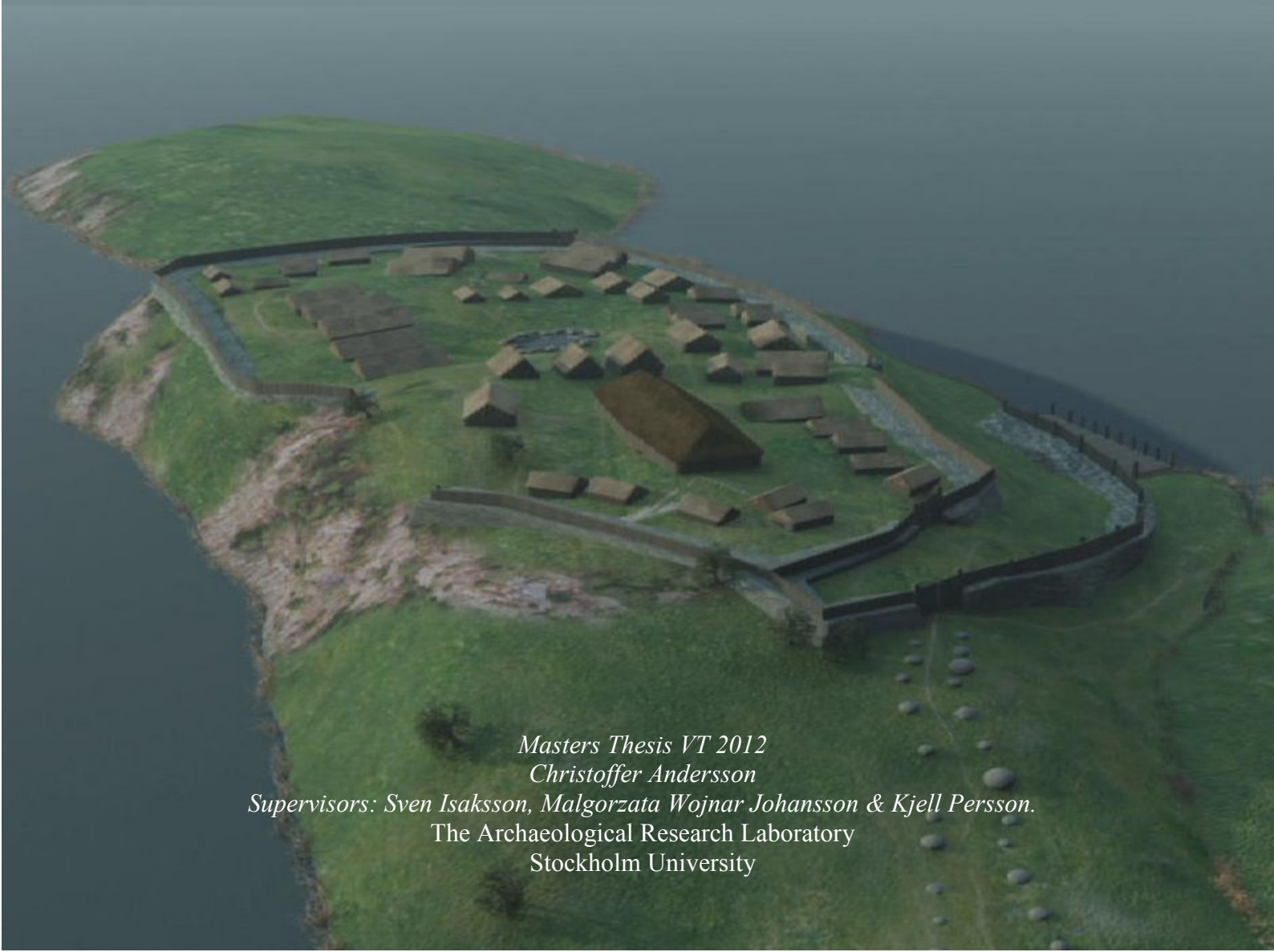


RUNSA

A HILLTOP SETTLEMENT DURING THE MIGRATION PERIOD

*DISTINGUISHING SPATIALITY AND ORGANIZATION THROUGH ANALYZING
CHEMICAL IMPRINTS OF DAILY ACTIVITIES.*



Masters Thesis VT 2012

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Runsa – A hilltop settlement during the Migration Period

Distinguishing spatiality and organization through analyzing chemical imprints of daily activities.

Abstract

Archaeologists have long noted the striking monumentality and large-scale efforts behind the Iron Age hilltop settlements. Yet, because of limited excavations, they represent a controversial part of the Migration Period society and much of their function remains hidden. This paper deals with questions concerning the inner organization and activities that took place within the Iron Age hilltop settlement at Runsa. The study is linked to the ongoing project "Runsa fornborg – En befäst centralplats i östra Mälardalen under folkvandringstid" which aims to investigate the socio-political functions of Runsa. In an attempt to establish a nuanced picture and distinguish space use within the hilltop settlement, a multi-variable approach is used. Alongside more traditional methods, element analysis by atomic absorption spectrophotometer (AAS) and lipid analysis by gas chromatography-mass spectrometry (GC-MS) is emphasized.

Keywords: *Migration Period, hilltop settlement, spatial organization, geochemistry, lipids, metal elements, Runsa, soil, vessel-use.*

Cover illustration: *Model of Runsa from Agaton television, produced for Svt/Vetenskapens värld*

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1. INTRODUCTION

1.1 Background

To date, the knowledge about Migration Period settlements is both qualitative and quantitative, however due to archaeological excavations being directed by exploitation, certain sites makes up missing puzzle pieces – hilltop settlements being one of them. During the early 20th century the interest in hilltop settlements was flourishing and several research-excavations were undertaken (Schnittger 1908a, 1908b, 1909, 1913 ATA; Gihl 1918; Hermelin 1929; Nordén 1938). These however, were of obvious reasons implemented using old archaeological documentary methods, why the information of find circumstances is limited. By the time of the mid-century, two larger excavations took place on Swedish ground, whereof Eketorp at the island of Öland, although somewhat different to mainland hilltops, is the best known site when discussing settlement features (Borg *et al.* 1976). The other excavation, at Darsgårde, remains unpublished. Over the last couple of decades interest once again have grown among archaeologists, leading to the establishment of two larger projects 'Ett fornborgsprojekt i Rekarnebygden, Södermanland' (Lorin 1985) and 'Strongholds and Fortifications in Central Sweden AD 400-1100' (Olausson 2009:6). Certainly these projects have contributed to considerable advances regarding dating, exterior attributes (Damell & Lorin 2010) and the overall character (Olausson 2008, 2009); nevertheless the knowledge gained around hilltop settlements are seemingly mainly of a contextual nature where the site is discussed based on the surroundings (Törnqvist 1993, Damell 1993, Wall 2003) or only notifications of whether a settlement can be verified or not (Damell & Lorin 2010). Although attempts have been made to deepen the understanding of mainland hilltop settlements (Olausson 2008, 2009), interpretations are based on limited material; thereby still hypothetical and in need of being evaluated. The main reason for this neglect can be traced in the fact that the majority of the investigations have been minor, the aim is consequently seldom to discuss the internal structure (see Damell & Lorin 2010). The most recent project round hilltop settlements, "Runsa fornborg – En befäst centralplats i östra Mälardalen under folkvandringstid", is focused to the hilltop in Runsa, Eds parish, Uppland. The project can be seen as an attempt to approach the socio-political role of a specific hilltop settlement. The investigation is of an interdisciplinary character, trying to establish a deepened understanding of Runsa at a micro-level in order to discuss the site in relation to the hinterland.

This thesis adds the knowledge gained mainly from geochemical methods, which are used to discuss and identify activity areas. Successful results have previously been reached on Swedish ground (Isaksson 2000a, Hjulström 2008) admittedly stressing the potential of geochemistry analyses in deepened settlement studies. The basic archaeological assumption is that human agency generates deposition of artifacts, however the less visible residues originating from waste disposal, food preparing, craft production, stabling etc. of both solid and liquid character (Middleton 2004), have been less observed. These residues are known as chemical imprints in the soil, and when studied together with the traditional parameters findings, constructions and location, they are thought to add another dimension in the interpretation of the internal organization of the Runsa hilltop settlement.

1.2 Area and material

Based on the many settlement traces above ground, Runsa, situated in southern Uppland, is a good example of a hilltop settlement during the Migration Period. It is currently being investigated by associate Professor Michael Olausson and the author of this thesis has had the opportunity to participate at the excavations over the past two years. It is viewed as a part of the context of stone wall systems within the eastern Mälar Valley, located mainly along the northern shore of Lake Mälaren. Examples from settlement studies within this area and hilltop settlements located in southern Sweden are referred to in the text, whereof several of the most important investigated sites are plotted on the map in fig. 1 and 2.

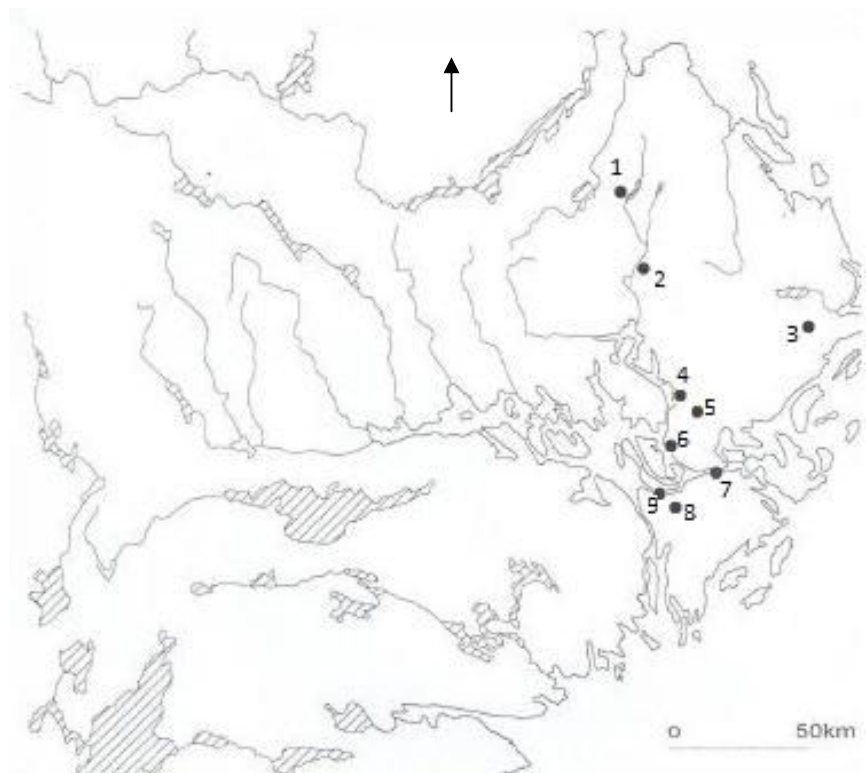
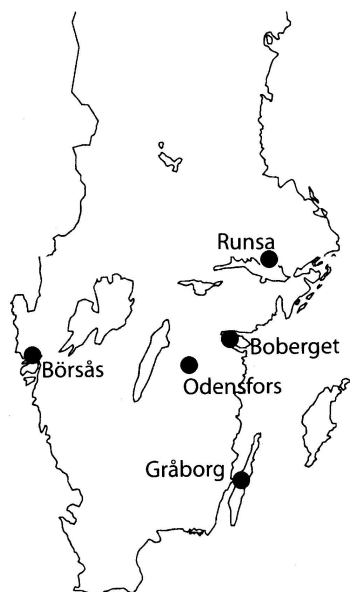


Figure 1. Left: Southern Sweden with selected sites mentioned in text (Bergström 2007:191).

Figure 2. Right: The Mälars Valley with reference points and important sites mentioned in the text. 1) Vendel 2) Valsgärde 3) Darsgärde 4) Runsa 5) Sanda 6) Gåseborg 7) Stockholm 8) Alby 9) Helgö.

The material in focus in this thesis consists mainly of soil samples and pottery collected during the excavation at Runsa in 2011. Artifacts and constructions are however used to aid the interpretations as well, together making up a study of the same phenomenon from multiple angles. The newly acquired information is mainly obtained from the trenches that were excavated during 2010 and 2011, but furthermore also put into a larger whole, i.e. the context of the hilltop settlement.

1.3 Aims and structure

As a contribution to the research of Runsa, and on basis of what was stated above, the aim of the thesis is to discuss the functions and spatial organization within the hilltop settlement. Using a traditional archaeological approach combined with laboratory analyses, i.e. geochemical analyses of soil samples and lipid food residue analyses of pottery, I intend to discern patterns and obtain information concerning the planning of the hilltop settlement, house arrangement and activity areas. In particular, I aim to approach the following questions:

- (i) The primary aim is to answer the question of how Terrace I and Terrace III were used. Is it possible to discuss and identify the functions based on geochemistry, vessel use and excavation results? Furthermore, can the obtained knowledge be used to understand how the settlement was spatially organized?
- (ii) How can we understand Runsa in relation to the earlier investigations of Migration Period settlements? Do the results contribute to a more nuanced picture? If so, does it infer a separate function for the hilltop settlement of Runsa or does it fulfill a similar role as the many ordinary and magnate farms in the area?

The thesis is constructed as follows: the first part of the text gives a review of the research of Runsa and briefly covers the research of hilltop settlements in general. The second part focuses on the methodological issues and how these will be applied and performed. Lastly the results are

presented, evaluated and interpreted, in particular on a micro-level but also to some extent in relation to the research front that concern Migration Period settlements.

2. RUNSA – A HILLTOP SETTLEMENT IN THE EASTERN MÄLAR VALLEY DURING MIGRATION PERIOD

2.1 Introduction and surroundings

“*The settlement with the many houses*”, is one of the proposed meanings of the place name *Runnhusa* (Vikstrand 2011:43). The place name itself might indicate the special position and characteristics that was connected to the Runsa hilltop during its active phase. Another characteristic, the monumentality, is still striking today. During the active phase, it most certainly gave a respectful impression in the landscape. Located to the northwestern point of Eds parish and according to paleogeographic maps Runsa was an island during the active phase (Risberg 2011:50). However, the historical arable land connected to the medieval village, *Runusum*, is about 5 to 7 m a.s.l, why a neck of land, joining the hilltop to the rest of Eds parish, probably was established during the late Iron Age.

While the land-use directly southeast of Runsa seems to be very sparse throughout the Iron Age, one of the most intensive land-use areas in the eastern Mälär Valley begins some 5 km southeast from Runsa. With its focus to the Fresta and Hammarby parishes this area with its characteristic systems of stone walls seems to have been fully colonized during the Migration Period (Ericson & Hermodson 1994:28). The area has been subject to several excavations and is one of the reasons behind today’s knowledge about the social organization during the midmost Iron Age (see Olausson (eds.) 2008). The same is valid for Norrsunda parish, northeast of Runsa, where the stratification between the settlements is pronounced, stretching from small simple households to ordinary farms and magnate farms with rather large-scale crafts and hall-buildings (Renck 2009, Hamilton & Vinberg 2011:92f).

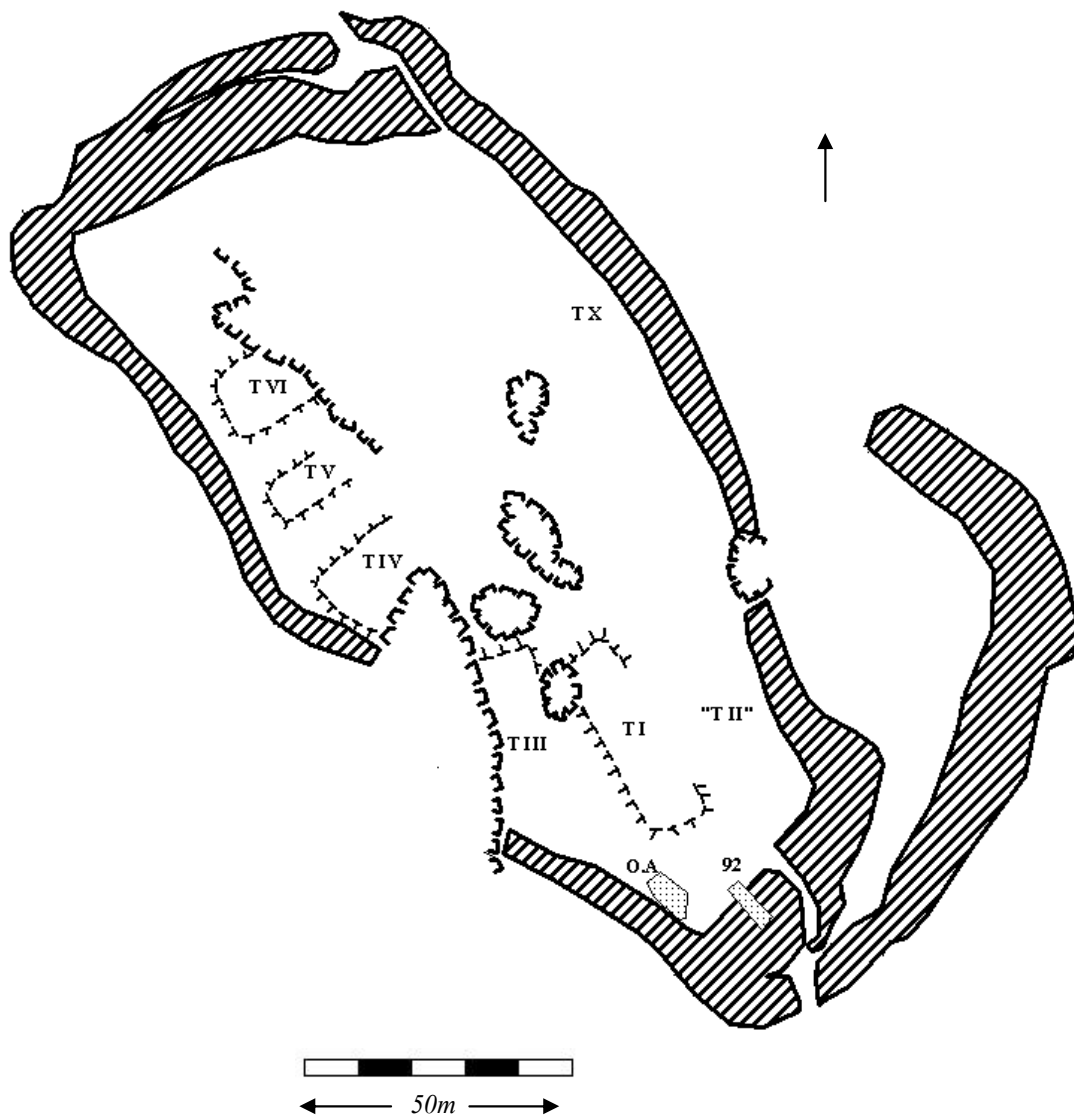
What distinguishes Runsa from these settlements is not only the fortification and settlement structure, but the absence of adjacent arable land and pastures as well (Olausson 2011b:15). The possibilities for resource exploitation are in general very limited at the site. Chisholm (1965:114) set up five location criteria for an agrarian settlement; water supply, availability of arable and grazing land, fuel supply and availability of building material. Runsa, however, do not fulfill any of these criteria completely. A water hole is situated in the center of the hilltop, but its capacity of supplying the inhabitants is unexplored. Fuel and building material must have been brought to Runsa from the lands in possession of the surrounding farms. This is demonstrated by the rampart; a massive construction that have involved an enormous effort, probably not only from the inhabitants. When it comes to the question about cattle and cultivation, it cannot be fully excluded. However, it can be said that the settlement was not oriented towards agriculture and the amount of animal bones found at the site is not in proportion to the possibilities of holding a livestock at Runsa. Nonetheless, animals may have been grazing in the courtyard or on small meadows beneath the outcrop. Another possibility for grazing is the leveled areas on top of *Kohagen*, east of the hilltop, which obviously, judging from the name, have been used during modern times.

To define the outer borders of a settlement is usually problematic, but in this case it is broadly a foregone conclusion. Runsa offers in comparison to other contemporary Iron Age settlements, a visible outline, the main wall, which in turn together with the topography narrows down the search for houses and activity areas. This is said with the existence of sites as Hultberget in mind, where contemporary terraces have been identified just outside the rampart (Damell & Lorin 2010:212). The hilltop is surrounded by steep outcrops in west and east, while the terrain is somewhat less steep in the north and southeast where two entrances are situated. Outside the southeastern entrance, a path cleared from stones leads up from the small valley below. Parallel

to the main wall, an offshoot leads down to approx. 8 m.a.s.l., which is equivalent to the sea level during mid-Iron Age. The function of this additional wall is not known, however it has been suggested as one of the probable locations for a harbor (Olausson 1996:9, Risberg 2011:50). Judging from the topography, a rather advanced construction must have been necessary to overcome the steep slope leading down to the inner, protected area of the outshoot. Nevertheless, an island with a settlement like Runsa most reasonably had a proper landing area with jetties and activities connected to the shore. Just east of the offshoot is a lower strip of land which has been connected to the shoreline in the north and south during the Migration Period and holds two more potential harbor areas, *Lilla Borgviken* and *Stora Borgviken*. The former, which include the outshoot of the wall, is deeper and also holds the findings of a wooden log boat dated to 7th century, found in a narrow trench intended for a telephone cable (Östmark 1976). The latter on the other hand, houses the burial grounds (RAÄ 1, RAÄ 3) connected to the inhabitants of Runsa, signaling property rights. These graves, situated on the former shoreline, were therefore possibly consciously exposed to foreign ships approaching the Runsa harbor.

2.2 The courtyard

The inner area (fig. 3), protected by the rampart, can be divided into four separate sections. Immediately within the south entrance is a flat open plateau with several traces of prehistoric activities above ground (Olausson 1996:9, Olausson 2011a:226). The survey from 1992 suggested that within this area were three parallel terraces which were the remnants of houses.



Figur 3. Runsa hilltop settlement, after Olausson 1996 (modified by the author).

Terrace I: Located at the highest point and in the center of this section, is the largest terrace at Runsa which measures 38 m between the gables marked by larger blocks. The northern gable-marking is somewhat asymmetrical in its position in relation to the southern one. The width is approximately 11 m and the overall impression is a terraced area with marked boundaries, also named *platahus* (sw.) (Olausson 1996:9, 14, Olausson 2011a:225f).

Terrace II: This terrace, situated east of House I, was originally interpreted as the remains of a longhouse, measuring approx. 25 x 9 m. However, the excavations during 2009 and 2010 (see ch. 2.3) showed traces of a rather small shed rather than a longhouse.

Terrace III: West of Terrace I, only separated by a small outcrop, is a somewhat smaller and less exposed terrace. Since only one gable is visible above ground, it is hard to determine the size of a probable house.

The central section of the inner area does not include terraces; instead it is characterized by outcrops and a topography unsuitable for housing. The northern part of the hilltop contains two areas, separated by an outcrop going north-south. The western area is situated on a lower level, while the eastern area is somewhat elevated in the central parts. The former is occupied by three defined terraces.

Terraces IV, V, VI: On a separated section lie three rather similar terraces. They are situated along the rocky outcrop at the central part of the hilltop and occupy the larger part of the area towards the wall.

The fourth section harbors no obvious indices of housing, although several potential locations can be spotted. These however, only have one terraced side, making the chance of them being natural formations considerable.

2.3 Earlier excavations – results and interpretations

The very first proper archaeological excavation at Runsa was implemented in 1902 by prof. Oscar Almgren (marked O.A in fig. 3). With the intention of examining the age of the rampart, a 25 m² large trench was dug along the southwestern part of the wall. Two different cultural layers were discovered, separated by a clayey layer without findings. The bottom layer yielded a fragmented crucible while most of the findings were retrieved from the upper layer; a dice, ceramics, crucibles, loom weights, rivets and bones from domestic animals. According to Almgren, similarities between the findings on Runsa and Birka made it reasonable to date the hilltop to approximately the same time. However, the spatial proximity to Sigtuna later contributed to the interpretation of Runsa as a garrison related to the defense around the early town (Gihl 1918:85, see Olausson 1996:4f).

It would take 90 years before any archaeological fieldwork were undertaken at Runsa again. This time the work was focused on two areas. A 20 m² trench was located to the wall at the southern entrance (marked 1992 in fig. 3), while the larger trench, 52 m², was located to the largest terrace, T I, within the courtyard. From the smaller trench it was concluded that the rampart had been burnt several times, hence rebuilt three or possibly four times (Olausson 1996:10). Directly inside the wall, findings of ceramics and animal bones, indicating food processing, was found throughout the trench. The central occupational layer also harbored a floor layer with a hearth, bordered by a wall. Other findings included loom weights, a polishing stone, carbonized bread, a whetstone, as well as a dress pin in bronze and a comb both dated to the late 5th century (Olausson 1996:13). The uppermost layer of the house displayed somewhat less findings in general, with the addition of slag. Overall, this gave the interpretation of a small Migration period house situated along the rampart, with activities connected to food processing and other everyday activities (Olausson 1996:13f). It has been stressed that the trench from 1902 show a rather similar context, together possibly being the remains of several buildings along the wall (Olausson 2011a:240).

The trench within TI was located to the southern gable, stretching north with a width of 2m. An additional minor test pit was excavated more centrally on the terrace. Remains of a large house were uncovered, including the southern gable wall and several post holes. The findings were generally sparse in comparison to the wall-trench mentioned above; they included ceramics, a few fragments of loom weights and crucibles. However, more interesting finds were uncovered here as well; a piece of bread and an iron-ring originating from a chain mail. The location, size and settlement context, led to the preliminary interpretation of this house being a hall-building (Olausson 1996:16, Bergström 2007:45). During the excavation and later on in the same year, phosphate mapping was implemented throughout the whole inner area of the hilltop settlement (Rudin 1992:4). The sampling points were located with 5 m interval and at approx. 15-30 cm depth, depending on the actual soil depth. The results from the phosphate mapping showed enhanced values at the western, lower part of the hilltop settlement, peaking at terraces V and VI. Certain points, directly southwest of the northern entrance also indicate elevated values. Along the eastern wall, and throughout the central and southern part, the levels were generally low (Rudin 1992:26). The high phosphate-values on the western side of the settlement area led Rudin to the suggestion of an eventual stable (V), a crafting area (VI), and a possible area for refuse deposition (IV) (see Rudin 1992:24). However, these interpretations must be seen as preliminary since trying to establish specific pre-historic activities based on just phosphate values is problematic (see ch. 4.1.1).

In 2009 the project round Runsa once again went into a phase of excavations. The investigated area on Terrace II resulted in a rather complex occupational layer. Remains of a smaller house were found in the center of the terrace, with several levels with traces of reconstruction superimposing the oldest phase. Two fragments of blue glass and three combs, found at different levels within the area used most intensively, can be dated to the time-span 5th to early 6th century A.D. Within the uppermost layer, two hearths were uncovered and later dated to the late 6th century. Other artifacts found at Terrace II include, an awl, loom weights, whetstones, a bolt to a shrine, a knife and a bead. Noteworthy are also the findings of sporadic crucibles, again indicating the existence of metal crafting within the settlement (Olausson 2011a:232ff).

The uppermost part of the occupational layer in the north end of House I was also excavated during 2010. A compact and low wall was discovered about three meters in from the stone-built edge of the terrace. It was found separating the main part of the house from a small northern gable, suggesting that the actual longhouse ended inside the wall. The use of the outer area was diffuse; sporadic animal bones, ceramics, iron fragments and slag were found. A more detailed picture of House I is given in chapter 5.

Several test-pits were also placed in the north and northeastern parts of the hilltop settlement. The results from these investigations reveal what appears to be a dense settlement with traces of postholes and clayey floor layers in most of the inner area of the hilltop settlement (see Olausson 2011a:226, 238). Among the concluding remarks from the early as well as the later research is the manifold of traces of different activities that have been uncovered, along with some distinctive artifacts, suggesting an elite-settlement during the Migration period (Olausson 1996:20, 2011:242f). In line with this and characteristic for almost all the trenches, except House I, are also the large amount of unburnt animal bones (Olausson 1996:16), suggesting food handling and presence of animals to an extent that greatly exceeds the potential of grazing inside and around the hilltop settlement. When discussing the active phase of Runsa, ¹⁴C-datings from the excavations correspond to the time-span 230-650 AD (Olausson 2011a:241), while the dateable artifacts emphasize the central part of this period, 450-550 AD, possibly indicating a rather short period of use (Olausson 2011a:238f).

3. THE IRON AGE HILLTOP SETTLEMENTS

3.4 Definition

When stone-constructions are found encircling a hilltop, the general term given by archaeologists is hillfort. Studies of a certain type of settlement, basically a site where house-terraces or other indications of buildings are found upon a hilltop and surrounded by a rampart, have obtained a separate title within the hillfort-category; hilltop settlements (sw. *höjdbosättning*). It should be stated at this point that it is difficult to tell whether a hilltop have harbored a settlement or not. On certain sites there are remains of several terraces that indicate that it has been populated at least occasionally, other sites have a few findings from minor excavations that shows an Iron Age activity. In line with the aim of this thesis the following review focuses on the hilltops where there are substantiated reasons to believe it once harbored a settlement, i.e. visible terraces or finds and datings indicating a hilltop settlement (see Damell & Lorin 2010). Nevertheless, it can be concluded that the hypothesis given that practically all forts harbored dwellings (Anjou 1935:2ff), is not supported by the archaeological record.

3.4.1 Distribution and settlement structure

The distribution of hilltop settlements in Sweden displays a concentration to southern Uppland and northern Södermanland where a total of about 20 hilltops with traces of dwellings are identified. The eastern part of Östergötland is another focal point with approximately 13 examples of hilltop settlements (Olausson 2009:47, 60). Similarities, i.e. accumulation of houses within a fortified area, is found within contemporary forts on Öland as well. These are however different regarding their structure and exhibits settlements with a more circular structure called 'ringforts', located to flat land areas. The disparities may however be partly explained by the natural conditions (Wegraeus 1976). The location in the landscape differs between the mainland hilltop settlements as well; central positions within the agrarian landscape are represented as well as peripheral positions at the borderline between cultivated land and forested areas. Generally though, they are situated at strategic positions with visual command over the surrounding territory (Olausson 2009:44).

A characteristic feature regarding several hilltop settlements are the density and extent of houses upon the yard. The ringforts is a separate category with a well-organized courtyard consisting of radial house foundations along the wall and a central block within. The mainland hilltop settlements display a more inconsistent picture; e.g. Gåseborg, Broborg and Darsgårde have a similar density of terraces as the ringforts (Ambrosiani 1958:168, Löfstrand 1982, Olausson 1996:24; Carlström 2003:8), but not to the same extent and definitely not organized similarly (see Näsman & Wegraeus 1976). The ringforts should rather be titled *fortified villages* (see Olausson 2009:47), when considering the fact that at least 12 contemporary farms were discovered at the Eketorp II fort (Nordström & Herschend 2003:51). Other hilltop settlements however, as Lundboborg in Uppland (Olausson 2008:30), Mjälleborgen in Jämtland and Männö fort in Södermanland have a settlement structure that are reminiscent of a single farmstead (Hemmendorff 1985:238, Olausson 1996:25). Furthermore, the concept also includes sites as Fållnäs, where the only area suitable for buildings was excavated with the results of only a couple of postholes and cultural layer being found, maybe indicating a single building (Olausson 2008).

Nevertheless, the density of buildings at several sites is striking and characteristic. Accumulated building groups have also been found elsewhere, as in arable fields on the lowlands (Appelgren 2002, Östling & Larsson 2007:292ff), these settlements, however, have distinctly discernible building groups representing different farmsteads. Most likely they have cooperated in some way regarding the organization of arable land and meadows, but the fact that they are so intertwined with the agrarian production is probably a major difference in comparison to most of the hilltop settlements. To find similar planning which is contemporary and somewhat similar also regarding economy, we must look upon sites as the impressive Helgö-complex. This site shows an

accumulated pattern of buildings, however still distinguishable into separate groups (Holmqvist *et al.* 1970, Reisborg 1994:17ff). On the other hand the economy seems more specialized on crafts and the question whether there has been a local agrarian production or not, is not settled as of yet (see Carlsson 1988). Moreover, the presence of an aristocracy is another joint-factor to the hilltop settlements. Summarizing the discussion over settlement structure it must be argued that the organization of the hilltop settlements distinguishes itself in comparison to the known structure of contemporary settlements on the lowlands. However, the amount of buildings is by no means standardized, indicating that this category, hilltop settlements, is not uniform.

3.4.2 Previous excavations and findings

Initially it should be stressed that several of the mainland hilltop settlements have only been partly excavated, and only a few sites has undergone more extensive excavations, e.g. Boberget in Ö Stenby parish, Gullborg in Tingstad parish, Darsgärde in Skederid parish, and Runsa in Ed parish (Schnittger 1908b, 1909, Nordén 1938:266f, Ambrosiani 1958, Olausson 1996, 2011).

The very first project concerning hilltop settlements with organized excavations were initially undertaken at Runsa in Uppland and later focused to Östergötland where eleven hilltops to a varying extent were excavated by Bror Schnittger during 1906-1913. When Arthur Nordén, summarized his work in 1938, a total of 17 hilltops had seen the efforts of archaeologists; many of the sites showing traces of settlement. However, Schnittgers and Nordéns research belong to a period when the archaeological documentary technique was undeveloped, why a major part of the information over the contexts and constructions are lost from these excavations since determining any houses or other features was not the same issue as it is today. Nevertheless, the findings from these excavations are of great value, however reflecting inconsistency and disparities. Three of the forts have a relatively rich combination of findings. Except a high amount of ordinary artifacts such as animal bones, ceramics, loom weights etc., they also display findings characteristic for settlements which are generally defined as magnate farms; Gullborg - gaming pieces, Roman glass, parts of a sword case, arrow heads, a gold rod, dress-pins and brooches (Schnittger 1908a & Schnittger 1913 ATA); Boberget - a silver rod, gaming pieces, spearheads, a brooch, bread (Schnittger 1908b, 1909) and Odenfors - gaming pieces, bread, arrow heads and brooches (Nordén 1938:308f). Other hilltop settlements such as Brudberget, Braberg and Borgberget display findings of a more ordinary character (Nordén 1938, Wahlberg 1964). Among the characteristics are the amount of traces after textile production from hilltops in Östergötland (Olausson 1987a, Hemmendorff 1992:13), including hundreds of fragments from loom weights in Onssten and Gullborg (Schnittger 1913 ATA, Olausson 1987b:405). Noteworthy is that among the reoccurring objects are also the strainers, i.e. perforated ceramics, which are found both at sites with rich find combinations, and the more ordinary sites (Schnittger 1908b, Schnittger 1913 ATA, Nordén 1938).

Strainers have also been documented in Baldersborg, Södermanland and Gåseborg, Uppland (Hermelin 1929:95, Carlström 2003). The findings from the hilltop settlements in Södermanland are otherwise to a greater extent characterized by what archaeologists expect to find in the ordinary Iron Age settlements; ceramics, unburnt- and burnt bone, loom weights and slag (Hermelin 1929:93, Lorin 1989, Damell & Lorin 2007, Damell & Lorin 2010:210ff). The relatively minor excavations within these hilltops might be part of the explanation to this discrepancy. One of few exceptional findings is the engraving tool from Hultberget, Husby – Rekarne parish (Damell & Lorin 2010:211).

The excavations of hilltops in Uppland have, besides from Darsgärde, also been very limited to their extent. Minor excavations have been undertaken in Gåseborg, Järfälla parish and Broborg in Husby-Långhundra parish (Löfstrand 1982, Carlström 2003). The latter resulted in the finding of one of very few objects, a blue colored glass bead, with a late Iron Age dating found at hilltop settlements. However, ¹⁴C-datings of a posthole resulted in a time span of 1470 BP ± 105 years (Fagerlund 2009:16, 19). In Darsgärde the prestigious objects are absent, yet the findings and

contexts indicate an upper hierarchical level; a scythe, a ploughshare, a ferrule ax (sw. *holkyxa*), a key, some clothing items and fragments from crucibles (Ambrosiani 1958:167).

The excavation of Darsgårde is the largest undertaken at a hilltop on the mainland and resulted in about 20 houses being documented (fig. 4), the greater part of the archaeological investigation however remains unpublished. The occurrence of crucibles and moulds for bronze casting as in Darsgårde are features that seem to be more frequently occurring at hilltop settlements than among other Migration Period settlements (see Hall 1992:33ff, Kangur 2004:24, Olausson 2008:31). The extent of the metal crafting is difficult to estimate, but so far seems rather limited (Olausson 1987b:409). The metallurgical ceramics from Gåseborg might be an exception, indicating production exceeding household needs (Carlström 2003:14ff, Olausson 2009:52) but cannot be compared to sites as Helgö. Metal crafting though is generally a high status indication during this period and even more so when traces after manufacturing of prestigious objects can be identified as again in Gåseborg where traces of gold crafts have been documented (Kangur 2004:24). Within this general picture of the findings from hillfort settlements are sites with obvious Roman influences; bread, rotary querns, agricultural iron-tools, pyramid-shaped loom weights, along with other very rare findings as the engraving tool and decorated antler pins (see Olausson 2009:52)

The question, whether hilltop settlements in general were used during the late Iron Age, has had a lengthy discussion and was once again raised recently. The prevailing perception during early 20th century placed the Iron Age hilltops mainly within the Viking Age (Gihl 1918:81ff; Almgren 1934:171), this was later questioned with arguments connected to the *crisis* during the Migration Period (e.g. Stenberger 1964:537ff), which better corresponded to the interpretations of Östergötland's hilltop settlements (Schnittger 1908a, 1908b, 1909, 1913 ATA). Based on the ¹⁴C-datings from hilltops in northern Södermanland, Damell & Lorin (2010:218) claims the time span for the use of hilltops as dwellings to be pre Roman Iron Age – Early Medieval Period, but with a main period of use during late Roman Iron Age – Migration Period. This summary generally seem to fit the other regions with a high density of Iron Age hilltop settlements as well; Uppland, Öland och Östergötland (Wahlberg 1964, Wegraeus 1976:43, Engström 1984, Olausson 1987a:92, 1987b:401ff). This is a somewhat simplified picture though, since forts on Öland have an obvious renaissance during the Viking Age and the extent of the continuity in use of hilltops on the mainland after the Migration Period still is rather unknown. However, the only house construction linked to a hilltop settlement that has been dated to late Iron Age on the mainland is located outside the rampart (see Damell & Lorin 2010:218ff).

3.4.3 Interpretations of functions

In the works investigating hillforts and hilltop settlements over the last century, the dominating interpretation over the reason behind the construction of them is based on their natural linkage to war, and therefore its defensive function as retreats in the periphery (e.g. Schnittger 1908:30f; Hermelin 1929:90). A connected and reoccurring thought stresses the relation to the great political turmoil on the continent (Damell & Lorin 2010:206) and the sometimes adjacent place names connected to the hillfort settlements with the prefix *Karl-* or *Rink-* have been seen as indications of a garrison related to a nearby hillfort (Hellberg 1975). David Damell and Olle Lorin (2010:218) also note that some hilltop settlements probably should be interpreted as if the rampart did have a protective function, while others do not seem to be defense facilities. A similar thought is presented by Michael Olausson who claims that



Figure 4. The hillfort settlement of Darsgårde (Olausson 1996).

the fortification was not always its primary function (Olausson 2009:48). Connected to this discussion is the question whether tree constructions have strengthened and elevated the wall. This has in fact been proven at several hilltops (Ambrosiani 1958, Engström 1984, Hemmendorff 1992).

Åsa Wall is among the archaeologists who have a conflicting view of the hilltop settlements. Wall sees them as traces after cultic exercise; the rampart or stone-wall surrounding the hillforts, including hilltop settlements, should be seen as a border-zone, separating the landscape of the living from the *inaccessible world* (Wall 2003). This fits well with the notion that the general absence of adjacent cemeteries have been seen as a sign of semi-permanent use (Törnqvist 1993:12), i.e. the population using the hilltop settlement are possibly residents from farmsteads or magnate farms in the hinterland. Furthermore, the general localization to the periphery between more populated areas has been proposed to be an indication of occasional use. In line with this, Wall stresses that the occupational traces and the houses are remains after simulations of activities associated with settlements. She describes these activities, i.e. food processing and crafting as transformations linked to the cosmology with the farm having an increasing significance within the cult, why the houses are not traces of proper settlements (Wall 2003:140,141ff, 183).

Michael Olausson on the other hand saw a connection between the hilltop settlements and centralization of the production and power (Olausson 1987b). He later describes the hilltop settlements in more detail as possibly a form of magnate farms harboring different families/groups of people (Olausson 1997:110f). In line with this reasoning terraces have been observed outside the rampart at a few hilltop settlements (Carlström 2003:8, Damell & Lorin 2010:212), which have been interpreted as a sign of local hierarchies (Skjellberg 1991:12ff, cf. Olausson 2008:27). Hierarchies on a micro-level are however also found within the ringforts of Öland (Nordström & Herschend 2003). In Olaussons (2009:38) recent discussions concerning the origin of the hilltop settlements, he interprets them as a *new way of life*, inspired by the Roman and provincial Roman models, where home, specialization of crafts, trade and military protection is combined (see also Olausson 2008). For instance the relation between bread and magnate farms has been pointed out as an indication of Roman influences (Bergström 2007). The presence of hall-buildings within hilltop settlements have also been stressed based on the topographical situation of certain terraces and the findings in others (Olausson 1987b:405, Olausson 2008:32). The wealth is also apparent in the studied bone-material from Gåseborg; the recovered bone-material displays ideal slaughter age and fragments of bones from the edible parts of the animals dominate the osteological material. These observations indicate slaughter outside the hillfort and possibility of choosing from different food sources (Olausson 2009:52). The picture that Olausson sketches in his attempt to interpret the people behind the walls of larger settlements, describes a family in leadership with an accompanying retinue (sw. *här*) and a luxury consumption of meat and crops. Craftsmen must also have been among the people who were included in this form of household. Furthermore, he reflects over the possibility of these men and other workers being thralls (Olausson 2008:32). Hence, the hilltop settlements probably overruled the hinterland to different degrees (Olausson 2009:38, 55).

David Damell notifies a certain type of hilltop settlement with very limited building traces. He links hilltop settlements as Sunnersta and the earlier mentioned Broborg to similar functions; i.e. guarding the trade routes on land- and waterways leading to Old Uppsala. The buildings are by this context interpreted as parts of a garrison and customs location, composing an outer defense system in the early state formation (Damell 1993).

Obviously, the hilltop settlements are not in themselves a homogenous group. The different levels of building density and settlement structures upon hilltops have been interpreted as indications of a hierarchical differences and variations in the status and composition of its inhabitants (Olausson 2008:29, 2009:54f). Magnate farms have different profiles and as Olausson argues (1987b), the

concept of specialized crafting includes different groupings. Darsgårde with unusual finds such as a scythe and a ploughshare made of iron as well as grindstones and pottery in quantities along with several buildings possibly for storage at its disposal might have been a magnate farm specialized in agriculture. Sites as Gullborg and Onssten with its characteristic loom weights might on the other hand be related to extensive textile crafting (Olausson 1987b:405). The discussion must also take the interpretations mentioned earlier into account as a holistic view stresses the need for somewhat sliding interpretations; from surveillance forts with few findings to forts as Sunnersta and Fållnäs with one or two buildings, to settlements more or less characterized by their aristocratic appearance, specialized crafting and trading functions.

3.4.4 The courtyard - activity areas

As a consequence of limited excavation-areas a more detailed picture of the spatial organization is difficult to depict. This problem is even more obvious when noting that almost the entire inner area seem to have been used at several hilltop settlements (Olausson 2009:49). As was briefly mentioned above, we might expect a hierarchical division within the larger hilltop settlements. Eketorp on Öland with several more or less ordinary farms together with a prominent building group including a hall might display a reoccurring pattern when discussing spatial organization within hilltop settlements. Darsgårde with approx. 20 houses serves as a point of departure. Analyzing the courtyard with the different buildings, a variation can be detected with one distinctively larger building in NE (fig. 4), containing two hearths in the western half and most findings, among shorter longhouses and small houses often with barely any findings and without hearths. A hypothesis has been proposed by Olausson (1987b:405) where he interprets the large house on the constructed terrace as a hall-building. In this house and in the surrounding smaller houses he argues for the possibility of storage-functions as their inner area measure about 1150 m² in total, which exceeds the area at ordinary farms by far. Certainly an organization of this type must have included a hierarchical society with inhabitants in power alongside labor.

Recalling all the functions that has been ascribed to hilltop settlements and all the traces of different activities that were reviewed above, it is somewhat disturbing that so little is known about the internal organization. Among the repeatedly documented activities are iron smithing, textile working and bronze casting, while gold crafting and bone working seems to be more unique (Kangur 2004, Olausson 2009:50). The extent of crafts seem to exceed the individual need to different degrees (Olausson 1987b:409, 2009:52) and it has occasionally been concentrated to a limited area (Schnittger 1913 ATA). In Eketorp on the other hand it is obvious that the production seems to be distributed between households (Rydberg 1995:25f).

3.5 Formulation of the research gap

The question about the meaning behind the hilltop settlements as debated above is according to my conclusions too wide and general in order to be answered thoroughly by a case study. Instead the expectation on the following chapters is to narrow down the question at hand and primarily add knowledge about one specific site, Runsa, in order to acquire a deeper understanding regarding one hilltop settlement. The fact is that hilltop settlements are often discussed in their relation to the surroundings and sometimes with the addition of finds without an accurate relation to their context, but seldom (ringforts excepted) a deeper knowledge is obtained about their inner organization and the functions that lay therein. With all knowledge that has been gained concerning the Late Roman Iron Age and the Migration period settlements (e.g. Göthberg (eds.) 2007; Olausson (eds.) 2008), it is exceptional how little is known about these monumental constructions and their relation to the mid-Iron Age society. In the light of this, it is interesting to investigate if several/certain crafts or ordinary agrarian functions can be traced at the monumental settlement in Runsa. Were there separate areas of activity and dwelling areas, or were there a spatial grouping based on households within the wall? How does the settlement differ from our knowledge of ordinary and magnate farms? What kind of houses can be traced and how were

they used? An eventual specialized production requires dwelling houses, or did the people live elsewhere? The questions are many and probably they cannot be answered completely in this study. However, the following sections approaches these questions and hopefully a more nuanced picture about what these settlements consisted of can be established.

4. ANALYTICAL TECHNIQUES

4.1 Geochemistry and vessel use

The basic thought behind using geochemistry in archaeology is that activities above ground will affect the composition of the soil. Deposition of solid particles and their by-products resulting from decomposition, alternatively by complexation and absorption of free ions or molecules originating from liquid residues, become fixed to the parent material in the soil (Middleton 2004:49). These changes in soil chemistry may also be better preserved than the actual artifacts and constructions that once were part of the prehistoric society. Unless the sudden event of a fire or an assault, settlements was seldom abandoned immediately, allowing inhabitants to collect their possessions. Most likely the domestic floors was also swept and kept relatively clean, thus obstructing the interpretation by the archaeologists. Chemical residues, however, have the ability to accumulate in their primary context (Parnell *et al.* 2002:379, Hutson & Terry 2006:394). Areas that are considered as more or less empty can therefore be given more interpretable variables. The soil characteristics that are discussed here are divided into two branches; inorganic and organic. The former is represented by metal elements and the latter by lipids in this thesis.

Likewise, as regarding the chemical imprints in soil, the matrix of prehistoric unglazed pottery reflects the contents, e.g. food ingredients or storage material, from mainly the last uses of the vessel (Craig *et al.* 2004). Nevertheless, studies of vessel use are thought to reflect food habits related to diet and functions such as storage, serving and processing of food. The concept has been used successfully to distinguish vessel use both between sites (Isaksson 2000b, Hjulström *et al.* 2008), and between houses/households or activity areas within sites (Isaksson *et al.* 2005, Olsson & Isaksson 2008, Dimc 2011). The different methods are briefly presented below, including a historical review and methodological concerns, before the next section discusses the on-site sampling strategies.

4.1.1 Phosphates

Phosphate mapping is certainly a part of the inorganic geochemistry together with the other metal elements, but it has a rather long and individual history in connection to archaeology (see Bethell & Máté 1989), why it deserves an introduction of its own. The theory behind measuring the amount of phosphates in soil is based on the fact that all organic material contains phosphorus. Thus, when organic material is deposited in the soil it is decomposed into phosphate ions. These, in turn, are distributed into the soil solution or become fixed to the surfaces of minerals. Phosphate (P) therefore appears in three different fractions, organic, stable inorganic (parent material) and plant available phosphate, which are held in equilibrium; plants receives their nutrition P from the available phosphate fractions and are later decomposed, transferring P back to the soils where they originated (Jahnke 1992:308). However, this can be altered by a displacement, interrupting this equilibrium, and input from a source containing phosphorus; therefore it is argued that accumulations occur where the organic input is greater. Hence, because of its ability to be stored in the soil, phosphates can be used to trace anthropogenic activities (Brady & Weil 2002:602f). There are different techniques for determining the phosphate concentration within soils; analyzing the amount of labile inorganic phosphate, i.e. plant available, is the common implementation, although it has been criticized for not taking the total phosphate level, i.e. the organic and the stable inorganic into consideration (Johnson 1956). Since the proportion of the different fractions vary depending on soil properties, analyses of total phosphate have been argued to be required when inter-site comparability is demanded (Bethell & Máté 1989:19f). The aim of the mapping therefore decides what method is suitable.

Reviewing the applications of phosphate mapping in archaeology, the initial and very important conclusion was drawn by Olof Arrhenius, where he pointed out the relation between enhanced phosphate values and prehistoric settlements (Arrhenius 1929). During the following decades several archaeologists noticed the same relation (e.g. Lutz 1951, Dietz 1957) and also tried to establish a more accurate mapping strategy in order to distinguish certain constructions (e.g. Barker *et al.* 1975). During the second half of the 20th century, phosphate mapping was frequently used as a standard survey method, both by archaeologists and also historical geographers. Their aims were often to locate settlements (e.g. Sporrang 1971, Widgren 1983, Broberg 1990), or harbors, i.e. human activity adjacent to shorelines (Carlsson 2004:19). Furthermore, phosphate mapping has also been used as a post-excavation analysis, for example to specifically pinpoint the functions of certain buildings (Ramqvist 1983, Eriksson 1995) or to determine the position of buried bodies (Barker *et al.* 1975).

The manifold of activities that results in deposition of phosphorus is though somewhat problematic when discussing functions and intra-site variations; deposition of organic material within settlement archaeology, can for example be associated with food handling, i.e. processing, consumption and disposal (e.g. Proudfoot 1976, Terry *et al.* 2004), burning of organic material (Middleton 2004:53) and certain areas of crafting such as processing of wood and bone or lapidary crafts (Eidt & Wood 1974:44, Middleton 2004). Wilson *et al.* (2008) summarizes this complexity with showing how P tends to concentrate to several activity areas, but with the byre often coinciding with its maximum and others at descending concentrations. On the other hand, low and relatively depleted values also are interpretable, for example as pathways, sleeping areas (Terry *et al.* 2004:1243) or storage functions (Sanchez *et al.* 1999:56).

Phosphate-analysis

The laboratory method used for this thesis is called the PMB-method (see Persson 2005). Approx. 1 g of each soil sample was dried and homogenized with a grinder. The phosphate ions were then extracted into solution by adding 5 ml of 2 % citric acid and put on a shaker table over night. After sedimentation, 2 ml of molybdenum-sulfuric acid and 0,5 ml of sodium sulphite hydroquinone solution was added. The solution was then diluted with distilled water to the 50 ml mark and put in an oven in 50°C for six hours. The dilute sulfuric acid functions as a reaction medium; the molybdenum reacts with the phosphate ions and forms phosphomolybdate complexes. These are then reduced with the hydroquinone and receive a blue color. The degree of blue color is finally determined using a spectrophotometer. The more phosphate ions within the sample, the bluer the solution become. As a standard, potassium dihydrogen phosphate (KH_2PO_4) was used. 1 ml of the standard solution is equal to 50 Phosphate° (P°). The absorption from the standard solutions was then divided with the known P° for each of them. The mean value is calculated and used as a quotient to obtain the P° values for the samples.

4.1.2 Metal elements

As well as for phosphorus, the composition and concentration of other metal elements relies both on geological aspects and human agency. As a natural consequence to the successful analyses of phosphates, other elements were soon experimented on as well. In the early 50's Lutz (1951) showed how Ca, Zn and Cu values, similar to P, were enhanced in anthropogenic soils. Other elements were tested, Konrad *et al.* (1983) showed how Mg could be useful and Bintliff *et al.* (1990) added Mn to the metal elements varying with human occupancy. It was also confirmed that accumulations of Ca, Cu, Mn and Zn also could be detected in settlements in Swedish soils (Arrhenius *et al.* 1981, Linderholm & Lundberg 1994). This is not a supreme picture however, other studies have demonstrated that enrichment of these metal elements on settlement sites is not obvious (Entwhistle *et al.* 1998), indicating that deposition varies between sites, alternatively that soil properties contributes to mobility and loss by leaching (e.g. Pickering 1986). Archaeologists soon also implemented more detailed studies where correlations and variations between elements were pointed out within the settlement limitations and described as different activity areas

(Konrad *et al.* 1983:22). During the last decades of the last century, the method became more frequently used, on a more general level (Aston *et al.* 1998, Entwistle *et al.* 1998, James 1999) as well as on a household-level (Middleton & Price 1996, Wells *et al.* 2000). The next step was consequently to shed light on the relationship between specific space use and chemical imprints, enhancements or depletions of metal elements. Ethnoarchaeological studies were one answer. These have been accomplished successfully and the results of metal element analysis have led to observations regarding activity areas and chemical imprints, which have aided in the interpretation of the prehistoric sites (Middleton & Price 1996, Fernandez *et al.* 2002, Terry *et al.* 2004). Similar suites of metal elements, i.e. defined patterns from ethnoarchaeological sites, have also been observed at prehistoric sites (Middleton 2004:55). One of the remaining problems however, is the difficulties of interpreting activities that do not exist among modern people and thus cannot be predicted (Hutson & Terry 2006:394). Following the ethnoarchaeological studies, metal element multi-analysis gained interest and acceptance and the methodology of sampling archaeological indoor spaces has recently been emphasized especially on Mesoamerican sites (e.g. Cook *et al.* 2006, Middleton 2004, Hutson & Terry 2006, Hutson *et al.* 2007). The validity of the method has also been demonstrated in works where discriminant analyses are performed on samples that are grouped by visible room divisions (Hutson & Terry 2006, Hjulström & Isaksson 2009). Nevertheless, the methodology is still only rarely used in Swedish settlement archaeology, works of Isaksson *et al.* (2000) and Hjulström *et al.* (2008) still are the only examples covering intra-site variations.

Metal elements used for interpretation

The metal elements that are analyzed in the current work consist of (K) potassium, (Mn) manganese, (Ca) calcium, (Fe) iron, (Cu) copper, (Zn) zinc and (Mg) magnesium. These are equivalent to the elements used by Hjulström (2008), and as can be concluded from earlier works, these display concentrations both to and within settlements (Konrad *et al.* 1983, Linderholm & Lundberg 1994, Middleton & Price 1996, Aston *et al.* 1998, Wells *et al.* 2000,).

Reviewing earlier works, the interpretations of relative concentrations of the current metal elements are obviously somewhat varying and confusing, underlining the inherent challenges with interpreting distribution of metal elements: Enhanced Ca values has, due to its inclusion in hydroxy apatite, been interpreted as areas where activities such as food preparation (Middleton 2004:56) bone butchering or deposition of bones were committed (Konrad *et al.* 1983:26), while it on the other hand has been stressed that Ca also is a major component in wood ash (Isaksson *et al.* 2000, Middleton 2004:56). K seems to be a relatively strong indication of heating activities connected to hearths as well (Isaksson *et al.* 2000, Middleton 2004:56). Mg belongs to the same category which has been pointed out as an indication of intensive burning, and therefore possibly signaling hearths (Heidenreich *et al.* 1971, Middleton & Price 1996). When no hearths have been located through excavation it has been mentioned in association with ash dumping and reduction of lithics (Konrad *et al.* 1983:26). Isaksson *et al.* (2000) also points out potentially elevated Mg concentrations due to manuring/stabling since it is a moderate component in plants.

Manganese has been interpreted as an indicator of organic refuses (Bintliff *et al.* 1990). Parnell *et al.* (2002:392) have suggested the same source, originating from food processing/consuming, for Mn and also Cu, since these appear to correlate to P values. Similar thoughts are presented by Hjulström (2008:18), who links manganese to cereals. The opposite interpretation is put forward by Hutson & Terry (2006) when investigating plaster floors in Chunchucmil; in what is interpreted as primary context, Cu, Mn, and Fe are found enhanced together with the lowest phosphate concentration. This fits the picture drawn by Isaksson *et al.* (2000), where the maximum Cu, Zn and Fe values are connected to metal crafting. However, Isaksson *et al.* (2000), also mention Fe together with Zn as significantly rich in meat. In a later work with the same authors, food is interpreted as the source, when elevated Mn, Fe and Zn values are detected (Hjulström *et al.* 2008). Elevated Fe values have elsewhere also been linked to crafting (Terry *et*

al. 2004:1244), workshops with worked bone and worked stones (Parnell *et al.* 2002:391), as well as to butchering and food processing (Manzanilla 1996, Parnell *et al.* 2002:391). Wilson *et al.* (2008) contributed to this discussion by analyzing post-medieval farmsteads on different soils, where the activity areas (e.g. byre, hearth, dwelling and midden) were known. Ca tended to have its maximum round hearths followed by the general dwelling-area. Zn showed similar tendencies. Generally elements were found to be elevated at a descending scale, ranging from hearth, dwelling, byre, and others (e.g. arable fields and gardens), with the exception of P (see ch. 4.1.1).

The passage above addresses the issue that when relative concentrations are measured, consequently the risk of masking occurs. An activity that deposits a high amount of a certain metal element may imply other elevations to appear as more moderate in the same population, e.g. metal crafting may mask the deposits of organic material, which otherwise, in a population without samples from a metal crafting area, may have been distinguished based on the maximum values. This is one of the explanations to the discontinuity in the interpretations, even though the enhanced metal element is the same. Every site is unique, and this is why relative values cannot be transferred in a general sense from one site to another, at least not without examining the activity areas and soil environments more closely (Wells *et al.* 2000). This is also underlined as the correlations between different metal elements are varying when comparing several studies where multi-element analyses are performed (see Isaksson *et al.* 2000, Parnell *et al.* 2002, Terry *et al.* 2004, Hjulström & Isaksson 2009). Different material obviously contains varying amounts of similar suites of metal elements (e.g. Isaksson *et al.* 2000:9ff), consequently making the potential to accurately pinpoint deposition of specific material more complex. The conclusion from this brief review must be that concentrations of a single metal element may originate from several potential sources (see Middleton 2004:54). Therefore they should preferably not be used solely, in regards to the interpretation of functions. Correlations between several metal elements must be considered and preferably mapping of metal elements should be used as a variable amongst others. The latter is clear in the works of Isaksson *et al.* (2000), Terry *et al.* (2004), Hutson & Terry (2006) and Hjulström *et al.* (2008), where the interpretation of activity areas is dependent on the varying values of metal elements but is still guided and aided by other sources; artifacts, organic residues, constructions etc.

Extraction & Atomic Absorption Spectrophotometry

The laboratory method used for this paper can be described as extraction using a strong acid followed by a measurement of the concentration through Atomic Absorption Spectrophotometry (AAS). Initially each soil sample is grinded with a mortar and pestle and quantitatively weighed in at approx. 1 gram. The following step, the extraction of the metal elements, has been, as all analysis of soil chemistry, lively discussed. The question is, as was mentioned above, whether a weak or strong acid is the best alternative. However it can be concluded that different techniques, using a weak acid (e.g. Middleton & Price 1996), and using a strong acid (e.g. Entwistle *et al.* 1998) have yielded archaeologically interpretable and pleasing results. Furthermore, when applied on the same material, similar results are achieved, although some areas appear to be detected only by one or the other technique (Parnell *et al.* 2002). Differences in the parent material, i.e. the natural background, may however be conclusive for which method is most suitable (see Parnell *et al.* 2002:382). Moreover, extraction techniques have previously been tested at the Archaeological Research Laboratory (ARL) with a reference soil. This was intended for investigations on Swedish soils and implemented in order to establish the best settings for the parameters; temperature, digestion acid and time (see Hjulström 2008:26f). It is the results from this evaluation which are used in this thesis. Hence, the samples were put in a teflon container and digested with 10 ml of Aqua Regis (nitric acid: hydrochloric acid 1:3 v.v) in a MAR SX microwave oven. Since it has been showed that the exchange level for certain elements were reduced when the temperature of the oven were set too high (Hjulström 2008:27), the maximum temperature were set to 175°C. This was achieved after automatically increasing the temperature

during 20 minutes. After filtration, a stock solution, diluted with deionized water to 25 ml, was created for each sample. Since the concentration of metal elements by experience differs a lot, the samples were once more diluted, depending on what metal element studied, in order to keep the measurable concentration within the detection interval.

The measuring technique executed by the AAS, in this case a Z-5000 Polarized Zeeman Atomic Absorption Spectrophotometer, then analyzes each sample with assistance from an auto sampler. The liquid solution is injected into a spray chamber, where the flame, fueled by acetylene, vaporizes the particles into gaseous molecules. These are further dissociated into free atoms. Simultaneously, a radiation beam is emitted by a cathode lamp, containing the element that is measured. Within the chamber, the electrons of the specific metal absorb energy, depending on the wavelength that is unique for each element, and becomes excited. This affects the output of energy, measured by the detector, and the absorbance, i.e. the concentration can be calculated since the original input of energy is known.

4.1.3 Lipids

Lipid is a generic name of a subgroup within the organic compounds, which in turn cover a manifold of compounds. It is often entitled as a synonym to fats, while a more proper but still simplified description views them as “...*fatty acids and their derivatives, and substances related biosynthetically or functionally to these compounds*...” (Christie 1987:42). Furthermore, this classification can be separated into two divisions; neutral and polar lipids, where the former composes the main material for this thesis, including: fatty acids, n-alkanols, triacylglycerols, sterols, and long-chain ketones. These compounds cover several functions among living organisms; energy storage, insulating material, structural components, signaling molecules, protection etc. (Brown & Brown 2011:54), while their joint factors are their origin from living organisms and general insolubility in water. These two factors hold great potential for using lipids as an archaeological tool, since amorphous and invisible organic residues, otherwise lost for the archaeologists, can be identified (Evershed 2008a).

The interpretative step when analyzing organic residues involve the concept of biomarkers. As Evershed (1993) stated, the concept of biomarkers is basically about fitting observed chemical imprints into known constituents of organisms likely to have been present during the period in question. In certain cases an observation of a single compound is enough, in other cases the mixture of components is characteristic for a specific origin, such as beeswax (e.g. Heron *et al.* 1994) and ruminant fat (e.g. Dudd *et al.* 1999). Moreover a measurement of a ratio of different components in order to distinguish between slightly different origins can be used (e.g. Evershed & Bethell 1996). Furthermore, the anthropogenic transformation of lipids as caused by e.g. heating (see Hayek *et al.* 1990, Evershed *et al.* 1995, Hjulström *et al.* 2006, Evershed 2008a:901ff) needs to be taken into account when interpreting activities once consciously performed by the prehistoric man. Another important alternation of the lipids occurs once deposited in the soil when the decomposition of these compounds sets in. Diagenesis certainly causes a loss of information, especially in the early stages after deposition, e.g. β -oxidation of fatty acids (Isaksson 2000a:34), however mapping of degradation products in order to trace the origin further backwards might be a possibility (Isaksson 2000a:34f, Hjulström 2008b:25). Altogether, analyzing the lipid residues, i.e. tracing the origin of certain compounds as described above, is often a key to obtain knowledge of for example space- and vessel use. However, it is of importance to stress that although biomarkers are identified, the results are still archaeological interpretations (Brorsson *et al.* 2007:422).

The background of lipid analyses originate from successful studies of visible organic remnants (Brorsson *et al.* 2007:421) in combination with the introduction of chromatographic methods during the mid-century (Evershed 2008a:896). As was mentioned above concerning the metal elements, lipids, due to their physical characteristics, can be stored in different materials. This may occur in the soil matrix after diagenesis of the organic material initially deposited, or in the

ceramics pores when fluids enter the matrix. This opened up for research on invisible organic residues by using a solvent to extract potentially bound lipids. The early investigations were very experimental but yet successful; Condamin *et al.* (1975) proved the presence of olive oil in ancient amphorae, Lin *et al.* (1978) showed survival tendencies of steroids in coprolites, Knights *et al.* (1983) discussed the possibility of using sterols to evaluate diets of past societies. Others had a more critical approach where the decomposition of lipids in for example soils (Moukawi *et al.* 1981, Bridson 1985, Bull *et al.* 2000), bogs (Evershed & Connolly 1994), and pottery (Heron *et al.* 1991, Malainey *et al.* 1999), was emphasized. However, the field has grown stronger and a multitude of archaeologists studying different fields, agriculture (e.g. Bethell *et al.* 1994, Evershed *et al.* 1997), diet (e.g. Morgan *et al.* 1984, Dudd & Evershed 1998, Isaksson 2000b) wood tar (e.g. Hayek *et al.* 1990, Aveling & Heron 1998), found the use of lipid residue analysis. These are all examples of key works which paved the way for the research on lipids in different archaeological materials and consequently also the background to the works recently implemented on Swedish grounds, which forms the methodological backbone for this thesis (Isaksson 2000a, 2003, Isaksson *et al.* 2005, Hjulström 2008).

There are two types of source material where lipid analyses have been applied for this paper; *soil* and *pottery*. Concerning the lipids in soils, whereof several occur naturally; these are in most cases measured relatively in order to distinguish areas with enhanced or depleted values, which in turn can be argued to depend on human activities if sampled from a cultural layer. Other lipids are as stated above, often direct evidences of certain activities. Results from earlier similar studies have proven the usefulness when discussing different settlement issues; Isaksson (1998) and Hjulström & Isaksson (2009) showed that lipids in the soil can be used to identify activity areas, and Isaksson (2003), Isaksson *et al.* (2005) and Hjulström *et al.* (2008) indicated the potential to distinguish different food habits on a micro level alternatively house functions by comparing lipids on potsherds statistically.

Lipids used for interpretation

Fatty acids are carboxylic acids with an adjoining carbon chain. When the compounds are not attached to other molecules, they are referred to as free fatty acids. The length of the aliphatic tail, the carbon chain, is described by the number following the chemical symbol C. These are the most common lipid compounds and occur as saturated or unsaturated, referring to an eventual double bond between the carbon atoms in the carbon chain. The number following the colon describes the number of double bonds. (Brown & Brown 2011:55). When these are found in soil samples or in the ceramic matrix, they are originating from different sources; degraded triacylglycerides originating from adipose tissue or vegetable oil, biological waxes both from plants and animals, membranes etc. Even though degraded, there are ways to interpret the pre-historical origin, whereof the two calculations used for this thesis are presented shortly below.

Palmitic acid (C16:0) and stearic acid (C18:0) usually make up the largest part of fatty acids among the lipid residues in pottery. The ratio of C18:0/C16:0 has been shown to be an indicator of input from adipose tissue from terrestrial animals in relation to plants or fish (Isaksson 2000b). Since stearic acid is abundant in animal adipose tissue, a calculated ratio of 0,5 or more is suggesting an input from animal origin (Hjulström *et al.* 2008). This tool was originally used on ceramics but has repeatedly shown results also for soil samples (Rogge *et al.* 2006:41, Hjulström *et al.* 2008, Isaksson 2009a).

The ratio of C17:0_{branched}/C18:0_{straight} has been shown to be indicative of the input from ruminant animals and milk lipid residues in pottery (Dudd *et al.* 1999:1480). This ratio has been shown to correlate well to the more established method using stable isotopes ($\delta^{13}\text{C}_{\text{C16:0}} - \delta^{13}\text{C}_{\text{C18:0}}$). A ratio of ≥ 0.02 has been suggested to indicate an input from ruminant animals or milk while ≤ 0.0077 is thought to show no traces of such input (Hjulström *et al.* 2008:11).

The overall picture is also defined by the distribution of fatty acids as calculated by ACL, CDI and CPI. An input of mainly short carbon chains, i.e. an input of mainly animal origin, results in low average chain length (ACL) and vice versa. The CDI value is a measurement of the diversity, meaning that there might be fatty acids of different lengths dominating the sample. A high score is indicating a large diversity. Lastly, CPI is describing the relation between odd versus even numbered carbon chains; a measurement of the age, i.e. the degree of diagenesis of the fatty acids. A number closer to 1 indicates that the diagenesis has proceeded farther.

n-Alkanols differs from fatty acids by the exchange of a carboxyl acid at the benefit of a hydroxyl group. Likewise they occur in different lengths, where long-chained alkanols are characteristic of decomposed plant material (Hjulström 2008:21). Similarly as for the fatty acids the amount of *n*-alkanols are measured for ACL, CDI and CPI.

Triacylglycerols (TAG) are formed by ester bonds between glycerol and three fatty acids and are a major component in vegetable oils and especially in adipose tissues of animals (Campbell & Farell 2006). These are however more seldom found intact; instead the TAG's are decomposed into free fatty acids. However, when they occur intact, they could be used as another indication of that the lipid composition derive from ruminant animals/milk fats (Dudd *et al.* 1999). This is based on the fact that short carbon chains are common in fat from ruminants and in milk products rendering in a broader range of TAG's. However, since short chained TAG's are decomposed faster than long chained TAG's, a lack of these compounds does not prove the absence of short chained TAG's originally (Brorsson *et al.* 2007:423).

Sterols are parts of the steroid group. Because of the differences in biosynthesis between organisms, they are found in animals as cholesterol, in plants as e.g. campesterol, stigmasterol or sitosterol and in fungi as ergosterol (Christie 1989:22). This distinction open up for the possibility to discuss sterols as biomarkers. As a measurement of the sterol input respectively, hence discussing handling of meat and dairy products contra plants, two different sterol-ratio calculations have been used for soil samples. Isaksson (1998) successfully analyzed the derivatives 5 α -cholestan-3 β -ol and 5 α -campestanol while Hjulström & Isaksson (2009) and Hjulström *et al.* (2009) used the compounds as they occur before reduction and also included the other two main phytosterols. The former was thought to better measure the ancient input (Isaksson 1998:46), although the latter also arguably is depending on human activities (Hjulström & Isaksson 2009:7) and has shown promising results (Hjulström *et al.* 2008:19). When analyzing potsherds, just identification of one or the other is taken as a signal of animal products or vegetables.

Another biomarker among the sterols is coprostanol or 5 β -cholestan-3 β -ol. The difference from 5 α -cholestan-3 β -ol, the derivative from cholesterol reduction in soil, is that this stanol is produced by biohydrogenation in the gut among animals with a high trophic level, and hence used to locate faecal material (Bethell *et al.* 1994). In the guts of ruminant animals, having a herbivorous diet, the reduction products are mainly 5 β -campestanol and 5 β -stigmastanol. A few projects have dealt with this particular biomarker, for example a Roman ditch was interpreted as a latrine drain due to detection of coprostanol (Knights *et al.* 1983). After analyzing faeces from cows and sheeps, the ratio of coprostanol/5 β -stigmastanol was suggested to detect an input of faecal material from ruminants (Evershed & Bethell 1996). The ratio in ruminant faeces is estimated to 0,25 (Bull *et al.* 2002). 5 β -stigmastanol is also known as 24-ethylcoprostanol and was successfully detected in the stable of a reconstructed Iron Age-house (Hjulström & Isaksson 2009).

Ergosterol (5, 5, 22-ergostatrien-3 β -ol), originating from fungi, could possibly be inherent in pottery shards due to mould growth. However it has been suggested as a biomarker for yeast and alcohol fermentation (Isaksson *et al.* 2010). It was successfully identified in studies of Bronze Age/Early Iron Age pottery, while it was absent in Neolithic pottery (Isaksson *et al.* 2010).

Terpenoids are a modification of the carbon structure among terpenes, caused by oxidation for instance. These cover a vast group of organic compounds all with the basic isoprene unit (C₅H₈)_n as a backbone (Brown & Brown 2011:60), however the substances that are targeted here includes triterpenoids (six units) and diterpenoids (four units) and their function as a component in resin. The former has been successfully detected in floor layers as in the case of betulin (Isaksson 2007, 2009b) a compound indicative of birch bark and together with lupa-2,22(29)-dien-28-ol also indicative of smoke. These two compounds are also major components in birch tar. The ratio lupa-2,22(29)-dien-28-ol / betulin has in turn been experimentally proven as a useful tool when trying to distinguish birch tar from birch bark, where a ratio > 0.2 often indicates tar production (Aveling 1998:91ff). Diterpenoids are also components in resins, although mainly from conifers. It may be found as abietic acid or dehydroabietic acid in soils where conifers are growing, alternatively indicating smoke (Isaksson 2009b:5). The by-product methyl dehydroabietate which is produced when the resinic acids reacts with methanol, however functions together with the diterpenoids mentioned above as a biomarker for distillation of resinous conifer wood, i.e. tar-production (Hjulström *et al.* 2006).

Ketones are compounds characterized by their carbonyl group, i.e. a carbon atom with a double bond to an oxygen atom (C=O), and by two more carbon atoms bonded to the carbonyl group. Ketones may be formed by oxidation of free fatty acids, hence detection of long chained ketones with an uneven number of carbon atoms (C29-C35) has been argued to demonstrate that a vessel has been heated, i.e. through cooking (Evershed *et al.* 1995). Recent experiments however, have questioned this hypothesis indicating that a temperature over 350°C is ideal when forming long-chained ketones, why vessels that displays a lipid distribution including these compounds have been suggested to demonstrate cooking failure (Evershed 2008b). However, there are other ways of preparing food in a vessel than boiling which might cause very high temperatures, why examining this factor still is fruitful (Isaksson pers. comm. 25/5 2012). Another potential indication of heated lipids are the ω-(o-alkylphenyl)alkanoic acids (Matikainen *et al.* 2003), which are produced when polyunsaturated fatty acids with three double bonds are heated.

Extraction, derivatization & Gas Chromatography - Mass Spectrometry

The separation and characterization of lipids is a method conducted in several steps. Before running the samples through the GC-MS, the samples need to be extracted and derivatized. The soil samples were therefore dried in an oven in 45°C over night and then grinded and sieved, and a small sample of each potsherd was pulverized using a tile grinder. Approx. 2 g and 0.5 g of the soil and ceramic samples were weighed in respectively.

The extraction of the lipid residues were carried out using chloroform and methanol (2:1) by the aid of ultrasonication. The analyte were then derivatized through trimethylsilylation by adding BSTFA, bis(trimethylsilyl)trifluoroacetamide (90%), and chlortrimethylsilane (10%), as a reagent.

The analyte transferred into separate vials were then injected into the gas-chromatograph via an autosampler with a syringe. The liquid sample is volatilized due to an increasing temperature. An inert gas, Helium (He) was then used as a carrier gas, transferring the analyte through a column in a mobile phase. The motion was hindered as the analyte molecules sticks chemically to the coating of the column walls, i.e. the stationary phase. Depending on the structure and volatility of the molecule, the constituents forming the analyte were progressing forward towards the end of the column as the temperature was rising. The time to complete the process is known as retention time and since the components possesses different properties deciding the absorption strength to the stationary phase, these are separated by retention time (Kitson *et al.* 1996, Brown & Brown 2011:63f).

Once separated the components requires identification, which is done in a mass spectrometer. The stream of separated compounds is initially guided into an ion source. Electrons are here emitted which in turn ionizes the compounds and transforms them into different ion fragments.

Thereafter the ions are fed onwards by a potential, entering a mass-selective filter, in this case a quadrupole, which selectively allows ions to continue to the detector. This is controlled by the use of oscillating electrical fields, which allows a certain range of ions to pass at a time, depending on an alternating radio frequency along with the variation of magnetic fields (Kitson *et al.* 1996: Brown & Brown 2011:64f).

Each sample generates a total ion chromatogram, established in the detector of the mass spectrometer, displaying abundance (Y-axis) and time (X-axis). The individual mass spectrums along the time-axis are then searched for ion compositions, characteristic for the biomarkers in question. Concerning the ACL, CPI and CDI calculations for n-Alkanols and fatty acids, an ion chromatogram for the characteristic ions m/z 103 and m/z 117 was used respectively. The peaks originating from the separated compounds are then integrated to obtain a percentage ratio. The same was implemented for the sterols with the characteristic ion m/z 129 in order to exclude other co-eluting compounds.

The equipment and settings used for the analysis in this thesis consists of a Hewlett Packard model 6890 GC supplied with a SGE BPX5 (15m x 220 μ m x 0,25 μ m) fused silica capillary column. The injection of the samples was performed by a pulsed splitless technique (pressure 17.6 Psi) at 325°C via a *Merlin Microseal*TM *High Pressure Septum* using an Agilent 7683B Autoinjector. The oven was programmed with an initial isotherm at 50° C successively increased with 10°/min until 350°C was reached, with a subsequent terminating isotherm of 15 min.

The adjoining mass spectrometer used is a HP 5973 Mass Selective Detector. The fragmentation of the separated compounds was carried out through electric ionization (EI) at 70eV, and the temperature at the ion source was 230°C. The mass filter had a temperature of 150°C and was set to scan in the range of m/z 50-700 providing 2.29 scans/sec.

4.2 Sampling strategies

4.2.1 Sampling in trenches

The aim of the phosphate, lipid and metal element analysis is firstly to discern patterns of space-use, especially within House I and III. Secondly, these analyses are used as an interpretative tool in order to identify the function of the observed areas. An initial geometric grid was applied to T I and III, with the aspiration to collect samples from layers identified during the excavation. The grid was constructed with sampling points every second meter in the longitudinal direction of the terraces. One meter separated these sampling-*columns* with a shifting starting position of one meters displacement, at every other column in order to cover the ground more thoroughly. However, these grids were adjusted as structures were discovered, and sampling points were in many cases relocated from border areas, e.g. from walls to inside/outside the activity areas. Additional samples were also taken around features, i.e. the hearths in T I, T III and T X, and the “oven” in T III, in order to establish a pattern on a smaller scale.

When executing the sampling of houses, the samples should preferably be collected from an actual surface, i.e. the floor, instead of sub- or above floor fillings (Middleton 2004:50). This advice was strictly followed wherever possible. No preserved floor layer was found in the uppermost occupational layer in T III, the samples from this layer were therefore taken in level with the topography of the terrace. However, both layer 2 and layer 3 had preserved floor remains, most pronounced centrally around the hearth and with diminishing occurrence further north. Layer 2 (34 samples) was only partially identified along the longer eastern and western walls; where no floor layer was identified, the samples were collected in level with the overall angle of the floor. The same principle was followed at the areas interpreted as outside the houses. Layer 3 (18 samples) was identified throughout most of the excavated parts; however the occupational layer outside what was interpreted as the northern wall is considerably thinner.

Trying to discern between levels without stratigraphic differences or references in the proximity was simply not possible, why no samples specific for layer 3 were collected outside.

Concerning T I, no continuous floor surface was found here either. However, the bottom of the layer containing most of the finds coincided with a stratigraphic transition point in the soil texture. Darker soil with finer grains, typical for occupational layers, was replaced by smaller stones and gravel. The samples were collected from this transition-level. Regarding the north gable (see ch. 5), the samples were taken within the limit of the constructed gutter (see fig. 5). A total of 97 samples were collected from T I.

In terms of T X, a more adaptive sampling was performed. The two uppermost non-dump layers, labeled L2 A and B were sampled with the aim to cover most of the excavated area (11 + 8 samples). No actual floor layers were discovered, however the soil properties, i.e. color and presence of charcoal and soot made the distinction easy. The lower stratification did turn out to be very complicated though, why only a few samples per layer were collected (see appendix). These were taken from the bottom of the different layers, visible in the profile.

As Hjulström (2008:34) concludes a larger set of samples, in this case all of the above mentioned soil samples, can be fruitfully analyzed by their concentration of different metal elements in order to discern certain space use areas. Secondly, the more time-consuming and expensive but also qualitative technique, lipid analysis, can be performed on a smaller set of samples from the observed groupings to identify the areas. In this thesis, the second step of this process was implemented by randomly selecting samples from the identified groupings based on the concentrations of metal elements. Regarding T I the samples which were considered to be responsible for the division in groupings were pinpointed and from this pool 25 samples were randomly selected. Concerning T III all the potential samples in the random selection (6 samples in each layer) were restricted to the area which was considered to be *active* (see ch. 5.3).

The pottery shards were sampled from all trenches, with the initial aim to make an intra-site comparison of vessel use. Due to the complicated stratigraphy in T X, and lack of suitable shards from House I, most of the analyzed shards, 12/15, are collected in House III. Rim shards generally hold a higher amount of lipids (Charters *et al.* 1993) why these were prioritized (9/15). Furthermore, an assessment to identify shards without damages on the interior and from unique vessels was implemented. This was done in order to enhance the chance of preserved lipids as well as to minimize the risk of analyzing shards from the same vessel several times.

4.3 Source criticism and problems connected to the sampling

Three problems need to be stressed in this section; the natural spatial variability that is inherent in the soil matrix, the risk of contamination during excavation and laboratory work and the diachronic variation in space-use. Beginning with the *natural conditions*, these can be divided into two problem areas. Firstly, the prerequisites in the soil vary, affecting the possibilities for inorganic material to be incorporated in the soil together with the parent material; the inner structure of primary and secondary minerals determines whether ions of different size fits (Eriksson *et al.* 2005:54), likewise the grain size determines the binding ability, i.e. the amount of inorganic and organic material that can be accumulated in the soil. Moreover, the moisture of soil affects whether mono- or multivalent ions are primarily bonded to the mineral (Eriksson *et al.* 2005:128). Secondly, the processes following the initial deposition are affecting the composition today. These include different factors linked to degradation, leaching and weathering processes such as activity from microorganisms, temperature, pH, moisture, mobility of groundwater, relief and red-ox potential (Eriksson *et al.* 2005:91ff, 197ff, 204f). Observations have in line with this been made considering post-depositional altering of the imprints (Ottaway & Matthews 1988). It is therefore of importance to evaluate these factors, especially when making comparisons between areas. The quantities may be affected, leading to misinterpretations of what seems to be a higher concentration, when it is in fact dependent on post-depositional processes (Hutson &

Terry 2006:394). Hereby it is vital to measure relative values within the site and not perform inter-site analyses (Terry *et al.* 2004). Absolute values differ due to soil properties but relative concentrations may better correlate between sites of similar use.

Contamination from modern sources is in most cases a manageable risk, in other words possible to minimize. In order to meet this requirement, all analyzed samples were taken with clean tools and put into plastic bags. Samples intended for lipid analyzes, including the pottery, were wrapped in aluminum foil. Before laboratory analyzes, all samples were stored deep-frozen. To avoid contamination from modern fingerprints (see Dimc 2011) minimum handling of shards have been performed in field, while in laboratory environment gloves have been used at all times.

Superimposed imprints may occur in the event of changed space use. A floor level in a household or activity area is often subject to changing activities and with that a gradual accumulation of different residues. This problem is as Middleton (2004) stresses however general for settlement archaeology. The contemporary spatiality is always an archaeological interpretation and the composition of superimposed signatures is an important conclusion as any. However, the limited time-span of dateable artifacts and ¹⁴C-datings at Runsa does decrease the necessary for caution regarding the interpretations of contemporary activities. Likewise the historical and modern activity seems negligible, causing no observed disturbances to the sampled layers. One recent pit has been identified however, located in the eastern central part of House I. Overlapping signatures may also derive from differences in the parent material, i.e. the constructed floor layer might differ in its composition within or between houses (Middleton 2004:55). Therefore, it is of importance to identify eventual variations in the surface.

5. RESULTS

5.1 Excavations 2011

House I

Parts of the terrace were as earlier mentioned unearthed during 1992 and 2010 (Olausson 1996, Olausson 2011a). During 2011, almost the entire Terrace I was excavated, with the exception of the northeastern part of the wall line (fig 5). The house located on the terrace has a convex shape; widest in the center and narrowing towards the gables. The total length of the longhouse is approx. 29-30 m, while an additional 3 m are found between the north gable of the house and the stone constructed terrace. Of the registered postholes, 15 can be ascribed to the roof-supporting construction of trestles, forming the nave. These are distributed over 8 trestles, whereof two, number 3 and 8 counted from the south, are single posts. The reasons why no paired posts are found at these spots are twofold; the west post of the northernmost pair must have stood on very shallow soil, therefore leaving no traces. The west posthole in the third trestle is probably superimposed by a hearth. A misplaced stone, larger than what a lone person can lift, intrinsic to the hearth, suggests that the hearth is part an activity subsequent to the active phase of the house. Perhaps this can be interpreted as a kind of activity connected to the abandonment of the house, were the former hall-building was ritually locked. Hence the hearth in the southern part of the house should be overlooked.

Furthermore, the small postholes between the 1st and 2nd trestle are probably not included in the supporting structure; their size infers a weak supporting capability. Similarly the accumulation of postholes at the center of the building most likely is the result of reconstructions, leading to the interpretation that trestle 5 and 6 are replacing each other. Hence, the position of and distance between trestles, as counted from the middle of each posthole, can be interpreted in two ways (see tab.1). Additional posts, which are not part of the roof-supporting construction, are primarily found within the central and southern parts. Parallel with the 3rd trestle and between the 3rd and 4th trestle, smaller postholes, within the aisles were discovered. These form pairs recessed to and parallel to the wall line. Opposing breaks in the row of wall posts were documented in line with

these, supporting the interpretation of entrances with adjoining portal posts. Recessed posts are also found in line with the 5th trestle, these are further discussed in the last chapter.

The wall lines encircling the house on the long sides are very unique in comparison to what is known round construction-techniques in the eastern Mälars Valley. The double rows of wall posts and an inner trench with traces after burnt clay suggests a massive wall structure. The walls were ended by larger gable posts, labeled *Hörn 2* (Ulväng 1992), typical for the mid-century AD (see Hjulström 2008). Among other features, the hearths are multiple; four of different size are located centrally within the mid-axis, while two is slightly offset, positioned in line with the western line of the trestles. As was mentioned above, the southern one of the latter must be relegated to a later stage.

Table 1. Approx. distances in meters between post groups in House I. H= hearth.

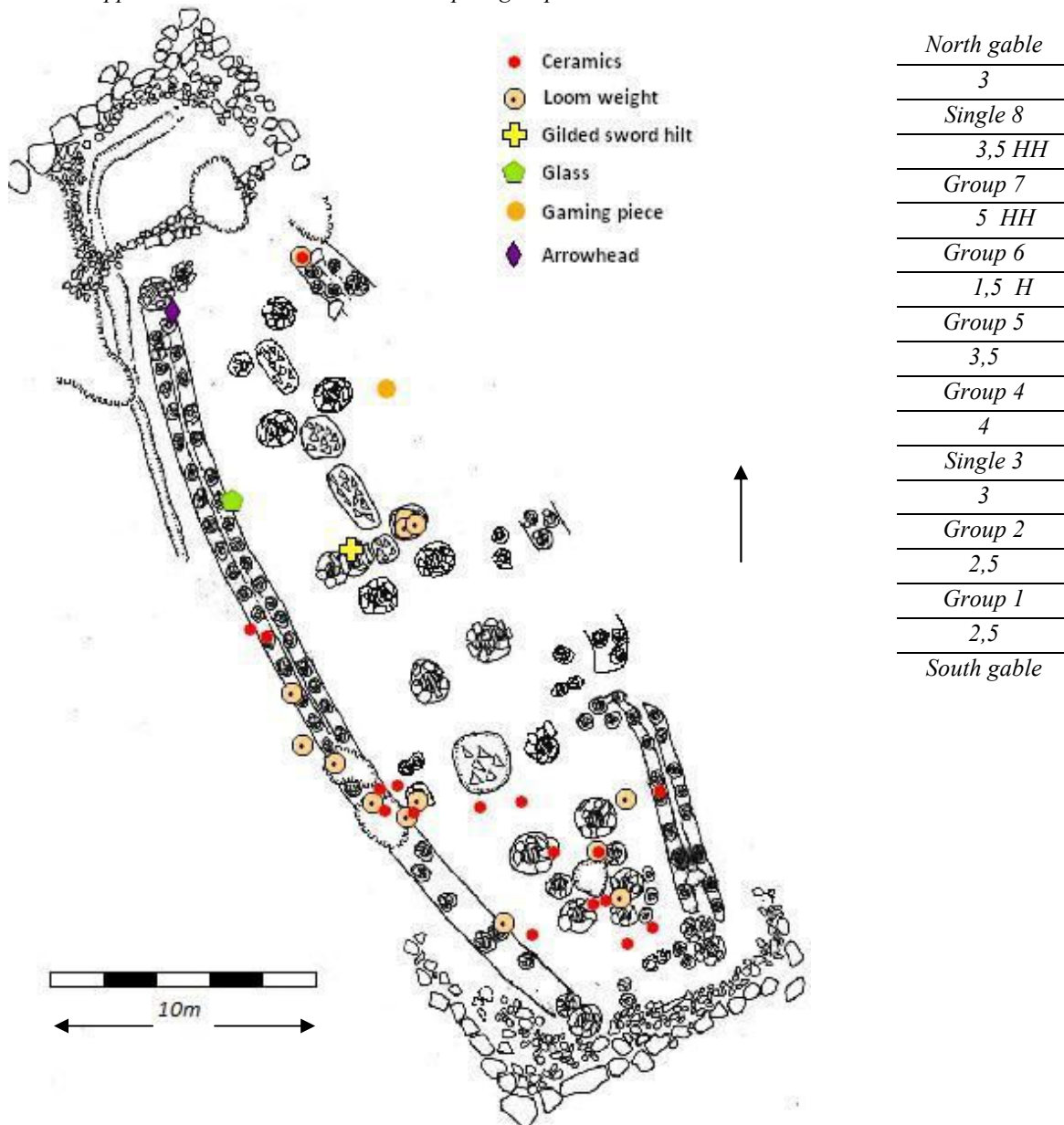


Figure 5. Distribution of finds in House I. The figure is incomplete and therefore preliminary. Only selected finds from the excavations of 2010 and 2011 are plotted. The finds from 1992 are missing (including the piece of bread and ring from a chain mail).

Within the postholes of the 6th trestle, a gold gilded cover plate of bronze, once part of a sword-hilt, and larger fragments of at least three loom weights were found. Similarly, within the 1st trestle several loom weights along with a spindle whorl were found. A thin ring of bronze was

found within the posthole in the 8th trestle and a lancet-shaped arrowhead was discovered in the wall line close to the northern gable. In the wall line between the 6th and 7th trestles, a small piece of *Snartemo-glass*, characteristic for magnate farms during the Migration period, was found. The find material is apart from the above mentioned very sparse, consisting of a few iron rivets, ceramic shards, fragments of loom weights, a sinker, a comb and knives. Interestingly, an accumulation of ceramics and material indicating household activities is seen in the southern end of the house (fig. 5). The bone material from House I is minor. Certainly, objects might have survived within the active part of the society over centuries, but the more or less dateable findings in House I, the comb, the sword-hilt, the arrowhead and the glass fragment, all point to the 5th and early 6th centuries AD, implying a rather short period of use (Olausson 2011a:238f).

The earlier analyses of the material from House I includes a soil sample from the left posthole of the 2nd trestle (Olausson pers. comm. 15/3 2012) which was examined for macrofossilized seeds. The analysis showed occurrence of arable weeds, which was already threshed.

House III

Terrace III was only partly excavated during 2011. From the stone construction, forming the north end of the terrace, and southwards slightly less than 100 m² were excavated. The features within Terrace III is generally more diffuse than within Terrace I, however a preliminary draft of the northern part of a house can be proposed. Centrally within the trench a semicircular construction of stones was discovered. It was extended southwards along the edges of the trench, suggesting that it might be a wall with rounded corners. No certain postholes were documented within the inner area of this feature though, somewhat questioning the construction of this potential house. Alternatively the area should be interpreted as a platform. However, in this thesis it is referred to as House III, which by extending the trench might be falsified in the future.

The occupational layer within the house was deep, complicating the question round stratigraphic layers. The uppermost occupational traces were very diffuse to their character, leaving the impression of randomly distributed refuse material. Within the major part of the occupational layer, two distinct timehorizons, i.e. floor surfaces, was identified. The more recent, which formed the bottom of *layer 2* (L2), was characterized by a round stone construction at the southern end of the trench. The feature had a flat stone slab at its base, with stones of different sizes laid on top of the edges. It was preliminarily interpreted as a baking oven or a cooking area. Most pronounced in the eastern proximity of this feature, and stretching northwards, was a compact grayish layer of clay. The extent became more diffuse towards the west and north, occurring there as white-grayish spots. Within the mid-section of the tentative house, an elongated hearth was discovered. The uppermost part of the hearth probably correlates with layer 2, while it was initially used contemporary to *layer 3* (L3).

The find material within L2 is abundant and holds a great diversity. Ceramics and unburnt bone material are plentiful. Common are also the waste products from iron work, i.e. slag as well as waste and semi-manufactured products from bone work. Concentrations of these traces are found primarily northwest and east of the hearth (fig. 6). The bone work activity is exemplified by material from all the production stages; bones with cut marks – worked bone – semi-finished combs. Dispersed findings of loom weights, beads and whetstones were also made. Belonging to the more unusual findings in settlement contexts are the polyhedral dress pin, a gilded belt buckle, a crossguard to a knife or small sword and three fragments of bread. Regarding the dating of L2, the combs are similar to the ones found in T II and T I, decorated with edge-lines. The polyhedral dress pin also belongs to the general time-interval of 5th – 6th century AD (Waller type II:1 1996:48, 117).

The floor layer, which was burnt in proximity of the hearth, laid firmly on top of a rectangular boulder situated close to the slab in L2. South of this block several flat stones were arranged at the same level, forming a small platform. Immediately north of it, the elongated hearth was

located, and surrounding the platform were layers of ash. This context was found resting on the floor layer labeled L3, an orange burnt layer of compact clay stretching throughout the area south of the semi-circular wall. The occupational layer upon L3 was dominated by bone material and ceramics. The more spectacular finds came towards the bottom of the hearth, a bone needle and a carved figurine with the appearance of a horse. However, as mentioned in 4.2.2 L2 was best preserved in the eastern parts and not identified along the walls making a separation of occupational layers difficult. Hence, it is somewhat tricky to assign the find material to either L2 or L3.

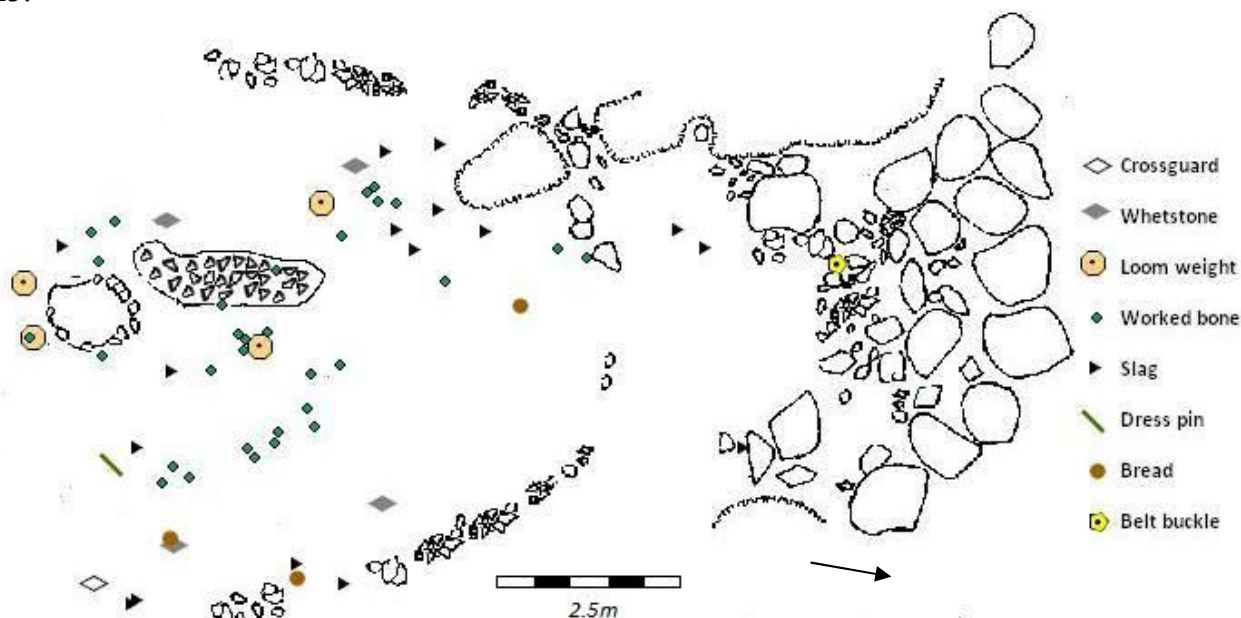


Figure 6. Distribution of finds and features at Terrace III Layer 2. Ceramics and unworked bone material are not included.

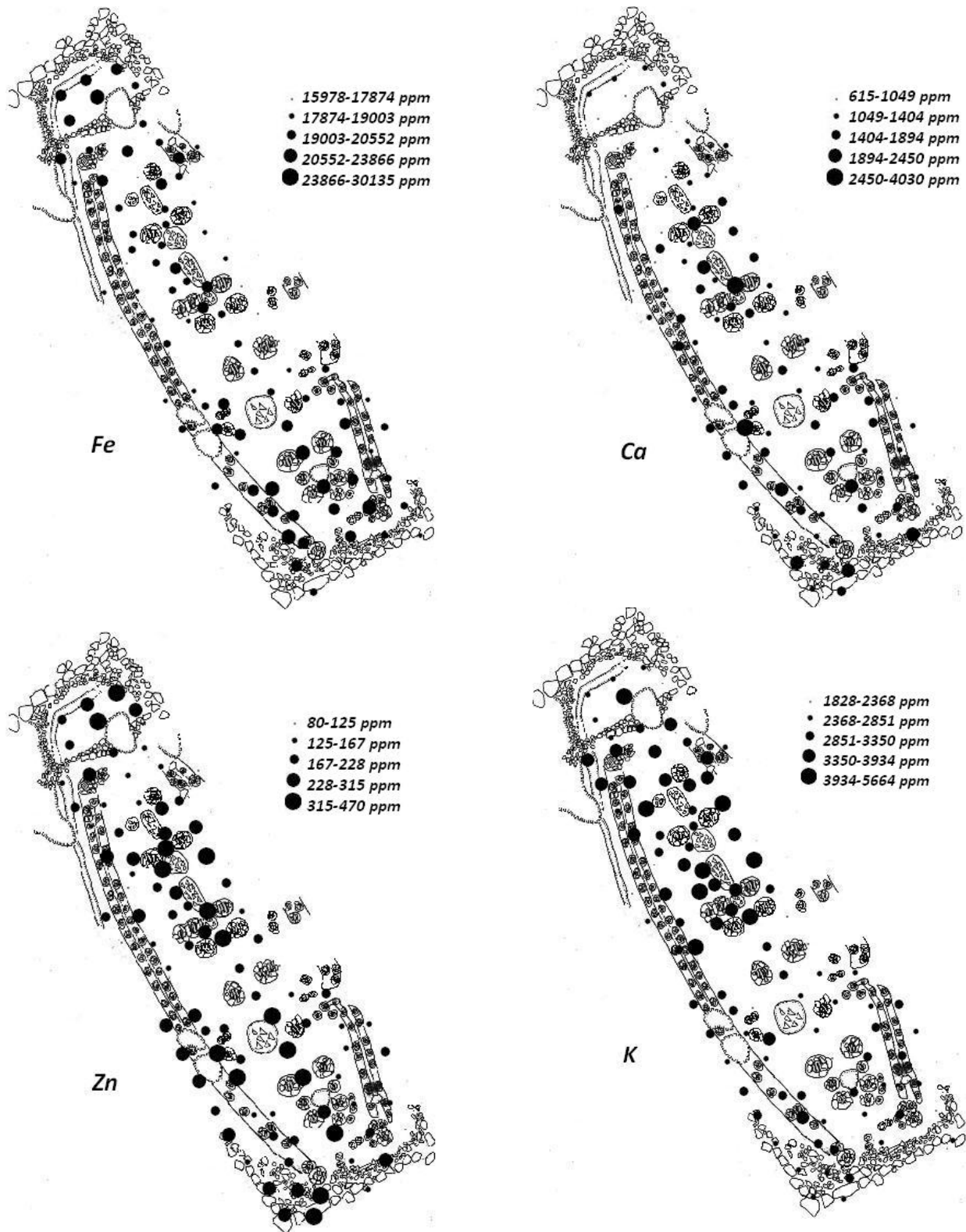
Trench X

Situated along the northeastern part of the wall an area characterized by hearths and surrounding soot layers was excavated. The topography is very rough and the area best suited for a house is located directly west of the trench. The excavated area can be seen as an activity area in relation to this house. The uppermost layers in the western part of the trench, which superimposed the sampled layers, contained a small equal-armed brooch, an artifact often found in graves in combination with the simple polyhedral pins, as was found in T III (Waller 1996:72). The general dating relates this find to the transition period/early Vendel period (see Waller 1996:72 and ref. therein). The upper layers may be dump layers while the lower layers (L2 A/B, L4, L3/6 and L9) were all interpreted as occupational layers. L2 is characterized by soot, hearths and bone material while L4, also containing abundant bone material, probably functioned as filling material to level the area. The oldest layers, L3/6 and L9, are more diffuse in character, whereof the former occurs in patches, hence the split labeling. It is noteworthy that a mould was found within the lower layers, indicating metal crafting. It is mainly L2 that was sampled and discussed in this thesis.

5.2 Terrace I - geochemistry

Although eight different elements were analyzed the degree of interpretability differs markedly (fig. 7). The occupational layer of T I is mainly characterized by four major patterns corresponding to the longitudinal direction. However, Ca more or less reflects variations within these observed areas while other metal elements occur concentrated in what must be interpreted as rooms. Beginning from the north, six samples were collected from the area encircled by a gutter and separated from the northern gable of the longhouse by the low and compact stone construction. The samples are characterized by relatively high concentrations of Fe, Zn, Cu, Mn and P, while Mg, K and Ca values are constantly low.

The inner area of the northern part of the house constitutes of a second identified activity area that reaches from the northern gable to the 5th trestle, counted from the south. This area is visualized by the distribution of K, that display significantly elevated values. There are similar tendencies in the distribution of Mg, however more complex and probably deriving from different sources (see ch. 6). Additionally, other metal elements within this area display an intrasite variation. Zn, Ca, Mn and P values are enhanced in the nave, in proximity to the hearths, while lower in the aisles.



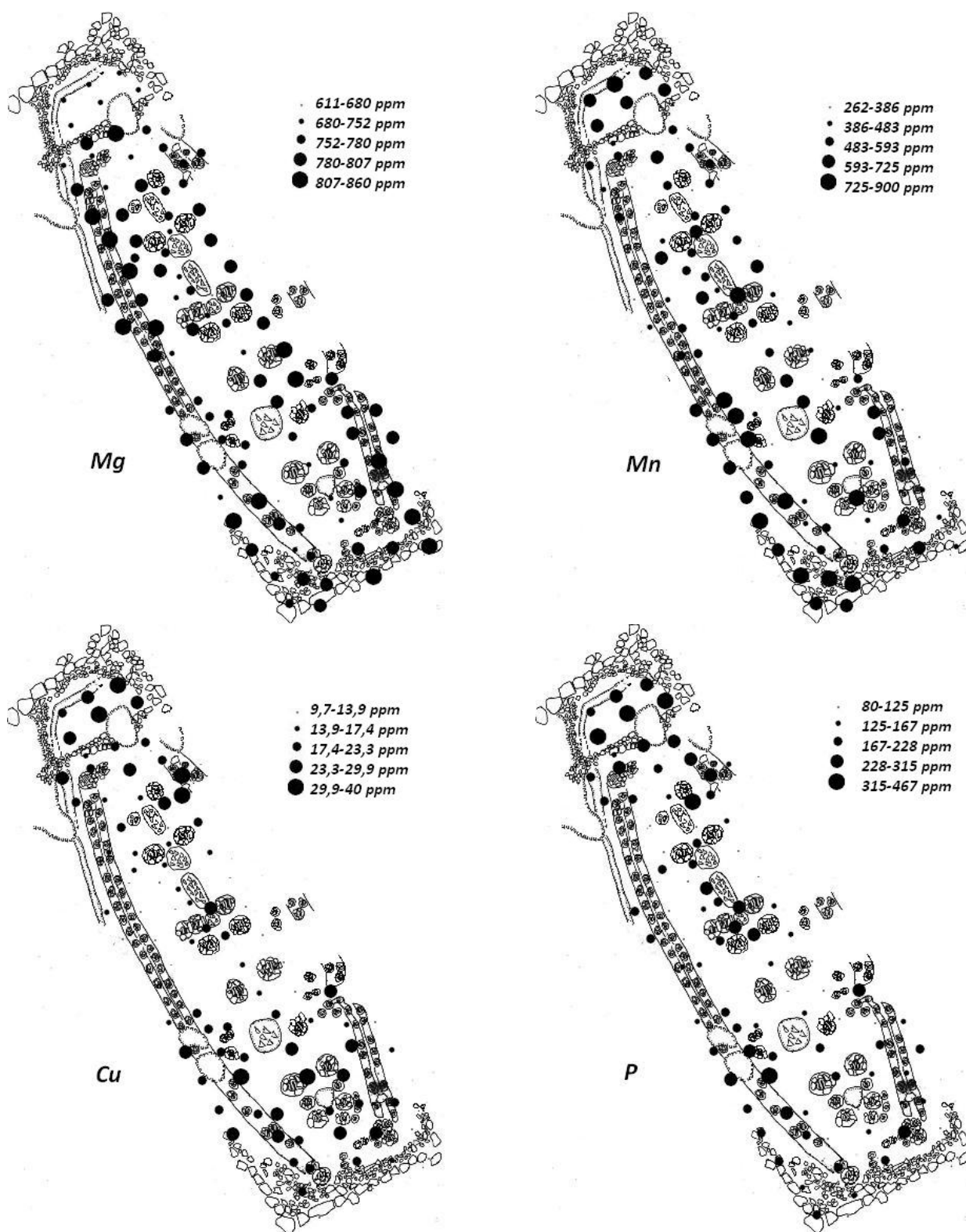


Figure 7. Distributions of metal elements across Terrace I. The symbols are graduated by natural breaks based solely on the samples from TI and the internal variation of each element respectively.

Between the 3rd and 5th trestles, excluding Mg, the concentrations of metal elements are generally low, probably reflecting a separate area with depleted values. In detail, the values seem to be depleting from west to east. In the eastern and central parts there is only one sampling point for two elements (Zn and P) that deviate from the overall pattern of low values. Furthermore, the floor at the western entrance and the ground just outside the house show rather high concentrations of Mn, Ca, P, Zn, and Cu, indicating a different concept and use of the two

The bar chart displays the sterol ratio for seven samples, grouped by location. The Y-axis represents the sterol ratio, ranging from 0 to 0.25. The legend indicates that the bars represent the 'Sterol ratio'.

Sample	SR	Ent	CR	NG	L2	L3	X
House I	0.09	0.05	0.09	0.07	0.05	0.05	0.08
House I	0.09	0.09	0.13	0.05	0.09	0.05	0.09
House I	0.07	0.13	0.12	0.12	0.04	0.06	0.15
House I	0.05	0.07	0.12	0.12	0.03	0.04	0.02
House III	0.13	0.11	0.08	0.11	0.06	0.05	0.08
House III	0.23	0.12	0.12	0.12	0.06	0.05	0.08
Trench	0.15	0.16	0.12	0.12	0.03	0.04	0.02

▲ methyl dehydroabietate
+ empty

○ Cholesterol / Phytosterol $\geq 0,1$
● C18:0 / C16:0 $\geq 0,5$
+ Cholesterol / Phytosterol $< 0,1$ and C18:0 / C16:0 $< 0,5$

30

Hence, based on the distribution of metal elements a tentative division of the terrace into four activity areas was implemented. Three of these areas were located within the actual house, while the context of northernmost area is more diffuse; the construction and relation to the building is not clear. In an attempt to further separate and identify the different areas, entitled *southern room*, *entrance*, *central room* and *northern gable*, soil samples were selected for lipid analyses. Respectively, seven (7) *southern room*, three (3) *entrance*, nine (9) *central room* and six (6) *northern gable* samples were selected for the analysis. The samples were compared based on four targeted variables, sterol- and C18/C16 fatty acid ratios, alkanolic acids and n-alkanols, as well as eventual identifications of other biomarkers.

The sterol ratio ($\text{cholesterol} / [\text{stigmasterol} + \text{campesterol} + \beta\text{-sitosterol}]$) as well as the C18:0/C16:0 ratio regarding alkanolic acids are both indicative of the input of material with animal origin in relation to plant material. The sterol ratio exhibits clear variations (fig. 8); the most distinct difference is found between the *southern room*, which have low values, and the rest of the house, where the ratio is generally exceeding 0,1. Hence, the input of cholesterol is significantly higher within the *central room* and *northern gable*. The samples from the *entrance* area are rather few, but seem to display a transition-zone between these two sections. Both ratios are illustrated in fig. 9b, with a high sterol ratio set to $> 0,1$ (cf. Hjulström *et al.* 2008:19). Sample points with coinciding positive indications are found mainly within the *northern gable* and the *central room*, while the *southern room* only displays sporadic indications among an overall picture of negative results. The strong correlation between these two variables, as seen in both fig. 9b and table 4, strengthens their validity as indications of activities associated with handling of animal products.

Another biomarker found at a limited area was methyl dehydroabietate. The samples with signals from this compound were all but one restricted to the *northern gable*, indicating a use of pine-, or less probable spruce tar within this small area (see fig 9a).

Table 2. Factor loadings for the two most influential factors in the factor analysis. AA = Alkanolic acids. AL = n-alkanols. Ch= Cholesterol. Ph= Phytosterols.

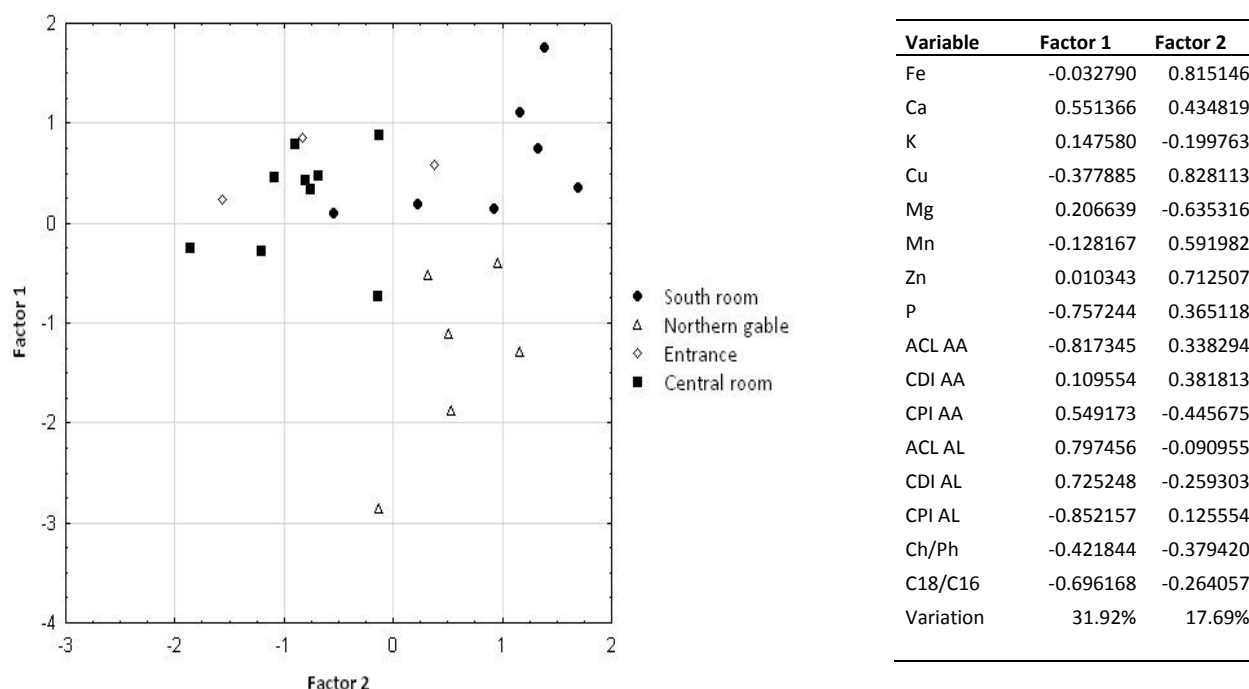


Figure 10. Scatter plot based on the factor analysis for all metal elements, the lipid indices ACL, CDI and CPI, the sterol ratio and the C18/C16 ratio from the observed activity areas on Terrace I.

The disparities between these areas are not as pronounced regarding the ACL, CPI and CDI calculations for alkanolic acids and n-alkanols. A rather homogenous result generates no

possibilities to discern between the tentative rooms, notable though is the somewhat surprising score considering the *northern gable*, where the ACL's for alkanolic acids are slightly higher, opposing the results of the sterol- and C18/C16 fatty acid ratios. On the other hand the ACL's for n-alkanols are slightly lower than the rest of T I, underlining the less input of plant material.

In order to visualize and weigh all variables together, a data reduction method was used, i.e. factor analysis. This method enables description of the variability among the observed variables and searches for joint variations. Hence, co-varying variables are weighed together in so called *latent dimensions* as caused by underlying non-observed variables. For example, an elevated value of three different metal elements might have a common cause, i.e. a non-observed variable. These, also known as *factors* are responsible for a certain amount of the variation within the population. Here the two factors which are mostly responsible for the variation are plotted in a two-dimensional diagram. In the legends, each variables contribution to the variation is described; a value close to zero equals a low contribution, while a value close to 1 or -1 equals a high ratio/enhanced value and low ratio/depleted value respectively.

The samples which were selected for lipid analysis were compared in a factor analysis where all the measured variables, the metal elements, the lipid indices ACL, CDI and CPI, the sterol ratio and the C18/C16 ratio, were used. The scatter plot (fig. 10) displays the distribution of the samples from the four observed areas. The tentative division is more or less verified in the scatter plot; the *south room*, *central room* and the *northern gable* are all significantly separated. The *entrance* area, as suggested above, displays an overlapping pattern indicating a transition zone. The *northern gable* is primarily separated from the actual longhouse by factor 1, responsible for 31,92% of the total variation; high negative loadings of P, ACL AA, ACL AL, CDI AL and CPI AL accounts for the major variance. However, the scores from the calculations of carbon lengths might be somewhat delusive (see ch. 6.2). Factor 2 separates the *northern gable* from the *central room* and also divides the *central room* from the *south room*; high positive loadings of Zn, Cu and Fe accounts for the major variance (tab. 2).

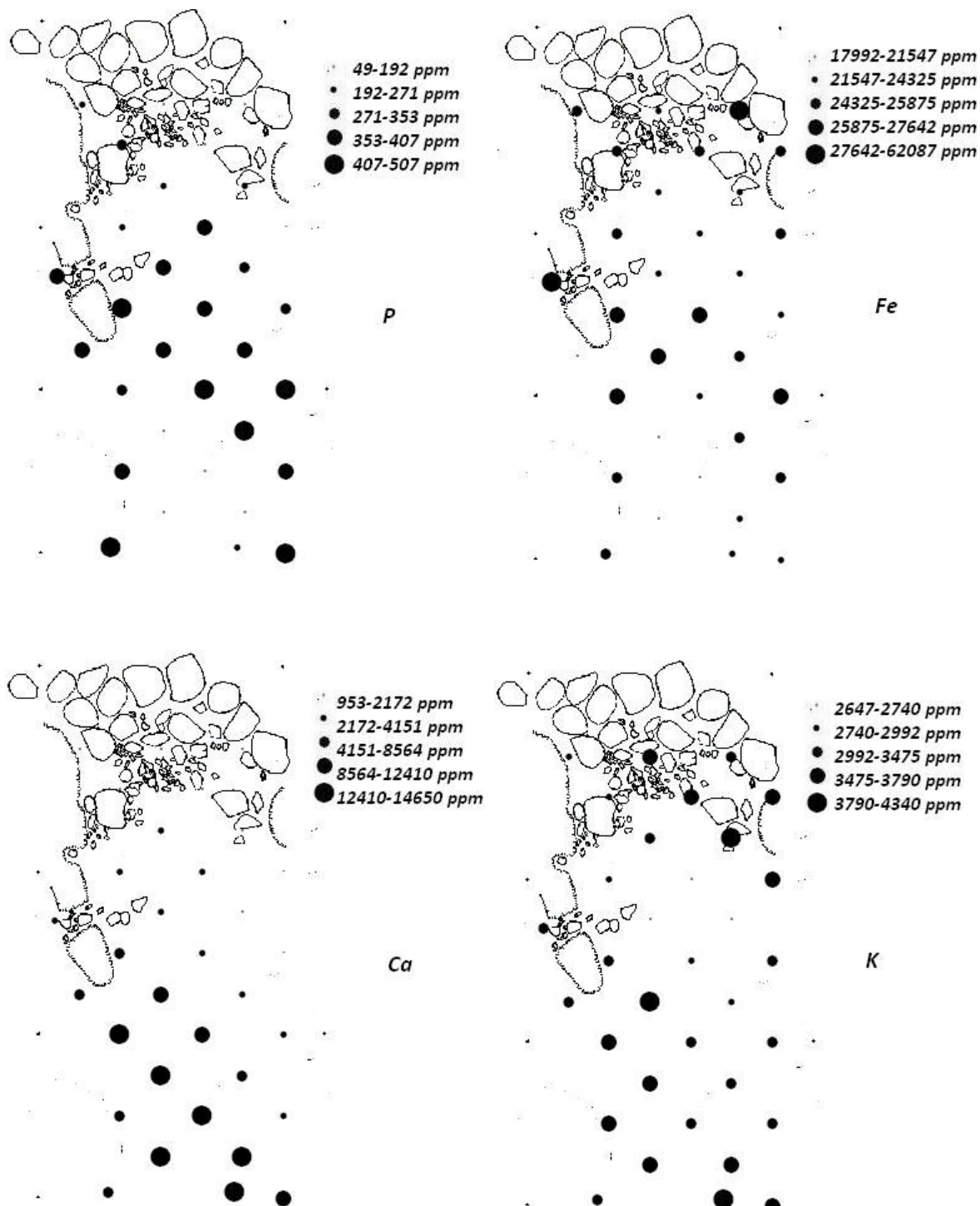
5.3 Terrace III - geochemistry

The samples from three different horizons within the occupational layer were analyzed for metal elements. However, due to the stratigraphic difficulties, i.e. no distinguishable floor layer, the uppermost layer was not prioritized in this thesis. The two older layers were both identified as floor layers based on deviations regarding texture and color, hence suitable as sampling horizons. The concentrations from layer 2 are illustrated in fig. 11 and 13, and layer 3 is visualized in fig. 11. Hence, the latter is not illustrated regarding intrasite variations; instead it is presented as a whole, only separating the in- and outside.

The spatial distribution pattern within layer 2 is very constant over the different metal elements; the semi-circular line of stones, located centrally within the trench, seems to form the northern limit of the concentrations of most metal elements (Cu, Zn, Mn, Ca, K, P, Fe), suggesting a division of the trench in two activity areas, whereof the southern area display intensive use, while the northern area is less used. However, minor intrasite variations are seen regarding some elements; Fe values are found very high in the central western part of the trench, while Fe together with P are found low around the hearth. The metal element that deviates completely from this picture is Mg, which forms an almost complete contradistinction to the other elements, there are low values in the southern part and high concentration within the northern part.

Regarding the distributions of metal elements from layer 3, these correspond generally well to the pattern observed for layer 2 (fig. 13). The observed division of the trench into two areas (fig. 11) is valid also for layer 3. Likewise, the concentrations of Cu, P, and Ca are similarly enhanced in comparison with the northern area, while Mg is again considerably lower, underling a similar space use over time. However, the only significant differences are found in the concentrations of Zn and Mn, which are lower in the layer 3.

Soil lipid analysis was performed on six samples from layer 2 and 3 respectively. These were all selected from the area with generally higher concentrations of metal elements, encircling the hearth. The sterol ratios are for both layer 2 and 3 very low and falls short of even the ratios measured for the *southern room* within T I, only exceeding 0,1 in one case (fig 8, Table 3). Similar results are obtained from calculations of C18/C16 fatty acids (Table 4), suggesting a rather low input of lipids of animal origin in comparison to plant material. The calculations of ACL's for the alkanolic acids are more or less confirming this conclusion, generally exceeding the results from T I. Judging from the n-alkanols the input from plant material seems to be rather similar or slightly lesser than in T I (Table 5). The biomarker betulin was detected within most samples from both layer 2 and 3. However, no traces of lupa-2,22(29)-dien-28-ol was detected excluding a positive identification of birch tar.



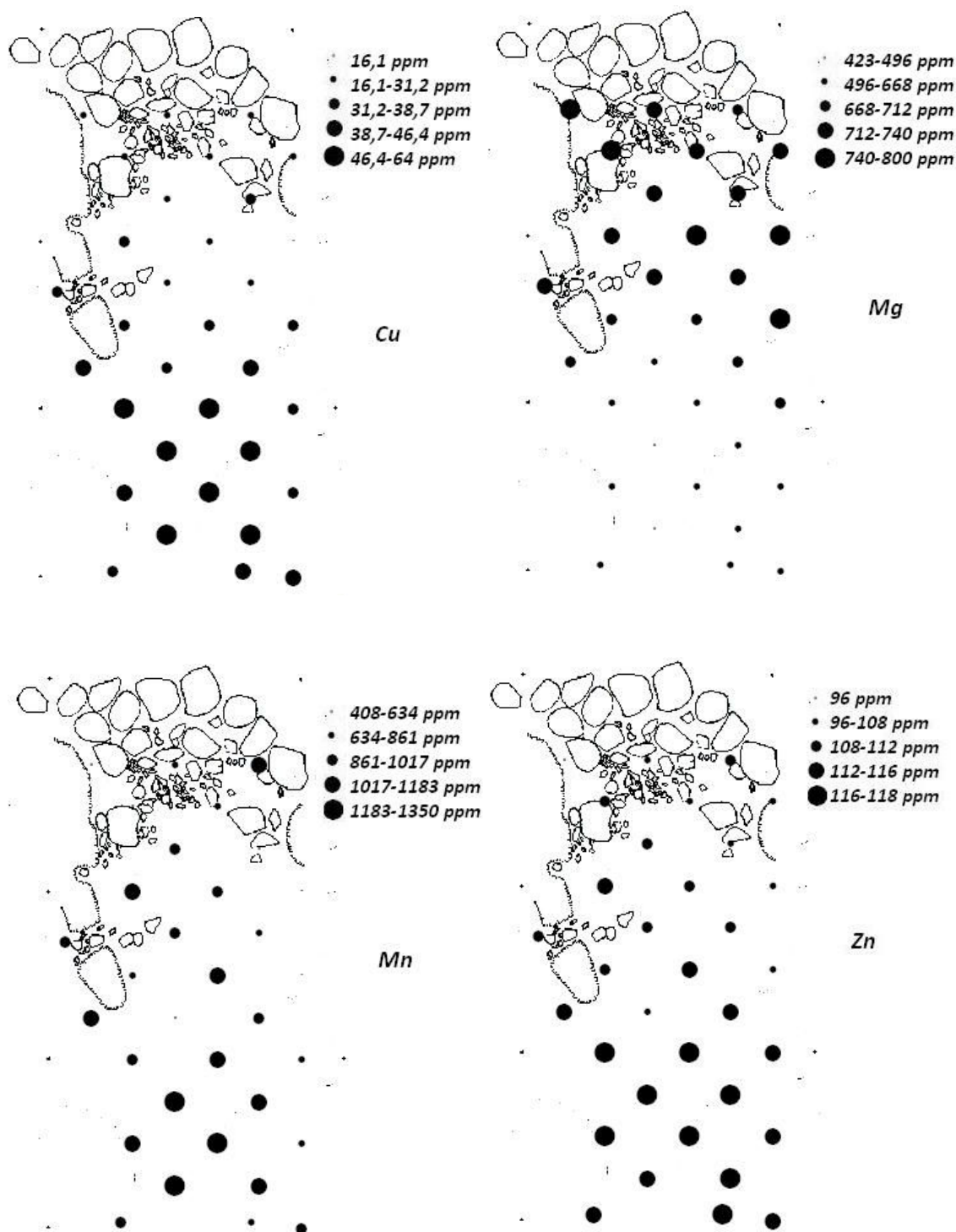


Figure 11. Distributions of metal elements within Layer 2 across Terrace III. The symbols are graduated by natural breaks based solely on the samples from TIII and the internal variation of each element respectively. The excavation planes (see fig. 5) are simplified in order to visualize the concentrations.

A factor analysis including samples from all trenches where all variables have been investigated show a similar factor 1 score between both floor layers in T III and the *northern gable* within T I (fig. 12). The major difference is observed in factor 2 where the Ca, Mn and Mg concentrations together with the sterol ratio accounts for the variation (tab. 3). The input from Ca and Mn is considerably higher in T III while the sterol ratio is lower.

To sum up, the two layers in T III show rather similar chemical imprints when compared internally; the organic material show very few traces of animal origin and the metal elements

display equal concentrations in generally. However, there is a discernable difference between a northern and southern activity area based on the elemental analysis.

Table 3. Factor loadings for the two most influential factors in the factor analysis. AA = Alkanoic acids. AL = n-alkanols. Ch= Cholesterol. Ph = Phytosterols.

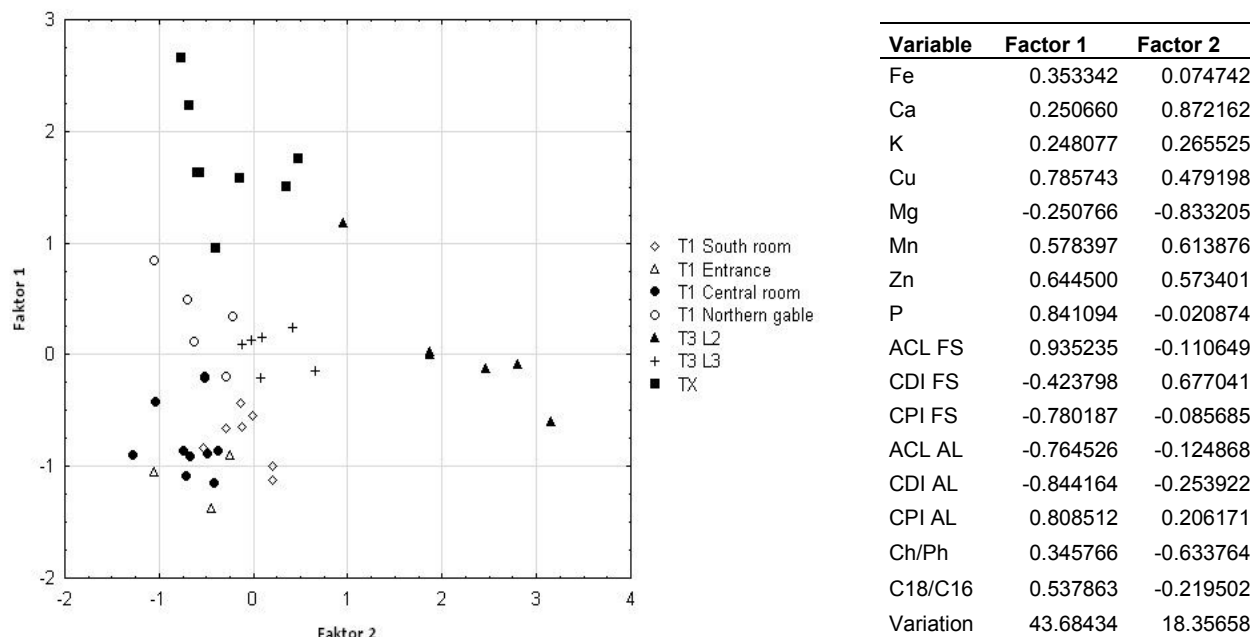


Figure 12. Scatter plot based on the factor analysis for all metal elements, the lipid indices ACL, CDI and CPI, the sterol ratio and the C18/C16 ratio from the observed activity areas on T I, T III and Trench X.

5.4 Trench X - geochemistry

The samples from TX were collected from layers with a complicated stratigraphy within a limited trench, hence a deepened understanding regarding space use cannot be reached. Nonetheless, it is interesting to discuss the results in comparison to, or as a reference material to the results from T I and T III. Considering the metal elements, the concentrations are similar to the results from layer 2 in T III (fig. 12). The maximum of Cu is however worth noting, a few samples within each layer exceed the values from T I and T III. Two of the samples are even in parity with the levels from the area characterized by handicraft in copper in Vendel (Isaksson *et al.* 2000:13). Slight differences in the inorganic material are also found in a few samples with very enhanced P values.

The organic material show greater disparities; as the sterol ratio and C18/C16 fatty acid ratios show (fig. 8, Table 3), the input of lipids with animal origin seem far greater in T X than in T III. Again the ACL's does not support this conclusion, instead the values are the greatest measured (Table 5). Additionally, the only samples with traces of coprostanol were documented within T X. These belong to the early phases on the terrace, layer 4 and 9. The traces were accentuated within layer 4, suggesting a leak downwards. No traces of 24-ethylcoprostanol could be detected, indicating that the coprostanol originates from human faeces. This observation is however most interesting in relation to T III and T I where no coprostanol were detected, hence inferring that these compounds can be preserved in these soils and a general absence of faeces as caused by diagenesis, should not be taken for granted.

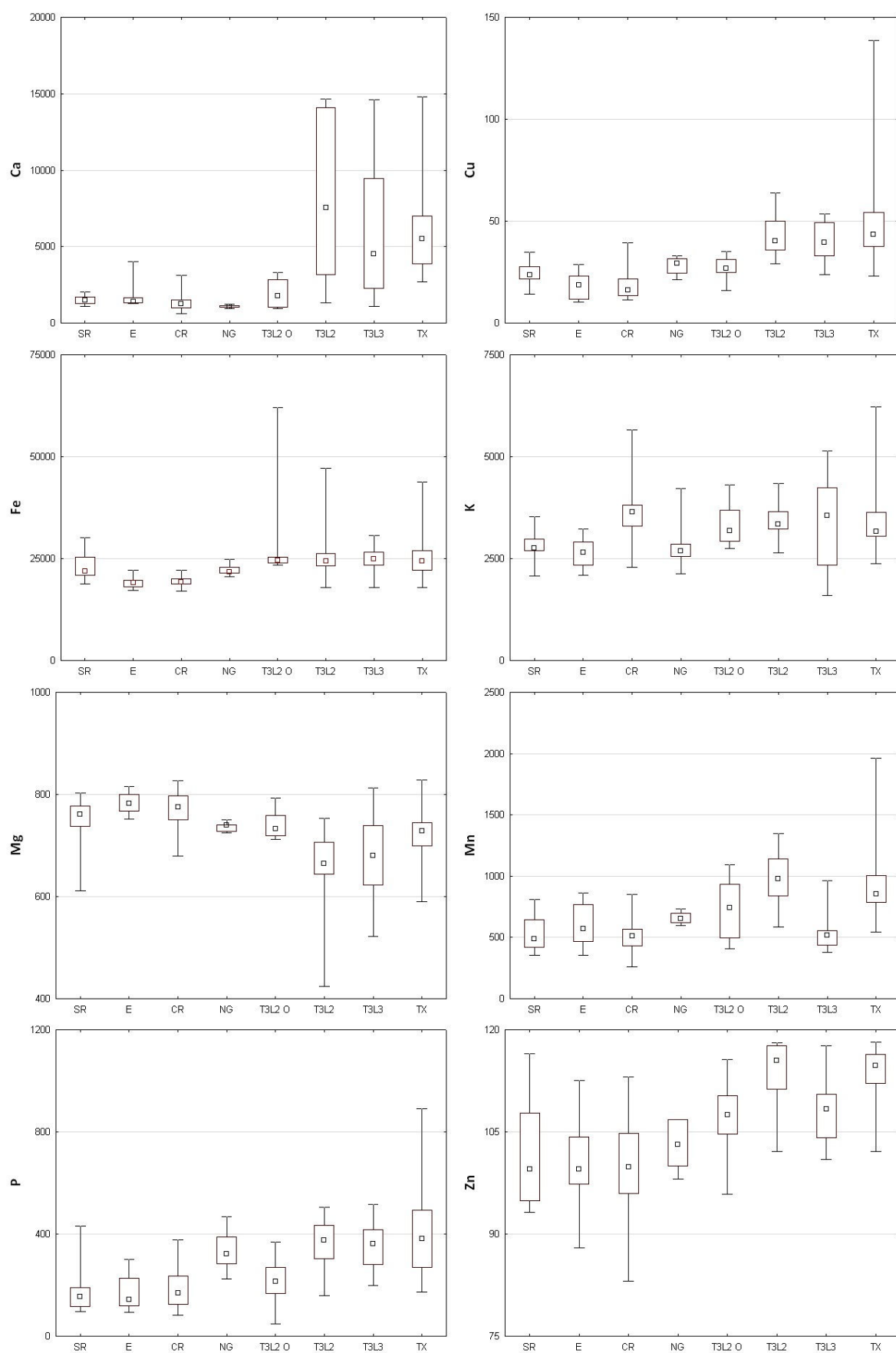


Figure 13. Box and whisker plots of mean values, quartiles and max/min values, all samples included. The samples are separated by the tentative activity areas. SR= South room TI. E=Entrance TI. CR= Central room TI. NG= Northern gable TI. T3L2O= Terrace III, layer 2, outside. T3L2= Terrace III, layer 2. T3L3= Terrace III, layer 3. TX= Terrace X.

Table 4. Sterol and C18/C16 ratios for T III and TX.

Table 5. ACL, CDI and CPI for alkanolic acids and n-alkanols within T I, T III and TX. C_{max} for Alkanolic acids.

$ACL = \sum ([C_i] * i / \sum [C_i])$; $CDI = 1 / \sqrt{([C_i / 100]^2)}$; CPI for alkanolic acids = $\sum_{even} (C8-C36) / C_{odd}(C9-C35)$ CPI for n-alkanols = $\sum_{even} (C8-C36) / C_{odd}(C9-C35)$.

C_i = the relative abundance of each carbon chain in percent. i = The carbon number.

			Alkanolic acid			Alkanols			Aa	
Sample	ACL	CDI	CPI	ACL	CDI	CPI	C _{max}			
T3 L2 sample	Sterol ratio	C18/C16 ratio								
19	0,037	0,437	17	24.1	3.2	4.5	23.2	2.6	7	C24
13	0,056	0,394	18	23.9	3.1	4.7	23.5	2.6	6.2	C24
17	0,038	0,596	52	24.2	3.1	4.2	23	2.6	6.7	C24
24	0,053	0,398	11	24	3.1	4.6	23.1	2.6	6.6	C24
25	0,03	0,434	43	24.9	3.2	4	23.3	2.5	6.3	C24
28	0,061	0,576	5	23.8	3.1	4.3	22.9	2.5	7.1	C24
			44	24.5	3.1	4.3	23.4	2.5	6.2	C24
			13	24.3	3.2	4.4	23.2	2.9	6.8	C24
			59	24.2	3.2	4.2	23.3	2.7	5.8	C24
			14	24.1	3.1	4.5	23.2	2.6	6.4	C24
			56	24.1	3.1	4.6	23.1	2.6	6.8	C24
			40	24.2	3.1	4.4	23.2	2.5	7.4	C24
			30	23.4	3.1	4.9	23.1	2.5	6.4	C24
			25	24.3	3.1	4.2	23.4	2.5	7.2	C24
			29	24.2	3.1	4.3	23.5	2.6	6	C24
			38	24.2	3.1	4.3	23.3	2.6	6.1	C24
			76	24	3.1	4.5	22.7	2.4	8	C24
			83	24	3.1	4.5	23.4	2.8	5.1	C24
			88	24.2	3	4.7	23	2.8	5.4	C24
			96	26	3.1	4.1	22.6	2.3	9.2	C28
			94	25.5	3.2	3.8	22.8	2.5	8	C24
			92	26.4	3.1	4.2	22.4	2.2	10.1	C28
			97	25	3.1	4	23.2	2.5	6.7	C24
			95	25.5	3.1	4	23.1	2.4	8	C24
			93	25.7	3.1	4	22.9	2.5	7.3	C24
			19	23.7	3.3	4.2	22.8	2.4	8.1	C24
			13	25	3.3	3.9	22.8	2.2	9.6	C24
			17	25	3.4	3.9	22.7	2.3	8.2	C28
			24	24.7	3.3	4	22.8	2.4	8.1	C24
			25	24.8	3.3	4	22.7	2.3	9.3	C24
			28	26.3	3	4.3	22.6	2.1	12.6	C28
			9	25.4	3.2	3.6	22.7	2.3	8.4	C28
			15	25.2	3.2	4.2	23.2	2.2	9.2	C28
			18	25.2	3.1	3.7	23.1	2.2	9.4	C24
			22	25.5	3.2	4	22.9	2.4	8.9	C28
			23	23.9	3.2	4.4	23	2.1	9.9	C28
			28	25.1	3	4.4	22.8	2.1	10.8	C28
			202	26.3	3	4.6	22.6	2.3	7.5	C28
			203	26.1	3	3.9	23	2.1	9.8	C28
			204	27.2	3	3.4	21.9	2	11.7	C28
			209	26.6	3.1	3.1	23	2.2	7.8	C28
			212	26.8	3	3.4	23	2.1	9.9	C28
			213	27.4	3	3	22.2	2	13	C30
			214	27	3	3.2	22	2.1	9.9	C28
			219	26.7	3	3.4	22.2	2.2	9.3	C28

5.5 Vessel use

The analyzed shards were collected from T I, three shards (3), and T III, twelve shards (12). The shards from T I derive from the *entrance* and *southern room*. The shards from T III are divided between the two floor layers L2 and L3, whereof the shards from the former were selected in the vicinity of the slab/oven, while the shards from the latter comes from the area east of the hearth. Three (L2) and nine (L3) shards were analyzed for the two layers respectively. A general distinction regarding the vessels can be seen in the thickness of the ware; slightly finer vessels with less temper size characterize the L2 and T I areas while coarser ware with a greater temper size was obtained from L3. This pattern suggested a variation in vessel use over time and between the terraces. Considering T III, the older phase could be dominated by cooking activity, while the findings of bread and the construction interpreted as a potential baking oven in layer 2 led to the assumption of parts of this area being used for baking. Hence one of the targeted biomarkers was ergosterol in order to evaluate a vessel use linked to the fermentation process. However, no such traces were found, giving no support for this hypothesis. Also opposing the initial working hypothesis, the shards from both layers in T III show a uniform pattern, while the

results of the three shards from T I are more difficult to interpret archaeologically. All shards from T III show traces of lipids of animal and plant origin; cholesterol, phytosterol and wax residues were detected in all shards, while the C18/C16 fatty acid ratio exceeded 0,5 in all cases, suggesting a considerable contribution from terrestrial animals. One of the shards from T I acceded to this pattern, while the other two shards were documented as *empty*, meaning that the peaks did not reach a measureable level in the ion chromatogram (tab. 6).

Table 6. Lipid distribution and interpretation of each shard. DT=Diterpenoids. A=Animal. V=Vegetable. I=Ruminant. M=Milk.

Sample	Terrace Layer	C18/C16	C17 _{br} /C18 _{st}	Intact Triacylglycerols	Cholesterol	Phytosterol	Ergosterol	Long-chained ketones	ω -(o-alkylphenyl)alkanoic acids	Terpenoids	Interpretation
F10228	TIII L2	0.96	0.006	-	X	X	-	-	-	-	AV
F10231	TIII L2	0.83	0.014	-	X	X	-	-	-	-	AV
F10114	TIII L2	0.50	0.009	-	X	X	-	-	-	-	AV
F10277	TIII L3	1.11	0.015	40-54	X	X	-	-	-	-	IMV
F10278	TIII L3	1.00	0.010	42-52	X	X	-	-	-	-	IMV
F10274	TIII L3	0.92	0.014	40-54	X	X	-	-	-	-	IMV
F10356	TIII L3	1.52	0.011	40-54	X	X	-	-	-	-	IMV
F10341	TIII L3	1.00	0.033	40-54	X	X	-	-	-	-	IMV
F10346	TIII L3	0.88	0.018	40-52	X	X	-	-	-	DT	IMV
F10348	TIII L3	0.94	0.009	-	X	X	-	-	-	DT	AV
F10323	TIII L3	0.52	0.018	40-54	X	X	-	-	-	-	IMV
F10347	TIII L3	0.76	0.020	-	X	X	-	-	-	DT	IV
F9005	TI	0.74	0.030	42-54	X	X	-	-	-	-	IMV
F9046	TI	-	-	-	-	-	-	-	-	-	-
F9120	TI	-	-	-	-	-	-	-	-	-	-

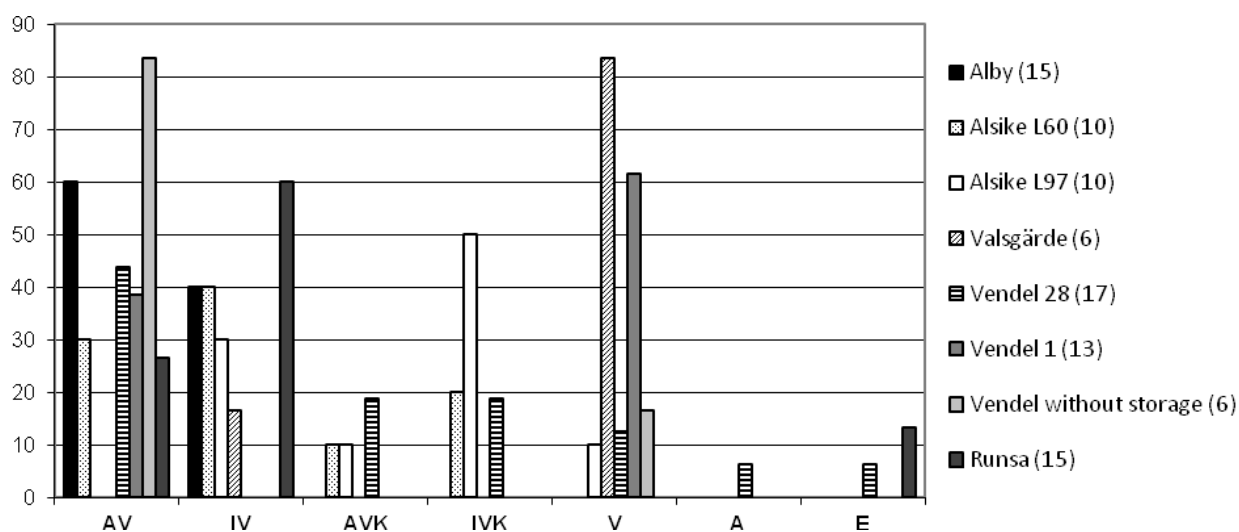


Figure 14. Bar-charts showing the pottery use at Runsa in relation to five other sites. The number of shards are shown within brackets. The shards from Vendel are collected from two areas, displayed in combination "Vendel" and as "Vendel without storage". A= Terrestrial animals; V= Vegetables; I= Ruminant animals; K= Cooking.

However, there are significant differences detected regarding the two floor layers within TIII. Targeting the intact TAG's and calculating the C17:0_{br}/C18:0_{st} ratios the ion chromatograms were searched for indications of an eventual contribution from ruminant fat or milk. A broad range of TAG's, i.e. a total of carbon atoms ranging between 42-52 to 40-54, was found in 7 out of 9 vessels from layer 3, while being absent within the samples from layer 2. Likewise, a ratio of C17:0_{br}/C18:0_{st}, exceeding 0,02 was documented in two of the shards from layer 3 and in none from layer 2. Another, but less informative disparity was observed concerning the diterpenoids, dehydroabietic acids originating from *Pinaceae* was found in small amounts within three shards from layer 3 indicating soot or smoke (see Brorsson *et al.* 2007:423). However, no traces of heating, as indicated by long-chained ketones (Evershed *et al.* 1995) or ω -(o-alkylphenyl)

alkanoic acids (Matikainen *et al.* 2003) were found in any sample. Even though the long-chained ketones have been questioned as a suitable variable, these are often found within vessels originating from *culinary contexts* (fig. 14). The fact that none of the samples within the population demonstrates these indicators suggests that the analyzed vessels have not been used for cooking.

Put in a larger context the pottery use at Runsa can be compared to similar studies from Iron Age settlements (fig. 14). Suitable sites are the settlements in Vendel, Valsgärde (Isaksson *et al.* 2000:5f), Alby (Hjulström *et al.* 2008) and Tuna in Alsike (Hjulström & Isaksson 2005, Forsgren 2007) which all have been subject for analysis of vessel use. Pinpointing unique vessels from joint contexts, certain shards from these sites must be selected (cf Hjulström *et al.* 2008:11f). The shards from the manorial site Valsgärde are collected from buildings labeled as *outbuildings* below a terrace with a hall. The shards from Alby originate from a prominent hall building. The analyzed shards from Vendel are collected from two separate settlements upon the Vendel-ridge; Vendel 1 and Vendel 28. The shards from the former are selected from a multifunctional house with a storage area combined with a dwelling/representational area, while the latter represents an ordinary farm, maybe dependent to the former (Isaksson 2000b, Isaksson pers. comm.). Lastly the shards from Alsike are chosen from two adjacent trenches at the historical farm *Mellangården*. The occupational layers, L60 and L97, were separated in time, but both dated to mid Iron Age. Deeper knowledge about possible house-constructions is unknown, but the findings within L97 suggest an adjacent manorial site, while L60 is associated with food preparation perhaps linked to a representational building (see Hjulström & Isaksson 2005:22ff, 36f, 44, Isaksson pers. comm.). The interpretations of vessel use from these sites are based on the material presented by Hjulström *et al.* (2008), Isaksson (2000b), Hjulström & Isaksson (2005) and Olsson & Isaksson (2008). Allocating a percentage of the total distribution of lipids among seven different classifications of vessel use, it is possible to discern certain patterns. Cooking pots are arguably found only at Alsike and Vendel 28. All vessels from T III in Runsa and from Alby display traces of terrestrial animal fats, while vessels with lipids originating from vegetables exclusively are found at all sites except Alsike L60, Alby and Runsa. However, separating the observed division of the Vendel-house, a similar pattern is obtained for the dwelling/representational area. Although, a variation concerning the lipids with animal origin is observed; more shards with traces of milk/ruminant fats are found at Runsa than at the other sites. This fits the picture given by the osteological report; mostly bones from cattle and sheep were detected, while pigs were rare but represented by young animals (Olausson 1996:17).

Table 7. The Euclidean distance between seven sites (Vendel 1:1 is separated into two areas) based on the seven categories of pottery use shown in figure 14.

	Alby	Alsike 97	Valsgärde	Vendel 1	Vendel 1 without storage	Runsa	Alsike 60	Vendel 28
Alby	0							
Alsike 97	76	0						
Valsgärde	105	90	0					
Vendel 1	76	87	47	0				
Vendel 1 without storage	49	102	108	64	0			
Runsa	41	60	99	88	85	0		
Alsike 60	37	40	94	77	72	33	0	
Vendel 28	53	64	89	57	49	70	46	0

Measuring the qualitative distance between the settlements, based on seven categories of vessel use, the Euclidian distance was calculated (Table 7). Frequencies in percent were compared between Runsa and the other sites, resulting in resemblance primarily to Alsike 60 and Alby. Similarly when Runsa is compared individually with each site, no statistically significant difference is seen between Runsa and Alby, Runsa and Alsike L60, and neither between Runsa and Vendel 1 without storage area (Table 8). Summarizing the vessel use at Runsa, T III, where

the majority of the samples are collected, is characterized by the contents of animal origin but without traces of cooking. Hence, showing great resemblance to the Alby population and to some extent also to Alsike L60 and Vendel 1 (without storage).

Table 8. Results of χ^2 tests of pottery use distributions. When pottery use-frequencies are equal to zero regarding the same classification for two sites, these have been excluded, resulting in differing degrees of freedom.

	Degrees of Freedom	Pearson Chi-Squ	Probab. P
Runsa vs Alby	2	3.68	0.15869
Runsa vs Alsike 97	5	11.16	0.04830
Runsa vs Vendel 1	3	16.58	0.00086
Runsa vs Valsgårde	3	12.96	0.00473
Runsa vs Vendel 1 without storage	3	7.80	0.05022
Runsa vs Vendel 28	6	15.37	0.01755
Runsa vs Alsike 60	4	4.36	0.35881

6. DISCUSSION AND INTERPRETATION

6.1 The prominent hall-building?

As is true when studying most cultures, the majority of the remains are from the people who could afford to manifest themselves. During the Migration Period it is argued that a certain kind of house, a *hall*, should be seen as an indication of high status. The definition is frequently used and also applied to a wide range of houses in archaeological contexts, ranging from central places with regional influence to local magnate farms (Hamilton 2008b:199) and as well as from being incorporated in multifunctional houses to separate buildings. The very meaning is thereby a bit diffuse but it is agreed of being a symbol in the upper strata of the Iron Age society. Hall-buildings functioned as manifestations of the social hierarchy between the chieftain, his retinue and the people with lower status. It was here that the religious activities were practiced and the social gatherings involving gift exchange were held (e.g. Olausson 2009:54). It is also notable that food preparations are not linked to the representative room (Hultgård 1996), while the actual eating and drinking are. The food ideal for the elite, gathered in these representative buildings, was meat and dairy products and beer to drink (Montanari 1994, Isaksson 2000a:55). It was of great importance for the reputation to be part of these feasting and for the host to be generous with food (see Isaksson 2000a:17ff and refs. therein), why we might expect an accumulation of animal products within the hall-buildings (see Hjulström *et al.* 2008). Frands Herschend (1998) defined different criteria for a building to be classified as a hall (translation by the author):

1. They belong to large farms.
2. They consist of a room with a minimum of posts.
3. They distinguish themselves by its location on the farm.
4. The hearths are neither used for cooking or crafts.
5. The finds in these houses are different from those found in the dwelling house.

Building I in Helgö constitutes a proper example of a hall, with rich findings and a typical construction (Herschend 1995). Another example is found in Sanda, Fresta parish, where the settlement context, findings of glass and gold items (Olausson 1996) along with the position are distinct indications of a hall (Åqvist 2004:58). Nevertheless, these criteria are more or less relative, which is obvious when looking at other sites interpreted as housing a hall. A prominent settlement such as Lilla Sylta in Fresta parish has been interpreted to consist only of two houses with one of them being a *hall* even though the characteristic findings within the actual house are absent (Edenmo *et al.* 2005:31,160). The interpretation of a hall in Skrävsta, Botkyrka parish, is based on the size (50m) of the house, the arrangement of posts as well as a rich weapon-grave assumed to be contemporary to the house (Bratt & Werthwein 1999). House 4 in Arlandastad, Norrsunda parish, and house XV in Skäggesta, Litslena parish has been classified as a hall based

on the dimension and distribution of the post holes over three trestles (Göthberg *et al.* 1996:98, Andersson 2001:43). This house also illustrates the fact that a hall function may be located within a multifunctional building, in those cases named *sal* (Thompson 1995, see also Hjulström 2008). House V in Skäggesta, Litslena parish, is a more typical multifunctional building including a hall function. Also this house lacks prestigious findings but has got several hearths interpreted as light sources rather than cooking pits, suggesting representative functions (Göthberg *et al.* 1996:101f, Herschend 1993:175ff).

As mentioned in chapter 3.3, House I in Runsa was considered to be a potential hall-building, as it fulfils criteria 1 and 3 mentioned above. The excavation and geochemical analyses was implemented to evaluate this hypothesis, and give a somewhat more detailed picture. Interpreting the metal elements, the elevated K values within House I are especially interesting. These are aggregated to a defined area, labeled the *central room*. The distribution pattern also appears to be spatially connected to the five hearths within this part of the longhouse. Since wood-ash is rich in K (Isaksson *et al.* 2000) this linkage is both exciting and illustrative. However, the extent somewhat contradicts the ethno-archaeological results (Middleton & Price 1996), where the K concentration is very tied to the immediate surfaces around the hearth. Parallels are on the other hand found in Vendel, Uppland (Isaksson *et al.* 2000) where the distribution of enhanced K values seems to be spread not only to the vicinity, but throughout the whole rooms where hearths are found. The enhanced Mg values within T I can be assigned a partly similar interpretation; the metal is obviously connected to burnt wood tissue (Middleton & Price 1996:678), but has also been connected to manure and activities such as stabling, owing to its presence in chlorophyll (Isaksson *et al.* 2000:9). Enhanced K and Mg values might be indications of stables (see Isaksson *et al.* 2000, Hjulström & Isaksson 2005) but the total absence of coprostanol as well as 24-ethylcoprostanol within the house indicate the contrary. The detection of coprostanol in Trench X shows that the possibility of total decomposition and leaching, therefore no traces, is negligible. The distribution of enhanced Mg values overlaps the increased K values, but furthermore it also seems to be oddly linked to the wall line. This might have a twofold explanation; burning activity within the *central room*, and inclusion of manure within the wattle-and-daub construction of the wall. The latter interpretation is possible since no samples from the wall line were analyzed for their lipid distribution. However, this hypothesis needs to be evaluated by analyzing the lipid distribution within the wall-samples before any conclusions can be drawn.

Monovalent ions as K^+ can fluctuate in soils by the degree of moisture and tend to aggregate and bond to the grains where the moisture is low (Eriksson *et al.* 2005:127). The *central room* is located at the highest point of the terrace, hence theoretically being the driest spot, but the coherence to both the bivalent ion Mg^{2+} and the archaeological features are too obvious to be explained as a pattern caused by natural effects. Examining the roof-supporting construction, if understanding the proximity between the 5th and 6th trestles as the result of reconstruction, the longer spans are found within the northern part of the house, thus correlating to the traces of wood-ash, but also extending southwards until the 3rd trestle. However, the abrupt decrease in concentration regarding K, found in line with the 5th trestle must be interpreted as a wall-division. Supporting this thought is the recessed posts that were documented in the eastern side-aisle, also in line with the 5th trestle, which might be the actual construction traces of the identified wall.

Adding the sterol- and C18/C16 fatty acids -ratios to this picture, these were concluded to be significantly higher within the *central room*. Relatively enhanced values have earlier been documented at what have been labeled culinary (Isaksson 1998), dwelling (Hjulström & Isaksson 2009) and feasting areas (Hjulström *et al.* 2008). In Frands Herschends (1995:225) summary of findings from several hall-buildings, he concludes a reoccurrence of certain items; glass, weapons, loom weights, figural gold foils, whetstones and knives, symbolizing luxury, power and domestic crafts. Studying the find distribution within the *central room*, the scarcity is marked; the findings characteristic for culinary and dwelling areas, i.e. cracked stone, ceramics, bone material

and household utensils are absent (Göthberg 2000:22f; Hamilton 2008a:77f). Instead the material consists of finds more typical for aristocratic contexts; an arrowhead, pieces of drinking vessels, gilded weapon details and a gaming piece. Additionally, a few findings linked to domestic crafts are noticeable as well; loom weights, knives and a polishing stone. The presence of lipids linked to animal products may therefore originate from spilling connected to eating and serving. The overall impression of a tidy floor in House I, established on the basis of find-distribution, is valid also for the metal elements. Apart from the wood-ash indications, several other elements (Zn, Ca, Mn and P) are low in the side-aisles, but somewhat enhanced in proximity to the hearths. A pattern with most of the elements elevated close to the hearth has been observed elsewhere (Middleton & Price 1996:676, Wilson *et al.* 2008) and might be caused by heating activities alternatively sweeping patterns and subsequent waste disposal in the hearths.

The overall impression of the *central room* suggests an area with several light sources but no traces of metal crafting or cooking although the presence of food is demonstrated by lipid distribution in the soil. Biomarkers linked to animal products, i.e. meat, together with the tidy room, settlement context, and artifacts, supports an interpretation of a representative hall-building, or in this case since being well delineated by a wall-division, a *sal*.

The spans between the 3rd and 5th trestle are also rather long but are separated both archaeologically and geochemically from the *central room*. No hearths were found in this area, and the findings are rather scarce and without characteristic artifacts. The location of two opposite entrances between the 3rd and 4th trestle does lead to the labeling *entrance*, of this area. The depleted values within this section supports this idea, as earlier works covering house floors, doorways and entrances seem to display constant and relatively low values (Middleton 2004, Barba 2007, Hjulström *et al.* 2008). Concerning Runsa this is only half the story since the values seem to be depleting from west to east. What must be viewed as the front door, when considering topography, relations to surrounding buildings and the entrance through the rampart, display repeatedly low concentrations of metal elements. Wear and tear resulting from frequent usage is the probable explanation, which subsequently have led to erosion and depletion of the metal elements. The deviating element is Mg, which does not fulfill the statement above. Interestingly this is the exact same conclusion that was drawn from the results from the Alby house, Botkyrka parish (Hjulström *et al.* 2008). The floor at the western door and the ground just outside on the contrary, show rather high concentrations (Mn, Ca, P, Zn, Cu). Parallels are found in other investigations where sweeping patterns are detected from the kitchen and consumption areas, as well as crafting areas, with high concentrations following deposition outside the living area (Parnell *et al.* 2002:386, 394). A similar pattern is found regarding the artifacts, with a clear accumulation around the western entrance (fig. 4). Most elements (P, Ca, Cu, Zn, Mn, Fe) have their concentrations located to the *south room* or the *north gable*, as well as in the proximity of the hearths in the central room. These patterns suggests tidying of the *central room* and *entrance*, with the consequence of enhanced values following deposition of refuse close to the hearths and at what must be considered as the backdoor. It can be concluded that the entrances were used differently, the eastern entrance were probably perceived as the main door which was exposed to the people entering the settlement, while the western entrance were used for disposal of wastes originating from the feasting.

The *south room* is delineated primarily by the concentrations of Cu and Fe, which are corresponding well to the probable inner wall indicated by the portal posts in line with the 3rd trestle. Sporadically enhanced levels of Mn and Zn are also documented within this area, however not delineating it. A section of short spans in combination with no hearth are often argued to be indications of a stable (Olausson 1998:40ff, Göthberg 2000:22f, Hamilton 2008a:81). High phosphate values from manuring is another strong variable (Hamilton 2008a:77, Wilson *et al.* 2008). The absence of the latter, coprostanol and 24-ethylcoprostanol suggests that stabling was not implemented here. A soil sample collected from the western posthole of the 2nd trestle during

the excavation of 1992, and examined for macro fossilized seeds, may lead to the answer of how this room functioned. Seed distribution has occasionally been used to locate and discuss functions within Iron age houses; cultivated seeds have been stressed as an indication of the dwelling area, alternatively storage (Ramqvist 1983:155, Liedgren 1992:154f, Viklund 1998:113) while documentation of wet- and grassland plants, associated with grazing and foddering, have been used to locate barns and stables (Ramqvist 1983:155, Viklund 1998:127). The sample from the southern room contained mainly threshed grains of barley, wheat, and oats (Olausson 1996, Bergström 2007:82, Olausson pers. comm.), i.e. cultivated seeds. Re-examining the metal elements characteristic for this area it is notable that Cu, Zn and Fe are highly present within both viscera and cereals (Isaksson *et al.* 2000:11) while Mn is abundant in especially cereals (Hjulström 2008:18). Certainly this suite of metal elements is characteristic for metal crafting as well (Middleton & Price 1996, Parnell *et al.* 2002), but the levels are much lower than what could be expected from that activity (see Isaksson *et al.* 2000). This is also underlined by the results from House III and Trench X where traces of metal crafting have been found. Furthermore, the absence of elevated P values and bone material limits the possibility of a space used for food handling (e.g. Proudfoot 1976, Sanchez *et al.* 1999, Terry *et al.* 2004). The metal elements indicating burning activities, Mg, K and Ca, are also low within this area, supporting the interpretation of the hearth at the 3rd trestle as remains from a later stage and possibly only a single use. The organic material, or rather the lack of traces originating from animal adipose tissues in comparison to the *central room* and *northern gable*, also supports the hypothesis that the inorganic substances does not derive from meat or viscera. Hence, the most plausible explanation is to understand the *southern room* as used as a storage area for grains. The findings from this area (fig. 4), i.e. pottery, loom weights and a spindle whorl, together with the absence of bone material as well as light sources underline the notion of a storage room (see Bennett 1984:45, cf. Hamilton 2008:86). The extra span with smaller posts, alongside the accumulation of posts in the eastern side-aisle of this room might be the remains of a loft (see Liedgren 1992:149). Hence, the grains might have been stored in ceramic vessels and divided over two levels.

The area between the longhouse and the northern stone terrace, labeled *northern gable*, is displaying an enhancement of a similar suite of metal elements, with the addition of P. Neither this area show traces of burning activities, neither archaeologically or geochemically. The lipid analysis suggests a high input of animal adipose tissues, which together with the relatively high P values suggests that the concentrations of Cu, Zn and Fe are traces from an activity area linked to meat storage. A similar distribution of P is visible in the hall at Arlandastad, Norrsunda parish, with elevated values in one of the gable rooms (Andersson 2001:40). How the traces of methyl dehydroabietate should be understood within this context can be discussed. Dehydroabietic acid occurs naturally within the soil but the methylated compound is only acquired by reaction between the abietic acid and methanol under anoxic conditions (Hjulström *et al.* 2006:284). It is possible the pine tar was used as a wood sealant either for the construction around the *northern gable* or of the tentative storage vessels containing the meat within this area. Alternatively the traces of pine tar should be seen as by-products from an anthropogenic or natural activity; a less likely interpretation suggests that the gable was used as a small smokery for the meat products, thereby accumulating the methyl dehydroabietate. This thought is however contradicted by the absence of charcoal within the area. Dry distillation might also have occurred in relation to the burning of the house or the hearths in the *central room*, where roots may have functioned as the dugout log in a tar dale, channeling the tar into the lower area of the *northern gable*.

6.2 Dwelling and crafting or a Harg?

The results from the analyses of T III are far more ambiguous than the ones obtained from T I. The consistency within the distribution of artifacts and metal elements suggests an inner and outer area divided by the semi-circular feature found centrally within the trench. The southern part of the trench might in fact be the northern part of a house, delineated by a stone-built

foundation of a gable wall. The most characteristic find material at the terrace, i.e. the abundance of bone material and ceramics within both L2 and L3, suggests that food processing was at least one of the activities here. This is also supported by the hearth located centrally between the walls since workshops and cooking activities often requires a hearth, either for heating or as a source of light. Areas characterized by a hearth, enhanced phosphate values and findings of household utensils are often labeled “cooking houses” (e.g. Hamilton 2008a:78, Göthberg *et al.* 1996:90, 93). Furthermore, dwelling areas are closely related to these cooking areas; sections within the multifunctional house are often combined workspaces and living areas with findings as grinding stones, loom weights and kitchen-ware (e.g. Myhre 1980:258, 323, Hamilton 2008a:82f). Northwest of the hearth within the house on T III, the traces of both iron slag and bone work are relatively abundant. More scattered throughout the house, findings of other craft-related artifacts as loom weights, whetstones and iron objects, were made, inferring a multitude of activities within House III. The traces of iron work are also separated by the concentrations of Fe, which are peaking within this area.

The bone work is not signaled by the metal elements; instead these signals are drowned in the major deposition of unworked bone material throughout the southern part of the trench. This input of hydroxy apatite, with its inclusion of Ca, is probably affecting much of the results obtained from the analysis of metal elements. Highly calcareous soils in the Maya region in Mexico, due to the regions carbonate geology, have been designated as very advantageous considering geochemical methods. This is because of the calcium ions and soil alkalinity which render metallic ions insoluble (Terry *et al* 2004:1238). The calcium-rich soils found on the Baltic islands often generates good conditions for preservation of bone-material as well, while the generally acidic calcium-poor podzols characteristic for large parts of Sweden is a far worse condition. A calcium-rich soil as caused by the extensive bone-deposition in House III probably have the same effect; the soil matrix become saturated with Ca rendering in a slower decomposition of the hydroxy apatite caused by fewer H^+ ions and more Ca^{2+} ions within the solution. Furthermore, the generally higher concentrations considering other metal elements at Terrace III, both within and outside the house, in comparison with House I, does not necessary derive from a more extensive input, rather the soil alkalinity might have led to fewer bonds between metal ions and grains being dissolved. In order to evaluate this hypothesis, the pH levels were tested for three soil samples from around the hearth in L2 and from the *central room* in T I respectively. The results showed around 4-5 pH for T I, which is in line with the results, 2,8 – 5,2, from the small trench dug in the *entrance* and *southern room* 1992 (Rudin 1992:21), while the pH for T III was generally close to 7. This must be considered a large intrasite variation since only approx. 10 meters are separating the terraces. Hence, the concentration of metal elements might appear greater on Terrace III, making studies of intrasite variations between T III and T I more complex. The impact from the Ca^{2+} ions is visible in the intra-distribution to the Mg^{2+} ions; the higher values of Mg form an almost reversed picture to the concentration of Ca. A great input of a cation as Ca leads to an exchange of the ions bonded to the grains. The concentration of Ca becomes increased within the inner solution, displacing other cations to the outer solution, where they are exposed to the risk of leaching (see Eriksson *et al.* 2005:143). The pattern of enhanced values regarding seven out of eight metal elements within the house, while Mg appears to be enhanced outside the house, is therefore explained by ion exchange and binding ability. Hence, the Mg values outside the house are not enhanced, rather it is the Mg values within the house that are depleted, following a deposition of most analyzed elements but with less input of Mg. The observation in field where the unburnt bone material appeared to be better preserved within the western part of the house than especially the northeastern part, coinciding with the Ca concentrations, also supports this interpretation.

Most artifacts derive from the upper floor layer (L2), whereof clothing objects, the crossguard and the three fragments of bread are not the kind of artifacts expected in ordinary dwelling contexts. The bread could be related to food preparations. Sporadic observations of a certain type

of construction, interpreted as baking ovens, has been made within some cooking houses (e.g. Holmqvist 1969:34, 42, Tesch 1972:26ff). However, the interpretation of the stone-construction within L2 as a baking oven is very vague, and is not supported by the lipid analysis performed on the shards from the direct vicinity. No traces of ergosterol, which would indicate fermentation, questions if the bread actually were processed on T III as my initial hypothesis suggested. An absence of traces within a few sherds is however no proof for an absence within the whole population. Neither the aspect of diagenesis should be neglected why any final conclusions cannot be drawn. However, in general, carbonized bread is almost exclusively found in graves, which are belonging to the upper hierarchy (Bergström 2007:200f, 217). Regarding settlement contexts bread is rare, but is closely linked to the hilltop settlements (Bergström 2007:217). The excavations of Boberget, Odensfors and Börsås are as stated above very old and difficult to approach more closely. In more detail, it is noteworthy that bread has been discovered in hall-buildings (Bergström 2007:45, 49). Recalling the only contemporary settlement within the Mälars Valley where more than one find of carbonized bread have been made, Helgö, it is of great interest to approach the different contexts that are not interpreted as dump layers. Within building group I, bread has been found in an oven (Holmqvist 1969:35) and close to the sunken floor houses, probably being remains from processing and consumption (Bergström 2007:36, 70). Within the prominent building group II, single findings of bread were documented outside the hall, outside the controversial building at Terrace III and next to the wall of the house on Terrace IV (Bergström 2007:36). However, the major parts of the bread findings are from graves (Sander 1997:77f, Melin 2001:76) and the ritual context upon foundation IV (see Zachrisson 2004:143). The ritual aspect of bread is also underlined by the observation of bread baked especially for the burial (Bergström 2007:217). Excluding the contexts of graves and processing of bread it is interesting to evaluate the possibility of a ritual context regarding T III in Runsa.

Lars Jørgensen has observed a certain type of building adjacent to hall-buildings at magnate farms in Tissø, Lejre and Gudme in Denmark, which he suggests had a function connected to pagan rituals (Jørgensen 1998:242ff, 2002:234) (fig. 16). An interpretation which has been applied to buildings at magnate farms on Swedish grounds, e.g. Uppåkra (Larsson 2006), Sanda (Åqvist 1996) and Lunda (Skjellberg 2008). The ritual context at Helgö, located in proximity to the hall-building within building group II, might be understood similarly. These constructions are linked spatially to the hall-building and they are distinguished from surrounding farm-buildings by the findings. The cultic practices are assumed to partially been performed within the hall, but not entirely, and as Åqvist (1996) and Andrén (2002:315f) stresses, these constructions might be understood as a *harg* or *haergtræf*, a cultic house or area known from the Old Norse literature.

Findings of both tools and material related to crafting are frequently documented in the aristocratic environment both within and in proximity to the hall-buildings. This is however not surprising since it appears to be a close relation between power, specialized crafting and religion within the Iron Age society (Söderberg 2005:221ff). The “side-building” in Borg at Vestvågøya, Lofoten, held except obvious ritual depositions also findings from the whole production process associated with ironwork (see Söderberg 2005:234 and refs. therein). Perhaps it is in this view the traces from the whole production process of bone work in House III, should be seen. Likewise, the accumulated deposition of ironwork and bone material as in House III has a parallel in the fenced area and “side-building” next to the hall in Järrestad (Söderberg 2005:212, 236). The latter has been associated with leftovers from ritual meals and the use of bones in ironwork. However, the connection between food processing, bone material and ceramics in House III is questioned by the lipid analyses. Both sterol and C18/C16 fatty acids ratios suggests a very limited input of animal adipose tissue, which is very surprising considering the amounts of bone material that were unearthed. Two potential explanations can be formulated; either the soft tissues were removed somewhere else and the bones later deposited on T III, or the burning of the floor layers (L2 and L3) and consequently oxidation of the organic material have altered the proportion of sterols and free fatty acids. Theoretically, oxidation should render a more random pattern with a

mixture of signals, the results are however uniform. Perhaps a more recent input of plant material following the burning could generate a distorted picture which is incomparable to unaffected areas as T I. This question will however remain unsettled.

If viewing the signals as not significantly altered, i.e. the proportion is reflecting the prehistoric input, then food processing must be excluded from the activities that were performed upon T III. The result obtained from TX, where the bone material is as extensive as in T III, on the other hand suggests a large input from animal adipose tissues. These are however questioned by the ACL calculation. The results of the latter might however be affected by the recent vegetation. In an analysis of reference soils from different vegetational biotopes, differences in C_{max} , i.e. the dominant free fatty acids, were detected; a dominance of C_{22} och C_{24} were characteristic for the coniferous forest while C_{28} and C_{26} were abundant in the deciduous forest (Hjulström & Isaksson 2007:259). Looking at the distribution for the terraces respectively C_{24} is dominating all samples within the longhouse on T I, while C_{28} and C_{24} dominates the samples within T III L2 and the *northern gable*. Within T III L3 and T X C_{28} is the dominating free fatty acid in all samples but one (Table 5). This pattern reflects the present vegetation very well, with three pine trees enthroning T I while deciduous trees and shrubs are characteristic for TX. Hence intra-comparisons regarding ACL's between the terraces cannot be implemented.

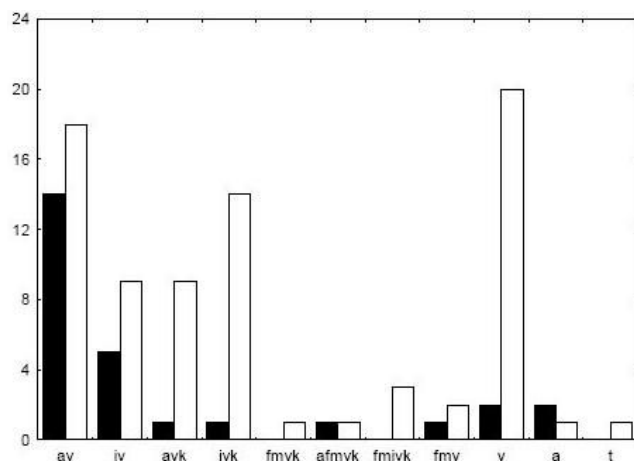


Figure 15. Bar-charts showing the relation between grave contexts (black bar) and settlement contexts (white bar) regarding vessel use. Fm= fish/marine, T= empty. Modified by author after Forsgren 2007.

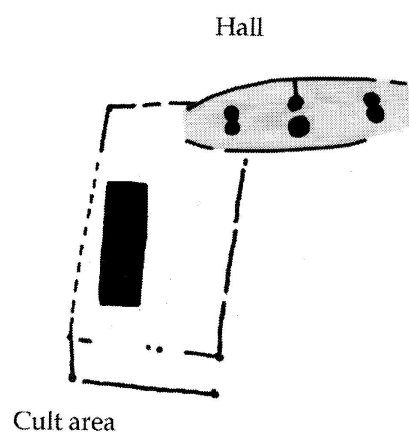


Figure 16. The Hall and the related fenced side-building in Tissø, phase 2. Modified by author after Jørgensen 2001.

Emphasizing the results from the lipid analysis of the sampled shards they support the thought of no food processing at T III, neither during the use of L3 or L2. No shards displayed traces of while residues from both animal and plant material were registered in all shards. Although traces after cooking can be difficult to detect within the lipid distribution and perhaps only occasionally will leave any signatures, the total absence of the ω -(o-alkylphenyl)alkanoic acids or long-chained ketones infers that no vessel in this context was used for cooking. The food content, i.e. the mixture of meat and vegetable products must be explained differently. Studying the vessels from T III in relation to the contexts of other sites, it can be concluded that the vessel use is most similar to the hall-building in Alby, and the dump layers interpreted as related to the food preparation to an anticipated hall, in Alsike 60 and 97. They are on the other hand distinguished from the dwelling/food preparation area within the ordinary farm Vendel 28, the farm-buildings from the manorial site Valsgårde and the multifunctional house in Vendel 1. The separating variables are the pure vegetable content as well as the cooking vessels. In a comparative study it was shown that these two categories were among the main distinctions between settlement contexts and grave contexts (fig 15, Forsgren 2007:31ff). An observation which has earlier been applied to the Alby site, where the vessel use, similar to T III, was stressed as indicative of a ritual context (Hjulström *et al.* 2008:13). Hence, the shards from T III can be understood as more in line with the vessel use expected from a grave context rather than settlement contexts.

When combining the results from the soil lipid analyses, the location, vessel use, the exclusive findings, as well as the recovered fragments of bread, it is tempting to link the construction on T III to the observations of cultic areas in proximity of the hall-buildings.

6.3 *Synthesis*

To be able to point out the uniqueness and characteristics of the hilltop settlements and Runsa in particular, it is of importance to briefly review the types of settlements that are known to archaeologists. The farmstead was the most common type of settlement during the Migration Period. The basic combination of houses, which have been discovered at archaeological excavations in the Mälars Valley, consist of a longhouse together with a smaller separated farm building (e.g. Hamilton 1995, Bratt & Lindström 1997:9ff, Frölund & Larsson 1997:15ff, Häringe Frisberg 1998). Furthermore, there are settlements that seem to consist of three or more contemporary buildings. Since a single house seldom can be dated more precisely than within a time span of 100 years or more there is always a question of whether the houses really are contemporary or not. This problem can be pointed out in examples where the buildings cannot be separated in time through ¹⁴C-dating even though they are overlapping stratigraphically (e.g. Andersson 2001:41). This is certainly a problem concerning the interpretation and it gets even more complicated since the lifetimes of a house on a farmstead have been approximated to a very wide time span, 30 – 300 years (Göthberg 2000:108f). It is nonetheless obvious at certain sites that the buildings are planned in relation to each other and that there must have existed large settlements (e.g. Tesch 1972, Göthberg *et al.* 1996:120f). These larger settlements, not universally though (see Göthberg 2000:101, Andersson 2010:25ff) as well as settlements with certain representational buildings, specialized crafts or exclusive finds are thought to demonstrate the upper strata of the hierarchical division among settlements.

To express the exclusivity and afford the luxury characteristic for the upper social strata, a production generating a surplus must have been necessary, which in turn requires an effort probably exceeding the labor and resources of an ordinary farmstead (see Widgren 1998:291). The consequence of this need is seen in the larger farms, the magnate farms, where the space requirements for storage have led to auxiliary buildings (Hamilton 2008b:201). To achieve this position in the mid-Iron Age society the prestige and economic wealth brought home from trading trips and primarily services in armies on the Continent, was probably vital. Therefore the ideal of warlords, as manifested in rich graves, with status expressions inspired from continental rulers, is significant (Grönwall 2008:128). In the densely populated stone-wall regions, the different settlement-types as described here, have been shown to occur in an intertwined pattern with larger and smaller settlements by turns, indicating a social organization with magnate farms in power of the smaller dependent farms (Grönwall 2008:123ff, Hamilton 2008a:101f, Renck 2009:II17ff). Runsa on the other hand is, as mentioned earlier, located at the periphery of these stone-wall regions characterized by agrarian production, but strategically positioned in relation to waterways.

Looking at Runsa from a wider perspective and in comparison to other settlement forms, judging from the excavated areas the hilltop settlement has similarities to the ringforts regarding the accumulation of buildings, presence and expressions of aristocracy and the separating and defensive wall. The ringforts however display both a close linkage to the Continent as well as the background of wealth; byres, ordinary dwellings, extensive craft material and storages are densely built in a village-like community surrounded by low-lands suitable for livestock farming, creating an ideal foundation for a surplus-production. Looking at magnate farms at different hierarchical positions in the vicinity of Runsa such as Vendel, Lilla Sylta, Arlandastad and Sanda, these are situated within the agrarian landscape with dependent farms or households within its properties and in the nearby systems of stone walls. Alternatively, they are characterized by extensive production of craft material as the unique site Helgö. In the same sense, the hilltop settlements of Östergötland, especially Onssten and Gullborg, has been noted for their many

loom weights, which in combination with a potential orientation towards stockfarming within the surrounding farms, make up indications for extensive wool-production and textile-craft (Olausson 1987b:406). However, the term specialized crafts as has been associated with the hilltop settlements does not necessary imply an extensive production as documented at these sites. The characteristic traces from specialized craftwork in form of crucibles for bronze casting and iron smithing in Darsgårde, Gullborg, Boberget and Braberg and gold smelting at Gåseborg has been argued to be the remains of an attempt to monopolize the administration and exchange of prestigious metals (Olausson 2009:51). Nevertheless, as Olausson stated earlier (1987b:409) “*so far there is no proof of forts where metal-craft has been performed in a larger scale than to cover household needs*”. In line with this statement it is difficult to see the so far scattered traces of crafting material in Runsa as being parts of a manufacturing with the purpose of extensive export and trade; nonetheless their ideological and symbolical significance is important, perhaps only meant for the present elite.

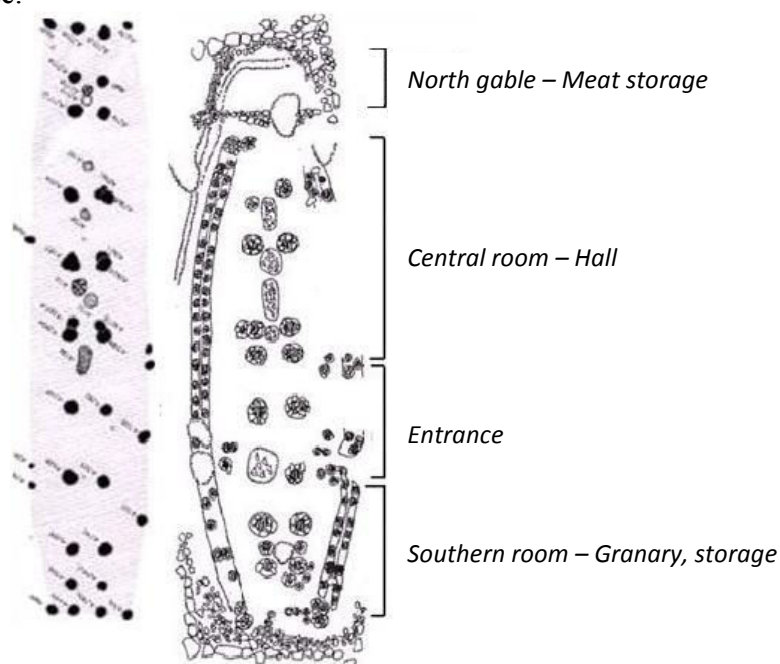


Figure 17. Left: House V, Skäggesta, Litslena parish (Göthberg *et al.* 1996). Right: House I in Runsa, Ed parish. Similarities regarding the inner construction and interpreted functions are found between the sites.

What does Runsa represent then? Undeniable, the manifest and solitaire position in the landscape and the impressive wall suggests that Runsa was a focal point within the mid-Iron Age society (Olausson 2011b:12). Material aspects from within the site, the hall-building, the traces of trading/tributes and crafting now underline this notion. However, at the moment it is mainly the flat plateau directly within the southern entrance, or subarea A (see Olausson 2011a:226), that can be described in more detail. Upon the central terrace, a 30 m long multifunctional house was located. A *sal*, a representational area where feastings were held and agreements were reached, along with a room intended for grain storage characterize this prominent building. A separate room/area for handling of meat products, probably a storage function, was discovered directly outside the northern gable. The building is by no means unique; hall-buildings which display areas linked to the household activities are not uncommon; cooking and storage functions, probably connected to the food that was served at the feastings are occurring at sites as Lunda (Skjallberg 2008:21), Eketorp (Herschend 1992) and Arlandastad (Andersson 2001:43). A close parallel regarding the inner construction and disposition are found in e.g. House V, Skäggesta, Litslena parish (fig.17), where the wider spans are located to the central part along with traces of reconstruction. This house is slightly longer and has an extra section of short spans. The northern part lacks hearths and has been suggested to have functioned as a storage area alternatively a stable, while at least six hearths, all in the nave, are found in the southern part (Göthberg *et al.*

1996:66, 102). The southern part of the house have been suggested as a hall-building (Herschend 1993:175ff) corresponding to the *central room*. Hence, similarities to the manner of construction is found among the upper strata in the region.

The occurrence of a granary within a hall-building situated on an island might at firsthand seem like a far-fetched thought. The importance of cultivated seeds is however reoccurring in different ways at hilltop settlements. Except for the relation between bread and hilltop settlements which is already mentioned, also rotary querns have been found at Boberget, Odensfors, Brudberget and Börsås. Additionally, grain storages have been documented at Odensfors (Nordén 1938:336) and probably also Börsås (SHM 14560 see Bergström 2007:191). The abundant findings of cultivated seeds within the ringforts of Gråborg (Hansson 2004) and Eketorp (Helbæk 1979), that exceed the amount found at ordinary farms is exciting in this context. The former also contained findings of bread, while the latter held unique findings of seeds meant for beer-production (Hansson & Bergström 2008:62). If the hilltop settlements were able to display a surplus of cultivated seeds, while having a disadvantageous position in relation to the arable land, this surely must have signaled their influence over the hinterland. Likewise, the processed products of beer and bread were luxury products closely related to power (see Bergström 2007:190ff). Cereal grains could also be used for e.g. frumenties and pottages. The presentation of a granary within the public building intended for social gatherings might therefore be a demonstration of power, control of land and external surplus-production (cf. van der Veen & Jones 2006:225f). Similarly, the power as centered around the Germanic warlord is manifested in the *sal*. The findings of a gilded piece of a sword hilt within the western posthole of the 6th trestle can be understood as *pars pro toto*, i.e. a fraction representing a concept. The weapon may symbolize the power of the chieftain and his retinue. Hence, House I can be paralleled to the main influences from the Roman empire, adopted by the Germanic aristocracy (Andersson & Herschend 1997:47).

In proximity to the prominent building a less exposed house characterized by some personal clothing objects along with findings of bread and vessels containing already prepared food, was situated. Whether this area was intended for dwelling and crafting or ceremonial/ritual activities related to the hall-building where bread was shared among the participants and meals were eaten, can be discussed. However, the link between bread, the sharing of bread and the chieftain has been stressed earlier (Bergström 2007:206) and is vital here, why I suggest a ceremonial/ritual space. In addition of the bread discussion also the reoccurring findings of perforated vessels at hilltop settlements, often interpreted as used for curdling (cf. Skyllberg 2008:56f), is interesting in relation to the relatively high representation of lipids indicating ruminant and milk fats within the vessels from T III. The assumption of the relation between curdling and perforated vessels however have not been verified in any lipid food residue analysis (Isaksson pers. comm 25/5-2012). Nevertheless, the suggestion of hilltop settlements as sites with specialization of cooking-related activities (see Bergström 2007:193) might be a clue to the greater understanding of how they functioned.

The disposition of the northern part of the inner area is still rather unknown. However, the many traces of buildings suggests that several functions remains to be uncovered. Furthermore, the suggested accumulation of organic material in the western area as indicated by phosphate concentration (Rudin 1992), was not detected in this study. A more detailed mapping of House I and III along with a renewed sampling upon Terrace VI (not included in the thesis) revealed phosphate concentrations to similar extents within T VI and both T III and the *northern gable*. Although a large area remains to be excavated, the presence of the aristocracy is obvious in Runsa. The two buildings at the southern plateau can be interpreted as incorporated in a wider complex of activities centered to the southern part of the courtyard (fig.18). The houses excavated along the southern wall might have functioned as cooking houses linked to the prominent house, while the findings within T II are more or less reversed, probably indicating a dump layer. However, postholes indicates a small house also at T II. As has been observed regarding some

hall-buildings and their immediate surroundings, they seem to be separated from the rest of the settlement area (Söderberg 2005:192). The massive stone terraces exposed towards the northern area of the courtyard fulfill this role at Runsa, distinguishing a ritual and official space from an area expectedly characterized by more private and daily activities. Yet, the household and crafting activities associated with the so far excavated areas within the settlement are more or less fragmentary. Only judging from the scattered findings of crucibles, loom weights, slag and pottery within T II, T III, T X, the trenches along the wall, as well as the test pits throughout the inner area, it is difficult to identify locations where the activities were performed continuously. The traces from crafts rather seem to be the remains of occasional use.

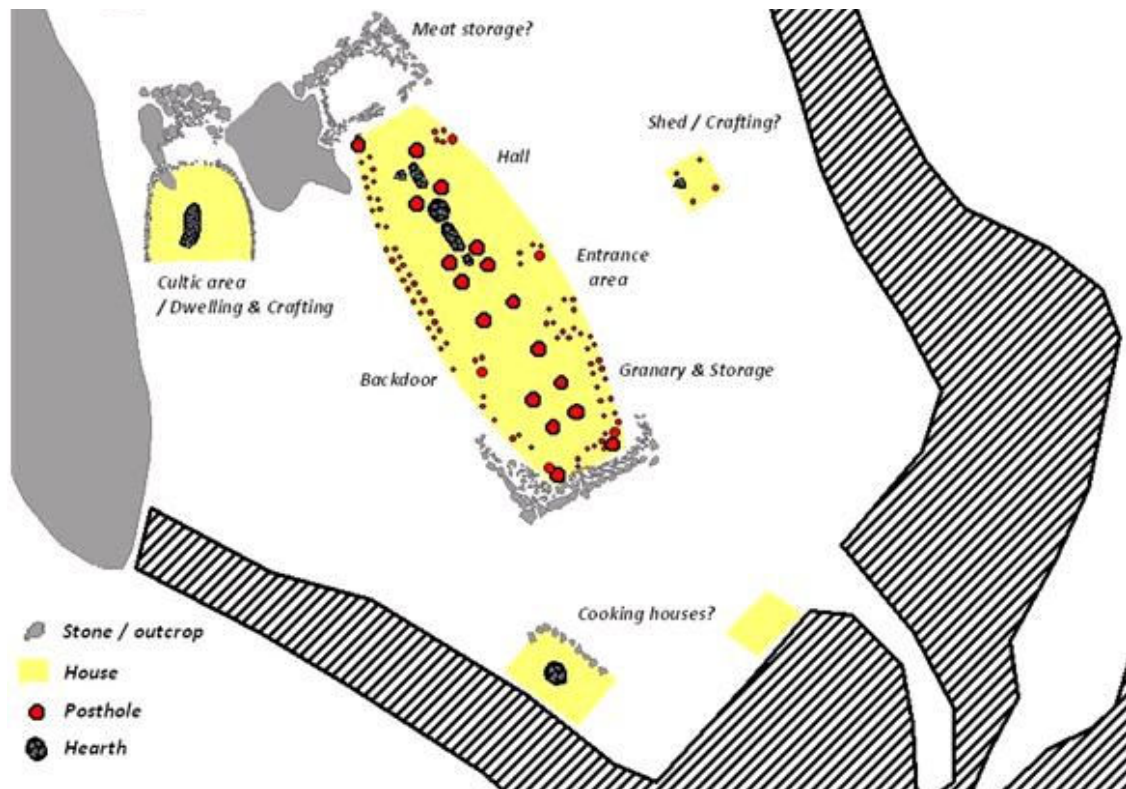


Figure 18. Interpretation of the space use for the southern plateau within the hilltop settlement of Runsa.

The extent of inhabitants and the number of dwellings and subordinate households is also unknown. Certainly, several potential houses and activity areas remain to be excavated but I would like to stress the interpretation of Runsa as primarily a demonstration of political power. The wall, the *sal* accompanied by a granary, along with the ceremonial/ritual context are all expressions of power and wealth, neither is a basis for wealth. How this power was obtained is difficult to capture. Basically and somewhat simplified, wealth, ideology and threats of violence can be important factors in creating this dependent hierarchy. These are all present within the hilltop settlement of Runsa manifested in the ceremonial activities where the order was normalized, the luxury of food habits and the need for defense and findings of weapons. However, the question of how the hierarchical relations originally were created demands further research beyond the range of this thesis. My point here is the conclusion that the wealth was seemingly not produced within the hilltop settlement of Runsa or the immediate surroundings, as is the case for magnate farms in the system of stone walls as well as the ringforts; the extent of workshop material in form of textile- or metal production is too small and the possibility to maintain efficient farming in the vicinity is excluded. Likewise, the ^{14}C -dating from the lower part of the wall (230-580 AD) (Olausson 2011a:241) more or less precedes the active phase of the houses as dated by the archaeological context (450-550 AD) (Olausson 2010, 2011). The massive construction of the wall must surely have been engineered and supervised by an already established elite. As is true with the ringforts of Öland (see Nordström & Herschend 2003:51),

the hilltop settlements were probably spatially planned from the beginning. This is evident from the outline of the wall, designed to harbor a certain amount of activities. My suggestion is that the wealth and social status of the people who used and lived within the hilltop settlement Runsa was created elsewhere, either by early formation of manors and dependent farms or possibly by payment of Roman warriors, plundering and trade. Regardless of the source, the contact with the Continent is indicated by the access to novelties and acquiring of precious metals. The establishing of Runsa is thereby primarily a consequence of a need to maintain and strengthen the prevailing hierarchical order. The disagreement with this social organization is seen in the reoccurring fires that have devastated the fort (see Olausson 1996:10).

Situated in a peripheral position in relation to the agrarian settlements, but strategically positioned in terms of trading routes Runsa might in a wider perspective have functioned as an over-regional port for magnates settled within the dense populated areas northeast and southeast of the hilltop settlement. The organization, alliances and agreements among the parties involved were restored by social and ritual gatherings within the houses upon the southern plateau. The exclusiveness was manifested in the food culture; abundances of meat and refined products from the cultivated seeds, both tributes or gifts from the farms in dependency to the magnate and his retinue. Osteological analyses performed on the material from the hilltop settlement Gåseborg indicated a seasonal use, primarily during summer time (Olausson 2009:53), perhaps a consequence from social gatherings and feastings primarily held during the time of the year when the waterways were passable. As has been stressed earlier, the hilltop settlements are not a uniform group (Olausson 1987b, 2011b:19) and variations within the organization and subsistence surely existed. The wealth might have been created or increased within sites as Onssten and Darsgårde by textile production and agriculture, while sharing functions similar to Runsa as well. The question whether Runsa was used occasionally or inhabited regularly remains unanswered. Likewise, the matter if Runsa should be seen as an initiative performed by a lone chieftain or a collective interest among the magnates in the hinterland is unsettled.

7. SUMMARY AND CONCLUSIONS

In an attempt to widen the knowledge of the inner organization and activities within the hilltop settlement of Runsa, soil samples and ceramic sherds were collected from the trenches excavated during 2011. The soil samples were analyzed for inorganic matter, metal elements K, Ca, Fe, Mn, Mg, Fe, P, Cu and Zn, as well as lipid distribution while the ceramic sherds were sought mainly for lipid food residues. These variables were furthermore analyzed in combination with the archaeological context in order to establish an understanding of the two terraces, T I and T III. Regarding the metal elements four major signatures were distinguished within T I, and two within T III. All recognized activity areas were also supported by the archaeological features, together discerning room divisions as well as in- and outsides of the houses. Intrasite variations within the rooms were interpreted as sweeping patterns, and accumulation in secondary contexts. Moreover, the space use within T I were convincingly identified by the aid of soil lipid analyses alongside distribution of artifacts and fossilized seeds. The correspondence between the concentrations of K, Mg, the considerable input of animal products, hearths as purely sources of light and the archaeological material characterized by exclusive finds led to the identification of a representational room within House I. Depleted values within the center of the house were linked to the main entrance at the eastern long side of the house while the enhanced values of Cu, Fe, Zn, and Mn in the southern part of the building were linked to the lack of hearths, but unilateral occurrence of threshed cultivated seeds, alongside ceramics and loom weights, indicating a granary/storage room.

The chemical imprints within T III resulted in discussions round the influence of a major input of Ca as well as the possible altering of signals caused by burnt floor layers. Two potential interpretations seemed relevant, a dwelling/crafting area alternatively a ritual context. However, the contents of the analyzed vessels alongside the fragments of bread found within the house

supported the thought of a ceremonial side-building related to the activities within House I. Based on the available archaeological records a discussion of the properties significant for the hilltop settlement of Runsa can be outlined:

- (i) The rampart and the location within the landscape.
- (ii) The focus on social gatherings/feastings and the specialized food.
- (iii) The traces of metal crafting.
- (iiii) The technical innovations (documented at hilltop settlements in general), novelties within the mid Iron-Age, as well as the Roman influences and imported precious metal.

None of the identified characteristics separates Runsa or hilltop settlements in general fully from the magnate farms. The combination of properties however suggests a close linkage between the Runsa and the Continent and implies a function as a port to the external world where innovation and influences are first embraced. The position might therefore have been advantageous in an attempt to create a contact point between the trade routes and the hinterland. The ruler and his craftsmen in Runsa might hereby have functioned as intermediaries, processors and distributors of the prestigious material (cf. Olausson 2009:52). Hence, the venue, i.e. the hilltop, was possibly a secured staging point situated in the borderland, where the desirable material was received and divided. The ceremonial activities and social gatherings, e.g. sharing of bread and feasting were the important and informal relations between the chieftain, his retinue and the guests. These were performed in the representational and exposed southern area of the yard before the more formal agreements were reached. The use of, and the extent of the traced crafts performed in the more private northern side within Runsa is still questionable.

The construction of hilltop settlements have been a most conscious act through which the upper level of the hierarchy managed to organize the landscape, both in the meaning of surveillance but more importantly through manifesting the social strata and landowning and furthermore control the exchange of goods and refined products.

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- Personal comments**
Michael Olausson 2012-03-15.
Sven Isaksson 2012-03-30, 2012-05-25.

Appendix I. Location, concentrations of metal elements (ppm), sterol ratio (C/P), presence of coprostanol (Cop) and methyl dehydroabietate (MeDHA) and abundance of the fatty acids C18:0 and C16:0 of each soil sample discussed in the thesis. The coordinate system used is ST74.

Sample	X	Y	Area	P	K	Ca	Zn	Fe	Cu	Mg	Mn	C18:0	C16:0	C/P	Cop	MeDHA
1	6605736.85	140315.5	T1	80	2507	959	89	18207	11.1	820	452					
2	6605738.7	140314.4	T1	83	2286	1010	80	19119	9.72	815	472					
3	6605740.45	140313.4	T1	155	2420	1327	96	19076	20.9	812	412					
4	6605742.2	140312.3	T1	146	3003	1116	88	18642	13.9	822	508					
5	6605744	140310.6	T1	176	2987	1603	96	20928	28.7	798	630	1334739	2471037	0.05		
6	6605745.35	140310.3	T1	116	2714	1711	94	19568	14.3	798	647					
7	6605747.45	140309.3	T1	300	2517	1493	100	19756	28.8	800	516					

8	6605736.8	140313.1	T I	111	2368	2415	104	20074	14.7	782	689					
9	6605738.55	140312.1	T I	237	3250	1861	99	30133	23.9	731	717					
10	6605740.4	140311.1	T I	97	2694	1354	94	20914	20.7	802	363					
11	6605742.15	140310.1	T I	156	2293	1092	95	22651	23.5	778	405	1744008	2845541	0.07		
12	6605745.6	140308.1	T I	115	2460	1531	97	19394	15.7	762	442					
13	6605747.4	140307.1	T I	93	2501	1346	95	18106	11.6	816	356	1902800	3987442	0.07		
14	6605749.25	140306.3	T I	100	2343	1351	88	17657	10.2	816	417	1959363	3500152	0.12		
15	6605734.95	140312	T I	124	1828	730	94	17816	12	860	300					
16	6605736.75	140311	T I	176	2624	1345	96	23172	19.6	798	500					
17	6605738.5	140309.9	T I	150	2803	1468	108	23866	27.8	737	418	1427725	4898685	0.09		
18	6605739.9	140309.2	T I	113	2876	2012	103	25386	21.6	730	810	1620793	3984193	0.05		
19	6605733.15	140308.6	T I	107	2722	1676	107	19496	13.8	798	642					
20	6605734.85	140307.5	T I	119	2681	1646	102	20725	19.8	787	856					
21	6605736.65	140307	T I	120	3158	1360	99	24764	20.9	747	528					
22	6605738.35	140306	T I	172	3570	1447	99	22361	24.1	797	402					
23	6605750.65	140298.3	T I	85	3176	1520	94	18859	13.2	810	502					
24	6605752.45	140297.3	T I	125	3741	1378	104	18786	13.4	792	432					
25	6605754.2	140296.6	T I	114	2296	919	85	17411	11.3	813	304	1442458	2864941	0.15		
26	6605756.2	140295.3	T I	89	3745	992	103	19003	16.6	827	317					
27	6605757.65	140294.3	T I	122	2488	1433	82	18004	13.9	824	547					
28	6605757.8	140296.1	T I	108	4632	781	100	19321	22.2	806	262					
29	6605756.1	140297	T I	83	3102	940	105	19206	15.4	797	463	1433280	2808526	0.14		
30	6605754.3	140298.5	T I	101	3644	1147	100	19438	13.4	790	488	1176364	3209937	0.12		
31	6605752.55	140299.5	T I	128	5664	1532	97	20538	12.6	739	604					
32	6605759.65	140297.3	T I	134	3617	918	95	17875	15.8	783	526					
33	6605757.7	140299	T I	110	3105	1185	104	19828	13.1	760	538					
34	6605756.7	140299.1	T I	172	2931	2268	108	19336	15.9	727	687					
35	6605753.9	140299.7	T I	315	4088	2450	105	22202	16.1	735	583					
36	6605752.7	140301.8	T I	303	3673	3138	113	20.88	23.5	680	851					
37	6605759.8	140300	T I	179	3412	1213	100	19568	39.4	767	576					
38	6605758.1	140301	T I	1153	4227	1629	104	18830	19.8	807	557	1739085	4622148	0.12		
39	6605756.2	140301.7	T I	124	3688	1535	107	18526	15.9	792	545					
40	6605754.55	140303	T I	119	4219	1486	99	18468	12.6	788	629	1348114	2232593	0.23		
41	6605752.75	140304	T I	151	3153	1273	93	17730	12.5	798	405					
42	6605750.95	140305	T I	137	2100	1299	99	17238	11.9	798	465					
43	6605742.05	140307.0	T I	191	2067	1450	112	26341	34.2	746	478	1474339	3587119	0.13		
44	6605743.8	140306.9	T I	208	2715	1883	117	21884	24.9	761	752	1217694	2590856	0.09		
45	6605746	140305.9	T I	139	2698	1382	113	19336	20.3	783	615					
46	6605747.35	140304.8	T I	119	2908	1679	97	19293	16.2	783	682					
47	6605749.1	140303.8	T I	157	3148	1302	100	19119	16.6	751	573					
48	6605750.95	140302.7	T I	251	4456	1445	108	19597	19.9	771	565					
49	6605734.5	140309	T I	133	2895	2313	109	17484	13.9	801	840					
50	6605736.3	140308	T I	172	3172	1133	87	20784	21.4	762	411					
51	6605738.05	140307.3	T I	122	2697	1231	100	21609	21.6	756	493					
52	6605739.75	140305.9	T I	156	2885	1237	93	27630	25.3	611	455	1216340	2434747	0.11		
53	6605739.7	140304.7	T I	283	3266	2001	96	21015	23.2	817	740					
54	6605743.3	140303.9	T I	171	3526	1292	101	21927	21.7	767	352					
55	6605745.2	140302.8	T I	143	2222	1291	101	21290	18.7	773	475					
56	6605750.55	140300.6	T I	175	3551	1388	101	17947	14.9	785	483	1139285	2536986	0.13		
57	6605742.05	140303.7	T I	430	2729	1607	114	18873	34.8	772	510					
58	6605743.65	140302.4	T I	266	2726	4028	107	22130	23.3	771	861					
59	6605745.1	140301.6	T I	228	3220	1635	98	19090	22.9	767	767	1363374	2905282	0.12		
60	6605746.1	140300.9	T I	216	3094	1793	104	18439	21.4	767	822					
61	6605749.05	140299.2	T I	159	4243	1405	94	19076	12.8	708	550					
62	6605733.3	140306.7	T I	173	2618	1371	102	17715	12.3	776	641					
63	6605735	140305.7	T I	144	2609	2135	102	17542	11.6	770	899					
64	6605736.7	140304.3	T I	186	2445	1134	95	16803	12.4	799	652					
65	6605738.45	140303.1	T I	210	2990	1126	105	18236	26.5	815	738					
66	6605740	140302.3	T I	217	2913	1574	99	19553	18.8	752	707					
67	6605741.85	140301.2	T I	311	2814	1800	104	16905	18.6	798	668					
68	6605743.6	140300.2	T I	213	3236	1894	103	19553	23.8	793	668					
69	6605745.45	140299.1	T I	136	2908	1195	103	18323	16.7	760	646					
70	6605747.25	140297.1	T I	131	3088	1533	95	19394	12.9	768	659					
71	6605748.9	140298.2	T I	147	2996	1728	85	17368	12.3	801	518					
72	6605750.7	140296.2	T I	181	2456	1123	84	15979	12	822	431					
73	6605752.4	140295.2	T I	174	2150	980	97	18974	16.5	801	344					
74	6605743.75	140313.1	T I	188	2661	1089	100	19148	14.8	807	387					
75	6605745.5	140312.1	T I	135	2901	1049	95	18902	10.1	794	364					
76	6605759.3	140298.8	T I	378	3636	1233	105	20943	25.5	763	386	1510305	3155756	0.08		
77	6605755.4	140298.9	T I	183	3327	1345	107	20248	16.3	757	540					
78	6605755.1	140296.9	T I	185	2910	1715	97	20046	14.9	781	725					
79	6605753.05	140300.5	T I	169	3791	1216	99	19090	14.5	767	407					
80	6605751.4	140301.5	T I	236	3783	1648	106	20813	18.8	748	524					
81	6605759.4	140293.3	T I	197	3384	631	99	18453	19.9	799	436					
82	6605760.9	140292.4	T I	219	3554	663	96	22448	26.7	748	593					
83	6605759.5	140295.1	T I	178	3746	799	94	20827	16.8	746	351	1894701	3284917	0.12		
84	6605761.5	140294.2	T I	256	3504	865	102	20103	22.6	751	504					
85	6605762.3	140293.9	T I	167	2470	616	83	17411	17.4	801	470					
86	6605761.4	140296.7	T I	196	3819	1224	95	20740	23.8	734	607					
87	6605762.9	140295.8	T I	305	3292	987	99	17064	21.8	812	386					
88	6605762	140298.7	T I	292	3351	1104	96	19481	22.5	776	511	1118017	2349127	0.08		X
89	6605763.15	140297.7	T I	253	3935	1045	96	20017	21.7	763	492					
90	6605761	140300	T I	274	3537	1233	94	21768	39.9	757	529					
91	6605761.7	140301.1	T I	133	2700	1129	86	18077	10.6	773	387					
92	6605763.4	140292.9	T I	360	2569	965	100	21681	28.5	740	598	1412786	2057127	0.16		X
93	6605765	140292.4	T I	225	2792	1158	98	21522	21.3	741	626	1679633	3514430	0.09		X

94	6605764.85	140294.7	T I	389	4220	1025	107	24764	32.9	725	680	1615267	2618470	0.12		X
95	6605766	140294	T I	283	2547	1221	104	21942	24.4	728	735	1961248	3372603	0.14		
96	6605765.65	140297.1	T I	467	2129	1088	103	20552	29.9	750	623	1071056	2053358	0.11		X
97	6605766.7	140296	T I	286	2851	1071	107	22897	31.5	739	697	1472720	2874992	0.1		
1	6604762	140284	T III L2	49	3696	1302	105	24476	26.2	727	607					
2	6604760	140284	T III L2	168	3779	1044	107	25774	16.1	761	495					
3	6604758	140284	T III L2	353	3323	1308	110	23197	35.8	754	634					
4	6604752	140284	T III L2	433	3639	11015	113	23375	40.1	660	939					
5	6604761	140285	T III L2	264	4303	1047	109	24058	33.8	718	483					
6	6604759	140283	T III L2	305	2648	2172	108	23974	29.2	732	839					
7	6604762	140282	T III L2	192	3613	1786	108	24603	25.3	732	743					
8	6604760	140282	T III L2	368	2740	2877	112	23907	28.5	753	931					
9	6604759	140282	T III L2	374	2976	3581	115	26779	38.1	712	1074					
10	6604763	140281	T III L2	170	3521	1821	107	23654	24.7	730	848					
11	6604761	140281	T III L2	216	3183	2839	110	23378	26.8	739	899					
12	6604759	140281	T III L2	366	2731	3124	111	23252	29.4	740	929					
13	6604752.15	140282.8	T III L2	253	4339	14465	118	22303	40.4	664	861	1388767	3524789	0.06		
13b	6604762	140280	T III L2	332	2886	1382	110	25424	31.2	759	571					
14	6604760	140280	T III L2	263	2992	3301	116	25300	35	719	1055					
15	6604758	140280	T III L2	494	3374	5525	111	27077	36.7	699	833					
16	6604763	140279	T III L2	271	2931	953	96	24850	23.4	792	408					
17	6604753	140281	T III L2	158	3790	14154	118	17992	63.9	496	1347	1415642	2376634	0.04		
18	6604753	140283	T III L2	192	3647	14603	118	24325	50.2	605	1141					
19	6604753	140282.3	T III L2	118	4149	15447	115	16859	58.6	404	1378	1118041	2558132	0.04		
20	6604756	140284	T III L2	506	3240	2765	107	27257	36.5	685	745					
21	6604754	140284	T III L2	380	3300	2735	116	25124	33.8	665	796					
22	6604757	140283	T III L2	390	2977	4151	111	24575	40.2	680	1012					
23	6604755	140283	T III L2	458	3426	7602	116	25225	51.7	659	1132					
24	6604756	140282	T III L2	471	3152	12410	117	23651	50.1	640	1183	1339559	3365207	0.05		
25	6604754	140282	T III L2	187	3253	14520	117	20875	47.9	566	1329	1428632	3292976	0.03		
26	6604757	140281	T III L2	390	4096	11185	116	26275	35	668	584					
27	6604755	140281	T III L2	161	3707	14647	116	20808	52.9	424	1281					
28	6604756	140280	T III L2	343	3638	14078	117	27642	50.2	649	1017	1102869	1913024	0.06		
29	6604754	140280	T III L2	371	3723	8564	116	25699	46.4	644	1173					
31	6604757	140279	T III L2	407	3228	7484	116	21547	45.2	707	1133					
32	6604758.8	140278.4	T III L2	377	3316	3183	111	47150	35.9	732	925					
33	6604752.15	140279.7	T III L2	435	3475	5736	115	25875	38.7	661	947					
34	6604763	140283	T III L2	147	3173	1918	109	62087	27.2	712	1092					
3	6605758	140284	T III L3	332	4064	1089	103	24900	49.4	700	445					
4	6605752	140284	T III L3	517	2262	3909	108	21300	29.2	743	477					
6	6605759	140283	T III L3	312	4642	1297	105	30600	36.4	645	556					
9	6605758	140282	T III L3	372	2344	3884	109	19975	33.0	813	518	970400	2113776	0.05		
12	6605759	140281	T III L3	366	3612	5131	113	26213	43.8	691	806					
15	6605758	140280	T III L3	254	2834	3174	104	23450	29.4	744	556	1585694	4764797	0.1		
17	6605753	140281	T III L3	278	2015	9233	111	28796	40.9	544	432					
18	6605753	140283	T III L3	504	2137	7563	110	17964	23.9	739	424	741586	1542321	0.04		
20	6605756	140284	T III L3	412	4177	1349	108	24576	52.5	699	376					
21	6605754	140284	T III L3	474	2435	2266	114	24527	38.4	738	545					
22	6605757	140283	T III L3	390	2680	1992	103	26546	36.9	750	512	1673659	3852433	0.03		
23	6605755	140283	T III L3	416	4631	2816	103	24800	41.7	669	436	1382853	4518433	0.07		
24	6605756	140282	T III L3	197	4517	14529	109	23553	53.7	638	639					
25	6605754	140282	T III L3	356	3485	9451	111	29004	50.9	521	424					
26	6605757	140281	T III L3	331	5140	10698	107	26675	41.9	622	527					
27	6605755	140281	T III L3	282	4130	10957	101	22931	35.7	625	443					
28	6605756	140280	T III L3	442	1590	8093	105	25125	30.4	619	544	444445	1204074	0.02		
29	6605754	140280	T III L3	241	4231	14609	118	25649	51.3	531	966					
1	6605829.85	140297.7	T X L2A	174	2533	5558	112	22390	22.9	786	836					
2	6605829.36	140296.8	T X L2A	202	3438	4911	105	26978	29.2	718	639					
3	6605828.84	140295.9	T X L2A	262	3091	5832	113	25184	31.9	735	846					
4	6605829.25	140298.1	T X L2A	234	3001	6259	111	22578	25.8	750	725					
5	6605828.71	140297.2	T X L2A	182	2886	6104	102	24909	25.4	734	541					
6	6605828.2	140296.4	T X L2A	219	2990	5540	103	25922	31.5	750	546					
7	6605826.6	140294.9	T X L2A	319	3700	5284	114	27195	42.9	677	789					
8	6605826.78	140298.4	T X L2A	401	3127	9674	118	22043	138.6	734	1080					
9	6605827.63	140295.5	T X L2A	280	3166	2894	106	22955	38.5	732	825					
10	6605827.96	140294.6	T X L2A	419	3360	3718	115	26761	46.5	748	825					
11	6605828.89	140294.7	T X L2A	293	3154	3973	115	27572	37.6	698	913					
1	6605829.85	140297.7	T X L2B	209	3059	5467	103	29453	28.7	729	542					
2	6605829.36	140296.8	T X L2B	260	3153	7453	112	24532	38.7	719	836					
4	6605829.25	140298.1	T X L2B	527	3397	7703	115	43825	38.9	701	836					
6	6605828.2	140296.4	T X L2B	323	3168	4496	113	25386	46.2	735	861					
12	6605827.35	140296.9	T X L2B	291	4097	4144	107	30090	39.2	617	559					
13	6605827.02	140297.9	T X L2B	489	3230	10682	118	23201	49.4	715	1010					
202	6605827.23	140297	T X L2B	386	4768	3865	111	26964	37.9	670	705	1078610	1055282	0.09		
203	6605827.23	140297	T X L3/6	715	4470	6341	118	28570	46.2	589	1672	980974	1359446	0.17		
204	6605827.23	140297	T X L4	478	3682	2678	112	22766	56.7	709	1088	2258307	4043625	0.22	X	
209	6605827.23	140297	T X L9	478	6221	3010	117	25674	66.5	593	1046	2011166	4083251	0.09	X	
212	6605827.5	140297.4	T X L2B	414	3099	4425	116	24185	64.2	734	1083	2229714	2542273	0.10		
213	6605827.5	140297.4	T X L3/6	702	3118	7368	118	20914	66.4	766	1065	4052890	5697279	0.15		
214	6605827.5	140297.4	T X L4	379	3588	2727	115	19655	62.5	701	816	2614375	4324518	0.23	X	
219	6605827.5	140297.4	T X L9	442	3125	3302	114	19765	70.1	776	1004	1791372	3084590	0.15	X	