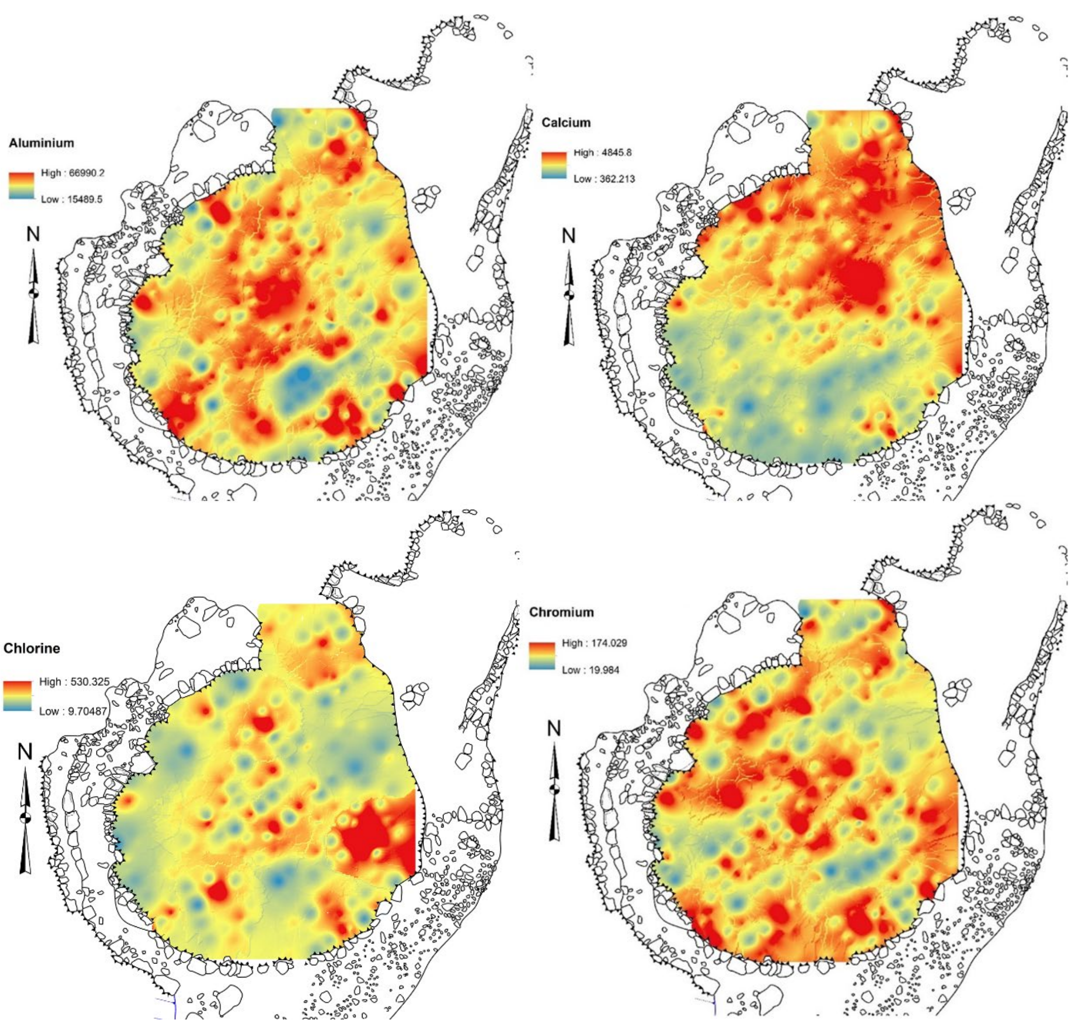

Figure 6.13: Distribution patterns of aluminium (top left), calcium (top right), chlorine (bottom left) and chromium (bottom right).

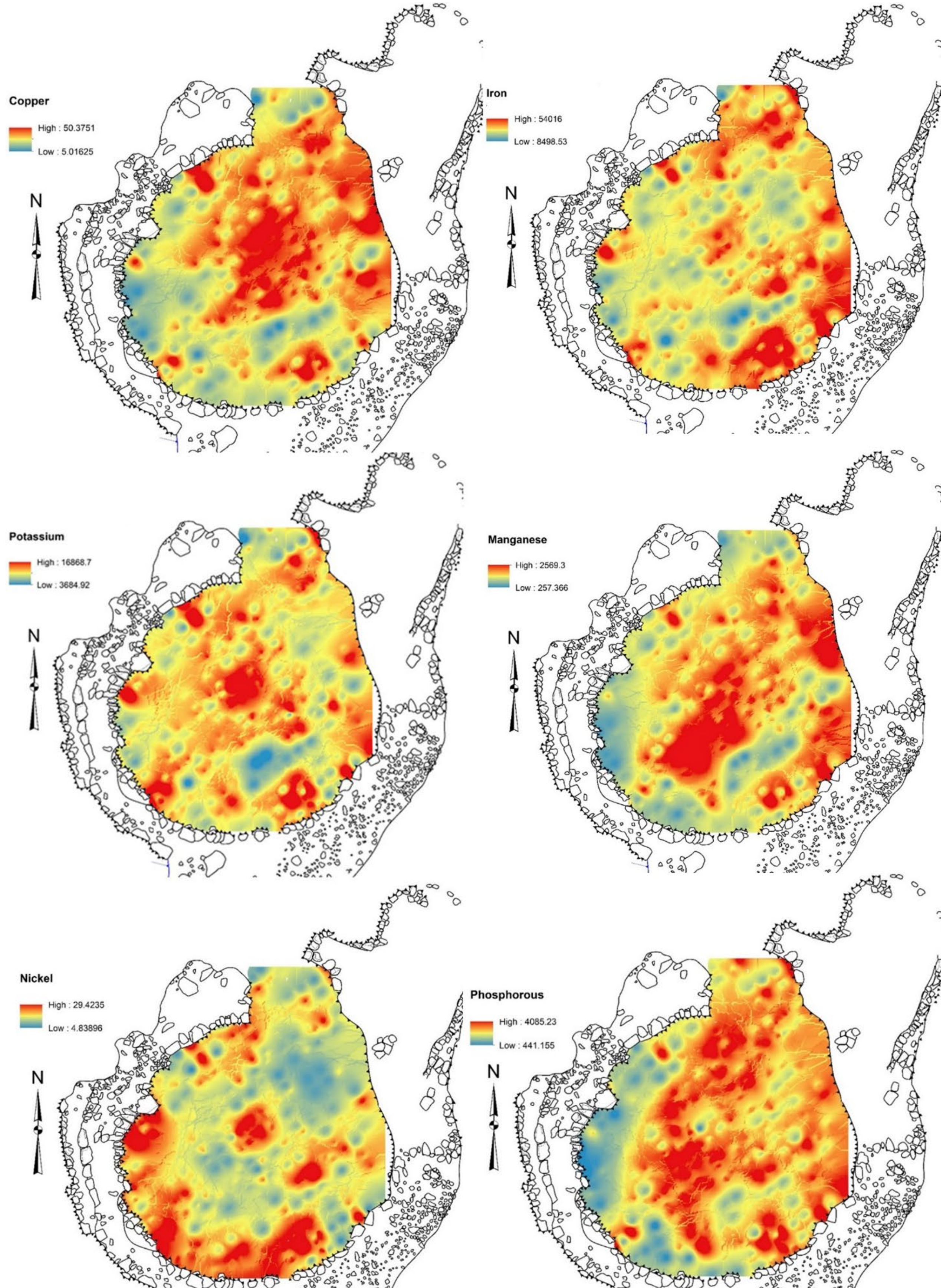

Figure 6.14: Distribution patterns of copper (top left), iron (top right), potassium (middle left), manganese (middle right), nickel (bottom left) and phosphorus (bottom right).

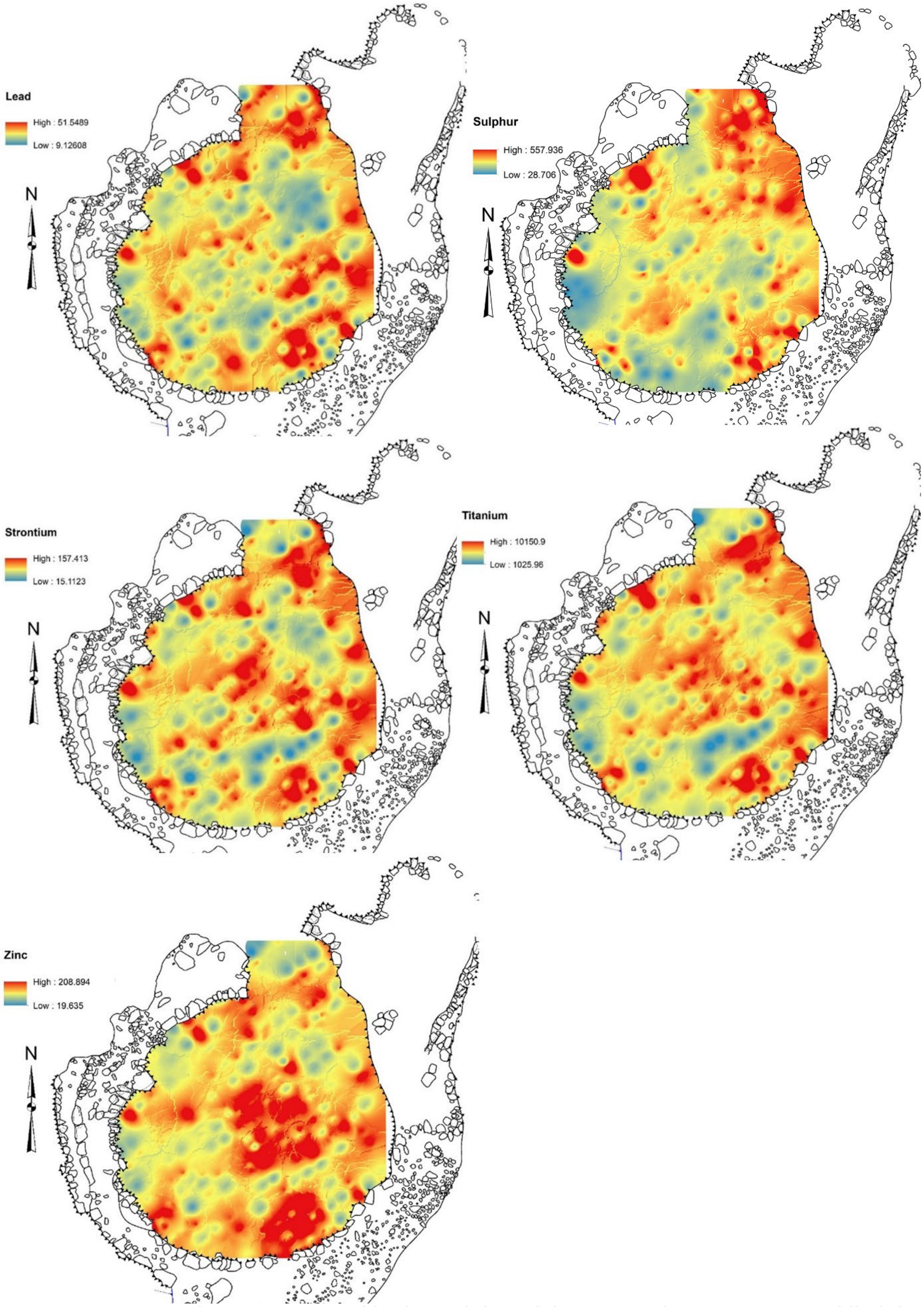

Figure 6.15: Distribution patterns of lead (top left), sulphur (top right), strontium (middle left), titanium (middle right), and zinc (bottom left).

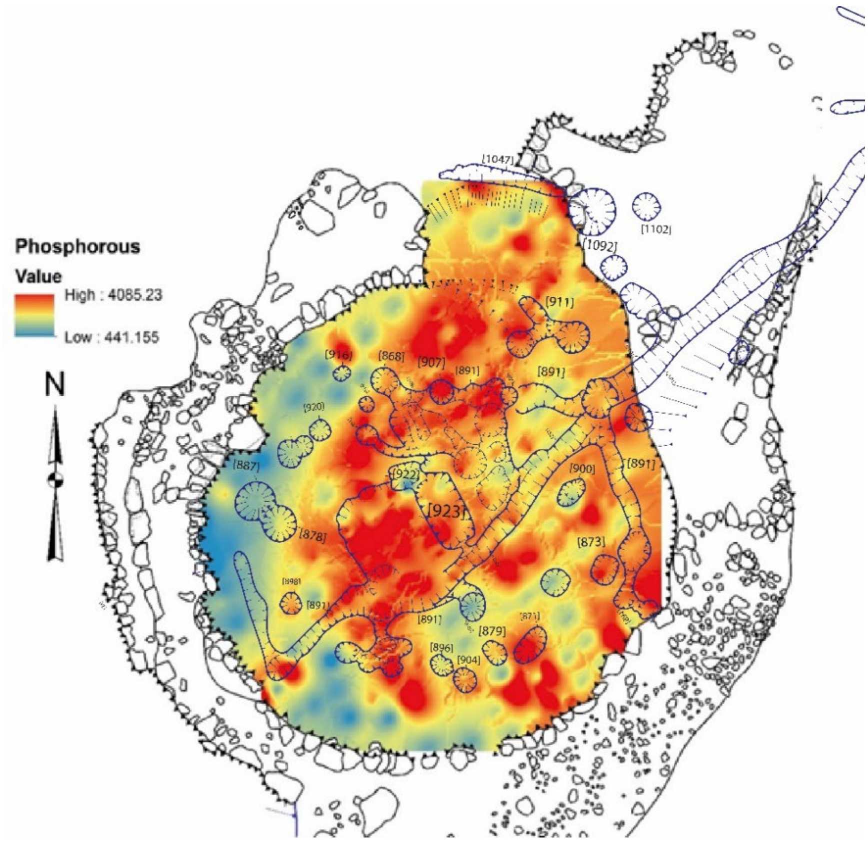

Figure 6.16: Distribution patterns of phosphorus overlying plan of internal features of the RH SO19.

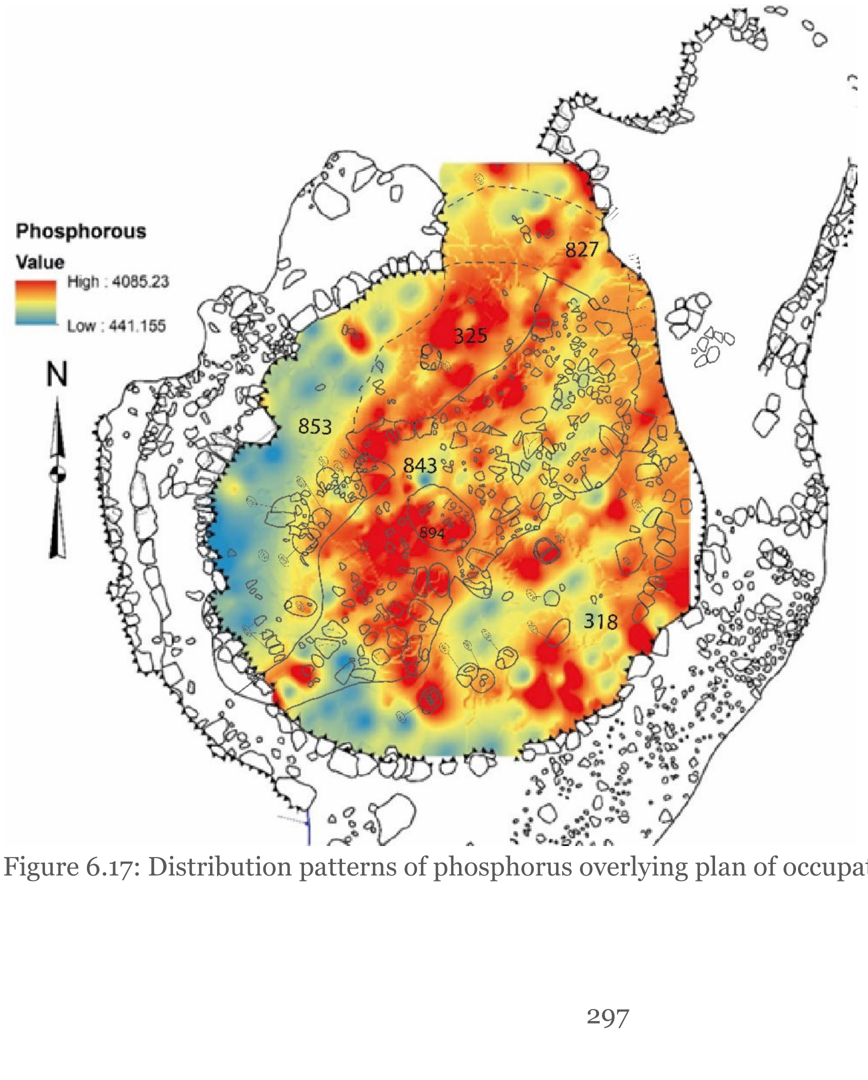

Figure 6.17: Distribution patterns of phosphorus overlying plan of occupation layers of the RH SO19.

Results of phosphorus study

The original phosphate analysis of this roundhouse, which was produced as part of an MA thesis (George 2017), indicated patterns in the organisation of the roundhouse floor. A cluster of high total P values was found in the central area of the house, with two particular areas of peak levels just off the centre of the house (Figures 6.16 and 6.17). These two areas contain a few samples assigned to context 843 and a few from context 318. These areas also lie directly above the two ashpits/hearths and the working hollow. The samples lying above the main branch of the drainage gully were found to contain P ranging from 1600 to 3200 mg/kg. This, perhaps, indicates the accumulation of waste or a system of cleaning the floor that led to the deposition of food refuse and animal remains. The data also was interpreted as indicating the possibility that the central area containing the hearth/ash pits might have served as the main hub for food preparation/handling. Drawing insights from the fluctuation in phosphorus levels observed, alongside the positioning of the inner post-ring within the dwelling, there was a potential to consider the division of the roundhouse into a central, approximately circular zone, and an outer annular area. Additionally, in the original MA study, the peripheral region was tentatively segmented into four uneven quarters within the annulus. However, these conclusions must now be tempered with the results from a wider range of studies of phosphorus from Late Bronze Age and Iron Age house floors, such as those at Cladh Hallan (Parker Pearson *et al.* 2021a) and Haddenham (Evans and Hodder 2006) as the MA study had only considered other Welsh phosphorus studies (explored below).

Overall, the western quarter had lower amounts of P, ranging from 600 mg/kg to 1000 mg/kg. However, two spots had levels of P around 1400-1800 mg/kg (Figures 6.16 and 6.17). This quarter overall seems to indicate lower activity compared to any other part of this house. This indicates that this area was, perhaps, kept clean.

The southern quarter showed that levels of P ranged from 800 to 2800 mg/kg, with most samples having P a little higher than 1200 mg/kg. This area could have been used for general/food storage, as this quarter shows the second-lowest levels of phosphorus in comparison to the other areas. However, this quarter does have a couple of isolated areas of high P levels.

The eastern quarter indicates overall higher phosphorus values than the other quarters. Almost all the samples from this region had P levels above 1600 mg/kg, including a few samples that had P levels above 2600 mg/kg. The branches of the drain (underneath the floor in this corner) may explain the high levels of phosphorus in the northeastern quarter/sector (Figures 6.16 and 6.17). This was interpreted in the original MA study as an area used for some activity productive in phosphorus, such as the possible stalling of young animals at some point, or that it may have functioned as an area for food consumption or workshop activities. The northern quarter, which is closer to the entrance, along with the porch, had levels of P ranging from 1400 to 2400 mg/kg. However, the sample taken from the top of sinkhole 1092 in the entrance had P levels just above 3000 mg/kg. This quarter could have been associated with the northeastern quarter possibly forming a part of the work/activity area.

Based on these phosphorus distributions analysed as part of my MA research (George 2017), I originally concluded that the south and the western quarter together were possibly a sleeping/storage area (see Figure 6.18), whilst the central area may have been the main cooking/activity area, along with the northern quarter which could also have formed part of an activity area. The eastern quarter was suggested to be a potential livestock stalling area (Figure 6.18). In the MA thesis, this was supported by several lines of observation. Firstly, the branches of the drainage system in this area were said to be suggestive that it may have been utilised for this purpose. Additionally, elevated levels of phosphorus in this area provide further support for this hypothesis. This interpretation was also then suggested to be consistent with previous studies of roundhouses, as proposed by Pope (2003) and Hingley (1990), which also suggest the use of such peripheral areas for the stalling of livestock.

However, the limitations of these original interpretations of the phosphorus study can now be reconsidered. For example, while a sleeping platform as such was not found at Meillionydd, a sleeping area was suggested to be located in the south and western quarters of the house due to low P levels. However, house 401 (floors 1311, 655) and house 801 (floor 1150) at Cladh Hallan contained sleeping platforms and these areas showed higher levels of P than the lower levels attributed to the suggested sleeping areas at Meillionydd (Parker Pearson *et al.* 2021c; 2021d; 2021f; Smith *et al.* 2021c; 2021f; 2021h). These elevated levels of P could be mostly attributed to the machair turf that made up the surfaces of the sleeping platform (See Chapter 3). Similarly in Building 6 at HAD V, Fenland, higher levels of P seen in the northern part of the house were suggested to be linked to the possible presence of reeds which may have been used as bedding (Evans and Hodder 2006, 145). As such, these findings cast some doubt on the interpretation of the sleeping areas at Meillionydd.

The northern and the eastern quarter at Meillionydd, with the higher levels of P, were suggested to be possible activity areas in the original analysis. However, it is also possible that the high levels of P in these quarters could be a result of sweeping action emanating from the hearth, as observed at HAD, Fenland, where high levels of P from the central region of Building 4, as well as the entrance of Building 6, was attributed to the sweeping action from the central hearths (Evans and Hodder 2006, 145).

Other possible causes also need to be considered for the distribution of P seen on the house floor of Meillionydd. For example, there is a possibility that the P distribution seen on the floor is actually a result of a roof that collapsed from the west side and decayed *in situ* on the floor. Such a collapsed decaying roof made of organic material could (if it slumped into one side of the building) produce a similar pattern of P distribution as seen in RH SO19. The distribution of P in the house can also be seen as a roughly linear area of high levels of P along the central axis of the house (through the entrance) with a bulge towards the central area. This area is roughly above the main branch of the drain underneath the floor. There is a possibility that the high levels of P seen here could be a result of heaped refuse or other waste products that accumulated during the use of the house. The following section explores the new insights that the multi-element analysis (conducted as part of this doctoral research) has brought to the understanding of the organisation of this roundhouse floor.

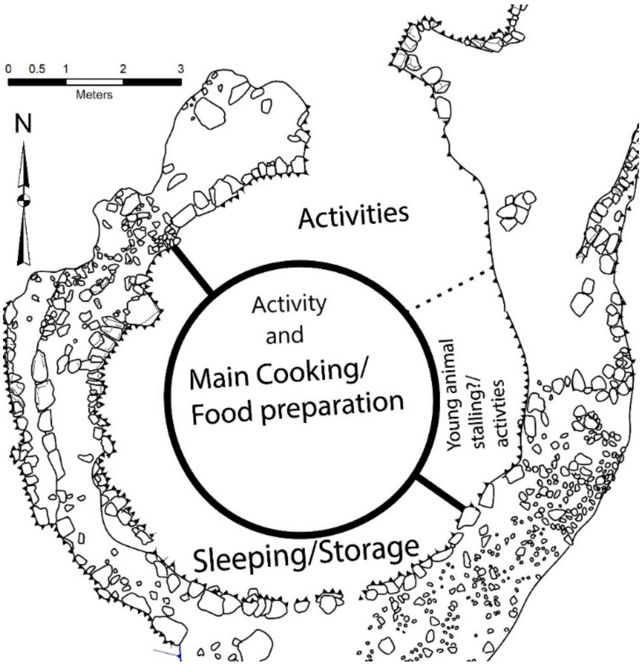

Figure 6.18: Plan of RH SO19 showing the suggested organisation of the roundhouse floor based on the phosphorus study in the MA thesis (George 2019, fig 8).

Multi-element analysis results

The distribution patterns of several elements (fifteen in total) were analysed in order to identify areas of clustering of both high and low values across the roundhouse floor. Based on the element distributions, a possible distribution pattern in several elements has been identified which may suggest that the house floor was divided into a central area and a peripheral annular area (see below). This was shown by the distribution patterns of aluminium (Al), calcium (Ca), chromium (Cr), copper (Cu), iron (Fe), potassium (K), manganese (Mn), nickel (Ni), phosphorus (P), strontium (Sr), titanium (Ti), and zinc (Zn) (Figures 6.13-6.17). In the case of some elements, it is seen that the central area has lower values, such as in the case of Ni and S, with the peripheral annular areas showing higher values of these elements. The opposite was observed in other cases, such as Al and K, and these differences might be a result of differentiation in activities that were carried out in different areas of the house (if it is all a result of anthropogenic factors). In terms of identifying possible activity areas within this roundhouse based on the archaeological evidence alone, the central area–defined by the post-ring–encompasses the two rectangular hearth pits and the 'working hollow' and this appears to be significant as an activity area where cooking and other activities were located. However, the levels of Cu and Ca show a front-back division more prominently than a division into central and peripheral annular regions. Considering such variability in the division of the house floor based on the levels of various elements, the division into the central and the peripheral areas is arbitrary, although it seems likely that the main principle of division in the roundhouse may have been the internal post-ring.

Central area

Along with phosphorus (P), the central area also had elevated levels of aluminium (Al) (c. 33000-43000 mg/kg), copper (Cu) (c. 28 mg/kg), potassium (K) (c. 8000-11500 mg/kg), manganese (Mn) (c. 1300-2400 mg/kg) and zinc (Zn) (c. 106-187 mg/kg) and, to some extent, calcium (Ca) (c. 1200-2200 mg/kg) (Figures 6.13-6.17). The area close to the central and larger hearth pit 923 and encompassing the working hollow had the highest levels of P. Strontium (Sr) (c. 157 mg/kg), Fe (c. 54000 mg/kg) and Ni (c. 29 mg/kg) show the highest levels in the larger hearth pit area. The analysis of flots of the central hearth pit 923 from wet sieved samples revealed material consisting of burnt peat fuel waste, charcoal, and cereal grains such as emmer wheat with small amounts of spelt wheat and hulled barley (Alldritt 2019). It was found that the primary fuel source was peat, and the hearth 923 was mostly used for domestic cooking purposes. It was also possibly used for drying cereal grain before storage (Alldritt 2019). The samples that were taken from the smaller hearth pit 922, although showed a spike in the level of P, they were slightly lower compared to the amount of P in the larger hearth 923. Considering that this smaller pit contained only a few remains of heather and a small amount of hazel charcoal, it was also suggested to be the rake out of ash from the bigger pit 923 (Alldritt 2019; Waddington and Karl 2016, 20). Based on these observations, it is likely that the central area of the house was used for domestic cooking and food preparation. Moreover, the hearth pit 923 is well highlighted by the samples collected from around the top of the pit fill, which shows higher levels of a suite of elements just within the boundaries of the hearth pit such as Ca (c. 1900 mg/kg), Cr (56 mg/kg), Cu (28 mg/kg), Fe (25000 mg/kg), K (c. 10000 mg/kg), Mn (c. 1500 mg/kg), Ni (c. 16 mg/kg), Sr (c. 155 mg/kg), Zn (c. 181 mg/kg) and P (c. 2200 mg/kg) (Figures 6.13-6.17). The high levels of elements seen in the area of the hearth pit 923 and the smaller hearth pit 922 such as Sr, P, Cu, Zn, K, Ca, Fe, and Mn correspond well with the elements linked to hearths or areas of burning seen in other studies (for comparisons, see Table 3.1).

In terms of P, the smaller pit (922) had lower levels than the larger one (923). However, the levels of potassium (K) were found to be higher compared to the rest of the house floor in the samples from both hearth pits (Figure 6.14); around 9000-115000 mg/kg from samples above the hearth 923 and around 7300 mg/kg in the samples above 922. Higher K levels in this context indicate the presence of wood ash rather than peat ash alone, as peat is deficient in K compared to wood (Steenari *et al.* 1999, 249-258). Considering that Alldritt (2019) claimed peat was the primary fuel here, based on the charred botanical remains from the settlement, this could suggest that wood was used as fuel for particular activities in this house. Nevertheless, despite the elevated levels of Al, Ca, Fe, and K observed in the hearth pit zones, surpassing the natural subsoil levels, it should be noted that these elements are raised in the bedrock and may partly be a result of that.

The high P, Cu, and Mn overall in the central area may also be a result of the overspill from the hearth. The working hollow, however, is highlighted by the highest levels of P in the entire house floor (c. 2800 mg/kg) and, to some extent, Cu (25 mg/kg) and Mn (c. 1800 mg/kg) (Figures 6.13-6.17). Nonetheless, it is also worth highlighting that the high level of Cu is from the samples on the north side of the hearth, while the working hollow is on the south side. Metalworking is unlikely here as there is no archaeological evidence for this and charcoal-rich deposits, especially from hearths, tend to have high levels of Cu (Wilson *et al.* 2008). Furthermore, Pb levels are not high enough in the central area to suggest metalworking, as seen in other studies where metalworking areas show high levels of Cu, Mn, and Pb (Haslam and Tibbet 2004; Oonk *et al.* 2009; Table 3.1). Meat processing, perhaps, and hide/leatherworking activities, may be supported by the elevated levels of Zn, P, and Sr (to some extent) (see Table 3.1), seen in the area around the working hollow and following the branch of the drain toward the eastern quarter. This follows the suggestion that the adjacent drain was utilised in these activities, as water is required when processing hides (see also below). The suggestion of a hide/leather working area takes into account the levels of P, Zn, and Sr (see Table 3.1). However, while the Sr levels are higher than in the natural subsoil, the levels of Sr in the bedrock (being between 61 mg/kg and 412 mg/kg) are comparable and this deserves consideration here as the natural geology may have affected the chemical signature of elements within the archaeological sediments. This makes the suggestion of a hide/leather working area tentative. Likewise, the occupation layers, particularly layer 843 situated in the central area, exhibited a notable absence of artefacts such as smoothing or abrading stones, which typically signify activities like leatherworking. For instance, House 801 (floor 1150) at Cladh Hallan contained artefacts in the occupation layer such as pumice and flint which were linked to craft activities like hide working (Smith *et al*. 2021c, 128). The absence of objects such as this in the floor deposits at RH S019 throws doubt on the suggestion that a leather or hide working area was located in this house.

At Meillionydd, an alternative interpretation also arises when considering the fairly evenly distributed placement of the drain throughout the structure. It is plausible that the fundamental function of the drain, owing to its widespread presence, was facilitating the drainage of rainwater run-off accumulating within the dwelling, which derived from the quarry hollow. It should be noted that a system of drains was also constructed in the adjacent entranceway of the outer bank, suggesting that the primary function of these drains is related to the management of rainwater run-off.

West quarter of periphery

The western quarter of the periphery showed the lowest levels of almost all elements, which were, in some cases, close to the natural levels observed in the control samples in comparison to other quarters (see Table 6.3). The elements showing low levels were P (c.700-1300 mg/kg), Zn (c. 35 m/kg except for two samples showing levels c. 80 mg/kg), Ti (c 2200 mg/kg), Sr (c. 37 mg/kg), Mn (c. 300-700 mg/kg), K (c. 5000-6000 mg/kg), Cu (c. 8 mg/kg) and Ca (c. 600-1400 mg/kg) (Figures 6.13-6.17). Holmqvist and Ilves (2022, 394), in their study, observed that low levels of elements in an area could be a result of specific use patterns, sporadic use, or the efficient cleaning of the space, and this is an interpretation worth considering. However, generally low levels of most/all elements observed in an area were suggested to be linked to a sleeping area by Vyncke *et al.* (2011). Furthermore, Pingarrón (2014, 2807) noted in their study that areas around and under the bed tend to show low P levels (also see Table 3.1). These patterns in RH SO19 could also indicate the presence of a permanent furniture fixture such as a wooden or stone bed or containers for storage. In the first case study of House 2 at Bornais, the areas attributed to sleeping (East Central North area) also showed low levels of most elements (see Chapter 5). Hence, this area of RH SO19 was possibly used for sleeping and, perhaps, non-food storage, as even the spot samples from the occupation layer (853) overlying the branch of the drain in this quarter also showed low levels of all elements compared to the rest of the house, except for Ni (Figures 6.13-6.17).

This western quarter of the house–when the position of the entrance is considered–can arguably be interpreted as part of the back of the house. This is interesting as sleeping or sitting areas in the form of stone settings have been observed in the back of houses in other stone-walled roundhouses in northwest Wales, such as Caerau I, Pant y Saer, Cae'r Mynydd I and Braich y Dinas (Waddington 2013, 113). A similar observation is also made by Pope (2007, 217) where chordal stone beds were seen at the back of the structures in Gwynedd (albeit for Roman Iron Age roundhouses).

The enrichment of Ni alone in this suggested sleeping area in RH SO19 is problematic. Ni does not form a major component of the bedrock Sarn Complexes and the levels seen in the western quarter are also higher than the natural subsoil levels. Yet, the reason for the enrichment of Ni remains unknown. Almost all the samples in this quarter were from context 853, which is different to the central area which consisted of samples from contexts 853, 843, 894, 325, and 318. The low activity suggested by the distributions in the western quarter is mostly observed in the area of context 853 as well. Still, samples from 853, which occur within the central post ring (i.e. central area), do show enrichment of some elements, which suggests that the overall low levels (except for Ni) in the western quarter are a meaningful pattern. Still, the raised Ni levels here remain unexplained.

South quarter

The south quarter, where the samples collected came mostly from context 318, showed the second-lowest levels of most elements along with P. At face value, it could be argued that this area may have been used for storage or an activity that does not alter the chemical nature of the sediments much, such as spinning and weaving. However, there is an elevation towards the southeast in the levels of Zn (c. 53-209 mg/kg), Ti (c. 4600 mg/kg), Sr (c. 51-108 mg/kg), S (c. 125-310 mg/kg), Pb (46 mg/kg), Mn (c. 760-2573 mg/kg), K (c. 6800 mg/kg), Fe (c. 27000-50000 mg/kg), Cu (24-45 mg/kg) and to some extent P (3700 mg/kg) and Ca (c. 900-2200 mg/kg in three spots). This suggests that this small area may have been subjected to some intensive activity or multiple activities. While the levels of Cu, P, Zn, and Sr are higher (yet not obviously as high as in the central area), it may suggest the possibility of contact with organic material such as meat, as high levels of Sr, along with P and Zn, are a possible indicator of contact with meat preparation (Middleton and Price 1996; Milek and Roberts 2013; see Table 3.1) (Figures 6.13-6.17). Nevertheless, it is pertinent to highlight that while the Sr levels surpass the levels in the natural subsoil, they remain within the range observed in bedrock levels (Tables 6.1 and 6.3). Furthermore, the chemical signature of the bedrock is generally high in Ca in the form of calcium oxide, and this might have affected the patterns here. While this quarter, based on the distribution pattern of most elements, might suggest a dormant area on one end and intensive activity on the other end, the area immediately beyond the southeast end of this quarter showed a marked drop in levels of elements such as P, K, Pb, Mn, Fe, Cu, Cr, and Al in the same three spots closer to the wall (Figures 6.13-6.17). This marked drop may be related to the removal of floor deposits during the previous excavations of RH SO19 between 2010-2012 (as discussed above; also see Figure 6.11), and as such it is difficult to confidently assign any specific function to this area. It is possible that this area forms part of the sleeping/storage area at the back of the house, which is suggested for the adjacent west periphery quarter.

Eastern quarter of the periphery

The samples from this quarter were from context 318, and a few samples from 843. This quarter as a whole is connected by the drainage gully and its branches–perhaps there was an activity that was carried out in this area that involved a lot of fluid, such as water for hide working, which resulted in the wastewater/fluid accumulating in the drains (although see discussion above where it is suggested that the primary function of the drains is for rainwater run-off from the quarry hollow). One initial interpretation considered for this area was livestock stalling (see George 2017, 2019). However, in studies of houses where differences in phosphorus levels between hearth/cooking and a byre were analysed, it was found that a byre tends to have higher levels of P than the hearth (Wilson *et al.* 2008, 421). In RH SO19, the levels of P in the east quarter are similar to, or lower than, the central hearth area (1600-2600 mg/kg) (Figures 6.16-6.17). Furthermore, Wilson *et al.*'s (2008, 421) study also showed Zn levels would have been higher in a livestock stalling area. Here, Zn, which was found to be c. 50 mg/kg in this quarter, would have needed to be significantly higher than the hearth (c. 80 mg/kg) to confirm this area as a livestock stalling area (Figure 6.15). It is possible, however, that some kind of craft activity was located here. Leather or hide-working seems unlikely given the absence of smoothing or abrading stones (see above), but the elevated levels of lead (Pb) (c. 26-38 mg/kg) along with P observed in this area (Figure 6.15) suggest that it may have functioned as a craft working area (Holliday 2004, 303; see Table 3.1).

This quarter towards its southeastern end had a shallow scoop (873) which was filled with a dark brown silt with large amounts of charcoal fragments. This was suggested to represent a dump of hearth material (Waddington *et al.* in prep., Chapter 3). Similarly, this quarter also contained two other shallow scoops 63 and 65. 63 had a reddish brown silt with charcoal flecks while 65 had a deposit that was rich in charcoal with large fragments of charcoal (discussed above). As a result, the elevation of various elements such as Cl, Cr, Cu, Fe, Mn, P, Sr, Zn, and, to some extent, Ca, K, and Ti could be related to this hearth material dump (these features were excavated in 2010-2011). It is interesting to note, however, that the elevated elements include the suite of elements associated with hearths as seen in other studies (see Table 3.1). This quarter also included other discrete layers which were excavated in 2010 and were not sampled for multi-element analysis (see Figure 6.11). These include a thin layer of dark grey silty loam that was fairly rich in charcoal, ash, and reddened burnt clayey material (67) and covered the capping stones of the drain here, and another 'discrete patch of dark grey soil containing a lot of charcoal and ashy material (828)' in the eastern side of the house (Waddington *et al.* in prep., Chapter 3). This is suggested to be indicative of sweeping activities originating from the hearth (Waddington *et al.* in prep., Chapter 3). It is interesting, however, that the high levels of lead (Pb) in this quarter are different to the levels seen in the central area containing the hearth or ash pit (where Pb is present in lower levels). This casts some doubt on the higher Pb levels seen here being the result of the ashy material from the hearth. It is also noteworthy in this quarter that some elements show intermittent low levels towards the north/northeast periphery of the house floor. It seems likely that the excavation strategy may have affected the results here, as this is the area that was excavated in 2011, and 318 was noticeably patchy here at the time of sampling in 2013 (see Figure 6.11). So, the patchy low levels of some elements seen here may simply be the result of the natural levels found in the exposed subsoil.

Northern quarter and the entrance

The northern quarter of the periphery contained samples from 325, 843 and a few samples from 853. All the samples from the entrance were from 827. Along with P, other elements that showed elevated levels were Ca (c. 1900 mg/kg), Cu (c. 17 mg/kg towards the west end and c. 24 mg/kg towards the east end of this quarter), Mn (c.1000-1600 mg/kg in the east half of this quarter), Pb (c. 29-42 mg/kg in the entrance area), Sr (c. 66 mg/kg on the east side of the quarter), Ti (c. 4000-6000 mg/kg) on the east side of the quarter with other elements to a smaller extent. This suggests an active use of this area. In terms of levels of different elements present, this quarter is similar to the eastern quarter. However, considering that this area encompasses the entrance to the roundhouse, this quarter falls within a generally high-traffic area of the house. Hence the elevation in the range of elements seen here may be related to this. It must also be noted that it was the left half of the entrance area and the north quarter that appeared relatively enriched in terms of levels of various elements overall. This may be related to the active eastern quarter nearby rather than a bias towards the east in terms of traffic and footfall. However, this is still speculation at this point without any further conclusive evidence. A drop in levels of Al, Ca, Cr, Cu K, Fe, Mn, P, Pb, S, Sr, Ti, and Zn is visible toward the west end of the northern quarter and the start of the western quarter (Figures 6.13-6.17).

The western quarter of the periphery showed localised spots of chemical elevations of all elements in the west and southwest, particularly against the walls. Similar localised spots of elevated levels are also visible in the northwest and southeast areas of the house floor as well as to the east of the entrance area. It remains inconclusive why these spots show marked elevations in chemical elements. It is possible that some of the elevated spots relate to dumps of organic material on the house floor which have since decayed away. In contrast, there are three spot samples which are aligned in a straight line, and which show the lowest levels of elements–this is positioned immediately next to the entranceway of the house in the north quarter, more specifically in the northwest. Intriguingly, this pattern of low levels coincides with two scoops (914 and 916), identified by Waddington *et al.* (in prep., Chapter 3) as possible components of an internal setting on the house floor (Figure 6.11, also shown in red in Figure 6.27). The simultaneous occurrence of this alignment of scoops and the observed low chemical element levels could be attributed to various factors. One plausible explanation is that these findings may indicate the location of some kind of internal setting which might have served to define an activity area. It was also suggested based on the study of the pattern of P distribution that there is a potential for it to be a result of a roof that collapsed from the west side and decayed *in situ* on the floor (discussed above). It is perhaps interesting to note that this is reflected to some degree in the Mn and Cu distributions (but not in the other element distributions).

Summary of the results

The multi-elemental analysis has helped to highlight possible activity areas in this roundhouse floor. As discussed, the structural evidence reveals a possible centre-periphery organising principle to the house. However, a left-right division, such that the left side of the house, including the central area, is an active part and the right side is a less active part of the house, is also possibly visible. Interestingly, the drain of the house can also be seen as dividing the internal area of RH SO19 in a similar manner. Some of the chemical signatures present in different areas of the house floor have been interpreted as activity areas in the house, but as explored, the situation is complicated: the excavation processes, as well as the natural and cultural formation processes of the house, and its abandonment and post-abandonment processes, must be considered as factors which contributed to the distribution of different elements across this roundhouse floor.

6.7 Comparison with Other Similar Roundhouses and Studies

Use of domestic space in roundhouses in Britain and suggested models

As stated near the beginning of this chapter, there have been numerous studies focused on other parts of Britain that have attempted to understand the use of space within the roundhouse by looking at the spatial arrangements of features, doorways, and deposits (Oswald 1991; 1997; Fitzpatrick 1994; Parker Pearson 1996; 1999). Among the earliest was Chadwick (1960), who suggested a north/south division of space for sleeping/living within the Iron Age roundhouse at Longbridge Deverill Cow Down, Wiltshire. However, it was Fitzpatrick (1994) who associated this with cosmological referents such as the passage of time and the orientation of the entrance. Oswald (1991; 1997) had earlier concluded that the orientation of roundhouse entrances in the Iron Age of Britain was concerned with a symbolic significance, as most were orientated to the east, southeast and the rising sun. Parker Pearson (1996; 1999), then, forming a connection with Fitzpatrick's and Oswald's conclusions, along with the idea of the movement of the sun and time around the house, established a cosmological model that dictated the division of space and life within the roundhouses of the Iron Age (Figure 6.19). This seminal work in the use of space stemmed from the study of roundhouse entrance orientations, and it has been influential in roundhouse studies.

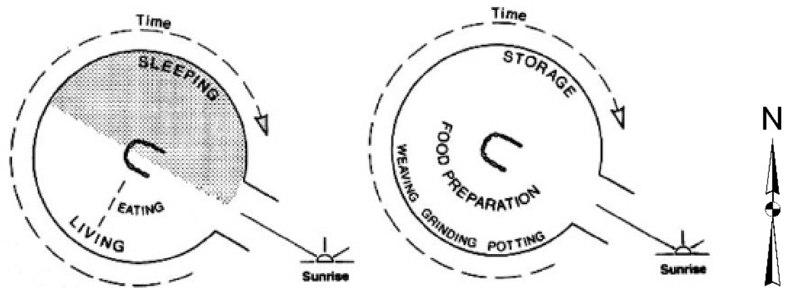

Figure 6.19: The cosmological model based on interpretations suggested by Parker Pearson (1999) and Fitzpatrick (1994) (Pope 2007, fig. 1).

The sunwise cosmological model was mainly based on the findings of Fitzpatrick (1994) at an Early Iron Age roundhouse at Dunston Park, Berkshire, and that at Longbridge Deverill Cow Down, Wiltshire (Chadwick Hawkes 1994). Fitzpatrick (1994, 68) suggested that there was a division of space in the Iron Age roundhouses at these sites based on the observation that the find depositions were concentrated in the porch and left side of the house[x]. At Dunston Park, small, abraded pottery sherds were recorded in the postholes on the left-hand side of the house, while three sherds of coarseware indicative of a storage area or a toilet were recovered from the right side (Fitzpatrick 1994, 68-69). At House 3, in Longbridge Deverill Cow Down, finds such as burnt flint, spindle whorls, querns, animal bones, bone tools, a possible loom and pottery were recovered from the left side of the house. These were claimed to indicate the location of domestic activities (Chadwick Hawkes 1994, 67). Due to the higher concentration of finds in the left front area of the house, it may have been this left front area that was the focus of domestic activities. This house was destroyed by fire at the end of its occupation (Chadwick Hawkes 1994, 67). Considering this, Pope (2007, 208) has suggested that it is probably more likely that, in this case, the finds do indicate a daily use of space here. Fitzpatrick

(1994, 70) used these findings to suggest a separate sleeping area on the right side and a living area on the left-hand side of the roundhouse. Incorporating this with the orientation of roundhouse entrances observed by Oswald (1991, 1997) to be towards the southeast, mainly in southern Britain, a cosmological sunwise model for the use of space was advanced (Parker Pearson 1999; Giles and Parker Pearson 1999; Parker Pearson and Sharples 1999, Figure 6.19). These various works proposed the application of the sunwise model as a general model for the use of space anywhere in the Late Bronze Age-Iron Age Britain, with local subtleties. It suggested that with the roundhouse entrances predominantly aligned with the sunrise during equinox and midwinter solstice (i.e. southeast), the sun's trajectory held meaningful organisational significance in the daily and annual practices of the Iron Age and within the Iron Age houses. As proposed by Fitzpatrick (1994; also cited in Giles and Parker Pearson 1999, 219), the prevalent alignment towards the winter sunrise suggested a conceptual framework wherein time progressed in harmony with the sun's movement around the dwelling. This arrangement delineated the interior of the roundhouse into a southern half associated with 'day' and a northern half associated with 'night'. Consequently, the sequential progression of activities within the dwelling corresponded with the sun's transit, encompassing daytime food preparation and craft activities in the southern half of the house and nighttime sleeping and storage in the northern half of the house (Giles and Parker Pearson 1999, 219). However, Giles and Parker Pearson (1999, 219) also acknowledged that there were local subtleties and differences, and this model could not be applied to all buildings.

Does RH SO19 at Meillionydd show a division of internal space in terms of a right-side sleeping/storage area and left-side living area, similar to Parker Pearson's (1996; 1999) and Fitzpatrick's (1994) sunwise model? Currently the evidence is not there to support this argument. In RH SO19, a cooking/food preparation area is argued to lie in the central area, located around the hearth, with a sleeping area at the back of the house, which would better conform with Hingley's centre: periphery model. RH SO19 also does not fully comply with the sunwise models as its entrance faces north and onto the eastern entrance passage to the settlement. However, Parker Pearson (1999, 50) noted that even when roundhouses had entrances facing other directions (such as west), the sunwise principle was still followed with the internal activities simply rotated.

Webley (2007), on the other hand, while promoting the idea of a left/right division of space within the roundhouse, claimed that it was the opposite side that was, in fact, the activity area. He suggested that depositions of finds recorded were a result of deliberate depositions during the abandonment process of the roundhouses and that only the evidence which is contemporary with the house can be used to discern the use of its floor. These claims are based on the clay-lined pits observed on the right-hand side of twenty-nine roundhouses from ten different sites in southern England. These pits have been used to indicate the location of activity areas located on the right-hand side of the house floors (Webley 2007, 133). Based on the artefact concentrations observed in a large number of Late Bronze Age to Iron Age roundhouses excavated across southern England, it is apparently evident that the concentration of artefacts in the roundhouse is unusual, and in most cases, the number of artefacts recovered from postholes or other structural parts of the roundhouse is small (Webley 2007, 133). It was also noted that in the very few cases where the floors were preserved, they appeared to be kept tidy or swept clean on abandonment (Webley 2007, 133). Webley also claimed that any artefact concentrations (where recorded) on the left-hand side were only in the case of a few roundhouses that belonged to the period of the Late Bronze Age to Early Iron Age transition (Webley 2007, 133). He proposed that it was unlikely that artefact concentrations observed were a result of accidental deposition formed through daily activities, but instead, they were deliberate 'structured' or 'ritualized' depositions made during abandonment (Webley 2007, 133-139). One example of such evidence for deliberate deposition comes from the excavation at Broom in Bedfordshire, where only the structural postholes on the left-hand side and the entrance had post-pipes while the ones on the right-hand side did not (e.g. Structure 2) (Webley 2007, 138). Post-pipes indicate that posts were left *in situ*. Furthermore, artefacts were concentrated on the side where posts had been left, suggesting the presence of a deliberate abandonment ritual, with one half of the house being pulled down and the other half allowed to stand forming the focus for structured deposits (Webley 2007, 138).

In another example, copious quantities of large broken pottery sherds were observed to have been deliberately packed into the upper fills of the burnt-out postholes on the left side of the house at Longbridge Deverill Cow Down. This example demonstrates that ritual deposition was happening here at the end of the life cycle of this building (Webley 2007, 136). Hence, he argues that the deposits found mostly on the left-hand side of buildings actually relate to the complex abandonment rites of the buildings, not their day-to-day use.

As such, based on the common location of clay-lined cooking pits found on the right-hand sides of roundhouse floors at Late Bronze Age to Middle Iron Age sites, Webley concluded that the right side of the roundhouses was the activity area. This had the effect of turning the sunwise model on its head, by suggesting that the north side of the roundhouse floor was the activity area while the south side of the house was reserved for passive activities like sleeping/storage. However, he also warned that it should not be assumed that all contemporary roundhouses were used in the same way and that the pattern was only based on evidence for southern England and hence cannot be assumed for roundhouses in other parts of Britain (Webley 2007, 141-142). Webley's (2007, 141) idea of a left/right division of space in roundhouses could be applicable to RH SO19 at Meillionydd. This distinction is visible such that as you enter the building, the front east side is possibly an activity area, whilst the back west side seems to be an area for passive activities such as sleeping/storage. However, the central area is also an active area, as this is where the hearth is located. Nevertheless, it is imperative to note a caveat, namely, that Webley (2007) formulated these ideas within the context of roundhouses featuring entrances oriented towards the east, whereas the entrance of RH SO19 at Meillionydd faced north. As such, it seems that whilst the orientation of the house entrance-way was not a structuring principle in the organisation of space within this house, the left-right division of that space seems to have been important (see also Parker Pearson 1999, 50).

Iron Age stone-built roundhouses of northern Britain and Scotland are better preserved in terms of floors and architectural layout, and some in Atlantic Scotland have radial stone partitions (Reid 1989). Effectively, these roundhouses, such as the brochs and wheelhouses, have an interior that is partitioned into a central area and a peripheral area, made up of smaller rooms or cells by stone radial partitions (Hingley 1990, 130). Whilst this might seem quite different to the timber roundhouses of southern England, such as Longbridge Deverill Cow Down discussed above, Hingley (1990, 130) noted that here the hearth was commonly located centrally in many of the roundhouses. Furthermore, central hearths seem to be characteristic of double-ringed and simple ring-post roundhouses (Hingley 1990, 130). Architecturally, the Scottish stone roundhouses and their timber counterparts in southern Britain are remarkably similar in layout. Based on these observations, Hingley (1990, 180) suggested that it was likely that the central area of any roundhouse in any area of Britain was for cooking, eating and activity, while the peripheral area was for sleeping and storage. The central area receiving the most light (natural and from the hearth) in the house was deemed the 'public' area used for eating, drinking, socialising, and entertaining around the hearth. The peripheral 'private' area, being dark and constricted, was assigned to other activities such as storage or sleeping areas but could have also been for stalling cattle and other livestock (Hingley 1990, 132; Figure 6.20). He cited evidence from phosphate analyses of Iron Age houses in Moel y Gerddi, Erw-wen and Cefn Graeanog (all in northwest Wales) that indicated high levels for the peripheral areas and low for the central area as evidence for the validity of such a model (Hingley 1990, 132; sites also discussed in detail in Chapter 2). He suggested that such elevated levels of phosphorus in peripheral areas, along with indicating livestock stalling, also indicated the presence of low roofs, making the peripheral area not very accessible and difficult to clean and sweep. Furthermore, Hingley (1990, 132) suggested there was a binary division of space that was also a conceptual division of the way in which Iron Age societies organised their worlds, between light and dark, and day/night, culture/nature, cooked/raw, winter/summer and male/female: such organising cosmological principles have been observed in many other societies (for further discussion see Hingley 1990, 132-135; see Chapter 8).

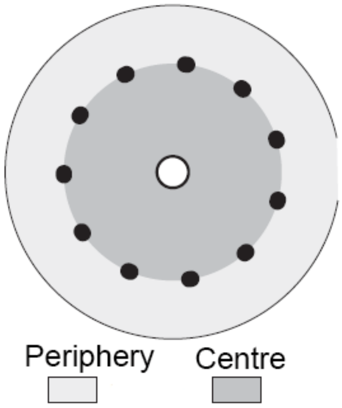

Figure 6.20: Centre-periphery model for the use of space in roundhouses suggested by Hingley (1990; cited in Sharples 2010, fig 4.3).

A central-peripheral division of space is possible at the Meillionydd stone roundhouse, with a central living space defined by the post-ring and hearths and working hollow, and peripheral areas which were possibly a focus for other activities. This would make the house similar in some senses to the stone-built roundhouses of Atlantic Scotland, such as Bu and the Howe in Orkney, which contain central areas containing a hearth and peripheral areas (Figure 6.3; Armit 2003). Hingley has also suggested a similarity here with the double-ringed timber roundhouses of southern Britain, where the inner ring of posts bordered the central area while the peripheral area was restricted by low roofs. At Meillionydd, in RH SO19, it would have been the central and front area of the floor that would have most likely received the most light due to the location of the hearth (923) and the natural light from the entrance. However, it must be highlighted that the entrance area of this house is orientated north, and as a result, it would never receive direct sunlight, which might suggest that RH SO19 was a darker house than some. This again suggests that the central area of this particular house was the most well-lit area due to the location of the hearth. Furthermore, based on the multi-element analysis, the likely eating, socialising (among possible activities), and daily working 'public' area would have been the central front area of the house. The idea of a darker peripheral 'private' area is nevertheless still possible at RH SO19 in the peripheral back areas of this house, which was likely reserved for sleeping and storage. However, Hingley (1990, 132) had used examples of phosphate analysis of Iron Age houses in Moel-y-Gerddi, Erw-wen and Cefn Graeanog that indicated high levels of P for the peripheral area and low for the central area to also suggest livestock stalling in the peripheral area where there are low roofs. At RH SO19, the opposite is observed, such that the P levels are high in the central and front areas and lower in the back peripheral areas. Thus, Hingley's centre-periphery model can be seen as applicable but only to a certain extent. It seems unlikely that livestock was kept in the peripheral areas in this roundhouse at Meillionydd, with the only peripheral area (east quarter) that would have been a good candidate to stall small livestock (if at all) not showing any significantly high levels of zinc (Zn) which is associated with livestock stalling along with P (Wilson *et al.* 2008). Furthermore, the active area of the east quarter indicates that this area was indeed accessible, which may be a suggestion of RH SO19 having higher roofs than the low roofs proposed in the timber roundhouses by Hingley (1990).

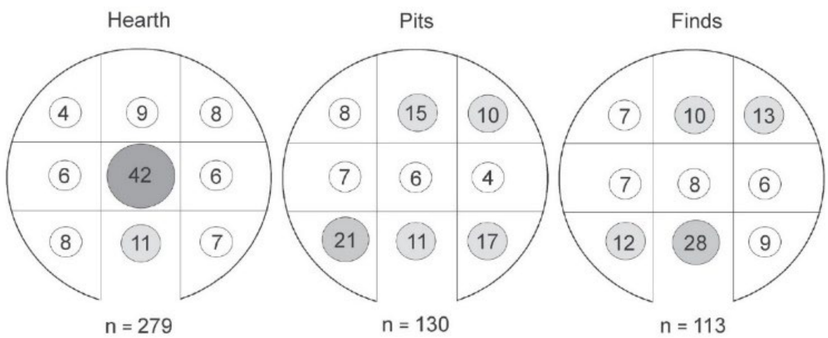

Figure 6.21: Spatial patterning of hearths, pits, and find (%) found by Pope (2007, fig. 7).

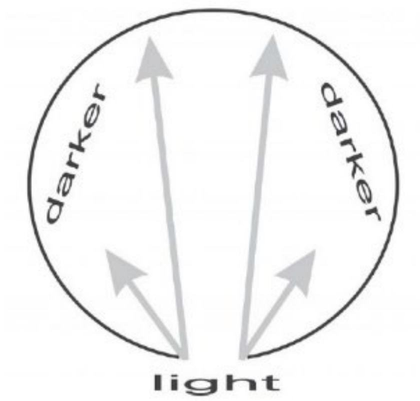

Figure 6.22: Falling of sunlight in roundhouse (Pope 2007, fig. 8).

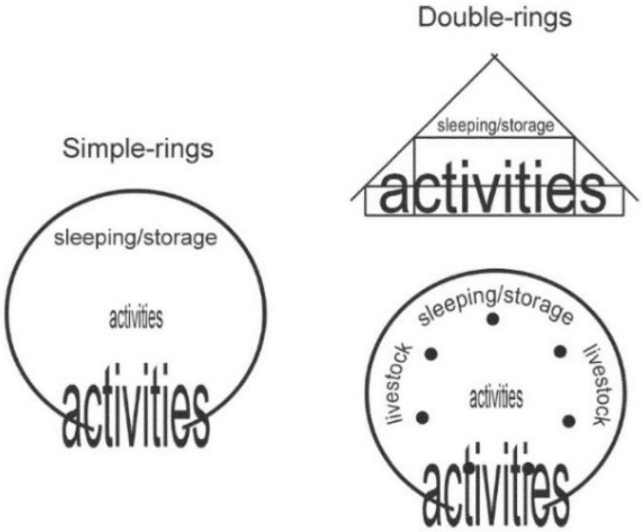

Figure 6.23: Pope's model of prehistoric use of domestic space (Pope 2007, fig. 12).

Based on the study of the position of hearths, pits, and finds from a large dataset of roundhouses in central and northern Britain, Pope (2007) suggested a model for the organisation of internal space in roundhouses around the distinction of centre-periphery and front-back spaces (Figure 6.21 and 6.23). Her study revealed that while pits in these regions were mainly found at the front of many houses, there was also a preference for the front left in their distribution (Pope 2007, 215; Figure 6.21). While observing that pits in houses were mutually exclusive and not linked to the hearths, the hearths were located centrally with some tendency towards the front of the centre. Distributions of finds suggested a strong preference for the entrance area and a minor tendency towards the back right (Pope 2007, 215; Figure 6.21). She observed that in the roundhouses, where there was a double-post setting that suggested the presence of a loom, they were all located in the front area of the structure (Pope 2007, 215). At Tormore10/1, Arran, where there were postholes producing finds suggesting activity in the area next to the doorway, there was also evidence for processing activities associated with wood and crops along with a concentration of lithics. Evidence for wood storage and grain was also found towards the back of the building (Barber 1997, 110; cited in Pope 2007, 216). While bedding material was found towards the back of the roundhouses at South Shields, a working surface and pits and debris from grain processing were found towards the front (Hodgson *et al.* 2001; cited in Pope 2007, 216). Along with these, citing other evidence from Roman Iron Age roundhouses in Northumberland and Gwynedd and with the idea of how light falls in a circular structure (Figure 6.22), Pope (2007, 217) claimed that there was a front-back division of space. Moreover, while she agreed with the general premise of Hingley's (1990) idea of a centre-periphery division of space, she also suggested that the peripheral area may have been just as dynamic in function as the central area (Pope 2007, 217-219). Pope, therefore, made a number of observations:

- there were either chordal or annular divisions of space in the peripheral region. Such chordal divisions, especially chordal bed arrangements, were observed in 25% of the structures from Tyne-Forth and North Wales region in her dataset;
- double-ring and triple-ring structures were two times more likely to house livestock than simple-ring structures (Pope 2007, 219);
- in her survey of ethnographic literature, ten of the twenty roundhouse-using communities had space allocated for livestock such as cows, calves, or goats (Pope 2007, 219);
- the often-overlooked area in archaeology that lies immediately outside the doorway of roundhouses may have been an activity area. She has interpreted the distribution of pottery between the doorway and gateway at the roundhouse at Longbridge Deverill Cow Down as an indicator of such domestic activity (Pope 2007, 221).

Therefore, Pope has suggested that two strong trends are observable in the use of internal space in roundhouses. One is the difference in the use of the front and the back of the house, wherein the backspace (particularly the periphery) was used for sleeping and storage. In the case of double-ringed structures, such activities may have taken place on an upper floor. The second trend is the division between central and peripheral spaces, similar to Hingley's model (1990). The central space was the focus of activities around the hearth and the entranceway, and the peripheral space was for stalling livestock (Pope 2007, 221). In essence, she suggests that 'active' practices tend to be towards the light and easily accessible areas such as the centre, front and outside of the house. In contrast, the 'passive' activities, such as sleeping and storage, tend to be towards the less accessible periphery, backspace, and upper floor (Pope 2007, 221; Figure 6.23). She also argues that the use and organisation of later British prehistoric roundhouses were probably not governed by static social 'rules' (Pope 2007, 221), although a survey of the ethnographic data presented in Chapter 3 suggests that this latter point seems unlikely.

Some observations and ideas suggested for the use of internal space within roundhouses by Pope (2003, 2007) can be seen as applicable at RH SO19 at Meillionydd. Pope's observations of chordal/annular division in roundhouses may be suggested at Meillionydd. The possibility of a sleeping area in the west peripheral quarter in RH SO19 is also reinforced by Pope's observation of several roundhouses from North Wales, which had evidence of chordal bed arrangements in the back. Although there is an inner ring of posts in RH SO19, the likelihood of a livestock stalling area inside, as suggested by Pope, is low as the levels of P would have been higher in the peripheral areas of the house than in the central area that encompassed the hearth. At the Meillionydd roundhouse, the opposite is observed. Pope's suggestion of an active area in front of the house just outside could not be investigated for RH SO19 as the entrance to this roundhouse was part of the entrance passage of the outer enclosure of the site. Hence, samples, if collected, would have been contaminated/disturbed.

While quite a few models and ideas for the use of space have been suggested, there are also problems associated with the evidence and methods used. Most models attempt to suggest a universal pattern for roundhouses for a generally large area or an area as large as Britain. The likelihood of regional patterns occurring is not studied or emphasised in great detail (except perhaps Pope (2003; 2007), who studied northern and central Britain). All these studies rely heavily on the finds distributions as the primary source of evidence. It is also often assumed that the find locations equate with daily activity. In other words, artefacts from house floors are used as a proxy for activity. However, Webley (2007) and Waddington (2014) have argued that many finds within roundhouses could be associated with complicated construction or abandonment processes. This highlights a possible flaw in models that are based on the idea that finds reflect routine activities. Equally, not all finds are a result of construction or abandonment activity. Some of the artefacts could indeed be indicative of the daily activity or an isolated activity during the use of the roundhouse. This was aptly demonstrated by Reynolds (1995) and Mytum and Meek (2020), who argued that small artefacts were likely to get deposited in postholes during the use of the roundhouses. House floors, on the other hand, can be an excellent source to extract information about the daily activity in a roundhouse. However, one of the problems in British archaeology is the poor survival of roundhouse floors. Another issue is that most distribution studies have only considered horizontal patterning. This inherently assumes that all finds found within the area analysed have a contemporary deposition. Waddington (2014, 90), in her analysis of houses in the Howe, Orkney, has shown that the temporality of depositions should be considered by taking into account the vertical distribution pattern. That is, it is necessary to identify whether the depositions are a result of depositional processes associated with construction, occupation, and abandonment processes (Waddington 2014).

While the identification of the artefacts in terms of what context they come from i.e. construction, occupation or abandonment is important, it is also important to identify what phase of the house lifecycle the individual layers are related to. Construction layers are layers that are often linked to the natural subsoil of the sites forming a substrate upon which houses are erected. Layers resulting from surface levelling (e.g. in the creation of roundhouse platforms) through the redistribution of natural subsoil also fall within the classification of construction layers. Similarly, floors constructed of stone could also be classified as construction layers rather than occupation layers. Given their likely sterility, the chemical composition of construction layers is anticipated to mirror or closely resemble that of the natural subsoil.

Occupation layers, conversely, are identifiable by their dark colours and substantial presence of micro-debris from processes such as trampling on the house floor, comprising detritus, charcoal and burnt organic matter (Dempsey and Mandel 2017, 486-487; Wass 1992, 129-130). Abandonment layers, in contrast, will exhibit relative sterility in terms of micro-debris and occupation detritus because they are not lived-on surfaces, and they will also exhibit less evidence for trampling. These layers may contain wind-blown sediments, such as sand. A good example of abandonment layers is observable at Bornais House 2, where the abandonment layers, which accumulated directly above the house floors, are characterised by the presence of wind-blown sand. Abandonment layers may also encompass sediments resulting from the intentional infilling of the dwelling, symbolising the end of the house, such as the infilling of houses with rubble and stony deposits (e.g. Meillionydd RH S008; Waddington *et al.* in prep., Chapter 4; and House 2222 at Trethellan Farm; Nowakowki 2001, 139-148). The artefacts in abandonment layers can sometimes be associated with the final occupation of the house floor: this is the case when artefacts are left on the surface of the floor of the house during the abandonment of the house (Barker 1993, 156). For instance, in House 801 at Cladh Hallan, and sitting directly on top of floor 1150 rather than being embedded within it, were artefacts like a hammerstone, a bone point, a grinding stone, and a cluster of six bone and antler tools (Parker Pearson *et al.* 2021c, 137). These artefacts were later combined with the overlying abandonment layers but clearly relate to the final occupation of the house floor. Nevertheless, the artefacts within abandonment layers could also be part of the deliberate infilling of the structure. There are also instances where the number of artefacts in the abandonment layers significantly outnumbers the ones in the occupation layers. While RH SO19 at Meillionydd is a good example of this pattern (see discussion above), another example comes from the Late Bronze Age settlement at Trethellan Farm (Nowakowski 2001) where several houses had substantially larger numbers of finds in the abandonment layers rather than the occupation layers. For example, House 648 had only ten artefacts associated with the main phase of the activity in the house, whereas over 196 finds were recovered from its abandonment layers (Nowakowski 2001, 143). Although abandonment layers typically may lack micro-debris linked to occupation, the final abandonment layers of House 2010 at Trethellan Farm contained extensive spreads of charred wild plant and cereal seeds and old wood. However, this charring has been attributed to an open fire that was lit on these layers sometime after the house had been abandoned (Nowakowski 2001, 142-143).

There are very few examples of sites in northwest Wales where the internal use of space has been studied based on internal features, artefact deposits, and geochemical analyses. This has been tackled through this study of RH SO19, although, unfortunately, it was not possible to conduct a spatial analysis of the finds, which will be forthcoming by the excavators (Waddington *et al.* in prep.). Nevertheless, comparisons for roundhouses with geochemical analyses in northwest Wales exist at Erw-wen, Cefn Graeanog and Moel y Gerddi (Kelly *et al.* 1988; Conway 1983). Although these studies were based solely on the levels of phosphorus, they are still useful in guiding the interpretation of the Meillionydd roundhouse. While a phosphorus study was also conducted at Woodside Camp and Dan-y-Coed in Pembrokeshire (Williams 1998), the results from within the roundhouse were inconclusive in revealing the use of internal space (see Chapter 3). The study of phosphorus in the Iron Age roundhouses at Erw-wen and Moel y Gerddi revealed that low levels of P were towards the centre, and higher levels were in the peripheral areas and close to the walls (Kelly *et al.* 1988; Figures 6.24 and 6.25). Such a pattern was attributed to two factors. Firstly, the central hearth was cleaned and swept regularly. Secondly, these roundhouses probably had low roofs, which made the peripheral areas hard to reach and clean, indicating an accumulation of sweepings (Kelly *et al.* 1988, 115-117). Similar patterns were observed in the roundhouses at Cefn Graeanog (Hut C, Roman Iron Age) (Figure 6.26) and the Later Iron Age site of Dalnaglar, Perthshire (Conway 1983; Stewart *et al.* 1964). According to Conway (1983, 123), the general pattern of higher values adjacent to the walls is best explained by the erosion of built floors made of dung-tempered clay or some similar material and the presence of patches of fine materials close to the walls in Hut C at Cefn Graeanog. He also suggests that higher values observed close to walls could result from sloping or the presence of structures such as bed platforms or benches adjacent to the walls (Conway 1983, 123). In other words, the peripheral areas in the interior of the house were inaccessible due to furniture and hence difficult to clean. Analysing such studies, Pope (2007, 217), alternatively, claimed that it indicates the peripheral areas in these roundhouses were used for livestock stalling.

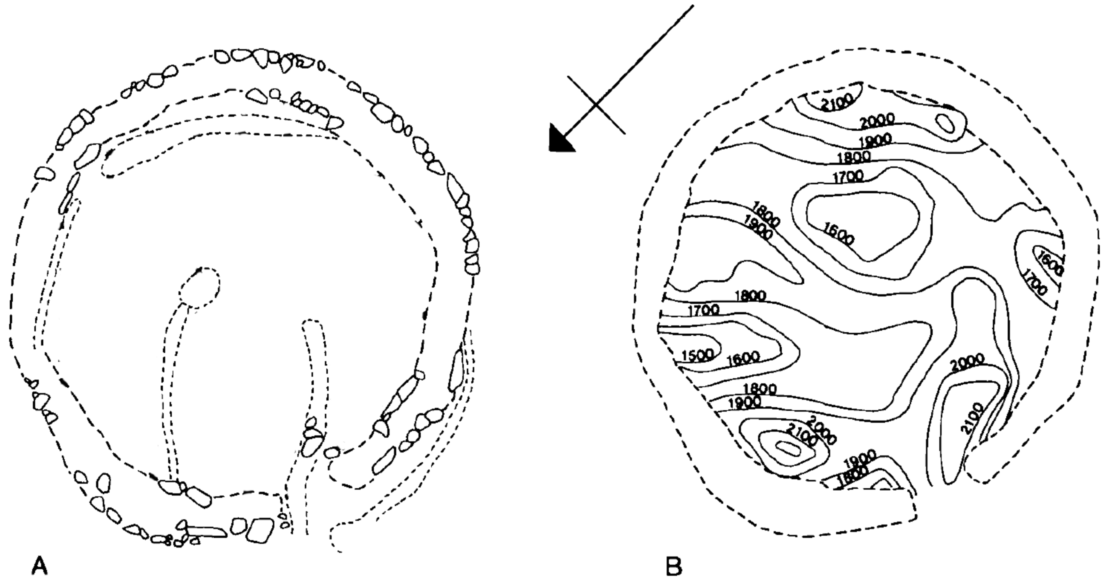

Figure 6.24: Sampling spots in the roundhouse at Erw-wen (A) and phosphorus levels in the same roundhouse in ppm (B) (Kelly *et al.* 1988, fig 21).

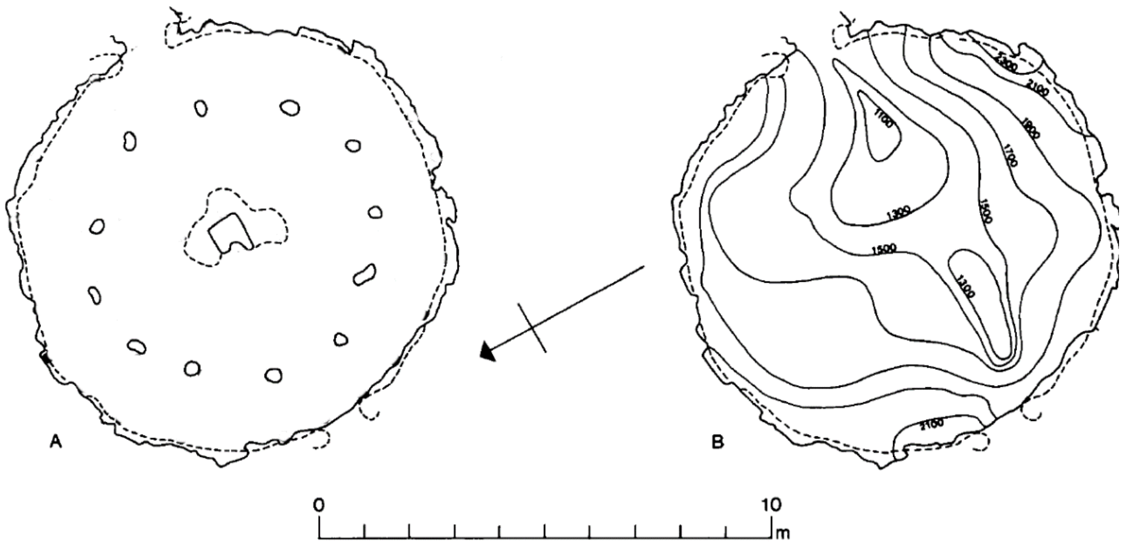

Figure 6.25: Sampling spots in the roundhouse at Moel y Gerddi (A) and phosphorus levels in the same roundhouse in ppm (B) (Kelly *et al.* 1988, fig 12).

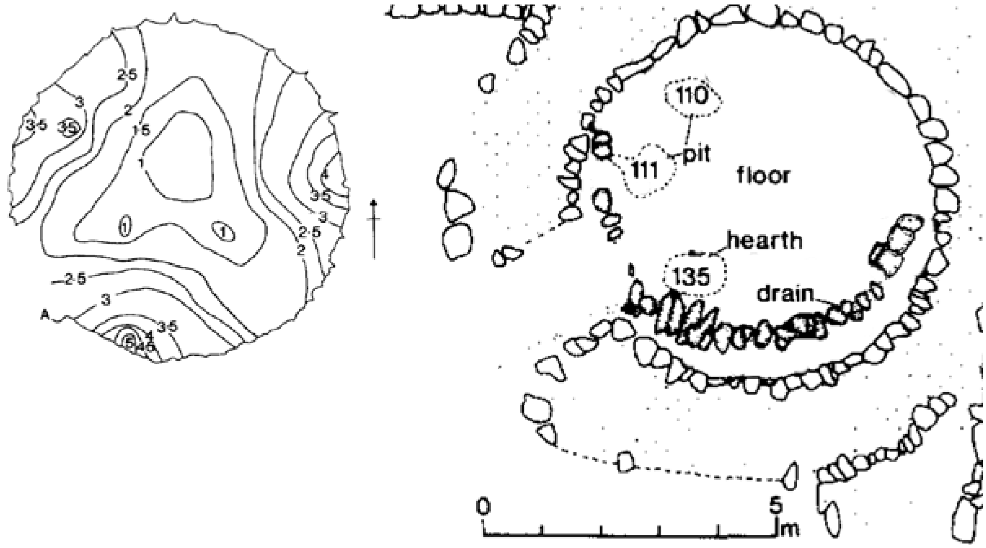

Figure 6.26: Phosphorus levels (in x1000 ppm) in Hut C at Cefn Graeanog (left) and plan of Hut C (right) (Conway 1983, fig 2).

This short review of the above roundhouses and their interpretations, along with the interpretation from the multi-element analyses at Meillionydd presented here, demonstrates that it can still be suggested that there was an accessible peripheral region for cleaning at RH SO19, as several elements showed lower levels of enrichment in the sediment in the western and southern quarters. On the other hand, the eastern quarter remains not very conclusive with one possibility being craft activities. Nonetheless, the periphery would have been accessible which could indicate that the roundhouse had a high conical roof or an upper storey or a chordal or annular loft supported by the internal post ring.

Leatherworking was tentatively explored to have been a possible activity in the central area, based on the observation of a working hollow connected to the drain. This is because working animal skins require a lot of water: the skins are cleaned of the adhering flesh with flint scrapers, and water is used to wash the residues away and to clean the skins (Sian Evans pers. comm.). The central working hollow would be a good place to do this work, with the drainage system carrying the material away. However, this interpretation remains highly speculative as there is a lack of artefactual evidence to support it, and it is more likely that the drains were used to manage rainwater run-off from the quarry hollow. While comparison can be drawn to roundhouses with internal drainage systems in other sites in northwest Wales, such as at Melin y Plas (Cutter *et al.* 2012) or House C at Bryn Eryr (Longley *et al.* 1998), where drainage gullies, similar to RH SO19, are connected to the central area of these houses, what is required is comparable multi-element analysis to suggest any ideas for the use of these features.

The complex implications arising from the over-digging of house floors in the southern and the eastern part of the periphery of the house floor, coupled with consequent data distortion, and the possible consequences of other cultural and natural processes at this site, and the lack of other independent lines of evidence from other studies, have engendered issues in the interpretation of the patterns at Meillionydd. One avenue to bolster the multi-element distributions involves the integration of soil micromorphological analyses alongside magnetic susceptibility analyses. The strategic allocation of sampling points, including representative selections from the four quarters as well as the central area of the house floors, would notably enhance the confidence in the interpretations, thereby affording nuanced insights into the stratigraphic and depositional dynamics inherent to this house floor.

Based on the results and interpretations from the multi-element analysis, along with the above discussion of other comparable sites, I would argue that RH SO19 possibly shows evidence of a front activity area of the house, which included the entrance, north quarter, and east quarter, which were active areas where daily work and craft production activities could have occurred (Figure 6.27). This might be supported by the evidence for an internal setting near the entranceway, on the right-hand side of the house as you enter, which may define one activity area. In addition, the central area with the hearth, bordered by the internal post ring, was probably the main cooking area of the house, which may have had other functions as well. Finally, the western quarter of the periphery and possibly a part of the southern quarter of the periphery (back of the house) could have been the sleeping/storage area and this marries up with evidence from other stone-walled roundhouses in northwest Wales. It has also been suggested that a small area in the southeastern part could have perhaps been used for food storage/processing. However, other secondary functions for this area cannot be ruled out (Figure 6.27). Furthermore, considering that the floor in this part of the house was patchy due to over-digging, this interpretation remains problematic.

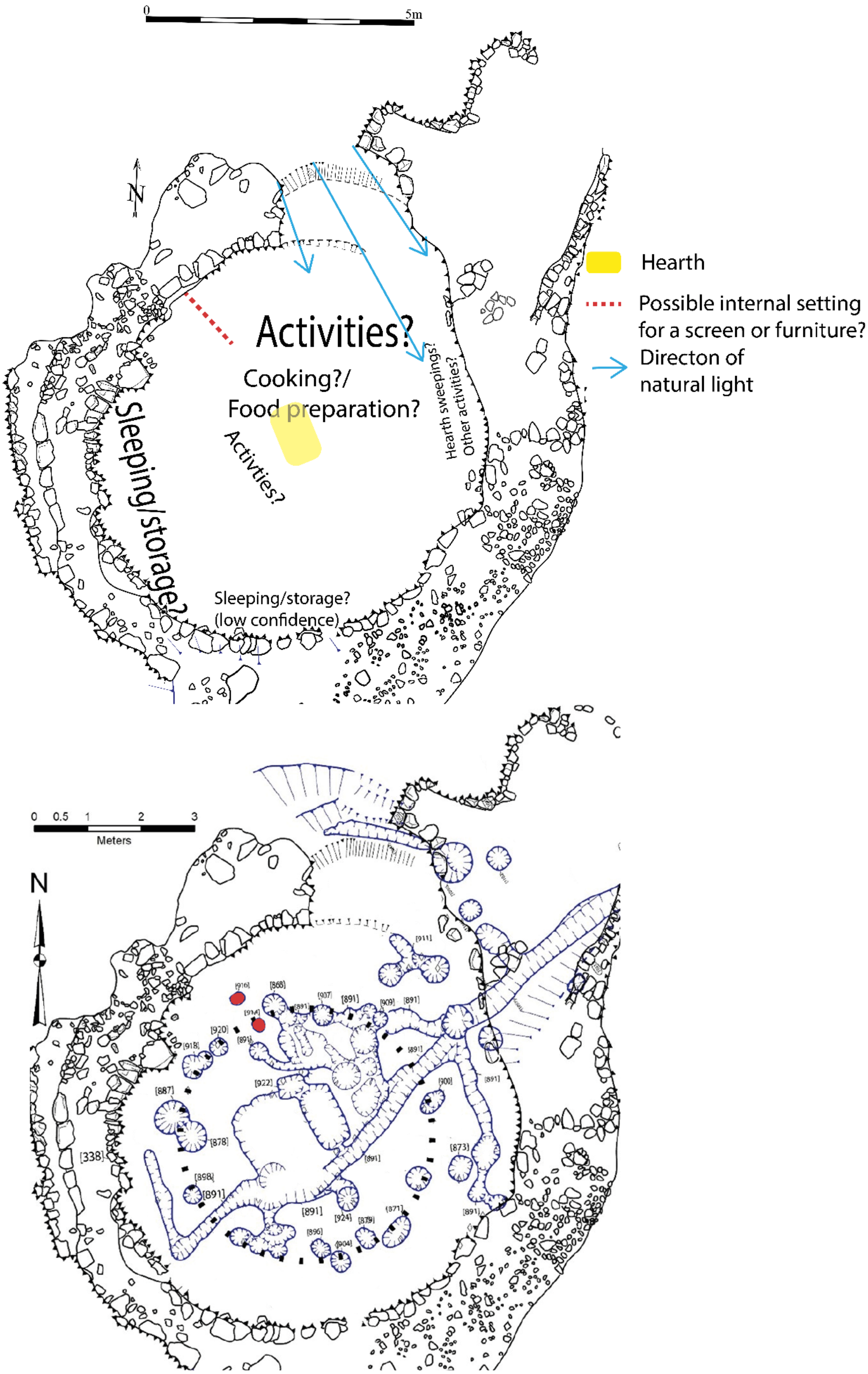

Figure 6.27: Interpretive schematic plan of RH SO19 showing the organisation of internal space (top), and plan of RH SO19 showing internal features with the two scoops or possible internal setting in red and the dotted circle showing the post-ring (bottom).

6.8 Conclusion

This study has demonstrated the advantages of a multi-element analysis compared to the sole phosphorus study of roundhouse floors. The multi-element analysis has contributed additional ideas for the organisation of this roundhouse floor, although as discussed, there are multiple reasons for the distribution patterns observed which may have been related to natural and cultural processes, as well as the abandonment and post-abandonment processes in the house, and the earlier excavations on part of this roundhouse floor. I have argued that the eastern peripheral quarter may have been associated with craft activities with the caveat that the higher levels of most elements seen here may be the result of ash material deposits accumulating here. The western quarter of the periphery was possibly linked to sleeping/storage, and this may have extended into the southern peripheral quarter, although the confidence in the interpretation of the levels of the chemical elements here is low because of the 2010-2011 excavation strategies. I have also argued about the possibility of an internal setting for a screen or furniture in the northwest based on a linear drop in levels of chemical elements which coincides with an internal setting. The central area around the hearth was likely a cooking/food preparation area, but the adjacent working hollow was possibly also used for other daily activities. The area to the north and the south of the hearth could have been used in different ways. While these arguments have been made, because of the complicated nature of the data at this site, it is imperative to reiterate that they remain just one of the possible interpretations of the data.

This study has demonstrated the possible utility of multi-element analyses in archaeology, especially in studying the internal space of roundhouses, but stressed that the data must be compared with the archaeological evidence. As demonstrated here, one of the flaws in most studies of the use of space within roundhouses is that they are heavily reliant on the spatial distributions of finds within the roundhouses and the assumption that the finds reflect routine activities, which may not always be the case. Hence, multi-element analyses, not being reliant on finds, could be a possible way to avoid that assumption and potential errors in interpretations. This method is particularly useful at sites with poor survival of artefacts and ecofacts (such as animal and human remains and ceramics), as demonstrated at Meillionydd. This suggests the versatility of multi-element analyses as well. Comparable investigations, akin to the examination presented in this chapter, possess the capacity to enhance accuracy in discerning the purpose of specific areas in roundhouses when amalgamated with the distribution patterns of artefacts, micro-debris and features along with the integration of other studies such as soil micromorphology and magnetic susceptibility. This methodology, as exemplified in the analysis of multiple floors in the buildings at Cladh Hallan (Parker Pearson *et al.* 2021a), holds promise for achieving heightened precision in identifying functional zones within a given context.

[ix] At the time of writing, these features had not been inserted by the excavation team onto the composite plan of the house.

[x] This is based on a person standing outside the house and looking in through the entrance.

Chapter 7: Late Iron Age Cellular House, Orosaigh, South Uist

7.1 Introduction

In this chapter, floor layers of two cells of a three-celled Late Iron Age cellular house on the islet of Orosaigh in South Uist, Outer Hebrides, were analysed for geochemical signatures. The analysis was carried out to identify the use of internal space and investigate whether any areas of the cells were reserved for specific functions. The settlement at Orosaigh was excavated by Niall Sharples, his colleagues, and the author between 2016 and 2018. This case study was ideal for incorporating as part of this thesis as this structure had well-preserved floors protected by mostly upstanding walls around and a rubble abandonment layer on top. One disturbed occupation horizon was identified in the largest cell here, and three floor layers were recorded in the adjacent middle-sized cell. The floor layers were sampled for geochemical analysis on a 0.5 m grid, and samples for wet-sieving were collected on a 1 m grid from every other metre. The results of the geochemical analysis will provide useful complementary information to the information gathered from the finds, coarse residue and flots analysis report that is forthcoming (Sharples *et al.* forthcoming).

7.2 The Iron Age in Atlantic Scotland

Atlantic Scotland is conventionally considered to comprise Scotland's western and northern mainland and the Northern and Western Isles (Henderson 2007, 150). The settlement record of Iron Age Atlantic Scotland is characterised by a diverse form of architecture that includes roundhouses, promontory forts, hillforts, crannogs, duns, brochs and cellular houses, most of which are built in stone. Given the focus of this chapter on a Late

Iron Age cellular house located in the Outer Hebrides, a brief overview of Iron Age structures in Atlantic Scotland, particularly in the Western Isles, is provided herein.

In the Outer Hebrides, the Iron Age is defined, overall, by the rise in monumental domestic architecture in the form of brochs, duns, and wheelhouses (Rennell 2015, 16). The Early Iron Age (c. 600/500 cal BC to 200 cal BC) in the Western Isles, especially the Outer Hebrides, remains relatively elusive and understudied compared to other parts of Atlantic Scotland. Nevertheless, Early Iron Age settlements and structures have been identified in South Uist at Sligeanach (Sharples 1998; Sharples 2012e) and Cladh Hallan (Parker Pearson 2012a; Parker Pearson *et al.* 2021a). Based on these sites, roundhouses seem to be prevalent in the Early Iron Age period. Large roundhouses of this early period have been suggested to function similarly to the later brochs indicating continuity in the structural form from the Early Iron Age to the Middle Iron Age (Sharples 2012e, 17).

The Middle Iron Age (c. 200 BC-400 AD) is typified in the Outer Hebrides and the Western Isles by the emergence of monumental or complex domestic architectural forms such as brochs, duns and wheelhouses. Brochs are large stone-built roundhouses with tower-like proportions and are characterised by architectural features such as concentric walling, intra-mural galleries and stairs, scarcement, and entrance passage and doorway (Rennell 2015, 16; Sharples 2012e, 17). Compared to brochs, duns are smaller non-circular stone houses that tend not to show evidence of the architectural features of brochs (as listed above). On the other hand, wheelhouses are stone roundhouses with radial piers that divide the interior of the houses into small bays surrounding a central area (Rennell 2015). Armit (1996, 2006) and Harding (2017) argue that the wheelhouses are generally successive to brochs and are considered a trailer to the Later Iron Age in Scotland. Sharples (2012e, 18) opposes this, saying that they are contemporary with brochs and that the available radiocarbon dates do not show a separation in the occupation of the two types of structures.

The Late Iron Age in the Western Isles is characterised by the decline in the construction of monumental structures, the dismantling of broch towers and the building of secondary structures of smaller proportions within or around the towers (Harding 2017, 304). Nevertheless, Sharples (2012e, 19) notes that the abandonment of the construction of brochs is problematic due to the lack of sufficient reliable radiocarbon sequences. Still, he also acknowledges that there appears to be a general consensus that brochs tend to stop being constructed between the 2nd and 3rd centuries AD.

Although wheelhouses are seen to be arguable successors of brochs in several sites in Atlantic Scotland (Harding 2017, 304) and were found to be used in the Atlantic Late Iron Age, the exact appearance and abandonment dates are contentious in the Western Isles, according to Sharples (2012e, 19). This is attributed to the fact that only two sites in the Western Isles have substantial numbers of radiocarbon dates. They are Cnip, Lewis and Sollas, North Uist (cited in Sharples 2012e, 19; Armit 2006, Campbell *et al.* 2004; Figure 7.1). While wheelhouses were constructed at Cnip as early as the first century BC, the ones at Sollas were likely to have been built in the 1st and 2nd century AD. However, Sharples (2012e, 19) notes that wheelhouses continued to be constructed in the Western Isles in the 3rd and 4th centuries AD. Furthermore, the wheelhouse at Bornais, House 1, in South Uist also suggests that wheelhouses were built in the late 4th century AD (Sharples 2012b, 48).

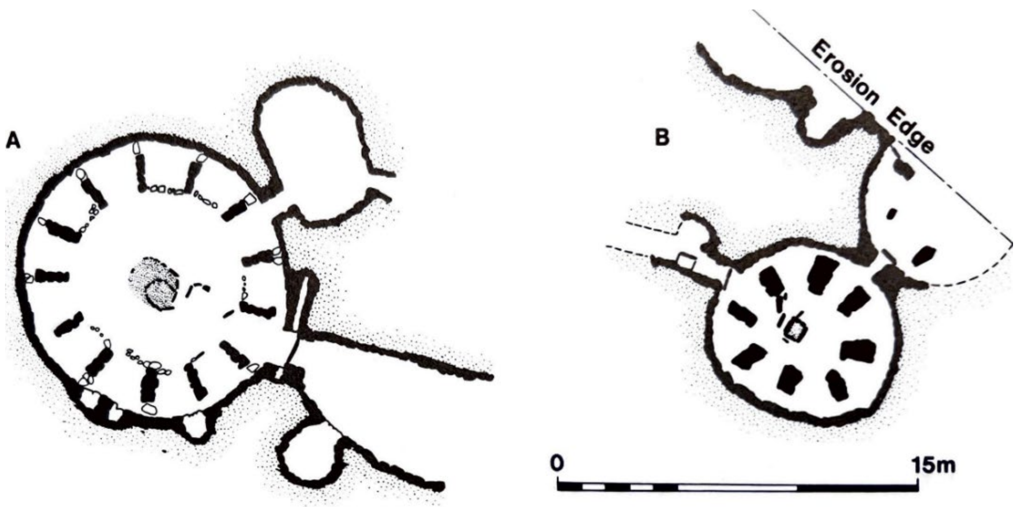

Figure 7.1: A) Plan of wheelhouse at Sollas, North Uist. B) Plan of wheelhouse at Cnip, Lewis (Armit 1996, fig 8.1).

In terms of the layout of internal space, a common feature of almost all Atlantic roundhouses of the Iron Age in Atlantic Scotland is the division of space between the central area containing the hearth and the peripheral area. Several of these roundhouses show the division of their peripheral areas by being partitioned into smaller bays or rooms. Instances of such divisions were documented at various sites, including a roundhouse settlement from the Early Iron Age in Orkney located at Bu (Armit 2003, 42-43; Figure 7.2 C), the Middle Iron Age broch in the Howe, Orkney (Balin Smith 1994; Figure 7.2 C; also discussed in Chapter 5), and Late Iron Age wheelhouse at Sollas, North Uist (Campbell 1991; Figure 7.2 D). It was upon observing a comparable division of internal space in such structures and identifying resemblances with the double-ringed roundhouses in southern Britain that Hingley posited a centre-periphery model for the use of internal space in roundhouses (Hingley 1990, 130; also discussed in Chapter 5). Such a similarity observed in the use of internal space of structures in Atlantic Scotland belonging to the Early and Middle Iron Age reinforces Sharples's (2012e, 17) suggestion that there is continuity in the structural forms and function of the various roundhouses in the Atlantic Iron Age.

Henderson (2007, 161) postulated that a broad shift in settlement forms occurred c. the 2nd century AD with the cessation of monumental structure construction. Sharples (2012e, 19), on the other hand, suggests that a decline or abandonment of architectural forms, such as brochs and wheelhouses, in the 3rd and 4th centuries AD is evident. This coincides with the widespread emergence of diverse forms of cellular structures, distinguished by their smaller scale and non-monumental nature. However, Henderson (2007, 161) asserts that such cellular settlement forms were constructed throughout the Western Isles from the 2nd to the 3rd century AD. While there is a discrepancy regarding the precise century in which cellular structures were extensively built, there is a consensus that they were constructed from the 3rd century AD onwards (Henderson 2007, 161; Sharples 2012e, 19).

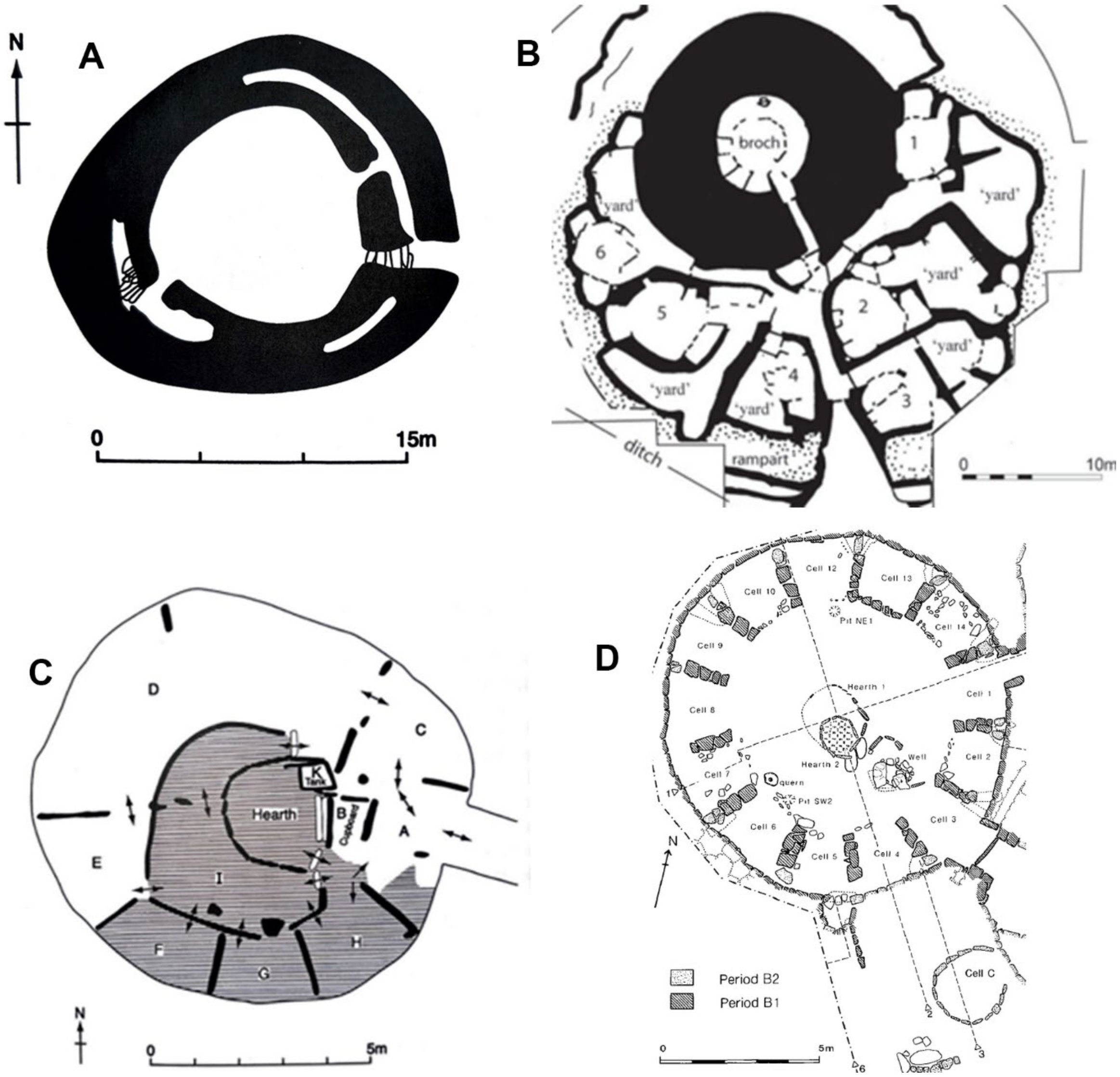

Figure 7.2: A) Plan of the broch at Dun Vulan, South Uist (Armit 2003, fig 23). B) Schematic plan of the enclosed broch settlement in phase 7 at Howe, Orkney (Waddington 2014, illus 5). C) Simplified plan of Bu roundhouse (Armit 2003, fig 17). D) Plan of structural features of the wheelhouse at Sollas, North Uist (Campbell 1991, illus 5).

Cellular structures of the Late Iron Age have rarely been the focus of intensive study. They are often excavated as later phases of the excavations of Middle Iron Age roundhouses such as brochs, duns and wheelhouses, especially in the Outer Hebrides. Rennell (2015, 18) notes that this is mainly a consequence of the monumentality and the visually dominating nature of Middle Iron Age settlements and the Iron Age studies in the Outer Hebrides often being studied through the lens of such monumental buildings. Cellular structures initially appear to be varied in terms of plans and tend to be restricted by the reoccupation of architectural forms that already exist (Sharples 2012e, 19). For example, they appear as cells surrounded by ancillary rooms infilling the original circular interiors of brochs, such as at Beirgh (Figure 7.3.1) and Dun Vulan (Figure 7.2A) (Sharples 2003, 159). At Cnip (Armit 2006, cited in Sharples 2012e, 19), this was recorded as a rectangular structure built into the wheelhouse there. However, by the later part of the first millennium AD, such cellular structures appeared to be consolidated into characteristic cellular buildings appearing to be free-standing buildings outside brochs or as independent settlement structures, according to Sharples (2012e, 19). Examples of these are recorded at Buckquoy (Ritchie 1977; Figure 7.3.3), Traigh Bostad (Neighbour and Burgess 1996; Figure 7.3.2) and the Udal (Crawford 1986, cited in Sharples 2012e, 19).

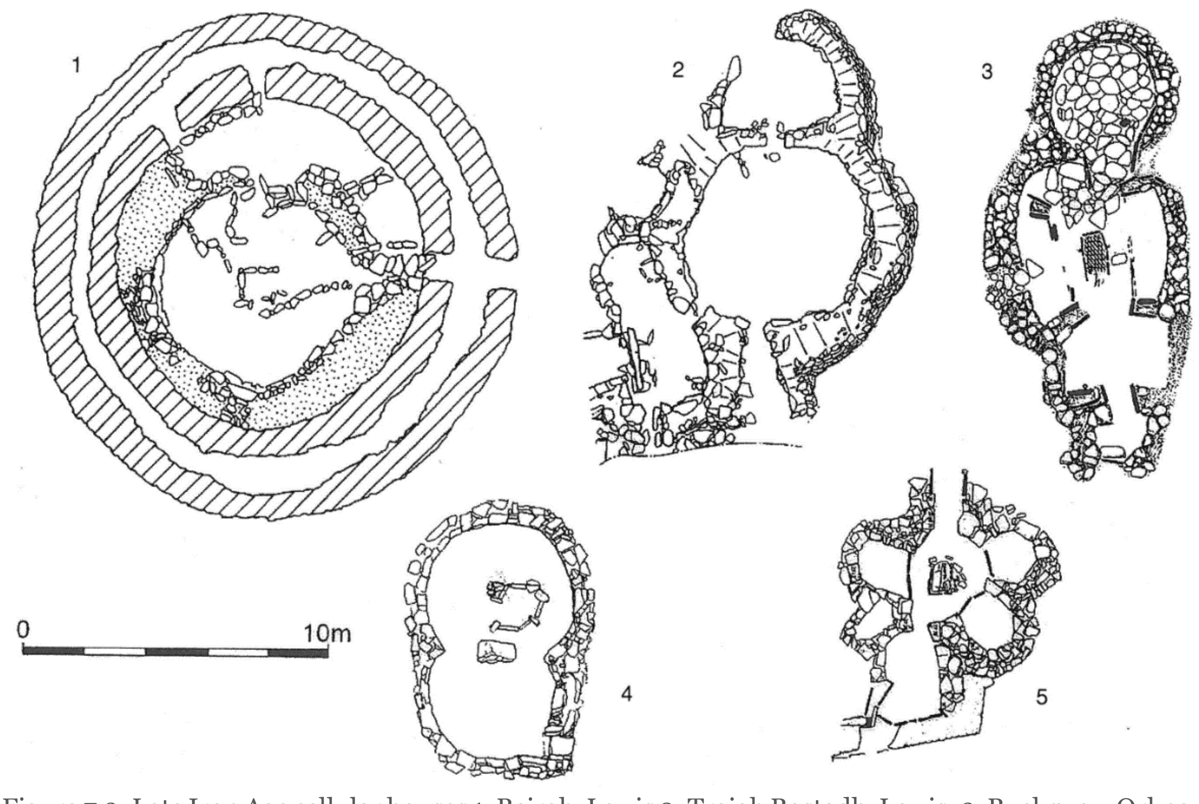

Figure 7.3: Late Iron Age cellular houses 1. Beirgh, Lewis 2; Traigh Bostadh, Lewis; 3. Buckquoy, Orkney; 4. Red Craig, Birsay; 5. Gurness, Orkney. (Sharples 2003, fig 7).

Cellular structures appear in various shapes ranging from rectilinear to circular to elliptical and irregular. The characteristic feature that remains common in all these shapes is the division of the structure internally into cells. While considered to be successors to Atlantic roundhouses such as wheelhouses and brochs, the similarity in their ground plan to these structures is also visible. An example of structures classified as cellular structures yet showing a striking resemblance to a wheelhouse is at Gurness, Orkney (Figure 7.3.5; Hedges 1987). At the cellular structure at Gurness, there was a radial arrangement of cells around a central space. This central space also contained a hearth. At Traigh Bostadh, the similarity of the cellular houses here to roundhouses was so distinct that Houses 1-3 were classified as roundhouses by the excavators (Neighbour and Burgess 1996; Figure 7.3.2).

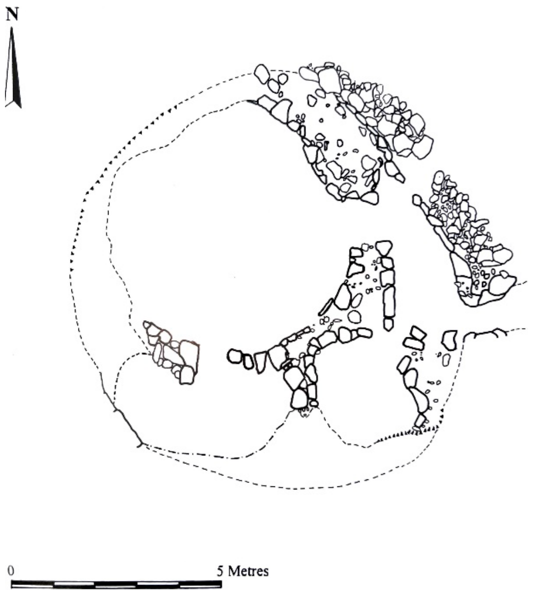

Figure 7.4: Late Iron Age cellular building within Dun Vulan (Parker Pearson 2012b, fig 20.18).

In terms of internal space, cellular structures at Dun Vulan (Figure 7.4) and the early cellular phase at Beirgh (Figure 7.3.1) show a sub-circular central space with surrounding cells separated from the interior by substantial stone partitions (Sharples 2003, 159). A hearth was centrally located in the structure at Beirgh (Harding and Gilmour 2000, 7). It was also noted that at Beirgh, later modification caused the central space area to be reduced even further. A similar layout of space that shows a reduction in central space and the presence of cells surrounding the central area and a central hearth can also be observed in the free-standing cellular structures at Gurness, Orkney (Hedges 1987), Traigh Bostadh, Lewis (Neighbour and Burgess 1996), NE building at the Howe (Balin Smith 1994), Buckquoy, Orkney (Ritchie 1977), and the Udal (Crawford 1986). At Dun Vulan (Figure 7.4), the Udal and Bostadh (Figure 7.3.2), Parker Pearson (2012b, 417) noted a three-celled arrangement that consisted of a smaller cell termed 'guard cell'[xi] to the side of the entrance. This led to a circular or oval room containing a central hearth which, in turn, opened up into a circular backroom. Such a layout is called a 'jelly-baby' house plan (Parker Pearson 2012b, 417). According to Parker Pearson (2012b, 417), such a layout for the use of space likely originated in the Middle Iron Age due to its similarity with the layout of wheelhouses, such as at Cille Pheadair, having an entrance area and a circular backroom that was smaller in size (Lethbridge 1952; cited in Parker Pearson 2012b, 417). However, he also noted that not all Late Iron Age cellular structures had a similar layout, as some buildings may have just one or two cells (Parker Pearson 2012b, 417). In terms of the evolution of these cellular structures, Sharples (2003, 159) argued that there was a shift from the initial haphazard or radial arrangement of the cells around a central space, such as at Gurness (Figure 7.3.5), to a more linear structural layout of weighted space as observed at Bostadh (Figure 7.3.2).

7.3 The Study Site

Figure 7.5: Location of Orosaigh in the Outer Hebrides on the map of Scotland with inset showing location in South Uist.

The cellular structure, which is the focus of this chapter, was located on an inconspicuous mound (Mound 6) on the islet of Orosaigh, situated on the western coast of South Uist (west of Boisdale) in the Outer Hebrides, Scotland. The soil on Orosaigh is shell sand which has a pH level usually greater than 7.0, which is classified as basic, which leads to the good preservation of organic components such as bones, as was observed at the site. The subsoil here underneath the archaeological deposits was a red brown sandy gravel that superficially covered the fractured gneiss bedrock surface underneath (Sharples forthcoming).

Similar to Bornais, also in South Uist (explored in chapter 5), the gneiss-derived subsoil likely contributed to the make-up of the house floor sediment and the natural subsoil at Orosaigh. The main composition of the gneisses in South Uist consisted of 67.1% silica (SiO_2), 15.48 % aluminium oxide (Al_2O_3), 4.81% calcium oxide (CaO), 4.62% sodium oxide (Na_2O), 2.38% iron oxide (FeO), 1.5% potassium (K_2O), 1.44% magnesium oxide (MgO), 1.26% ferric oxide (Fe_2O_3), 0.34% titanium oxide (TiO_2) and 0.05% manganese oxide (MnO) (Fettes *et al.* 1992, 14) and other individual elements as seen in Table 5.2 in chapter 5. It suggests that the levels of aluminium (Al), calcium (Ca), iron (Fe), and to a small extent potassium (K) and manganese (Mn), which are seen in the house floor sediments of the cellular structure at Orosaigh, may be the result of the weathered bedrock in the sediments. The other elements that could also be seen in the sediment due to natural processes include chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), strontium (Sr) and zinc (Zn) (Table 5.2).

The structure was roughly elliptical in shape and had an entrance orientated to the north-northeast (Figures 7.6 and 7.7). The internal space consisted of two small cells and one main room connected to each other by an entrance passage. The two small cells were accommodated by the extension of the south wall. Cell C was a smaller eastern cell that opened to the entrance passage. Cell B was a larger rectangular cell that was separated from the main room (A) by a detached wall running lengthwise. The entrance to this cell was in its northeast corner, where the entrance passage opened towards Main Room A. The main room was roughly L-shaped in plan with an entrance on the east. Sharples (forthcoming) recorded that there was a small recess at the east end of the room next to the entrance.

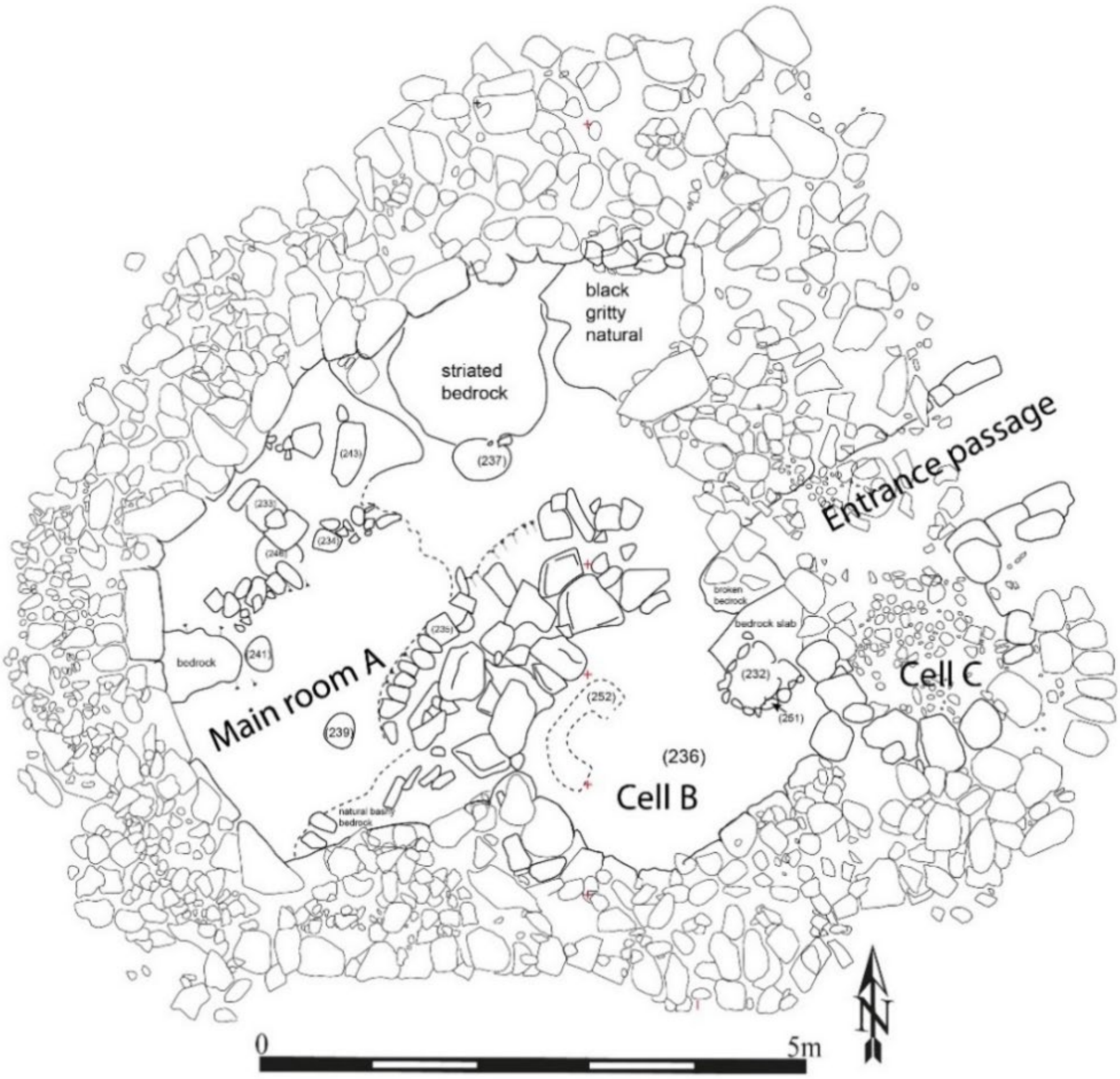

Figure 7.6: Plan of the cellular house at Orosaigh after removal of layer 230.

The state of preservation of the structure’s walls varied, with poor preservation noted on the east side but good preservation elsewhere. The external wall of the house on the east side was demarcated by six sizable boulders forming an arc in the basal course. On the west side, the wall was marked by a discontinuous row of large cobbles, lacking alignment with the wall face. Along the south side of the house, behind the two cells, the wall face extended as a chaotic array of medium to large cobbles.

Figure 7.7: Photograph of the cellular house at Orosaigh taken from southwest to northeast with Main Room A in the foreground and the entrance in the background.

The northeast wall suffered from poor preservation and significant disturbance from a later field wall. Even though this area was badly disturbed, Sharples (forthcoming) approximates that the wall was at a right angle in the northeast corner, which lined up with the southeast corner that was well defined and that the house had an east-facing façade that was straight. In the northwest corner of the structure, a platform extending from the wall was recorded. It was constructed as a single layer of large cobbles that made a relatively flat surface. Sharples (forthcoming) remarked on the uncertainty of whether this platform was a later addition to the wall or whether it was part of the original construction. This was due to the indistinctness of the black soil layer underneath, which could not be distinguished from the soil beneath the house wall and beyond the platform.

The internal wall face of the structure exhibited superior preservation and definition on the west and south sides, in resemblance to the external facing. Conversely, the wall face on the north side was poorly preserved, and discerning the definition on the east side was difficult. A wall, measuring 2 m in length and 1 m in width, divided Cell B from Main Room A. This wall consisted chiefly of slabs and sizable angular cobbles.

Apart from the occupational deposits, a few internal features were also identified in this house. In Cell B, in the southeast corner, was a pit (260) which was roughly rectangular in shape with steep sides and an uneven base. The fill of this feature was a homogenous fine silty dark grey sand (259). Several features roughly forming a circle over a space spanning the Main Room A and Cell B were identified as possible postholes. Five of these were recorded in Main Room A, and an isolated one was in Cell B. Sharples (forthcoming) claims that if these were postholes, then they may have held posts that supported the roof of the house. A stone-built pier (233) was found to be partially overlying one of the postholes (247). This was recorded as three flat slabs forming the basal course, and it was 0.7 m long, extending into the interior, and 0.32 m in width. An exposed bedrock area was found to have a similar layout as the pier (233). Sharples (forthcoming) suggests that this may indicate the foundation of another pier that was later removed. Based on these two possible piers, he has drawn some parallels with piers found in wheelhouses.

Two gullies were also recorded in this house as significant internal features. One gully was recorded in Main Room A, outside the north wall of Cell B. This was longer and well-defined, approximately 2.2 m in length and 0.2 m in width. The west half of the gully was covered with relatively flat slabs that were closely laid together, covering the fill of the gully. The second gully had a curvilinear layout around pier 233, extending from the north wall of Main Room A. This shorter gully was 1.4 m in length, had the same width as the longer gully, and had medium-sized stones sealing it. Two cobble tools (finds nos. 1117 and 1118) were found to form part of the sealing stones.

The occupation layers in this house were preserved under a rubble layer that covered the layers and filled the house and, hence, were chosen for multi-element analysis. They were also subject to intensive wet-sieving of every other square metre (Sharples forthcoming). The occupation horizon in Main Room A was context 230, a dark brown sandy loam. This layer was

0.2 m thick at the west end of the room and thinned to about 0.02-0.07 m towards the east end. It had occasional mottled red-brown patches and a lighter colour towards the east end. Sharples (forthcoming) suggests that the lighter colour is due to the proximity of the natural subsoil underneath (230) as it thinned out. The natural subsoil underneath the layer likely incorporates the weathered bedrock (gneiss) which is exposed here. This suggests that there is a high chance that elevated levels of Al, Ca, Fe, Mn, Cr, Cu, Ni, Pb, Zn, and Sr seen in the floor deposits are likely to be the result of the varying proportions of the weathered bedrock in the subsoil, irrespective of anthropogenic activity. As such, the thinner floor layers in the east end of Main Room A, which show elevations in the levels of these elements, are likely to be enhanced (potentially entirely) by the underlying bedrock which is exposed here (due to the shallowness of the natural subsoil in this area). Here, we must take into account the issue of equifinality, as any pattern of high levels of these various elements seen towards the east end of Main Room A may be a result of the influence of the exposed bedrock.

Sharples (forthcoming) also indicated that this layer, rather than being an *in situ* floor layer, was an occupation deposit created by the disturbance of floor layers during the destruction of the house. This disturbance layer included primary occupation material that was redistributed and added to during the systematic destruction and robbing of the house. No obvious floor layers were observed below the disturbance layer. This layer contained some loose stone slabs towards the west end of the main room, an arc of small pebbles, and two large slabs in the southwest corner. These have been suggested to indicate the presence of internal structural features, though not *in situ*. The slabs in the southwest corner have been proposed to be part of a possible pier similar to 233.

Cell B was also initially found to be covered by a brown sandy loam equivalent to 230. However, excavation revealed that this sealed a complex sequence of earlier layers. The earliest layer in this was dark grey-brown sand (254). This layer contained patches of concreted deposits that were likely linked to the overlying hearths (Sharples forthcoming). 254 also encompassed a scatter of flat slabs that lay horizontal. In the northeast corner towards the entrance of the cells were five edge set stones (258) that were surrounded by flat slabs (257).

Although 258 appears to be packing stones of a posthole, Sharples (forthcoming) suggests that it is an unusual place for a post, casting doubt on this interpretation. A small patch of hardened reddish sandy ash was found in the northwest and southeast corner (255 and 253). 255 appeared to be overlain subsequently by 252, a much thicker and more extensive layer of red-brown sandy ash abutting the north wall of the cell. A layer of thick dark brown silty loam (236) overlaid all these layers. However, 252 was observed as poking through 236 in certain areas. An oval stone hearth 0.6 m in length and breadth was built on top of 236 abutting the eastern wall of Cell B. This hearth had an outer kerb of rounded pebbles, and the interior was covered mainly by two large slabs, and another two elongated smaller slabs (251) were parallel to the wall of the cell. Overlaying these hearth stones was a compact orange sand layer (232) with charcoal lenses. Atop all these layers discussed above in Cell B was 230.

Cell C had a minimal amount of overlying rubble compared to Cell B and Main Room A. There were two significant layers in this cell. The earliest layer was a dark brown silty sand which is suggested to be the possible natural soil on which the structure was built. Over this was a compact layer of small round pebbles (227) (Sharples forthcoming).

The finds assemblage from these occupation deposits was dominated mainly by pottery recovered from the floor layer 230. Most of the ceramic assemblage was recovered from Main Room A. In this room, it seems to be concentrated in the area from the centre towards the north wall. Some large sherds were recovered in the area to the west. In Cell B, a large quantity of pottery was recovered close to the cell wall, with a significant quantity found close to the hearth and the entrance of this cell. The other finds from the house include assemblages of flint and quartz, several cobblestone tools, a few pieces of pumice and a few iron objects (Sharples forthcoming). At the time of writing this chapter, no finds reports or spatial analysis of finds were available except for the images showing the distribution of pottery sherds. Therefore, aside from the pottery, this other such information could not be incorporated into the study presented here.

7.4 Methodology

Spot samples for multi-element analysis were collected on a 0.5 m grid during the excavation of the floor deposits. These samples were collected over two seasons, covering the occupation deposits in Main Room A and Cell B. In the 2017 season, samples were collected from Main Room A and Cell B. The samples from Main Room A were from the surface of context 230. The samples collected from Cell B also belong to context 230. In the 2018 season, samples were collected from Main Room A and Cell B again. In this season, the samples from Main Room A were collected from the surface natural deposits exposed by the removal of context 230. However, in Cell B, two sets of samples were collected. The first was from the surface of context 236, which also contained samples from the hearth (232). The second set of samples was collected from the surface 254. Thus, a total of five sets of samples were collected and analysed separately. The information regarding the various layers has been derived from a structures report (Sharples forthcoming) as well as individual context sheets, which have undergone enhanced analysis. The fifteen elements analysed were aluminium (Al), calcium (Ca), chlorine (Cl), chromium (Cr), copper (Cu), iron (Fe), potassium (K), manganese (Mn), nickel (Ni), phosphorus (P), lead (Pb), sulphur (S), strontium (Sr), titanium (Ti) and zinc (Zn). Henceforth in this chapter, the chemical symbols of the elements have been used in the text.

Initially, the plotting of the results obtained from the samples collected in context 230 of Main Room A posed certain challenges. The geochemical analysis did not yield the expectation of similar results for the surface of 230 and the surface natural immediately below 230 as anticipated by the author and the excavator, Niall Sharples (pers. comm.). This discrepancy was initially attributed to potential sampling errors. However, it was soon discovered that the results of the upper part of context 230 were indicative of the layer being disrupted by post-depositional mixing with abandonment or destruction deposits (also discussed below). Subsequently, the layer was considered a disturbed layer, and the results of the geochemical analysis have been elaborated on and discussed below.

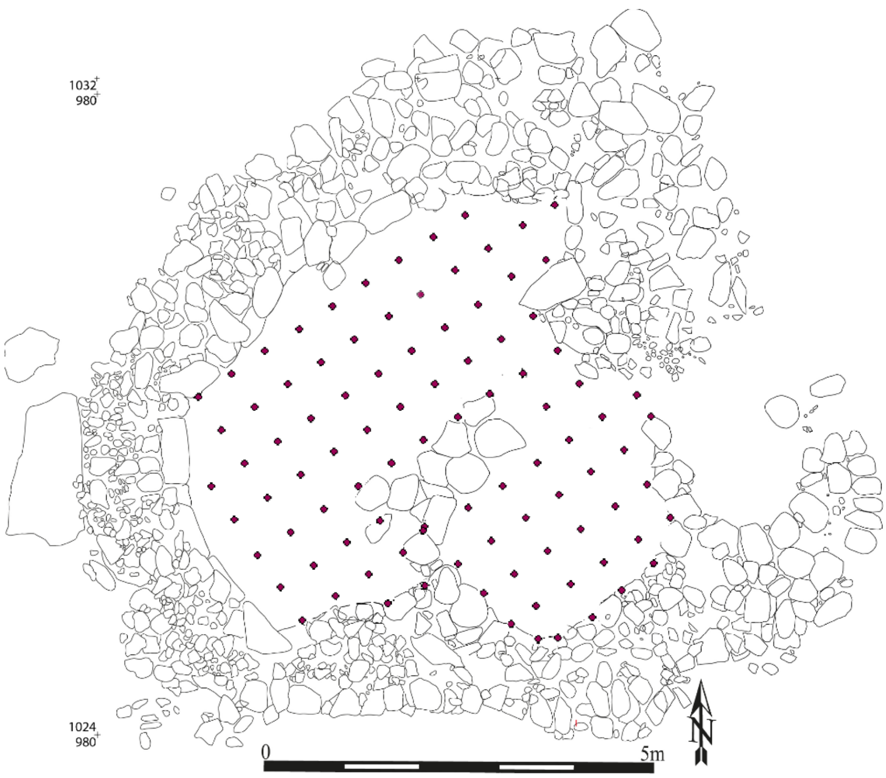

Figure 7.8: Location of spots from which different occupation layers were sampled at Orosaigh.

Context number	Description	Cell	Floor level
230	Brown sandy loam, dark brown to black with red mottles. It was hard compact in some places with soft patches in other places.	A and B	Main floor in Main Room A and upper floor in Cell B
232	Compact orange sand layer of a hearth with a lot of charcoal and a lot of pottery sherds around it.	B	Middle floor
236	Thick dark brown silty loam that was a build-up of occupation/accumulation within the cell with a fair scatter of pottery which was trampled into. It had a mound of ash.	B	Middle floor
252	Red-brown sandy ash in the northwest quadrant of Cell B, under 236, that was possibly a dump of peat ash.	B	Bottom floor
253	A small patch of fairly compact reddish brown sandy ash in the southeast quadrant of Cell B.	B	Bottom floor
254	Dark grey-brown silty sand floor layer which was humic and lies under 252. Probably a pre-existing surface that becomes a floor through use.	B	Bottom floor
255	Very hard compact sandy ash that seems to lie in a slight hollow. It appears to be a result of intense fire heat and is a likely position for a hearth or a fireplace in the northwest quadrant of cell B.	B	Bottom floor

Table 7.1: Context from the cellular house at Orosaigh analysed using multi-element analysis.

7.5 Multi-element Analysis: Results

The results of the multi-element analysis conducted at the Orosaigh house have revealed distinct patterns in the occupation layers. A notable pattern was observed in the levels of various elements, which followed a specific division of areas in Main Room A and Cell B. The primary disparity between the upper and lower sampled layers is the fluctuation in the levels of various elements in those particular areas. The patterns seen in the distribution plans of each element have facilitated the division of the cells into multiple areas, allowing for easier interpretation of each space. Each of these areas has been discussed individually in the case of each layer analysed and the relative levels of various elements in them. The higher to lower levels of each element in each area have been utilised to deduce the possible function of that area during the relevant occupation of the cells. Figures 7.13, 7.14, and 7.15 have been included to illustrate these divisions.

The presentation of the results in the various figures is arranged such that the patterns for all elements analysed from the surface natural below 230 in Main Room A are paired with 254 (lower floor) in Cell B, followed by the patterns in 236 (middle floor) in Cell B. The reason for this pairing is that both 254 and 236 appear to be contemporaneous with the primary occupation represented by the chemical residues left on the surface natural beneath (230). The subsequent discussion of these findings is then presented. In a similar fashion, the figures displaying patterns obtained from the analysis of the surface of 230 in Main Room A are coupled with 230 (top floor) in Cell B, as they are also contemporaneous layers. This is followed by a discussion of the results of these upper layers. The overall levels of P (highest around 2250 mg/kg) seen at this site are significantly lower than the levels of phosphorus (P) seen in the nearby sites of South Uist, and this might indicate more sporadic or short-lived occupation phases in the house, rather than the intensive occupation seen at other sites. This will be explored further in the discussion.

Lower contemporary floor layers in Main Room A and Cell B

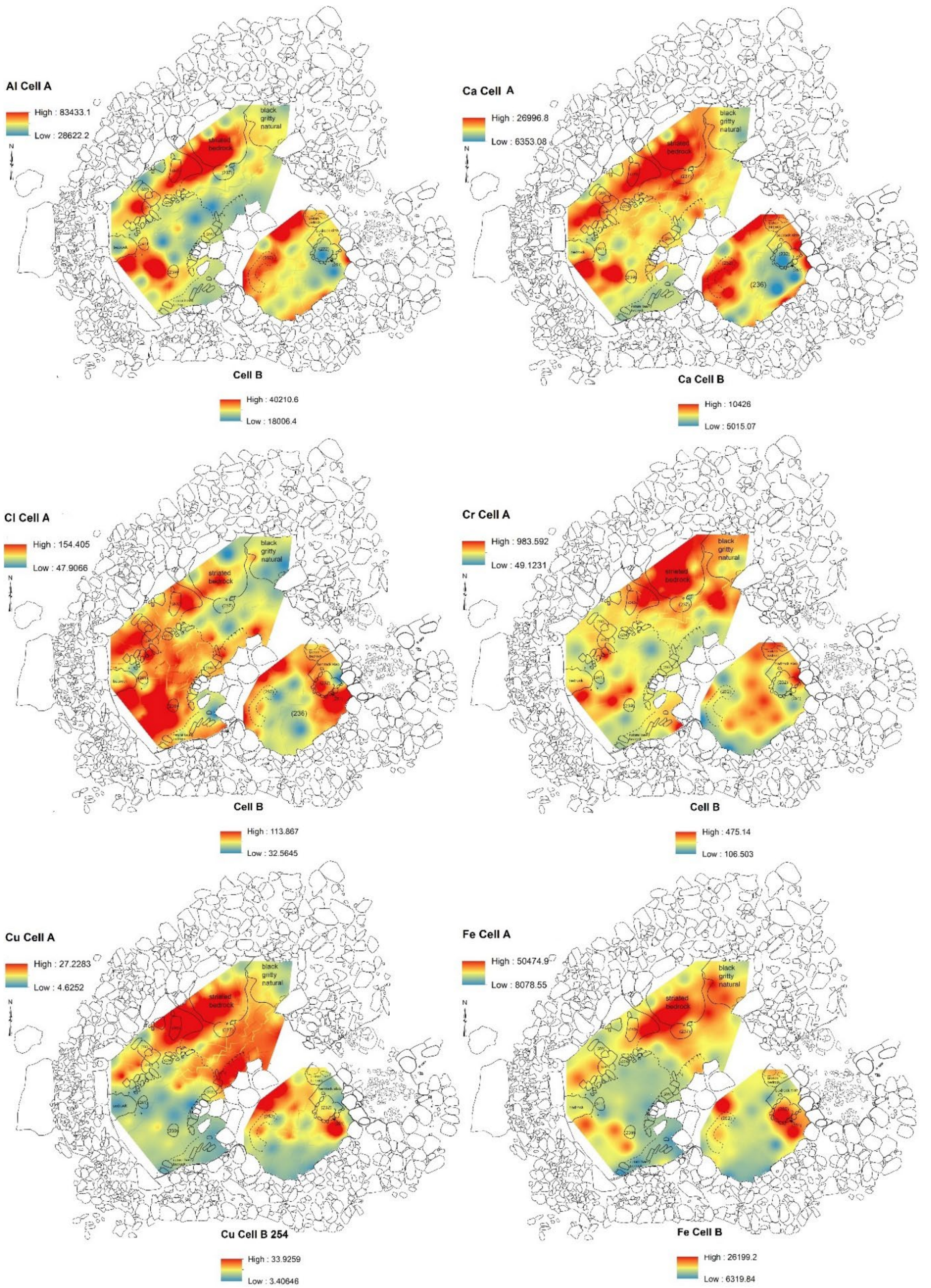

Figure 7.9: Distribution patterns of Al, Ca, Cr, Cl, Cu, and Fe in the surface natural of the house floor under layer 230 in Main Room A and that of layer 254 (bottom floor) in Cell B.

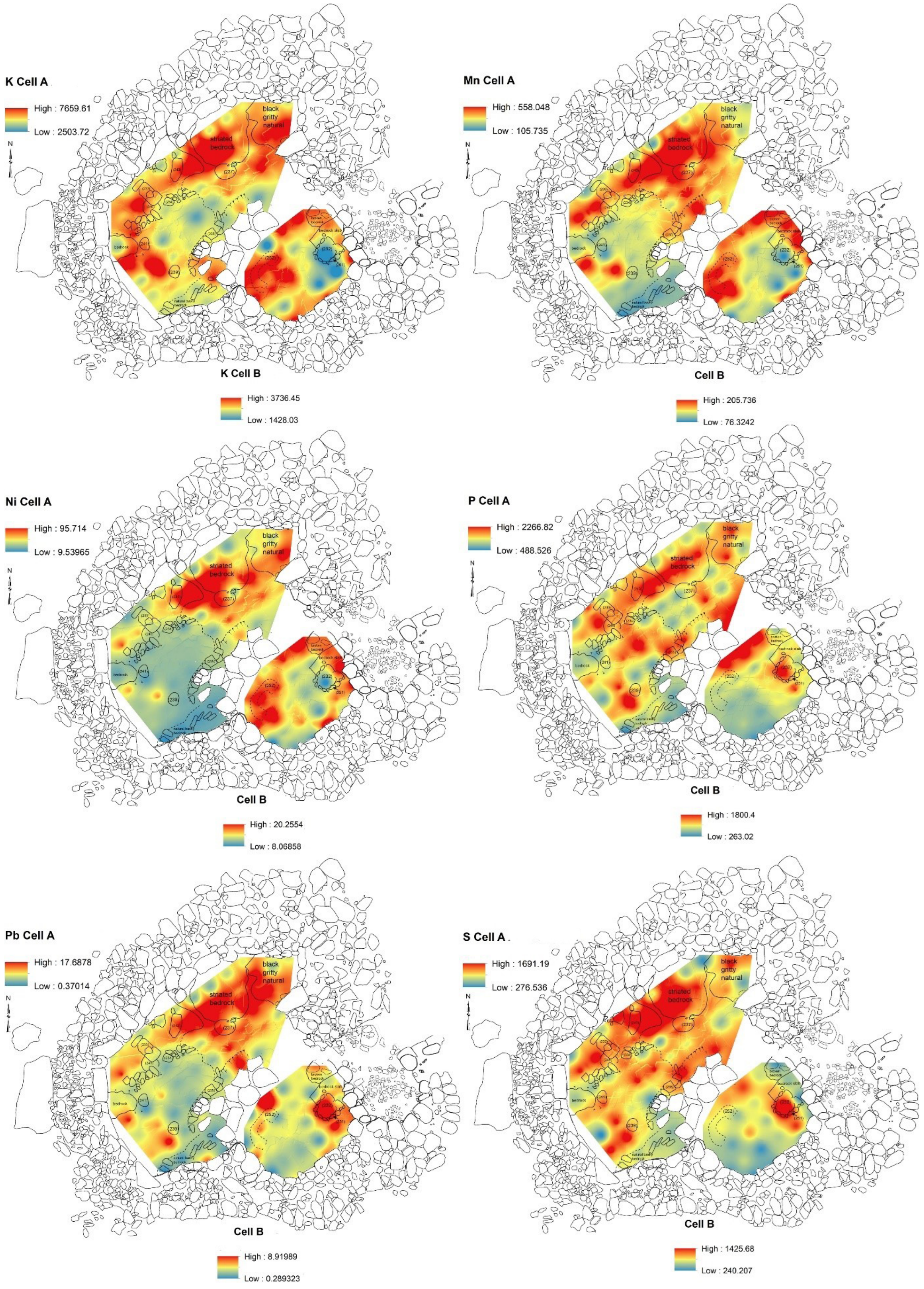

Figure 7.10: Distribution patterns of K, Mn, Ni, P, Pb, and S in the surface natural of the house floor under layer 230 in Main Room A and that of layer 254 (bottom floor) in Cell B.

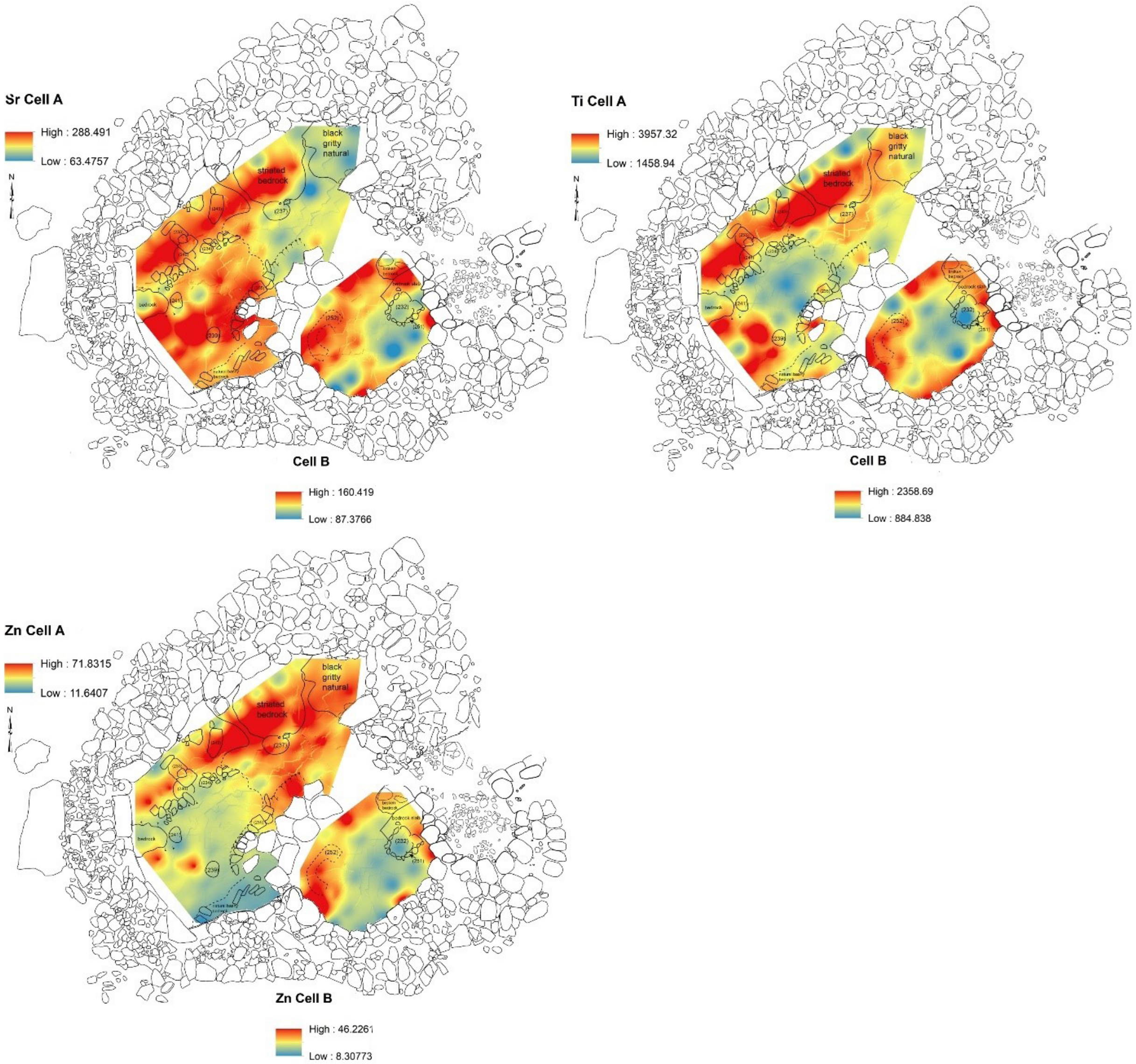

Figure 7.11: Distribution patterns of Sr, Ti, and Zn in the surface natural of the house floor under layer 230 in Main Room A and that of layer 254 (bottom floor) in Cell B.

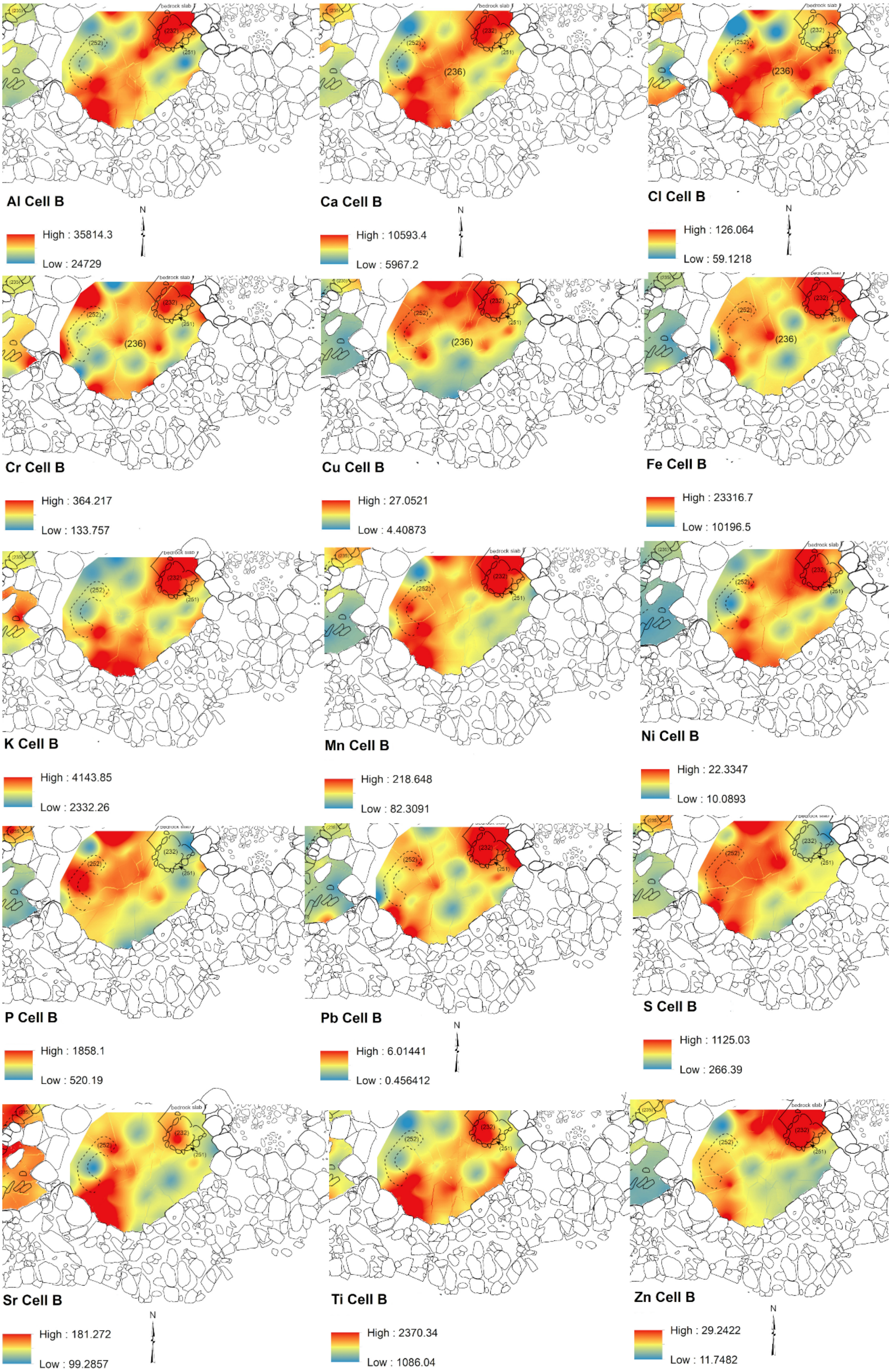

Figure 7.12: Distribution patterns of Al, Ca, Cl, Cr, Cu, Fe, K, Mn, Ni, P, Pb, S, Sr, Ti, and Zn in layer 236 (middle floor) in Cell B.

Main Room A

Analysis of surface natural in the house under 230

The Main Room A, based on the patterns from the geochemical analyses, can be divided into seven different areas. These areas have been numbered, as shown in Figure 7.13, and the distribution patterns of each element are shown in Figures 7.9, 7.10 and 7.11.

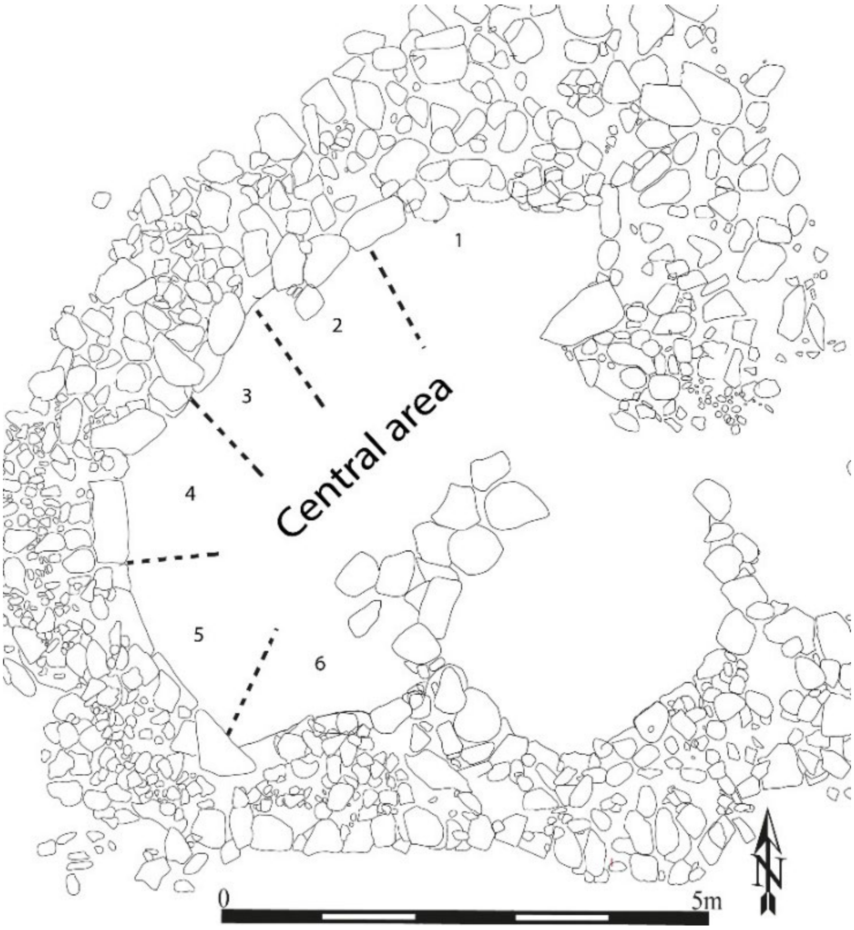

Figure 7.13: Division of Main Room A based on geochemical analysis results for layer 230 and surface natural below.

Area 1

This is the northeast corner of Main Room A. This area had the second highest levels of various elements. They were Cr (330-496 mg/kg), Fe (18000-30000 mg/kg), K (c. 4400 mg/kg), Ni (20-53 mg/kg), Pb (c. 6-10 mg/kg), Mn (c. 240 mg/kg), P (c. 1230 mg/kg), S (400-1150 mg/kg), and Zn (33-45 mg/kg). On the other hand, Ca, Cu, and Ti had elevated levels as one moved closer to Area 2. Area 1 possibly has a close link in terms of activity with the possible presence of a hearth in Area 2. The level of Sr is considerably low here to suggest any processing of food (such as meat or fish) to have taken place. Elevated levels of Cu, Mn, and Pb in this region might suggest the occurrence of smelting and manufacturing operations (see Table 3.1). Despite this, no archaeological evidence of metalworking, including micro-residues and slag, particularly those of copper and lead, which would not have been destroyed under alkaline soil conditions, were discovered within this house. Furthermore, even basic smithing operations would have generated slag that could have been retrieved. Conversely, smelting would have produced sizable quantities of slag in large masses (Niall Sharples pers. comm.). However, with the arguable presence of a destroyed hearth in Area 2 nearby (discussed below), this area was probably intensively used in daily activities. However, as discussed earlier, the shallowness of the natural subsoil in Area 1, and its proximity to the bedrock, means that any elevation in the levels of Al, Ca, Fe, Cu, K, and Mn in the floor deposits here may be the influence of the weathering of the gneiss bedrock, which is exposed here. As such, this provides another possibility for the enhanced levels of the different elements seen here, and they are not necessarily the result of anthropogenic activity. Still, the levels of other elements such as Pb, Cr, P, and Zn are at higher levels than the ones in the bedrock, and these elements could be a result of anthropogenic activity.

Area 2

Area 2 had the highest levels of most elements. They were Al (c. 70000-80000 mg/kg), Cu (24-27 mg/kg), Ca (20000-26000 mg/kg), Cr (355-980 mg/kg), Fe (c. 40000-50000 mg/kg), K (c. 7400 mg/kg), Ni (c. 95 mg/kg), Pb (10-17 mg/kg), Mn (340-558 mg/kg), P (c. 900-1710 mg/kg), S (1150-1690 mg/kg), Zn (44-71 mg/kg) and Ti (3400-3900 mg/kg). Although Sr levels were high (c. 161 mg/kg), similar levels were observed in other areas. The significant levels of the various elements could indicate the arguable presence of a destroyed or cleaned-out hearth here (see Table 3.1 for a list of elements typically associated with hearths, which lists Sr, P, Cu, K, Zn, Pb, Fe and Mn as being significant in these features). The reason for calling it a destroyed or cleaned-out hearth is that the disturbed occupation layer 230 had no obvious signs of a hearth or *in situ* burning in this location. Furthermore, there were no obvious peat ash concentrations to even suggest waste from the hearth being dumped here (Niall Sharples pers. comm). However, it does seem unlikely that a large cell, such as Main Room A, being located away from the entrance and possibly a cell where most occupants would have assembled, would not have a hearth as a source of heat and light. Additionally, most cellular structures in Scotland tend to have a central hearth in the main large cell (e.g., Beirgh; Harding and Gilmour 2000), Buckquoy; Ritchie 1977; also discussed below). Furthermore, the absence of complementary evidence from other studies, such as magnetic susceptibility analysis and soil micromorphology, means that these provisional interpretations cannot be tested (see Chapter 8 for a useful discussion of the potential value of pH sediment analysis of detecting areas of burning).

Although the levels of most elements here are the highest seen in the entire structure, it is important to draw attention to the fact that in the case of elements such as Cu, the levels are not significantly higher than the natural chemical composition of the gneiss bedrock. However, the suite of elements exhibiting high levels in this area is comparable to the range of elements displaying relatively high values for the visible hearth which was excavated in Cell B. This is a meaningful pattern. The level of these elements in Area 2 is, in fact, higher than the levels of these same elements from the hearth samples of the well-preserved hearth (232) from the middle floor in Cell B (discussed below). This raises the possibility that there may have been a hearth that was destroyed in Area 2, which was no longer visible to the naked eye during excavation. The higher elevations in the levels in this area could also suggest that this hearth, if it were here, was used for much longer than the one in Cell B, leaving significant chemical residue on the natural surface. Hence it is a possibility that Area 2, and its possible destroyed hearth and nearby areas of Area 1 together, may have functioned as the area of intensive daily activity that could also include cooking activity. Furthermore, Area 3 (below) has shown some signs of a possible food processing area which may be suggestive of the close connection with a possible hearth or cooking area if it was present here.

Area 3

Apart from the central west area and Area 6, this area showed the lowest levels of most elements except for Ca, P, Mn, S, Sr, Ti and, to some extent, Zn. While the exact function of this area is unclear, this area could have had exposure to organic matter, which may be associated with the destroyed hearth in Area 2, due to the elevated level of Ca, P, and Sr. A food preparation area that includes meat is possible here based on the higher level of P, Ca, Sr, and to some extent Cu (see Table 3.1 for elements linked to meat preparation). However, the levels of Ca, Sr, and Cu are not significantly higher than the natural bedrock levels and, as such, may be the result of natural processes. The western limit of this area is characterised by a drop in the levels of almost all elements between areas 3 and 4. This drop lies in the same place as pier 233, suggesting the pier to be a possible western boundary of Area 3.

Area 4

The low levels of almost all elements in its northern and southern ends could suggest that Area 4 was possibly bordered by pier 233, another pier (likely over the bedrock), and adjacent posthole 241. Area 4 had elevated levels of Ca, Cl, Cu, Mn, P, S, Sr, and Ti, but lower levels than areas 1 and 2. Some minor elevation in levels of Zn, Fe, and Pb was also seen here. Specific dedicated activities could have occurred here; however, it is inconclusive what they were. It is interesting to note that the samples taken from close to the bedrock layers show among the lowest levels for most elements. In fact, the levels seen here are lower than those seen in the bedrock gneisses of South Uist (Table 5.2). This could be a result of an efficient cleaning of the area during the occupation of this floor, keeping it clear of organic wastes, which could show in such areas showing levels lower than the natural (discussed below; Holmqvist and Ilves 2022, 394).

Area 5

The drop in levels of all elements at the eastern and western end of this area may suggest it had boundaries defined by the pier in its west end and another possible pier in its east end following the natural bedrock and the posthole 239. This area had high levels of Al, Ca, Cl, K, Sr, and Ti. Cr, P, Mn, and S were found to be elevated in a couple of spot samples. The level of P is significantly elevated (1622.91 mg/kg) in one spot sample that was close to the east-end partition. However, this is an anomaly compared to the general trend of low levels of P here, ranging mostly under 1000 mg/kg. This area overall may suggest a low-activity peripheral area of the house.

Area 6

This area is the southern corner of Main Room A. The lowest levels of all elements were observed here. This may suggest that this area was possibly used for activities such as storage or sleeping (see Table 3.1 for a characterisation of these areas). However, this area alone is too small to accommodate a sleeping area as such. Nevertheless, if this area is combined with Area 5, the area would be large enough to accommodate a sleeping area. It is a possibility that areas 5 and 6 may have functioned as a combined sleeping and storage of this house. Furthermore, based on the elevated levels of P, Ca, and Sr in areas 5 and 6, some exposure to organic substance using activities such as food storage may be suggested, especially in Area 5.

Central area

The central area can be divided into the western and eastern halves based on the levels of various elements. Overall, the western half shows lower activity than the east half, closer to the possible hearth in Area 2. The eastern half showed medium-high to high levels of Ca, K, Cr, Cu, Ni, Pb, Mn, Zn and, to some extent, Ti, and Fe. However, these same elements showed low levels in the western half. On the other hand, P showed higher levels closer to the arguably destroyed hearth and the entrance in the eastern half and, overall, in the west half. This may be suggestive of higher exposure to organic matter in the western half. The terminal of the western gully of this room was also in the western half of the central area (Figures 7.6 and 7.13) from where a grinding stone was recovered, and this could suggest a food preparation area. High levels of Sr were also seen here along with raised P. Additionally, Ca was slightly elevated in the western half but was still comparatively lower than in the eastern half. The levels of Ca, along with P and Sr, may be suggestive of this area being used for food preparation (Table 3.1).

Still, it is worth reiterating here that the levels of Ca and Sr although relatively high compared to the rest of the house, are still not higher than the natural levels in the gneiss bedrock.

The geochemical analysis of the samples from the natural under 230 has revealed a division of Main Room A such that it is divided into areas based on activities. These areas also seem divided based on the partitions/piers that have become visible through this analysis. Overall, it suggests a front and central active area and the back peripheral area reserved for activities such as sleeping or storage.

Cell B

Context 254-lower floor

254 was identified as a floor layer that contained (or was below) ash spreads 252, 253, and 255 under 236. The distribution patterns of the levels of various elements of this floor (Figures 7.9, 7.10 and 7.11) are different to that of context 236 (Figure 7.12). The west half of this cell can be divided into the south and the west quarters. The east half can be divided into an L-shaped area along the east wall and entrance, which surrounds a roughly rectangular-shaped area (Figure 7.14).

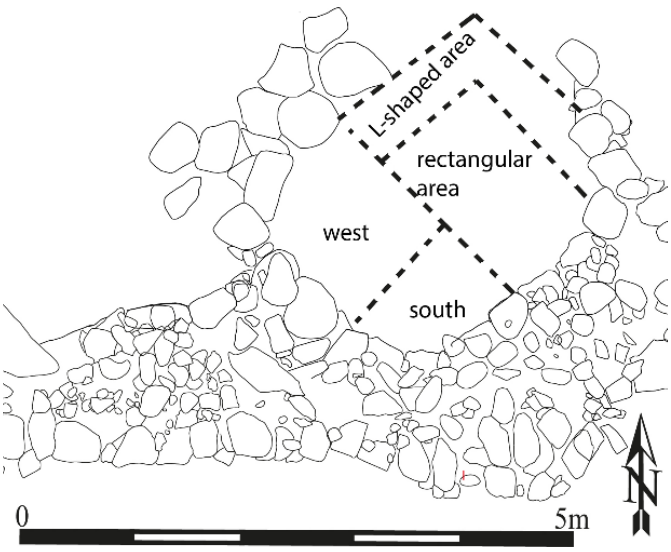

Figure 7.14: Division of Cell B based on geochemical analysis of layer 254.

West Quarter

This quarter possibly contained a hearth. The presence of a hearth is supported by the contexts excavated (255 and 252). While context 255 was a patch of very hard red concreted ground, context 252 was red-brown peat ash indicating a hearth's presence. Additionally, the excavator had also described both these contexts as compact and concreted. 255, also suggested to be an ash spread, is described by the excavator as a result of *in situ* burning and the likely position of a hearth (context sheet: 255; Table 7.1). This quarter showed the highest levels of Al (c. 34000 mg/kg), Ca (c. 9900 mg/kg), Cu (23-30 mg/kg), K (c. 3400 mg/kg), Ni (c. 19 mg/kg), Mn (c. 174 mg/kg), Sr (c. 136-148 mg/kg), Zn (c. 21-46 mg/kg), and Ti (c. 2300 mg/kg). However, P (c. 1600 mg/kg) and Fe (c. 26000 mg/kg) levels were significantly elevated closer to the north wall. High levels of Sr, P, Cu, Zn, K, Ca, and Mn are frequently associated with hearths or areas of burning (see Table 3.1). With the results of the geochemical analysis in this quarter complemented by the ash layers observed here, there is a higher possibility that this lower floor of Cell B contained a hearth or an area of burning as suspected by the excavator. However, it is still worth noting that the levels of Cu are Sr are similar to the bedrock levels making the interpretations of a hearth here speculative. Additional, analyses are needed to verify these interpretations (see Chapter 8).

South Quarter

The south quarter showed the lowest levels of almost all elements suggesting an area that was possibly dormant in terms of activities or an area that was swept and cleaned regularly. This is similar to the observations seen in the east quarter of context 236 above. This quarter may have served as a storage area.

Rectangular area in the eastern half

Low levels of most elements defined this area in the eastern half of Cell B. However, Cl, Fe, Pb, P, and S levels, similar to that of the west quarter, could be attributed to the reddish sandy ash (253) observed here in the southeast part of this area. However, based on the results from other studies, it must be noted that Cl and S are not elements typically linked to ash (Haslam and Tibbett 2004; Steenari *et al.* 1999; Middleton 2004). This ash may have come from the hearth that was likely in the west quarter discussed above. This ash spread here also had low levels of potassium (K). If the source of the ash is the hearth in the west quarter, then it is likely that it is peat ash here as it is deficient in K. Flat-laid stone slabs were also recorded, specifically in this area. The samples collected from this area were from between and under these slabs. The low levels of the various elements observed here could be a result of these slabs covering the sediment underneath, leaving them undisturbed throughout the occupation phase, during which 254 was the floor. This, perhaps, suggests that the slabs here served the purpose of being a support surface for something on it. Furthermore, in the northern part of this area, beyond the stone slabs, was a group of stones suggested to be a socket for a pot. Overall, this square area may be associated with the possible hearth in the west quarter, serving as a platform for storing pottery or some activity linked to the hearth.

L-shaped area

This area was defined by high levels of elements such as Al, Ca, Cl, Cr, K, Ni, Mn, Sr, Zn, and Ti along the entrance and the east wall of Cell B. The elevation in the levels of various elements in the northern part of this area may be explained by the proximity to the hearth and its location, as the entrance is an area of higher traffic than the rest of the cell. However, it may have had some association with the rectangular-shaped area that had the platform.

Through geochemical analysis, context 254, described as a black/dark grey silty sand with overlying ash spreads, may have contained a possible hearth in the northwest. This is a different location from the hearth seen in the later phase in context 236. The analysis of 254 also revealed a possible storage area in the south and a platform in the eastern quarter that may have been linked to the use of the nearby hearth.

Floor layer 236 and hearth 232-middle floor in Cell B

Although this layer is referred to by context 236, the layer also included layer 232, which was the hearth layer contemporary with 236. Based on the patterns observed for levels of various elements for the samples from floor layer 236 and hearth 232, Cell B can be divided into the north (that includes the entrance to the cell and the hearth), south, east, and west quarters, as shown in Figure 7.15. The activities identified because of the patterns of various elements observed also happen to fit within the suggested quarters, as discussed below.

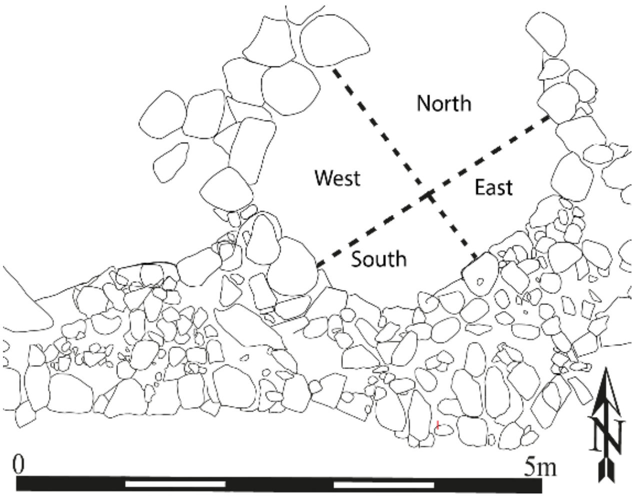

Figure 7.15: Division of Cell B based on geochemical analysis of layers 236 and 232.

North Quarter of Cell B

The north quarter included the entrance and the hearth; hence, the samples were collected from contexts 236 and 232. The entrance area was highlighted by high levels of Al (c. 32000 mg/kg), Cu (c. 15-27 mg/kg), Mn (c. 182 mg/kg), P (c. 800-1800 mg/kg), S (c. 1125 mg/kg), and Zn (c. 23 mg/kg). The hearth area was clearly highlighted by the elevated levels of Al (c. 33000), Ca (8400-9600 mg/kg), Cr (c. 300 mg/kg), Cu (c. 24 mg/kg), Fe (c. 20000 mg/kg), K (3700-4100 mg/kg), Ni (c. 22 mg/kg), Pb (c. 4-6 mg/kg), Mn (c. 218 mg/kg), S (600-700 mg/kg), Sr (c. 147 mg/kg), Ti (c. 1421-2370 mg/kg), and Zn (c. 29 mg/kg). Medium-high levels of P (c. 800-900 mg/kg) were observed here in the samples from the hearth. However, there is a rise in the levels of P immediately beyond the stone edges of the hearth towards its north side. This could indicate the cleaning or sweeping action towards the north. There is a possibility that this area could have been used for cooking. However, the data is insufficient, and the suggestion must remain tentative. The samples collected from the hearth layers also showed the highest level of Cu, Pb, and Mn compared to all samples within this cell. High levels of these three elements in the same area may indicate smelting or production activities (see

Table 3.1 for a characterisation of the elements associated with these activity areas). However, with it being a well-preserved hearth and no evidence of slag or micro-residues for smelting or production activity (similar to Main Room A), it was deemed unlikely (Niall Sharples pers. comm.). Still, it is evident that some form of activity involving burning took place here. Also, although the level of various elements in this quarter with the hearth is the highest in Cell B, it is still lower than the levels of most elements observed in Area 2 of Main Room A, where there may have been a destroyed hearth. This could suggest a shorter or less intensive use of this hearth. This is particularly interesting as here we have the actual remains of a hearth with visible evidence of burning and ash, yet the levels of the elements associated with the hearth are actually similar or lower than the levels of the same elements found linked to the destroyed hearth of Main Room A. Furthermore, these levels are not significantly higher than those seen in the natural gneiss bedrock of South Uist (Cu-25 mg/kg, Cr-26 mg/kg, Ni-23mg/kg, Pb-6 mg/kg, Sr-370 mg/kg, and Zn-35 mg/kg), possibly indicating the influence of gneiss bedrock.

West Quarter

In terms of elevation of levels of various elements, the west quarter is the second most active area in Cell B. Here, medium-high levels of Cu, Fe, Pb, Mn, P, S, Zn, and Ti were observed. Sr, Mn, Pb, Ca, Fe, and K were found to have the highest values at the end of this quarter, closest to the west wall. While the exact function of this area is unclear, the proximity to the hearth in this smaller cell could suggest an associated activity. Here, however, the levels of the elements are actually similar or lower than the ones observed for the bedrock, and their presence here could be the result of natural processes.

South Quarter

This quarter had lower levels of most elements except Al, Ca, K and Ti. Elevated levels of Pb, Mn, S, Sr, Zn and Ti were observed close to the west wall as in the west quarter (see above). P was found to be low in this quarter except for the elevated levels close to the west wall as above. This area overall indicated low activity. It may be that this quarter was used for an activity such as storage that does not leave significant traces in the sediment here. Such high levels of P close to the west wall may be suggestive of food storage, as seen in the study by Hutson and Terry (2006) where food storage areas showed high P levels in corners of the room (also see Table 3.1).

East Quarter

The east quarter showed the lowest levels of all elements compared to the rest of Cell B. This could suggest that this area was the least active in terms of activity. However, considering the proximity of the hearth here, it is also likely that this area was regularly kept clean during its use.

Overall patterns in the middle floor of Cell B

Layer 236 was identified as generally homogeneous, yet an overall variation in the different levels of various elements was visible depending on the area within Cell B. This indicates that certain areas were reserved for certain activities. A scatter of pottery was also identified here, with the excavator raising the question of whether they were dropped and trampled into this accumulated surface. Based on the geochemical analysis, Cell B was likely used for a dedicated purpose. The activities in this cell may have included cooking and food processing-related activities in the north and west quarters and storage in the back area of the cell close to the south wall. Nonetheless, cooking as an activity here remains speculative without any further evidence to support this hypothesis, such as charred grain or burnt bones. Had a sediment micromorphology analysis of the hearth or the immediate area been done, this hypothesis could have been verified.

Although the full report is yet to be published, the distribution of pottery sherds in the lower floors of Main Room A and Cell B suggests a particular focus of production and consumption activities in two areas in the house (Figure 7.16). The first is in Main Room A where Areas 2 and 3 show significantly higher amounts of pottery sherds. This is interesting as this area is closer to and surrounds the possible destroyed hearth that the geochemical analysis has indicated. In the case of Cell B, the pottery distributions include both the middle floor and the lower floor. The high amounts of pottery sherds are seen in the area around the hearth of the middle floor, as well as in the area in the west quarter that contained the possible hearth in the lower floor of Cell B. This supports the interpretations offered here that these areas were possibly used for intensive production and consumption activities involving food, supporting the likely presence of hearths.

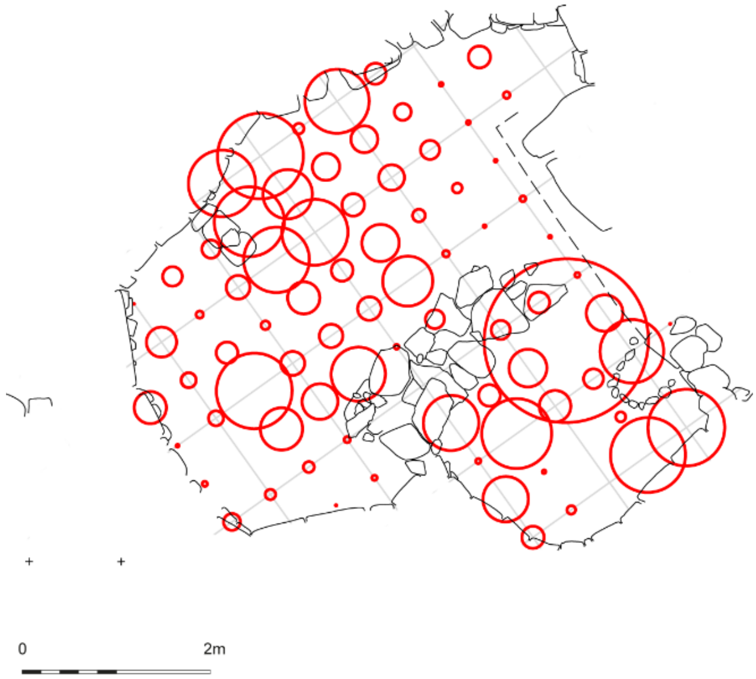

Figure 7.16: Distribution of pottery sherds in the lower part of layer 230 in Main Room A and layers 254, 236 and 232 in Cell B (Mike Parker Pearson pers. comm.).

While some patterns have been identified, attention must be drawn to the fact that the bedrock was exposed in certain areas of the floor, especially in Area 1 and Area 2, and the potential influence of the gneiss bedrock seen on the elevated levels of different elements has been highlighted throughout this analysis. However, another point of contention is the fact that some areas of Main Room A and Cell B show lower levels of various elements seen in the bedrock gneisses of South Uist. While this could be a result of the natural variation seen in the sediments or bedrock here, Holmqvist and Ilves (2022, 394) note that sometimes low levels of elements seen, which may be even lower than the 'baseline' levels, can derive from specific use patterns, sporadic use, or the efficient cleaning of the space. These could include areas which are cleaned and kept clear of animal and human waste, or other organic waste, such as patios and pathways and space set aside for festivities, rituals, ceremonies or entertaining (Holmqvist and Ilves 2022, 394).

Upper contemporary floor layers in Main Room A and Cell B

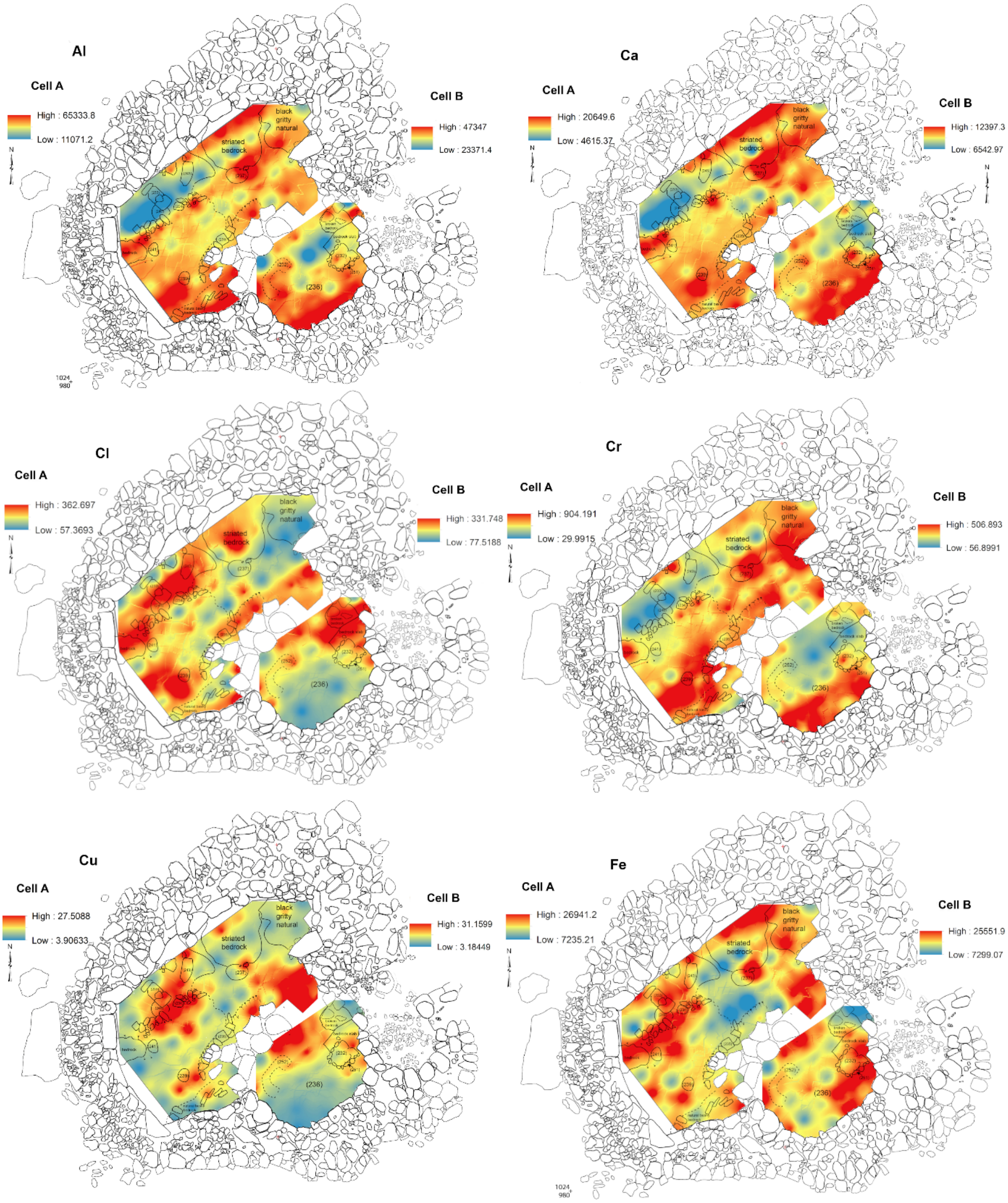

Figure 7.17: Distribution patterns of Al, Ca, Cr, Cl, Cu, and Fe in the surface of layer 230 in Main Room A and that of layer 230 in Cell B.

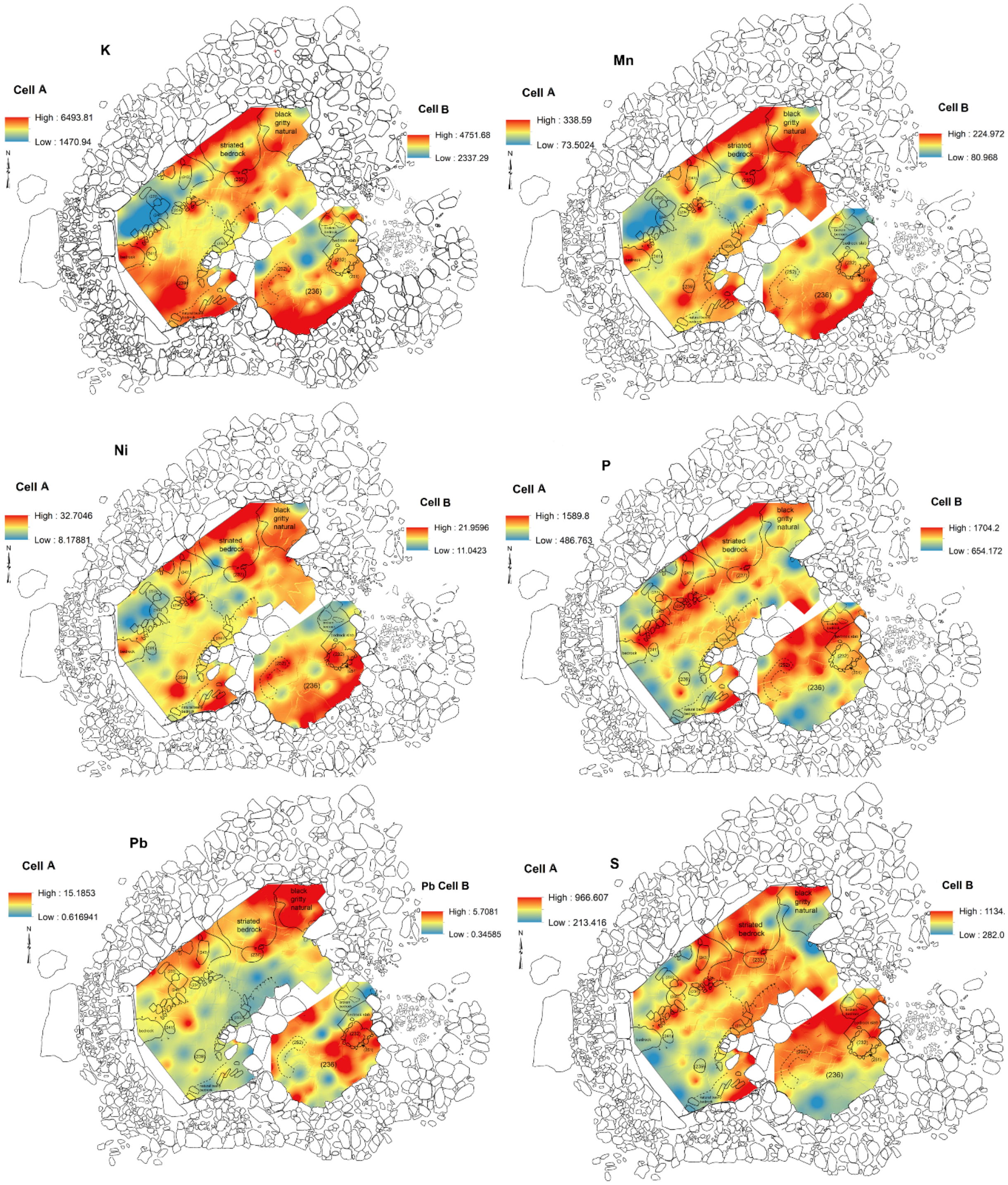

Figure 7.18: Distribution patterns of K, Mn, Ni, P, Pb, and S in the surface of layer 230 in Main Room A and that of layer 230 in Cell B.

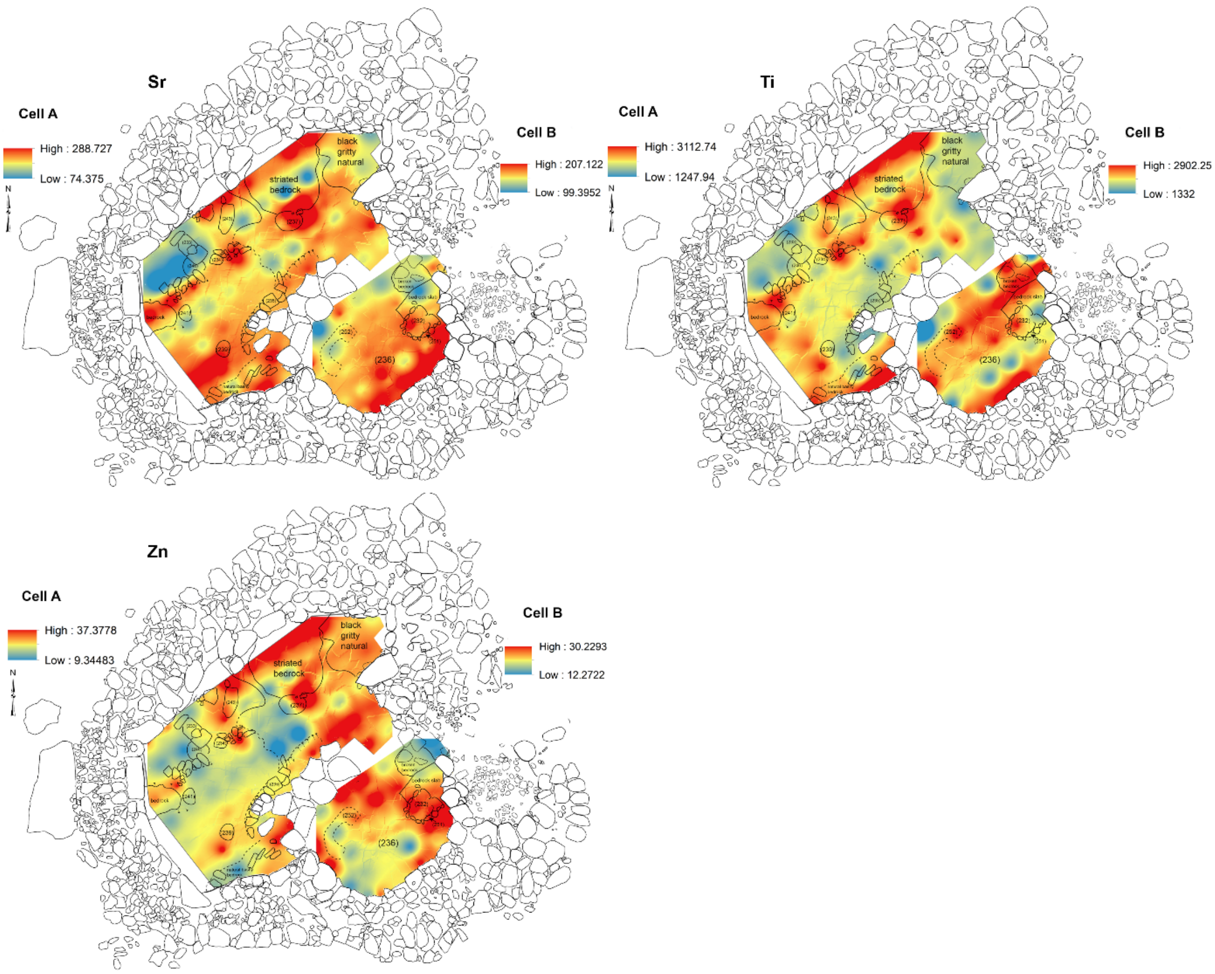

Figure 7.19: Distribution patterns of Sr, Ti, and Zn in the surface of layer 230 in Main Room A and that of layer 230 in Cell B.

Main Room A

Surface of context 230 (upper floor)

The sample collected from the surface of 230 was problematic. Context 230 has been described as a mixture of 'primary occupation material disturbed, redistributed and added to during the systematic destruction and robbing of the structure' (Sharples forthcoming). Moreover, no other occupation layer was found underneath 230. Hence, it is likely that the chemical residues on the natural surface immediately under 230 could represent the activities during the use of the house, while 230 was a disturbed layer made up of a mix of the primary occupation layer and destruction/abandonment layers. Based on the geochemical analysis of samples collected from the upper part of 230, the floor was divided into the same seven areas, as in the case of the surface natural below 230 in Main Room A (as shown in Figure 7.13). This was done so that a direct comparison could be made between the two sets of samples analysed. The distribution patterns of each element are shown in Figures 7.17, 7.18 and 7.19.

Area 1

This area, accommodating the northeast corner of Main Room A, showed roughly similar patterns for the levels of almost all elements when the samples from the surface of layer 230 were compared to ones from the natural surface below it. The substantial similarity observed in this area can be attributable to the fact that layer 230 was only 0.05-0.07 m thick here in comparison to the 0.2 m thickness observed closer to the west end of the house. It is probable that the samples gathered in Area 1 from the surface of 230, and the surface natural below this layer, represent the same occupation phase and that layer 230 was not as disturbed here as elsewhere. This area showed high levels of Al, Ca, Cr, Fe, K, Mn, Ni, P, Pb, S and Ti. These were similar to the levels of the elements observed for the samples taken from 230, except for Cu (c. 4-9 mg/kg). Overall, this area indicates exposure to higher levels of organic matter or potential proximity to a hearth if it existed here. It is possible that this area was used for food processing and was also likely part of a daily activity area, just as Area 1 in the case of the results from the samples of the lower part 230 (see above). However, the sediments were likely affected by the exposed bedrock here as the raised elements are found to naturally occur in the underlying geology. As such, the confidence in the interpretations of the pattern of the distribution of chemical elements is low here.

Area 2

This area overall showed higher levels of almost all elements in most of the samples except for a couple in the centre of this area. The elements that showed elevated levels (compared to other samples from the surface of 230) here were the same as in the case of Area 2 for the surface natural below 230, indicating a similarity in the pattern. However, overall, the exact levels of each element were lower in the samples from the surface of 230. For example, Ca levels here are c. 11000-20000 mg/kg, while in the surface natural, it was 20000-26000 mg/kg. Another striking similarity of Area 2 of the surface of 230 to the surface natural below is the drop in levels of various elements at the eastern and western ends of this area. This possibly emphasises the presence of partitions here.

Area 3

This area was highlighted by the higher levels of Cl, Cu, Fe, P and S, while the rest showed low levels of enrichment here. This is different to the result from surface natural under (230) (see above), which showed higher levels of Ca, P, Mn, S, Sr, Ti, and, to some extent, Zn. While there is a difference in the levels of various elements between areas 3 and 4, the distinction between the two is not in the same place as pier 233. This is different from what is observed in the case of geochemical analysis results of the surface natural under 230.

Area 4

This area in the west corner of Main Room A showed the lowest levels of all the elements analysed. Although this area is bordered by pier 233 to the north, the layer 230 was also found to lie over pier 233. Still, a marked increase in levels of all elements in the area immediately beyond pier 233 is visible. If the layer here formed part of an *in situ* occupation layer, then Area 4 may be an area used for non-food storage or other such docile functions that do not leave any traces in the sediment. However, in the samples from the surface natural underneath 230 here, this area showed medium to medium-high levels of almost all elements, suggesting that this area accommodated an intense activity at one point. There is a possibility that the layer here is substantially disturbed, which could elucidate the lowest levels of various elements here.

Area 5

In contrast to the findings from the analysis of the surface natural below 230, areas 5 and 6 did not exhibit clear differentiation from the central area. Still, for the sake of comparison, it is looked at separately here. The western end of this area, based on the drop in the levels of Al, Ca, Cr, Fe, K, Mn, Sr, Ti, and, to some extent, Zn, suggests that it was treated separately from Area 4, indicating a possible partition here (physical or assumed). However, this does not follow the alignment of the bedrock and the posthole (241) as a partition, as was the case for the lower part of 230. The eastern limit of this area was not visible as such. The difference in the results from this layer to that of the surface natural below 230 further suggests that the two layers are separate contexts from different occupation phases or that it is further evidence to the disturbed nature of 230.

Area 6

The samples from 230 in this area generally had lower levels of several elements. However, some elements were observed to be at elevated levels. These include Al, Ca, K, Mn, Ni, S, Sr, and Ti. This differs from the results of the samples from the surface natural below 230. This can be attributed to this area having another function later in the occupation or because the layer here was disturbed significantly by post-depositional mixing, as observed in areas 3, 4 and 5.

Central area

The levels of all elements in the central area were not such that the central area could be separated into two halves, as was the case with the results of surface natural under context 230. The results of the surface of 230 showed a general elevation of elements such as Al (c. 36000-49000 mg/kg), Ca (c. 10000-14000 mg/kg), Cr (c. 400-800 mg/kg), P (c. 750-1150 mg/kg), S (c. 500-600 mg/kg), and to some extent, Sr (c. 140-180 mg/kg).

The results of the geochemical analysis of layer 230 and the surface natural under 230 show some significant differences, especially towards the west half of Main Room A. However, roughly similar (though not exact) patterns for levels of almost all elements are seen as one moves towards the east end. The difference between the two sets of results towards the west of Main Room A likely stemmed from the occupation layer being more disturbed here. It was also observed that overall, the range of the levels of almost all elements was higher in the samples taken from the surface natural under 230 than from 230 itself. For example, P was in the range of 489.7-1589.8 mg/kg in the samples from the surface of 230, while it was in the range of 486.5-2266.8 mg/kg in the samples from the surface natural below. This provides additional evidence in favour of the argument that the surface natural under 230 best represents evidence for primary occupation as in it is the original occupation surface, while the surface of 230 was a combination of the primary occupation layer and a layer resulting from destruction or abandonment, rendering it a disturbed layer. Hence, the patterns from the analysis of layer 230 cannot be used confidently to make any interpretation. Therefore, the production of an interpretive plan for this layer (such as for the surface natural under 230 discussed and shown below) was deemed unfeasible.

Cell B

Layer 230 (upper floor of Cell B)

This layer was contemporary with the disturbed occupation layer (also context 230) in Main Room A and, hence, was sampled at the same time as the upper part of 230. This layer was probably disturbed as well. Cell B, in this case, can be divided into four quarters, as in Figure 7.15, based on the levels of various elements.

The north quarter showed the highest levels of Cl (c. 300 mg/kg), P (1150-1670 mg/kg), S (c. 1100 mg/kg) and Ti (c. 1800-2500 mg/kg) and low levels of the rest of the elements analysed from the samples from layer 230 in Cell B. The high levels of P here were likely due to the proximity to the entrance passage area and the trampling that would have taken place here. The west quarter had the highest levels (for this layer in Cell B) of Cu and Zn and medium-high levels of Al, Ca, Fe, K, P, S, and Ti. Nevertheless, these elevated levels did not appear as a cluster but instead were dispersed. Three spot samples, the first in the southwest close to the wall, the second in the centre and the third close to the north wall by the entrance, showed uniformly high levels of all these elements. This may be a suggestion that some form of post-depositional mixing had happened within this layer.

While the south quarter showed the highest levels of Al, Ca, Cr, and K and the lowest levels of Cl, Cu, Fe, P, Pb, S, and Zn (for this layer in Cell B), the east quarter had the highest levels of Fe, Ni, Mn, Pb and Sr and the second highest levels of Ca, Cr, and K. A specific function for both these were inconclusive, just as the other quarters of layer 230 in Cell B.

This layer in Cell B showed signs of containing sediments exposed to organic matter based on the level of P and Ca. However, the highest level of P in this layer is around 1700 mg/kg, which is closer to the highest levels found in 230 in Main Room A, about 1600 mg/kg. On the other hand, layer 236 in Cell B (middle layer of Cell B) and the natural surface below 230 in Main Room A had their highest P levels, around 1900 mg/kg and 2300 mg/kg, respectively. The possibility arises that layer 230 in both Cell B and Main Room A is disturbed, and no clear patterns are visible to suggest the use or the division of space. Therefore, layer 230 in Cell B is inconclusive in terms of the functions of the cell.

Nonetheless, the overall levels of P (highest around 2250 mg/kg) seen at this site are significantly lower than the levels of P seen in the nearby sites of South Uist, and this might indicate a more sporadic or short-lived occupation phases in the house rather than the intensive occupation seen at other sites. At Cladh Hallan, most structures have levels of P c. 4000-5000 mg/kg at its highest (Parker Pearson 2021a; see Chapter 3). House 2 on mound 2, Bornais, also on South Uist, has levels of P c. 14000 mg/kg (see Chapter 5). Similarly, in the Late Iron Age House 2 on mound 1, Bornais, the highest levels of P were at around 4000 mg/kg (Smith and Marshall 2012; see Chapter 3). The nearby site of Cille Pheadair has two houses (houses 500 and 700) (Parker Pearson *et al.* 2018b; 2018c): house 700 showed the highest P levels, c. 6000 mg/kg; while house 500 showed levels of P as high as 5000 mg/kg.

The geological composition of sites can influence the presence of various elements within them. Similarities in geological attributes can render sites comparable in certain aspects. For instance, Cladh Hallan is situated in an area characterised by aeolian sand, constituting the parent material for its soils and sediments, whereas Bornais, located somewhat farther from Orosaigh, features Lewisian Gneiss Complex bedrock as the parent material. Similarly, Cille Pheadair, being the nearest, also exhibits gneisses as the parent material for its soils and sediments. However, despite variations in immediate geological features, all these sites share a common bedrock comprising gneisses from South Uist, thereby establishing a degree of comparability among them. The significantly low levels of P seen at Orosaigh may suggest that this site was perhaps only sporadically occupied and not a permanent dwelling. A possibility also remains that the occupation layers in this site have been removed on abandonment leading to the low levels of P detected here. This is an interpretation supported by the presence of the destroyed hearth of Main Room A. However, the distribution of pottery sherds seen in the house floor may suggest that the occupation layers were not entirely removed, and so it is, perhaps, more likely that this is the result of sporadic occupation activities or short-lived occupation. However, it is also worth considering that the scale of enhancement of various elements, especially in the surface of 230, that was found to be lower and difficult to interpret, gives evidence to the observation by Wilson *et al.* (2009, 2333) that 'differences in anthropogenic processes, particularly of abandonment and post-abandonment use, such as cleaning out of abandoned sites, have a significant effect on the scale of enhancement and the within site spatial patterning of element concentration'. Hence, it is worth considering whether lower levels of various elements, especially P, result from sporadic and short-lived use or the abandonment and post-abandonment use of this structure.

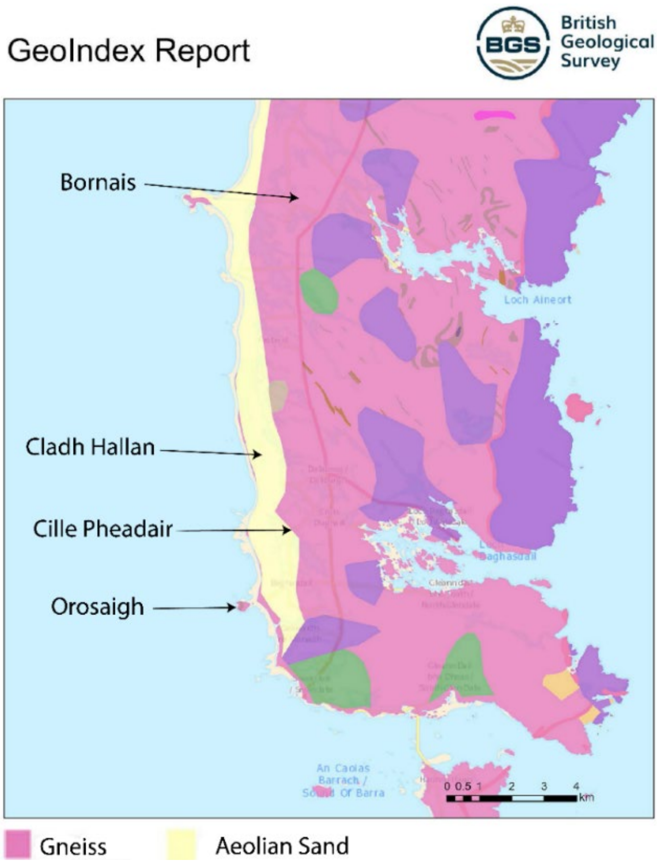

Figure 7.20: Parent material for the local soil and sediments in South Uist (British Geological Survey n.d.).

The distribution of pottery from the upper part of layer 230 shows a higher amount of pottery sherds in a similar area to that seen in the lower floors in Main Room A. This likely suggests a focus of activities in the central area of Main Room A (Figure 7.21). This complies well with the levels of various elements seen in the natural surface under 230 too where the central area shows higher levels of most elements (discussed above). The distribution of pottery in the case of Cell B shows higher amounts of pottery around the area of hearth 232 in the middle floor 236. This is a meaningful pattern, and it more or less mirrors the distribution of enhanced levels of various elements in the middle floor that highlighted the hearth.

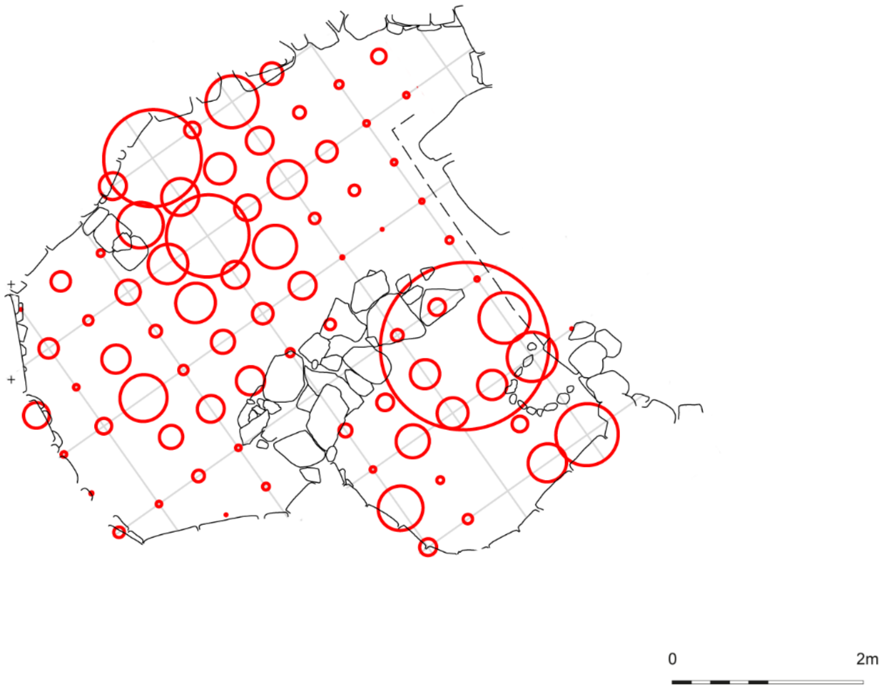

Figure 7.21: Distribution of pottery sherd in the upper part of layer 230 in Main Room A and layer 230 in Cell B (Mike Parker Pearson pers. comm.).

Summary of overall results

The geochemical analysis of the natural surface under (230) and layers 230, 236, and 254 in Cell B has revealed two distinct phases of occupation and a destruction phase. It has also indicated as a possibility the presence of a possible hearth in Main Room A that was destroyed and cleaned, leaving no visual traces during excavation. In Cell B the hearth in 236 and the possible hearth in 254 were highlighted in the excavations as well as in the chemical distributions.

In this study, two layers were analysed in Main Room A and three layers in Cell B of the three-celled house at Orosaigh, which revealed distinctive patterns. It is essential to contextualise the results from these layers in terms of each other. Only a single thick occupation layer was identified in Main Room A (as context 230) that continued to the passage and Cell B of the house. However, the sampling strategy followed in Main Room A sampled the upper surface of this layer and the natural surface immediately below this layer. The geochemical analysis indicated that the surface of 230 was a disturbed layer that was a mix of the occupation layer and a post-depositional abandonment/destruction layer. In contrast, the lower natural surface provides the best evidence for primary occupation, particularly as this was the original living surface of the house. Context 230 was on top of context 236 (middle layer) in Cell B and this was similar to layer 230 in Main Room A. Considering that there was only one occupation horizon (230, albeit disturbed) identified in Main Room A alongside the natural surface below 230, it is likely that primary occupation represented by the natural surface in Main Room A and layer 236 (i.e. middle layer) in Cell B are contemporary. However, there was still a layer under 236 in Cell B, i.e., 254 (the bottom layer). This raises a possibility that either this latter context (254) was contemporary with the primary occupation in Main Room A, and a possible secondary occupation represented by 230 was contemporary with 236. It is also possible that the primary occupation horizon in Main Room A was removed and cleaned before the formation of the secondary occupation. Such a removal of the primary floor in Main Room A would also explain the removal of the hearth, whose presence was indicated by the chemical signature in Area 2 on the natural surface below 230 (see Figure 7.19), even though there was no visible archaeological evidence for a hearth.

Another interesting finding from this geochemical study is the overall low levels of phosphorus (P) seen in this house (when compared to other archaeological structures in South Uist where the house floors have shown significantly higher levels of P). This could, potentially, be suggestive that this cellular house had short-lived or sporadic occupation. It may also be a result of regular cleaning out and removal of house floors at the end of each occupation phase, as explored above.

Based on contemporary layers, interpretive plans can now be developed, as depicted in Figures 7.19 and 7.20. However, these interpretations must remain tentative as some of the patterns in the levels of different elements could be a result of the natural variation of various elements in the sediments. Nevertheless, it is possible to propose some patterns and activity areas. The destroyed hearth in Main Room A, if it existed, during the primary occupation, was possibly located in the eastern part of the central area during most of its use in this phase. While the suite of elements associated with a hearth (see Table 3.1) can be seen here, the levels of Pb, P, Zn and Cu (higher than in the underlying geology to some extent) along with the higher distribution of pottery in the area around the possible destroyed hearth gives some confidence to the interpretation. The eastern part of the central area, as well as the northeast area of the main room, could have been utilised for daily activities related to the hearth which may be supported by the higher levels of Cr, P, and Zn than their levels in the underlying geology. The western part of the central area was possibly linked to food processing activities and possible consumption based on the elevated levels of Sr, P, and Ca. Although the levels of Sr and P are not higher than the natural levels in the bedrock, some confidence in this interpretation comes from the grinding stone recovered in this area lying on top of the drain, and the high amounts of pottery compared to the back and front areas of this room (Figure 7.21). The back and peripheral regions may have accommodated sleeping and storage activities based on the low levels of most elements in this part of the floor. However, the confidence in this interpretation is low due to anomalous spots of high levels of P here. In the smaller Cell B, a possible secondary destroyed hearth of this phase was present. This hearth in Cell B is said to be secondary as it had lower levels of various elements compared to the possible hearth in Main Room A, indicating that it may not have been used for as long a period as the primary hearth. While the confidence based on the multi-element analysis low, especially in comparison to the possible destroyed hearth in Main Room A, some confidence in this interpretation comes from the observation of ash spreads around this area. it may have been used for cooking with a well-built socket for holding pots and a platform for storage and food processing (Figure 7.22).

The next phase of this house is represented by layer 236 in Cell B, which either was still contemporary with the primary occupation of Main Room A or was contemporary with a secondary occupation in Main Room A. The absence of traces of a hearth in layer 230, and its presence in Cell B, may suggest that the main hearth was relocated to Cell B in this second phase. Additionally, it is noteworthy that levels of almost all elements from this well-preserved hearth in Cell B are comparable to those from the possibly destroyed hearth in the primary occupation of Main Room A. In this phase, hearth 232 may have functioned as a cooking hearth, with the back southern area of the cell being perhaps utilised for storage purposes (Figure 7.23).

Should it be the case that the primary floor of Main Room A was removed at the end of the first occupation phase, it would provide a compelling example of multiple c-transforms acting on that occupation horizon here, such as maintenance process and lateral recycling (see Chapters 1 and 8). Lastly, it is worth noting that the top layer (230) in Main Room A and Cell B (also 230) are both clearly disturbed and mixed through post-depositional processes, and thus, interpretive plans were not drawn, as any deductions made would be flawed.

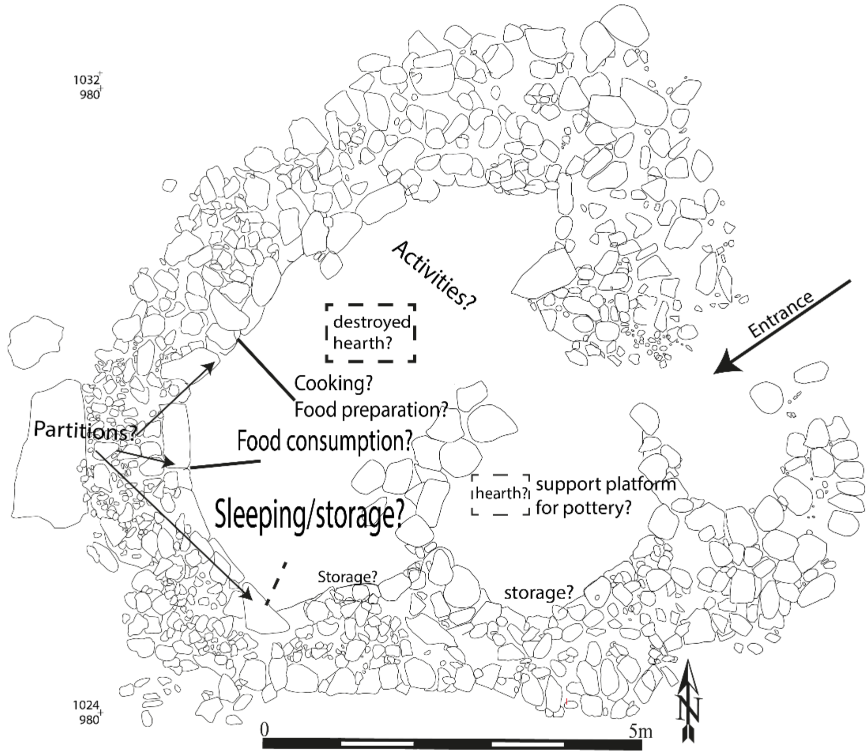

Figure 7.22: Tentative interpretive plans of Main Room A, based on the primary occupation represented by surface natural under 230, and Cell B, based on layer 254 (bottom floor).

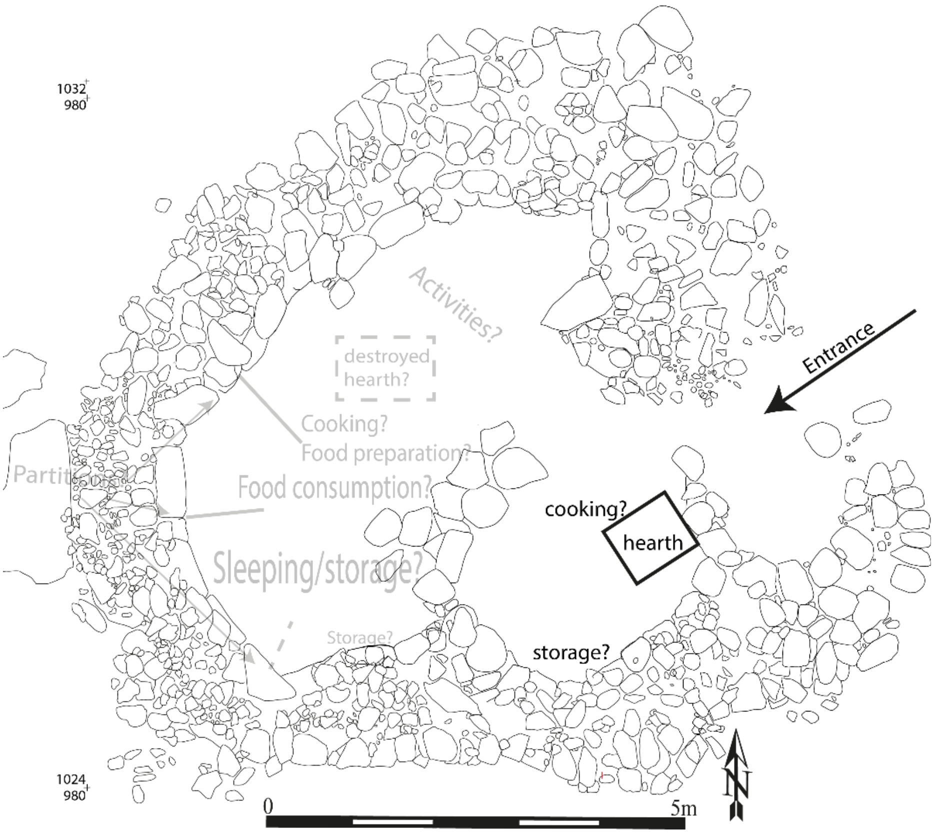

Figure 7.23: Tentative interpretive plan of Cell B: based on layer 236 (middle floor).

7.6 Comparison with other cellular houses in Scotland

Cellular houses in Scotland are generally understudied. As such, no cellular houses have been studied by geochemical analysis, nor have many spatial models been produced for the organisation of these floors. Nevertheless, some comparisons can be drawn from other Late Iron Age cellular structures where interpretations have been made based on structural remains. This section aims to explore similar examples of cellular houses and take account of the interpretations of the organisation of space within these structures. By comparing and contrasting various studies, it may be possible to develop a model that sheds light on the spatial organisation of cellular houses.

As discussed earlier in this chapter, the cellular structures at Dun Vulan and Beirgh showed a sub-circular central space with surrounding cells separated from the interior by substantial stone partitions. The structure at Beirgh also had a central hearth (Harding and Gilmour 2000). Such a layout was also seen at Gurness, Orkney (Hedges 1987), Traigh Bostadh, Lewis (Neighbour and Burgess 1996), NE building at the Howe (Balin Smith 1994), Buckquoy, Orkney (Ritchie 1977), and the Udal (Crawford 1986 cited in Sharples 2003). Similarly, Orosaigh had an arguably destroyed central hearth in Main Room A. However, these sites differ in layout from the cellular structure at Orosaigh, such that the largest Main Room A is furthest away from the entrance, and the smaller cells do not surround Main Room A. Instead, the three cells were connected by an entrance passage. Apart from the presence of hearths, the above examples lack enough information regarding the organisation of these buildings. However, one common theme seen in all these examples is a suggestion of the use of the central circular main area with the hearth for daily activities and the smaller cells being suggested for storage. At Orosaigh, while some storage may have occurred in the smaller cells, it was certainly not the exclusive function in the case of Cell B, where hearths were also identified. Parker Pearson (2012b, 417) observed that in some Late Iron Age cellular structures such as Dun Vulan, the Udal and Bostadh, a three-celled arrangement was present, where a smaller cell, commonly referred to as the ‘guard cell,’ was located next to the entrance. This cell led to a central circular or oval room containing a hearth, which in turn led to a back circular room. Such an arrangement is termed a ‘jelly-baby’ house plan (Parker Pearson 2012b, 417). Although this specific arrangement is not found in Orosaigh, a smaller cell, Cell C, located at the entrance of the structure, could be considered a ‘guard cell’, although this assertion is speculative. The idea of a ‘guard cell’ comes from the Atlantic roundhouses, where they were located partway along their entrance passages (Parker Pearson 2012b, 417). However, Armit (2003) suggests that the defensive function of these entrances is debatable and instead proposes that they may have been used for storing items, such as dog kennels, wet clothes, or boots. Consequently, attributing any specific function to Cell C at Orosaigh remains conjectural.

An example of a well-preserved, clearly organised cellular house is found at Loch Na Beirgh, Riof, Isle of Lewis, where cellular structures were found in the post-broch phase at this site (Figure 7.24). The latest construction within the tower was cellular in the plan, and some suggestions were made for the internal organisation of that space (Armit 1996, 167). It consisted of a substantial circular cell with the entrance facing east, which was the remodelled entrance of the earlier broch tower. This circular cell was connected to a second cell through internal access in an interior wall, and the second cell curved back around the inner broch tower wall towards the entrance. The main entrance of the whole structure led to a paved passageway to the circular cell, which had a large central hearth as the focus of daily activities. Two shelves or seats were built into the wall opposite the entrance at the other end of this cell. These have been suggested to be important seating areas or shelves that display prestige objects. Such an arrangement has also been claimed to be similar to the amounts of ritual material found in bays opposite the entrance in several wheelhouses (Armit 1996, 169). Stone alignments were recorded in the peripheral areas of the circular cell, which Armit (1996, 169) suggests separated the cell into different functional areas though the exact function was unclear. The second cell that lay to the right of the hearth was recorded as having very few features with no hearth and functioned as a storage area.

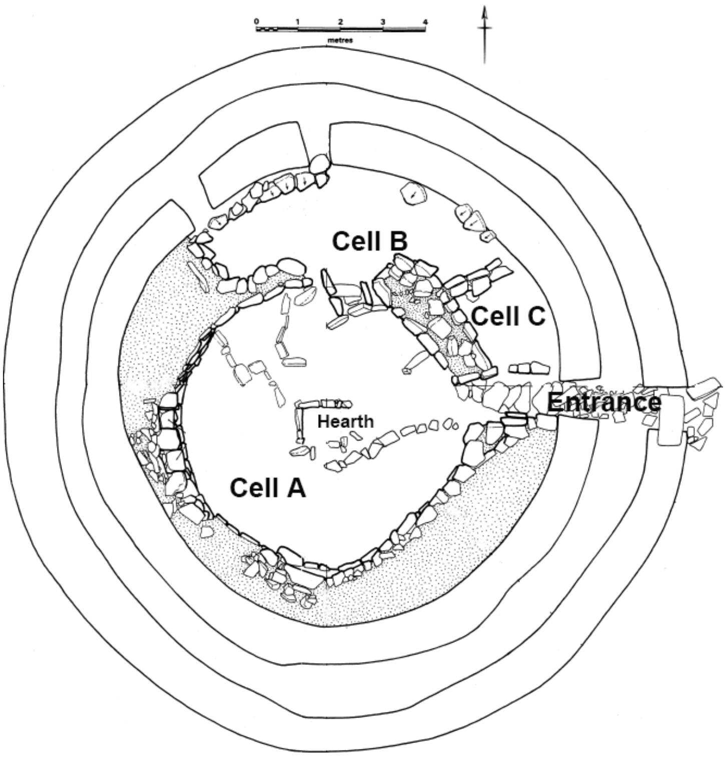

Figure 7.24: Final phase cellular structure at Loch Na Beirgh, Riof, Isle of Lewis (adapted from Harding and Gilmour 2000, fig 5).

Loch Na Beirgh and Orosaigh cellular structures have some similarities. The main cells at both these sites have a hearth (arguably a destroyed one at Orosaigh) in line with the entrance and partitions that divide the back peripheral areas into separate functional areas. Furthermore, the focus of the main activities seems to be directed towards the hearth and central area of the house. However, the secondary cells functioned differently. While at Loch Na Beirgh, it is argued to have been used for storage, at Orosaigh, the second cell had a hearth, with food processing activities also taking place. At Orosaigh, there was also a smaller third cell (Cell C) that was close to the main entrance of the house. Such a smaller cell was also seen at Loch Na Beirgh, but its function has not been suggested by Harding and Gilmour (2000) or Armit (1996).

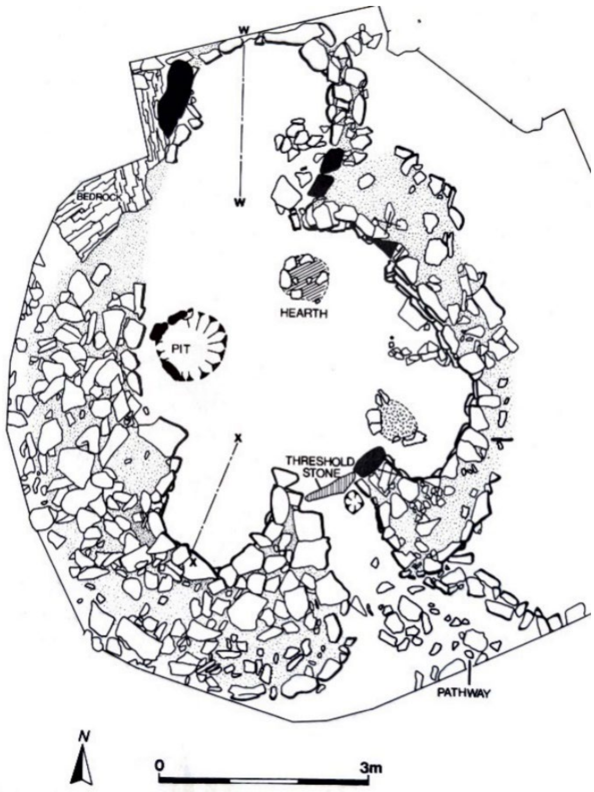

Figure 7.25: Phase 3 cellular structure at Eilean Olabhat, North Uist (Armit 1996, fig 9.10).

Another example of a cellular structure similar to Orosaigh is at the site of Eilean Olabhat in North Uist (Figure 7.25). This site is a small natural promontory that was formerly an islet projecting into Loch Olabhat. The third phase of the building at this site has a pronounced cellular layout. The building consisted of a series of cells with a hearth off the centre. The largest cell was suggested to be a living quarter, while its centre with the hearth was used for metalworking (Armit 1996, 177). Metalworking was represented by the recovery of several clay mould fragments, crucible fragments, pieces of tuyere and other by-products of metalworking for precious metals, including bronze (Armit 1996, 177). Armit (1996, 176) also noted that no formal kiln was recorded at this site, suggesting that a simple hearth is sufficient for the production activities here. It was also pointed out that hazel and birch twigs and branches were used as fuel for the metalworking process, though peat was also recovered. This is in contrast to the previous phases, where there was no evidence of metalworking, and the primary fuel was exclusively peat (Armit 1996, 176-7).

Eilean Olabhat also has similarities to Orosaigh. The area to the west of this hearth and towards the back of Main Room A was indicative of being a living/domestic area. This is similar to the observation at Eilean Olabhat, showing a centre and front activity area and the back peripheral areas for passive domestic activities. Although peat ash was recorded on site and peat was readily available at Orosaigh, the destroyed hearth in Main Room A and hearth 232 in Cell B showed high potassium (K) levels. This indicates the use of wood as fuel along with peat which seems to be more typical. This is because peat alone would not have resulted in the enrichment of K in hearth samples as peat is deficient in K while wood is rich in it (Steenari *et al.* 1999, 249-258). This suggests the use of the hearths for activities requiring higher temperatures when wood would have been used. Though geochemical analysis showed elevated levels of copper, lead, and manganese in the primary (destroyed) hearth in Main Room A and the well-preserved hearth 232 in Cell B at Orosaigh, indicating some metalworking activities, no archaeological evidence was recovered, casting doubt on this interpretation. However, if we follow an interpretation that this floor and hearth were deliberately removed, it is not unlikely that any evidence for metal working, if at all, was also removed.

The utilisation of internal space within the Late Iron Age cellular structures of Atlantic Scotland remains a poorly understood and understudied area, mainly due to the lack of comprehensive studies on these buildings. The multi-element analysis conducted at Orosaigh attempted to explore this issue in more detail. It is now plausible to suggest, with greater confidence, that Main Room A at Orosaigh encompassed an activity area, around a destroyed hearth, located in close proximity to the entrance and northeast corner. At the same time, the western area, extending from the destroyed hearth towards the back peripheral areas of the room, possibly served as the living quarters in Main Room A. The central area of the western part, may have also served as an area for food consumption and processing, based on the heightened phosphorus levels. The back peripheral area, separated by stone partitions, could have served as a storage or sleeping area. Cell B, with a hearth each in both the recorded phases, possibly functioned as a cooking and storage area based on the archaeological and geochemical evidence. This is unlike other sites where smaller cells were suggested to be used for storage.

7.7 Conclusion

The geochemical analysis of the floor of the house at Orosaigh has not only helped reveal the possible nature and duration of the activities that were carried out within the building but also helped highlight other significant aspects that may have been overlooked in the biography of this building. Firstly, it was discovered that there is a possibility that the primary occupation in Main Room A was represented in the chemical residues left behind on the natural surface immediately below the disturbed layer 230. However, consideration has been given to the possible influence of the gneiss bedrock weathered subsoil here. Secondly, although only a single hearth had been identified during excavation in Cell B, the geochemical analysis, along with the distribution of pottery sherds, revealed the arguable presence of a destroyed hearth in Main Room A. This may have served as a primary hearth during the primary occupation phase and a secondary hearth in Cell B, also likely in use during the same phase. However, this study also highlighted the need for other forms of study such as soil/sediment micromorphology, magnetic susceptibility analyses, and pH level analyses (see Chapter 8) that would have helped verify the possibility of the presence of these potential hearths or areas of burning. Moreover, the geochemical analysis of the secondary, mixed occupation horizon confirmed the archaeological observations that this was a mixed layer, and that in itself is reassuring. Furthermore, the lower levels of phosphorus seen in the floor through this study raise the possibility that this cellular structure had short-lived or sporadic occupation phases.

The application of geochemical analysis has enabled the revelation of insights into the daily life within the cellular house located at Orosaigh, South Uist, which otherwise would have been arduous to discern due to inadequate internal structural evidence. Additionally, this technique provides valuable insights into the social values that govern the utilisation of space within these buildings. Despite the absence of a standardised layout for cellular houses in Scotland, a possible division of space into distinct areas can be observed. The central and front spaces, located closer to the entrance, may have been utilised as major areas for daily activities, while the peripheral/back areas were reserved for passive activities within these houses. The subsidiary cells, on the other hand, could have been utilised for both passive activities like storage and active ones like cooking. The presence of a third cell near the entrance, where it exists, may have functioned as a 'guard cell', as proposed by Parker Pearson (2012b, 417), or for basic functions such as storage, dog kennels, or as a place to hang wet clothes or boots, as proposed by Armit (2003, 65-66). However, this necessitates further investigation by conducting similar geochemical studies on other cellular structures so that this model can be tested and validated.

[xi] A guard cell is called so as someone would be stationed there controlling the entry and exit to the building.

CHAPTER 8: DISCUSSION

8.1 Introduction

In this discussion chapter, I will provide a comprehensive summary and examination of various themes and ideas that have been introduced in previous chapters. The aim is to revisit and scrutinise these concepts alongside summarising the findings from the case studies conducted. The topics covered here go beyond mere quantitative and qualitative analysis, encompassing a broader perspective that integrates multiple case studies. I will refer back to the main aims of the PhD as established in the introductory chapters, whenever relevant. By doing so, I hope to maintain a connection between the overarching objectives and the specific findings presented in the research. Additionally, I will discuss the potential avenues for future research that can build upon the current findings and expand our understanding of the subject matter.

Firstly, a brief summary of the principal findings from each case study is provided. This is followed by an investigation into the identification of chemical signatures correlated with specific activities across the houses examined in this study. Subsequently, a discussion on the diverse soil formation processes that could have influenced the house floors of the three case studies is presented. This is followed by a re-examination of anthropological themes discussed in Chapter 2 in relation to their pertinence to the houses explored in case study Chapters 5-7. Following this, it is a section on suggestions for future research and methods. Overall, this chapter serves as a critical reflection on the research conducted, tying together the various threads explored throughout the thesis and offering a holistic perspective on the outcomes and implications of the study.

8.2 Summary of Organisation of Space in the Three Case Study Houses

Using multi-element analysis, each case study presented in this thesis has unveiled possible organisational models for domestic space. The utilisation of internal space within each house was deduced by observing the elevation or decrease in levels of a cluster of elements which might be the result of particular activities. The patterns were compared to features within the houses, alongside the spatial analysis of finds, where available. These associations were identified based on relevant literature on geochemical analysis of sites from various periods and locations, as discussed in Chapter 3 and table 3.1. Consistent clusters of such elements were observed across different sites, which delineated possible chemical signatures for specific activities. For example, the study by Smith and Marshall (2012) of the Late Iron Age house at Bornais, and Wilson *et al.* (2008), in the cross-site study of six sites across Britain, found that a significantly high cluster of most elements analysed (including P, Cu, Pb, Zn, Ca, and Sr) was found in hearth areas. However, a drawback identified in the review of the extant literature on geochemical analyses of structures (as discussed in Chapter 3) was the limited comparison of those particular examples with other case studies. To address this limitation, the houses at each case study site in this thesis were extensively compared to their similar counterparts elsewhere to refine the interpretation of the organisation of domestic space. The resulting tentative models are summarised below.

In the case of the Middle Norse house, House 2, at Bornais, the house appears to have consisted of a central living space, a rubbish accumulation area and a fabric stitching area in the eastern end (Figure 8.1 A). Based on the spatial analysis of finds, internal features, and the presence of patterns of the distribution of different elements, the central living space was differentiated into three aisles: the central aisle with a long hearth and a secondary fireplace and two side aisles. The northern aisle may have been utilised as a seating, food consumption and sleeping area, possibly with an adjacent wool production area based on the textile production objects present here. The southern aisle near the western long hearth functioned as the primary food preparation and consumption area, suggesting a central location for social activities. Adjacent to this, a lead-working area was found, and within the vicinity here towards the walls, it was suggested to be another sleeping/sitting storage area. The eastern part of the longhouse, closer to the secondary fireplace, was possibly used for occasional cooking. However, association with lead-working is also likely as this hearth was burnt to higher temperatures, as evidenced by the frequent use of wood as fuel in this fireplace along with the more usual peat (see Chapter 5).

The study of the Iron Age house RH SO19 at Meillionydd explored possible ideas for the organisation of this roundhouse floor. However, as discussed in the chapter, the data is not clear, and there could be multiple reasons for the distribution patterns observed, which may have been related to natural and cultural processes in the formation of the archaeology, as well as the excavation strategies themselves muddying the patterns making the suggestions for the different use of areas in the house just one of the possible interpretations. The western peripheral quarter might have been linked to sleeping/storage activities, and this may have extended into the southern peripheral quarter, although confidence in the data is not high here. Additionally, the possibility of an internal setting delineating an activity in the northwest is also proposed. The central area surrounding the hearth was likely a cooking/food preparation area, but the adjacent working hollow might have also been used for other daily activities. The areas to the north and south of the hearth could have been utilised in different ways. Due to the complicated nature of the data at this site, it is imperative to reiterate that these proposals are tentative (see Chapter 6). While the phosphorus distributions neither dispute nor strongly confirm the proposed interpretations, one possibility for the spread of the enhanced levels of P relates to post-abandonment processes, with the collapsed organic roof perhaps decaying *in situ*.

The cellular house at Orosaigh highlighted some organisation of space over the different phases of occupation. In Main Room A of the house, a destroyed hearth was identified in the eastern portion of the central region (Figure 8.1B). This room comprised an activity area situated in close proximity to the entrance and northeast corner. Concurrently, the western section, spanning from the demolished hearth towards the rear peripheral zones of the room, could have served as the main living area within Main Room A. The central portion of the western area, while possibly functioning as a food processing zone, potentially doubled as a space for food consumption, as suggested by the elevated phosphorus levels. The back and peripheral areas of the room were presumably used for sleeping and storage purposes because of the low levels of most elements (See Chapter 7).

The smaller Cell B was found to contain a hearth during this phase of occupation of its middle floor (Figure 8.1 B). This hearth differed from the destroyed hearth in Main Room A as it showed comparatively lower levels of various elements. Consequently, it is possible that this hearth was not utilised for as long a period as the one in Main Room A. Additionally, given that the structure of this hearth was preserved while that of the Main Room A hearth was not, it may have been a later addition to the house during this occupation phase. It is possible that this hearth in Cell B was used for cooking and food processing. Another hearth (also destroyed) was also seen as a possibility in the lower floor of Cell B (Figure 8.1C; see Chapter 7). Finally, it was observed that the levels of phosphorus in the house floors at Orosaigh were lower compared to levels seen in the phosphorus studies at other houses in South Uist with comparable geologies, such as Bornais, Cladh Hallan, and Cille Pheadair. A possible explanation for this is that Orosaigh had short occupation phases or was occupied sporadically.

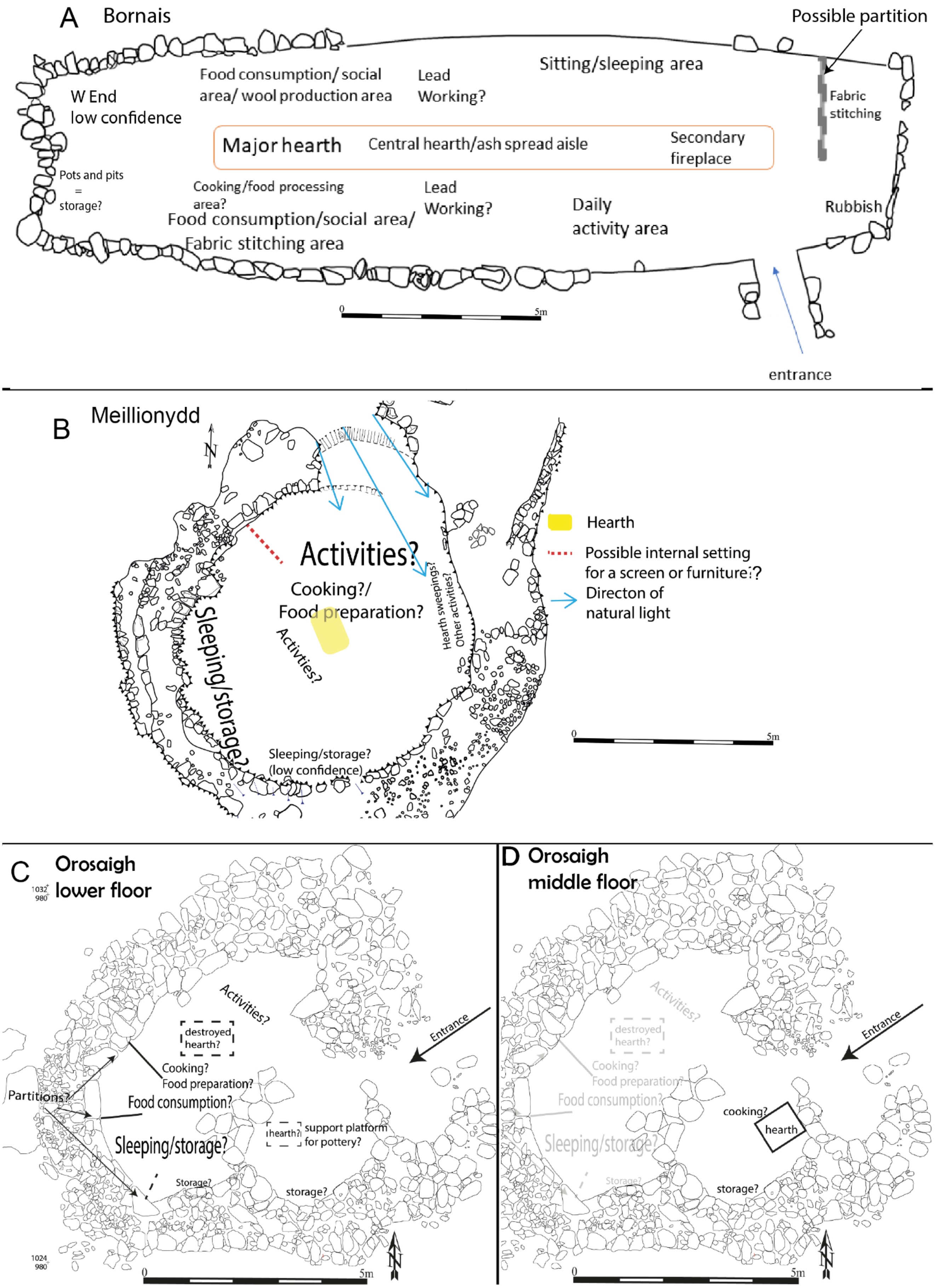

Figure 8.1: Interpretive plans for the three case studies in this thesis.

8.3 Activities and Chemical Signatures

In the models summarised above, it is observable that some of the features or particular activities are seen across all three sites, which can now facilitate cross-site comparisons. One of the aims of this study was to develop a repository of chemical markers that could be correlated with distinct functions/activities within particular areas or features of the house floors. In this study, the exploration of occupational horizons across diverse case studies has generated substantial information. To facilitate the comparison of findings pertaining to specific activities across these case studies, the elevated elements associated with each activity or feature are extracted from each site and are consolidated and presented as tables below (Tables 8.1-8.5). Each table outlines the elements associated with a particular activity or feature. It is important to note that comparisons can only be made between similar activities or features that are visibly present across all three case studies, regardless of their temporal or geographical context. Activities or features identified at one site but not at others are excluded here.

Three activities and two features were chemically observed or interpreted across all case study sites: cooking/food consumption/food processing areas, activity areas, sleeping/storage areas, hearths, and partitions. However, it is not possible to compare the exact levels of each element associated with these activities, as they can vary depending on the site's geology and archaeology. What can be compared are the relative enhancements of each element in relation to the activity or feature, as well as the overall house floor. These enhancements can be broadly classified as medium, medium-high, and high based on visual inspection of the distribution plans. These categories are defined as follows: medium levels represent approximately 50% of the highest value for a given element at each site, medium-high enhancements are above medium levels but below 75% of the highest value, and high enhancements constitute the level above 75% of the highest value for an element. However, it must be noted that consideration was given to the actual value ranges of individual elements within each of the distribution maps in order to ensure that the value ranges are representative of broad patterns for that particular element in that particular 'area' of enhancement (see Chapter 4). For example, random erroneous extreme outliers of high or low values from single-spot samples were removed from this analysis. Furthermore, only areas producing three or more spot samples showing relatively high levels, or relatively low levels were considered (for similar methodology, see Doonan and Lucquin 2019). These classifications are also already visually represented in the distribution maps of individual elements for each case study: medium values correspond to predominantly yellow areas, medium-high values are indicated by a mix of yellow and red, and high-value areas are primarily red. Utilising this classification system, the tables below present a range of chemical signatures which appear to be consistent within activity areas or features such as hearths. As an example of the classification, at Bornais, medium values for nickel (Ni) would be approximately 12.07 mg/kg (shown by an area that is mainly yellow), medium-high values would be up to 18.107 mg/kg (shown by an area that is a mix of yellow and red), and high values would range from 18.107 mg/kg to the maximum value of 24.1435 mg/kg (shown by red areas) (Figure 5.10). If required, the reader should refer to the individual chemical element distribution plots for Meillionydd (Figures 6.13-6.15), Orosaigh (Figures 7.9-7.12; 7.17-7.19) and Bornais (Figures 5.8-5.11) in order to gauge the ranges (e.g. lowest to highest number) that were in existence for individual elements within each site. For a better visualisation of this data, the reader may refer to Appendix II, as it shows the elevated elements associated with the features and the elements showing low levels. Additionally, the following tables also include a column that lists the chemical elements present in the underlying geology that may have influenced the chemical signatures seen at the three case study sites. In instances where the levels of specific elements in the local geology are comparatively lower than those detected at the site, a '?' suffix has been appended to denote potential minimal influence and those elements which are naturally raised are highlighted in bold. Those which are present in the geology, but their influence on the archaeology is unclear, are shown in italics. Direct comparison of most of the chemical elements in the house floor to the ones in the geology was not possible as most of the chemical elements in the geology were observed in their compound form as oxides rather than elemental form (also discussed in Chapter 5, 6, and 7).

Site	Feature type	High	Medium-high	Possible influence of underlying geology
Meillionydd	Hearth	Aluminium, Copper, Potassium, Manganese, Nickel, Zinc	Calcium, Chromium, Iron, Phosphorus?, Strontium	**Aluminium**, **Iron**, S**trontium**, *Titanium, Calcium, Potassium,* Phosphorus?, Manganese?
Orosaigh Main Room A	Possible destroyed hearth	Manganese, Nickel, Zinc	Aluminium, Calcium, Chromium, Copper, Iron, Potassium, Lead, Sulphur	**Aluminium**, **Iron**, C**alcium**, *Titanium, Potassium, Nickel, Copper, Lead, Zinc, Manganese, Strontium,* Chromium?
Orosaigh Cell B, lower floor	Possible hearth (identified by heat-affected sediment and ash spread)	Copper, Potassium, Manganese, Nickel	Aluminium, Calcium, Chlorine, Iron, Phosphorus, Strontium, Zinc	**Aluminium**, **Iron**, C**alcium**, *Titanium, Potassium, Nickel, Copper, Lead, Zinc, Manganese, Strontium,* Chromium?
Orosaigh Cell B, middle floor	Hearth	Aluminium, Calcium, Copper, Iron, Potassium, Manganese, Nickel, Zinc	Chromium, Lead, Strontium	**Aluminium**, **Iron**, C**alcium**, *Titanium, Potassium, Nickel, Copper, Lead, Zinc, Manganese, Strontium,* Chromium?
Bornais	Long hearth	Calcium, Chlorine, Copper, Manganese, Zinc	Aluminium, Iron, Nickel, Phosphorus, Strontium	**Aluminium**, **Iron**, **Calcium**, *Titanium, Potassium, Nickel, Strontium,* Copper?, Chromium?, Lead?, Manganese?, Zinc?
Bornais	Possible Secondary fireplace	Aluminium, Chlorine, Chromium, Iron, Nickel, Phosphorus, Sulphur	Calcium, Copper, Potassium, Manganese	**Aluminium**, **Iron**, **Calcium**, *Titanium, Potassium, Nickel, Strontium,* Copper?, Chromium?, Lead?, Manganese?, Zinc?

Table 8.1: The chemical signature in the occupation layers associated with hearths or possible hearths at each site. The chemical elements listed on the far right column are those that are present in the natural geologies of each site, which are often listed only as compound forms. Those elements which are naturally raised are highlighted in bold. Those which are present, but their influence on the archaeology is unclear, are shown in italics. Those with the suffix '?' are likely lower than the archaeological levels.

Site	Feature type	High	Medium-high	Medium	Possible influence of underlying geology
Meillionydd Central Area	Cooking?/food processing?/ food consumption area?	Aluminium, Calcium, Copper, Potassium, Zinc	Chromium, Iron, Manganese, Phosphorus?, Strontium		**Aluminium**, **Iron**, S**trontium**, *Titanium, Calcium, Potassium,* Phosphorus?, Manganese?
Orosaigh Main Room A	Cooking?/food processing?/ food consumption area?	Calcium, Phosphorus, Strontium	Chlorine, Manganese, Sulphur	Zinc	**Aluminium**, **Iron**, C**alcium**, *Titanium, Potassium, Nickel, Copper, Lead, Zinc, Manganese, Strontium,* Chromium?
Bornais-north side of the central aisle	Cooking/food processing/ food consumption area		Calcium, Copper, Manganese, Phosphorus, Zinc	Aluminium, Strontium	**Aluminium**, **Iron**, **Calcium**, *Titanium, Potassium, Nickel, Strontium,* Copper?, Chromium?, Lead?, Manganese?, Zinc?
Bornais-south side of the central aisle	Cooking/food processing/ food consumption area	Copper	Calcium, Manganese, Phosphorus, Zinc	Strontium	**Aluminium**, **Iron**, **Calcium**, *Titanium, Potassium, Nickel, Strontium,* Copper?, Chromium?, Lead?, Manganese?, Zinc?

Table 8.2: The chemical signature in the occupation layers associated with each site's possible cooking/food processing/ food consumption area. The chemical elements listed on the far right column are those that are present in the natural geologies of each site, which are often listed only as compound forms. Those elements which are naturally raised are highlighted in bold. Those which are present, but their influence on the archaeology is unclear, are shown in italics. Those with the suffix '?' are likely lower than the archaeological levels.

Site	Feature type	High	Medium-high	Medium	Possible influence of underlying geology
Meillionydd	Front activity area?	Phosphorus?	Calcium, Copper, Sulphur	Manganese, Strontium, Zinc, Lead	**Aluminium**, **Iron**, **Strontium**, *Titanium, Calcium*, *Potassium*, Phosphorus?, Manganese?
Orosaigh Main Room A	Front activity area?	Aluminium, Chlorine, Manganese, Nickel, Lead, Sulphur, Zinc	Calcium, Chromium, Copper, Iron, Potassium, Phosphorus	Strontium	**Aluminium**, **Iron**, **Calcium**, *Titanium*, *Potassium, Nickel, Copper, Lead, Zinc, Manganese, Strontium,* Chromium?
Bornais	Daily activity area		Calcium, Sulphur	Chromium, Copper, Potassium, Manganese, Phosphorus, Lead, Strontium, Zinc	**Aluminium**, **Iron**, **Calcium**, *Titanium*, *Potassium*, *Nickel*, *Strontium,* Copper?, Chromium?, Lead?, Manganese?, Zinc?

Table 8.3: The chemical signature in the occupation layers associated with possible activity areas at each site. The chemical elements listed on the far right column are those that are present in the natural geologies of each site, which are often listed only as compound forms. Those elements which are naturally raised are highlighted in bold. Those which are present, but their influence on the archaeology is unclear, are shown in italics. Those with the suffix '?' are likely lower than the archaeological levels.

Site	Feature type	Chemical signature
Meillionydd West Quarter of Periphery	Possible primary sleeping/storage areas	Wider area showing relatively low values of almost all elements, with nickel and potassium being inconsistently high and low
Orosaigh-Main Room A	Possible primary sleeping/storage areas	Wider area showing relatively low values of almost all elements, with strontium and potassium being inconsistently high and low
Bornais	Possible Primary sleeping/storage areas	Wider area showing relatively low values of almost all elements, with nickel and potassium being inconsistently high and low

Table 8.4: The chemical signature in the occupation layers associated with each site's possible primary sleeping/storage areas.

Site	Feature type	Number identified	Chemical signature
Meillionydd NW Part of Periphery	Possible/internal setting	1	A straight line of low values of almost all elements generally extending from a wall.
Orosaigh-Main Room A	Possible partition	3	A straight line of low values of almost all elements generally extending from a wall.
Bornais	Possible partition	1	A straight line of low values of almost all elements generally extending from a wall.

Table 8.5: The chemical signature in the occupation layers associated with possible partition within houses at each site.

Tables 8.1-8.5 above propose that certain elements, with particular enhancements, are possibly associated with different activities across the three case study sites. Simultaneously, some elements do not exhibit enrichment for specific activities across all the sites, even if they appear at higher levels in correlation with a certain activity at one location (see below). Consequently, this analysis aims to extrapolate the elements associated with each activity or feature across all three case study sites in the tables above, so as to assess the validity of this analysis. However, though specific functional areas have been delineated within the three case study houses through analysis of chemical signatures observed at these locations—a methodology derived from Table 3.1, which in turn draws from the extensive literature on geochemical investigations of domestic space—it would be a circular argument to now suggest the chemical signatures seen at these houses are an indicator of universal chemical signature for these functional areas. Hence, only chemical signatures linked to confirmed features, or confirmed functional areas demonstrated through independent lines of evidence in these houses can be used for cross-comparisons. One example of such a feature seen at all three sites is the hearth. It must be stressed that there are several elements whose elevated levels may be the result of the underlying geology rather than a result of anthropogenic factors (also see Chapters 5, 6, and 7).

At Bornais, the elements that correlate with the position of the long hearth in the West half of the house are Cl, Fe, and to a certain extent K. At Meillionydd, these are K, Ni, and Fe. Interestingly, however, the locations of the hearths at both these sites show a pattern for Zn and Mn such that the area accommodating the hearth and the area around it show high levels. In the case of the middle floor of Cell B in Orosaigh, the hearth area showed high levels of Fe, K, Mn, Ni, and Pb. Just as at Bornais and Meillionydd, the hearth area and immediate surrounds showed high levels of Zn too. While most element concentrations align with the studies associating various elements with hearths, as discussed in Chapter 3 and Table 3.1, the identification of Ni in relation to hearths or fireplaces is noteworthy. Only a few studies have incorporated Ni in multi-element analysis, although Ni has been connected to human habitation areas (e.g. Oonk *et al.* 2009).

In the context of food consumption areas (Table 8.2), these spaces tend to display high levels of Cu, Mn, and Zn at Bornais. Notably, Ca, P, and Sr levels are higher than those found in hearths, while Cu levels are nearly on a par with hearths, and Zn exhibits similar or lower levels than hearths. However, in the case of Meillionydd and Orosaigh, without corroborative or independent lines of evidence, it is difficult to suggest the elements associated with these areas in these sites as indicators of food consumption areas.

Potential activity areas found in all three case studies were seen as focused towards the hearth and front areas of the house. Consequently, activity areas were found to exhibit medium-high levels of Ca, Cu, P, and sulphur (S), along with generally high levels of Mn. The ranges of Sr and Cr consistently displayed medium levels in these regions. Although Zn and Pb demonstrated some elevation in activity areas, these elevations were inconsistent. This inconsistency may be attributed to the wide range of activities encompassed under the term 'activity areas'. It is crucial to emphasise that the designation of an activity area does not just imply a specific function, as in the case of hearths or cooking/food consumption areas. Given the wide array of human activities in the past, it is difficult to ascertain a singular function for these areas. Furthermore, considering that several of these chemical elements seen in the case of the possible hearths, the possible food consumption/cooking area or possible activity areas can be seen in the underlying geology, the confidence in these chemical signatures is low.

Possible sleeping/storage areas and partitions/internal settings do not exhibit any notable elevations of most elements. While broader areas generally displaying low levels of most elements are inferred as sleeping and storage spaces, it does not necessarily imply that other areas with higher levels of other elements, including P, cannot be part of a sleeping area. In conjunction with comparisons to sites with archaeological evidence of sleeping areas/platforms, the identification of such areas in this PhD research has been grounded in the notion that sediments beneath sleeping platforms/furniture/bedding tend to remain undisturbed or less exposed to organic matter or artefacts or activities (as observed by Pingarrón 2014; also see Table 3.1). Nonetheless, sleeping furniture or raised beds constructed from organic material can lead to high P levels. This phenomenon is possibly evident at Bornais, where elevated levels of P and other elements were observed in areas suggested to be part of sitting areas (which may have been used for sleeping as well) south of the central hearth aisle (see Chapter 5). A recent example of such a phenomenon can also be seen in some of the houses analysed by geochemical analysis using P at Cladh Hallan (for examples please refer studies by Smith *et al.* in Parker Pearson *et al.* 2021a; see Chapter 3 for discussions). Although potential chemical signatures for associated features or functions are observed across the three case studies, it is imperative to acknowledge the provisional nature of these findings, given the complexities of equifinality elucidated within the respective sites discussed in chapters 5, 6, and 7. Additional considerations regarding equifinality, which may pertain to all three case studies, are elaborated upon below.

8.4 Sediment Formation Processes and Multi-element Analysis

While various activities/features and their associated chemical signatures have been identified in the previous section, it is important to realise that there are several factors at play here which could influence the accurate or inaccurate identification of those activities/features in the occupation layers. The above chemical signatures or interpretations must take into account certain caveats. Multi-element analyses, along with measuring the contents or composition of the sediment, are essentially ways to measure the processes that affect sediments over time, including how they break down organic and mineral inputs and redistribute them. Although the time frames archaeologists work with may be relatively short in terms of formation processes, the sediment still undergoes physical and chemical changes that impact its ability to retain and distribute these inputs. Plants, in particular, can recycle these nutrients over generations, making it difficult to discern the original patterns of human activity. While we assume that the sediment has not drastically altered or removed these inputs since human activity ceased within these houses, this assumption is not always valid and can limit the usefulness of soil geochemistry in studying ancient settlements. The ways sediments in the context of occupation horizons can be altered and our interpretation can be inaccurate have been briefly looked at in Chapter 1. The interpretations from the case studies in this thesis can now be scrutinised in terms of the possible cultural and non-cultural formation processes that may have affected the occupation horizons studied. Schiffer (1987) classified cultural formation processes into four categories. They are reuse processes, cultural deposition, reclamation processes and disturbance processes. While all of the processes may apply to occupation horizons, only the ones that are relevant to the case studies of this research are considered here. These processes are explored below in a discussion that is broadly organised around the life history of a house and its floor/s.

Construction of houses and floors

Various processes involved in the construction of houses, especially house floors, can affect the archaeological soil formation processes of house floors and, as a result, chemical signatures identified by geochemical analyses. Consideration needs to be given to how a floor is constructed. Floors can be made with a variety of methods and materials. For example, they may be constructed of rugs or floorboards or as beaten earth floors. They may even be made by stripping down to natural soils. All the different materials and methods can have their own way of influencing the chemical signatures found in the sediment when analysed several millennia later. Such construction of floors using the natural surface is a process that affects the chemical signatures in the floor. For example, in the case of Orosaigh and Meillionydd (where the houses were semi-subterranean), it was found that the natural surface at the base of the cut for the house formed part of the original floor, and over time, there was a build-up of occupation deposits on top. As a result, the chemical residue of the activities that took place on the earliest floor was found to be reflected on the surface natural, especially in the case of Orosaigh (also discussed further below). Such a phenomenon was also seen at Meillionydd on the east side of the house, where the floor was patchy due to the excavation strategies in the previous years.

Another method of construction of the floor is through scavenging (Schiffer 187, 103-104). In the case of occupation horizons, which appear to be 'earthen floor,' it can refer to parts of floor construction that involve some form of scavenging. As discussed in Chapter 1, the source of the sediment the floor is made from is an important factor in determining its suitability for geochemical analyses, especially if sediments from refuse areas are used to create floors, as seen among the Maya who used secondary refuse as a platform for temples (Schiffer 1987, 109). Such scavenging would alter levels of various chemical elements' levels even before its use as a floor. Consequently, the chemical composition of sediments obtained from a floor of this nature would mirror the combined impact of household activities and the secondary refuse buried here. Furthermore, Schiffer (1987, 111) noted that in the case of floors of structures occupied for a long time, the floor may require frequent repair, and nearby refuse deposits may be used for such repairs. While such scavenging may have occurred in all three case study sites, archaeological evidence for floor repairs was identified at House 2, Bornais. Sharples and Davis (2020a, 155) noted that during the occupation of the house, some areas of the floor, perhaps those that were most heavily used, exhibited signs of infilling and levelling, i.e., repairs. It was unclear where the infilling sediment came from; however, considering that such infilled layers still generally showed consistent distribution patterns in each area in the multi-element analysis, the effects of scavenging material from other areas of the house, if at all, were not visible.

Use and maintenance of floors

A significant number of processes can affect the chemical composition of occupation horizon during the use and maintenance of house floors. After a house (or floor) is constructed, the floor on which various activities begin to take place undergoes changes based on the kind of activities. Along with the activities taking place within the houses, also comes the act of daily maintenance of the house and everyday activities in the form of cleaning, tidying and so on. Maintenance processes are cultural processes that can affect occupation horizons during the use of the house. Referring to artefacts, Schiffer (1987, 49) distinguished maintenance processes into ad hoc and regular, as discussed in Chapter 1. Maintenance processes can also have various effects on the occupation horizons. It also depends on whether it is an ad hoc or regular maintenance processes, such as sweeping or cleaning. Similarly, the clean-up activity's intensity or extensiveness can also affect the development of the occupation horizon. For example, in the case of the cooking area, it may be subject to regular cleaning for the disposal of food and fuel debris. Suppose the cleaning is done regularly here whenever there is enough residue build-up. In that case, the sediment composition can change more dramatically compared to ad hoc cleaning (e.g. when there is an immediate clean-up if there is spillage of food or fuel waste). This is because the longer the occupation horizon is exposed to food and fuel waste, the higher the chance and intensity of change in the chemical composition of the sediment. On the other hand, if the clean-up is ad hoc, then the sediment's exposure to food and fuel waste is far less extreme. While the burning in the area may still be identified, cooking activity here may be relegated as a minor activity or not recognised at all due to regular cleaning activities. Furthermore, how cleaning is undertaken can also affect the chemical composition and thickness of the floor. If the cleaning is done such that along with sweeping of the food and fuel debris, the impacted floor is also removed and discarded, then barely any trace of cooking may be seen in the occupation horizon, both chemically and archaeologically. Such cleaning has been suggested in the case of the floors of a Middle to Late Bronze Age hut circle at Port Cressa, on the Isle of Scilly, where it was proposed to have likely undergone intentional removal of the floors in the form of periodic scrape cleaning, with small amounts of the original surface and accumulated debris being removed (Ratcliffe and Straker 1996, 74). This can be exacerbated if the floor is replaced each time as well. In this case, both regular and ad-hoc maintenance processes may hardly leave any traces of cooking.

Another process of maintenance could be the construction of screens or partitions to create designated activity areas. The suggested partitions identified in the houses in this thesis, identified by multi-element analysis, suggest that such temporary structures were important during the occupation of these houses. While the activities within these spaces may have been performed in an ad-hoc or regular manner, the maintenance of such areas (enabled by partitions) helped identify the boundaries of such functional areas. These did not always survive in the archaeological record, and they would not have been identified if this multi-element analysis had not taken place. At Orosaigh, the sleeping and storage area appeared to be partitioned off from other areas of the house. At Bornais, the East End with a possible fabric stitching area seems to be partitioned off from the nearby secondary fireplace and the surrounds based on the observation of a posthole that was suggested to be part of a structural setting or an internal division (Sharples and Davis 2020a, 156), which also marries up with a sharp decline in the levels of a number of chemical elements. At Meillionydd, an internal setting closer to the entrance in the northwest part of the periphery also seemed to marry with a drop in chemical levels.

While these activities are carried out and areas are maintained in relation to the daily living within the house, there may be several processes that can disturb the natural composition or physical characteristics of the floor. Disturbance processes within the context of cultural formation processes refer to human-initiated activities that inadvertently lead to the alteration or displacement of artefacts and deposits (Schiffer 1987, 121). An exemplary instance of superficial disturbance that happens during the occupation phase of a house is trampling, which occurs when individuals or animals traverse structures during their movements or daily activities. Trampling contributes to the compression of occupation horizons and the subsequent downward displacement of artefacts and deposits. This displacement is more prominent in areas with less rigid, softer surfaces. Upon contact with the floor, trampled objects and detritus may alter the sediment's chemical composition through reactions or decomposition processes. The impacts of trampling may be confined to specific portions of an occupation horizon subjected to high levels of foot or animal traffic. Intense trampling can result in the lateral displacement of artefacts from high-traffic to low-traffic areas (Schiffer 1987, 127). As outlined in Chapter 1, such lateral displacement is also plausible for an occupation horizon, particularly if the horizon serves as a floor subject to direct trampling. Consequently, material from an area designated for one activity might also encompass material from another activity. Trampling can introduce inaccuracies when attempting to discern the boundaries of specific activities, particularly in areas adjacent to high-traffic zones. It is possible that trampling disturbances transpired in each case study, with regions in proximity to entrances being most severely impacted. However, accurately determining the precise implications of trampling through geochemical analysis proves challenging. Nevertheless, areas of high traffic within the houses may well have been the areas where daily activities took place, and such activity may well account for the combination of raised elements seen in the activity areas within the case studies.

The effects of trampling are most easily identified near the entrances of all three houses studied in this thesis. These areas, especially near the entrances, were also found to be associated with open activity areas (i.e., not cordoned-off areas). It is likely that such activity areas were significantly affected by trampling. Conversely, the effect of trampling was least observed where partitions were identified. In such circumstances, soil micromorphology would offer a more suitable method for examining the extent of trampling effects on the occupation horizon beyond the entrance zone. Interestingly, the identification of the central opening in the partitions of the West End of House 2 at Bornais may be attributed to the effects of trampling caused by the movement of people between the West End and the West Central area.

Various depositions can also take place during the normal use of the floor and its maintenance as discussed above. This can also be how the occupation horizons are formed. Among such deposition processes are discard processes (Schiffer 1987, 49). According to Schiffer (1987, 49), they are means by which artefacts end up being selected for discarding. Such a discard process can affect occupation horizons. This is especially the case where some areas of the house floor tend to be used more than others due to the function in that area. For example, the floor in the cooking area and sediments near the house entrance, such as in the case of all the houses studied in this thesis, may have been replaced or cleaned more often than in an area for storage due to the accumulation of waste debris and high traffic. This could lead to a loss of information in the higher traffic areas, especially if they are cleaned just before abandonment. This could also result in varying thicknesses of the preserved floor deposits. Conversely, in storage areas, the sediment composition may remain mostly unchanged. If the floor material in high-traffic areas is frequently replaced, the multi-element analysis here will only reveal the chemical effects of the activity here since the last replacement/cleaning.

Occupation horizons can also behave as artefacts in terms of turning into primary and secondary refuse during the normal use of the house (also discussed in Chapter 1). This is evident in the above case if it is considered that along with the debris from cooking that includes some sediments, i.e., a part of the occupation horizon, is discarded in another area of the house, becoming secondary refuse. This would lead to two areas having very similar chemical compositions. However, in reality, there may be only one cooking area in the structure. In the case studies of this PhD, most of the floor deposits are classified as, or assumed, to be primary refuse, i.e., material left in place of use. However, the central hearth aisle at House 2, Bornais (containing the ash spreads), is a good candidate for secondary refuse. While it may be argued that the ash spreads here may be just secondary refuse, it can be argued that the comparative study of Norse houses from other areas in Scotland (see Chapter 5) suggests that such minor hearths are also a feature of Norse houses and they may have exited at Bornais, too.

Secondary use is defined by Schiffer (1987, 30-32) as the reuse of objects without any extensive modifications. Often during normal living within a house, it is likely that people use some areas for multiple activities. Hence, in the case of occupation horizons, secondary use could mean the use of an area of the occupation horizon that was reserved for a particular function being reused for another purpose. Such secondary reuse may have happened in all of the case studies. Similar to recycling (discussed below), such a change in the use of a particular part of the house can alter the floor's thickness and the chemical composition of the sediment in the area. This also increases the probability that when the sediment from this area was analysed, it was attributed to only one function, as the previous function may have become obscured. This is especially the case in areas which accommodate high and low-intensity activities. Such multifunctional areas will always tend to create an 'intense activity bias' in the geochemical record of the occupation layer. Hence, when the result of a geochemical analysis is presented, it is imperative to realise that they are a reflection in the sediment of one or few possible high-intensity activities or a summation of all the activities that took place in the area of a particular phase of occupation from where the sediment samples were collected.

Until this point, the focus has been on the variability of the activities within the house during its use, however, who is performing the activity and when is also important. Lateral cycling is a reuse process defined by Schiffer (Schiffer 1987, 29) as involving the transfer of artefacts between individuals or social units, with the form and use of the artefact remaining unaffected. Gift exchange is one way in which lateral cycling of artefacts can take place. Such lateral cycling can occur in a structure and hence a house floor, i.e., occupation horizon. For example, each of the houses in the case studies had an occupation of several years (e.g. possibly 70 years for Meillionydd and 50 years for Bornais). Any of these houses may have had a transfer of ownership when passed down from one generation to the other or when passed as a gift. As there is continuity in the occupation of the house, the new owner's behaviour may significantly alter the occupation horizon if a new floor is not built over the existing one. At Meillionydd, a transfer of ownership is visible with the main hearth having been recut once, with a repair wall being constructed on the outside.

In the case of House 2 at Bornais, a few multifunctional areas were identified. While multifunctional areas within Viking longhouses are also attested by the observations from Viking literary sources (Vidal 2013), it cannot be ruled out that the 'multifunctional' areas were a result of lateral cycling. House 2, at Bornais, was suggested to have been occupied for a relatively short period of c. 50 years (68% probability). While this does not necessarily indicate the use of the house over several generations, it still is enough time to have had an increase or change in the occupants since the start of the occupation period. Lateral recycling of the house as a change of ownership or lateral recycling of areas of the house depending on the changing needs and persuasions of the occupants are among the possibilities at this house. An example of such change in the use of an area is evident from the East End quarter of the house, where excavators suggested a rubbish accumulation area, but the sediment samples collected for multi-element analysis came from the final occupation layer, which did not show any elevation of an element such as phosphorus (P) as expected for a rubbish accumulation area. Had the occupation layers underneath the samples from the East End, which were collected for multi-element analysis, not been subjected to wet-sieving, then such a rubbish accumulation area would not have been encountered.

Orosaigh, on the other hand, has shown signs of multiple phases of occupation within the same structure (although radiocarbon dates are not yet available). While it is not unlikely that lateral cycling may have happened here, the chances of such a process are reduced by the multiple distinct floors observed, indicating the new owner or users ‘created’ a new floor in each phase of occupation. However, the lower floor of Main Room A was found to be possibly contemporary with the lower and middle floor of Cell B. Still, the strong patterns of various elements suggest that in Main Room A, the effects of lateral cycling are not clearly observed by the patterns shown in the geochemical analysis. Nonetheless, the low levels of phosphorus observed here may suggest sporadic occupation rather than intensive occupation.

Occupational variability and reoccupation are additional factors that can impact the formation of occupation horizons. The duration in which a structure or surface is occupied or used can vary significantly, ranging from brief stays of less than a day to several years. Over time, the same occupation site or surface may be repeatedly used with intervals of inactivity between periods of use. The duration of these breaks (i.e., abandonment) facilitates the distinction between one occupation horizon and the next. This differentiation is typically evident from non-cultural deposits, particularly if they occur rapidly (e.g. wind-blown sand). Conversely, if the environmental deposition processes are gradual, the various occupation horizons accumulate on top of previous ones, creating complex palimpsests. Such accumulation can compromise data, particularly if the geochemical analysis is performed to draw inferences about the use of space on occupation horizons. If the structure or surface is utilised differently during each phase of occupation and slow environmental deposition occurs between each phase, the resulting mixture of horizons is further unsuitable for analysis.

The cellular house at Orosaigh contained a mix of occupation layers in the upper floor layer (230) of Main Room A. The multi-element analysis confirmed that this upper floor was disturbed and mixed. This is because no consistent patterns could be identified, and the picture was extremely muddled. However, the primary occupation phase, which was likely removed (along with the destroyed hearth), was possibly seen to be reflected in the natural surface analysed. It could be argued that the patterns observed on the natural surface resulted from leaching originating from the upper floor or the use of the natural surface as the initial floor. Although most elements exhibit elevated levels compared to the entire structure, it is noteworthy that elements like Cu do not significantly exceed natural levels found in the gneiss bedrock. This suggests the observed pattern of elevations in the levels of Cu, Al, Ca, Fe, K, and Sr on this surface may not solely result from human activity, hinting at natural variations in the weathered bedrock in the subsoil suggesting that these elements may be naturally raised on this site. However, the suite of elements showing high levels are similar to those found in the hearth of Cell B, indicating a meaningful correlation. Levels of these elements in Area 2 of Main Room A surpass those in the well-preserved hearth of Cell B, hinting at a potentially destroyed hearth in Main Room A. The heightened levels in this area may indicate prolonged use of a hearth, leaving substantial chemical residues on the surface. Nonetheless, due to the issues of equifinality, the presence of a hearth in Main Room A remains just one of the possibilities that could explain the pattern of elevation of chemical elements seen here. A point to stress here is that it is unlikely that the combination of chemical elements specifically associated with particular activities/features (e.g., the hearth), observed at other sites as well, would be leached onto the natural surface or enriched by the bedrock in exactly the same combination. Had it been a result of leaching alone, then, only some elements in varying amounts would have leached downwards onto the surface natural. This is due to the fact that different elements leach in varying manners and quantities. While certain elements may leach downwards, others may leach upwards. For instance, phosphorus is typically resistant to leaching, and if any leaching is observed, it generally occurs upwards as a result of plant activity (refer to Chapter 3). Nevertheless, given the young nature of multi-element analysis in archaeology, the information regarding the leaching behaviour of most individual elements is currently not available, and this is an area for future research. The case of House 2 in Bornais, situated near the coast, where wind-blown sand formed the abandonment layer, indicates that the environmental deposition processes in this area were immediate, following the abandonment of this building. At Meillionydd, a thin layer of occupation horizon was identified on top of the one analysed in this thesis, suggesting that two distinguishable horizons existed, and that the likelihood of the two layers mixing was low.

During the use of a house, a process that affects the construction of house floors in a similar manner to scavenging is recycling. Schiffer (1987, 29) defined recycling as a reuse process where artefacts return to a manufacturing process after a period of use. This is applicable in the case of occupation horizons as they can be used as raw material for secondary or new floors in quite a few ways. One example is when a house is cleaned and reused after a period of abandonment, and the new owner decides to use the surface of the house floor from the previous phase of occupation to make a new house floor. Such an issue has also been highlighted by Hester (2016, 108-109). Such reuse can cause the chemical composition of the occupation horizon to change dramatically in some instances. For example, in the case of RH SO19, Meillionydd, if the area identified as being used for cooking has material from a different floor (or earlier phase) that was reused, then this might be the dominant activity that would be mainly visible in the chemical analysis. At Orosaigh, the lower floor of Cell B is suggested to have had a hearth that was destroyed, which was also supported by the ash spread recorded in the same place (see Chapter 7). Niall Sharples (pers. comm.) had raised the possibility of whether the source of the ash spread was from elsewhere in the house. It is possible that this 'hearth' seen in the chemical record of the sediment in this cell may be a result of accumulations from a different hearth, for instance, from the 'destroyed hearth' in Main Room A. In that case, it could mean the interpretation in Cell B is inaccurate. However, such a possibility was mitigated by the observation of a difference in lead (Pb) levels between the destroyed hearth in Main Room A and the Pb levels seen in the ash spread in Cell B. Furthermore, comparisons with other cellular houses have shown that some cellular houses tend to have a hearth in the smaller cells too. The later phase hearth in Cell B is also an example of the presence of hearths in smaller cells, which gives more confidence that there could have been a hearth in the lower floor of Cell B. However, this does not rule out the possibility of the ash spread being from a fire outside the structure entirely, with the material being brought into the house as secondary deposits in order to make up or repair the floor. Furthermore, the difference in the lead (Pb) levels could also result from the source of ash (if it were from the hearth in Main Room A) being from a phase of the hearth using a fuel lower in lead levels. Taking into account these possibilities and the other issues relating to equifinality, any suggestions made for the destroyed hearths of Orosaigh and the cooking/food consumption areas of both Meillionydd or Orosaigh remain just one of the possible interpretations for the patterns of chemical elements seen, especially, when other lines of independent evidence are not available to corroborate the observed patterns. However, at Bornais, due to other evidence in the form of the distribution of small finds and ecofacts, there may be some confidence in the patterns of chemical elements seen in relation to areas such as hearths and food preparation/food consumption areas.

Abandonment of house and floors

In the life history of a house, the permanent abandonment often marks the 'death' of the house. It is from this point on onwards, following the abandonment, that various processes can still affect the formation of occupation horizons. Such processes are termed abandonment processes by Schiffer (1987,97), which are processes by which an area of activity, structure or a whole settlement is turned into an archaeological context. As a corollary of this abandonment process, de facto waste deposition occurs, whereby refuse comprising functional tools, structures, and other cultural materials that retain their utility are abandoned in place of use (Schiffer 1972; also cited in Schiffer 1987, 97). Schiffer (1987, 97) remarked on the potential variability in the de facto waste deposition, contingent upon multiple factors. These factors encompass the nature of the abandonment, including whether it was a slow and deliberate process or an abrupt and unplanned one, as well as aspects such as the mode of transportation available, the timing of abandonment, the proximity to the next settlement or occupation area, the activities that will be carried out in the next settlement, the size of the population involved in the move, and the intention to return. It is not essential to have areas with de facto refuse to identify the organisation of space based on geochemical analysis as long as the sediment associated with each designated area in the house is largely undisturbed. However, as part of abandonment, some features or structures within the house and hence associated sediment may be removed. For example, along with periodic cleaning of the floor (and hence removal) during its use, intentional removal of entire floor layers just before the abandonment of the building has been suggested for the Middle-Late Bronze Age hut circle at Porth Cressa, St Mary's, on the Isle of Scilly (Ratcliffe and Straker 1996, 74-76).

As part of abandonment processes, purpose-built areas such as hearths or areas with built-in furniture may be removed partly or wholly and replanted elsewhere in another structure. In the case of the hearth, the kerb stones and the hardened fired sediment that form the bottom of the hearth may be removed and reused elsewhere. This could lead to the now-removed hearth appearing as a pit fill or rubbish deposit elsewhere on the site. However, areas used for other activities in the occupation horizon survive. An example of such a case is possible at Orosaigh. In Cell B, it is not unlikely that kerbstones and hearth layers of the middle floor came from the hearth of the lower floor or perhaps the destroyed hearth in Main Room A. However, even if it did come from the lower floor in Cell B, the hearth was still identified in the lower floor through the multi-element analysis, which would have been difficult to confirm otherwise.

In the case of House 2 at Bornais, there appears to be a period where it was left unoccupied, during which an abandonment layer in the form of wind-blown sand accumulated. Still, some sporadic human activity was seen in the form of small occupation deposits on top of the wind-blow sand layer (Sharples and Davis 2020b, 251). However, abandonment can also affect maintenance and discard processes. For example, in cases of anticipated abandonment in the immediate future, the occupant of a structure may relax their cleaning standards, and such activities may be undertaken less often or forgone altogether (Green 1961 cited in Schiffer 1987, 97). Equally, refuse may be discarded in areas that may not be the initially intended area for refuse (Stevenson 1982). In the case studies looked at in this thesis, it is difficult to ascertain whether the abandonment processes of the buildings have affected the maintenance and discard process within the houses. Along with the abandonment process, rituals associated with the process can also have varying effects on the survival of artefacts and occupation horizons. There are examples of structures being burned or buried as part of the abandonment processes in later prehistory and the Viking Age (Eriksen 2016; also discussed in Chapter 3).

An abandonment ritual as such was not observed in the three case study sites explored in this thesis.

Post-abandonment processes

While there are a host of post-abandonment processes, especially environmental processes (see Chapter 1), that affect a house floor, a cultural process in the form of surficial disturbance during post-abandonment is ploughing. It is an activity that can impact artefacts and occupation horizons at any point after the abandonment of a site. The case studies for this thesis were selected carefully and cautiously to ensure that the floors had not been subjected to post-depositional ploughing. As discussed previously, each of the analysed occupation horizons was well preserved under an abandonment layer. Furthermore, while some areas of the Meillionydd site were affected by ploughing, the effect of such activity was less likely in RH SO19, which was protected by its location within a deep, wide quarry hollow which filled in following abandonment. However, post-abandonment processes may have affected the phosphorus (P) distribution at Meillionydd. For example, it is a possibility that the large spread of elevated levels of P may be linked to the *in situ* decay of organic roof material on top of the floor. In the cases of Bornais or Orosaigh, the floors were not found to be impacted by ploughing. However, scavenging in the form of some robbing of stone from certain areas of the walls to construct modern field boundaries at Orosaigh, and subsequent structures at Bornais, was observed. Nevertheless, this activity did not appear to significantly affect the internal occupation horizons.

The preceding section has illuminated the cultural processes (i.e., processes instigated by humans) that affect the formation processes of house floors. These processes underscore the inadequacy of relying solely on artefacts to study internal space in structures. They also demonstrate that geochemical analysis, in isolation, is not a fail-safe approach for the same endeavour and that other independent lines of evidence are required to test the confidence in the interpretation of the chemical element patterns (see discussion below). Notably, cultural transformation processes reveal that various ancient and modern activities have the potential to modify artefacts and occupation horizons within archaeological contexts. Despite different underlying causes, these processes exhibit substantial overlap in their effects on material culture and occupation horizons. Nonetheless, with careful attention devoted to each site's study, it is possible to account for the impact of these processes, thereby mitigating (if not completely eliminating) errors in the analysis and interpretation of artefacts and occupation horizons.

Various other natural formation processes which can affect house floors during post-abandonment processes are possible and some of these have been discussed in Chapter 1. These are not reiterated or discussed further here. However, a point of note arising from this discussion pertains to the cultural and environmental formation processes that can impact floors, as set out by Schiffer (1987). As this discussion has demonstrated, these processes also hold relevance to occupation horizons. This prompts the question as to whether occupation horizons merit classification as material culture. The present thesis has investigated occupation horizons to uncover valuable insights into past houses, the associated human activities which led to the formation of these floors, and how society and daily life may have manifested. While such information is commonly gleaned from artefacts or material culture, occupation horizons may not be readily discernible as tangible artefacts, and instead necessitate examination via techniques such as multi-element analysis. Nonetheless, a variety of archaeological objects are also subjected to analytical methods to discern the same details regarding their use, associated human activities, and insights into daily life and society. Hence, it may be inferred that, in many respects, occupation horizons can be regarded as material culture, and we should aim to explore them in similar ways, with a life history, function and significance.

8.5 Anthropological Insights

This PhD research mainly concerns the application of multi-element analysis on house floors of archaeological structures in Britain (i.e., 'houses') and until now in this chapter, attempts have been made to bolster the identification of various activities in this thesis through geochemical analysis. As highlighted in Chapter 2, however, the majority of published geochemical studies present conclusions that are limited to the empirical data from single structures, with only some allusions to economic and social interpretations. Frequently, such studies do not sufficiently tackle the complexities emanating from potential interpretations and the presuppositions employed by archaeologists (and archaeological or soil scientists) during the demarcation of the sampling area and the transition from rudimentary data to elucidation. Such a bias was also shown in the sampling strategy used in the current study, where the sampling was restrained to the occupation area within the walls of the structure. In the context of various multi-elemental methodologies, precise deductions of functional areas within the house are made, such as specific areas for food preparation, meat processing, metalwork, etc. (Coronel *et al.* 2014; Cook *et al.* 2010; Hjulström *et al.* 2008; also see Table 3.1). Typically, these deductions are made using spatial statistics and analyses that are visually represented and often juxtaposed with excavated or established archaeological phenomena, with functional areas identified and described whenever possible using practical and structured terminology. Until this point in the thesis, the author of this PhD research has also adopted the same approach. However, this approach often falls short. That is because at the core of these interpretations lies the concept of the 'house,' which, from a contemporary Western viewpoint, may often be regarded as a mere functional space for living, providing shelter and a stage for the performance of specific routine activities. Consequently, Chapter 2 aimed to offer an overview of diverse notions of domestic spaces and houses from various global perspectives, thereby emphasising the necessity for interpretations that extend beyond the mere identification of functional zones within archaeological structures.

The exploration of the organisation of houses in various anthropological examples in Chapter 2 highlighted several organisational principles that govern them. However, one central theme seen throughout the examples is that houses are generally organised in such a way that certain areas of the house tend to be reserved for particular functions. Frequently (though not always), the organisation is also seen to be governed by the ideas of polar opposites; for instance, front-back, left-right, centre-periphery, etc., which derive from structuralism. The reservation of space for particular activities is crucial for geochemical analysis since an extreme degree of flexibility in the use of different areas of the house would reflect the chemical signature of a combination of all activities carried out therein, particularly if no single activity predominates in each area.

The centre-periphery model advanced by Hingley (1990) for the organisation of space in later prehistoric roundhouses has been discussed in Chapter 2 and Chapter 6. This model adopts a structuralist approach, establishing a dichotomous relationship within a household, defining the private and public spaces as opposing entities. Hingley (1990, 132-133), however, argues that binary divisions are a prevalent organising principle across numerous societies, characterised by multiple sets of oppositions, as depicted in Figure 8.2. The arrangement based on these oppositions, in one variation or another, is observable in the majority of the examples analysed in this thesis.

However, the construction or perception of binary divisions was not the only approach to organising space in houses. Chapter 2 illustrates the example of several societies in Southeast Asia that view the house as a human or animal body. For instance, the Balinese consider their family shrine as the head, the sleeping area and social parlour as the arms, the courtyard as the navel, the gate as the sexual organs, the kitchen and granary as the legs and feet, and the refuse pit in the backyard as the anus (Covarrubias 1937, 88). This exemplifies an organisation of space based on activity areas, with the guiding principle behind the organisation being the notion of the house as a human or animal body. Roundhouse studies have seen a variety of models being suggested for the organisation of the houses. While a reanalysis of those models is not intended here, the following section aims to consider the ideas from anthropology in order to determine their applicability to the case studies of the PhD and to offer a possible interpretation of the organisation of space in these dwellings.

'Public'	'Private'
Open access	Constrained access
Central space	Peripheral space
Light	Darkness
Cooked	Raw
Clean	Dirty

It may be possible to argue for a range of additional oppositions:

Day	Night
Summer	Winter
Culture	Nature
Fertility	Infertility
Life	Death

Another possible association is:

Male	Female

Figure 8.2: Binary oppositions seen in most societies according to Hingley (1990, 133).

One of the most prominent organising factors reflected in the organisation of space across societies is gender, as seen in Chapter 2. The division of the house based on gender relations frequently exhibits a recurring pattern, with specific activities, such as cooking, food processing, and handling, being predominantly associated with women. In the roundhouse at Meillionydd, although the suggested functions of the different areas are very speculative, the possible activities and layout do not explicitly indicate a gender-based division within the dwelling. However, the central area does contain a range of occupation features, including the hearth, and it was evidently a focus for activities. Hingley's (1990) centre-periphery model may be said to be applicable to this house due to the central hearth, especially if the central ring of posts did enable a division of the house into a central area and peripheral area. However, whether or not this relates to a gendered division of space is debatable, and Hingley's ideas regarding the public/private division of space may be more pertinent in this context. The central and front sections of the house were suggested to be possibly used for intensive activities, while the back peripheral areas were reserved for more passive activities such as sleeping and storage. A number of houses explored in Chapter 2 suggest that public areas tend to be located in the central and front sections of the dwelling, exemplified by the case of the Nakarattar houses in India. While the Nakarattars designated a front public area and a rear private area, their cooking spaces were situated at the back of the house. Nonetheless, the central area also encompassed a dining hall for food consumption. In the case of RH SO19, the cooking and food consumption area has been proposed to be in the central area around the hearth. The Nakarattar house was divided along gender lines, with the front public areas associated with men and the rear areas with women. It is vital to acknowledge that although women are frequently observed to be involved in cooking, attitudes towards this activity may not be universally consistent. The association of cooking and consumption activities with a hearth in the central region of the house might also imply that cooking could have been a communal activity, potentially involving the entire household or even their guests.

A similar front and back division of space is also inferable in the cellular house at Orosaigh, although the interpretations for the organisation of this house remain tentative. However, such a division is mainly evident in Main Room A, where intense activities are possibly focussed in the centre and the front towards the entrance of the cell, and the back areas of the cell are reserved for sleeping/storage activities. However, an important point to note here is that Main Room A forms the larger back cell at Orosaigh. The adjacent Cell B could have also had some secondary cooking activities or hearth-related activities, and the front cell, Cell C, has been termed 'guard cell' (with much caution to be taken when considering the connotations of this term). However, it is not unlikely that a hierarchy of spaces going from public to private could have also existed here. For example, the 'guard house' may have been the foremost public space receiving visitors to the house, with Cell B with a secondary cooking area being open to more informal guests; and, finally, the Main Room A being reserved for the occupants of the house and perhaps the most intimate or important of guests.

The Middle Norse House at Bornais has shown the most evidence for activities that may be traditionally associated with the female gender. According to Sharples (2020f, 608), there is a notable gender differentiation of activities within the house, particularly if cooking is regarded as a female task. He observes that the kitchen area of this house was situated at the western end, which was the most inaccessible part due to its distance from the entrance. This inaccessibility was further emphasised by the absence of a subsidiary entrance, as observed in the kitchen area of similar bow-walled houses such as at Aðalstræti, Iceland (Sharples 2020f, 608). Sharples draws upon Einarsson's (1995, cited in Sharples 2020f, 609) analysis and suggestions regarding the bow-walled Norse house at Granastaðir in Iceland, which propose a gender-based division of the living room, with females occupying the west side and males the east side (Sharples 2020f, 609).

Expanding upon this notion, Sharples (2020f, 610) applies the argument to House 2 at Bornais and posits that women in Iceland enjoyed a more prominent position compared to women in the Hebrides. He goes on to argue that this disparity could potentially signify that women in the Hebrides held a considerably lower social status and that they might have served as slaves catering to high-status women or been regarded as second-class wives (Sharples 2020f, 610). However, it is important to note that Sharples' (2020f, 608-610) analysis relies substantially on a single cooking area associated with the long hearth situated in the west half of House 2 and away from the entrance. The presence of a secondary fireplace, which was identified through the presence of burnt organic matter and complemented by multi-element analysis, is not considered in the publication as it was not available at the time of publication. Consequently, Sharples' analysis could be re-evaluated in light of the identification of this possible secondary fireplace, which has indicated the possibility of a smaller cooking area closer to the entrance.

Overall, the primary cooking area in House 2, Bornais is still in the most inaccessible area of the house (i.e., furthest away from the entrance); however, we now know that cooking is also situated in the public area close to the entrance, similar to the Icelandic houses. Sharples (2020f) also alludes to the division of the house into public and private spaces where women are confined to private spaces in the western end. Based on the multi-element analysis, it is possible that daily activities or perhaps activities associated with men (such as lead working, for instance) were indeed located in the more public areas of the house, which were closer to the entrance. Considering that this also incorporated sitting/sleeping areas on either side of the aisle, it could also suggest a public sitting area which is different to the sitting/sleeping area in the western half (which also had elaborate finds suggesting seating areas of important people). This could indicate a hierarchy of spaces for the occupants or for their guests similar to the one discussed for Orosaigh. The western half, with the primary cooking/food consumption area and the seats of important people, could actually imply the presence of a space reserved for important or intimate guests, along with the occupants. Furthermore, these areas also accommodate activities such as wool production and stitching which are activities typically associated with women (Sharples *et al.* 2020, 214). Another point to note here would be that the western half of the house, being away from the entrance and having a larger, relatively more formal hearth, would have been the area with more light and warmth in this otherwise dark Norse longhouse where areas closer to the entrance may be colder. As such, rather than being a confined, concealed, low-status area, it might have been a high-status, relatively intimate, and private area.

While Sharples (2020f, 608) argues the western half of the house, with its association with activities linked to women, suggests a subordinate status for Hebridean women compared to their Icelandic counterparts, the concept of public and private spaces in association with women at Bornais could also be reassessed if we compare them to the examples in Southeast Asia (see Chapter 2). The idea of public and private space is not seen through the lens of superior and inferior among the Northern Thai, Acehnese, Minangkabau, Toraja, Ema of Central Timor, Atoni of western Timor and Savu of eastern Indonesia (Cunningham 1964; Kana 1980; Waterson 1993). Instead of having front-back divisions of space, they have an inner/outer division of space, with women being associated with the inner portion of the house, where the kitchen or hearth was located, with links to ideas of life, fertility, and nourishment being privileged here. The structuralist binary division of space, as noted by Hingley (1990), can be seen here. Dall (1982, 53) had also noted that among the Acehnese, Minangkabau, and Toraja, the house is considered to be the domain of women and that men are considered little more than guests, and hence, where a front-back division is visible, it is the men who are confined to the front areas of the house. These ideas can also be seen as applicable at Bornais. Hence, it is questionable as to whether Middle Norse Hebridean women were second-class wives/slaves confined to the inaccessible back spaces of the house, or whether, instead, these women enjoyed the more comfortable, warmer, and private back spaces of the house near to the seating areas of high-status people, with men instead being confined to the 'public' front spaces of the house where some daily activities took place. However, contrary to this idea, the example of Namboothiri Brahmins of Kerala, India, can also be seen as applicable at Bornais, where women (known as *antharjanam,* which connotes people associated with the dark inner spaces of the house) indeed were relegated to the private and inaccessible back areas of the house and considered subordinate to men. The point here is not to definitely say that one idea trumps the other in understanding House 2 at Bornais, but instead to highlight the need for caution when looking at the division of spaces through a Western lens that often associates women to certain activities which are further linked to 'inferior' spaces.

House beyond the walls

Hingley (1990, 134), in his analysis of roundhouse and settlement organisation, suggested some Iron Age settlements as homologous to the roundhouse and that such binary opposition in the organisation of the houses can be seen in the organisation of settlements. Such a settlement organisation can be seen in the example of Marakwet compounds which suggests a division of the compound based on gender, where some houses were associated with men and some with women and their associated activities. However, each 'house' on its own did not show a strong gendered division. The case of Marakwet is a good example of the idea of the house being a representation of society's cosmological ideas. However, it is important to realise that it would be the Marakwet compound as a whole that reflects their conception of society. Similarly, a house or a building on its own may not necessarily reveal the actual governing principle behind the organisation of space within it. Perhaps, it is necessary to look beyond that or, in fact, to change the concept of the house from the Western lens that it is confined to the space within the walls of a structure. Various societies in the world actually define a house or home as a place that goes beyond the structure. The areas around the house, or secondary houses or structures in close proximity, may be part of the 'house' defined by the respective society. In such cases, studying a house based solely on what is inside or, in the case of this PhD, based on the sampling of occupation layers within the confines of a building may represent a partial picture. As a result, the understanding of the organisation of the internal areas of the house may be skewed or partial. Another important point to consider is the focus of academic discourse on houses and domestic spaces in relation to their entrances. While a significant number of societies do place importance on the entrance as the threshold that separates the house from the outside, considering that the Western definition of the house may be limited, as discussed above, the central emphasis, often placed on the concerns for the entrance of the very same house by Western definition, may not be universal.

The Western lens is criticised as myopic by the author in this thesis several times. However, it should also be acknowledged that Western ideas of the house are just as crucial, as it reflects another way of thinking about home and house in human societies. The point to make is that it appears that different societies have different ways of organising their houses, and this may have different meanings and significance. Nevertheless, we can certainly say something about how they were organised, and we can definitely employ insights from the field of anthropology to facilitate our examination of the broader implications manifested by patterns observed.

8.6 Current Constraints and Future Research

Chapter 3 suggested that the scarce application of phosphate and, especially, multi-element analysis on the floors of structures in Britain has left a knowledge gap in terms of the viability of such techniques, specifically in the study of the organisation of internal spaces of archaeological structures in Britain. Each case study selected and analysed in the thesis is presented in such a manner that issues emerging from the literature review are addressed and offer an approach that bridges the gap between archaeological/soil scientists/analysts and archaeologists by providing a holistic approach to study, and in our understandings of the houses from the distant past. The potential usefulness of multi-element analysis is demonstrated through the case studies explored in this thesis, such that it can be a powerful tool in the study of houses and the way people in the past interacted with their houses and lived. However, several constraints were encountered in the course of the analysis: the issues relating to equifinality and the lack of other independent lines of evidence, in the case of Meillionydd and Orosaigh, have undermined the interpretations of the patterns identified. Furthermore, multi-element analysis has some way to go in terms of the refinement of techniques and interpretation, as it is a relatively new approach to the analysis of house floors. In the application of this method and analysis of the resultant data generated, some issues (discussed below) were encountered. Future research would benefit house investigations if the suggested best practices outlined below are followed as part of the research strategy.

First and foremost, one of the issues identified pertains to the necessity for a consistent strategy for sampling and sediment description. Ideally, sample collection should ensure an even coverage of the house floor, employing a grid of 0.5 metres, as recommended by Historic England (2015). While achieving such uniform coverage was feasible at Orosaigh, it posed challenges at Meillionydd and Bornais due to sampling occurring over multiple excavation seasons. Alongside systematic sampling, it is imperative to provide detailed and consistent physical descriptions for each sampled context, particularly focusing on sediment colour using a Munsell Soil Colour Chart, texture, consistency, and the inclusions present.

Such meticulous description aids in discerning whether sediments result from cultural processes and can be classified as occupation floors. Furthermore, it is highly recommended that all samples be collected by the same individuals to minimise the potential for sampling and sampler biases. Ideally, the individual conducting the laboratory analyses should also handle sample collection and check sediment descriptions on context sheets, to further mitigate description bias or errors. These checks should be informed by conversations with the excavators to better understand the context sampled (discussed below). In excavations where the presence of a soil analyst is unfeasible, samples may still be procured from the various floor layers. These samples require meticulous labelling and should include comprehensive documentation such as notes and photographs of the sampling process and floor conditions in order to identify any potential sampling errors.

While in Chapter 3, the need for control samples of natural subsoils on archaeological sites along with the sampling of occupation horizons was emphasised, only one case study in the current study afforded the analysis of control samples. The control samples collected helped reinforce, to some extent, the levels of various elements observed in certain areas of the roundhouse at Meillionydd. This is especially important in cases where occupation horizons are disturbed, and where the natural surface is used as a proxy for the house floor, as in the case at Orosaigh. Additionally, it is crucial to analyse the chemical makeup of the bedrock beneath the site, alongside control samples from the natural subsoils. This step is essential to understanding any potential influence the underlying bedrock may exert on the formation processes of archaeological deposits on the site. By doing so, researchers can address concerns related to equifinality, thus enhancing the accuracy and reliability of their findings.

In terms of the collection of control samples, it was observed that the level of each element can vary between samples to some extent, and hence control samples from several locations are best represented as a range rather than specific mean values. This is because mean values may be considerably lower than the highest level of element observed in the control sample, and if the mean value alone is used for comparison with levels of various elements seen in the occupation layers, then a false elevation of levels in the occupation horizon may be inferred which can lead to inaccurate interpretations. While all control samples were taken from areas significantly away from any visible archaeology at Meillionydd, the important point to stress here was that it was archaeology not visible to the naked eye that decided the location of the test pits from which the control samples were taken. Archaeology not easily detectable during the digging of a test pit can obscure the data collected for natural levels of various elements. To mitigate such issues, it may be worth adopting a strategy that involves control sample collection from areas that have been surveyed using geophysical techniques that have shown no signs of archaeology, from natural soil that is at least a few decimetres below the earliest exposed natural surface under archaeological layers, and from natural layers taken from test pits dug several metres away from any identified archaeological settlement areas. Such a wide collection of control samples may better reflect the range for the natural level of various elements on a given site.

Another important aspect of the sediment that needs assessment is the pH levels. While the levels of various chemical elements in sediment samples analysed in this study are known, the impact of the sediment pH level on the retention of the various chemical elements is unknown. It would prove beneficial to examine the pH levels of the actual floor sediment samples being analysed. This would provide a more comprehensive understanding of potential influences on the multi-element analysis of soils/sediments that display extreme acidity or alkalinity, especially as the behaviour of various elements in such conditions remains inadequately explored in the wider literature on geochemical analysis as well. Furthermore, it has been identified (e.g. Barba and Ortiz 1992; Pingarrón 2014) that areas where hearths and fireplaces are located tend to show high pH values. If such high pH values were found in those areas proposed in the case studies of this PhD thesis to contain possible destroyed hearths and fireplaces (in the houses at Bornais and Orosaigh), it would have provided another vital independent line of evidence to support the hypothesised location of these hearths and fireplaces at these sites.

One of the weaknesses of this PhD research is the lack of measurement of magnetic susceptibility from the floor layers from the case study houses analysed. The measurement of the magnetic enhancement of sediment samples would have helped verify or undermine the interpretations offered. This would also have been particularly useful for those areas of potential destroyed hearths/burning identified at Bornais and Orosaigh. Hence, it is highly recommended that magnetic susceptibility analyses of house floor areas be combined with geochemical analysis. Excellent examples of the successful combination of magnetic susceptibility and phosphorus analysis can be found at the Late Iron Age site of Mound 1 at Bornais, (Smith and Marshall 2012; Sharples 2012a) and in the roundhouses at Cladh Hallan (For examples please refer studies by Smith *et al.* in Parker Pearson *et al.* 2021a), both in South Uist.

The studies at Bornais, mound 1 (Milek 2012) and Cladh Hallan (French 2021) which have been explored in Chapter 3 of this thesis, alongside those at Çatalhöyük (Mathews *et al.* 1996) demonstrate the advantage in incorporating soil micromorphology studies along with other studies of the floor sediments. Soil micromorphology is a method of studying undisturbed soils and regolith samples with microscopic and ultramicroscopic techniques to identify their constituents and determine mutual relations in space and time and identify the formation or transformation of soils and sediments (Stoops 2003, 5, cited in Kovács 2013, 11). Such a method is well-equipped to identify the presence of dung plaster on house floors, for example. If it is used in conjunction with multi-element analyses, it can help refine the analysis further. One may argue that soil micromorphology may be advantageous over multi-element analysis to some extent, and it has indeed been used in the study of house floor and domestic space (e.g. Kovács 2013). However, the sample collection is often restricted to individual features or certain areas of the house, and the number of samples collected is also limited due to the restrictions of high costs. Furthermore, in the study of houses overall, significant advances can be made by the use of multi-element analysis if also complemented by some soil micromorphological studies. This is because, with an increase in the use of such techniques, significant advances and refinement can also be achieved in the secure identification of chemical signatures associated with specific activities. Furthermore, along with such refinement, it would also be advantageous to carry out portable and faster forms of multi-element analysis such as p-XRF (portable-Xray fluorescence) to check the accuracy of the results across multiple sites, which would help provide confidence in analyses using p-XRF analysis (also discussed in Chapter 3).

The data gathered from the multi-element analysis at each site was presented as distribution maps that visually created a surface that was projected onto the plan of each house, covering the horizontal extent of the occupation horizon in each house. This modern method of visualising data using GIS was found to have significant advantages over the traditional scatter plot method used (e.g. George 2017). There are some good examples of such GIS distribution maps used, such as at Mound 1, Bornais (Marshall and Smith 2012) and Cladh

Hallan (for examples please refer studies by Smith *et al.* in Parker Pearson *et al.* 2021a). It is interesting that a recent study of roundhouses at Cladh Hallan employing a combined study of various data (similar to the study of Bornais in this thesis) has employed such a method in visualising data from geochemical analysis (in this case, P), and other archaeological data (such as finds, detailed pottery distributions, magnetic susceptibility etc.) to study the use of domestic space in roundhouses. Based on these analyses, one of the roundhouses at this site, House 401, having the entrance orientated to the east, was found to comply with the sunwise model and the left-right division of space (Figure 8.2). It is highly recommended that such data visualisation methods be used in future multi-element studies of occupation horizons as well as finds distributions within well-preserved house floors. The value of such a visualisation method is clearly apparent.

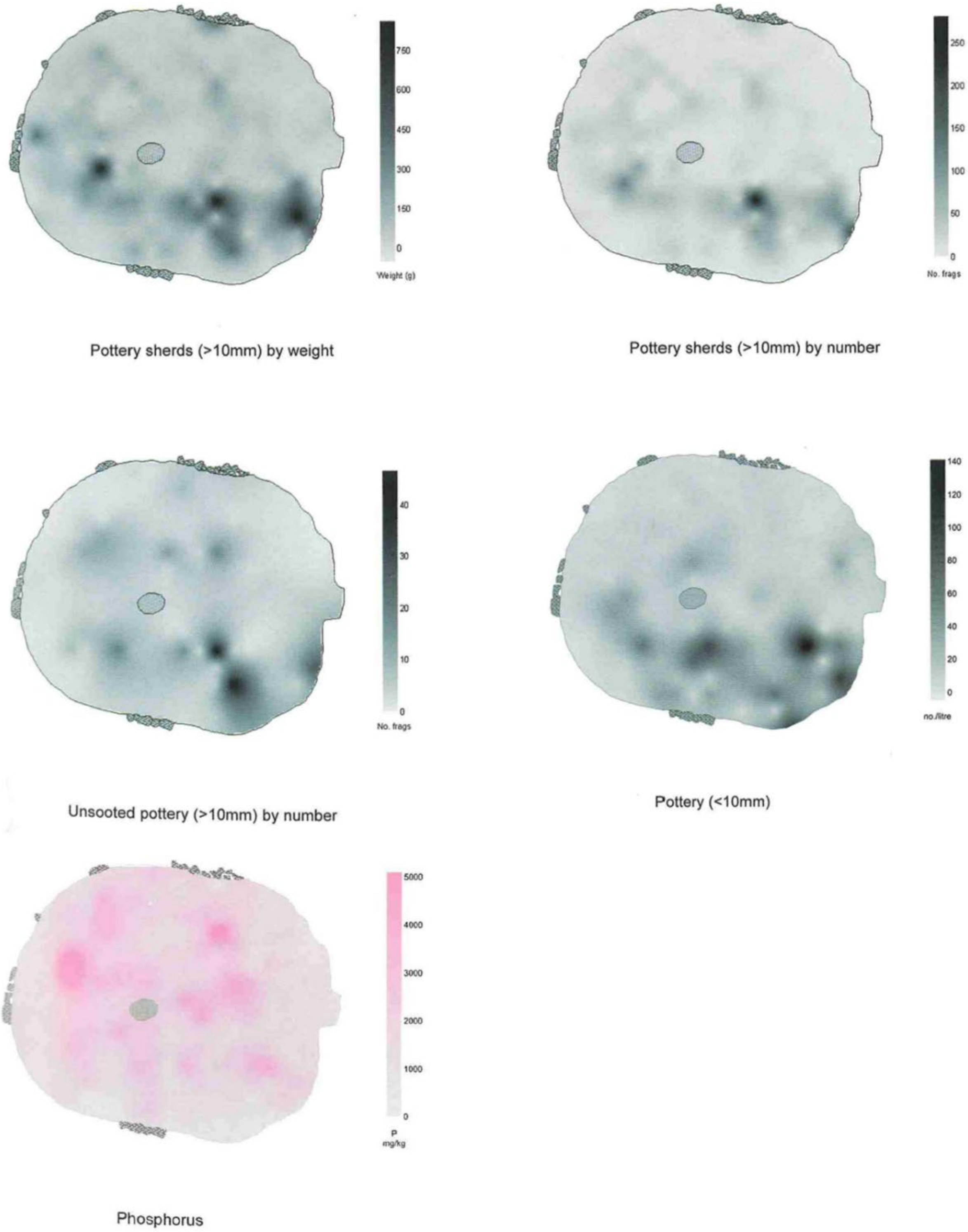

Figure 8.3: Spatial distribution of pottery and phosphorus on floor 1311 in House 401 at Clad Hallan (adapted from Smith *et al*. 2021e; 2021f, figs 5.43 and 5.45).

The importance of establishing a dialogue between the excavators responsible for uncovering the house floors and the individuals conducting geochemical analyses needs to be emphasised. The importance of such dialogues has been underscored by Barker (1994, 94), who posited that 'a dialogue between an excavator and a soil scientist is likely to raise questions that would not have occurred to either individually'. This collaborative approach was evident as this PhD research was undertaken, especially regarding the potentially destroyed hearths at Orosaigh and Bornais, the confirmation of a disturbed layer of context 230 in Main Room A at Orosaigh, and the possibility of an internal setting being present at Meillionydd, alongside the impact that the different excavation seasons had on parts of the house floor which may have affected the results in RH SO19. Such dialogue proves especially valuable in guiding interpretations drawn from the collective findings of multiple studies conducted on the house floor.

One of the significant outcomes of this PhD was the possible identification of certain chemical signatures associated with particular activities. However, the identification of these chemical signatures was limited to particular activities which were identified at all three sites (e.g., hearths). The identification of chemical signatures for different activities necessitates a wider study of multiple buildings using multi-element analysis as the main approach. However, due consideration must be given to the idea that such activity areas may represent a diverse array of human activities carried out in a specific location. Another example of activities in the house that can compromise geochemical studies comes from the author's experience of houses in rural North India, which are also documented in other studies (e.g. Gur-Arieh *et al.* 2018; Gupta *et al.* 2016). This relates to the plastering of house floors and walls with cow dung as a means of providing insulation during summer and winter and as a means of ritual cleaning linked to Hinduism. Such plastering of cow dung on floors would obscure the distribution of various elements across the floor, and this is a good example of cultural formation processes which may affect the chemical signature of that floor. A mitigation strategy for such obscuring activities is the implementation of soil micromorphology (discussed above).

The utilisation of multi-element analyses in an ethnoarchaeological framework in Britain and elsewhere may offer a significant avenue of research in multi-element studies (e.g., Rondelli *et al.* 2014; Middleton 2004). Such ethnoarchaeological studies, or even experimental archaeological studies of reconstructed houses which have been dismantled and the floors excavated (e.g., Bell 2015; Mytum and Meek 2020), can give us a sounder understanding of the chemical signatures associated with particular household activities.

One of the limits of this thesis, however, was the limited study of the various pedological processes (especially environmental) contributing to the formation of anthropogenic sediments. It is a significant assumption that is made in this thesis that anthropogenic inputs to the house floors are preserved so overwhelmingly that the sediments, even after thousands of years, are unable to redistribute the inputs and have not dramatically changed the quantitative and spatial patterning of those inputs since the ceasing of human activity. In their seminal work on the chemical analysis of the Sutton Hoo burial, Bethell and Smith (1989) made an observation regarding the distinctive chemical characteristics of the burial site in comparison to its surrounding environment. However, they emphasised that the observable distinct chemical signature was contingent upon the specific environmental conditions present. Drawing from this notion, Cannell (2016, 221) similarly acknowledged that the distinctive indicators of a body or a particular activity within a given archaeological site cannot be universally extrapolated to another context with different environmental circumstances. It is imperative, therefore, to recognise that each site possesses inherent distinctiveness dictated by the idiosyncrasies of its natural soil/sediment composition, geology, and archaeological elements. However, Cannell (2016, 221) also noted the advantages of techniques that analyse the whole sample, which helps measure the dominant properties which are present. TXRF spectrometry (used in this PhD research), is one such technique that finds the total level of each element in each sample rather than the level of each element elevated by human activities alone, and it has helped identify the dominant properties of the sediment and facilitate some possible archaeological interpretations. The next chapter is the final concluding chapter of this PhD which brings together the key highlights and the significance of this PhD research.

CHAPTER 9: CONCLUSION

In this concluding chapter, I will address the overall aims and objectives of this research and highlight the key contributions and insights obtained from this study. One of the central aims of this doctoral research was to explore the feasibility of utilising multi-element analysis as a means of interpreting archaeological house floors in various structures across Britain. The study targeted three well-preserved buildings from different time periods in western Britain, namely the Early Iron Age, Late Iron Age (in Scotland), and Middle Norse period. The research sought to identify discernible patterns in the use of floors within excavated houses based on multi-element analyses of the sediments that make up the floors. Emerging patterns in each case study were found, on the whole, to be consistent with the growing and evolving literature on the association of certain chemical elements with certain activities. While phosphorus (P) has traditionally been the element most associated with human occupation in the past, this study, along with the slowly increasing literature on multi-element analyses, gives evidence for the wide range of elements associated with human activities, which are present in anthropogenic sediments, and which can prove useful in archaeological interpretations.

Variations in the organisation of domestic space were observable in varying degrees of confidence in each of the three houses explored. Some similarities, such as a possible distinction between front and back areas or perhaps public and private spaces, were seen as a common theme. The models, however, were significantly reliant on the limitation caused by the definition of 'the house', assumed in this study to be within the walls of a structure used for domestic purposes, with the sampling restricted to the preserved occupation layers within such 'houses'. Future studies should aim to investigate external spaces adjacent to houses, as those 'outside' areas may have been just as important in the functioning and interpretation of that 'domestic' space.

The examination of the Middle Norse house at Bornais exemplified a meticulous amalgamation of diverse sources of information, resulting in an enriched spatial understanding of the house. The combination of published data from soil micromorphology, coarse and fine residues, along with the distribution of one of the largest assemblages of artefacts found in Norse houses in Britain, and the data from the multi-element analysis, further augmented the understanding of the activities in this house. It also gave an idea of the daily life in this Norse house that was arguably separated into front and back, and possibly into public and private activities. In addition, the study corroborated suggestions (based on archaeological evidence) of a possible partition separating different activity areas towards the East End of the house and a possible secondary fireplace which was not visible during excavation. It also indicated the possibility of lead-working activities, creating a detailed picture of the daily life in this house.

The floor samples originating from the West End of the house at Bornais primarily derived from context 182, designated as an abandonment layer following the soil micromorphological study. Notably, this layer occupied a higher stratigraphic position than the occupation layers obtained from other areas of the house floor. This discernible disparity between context 182 and the remainder of the house floor was further underscored by the multi-elemental analysis, which revealed uniformly reduced levels of aluminium (Al), chlorine (Cl), chromium (Cr), iron (Fe), and potassium (K) in comparison to remaining house floor layers analysed.

In the case of Meillionydd, the Early-Middle Iron Age structure revealed the possibility of the use of various distinct spaces, which would have otherwise been challenging to identify due to the low number of finds at this site. While this study showed possibilities of the house accommodating a central cooking area, a possible sleeping/storage area and a possible activity area at the front of the house, the model remains tentative because the data is not clear and there may be multiple reasons for the distribution patterns, which include various excavation strategies of the house floor and the effects of the underlying geology.

The study of the cellular house at Orosaigh, along with revealing one possible model for the use of internal space, represents the first provisional model for the organisation of domestic space in the Later Iron Age cellular structures of Atlantic Scotland, which was achieved via multi-element analysis. However, the gneiss bedrock here contained various levels of Al, Ca, Fe, Mn, Cr, Cu, Ni, Pb, Zn, and Sr and it is a possibility that the different levels of these elements in the floor deposits here are likely to be the result of the varying proportions of the weathered bedrock in the subsoil, irrespective of anthropogenic activity. Still, due to the sampling and analyses of multiple floors at this site, this study raised the possibility of distinct occupation horizons lying on top of each other, revealing the possible differential use of internal space over different occupation phases of the same house. However, these interpretations must again be with caution. Still, among the possibilities raised as a result of the multi-element study at this site are the suggested destroyed hearths in Main Room A and in the lower floor of Cell B which were not visible when the floor was excavated.

The efficacy of the methodology employed in this doctoral research, concerning multi-element analysis, contributes to providing recommendations for future investigations. When sampling houses, it is advisable to adopt a grid sampling approach with a spacing of 0.5 m for horizontal sampling. This approach should encompass well-preserved house floors as well as areas surrounding the house, including the front, back, and sides. In cases where archaeologically disturbed or mixed floors are encountered, the immediately underlying natural surface may serve as a proxy for the earliest floor of the house, as exemplified in the case of Orosaigh. Nonetheless, such sampling should be done with much caution, focusing solely on the ephemeral layer without delving deeper. Additionally, numerous control samples should also be collected from the natural soils, following the method discussed in the previous section and analysed to provide a baseline for the natural levels of various elements in the soil. For investigating the organisation of houses based on the grid sampling of house floors, multi-element analysis techniques such as TXRF spectroscopy are most suitable for generating high-resolution data concerning multiple elements along with magnetic susceptibility and soil micromorphology.

After analysing the samples, it is advisable to visually present the data using statistical analysis techniques such as standard deviation and interpolation using GIS spatial analyst tools to create distribution maps. This facilitates the identification of distinct functional areas within the house. Every study should also incorporate other studies of the structure, such as the ones based on the stratigraphy, finds distribution and any other available. Ideally, if the multi-element analysis is coupled with soil and sediment micromorphology studies of identified features within the floors during excavation, magnetic susceptibility analyses and pH analyses of all the samples, then the interpretations can be made more secure. Furthermore, comparisons should be made with other case studies involving similar structures, in order to refine and enhance confidence in the interpretations made for the particular house under examination. In these interpretations, due consideration should be given to the impact of various formation processes of soils along with the chemical composition of the underlying geology that may influence the data and subsequent conclusions. Finally, with a growing body of studies using multi-element analysis, it is recommended that a comprehensive database of chemical signatures is created. This database should encompass chemical signatures associated with diverse activities, accompanied by an assessment of the relevant soil and sediment formation processes and the impact of the underlying geology on the chemical signatures. With an extensive collection of chemical signatures derived from numerous studies conducted at various sites (with ethnoarchaeological studies of more recent houses perhaps being the most valuable here, where multi-element analysis can be undertaken), statistical probability methods can be employed to further refine the identification of chemical signatures linked to specific activities.

Overall, this study has made some strides in advancing our understanding of archaeological house floors in Britain. Integrating multi-element analysis, comparable structures, and spatial models has shed light on the usage of space within houses and provided valuable information regarding the possible functions of specific areas within these structures. The research has demonstrated the potential for multi-element analysis to contribute to the interpretation of archaeological sites and has opened avenues for further exploration in this field. Furthermore, multi-element analyses using a TXRF spectrometer is a powerful tool that can be performed simultaneously with phosphate analyses. This is mainly because the sampling strategy and time for analysis are the same, if not faster, than other techniques used for phosphate analysis. As it is a simultaneous analysis of the same sample for a number of elements, there is no additional cost as opposed to analysing phosphorus alone. While there are some issues with the level of accuracy using methods such as portable forms of multi-element analysis using pXRF (Portable X-ray fluorescence spectroscopy), the extensive use of TXRF spectrometer across different sites will help refine the chemical signature for various activities associated with the house floors of archaeological structures. Once a significant refinement of such chemical signatures has been achieved, the signatures can be extrapolated to identify activity areas using on-field analysis techniques such as pXRF. The combination of all of these approaches will significantly advance our understanding of daily life in the houses of the distant past and it will help archaeologists to better understand the ideas of home, which were so important to the communities who lived in them.

APPENDIX I

Element	Sample no. 1	Sample no. 2	Sample no. 3	Sample no. 4	Sample no. 5
Al	20232.06	29242.96	27845.51	31546.03	33198.27
P	201.329	328.97	441.3965	617.5215	406.8135
S	63.2831	45.9945	65.1745	70.816	86.41
Cl	46.2395	37.1145	37.679	44.182	27.603
K	5075.933	6521.845	58289.92	61824.72	6582.181
Ca	677.892	719.3765	607.826	670.951	659.1985
Ti	1941.727	2302.766	2257.509	2112.193	1888.771
Cr	63.3365	39.739	54.224	60.1725	34.5095
Mn	191.1575	449.7135	602.0245	516.8985	463.2105
Fe	11288.03	15963.01	23317.58	21263.28	16620.29
Ni	14.407	14.8135	13.859	12.989	11.23
Cu	7.1135	7.912	17.6885	17.6535	7.298
Zn	44.4185	41.377	59.917	52.0445	33.971
Sr	38.673	32.5745	47.9905	45.571	28.054
Pb	14.931	16.3275	20.4495	22.4285	17.0445

Table A1.1: The level of various elements in the control samples from Meillionydd in milligrams per kilogram (mg/kg).

Sample	pH level
Control sample no. 2	5.5
Control sample no. 5	5
Context 853	5
Context 11	5.5
Context 843	5.5

Table A1.2: pH level of samples selected at random found using litmus test from Meillionydd

APPENDIX II

Site	Meillionydd			Orosay Main Room A			Cell B lower floor	Cell B middle floor	Bornais				
Feature	Hearth	Cooking/food consumption/ food processing	Activity area	Destroyed hearth	Activity area	Food processing/ consumpiton	Hearth (identified by heat-affected soil and ash spread)	Cell B middle floor hearth	Secondary fireplace	Hearth	North side of the central aisle-possible cooking/ food processing/ food consumption area	Activity	South side of the central aisle-possible cooking/ food processing/ food consumption area
Al	4	4	2	2.5	4	1	3	4	4	3	2.5	2	2
Ca	3	4	3	3	3	3.5	3	4	3	3.5	3	3	3
Cl	1	1	1	1	4	3	3	2	4	4	2	2	2
Cr	3	3	2	3	3	2	2	3	4	2.5	2	2.5	2
Cu	4	4	3	3	3	1.5	4	4	3	3.5	3	2.5-3	4
Fe	3	3	2	3	3	1	3	4	3.5	3	2	2	2
K	3.5	4	2	3	3		4	4	3	2.5	2	2.5	2-2.5
Mn	4	3	2.5	3.5	4	3	3.5	4	3	3.5	3	2.5	3
Ni	4	1	1	4	4		4	4	4	3	1	2	2.5
P	3	3	3.5	3	3	4	3	2	3.5	3	3	2.5	3
Pb	2	2	2	3	4	2	2	3	1	2.5	2-2.5	2.5	2.5
S	1.5	1.5	3	3	4	3	2	1	4	2.5	2	3	2-2.5
Sr	3	3	2.5	2	2.5	3.5	3	3	2-2.5	3	2	2.5	2-2.5
Zn	4	3.5	2.5	3.5	4	2.5	3	4	2-2.5	3.5	3	2.5	3

Table A2.1: Table showing levels of various elements linked to different features with similar colour schemes denoting similar features or activity areas.

The above table is based on the same system as described in Chapter 8, where various levels of elements were categorised into high, medium-high and medium in each area corresponding to the feature or activity area in the respective distribution map. However, such categories were also given numerical values ranging from 1 to 4, where 4 corresponded to high values, 3 corresponded to medium-high, 2.5 to medium. 2 to medium-low and 1 to low. These categories are also already visually represented by colours on the distribution map of each element, as shown in the table below.

Colour of the area in the distribution map	Range: High to low	Numerical range given: 4-1
Mainly Red	High	4
Mix of yellow and red	Medium-high	3
Mainly yellow	Medium	2.5
Mix of yellow and blue	Medium-low	2
Blue	Low	1

Table A 2.2: Table showing colours seen in distribution maps of each element that correspond to the high-low areas and ranges 4-1.

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