Skomer Island's archaeology revealed

A multi-proxy analysis on samples from Skomer's first modern excavation

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Abstract

Based on a recent reinterpretation of Skomer Island, it appears that its archaeological background is much more complicated than previously thought. Occupation periods may have ranged from the Late Bronze Age to the Medieval Period and contained intervals of retrieval and re-occupation.

In 2014, the first modern excavation on Skomer Island took place. Six soil samples were taken during the excavation of a mound of burnt stones that is associated with a hut group of the North Stream Settlement. This multi-proxy research discusses the magnetic susceptibility, loss-on ignition, particle size analysis and pollen analysis of the samples from the mound. Suggestions are made on the past vegetation, landscape and indicators of human influence on the area. In addition to the pollen analysis, three pollen diagrams from Skomer and south Wales are used for comparison and the search for trends in the changing vegetation. This research reveals the archaeological potential of Skomer and shows the complicated situation of the excavated mound in the north.

Acknowledgments

I would like to thank Dr. E. Forster and Dr. G. Ayala for all their support, guidance and enthusiasm throughout the entire process. I appreciate their guidance during the collection of data and the processing of the results very much. Furthermore I would like to thank Dr. R. Johnston for providing me with the excavation reports and important files and for discussing the results with me. It has been a great experience!

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Chapter one - Introduction

This study is based on soil samples that were collected during an excavation of a mound of burnt stone on Skomer Island. The archaeological background of the area will be discussed first. This will be followed by further background information.

Besides independent research on six samples from the excavation area, three additional pollen diagrams from Skomer and south Wales are used for comparison. These will be discussed in chapter four. Their locations are shown in **figure 1** of this chapter.

1.1 Background of the samples

During the season in 2014, an excavation has been conducted on a mound of burnt stone which is associated with a hut group (Hut group 8) as part of a settlement (North Stream Settlement) (Barker et al. 2014, 6). The initial goal of this excavation, which is also the first modern excavation conducted on the island, was to locate buried charcoal and/or other material suitable for radiocarbon dating (Barker et al. 2014, 6). Relevant chronological dates could hereby point out phases in the development of the landscape of Skomer and contribute to the reconstruction of Skomer's environmental history (Barker et al. 2014, 6). Furthermore, an assessment of the changing impact of human occupation was aimed to be carried (Barker et al. 2014, 7). The excavation was the result of a collaborative research project between the Royal Commission on the Ancient Historical Monuments of Wales, The University of Sheffield and Cardiff University (Barker et al. 2014, 7).

1.1.1 Trench and samples - locations

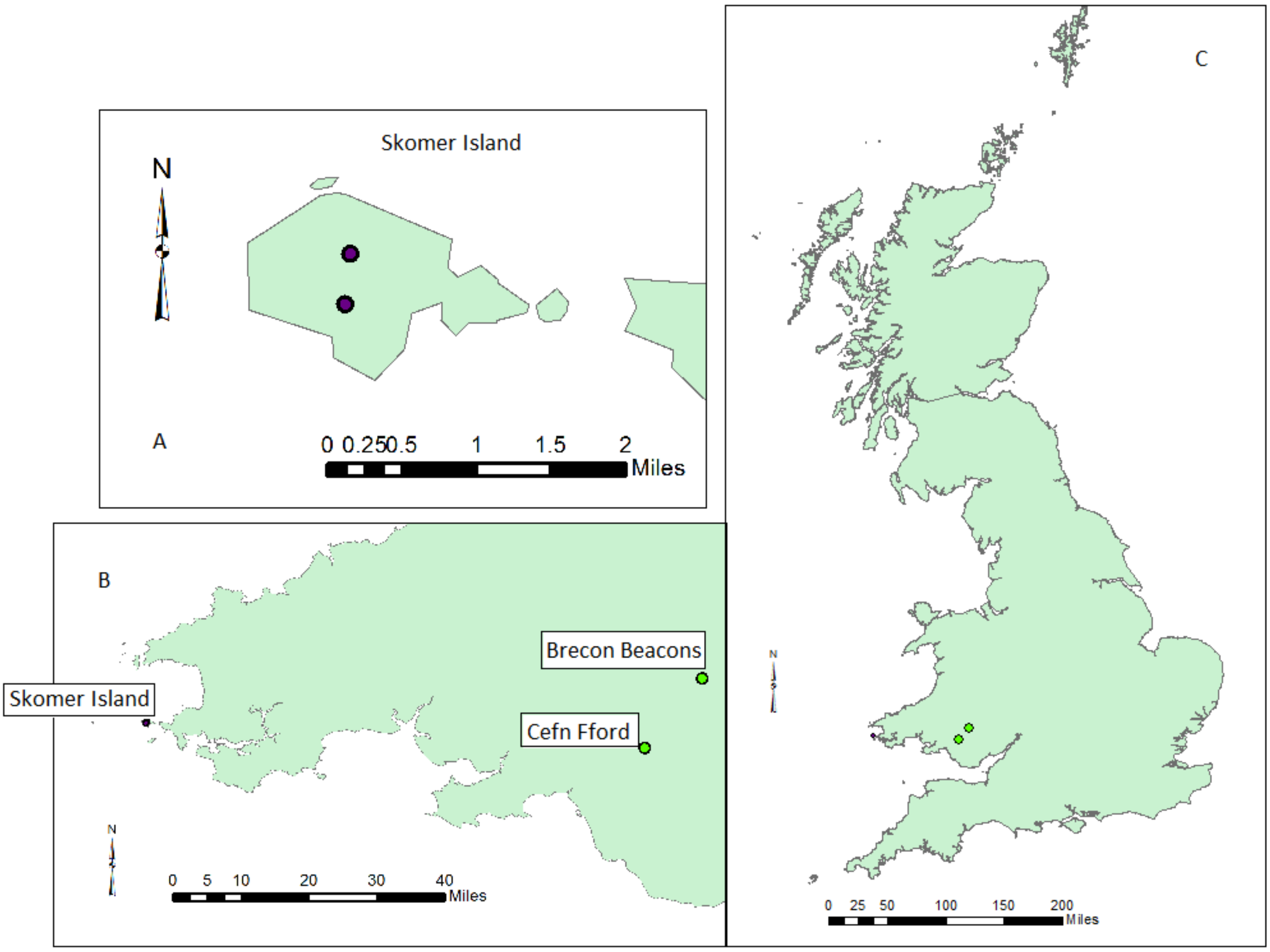


Figure 1. *Locations of pollen samples used for this research. Part A: Skomer with in the north (upper circle) the location of the trench and in the south (lower circle) the location of a separate pollen study. Part B: Location of Skomer Island and two site locations of additional pollen studies used for this research (indicated by the green circles). Part C: the location of all sites relative to the UK.*

The excavation took place in the North (centre) of the island as shown in **figure 1**.

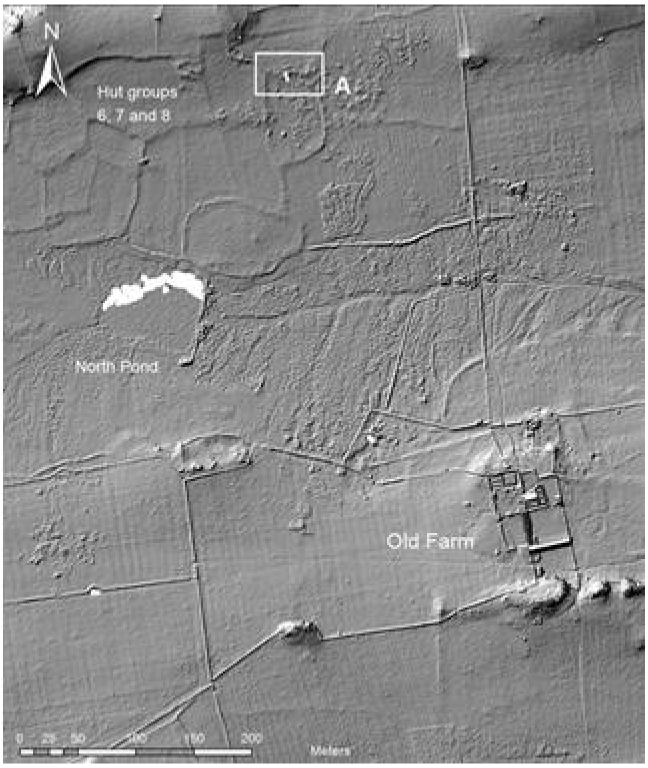


Figure 2. *The location of hut groups 6, 7 and 8 (square A) shown on a hillshade model, which is based on a digital elevation model. The field boundaries are made visible as lines because of this hillshade analysis. (Crown Copyright RCAHMW; © Environment Agency copyright and / or database rights 2015. All rights reserved).*

Figure 2 shows the hillshade digital elevation map containing the location of the hut groups of hut 6,7 and 8, together with the Old Farm located further to the south. The hut group had previously been studied by J.G. Evans (1986). Every hut group consisted of two huts or dwellings that were accompanied by a yard (see **figure 3**). The interpretation is based on the current occurrence of two circular structures of low ring banks consisting of earth and stone. Each ring is assumed to represent the foundation of a hut (Evans 1986, 5). Furthermore, every hut group was accompanied by a mound of burnt stones. Following Evans' interpretation of the island's varying types of preserved huts, it seemed that not all of them functioned as dwelling houses. Smaller ones are believed to have functioned as huts for the storage of grains or animal fodder for example (Evans 1986, 9). The walls of the huts were probably of a similar height as they are nowadays and were made out of stone rubble and earth, faced with stone. It is possible that the huts have been capped with turves for a better durability (Evans 1986, 9). A single post would have supported the roof of the huts (Evans 1986, 9).

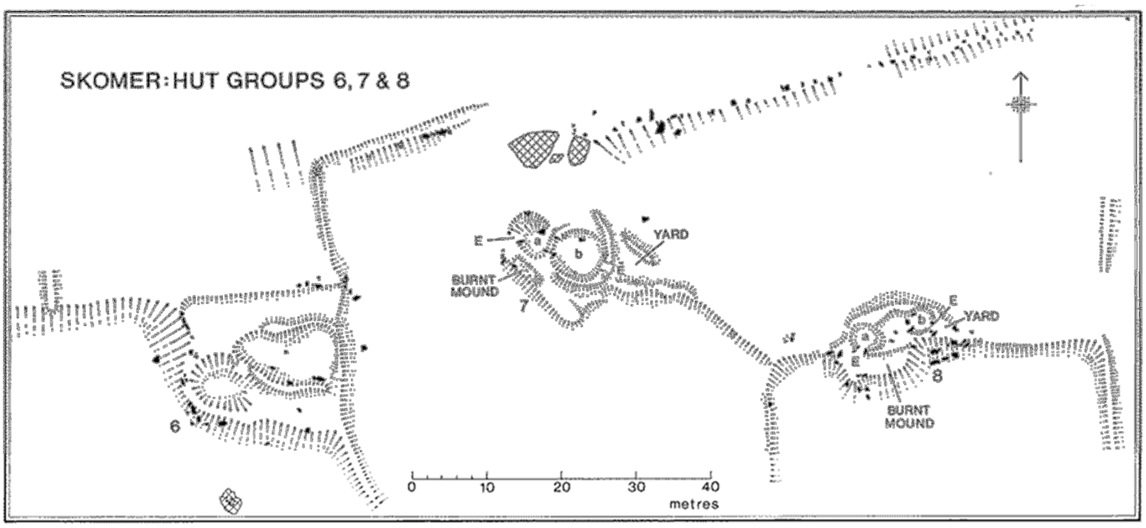


Figure 3. *Map showing the arrangement of the hut groups 6, 7 and 8 (DI2015_0235, Copyright Reserved).*

The excavation took place at hut group 8, where part of the mound of burnt stones has been excavated until two subsoils were found (layers 107 and 110) (Barker et al. 2014, 12). The main reason for choosing to excavate hut group 8 was due to the fact that the mound of burnt stone seemed to be distinct compared to the ones of hut groups 6 and 7. The mound is located to the south of the round houses, whereas that is not the case at hut groups 6 or 7 (Barker et al. 2014, 12). In total, the mound measured 11.5m in East-West direction and 5m in the North-South direction, almost reaching a height of 1m. Similar to many other settlements on the island, the settlements of hut groups 6,7 and 8 appeared to be laying on top of a pre-existing field boundary (see **figure 4**) (Barker et al. 2014, 12).

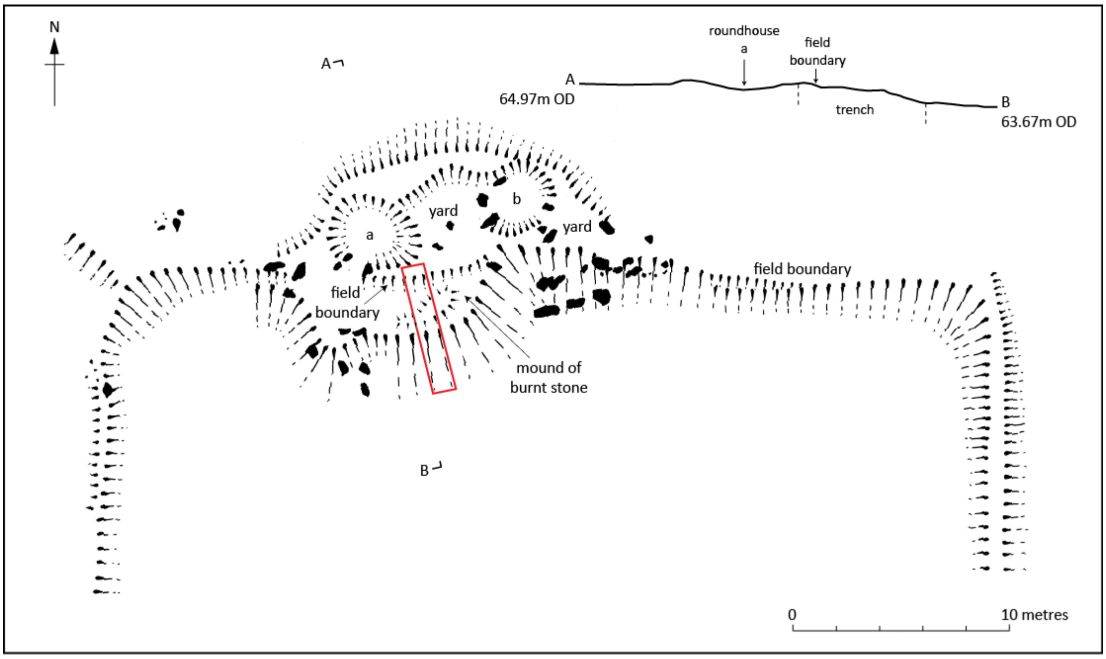


Figure 4. *Hut group 8 and the location of the trench indicated in red (Barker, L., O. Davis, T. Driver and R. Johnston 2014, 11).*

Field boundaries

Evans identified three different types of field boundaries on the island. Type 1 is described as low banks of stone and earth, type 2 as lines of large stones, reminiscent of ritual alignments and the third type as cultivation terraces that are also known as ''lynchets''. The latter type is present in the area of hut group 6, 7 and 8 and is believed to represent prehistoric inhabitation of the island (Evans 1986, 9). Based on the fact that no more than 25 dwellings existed, Evans concluded that there were a total of hundred to two hundred people living on the island. Although there was no evidence found, Evans based his conclusion on the assumption that all houses were occupied at the same time (Evans 1986, 15). Furthermore, since Evans found no subdivision within the fields, he stated that the occupation period probably ranged from a few generations to no more than a century (Evans 1986, 15 and Barker, 281).

1.1.2 Reinterpretation of Skomer's landscape

A more recent study has been carried out by the Royal Commission on the Ancient and Historical Monuments of Wales and show evidence of a more complicated field system on the Island than previously thought. Flown aerial photographic reconnaissance was carried out in March 2008 and LiDAR data of Skomer has been collected in 2011 (Barker, 286). Furthermore, a selective field survey has been carried out in order to reinterpret the landscape of Skomer (Barker et al. 2012, 281). The presence of a coaxial field system (a system that includes one prevailing axis of orientation) and several house platforms indicate the possibility of a later Bronze Age settlement (Flemming 1987, 188 and Barker et al. 2012, 282).

Hut group 6, 7 and 8 are the only three settlements that are located in the North of Skomer. The fourth settlement was found in the south side of Skomer, located on a rock outcrop. Besides these settlements, three conjoined huts have been found. With the help of a digital elevation model that was produced with the new LiDAR data, the settlements were recognised to all be located on gently sloping grounds and tend to have a southerly aspect in the direction that they face in (Barker et al. 2012, 288). A further reinterpretation of other relict buildings on the island, show a categorisation of four types which are similar to previous identifications made my Evans. The four types include: circular stone huts, circular platforms, oval stone huts and rectangular stone huts. The first category mentioned, most likely represents the remnants of structural walls, as described earlier by Evans as a field boundary (Barker et al. 2012, 288). They are often located in the east of the Island, together with the circular earth platforms that were created in the hill slopes (assumed to make timber building possible) (Barker et al. 2012, 288). Opposite to Evan's previous suggestions, the recent interpretation of Skomer's settlements suggests a much longer period of occupation. This hypothesis is mainly based on the differences in settlement forms together with their varying landscape settings (Barker et al. 2012, 289).

Occupation period of Skomer Island

This recently retrieved data on Skomer Island now suggests an occupation period starting from the later Bronze Age to the Medieval Period, with intervals of retrieval and re-occupation. The possible occupation of the island in the Early Bronze Age is indicated by the new identification of field systems and a well-preserved Early Bronze Age round barrow in the south east of Skomer (Barker et al. 2012, 292). Other evidence for this new theory on the occupation period of Skomer also comes from the south of the island. Phasing of the field systems was made possible with the use of LiDAR data and shows an old enclosure and building overlaying an earlier field boundary. This supports the similar presumed pattern of hut group 8 overlaying old field boundaries and thus suggests different phases of occupation on Skomer Island (Barker, 293). The field survey provided even more evidence with the finding of some occasions where field boundaries overlay each other, including two occasions where lynchets were overlaying each other (Barker, 295). Even though new data has been collected, the interpretations that are derived from them cannot provide full evidence of the first occupation of the island. Furthermore, the new data cannot be used to identify why people (temporarily) retrieved from the island and were attracted in a later period (Barker et al. 2012, 301).

1.1.3 Sample background

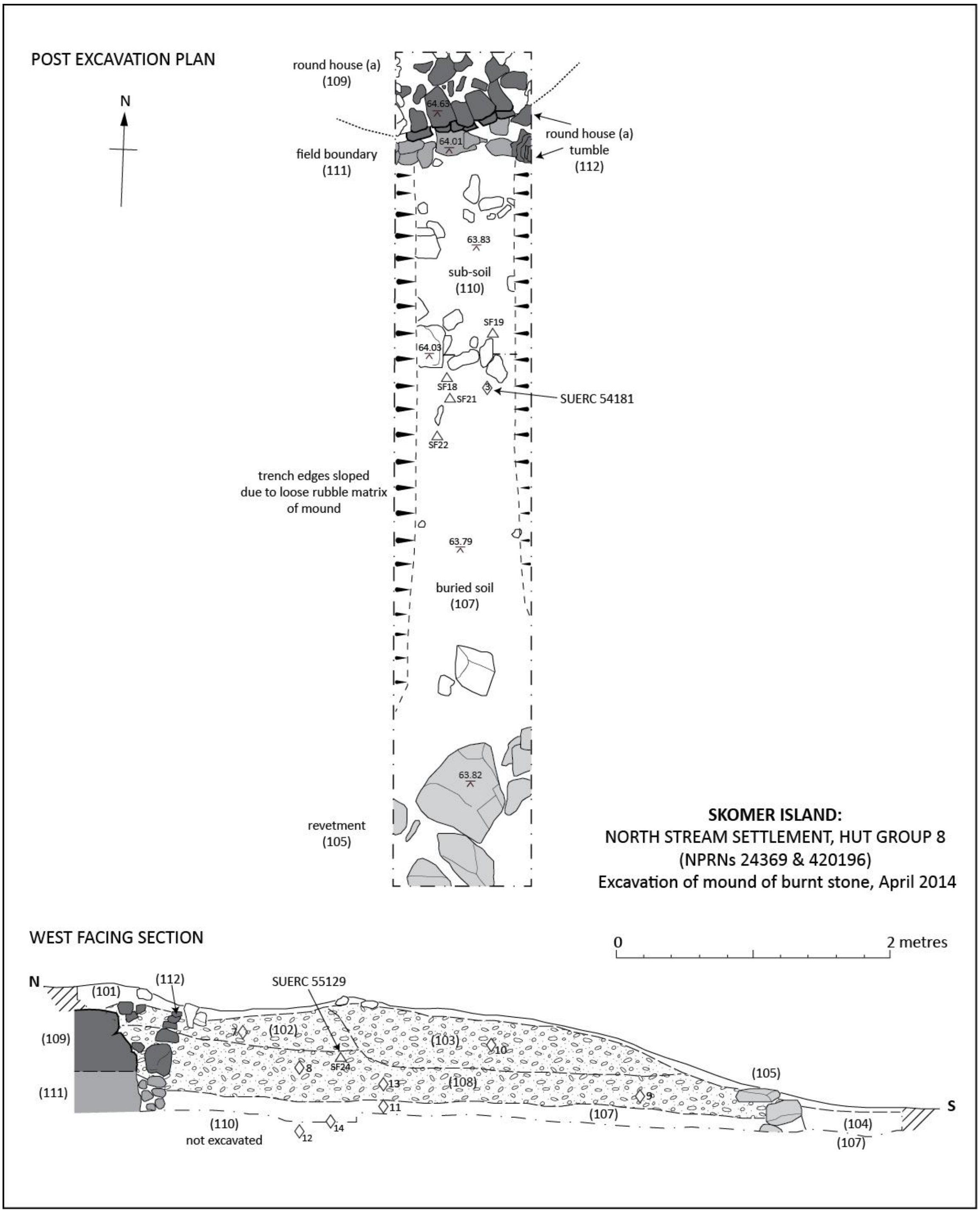


Figure 5. *A digitalised drawing of the trench and its profile. The diamonds indicate the location of the soil samples that are used for this research (Barker, L., O. Davis, T. Driver and R. Johnston 2014, 16).*

The excavation took place in the shape of a hand-excavated trench being 6.06m in length, 1m wide and 0.9m deep. The trench represents a cross-section of the mound with the external wall of the roundhouse to its southern boundary and the original ground surface level of the prehistoric field in the northern part of the trench (Barker et al. 2014, 16). As visible in **figure 5**, the excavated trench contained three deposits and two sealed layers underneath the mound. Layer 107, which is believed to be a potential old A-horizon, contained a piece of charcoal of (probably) blackthorn, which was dated to 751-408 cal. BC (Early Iron Age) (Barker et al. 2014, 8 and 17).

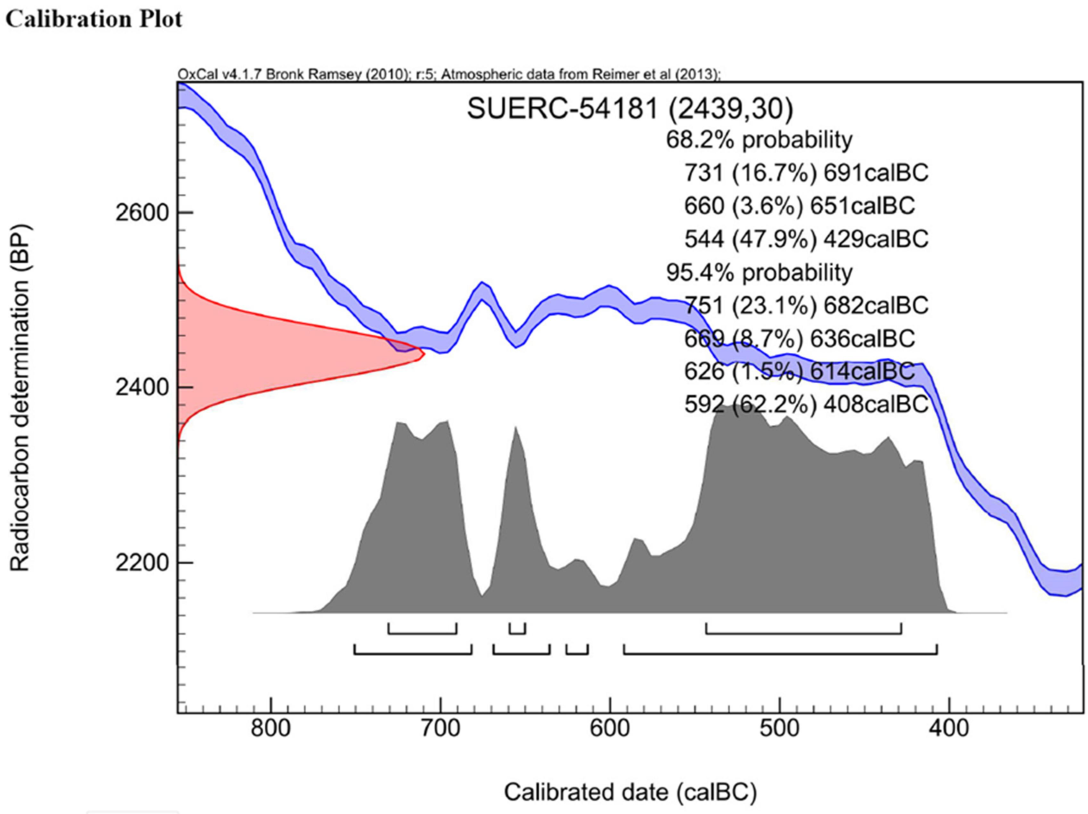


Figure 6. *The radiocarbon diagram of the charcoal piece from layer 107 (Barker, L., O. Davis, T. Driver and R. Johnston 2014, appendix).*

Figure 6 shows the radiocarbon diagram, containing a 95% probability rate. This dated piece of charcoal, along with several finds of worked flints, can be indicative of domestic activity in the environment of the settlement before hut group 8 was established during the Late Iron Age. A cattle tooth from within the mound (layer 108), was dated to 161-51 cal. BC (Late Iron Age) (Barker et al. 2014, 8). **Figure 7** shows the radiocarbon diagram, with again a 95% probability rate.

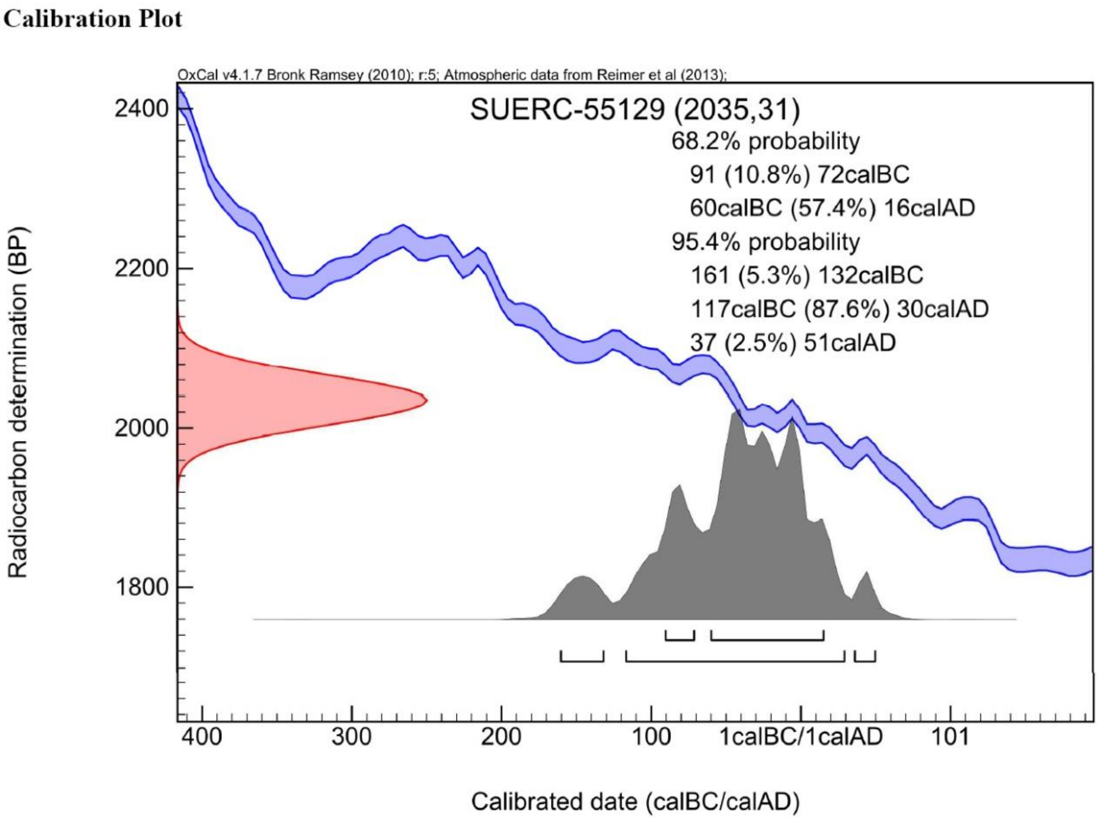


Figure 7. *The radiocarbon diagram of the cattle tooth from layer 108 (Barker, L., O. Davis, T. Driver and R. Johnston 2014, appendix).*

Context of the layers

A profile of the trench and the layers are shown in figure 5. Layer 110, a buried sub-soil, was not excavated, but was described as a yellow-orange compact clayey layer (Barker et al. 2014, 19). Layer 107, interpreted as the uppermost buried soil layer, overlay 110 and was described as a ''pale, smooth, clayey horizon representing a marked change from the stoney-mound above'' (Barker et al. 2014, 19). It contained many flakes, pebbles and artefacts and was flecked specks and lumps of charcoal (Barker et al. 2014, 19). If it were an old A horizon, layer 107 could represent a possible Bronze Age soil layer, suggesting activity in the area of the settlement previous to the period of Hut group 8's existence (Barker et al. 2014, 19). On top of layer 107, was layer 108. This layer, as well as the other two (102 and 103) is associated with the mound of burnt stones (Barker et al. 2014, 20). Layer 108 appears to represent the first deposition of burnt stones of the mound, measured 0.44m in depth and was distributed over an area of 4.6m long (Barker et al. 2014, 20). Furthermore, it seemed to contain more angular burnt stone blocks than layer 102 and 103 and consisted of a sticky rich soil matrix. Because it covered quite a large area, layer 108 could have been levelled or spread out before the commencing of the later tipping of the following deposits (Barker et al. 2014, 26). Layers 102 and 103 were located on top of layer 108 and consisted of a dark reddish-brown loose matrix, including burnt stones (Barker et al. 2014, 21). Throughout all the mound deposit layers, only the cattle tooth was found, along with several river or beach pebbles and utilised or rubbing stones. The deposits contained no charcoal (Barker et al. 2014, 22).

Although the mound of burnt stones does not show any stereotypical characteristics of a classic mound, it cannot be categorised as one (Barker et al. 2014, 29). Most mounds of burnt stones date to the Bronze Age, whereas the mound related to the settlement, most likely dates to the Iron Age (Barker et al. 2014, 29). Whether the round house nearby was the actual cooking hut, as concluded by Evans, or that the adjacent yard was the centre of water heating or cooking activity cannot be stated yet. The burnt stones from the mound are either way associated with cooking or water heating and must have taken a special role in the landscape (Barker et al. 2014, 30). It might have represented the number of prepared meals, the effort of stone quarrying or the longevity of residence of the settlement as the pile grew larger (Barker et al. 2014, 27).

1.1.4 Samples and research questions

Six soil samples that were taken during the excavation of the trench have been used in this research. For every sample, loss-on ignition, magnetic susceptibility and particle size analysis have been carried out. Additionally, six subsamples were taken in order to conduct pollen analysis. The following layers are included in the research: 102, 103, 108 north (8) and 108 south (9), 107 and 110. Two kubiena tins were also sampled from layer 110, and have been used for the subsampling and preparation of six microscopic slides in order to carry out pollen analysis. With the new collected data, extracted from these samples, an attempt was made to answer the following research questions:

1. Can the new gathered data confirm that layer 107 was an old soil horizon, or does it suggest otherwise?

2. What would the environmental reconstruction of the area of hut group 8 show?

3. Are there any indications for the influence of human activity on the past vegetation or landscape?

1.2 Soils of Skomer Island

1.2.1 Geology of Skomer

The geology of Skomer comprises a series of Lower Palaeozoic strata, mostly containing extrusive Silurian igneous rocks (Davis 2012, 1). These so called ''Skomer volcanic series'' consist of varying igneous rock which are interbedded with shales and flagstones (Ziegler et al. 1972, Thorpe et al. 1989 in Jenkins and Owen 1995, 1). Outcrops are generated in an East-West direction by a dip in these volcanic strata of 20 to 40 degrees. Various high angle faults at a number of orientations create rocky ridges over the east west directions of the island (Jenkins and Owen 1995, 1). The ridge intervenes the shallow north and south stream valleys and coastal gullies are eroded along the faults (Jenkins and Owen 1995, 1). Super-imposed by these valleys is a platform lying between 40 to 70m above sea level. The age of the platform is believed to be one of the Cretaceous Age, since the sea level was 40m lower in this time period. Furthermore, the platform has probably been wave-cut during this era, but was uplifted during the Tertiary (Jenkins and Owen 1995, 1). Although these strata are not part of the superficial geology and are not the parent material for the soils nowadays, they do determine the topography of the island. Since the island is located within the south-east margin of the Late Devensian (dating from 118000 to 10000 years BP) and of an earlier Irish Sea Ice Sheet, deposits are expected to be of glacial and glaci-fluvial source (Delaney 2003, 27). Origins of these deposits can thus be from the north or of locally originating material (Jenkins and Owen 1995, 1).

1.2.2 A reconnaissance of the soils of Skomer.

A total of 60 sites distributed over Skomer Island were inspected by Jenkins and Owen (1995). This resulted in the identification of 8 soil types that are present on the island. Shallow Rankers were found at peripheries of the rock outcrops. Furthermore, 4 types of brown soils have been identified which underlay most of the previous agricultural land and contain a developing littler layer. Among these are brown earths, showing a darker humic Ac horizon and a coarser, sandy variant (Jenkins and Owen 1995, 3). Gleys tend to occur in the more poorly drained areas and would further develop into Humic Stagnogleys or Humic Stagnopodzols in one or two selected sites on sloping ground (Jenkins and Owen 1995, 3).

Brown soils

The normal brown soils contain a dark brown (10YR3/3) Ah horizon that ranges in thickness from 16 to 32 cm (Jenkins and Owen 1995, 9). The loss-on ignition values range between 11 and 68% and the surface can include a grass litter zone. Underneath this layer, a dark yellowish brown (10YR4-5/4) B horizon is present and goes down with an average of 50cm, ranging from 33 to 78 cm. The B horizon has been assigned to a Bw horizon based on its low chroma. It is however possible that it involves Bs horizon instead, based on the pH values of 11 at the basal profile (Jenkins and Owen 1995, 9). The Bw texture is that of a humic silty loam or sandy silty loam, occasionally grading to a sandy loam at depth and changing further down to a weak fine subangular blocky structure. The soils are ranging from very slightly stony at the surface to very stony at the base which also limited augering (Jenkins and Owen 1995, 10).

By morphological distinguishing in the field or by examination of the soils in the lab, brown earths with a developing mor humus have been identified. These soils are recognised by their higher loss-on ignition values with an average of 50% along with lower pH values with an average of 4.3 in the Ah horizon increasing to a 4.7 in the Bw horizon (Jenkins and Owen 1995, 10). All values of the darker Brown earths are intermediate. This means that the distinguishing of the soil is solely based on its darker colour.

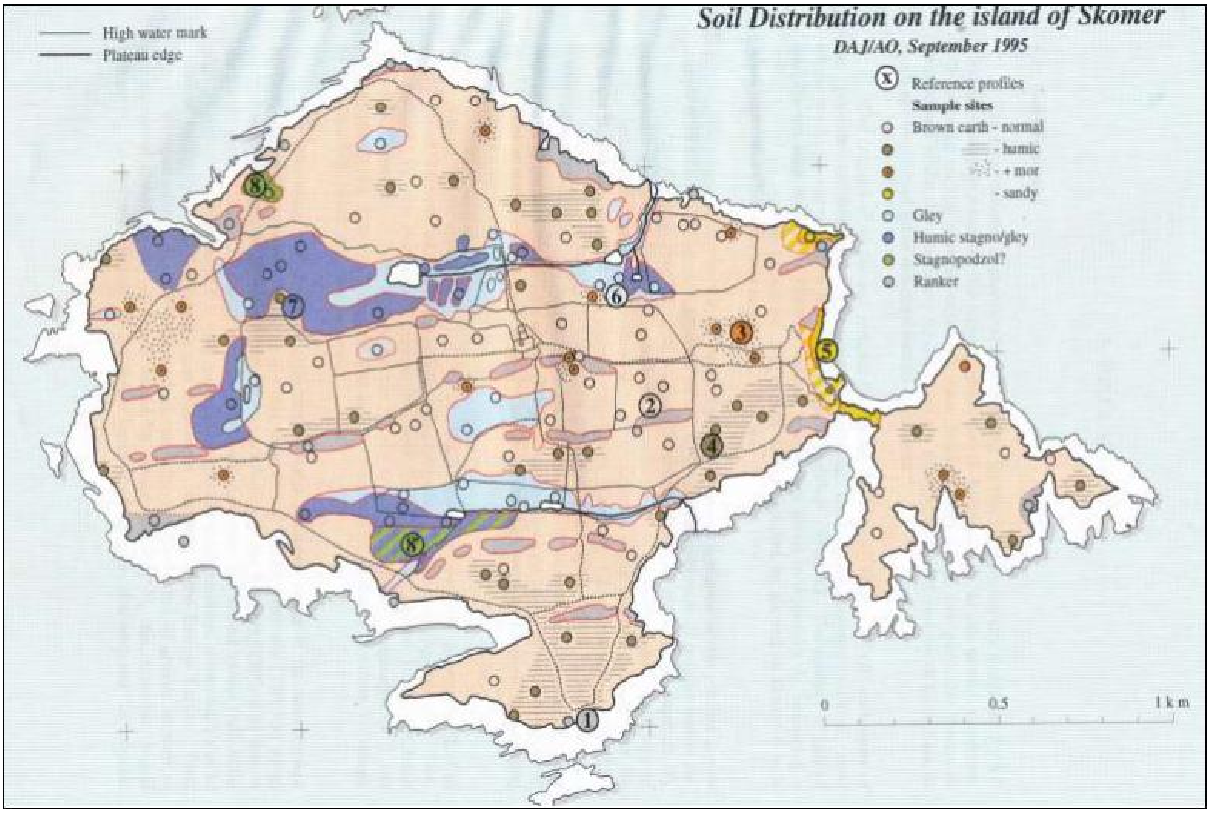


Figure 8. *Soil distribution map of Skomer Island following the research of Jenkins and Owen (1995) (Alexander 2014, 7).*

Figure 8 displays the soil distribution of Skomer Island. As indicated, most samples in the direct area of the hut group contained normal and humic brown earths. Next to the Brown earths, two types of brown sands have been identified based on a sandy loam texture elsewhere on the island. The Ah horizons consist of a dark brown colour (10YR4/4) which are slightly stony with a weak fine granular structure. The Bw underneath it contains a dark yellowish brown/yellowish brown (10YR4/4-5/6) colour, being moderately stony and massive at depth. Horizons are quite often buried at the top of the profile and the occurrence of surface casting shows the high preference for these types of soils by the rabbits and shearwaters to use for burrows (Jenkins and Owen 1995, 10).

Gley soils

Several gley soils have been identified in the middle of the island, where a patch of gley soils are located in the near environment of the excavated hut group 8. Soils of the groundwater gleys (which is one of the four identified gley soil types) consist of a dark greyish brown A horizon (10YR4/2) underlain by a wet and paler B horizon (10YR6/4). Loss-on ignition values decrease here from 42% to 5%, whereas pH values are higher compared to the ones from the brown earths. Values range from an average of 5.0 to 5.6 from the surface downwards (Jenkins and Owen 1995, 10). No stones have been found on the surface, but the contents increased up to 24% at depth in the groundwater gley soils. In the environment of the Old Farm, humic stagnogleys have been identified. These soils are characterised by a dark peaty surface layer (Ol/f/h) and have a fairly high loss-on ignition average of 87%. Under this described layer lies a stoneless very dark greyish brown (10YR3/2) Ah horizon. Further down, at around 40 to 50 cm, the humic stagnogleys get slightly paler (10YR5/4) and show a 10% average of loss-on ignition values together with a stone content average of 15% (Jenkins and Owen 1995, 11). PH values range from 3.8 at the surface to an average of 4.6 at depth (Jenkins and Owen 1995, 11). Stagnopodzols and rankers are not located in the near vicinity of the excavated area, which is why these will not be described into further detail.

1.3 Vegetation of Skomer Island

A current lack of trees on the Island limits the vegetation to shrubs and herbs. The vegetation of Skomer is mainly dominated by bracken, heather and grassland. Bray (1981) has mapped the vegetation with the use of a statistical analysis of 270 quadrats which resulted into 16 vegetation types (Jenkins and Owen 1995, 2). Various biological factors influence the vegetation. A first example is the effect of salt-spray together with the grazing of large populations of rabbits, which caused the growth of very short *Agrostis tenuis* (common bent) or *Festuca rubra (red fescue)* swards (Jenkins and Owen 1995, 2). Swards on the Island have been further damaged by trampling, nest burrowing, nest collecting and defaecation of large bird colonies of species such as puffins, shearwaters and lesser black backed gulls (Gillham 1964 in: Jenkins and Owen 1995, 2). Since 1955 a trend of the expansion of bracken at the expense of heathland and grassland has initiated (Jenkins and Owen 1995, 2). Since the introduction of rabbits to the island happened over the last century, the vegetation (and soils) were less influenced by the fauna and might have shown a higher variance in plant species on Skomer.

Weather conditions on Skomer Island

Skomer Island has a meioceanic climate with warm summers and mild winters. The total annual rainfall is just under a 1000mm per year with a moisture deficit of a 100-140mm. Furthermore, it is assigned to be very exposed, since the average annual wind speed is over 6.6 meters per second (Jenkins and Owen 1995, 2). Gales were recorded to have been damaging the local vegetation of Skomer Island, but are very infrequent (Alexander 2014, 32). The most damage to vegetation is usually done in the south and west coasts of Skomer, but other parts have been affected in the past as well. Not only gales have caused previous damage, but also periods of drought (particularly during summer) have previously caused vegetation to die off. Drought has particularly damaged vegetation in combination with salt-spray on the island. Records of high salt values in the dried out soils prevented plant species such as *Festuca rubra* (red fescue) to perform osmosis and therefore could not get any water out of the soil to live on (Alexander 2014, 32).

Chapter two – Methods and analysis

2.1 Magnetic susceptibility

2.1.1 Lab methods

Six subsamples were recovered from trench 1, hut 8 from the six samples mentioned in chapter one and have been used for a magnetic susceptibility analysis. All subsamples were first oven dried on 105 degrees Celsius. The dry weights of the samples vary between 6.11 and 10.77 gram. **Table 1** (see appendix) describes the process of the subsample preparation before the analysis could take place. The magnetic susceptibility analysis was carried out with a Bartington meter Ms2. Methods follow Gale and Hoare (1991, 222-226).

2.1.2 Principles of Magnetic susceptibility

Magnetic susceptibility makes it possible to measure bulk magnetic properties of the soil samples in a non-destructive way (Gale and Hoare 1991, 202). It relies on the two occurring movements of electrons around the nucleus of an atom (axial spin and orbital rotation). This causes electrical currents to flow around the atom which is associated with a so-called ‘magnetic moment’. The product of the currents is measured in amperes and is associated with the area of the loop (Gale and Hoare 1991, 202). The magnetic moment consists of the spin and orbital magnetic moments combined and is also known as *magnetisation* (Gale and Hoare 1991, 202). When one applies a magnetic field to the material of research, the magnetisation of that material increases and it is the extension of the rise in magnetisation which is measured as magnetic susceptibility, recorded in SI (system internacionale-meter-kilogram-second) units (Gale and Hoare 1991, 202).

2.1.3 Application on archaeological studies

The magnetisation of material can be compared with that of its parent material (Gale and Hoare 1991, 208). This however may be altered in a situation where (bio)chemical weathering has occurred. Quite often, a close relationship is found between the particle-size distribution and magnetic susceptibility (Gale and Hoare 1991, 205). Furthermore, the addition of organic matter, the precipitation of iron-rich groundwater, pedogenesis and burning of the material can all contribute to a change in magnetic susceptibility of the material (Gale and Hoare 1991, 209-214). Measuring the magnetisation of palaeosols or sediments can thus be an analysis that confirms their identifications.

2.1.4 Calculations

The Bartingtonmeter has two options in terms of frequencies of magnetic susceptibility: 1 and 10 kHz. For this study, the frequency of 1kHz was chosen (Thompson and Oldfield 1986, 56). Measurements were recorded in SI units and have been converted into standardised units: 10^8m^3kg^1. The first equation shown here was used to correct the values of the two readings that need correction due to the drift of the sensor during the readings.

$$K(corrected) = mean\ measurement - [\frac{first\ air\ reading + final\ air\ reading}{2}]$$

After correction of the results of all sample measurements, the last equation was used to get the results in the desired units of measurements: $(\frac{SI\ value}{dry\ weights})/10$.

All values, including the converted ones are shown in chapter three.

2.2 Loss-on ignition

2.2.1 Lab methods

Loss-on ignition was carried out directly after finishing magnetic susceptibility. The same subsamples were used for both analyses. The first step in the process (oven drying of the subsamples) could be omitted, since that had already been carried out for the magnetic susceptibility analysis. The subsamples were shifted from plastic pots to labelled crucibles with the use of a spatula and further methods follow Heiri, Lotter and Lemcke (2001). A muffle furnace was used for heating the samples to 550 and 950 degrees Celsius, while a different oven was used for drying out the samples in order to collect the dry weight values.

2.2.2 Principles and archaeological applications of Loss-on ignition

Loss-on ignition is a method that is used for estimating the amount of organic matter and carbonate contents of sediments (Bengston and Enell 1986 in: Heiri, Lotter and Lemcke 2001, 102). By placing subsamples in crucibles in the oven on 550 degrees Celsius for one up to four hours, organic matter in the sediments is oxidised (Heiri, Lotter and Lemcke 2001, 101). This treatment is then followed by the weighing of the samples, in order to estimate the amount of organic matter of the material. After weighing, the samples are placed back in the oven and heated up to around 950 degrees Celsius (temperatures vary between 900 to 1000 degrees Celsius, depending on methods applied). This will cause the carbon dioxide to be oxidised from the sample which can then be measured by weighing the samples again once they have cooled down (Heiri, Lotter and Lemcke 2001, 101-102).

2.2.3 Calculations

The results in chapter three are shown as weight percent organic matter and carbonate contents, in order to be able to compare them to each other. Two equations have been used to convert the measurements into percentages and are shown below, following calculations from Heiri, Lotter and Lemcke (2001).

$$LOI550 = \left(\frac{DW105 - DW550}{DW105}\right) * 100$$

LOI550 stands for Loss-on ignition of organic matter (the 550 represents the temperature of the furnace), whereas DW stands for dry weight, so DW105 stands for the dry weight after an oven treatment of 105 degrees Celsius and DW550 represents the weight after the samples had been in the oven of 550 degrees Celsius.

$$LOI950 = \left(\frac{DW550 - DW950}{DW105}\right) * 100$$

LOI950 represents the results in percentages for the loss of carbonate contents in the sediments. DW550 and DW105 remain the same as in the first equation and DW950 stands for the dry weight after a 950 degrees Celsius treatment.

2.3 Particle size analysis

2.3.1 Lab Methods

Lab methods for this analysis are limited to hand sieving and weighing. Results of the small particle sizes had already been obtained through a previously carried out session of particle size analysis on the subsamples of Skomer Island a year prior to this study. The machine Horiba has been used for this analysis and results were directly digitally available. In order to take larger particle sizes into account with the analysis, hand sieving of subsamples took place. From all samples, a small amount of subsamples were taken and oven dried on 105 degrees Celsius. They were left to dry overnight and crushed afterwards with a ceramic pestle and mortar. Once all the material was crushed, it was sieved through a total of seven sieves of varying sizes. Due to the fact that the sieve sizes did not completely overlap with the particle sizes in the calculation data, they were linked to the most closely related particle sizes. **Table 2** displays the sieve sizes used for this research and the particle sizes they were linked with in the calculation data. The material that did not pass a certain sieve was weighed and calculated as the percentage of the total weight. These percentage measurements were used as input data in the calculation sheet. Further explanation of this calculation sheet is discussed in paragraph 2.3.3. The method discussed here can be carried out either with the so-called sieve-pipette method or with the help of a laser diffractometry (Beuselinck et al. 1998, 194). In this study the latter option was used in order to save time and the options of using a smaller amount of sediment. Using the laser diffractometry also provides more detailed results on the grain size distribution (Beuselinck et al. 1998, 194). A disadvantage of this method however is caused by a possible underestimation of clay size particles present in the samples and are likely to be identified as silt particles. Clay particles are smaller than 0.4 nanometre and therefore diffract light at all angles, causing the laser diffractometry to create possible errors in identifying their true size (Beuselinck et al. 1998, 206). This possible error will be taken into account for the interpretation of the data, but the relative differences will stay the same for the samples, as the Horiba machine has been used for all samples.

Soil type determination

With the use of an online soil texture calculator, the particle size distribution results were used to determine the soil types for every sample (Natural Resources Conservation Service Soils). The soil types are defined by the ratio of percentages of sand, silt and clay and can help identify the origin of the layers of and underneath the excavated mound.

2.3.2 Principles and archaeological application of particle size analysis

Particle size analysis is a method to investigate the particle size and particle-size distribution of unconsolidated geological materials (Gale and Hoare 1991, 56). It is based on the fact that a mineral fraction of a soil consists of particles that can range in size (Canti, 1). The particle size distribution is identified by measuring what percentage of the soil weight makes up for every grade in particle size (Canti, 1). The laser diffractometry relies on other principles than the sieve-pipette method. It measures the volume percentages of particles which are based on their optical diameters. Every particle diffracts light at a different angle, depending on the grain diameter and spherical diameter and is presented by an inversion model of diffracted light (Beuselinck et al. 1998, 204).

By identifying the particle size and particle-size distribution of the samples, a better understanding can be reached on the behaviour of a regolith under varying physical conditions (Gale and Hoare 1991, 56).

2.3.3 Calculations

As mentioned in 2.3.1., the only calculation carried out during the preparation was the calculation of percentages of total weight of the material that remained in the sieves. These measurements, together with the Horiba measurements were put into an excel file, where calculations follow the method of A. Danujko and where statistics for fractions smaller than 3mm are calculated according to Gale and Hoare (1991) (Gale and Hoare 1991, 65). For every sample, statistics for fractions under 3mm are given, along with a table of sediment size distribution (also presented in the form of a histogram). Furthermore, diagrams of the following information were given by the calculation file:

- A diagram displaying the diameter of particle sizes in phi units as well as a diagram showing the values measured in mm, plotted against the percentage of presence within the samples.
- The particle size in nanometres plotted against the cumulative frequency in percentages and one where the values are displayed in phi units, also plotted against the cumulative frequency. The results can all be found in chapter three.

2.4 Pollen – Methods in the lab

2.4.1. Subsampling and pollen preparation

A total of six 0.5cm³ subsamples were taken from the two kubiena tins mentioned in chapter one. From each tin, three subsamples were collected with the use of a spatula. **Table 3** (see appendix) shows the depths of each subsample.

Subsamples were processed following the chemical methods of Faegri and Iversen (1992). Some adjustments have however been made. The samples were for instance centrifuged for 3 minutes on 3000 rounds per minute. This will not affect the results in any way. Furthermore, step 5 of the Potassium Hydroxide Digestion part (see figure 9) has not been carried out. For safety reasons an alternative of step 2 to 4 in the Hydrofluoric acid treatment part has been conducted. 1ml of distilled water was added to the mixture and mixed well before adding the Hydrofluoric acid to the mixture. In the Acetolysis part of the preparation, step 6 was cancelled out by adding 2ml of glacial acetic acid to the subsamples during step 3.

5mm of every subsample has been used in the process. For every tube containing subsamples, two Lycopodium tablets have been added, where each tablet contains 10679 Lycopodium spores. The Batch number of the tablets used is 938934. Adding these spores was necessary to determine the pollen concentration of each slide (Stockmarr 1972 in: Almquist-Jacobson and Sanger 1995, 215).

2.4.2. Microscopic analysis

From every prepared subsample, two slides have been produced and assessed on the presence of pollen. A binocular microscope (Zeiss) was used to carry out the identifications of the pollen in the slides. Magnifications of a 100 and 400 times were used and for the identification of one pollen a magnification of 1000 along with immersion oil was used.

No pollen seemed to be present in the samples. For this reason, Lycopodium spores were counted for one slide per depth up till the amount of 50. In case there were less than 50 Lycopodium spores present in the slide, the total amount of spores was recorded.

In order to get palynological information on the site, six previously prepared subsamples were used in this study and originate from the soil samples that have also been used for the soil analyses in this research. Chapter one discusses their origin. Initially, six slides were created for the analysis of six different layers (the same layers that were researched for soil analyses). For every depth a total of at least 500 pollen were aimed to be identified, where spores, aquatics and unidentifiable pollen did not count. The total number of present Lycopodium spores was recorded for every slide. Separate recording sheets were used for every slide. In case less than 500 pollen were identified for one slide, a second or third slide was prepared and analysed. There were unfortunately still very little pollen in some samples, even though three slides per sample were prepared and analysed in some cases.

Unidentified pollen

Most unidentified pollen were only categorised as such because of very bad preservation or where no features were visible or recognisable. One pollen potentially identifiable pollen was categorised as unidentified, since, even with the features and use of a 1000 times magnification, it could not be assigned with confidence to a certain species. Two of these pollen were found in the subsample from layer 102.

A magnification of 1000 was used in order to attempt this unidentified pollen. It is presumably a trizonocolporate pollen, with a psilate (rather smooth) structure. The identification key of Web and Moore was followed (1991). A reference collection was available and all possible species that followed from the identification key were taken from the collection for comparison. Not all options from the key were available in the reference collection and some options could not be checked. Since comparisons could not have been made in some cases, the confidence of identification of the pollen in the sample remains too low for a concluding result. A list of species was checked and the following species were excluded from the options:

Spergula-type pollen was not available in the collection and *Digitalis*-type pollen looked more rounded in comparison with the unidentified pollen from Skomer. Several other species were excluded from the list due to their thicker external wall or for having a different texture than the pollen from sample 102. These species are: *Anthrisus caucalis* and *Petroselinum segethum*, *Glaucium*-type pollen, *Frankenia levis, Myrica germanica*, *Cristo palustris* and *Craetaegus*-type pollen. There was no slide containing Sison Amomum in the reference collection, nor a picture of it in the book, making it impossible to check this option. *Rubus* species appeared to contain more obvious pores than the mystery pollen and thus no other option from the key remained to be checked.

2.4.3. Post-identification analysis.

Since there are no chronological details for the samples, the use of the Tilia programme has been left out. The results for all samples have been put into diagrams displaying the absolute count, the percentages of pollen and the pollen concentration per species recorded. In order to calculate the pollen concentration for every species, the following formula has been applied:

$$Pollen\ concentration = \left(\left(\frac{p}{m}\right) * (2 * 10679)\right) * 0.5$$

The letter 'p' in the equation represents the amount of identified pollen of a specific species, whereas 'm' stands for the amount of counted lycopodium spores in the sample. This is then multiplied by the average amount of pollen spores per added tablet. Because two tablets were used for every sample, this average has to be multiplied by two. Eventually, the outcome of this calculation is then divided by 0.5, which represents the volume or weight of the subsample that has been prepared for pollen analysis.

2.5 pH values

In addition to the analyses, pH values were obtained from six subsamples taken from the six samples used for the soil analyses and pollen analysis. For the pH values to be measured, the subsamples were taken from the sieved and crushed material that was previously used for the hand-sieving part of the particle size analysis. Six glass beakers were filled with distilled water to around 150 ml and very little crushed and sieved material was then added and stirred through with a plastic spoon. The first measurements were carried out with a pH measurer to obtain the exact values (a pHep machine of the type HI98187 was used). This hand-held device was manually calibrated to 7.0 whilst being placed in distilled water every time before a measurement took place. The measurer was washed with tap water before being used for measuring the pH of a new sample in order to prevent contamination or the mixing up of values. In order to get a double check and to make sure that the measurements were accurate, a second time of pH measuring was done on the same solutions of distilled water and sieved material. The second time was however carried out with pH measuring sticks. These were only used as an indicator for the accuracy, as they do not provide exact values but only whole number values (the measurer gave values with one decimal accuracy). Results can be found in chapter three.

Chapter three - Results

3.1 Magnetic susceptibility and loss-on ignition

Table 4 displays the results for the magnetic susceptibility analysis both in SI units and their standardised units. Although the values don't range very much from each other, some of them are distinct from the rest. The values of layers 107 and 110 appear to be the lowest of all and lay very close to each other. Sample 102 has far out the highest value and suggests a different composition of minerals in the material, which will be discussed in the next chapter. When the magnetic susceptibility values are compared to the loss-on ignition results (both visible in **table 5** and **7**), layers 107 and 110 seem to differentiate themselves from the others again. Their relatively low organic matter percentages could be an explanation for the low amount of pollen they contained. This would be in agreement with the high organic matter values of samples 102 and 103, who had the highest amount of identified pollen (see **table 7**).

The levels of carbonate content don't seem to be very different amongst the samples, but it does become clear again that samples 102, 107 and 110 are the outliers. The carbonate content does seem to have less to do with the amount of pollen in the samples. **Table 7** shows the combined values of the magnetic susceptibility, loss-on ignition and the amount of identified pollen. When comparing the different values for the different samples, it seems most likely that the amount of pollen in the samples is related to the organic matter. Carbonate contents suggest being less related to the amount of pollen. Sample 103 has for instance a lower carbonate content than samples 107 and 110, but has a much higher amount of pollen present. Sample 102 has the highest carbonate content, but also contains a high amount of pollen.

Sample number	Dry Weight (g) sample	AR)1	(SI) Lf1	(SI) Lf2	AR2 (final)	Mean SI value	Corrected SI value	χLF (10-6 m3 kg-1)
102 - 7	810	-0.4	417	416.5	-0.8	416.75	417.35	0.0515
108 N- 8	847	0.8	216.4	217.1	0,4	216.75	216.15	0.0255
108 S- 9	756	1	215.7	216.1	0.8	215.9	215	0.0284
103 - 10	611	-00.6	170.8	170.7	0,3	170.75	170.9	0.028
107 - 11	1070	-0.1	166.8	167.6	-0.7	167.2	167.6	0.0157
110 - 12	789	-00.6	97.3	97.9	-0.1	97.5	97.85	0.0124

Table 4*. Magnetic susceptibility values of the soil samples. Measurements derived from independent study.*

Sample number	Dry wgt 105	Wgt 550	Cruc Wgt	Sample Dry(105)	Sample 550	LOI 550	Wgt 950	Sample 950	LOI 950	LOI% (organic matter)	LOI% (carbonate contents)
102	2259	2152	1449	810	703	107	2146	697	6	13	0.74
108 north	2261	2189	1414	847	775	72	2183	769	6	9	0.71
108 south	2160	2091	1404	756	687	69	2086	682	5	9	0.66
103	2010	1884	1399	611	485	126	1880	481	4	21	0.65
107	2481	2448	1411	1070	1037	33	2439	1028	9	3	0.84
110	2204	2167	1415	789	752	37	2160	745	7	5	0.89

***Table 5**. Loss-on ignition values of the soil samples. Measurements taken from independent study.*

Code	Meaning
Dry wgt 105	Dry weight after 105 degrees oven
Wgt 550	Weight of sample and crucible after 550 degrees oven
Cruc Wgt	Crucible weight
Sample Dry (105)	Sample – crucible weight after 105 degrees oven
Sample 550	Sample – crucible weight after 550 degrees oven
LOI 550	Loss-on ignition after 550 degrees oven
Wgt 950	Weight of sample and crucible after 950 degrees oven
Sample 950	Sample – crucible weight after 950 degrees oven
LOI 950	Loss-on ignition after 950 degrees oven
LOI% (organic matter)	Percentage of organic matter lost by ignition
LOI% carbonate content)	Percentage of carbonate contents lost by ignition

Table 6. Legend for the loss-on ignition table above (**table 5**)

Sample number	LOI% (organic matter)	LOI% (carbonate contents)	χLF (10-6 m3 kg-1)	Total amount of identified pollen present in sample
102	13	0.74	0.0515	872
108 north	9	0.71	0.0255	84.5
108 south	9	0.66	0.0284	73.5
103	21	0.65	0.028	500
107	3	0.84	0.0157	3
110	5	0.89	0.0124	12

Table 7*. Combination of magnetic susceptibility and loss-on ignition results, together with the total amount of identified pollen that was present in each sample.*

3.2 Results pollen analysis

The identified pollen are shown in **table 8**, expressed in absolute counts along with their relative abundance (expressed in percentages). All species are categorised into trees, shrubs or herbs. Tree pollen appear to be almost absent from the samples. Only sample 102 contains several tree pollen, but the percentages are very low and are not very convincing for the idea that they originate from Skomer (this will be further discussed in the next chapter). All samples suggest that shrubs and herbs have been dominating the landscape around the settlement. Although ratios may differ slightly between the samples, there seems to be a consistency in the species of the samples. The highest percentages are taken up by *Calluna vulgaris* pollen (common heather) and Poaceae pollen (grass family). As also visible in the table, only samples 102 and 103 contain a statistically reliable amount of identified pollen to base an interpretation on. Samples 107 and 110 contain a very low amount of pollen, but the ones that are present do suggest the presence of similar species to those from other layers. Furthermore, the pollen concentrations shown in **table 9** suggest a probably higher presence of the species found in samples 107 and 110 that would initially be expected after seeing **table 8**.

Sample number →	**102**	**102**	**108 – 8**	**108-8**	**108 - 9**	**108-9**	**103**	**103**	**107**	**107**	**110**	**110**
Species	*Total of 2 slides*	**In %**	*Total of 3 slides*	**In %**	*Total of 3 slides*	**In %**	*Total of 1 slide*	**In %**	*Total of 3 slides*	**In %**	*Total of 3 slides*	**In %**
<u>Trees</u>												
Pinus sylvestris	1	**0.11**	1	**1.18**	-	-	-	-	-	-	-	-
Tilia	2	**0.23**	-	-	-	-	-	-	-	-	-	-
Ulmus	4	**0.46**	-	-	-	-	-	-	-	-	-	-
Fraxinus excelsior	1	**0.11**	-	-	-	-	-	-	-	-	-	-
<u>Shrubs</u>												
Corylus avellana-type	1	**0.11**	-	-	-	-	-	-	-	-	1	**8.33**
Salix	60	**6.88**	8	**9.47**	13	**17.69**	23	**4.6**	-	-	5	**41.67**
Calluna vulgaris	556	**63.76**	28.5	**33.72**	23	**31.29**	146.5	**29.3**	2	**66.67**	-	-
Ericaceae	64	**7.34**	-	-	-	-	29	**5.8**	-	-	-	-
Vaccinium-type	-	-	-	-		-	8.5	**1.7**	-	-	-	-
<u>Herbs</u>												
Apiaceae	-	-	-	-	-	-	4	**0.8**	-	-	-	-
Poaceae	176	**20.18**	44	**52.07**	37.5	**51.02**	268	**53.6**	1	**33.33**	6	**50**
Asteraceae	-	-	-	-	-	-	8	**1.6**	-	-	-	-
Asteraceae *Taraxacum*	3	**0.34**	2	**2.37**	-	-	1	**0.2**	-	-	-	-
Plantago lanceolata	4	**0.46**	1	**1.18**	-	-	10	**2**	-	-	-	-
Filipendula	-	-	-	-	-	-	2	**0.4**	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Degraded	96	**9.5**	26	**22.1**	12	**13**	123	**19.6**	-	-	5	**16.7**
Obscured	41	**4.1**	7	**6**	7	**7.6**	3	**0.5**	3	**50**	13	**43.3**
Total amount of identified pollen	*872*		*84.5*		*73.5*		*500*		*3*		*12*	

Table 8. *Diagram of identified, unidentified and obscured pollen in absolute counts and percentages. Note: The percentages for the identified pollen are calculated from the total amount of identified pollen. For the calculation of the percentages of the unidentified and obscured pollen, absolute counts of all pollen have been used (per sample).*

Sample number→	**102**	**108-8**	**108-9**	**103**	**107**	**110**
Species						
Trees						
Pinus sylvestris	89	188				
Tilia	178					
Ulmus	356					
Fraxinus excelsior	89					
Shrubs						
Corylus avellana-type	89					555
Salix	5340	1505	4552	2077		2774
Calluna vulgaris	49479	5363	8053	13230	1709	
Ericaceae	5695			2619		
Vaccinium-type				768		
Herbs						
Apiaceae				361		
Poaceae	15663	8280	13130	24203	854	3329
Asteraceae				722		
Asteraceae *Taraxacum*	267	376		90		
Plantago lanceolata	356	188		903		
Filipendula				181		

Table 9. *Pollen concentrations per sample. Concentration were calculated based on a sediment volume of 0.5cm3 and 2 tablets of Lycopodium containing an average of 10679 spores being added to each sample.*

3.3 Particle size analysis

Results from the particle size analysis are derived from the Horiba data that was further analysed and calculated with the Danujko calculation excel file. Several figures and tables resulted from the calculations and are shown in this paragraph. **Table 10** displays the particle size distribution when all material is categorised into sixteen different categories based on the size of the particles that were present in the sample. The data is expressed in percentages and this makes it possible to use the data in order to determine the possible soil types of the layers. Percentages of sand, silt and clay particles were used and thus only three categories were necessary (percentages of fine, medium and coarse sand were added together to represent the total percentage of sand, for example). **Table 12** shows the identified soil types. According to this data, all subsamples suggest to be either a sandy loam or a silt loam, which would explain their mixed behaviour of particle size composition. This is in further agreement with the statistical values of the particles smaller than 3mm, displayed in **table 11**. The poorly sorted character of all the samples would also support the idea that the layers (if the samples would truly represent the layers) are very similar to each other and indicate they are from a local origin.

Next to the tables, several figures are derived from the particle size analysis in order to get a clear view of the particle size characteristics. Figure 10 to 27 display the particle size distribution in bar charts, the diameter expressed in phi units plotted against the percentages and the particle size plotted against the cumulative frequency for all particles under 3mm. Two more diagrams are given for each sample: the diameter plotted against the percentages and the particle size expressed in phi units plotted against the cumulative frequency. Interpretations discussed in chapter four will be based on the tables as well as on the figures of this analysis.

	Sample 102	Sample 108-8 (north)	Sample 108-9 (south)	Sample 103	Sample 107	Sample 110
V. Large Boulders	-	-	-	-	-	-
Large Boulders	-	-	-	-	-	-
Medium Boulders	-	-	-	-	-	-
Small boulders	-	-	-	-	-	-
Large Cobbles	-	-	-	-	-	-
Small Cobbles	-	-	-	-	-	-
V.coarse Pebbles	-	-	-	-	-	-
Coarse Pebbles	-	-	-	-	-	-
Medium Pebbles	-	-	-	-	-	-
Fine Pebbles	-	-	-	-	-	-
Coarse Sand	30.30825688	22.30392157	15.77669903	29.72972973	34.28258488	9.759036145
Medium Sand	10.13551017	8.22192695	10.89368308	10.09981513	2.318633915	3.242322821
Fine sand	15.85255541	16.31500517	19.99473039	21.3908846	16.9026748	23.31906804
Silt	41.02659039	49.89968797	50.39449915	37.97791176	40.14956533	54.27481155
Clay	2.677087156	3.259458333	2.94038835	0.801658784	6.346541073	9.404761446
Total	100	100	100	100	100	100

Table 10. *Particle size distribution (expressed in percentages) categorised in different particle size groups.*

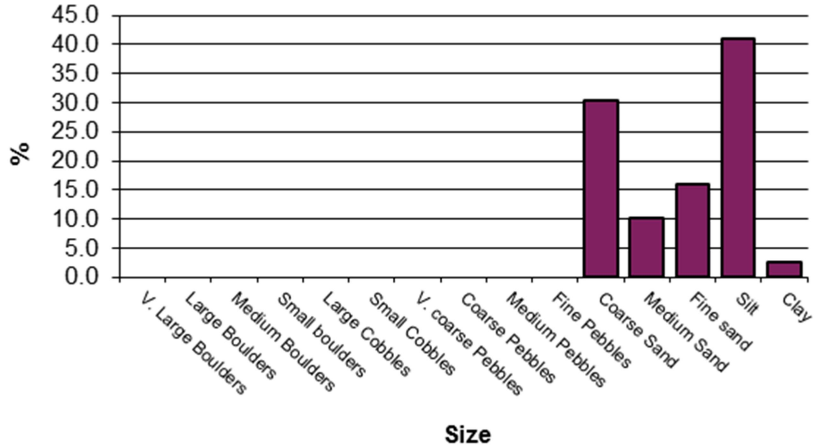
Statistics for < 3mm fraction	Median (Md)	Mean (Mz)	Sorting (σI)	Skewness (SkI)	Kurtosis (KG)
Sample 102	3.510080513	3.448907984	-2.89443849	0.047872647	0.658927058
Description	Very fine sand	Very fine sand	Very Poorly sorted	Nearly symmetrical	Very platykurtic
Sample 108 north	4.227851387	3.840607979	-2.773976554	0.158171285	0.660225059
Description	Coarse silt	Very fine sand	Very Poorly sorted	Postitive skew	Very platykurtic
Sample 108 south	4.178699404	3.978337048	-2.565703592	0.127850271	0.747253166
Description	Coarse silt	Very fine sand	Very Poorly sorted	Postitive skew	Platykurtic
Sample 103	3.337795444	2.739150174	-3.029138836	0.193801361	0.76360559
Description	Very fine sand	Fine sand	Very Poorly sorted	Postitive skew	Platykurtic
Sample 107	3.784694982	3.133165219	-3.467450587	0.159201495	0.628338178
Description	Very fine sand	Very fine sand	Very Poorly sorted	Postitive skew	Very platykurtic
Sample 110	4.648382741	4.85410754	-2.44321691	-0.05394218	1.172244842
Description	Coarse silt	Coarse silt	Very Poorly sorted	Postitive skew	Leptokurtic

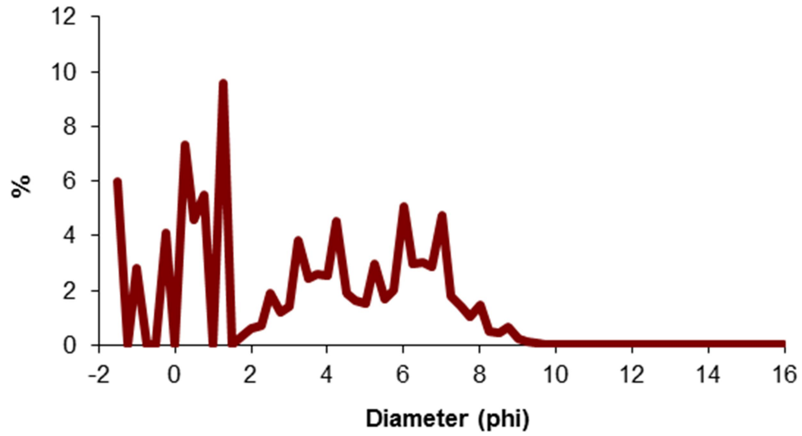
Table 11. *Statistical values of the soil samples derived from the particle size analysis, including soil descriptions based on the values.*

	Sample 102	**Sample 108 - 8**	**Sample 108 - 9**	**Sample 103**	**Sample 107**	**Sample 110**
Soil texture	Coarse sandy loam	Coarse sandy loam	Silt loam	Coarse sandy loam	Coarse sandy loam	Silt loam

Table 12. *Soil texture per sample, calculated with the soil texture calculator.*

Sample 102





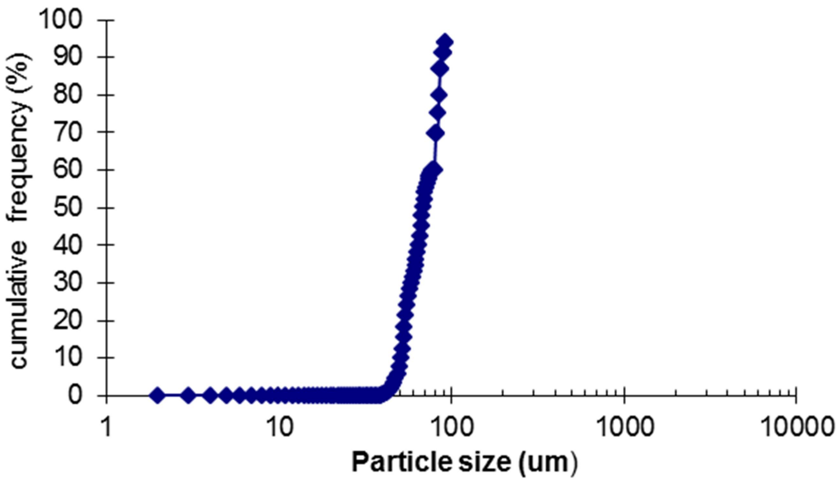


Figure 10.

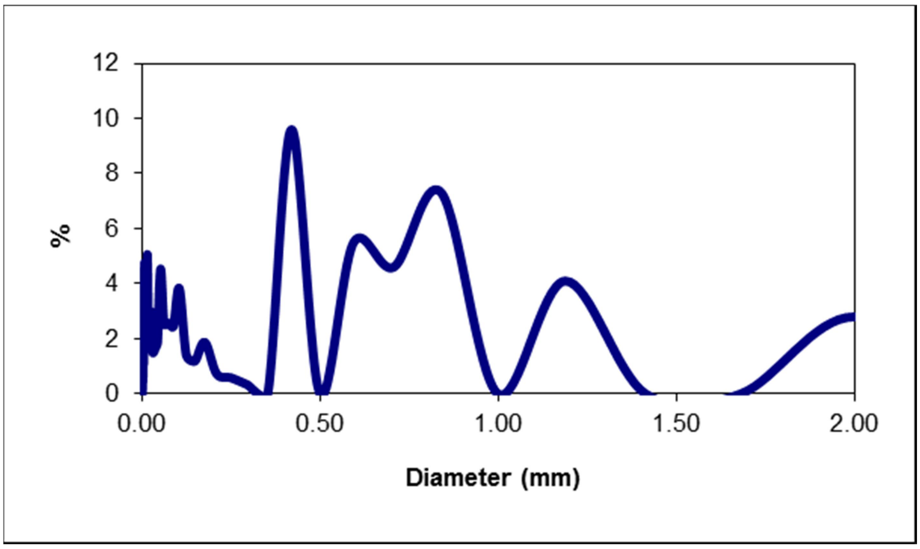


Figure 11.

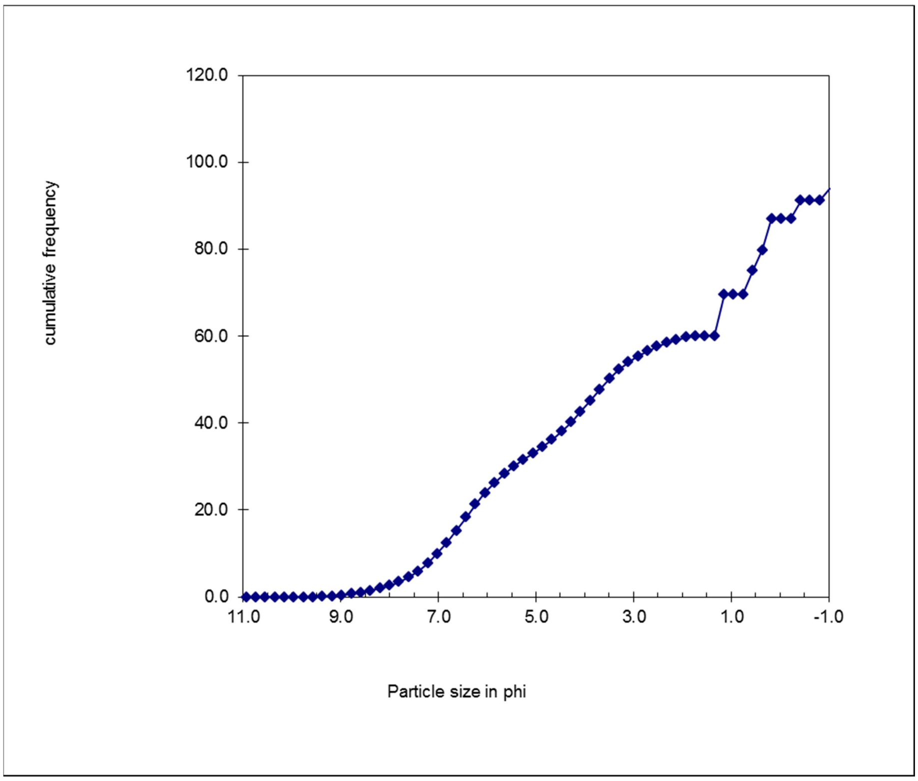


Figure 12.

Sample 108 – 8

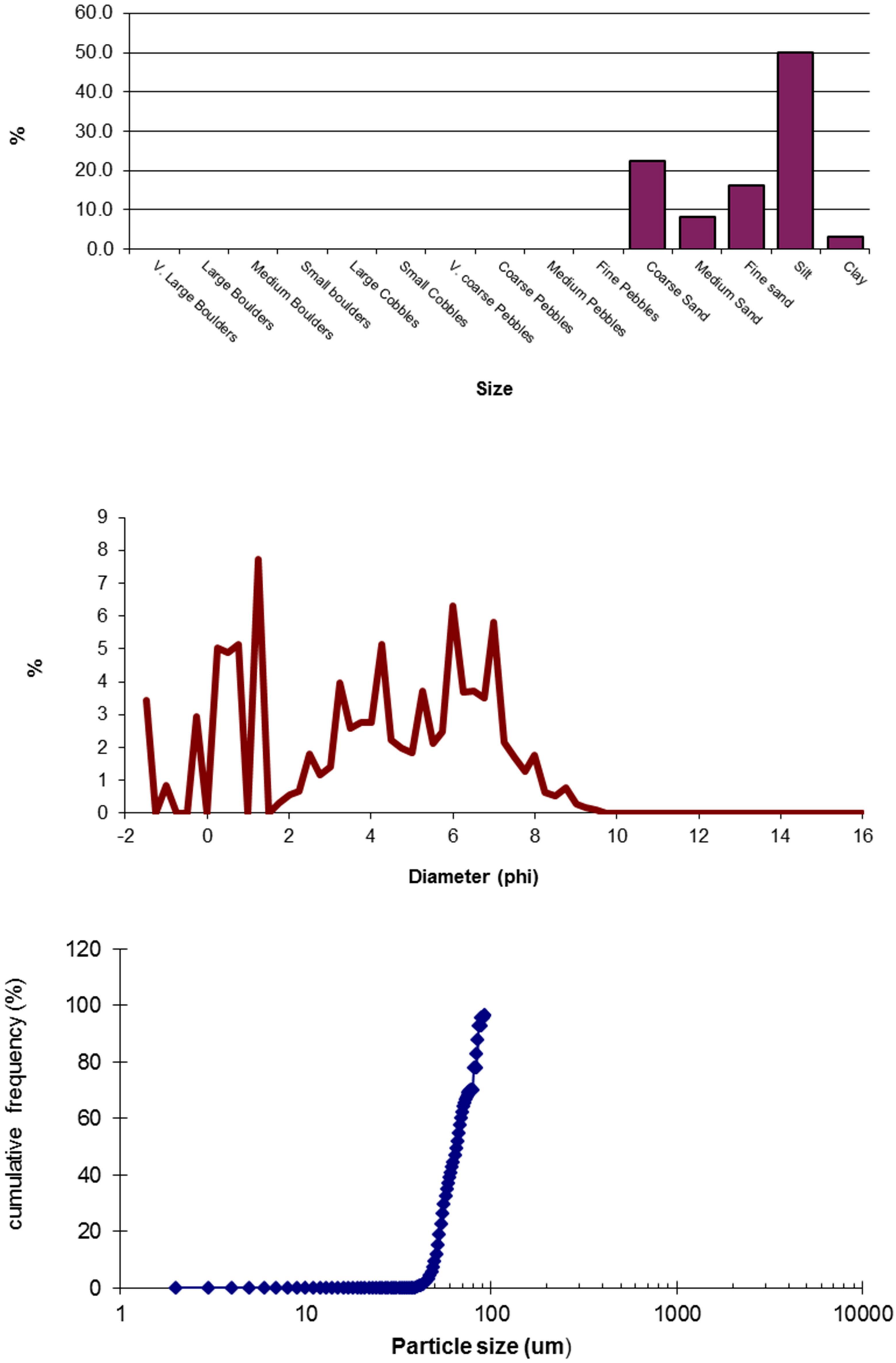


Figure 13.

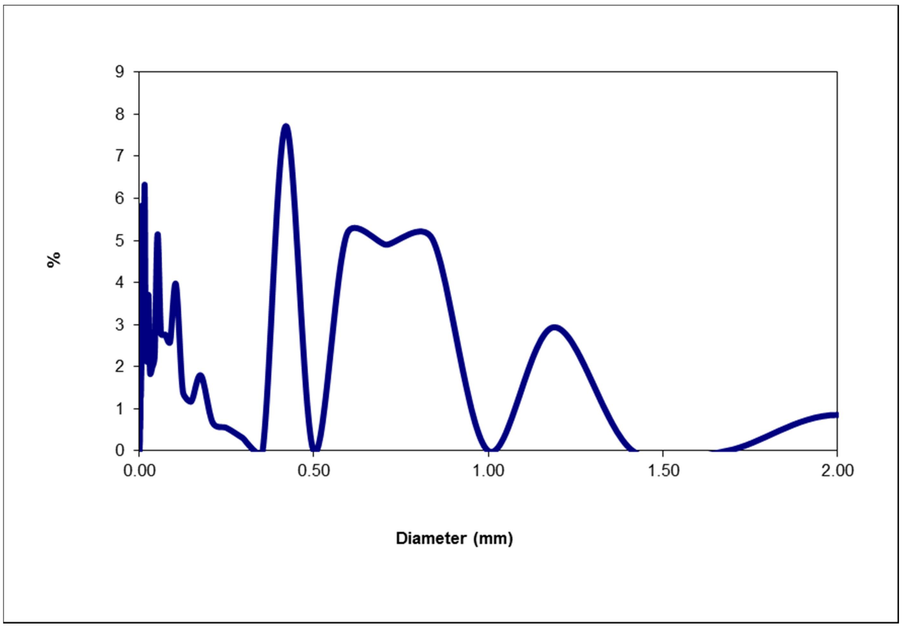


Figure 14.

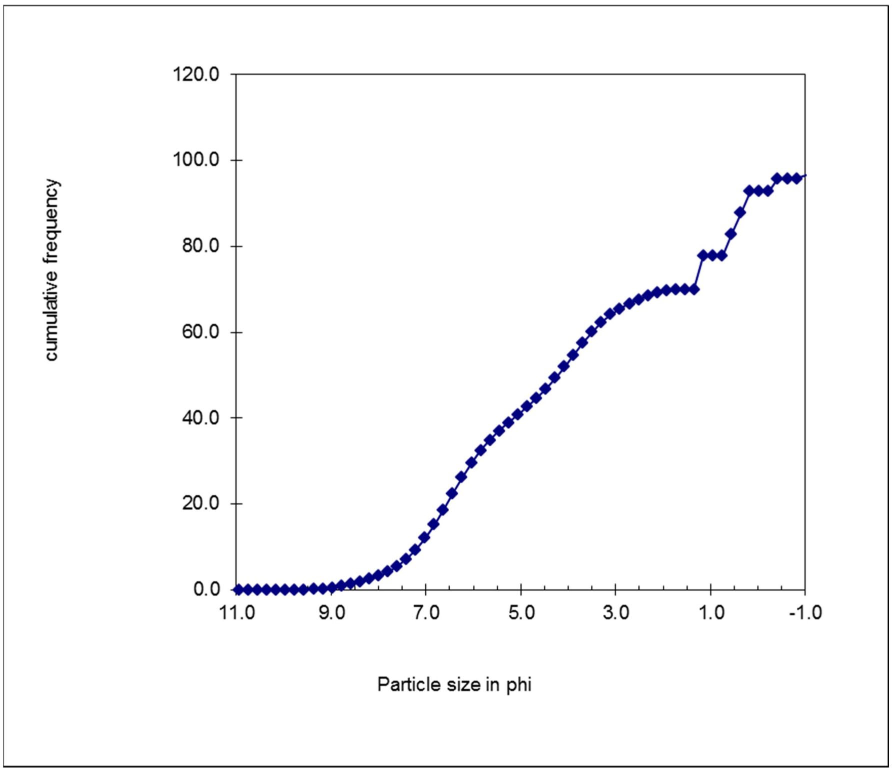
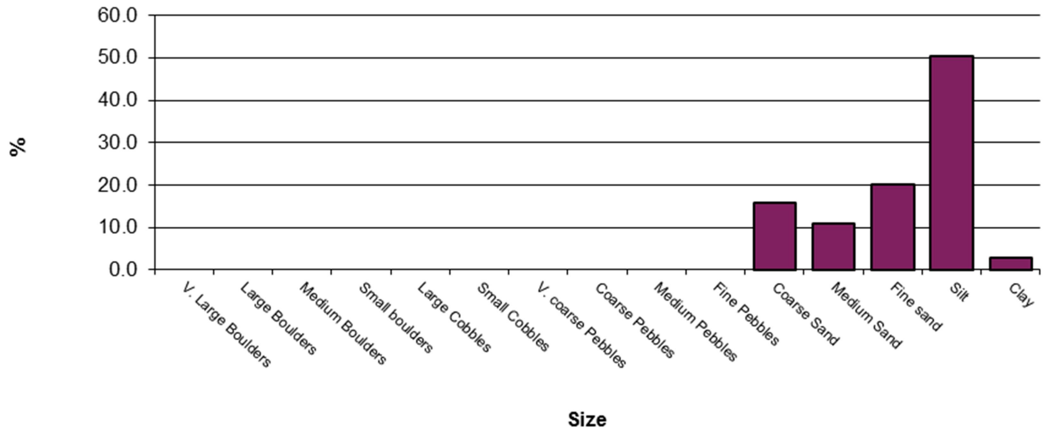
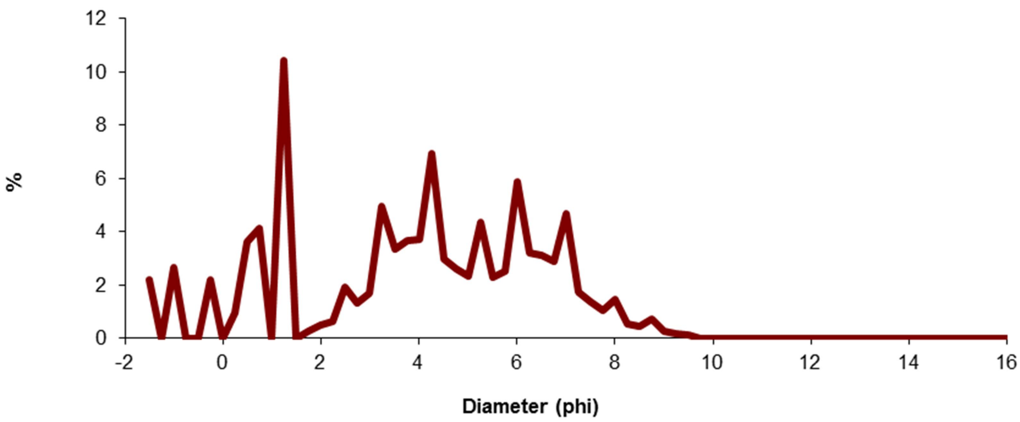


Figure 15.

Sample 108 – 9





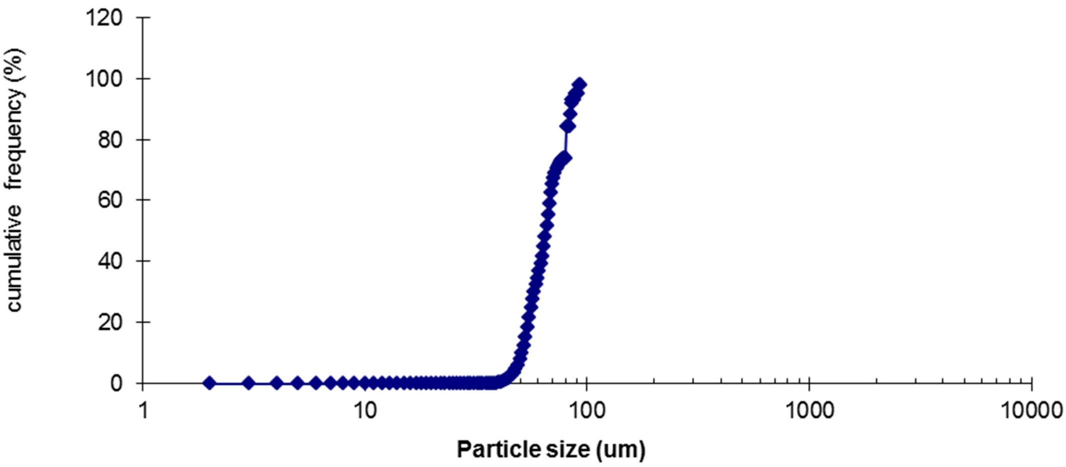


Figure 16.

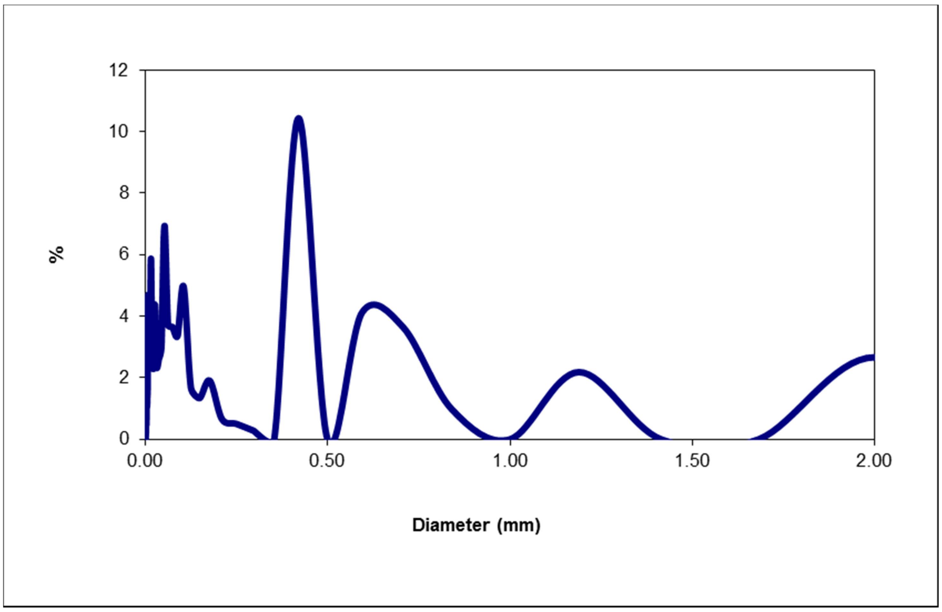


Figure 17.

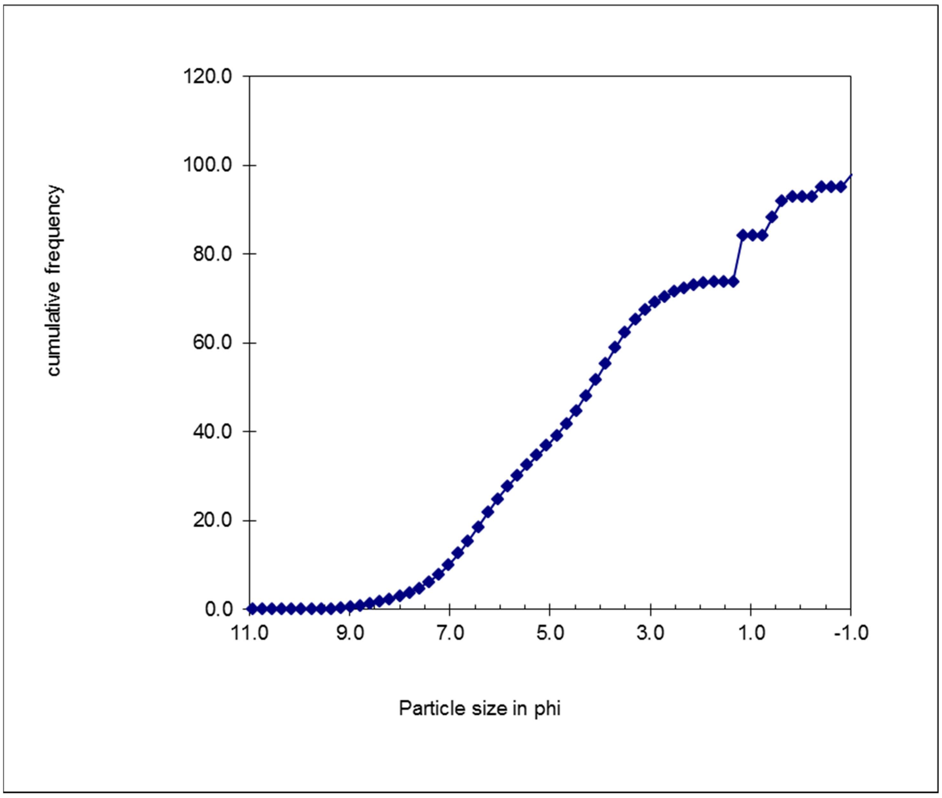
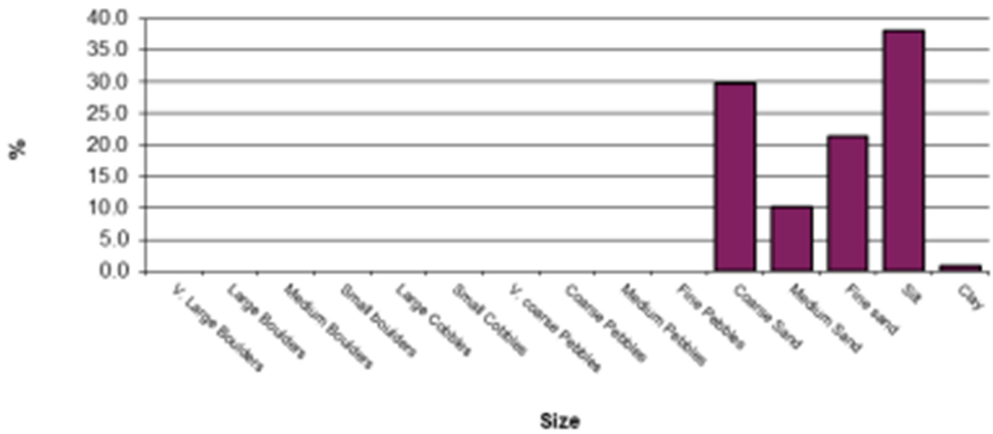
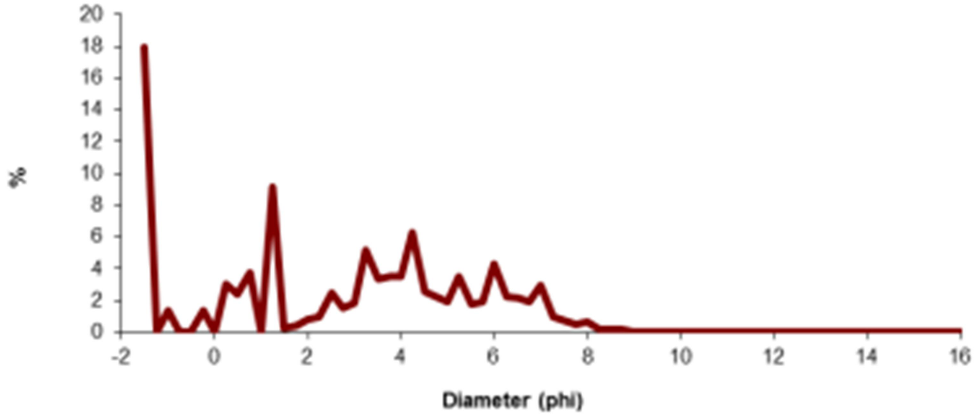


Figure 18.

Sample 103





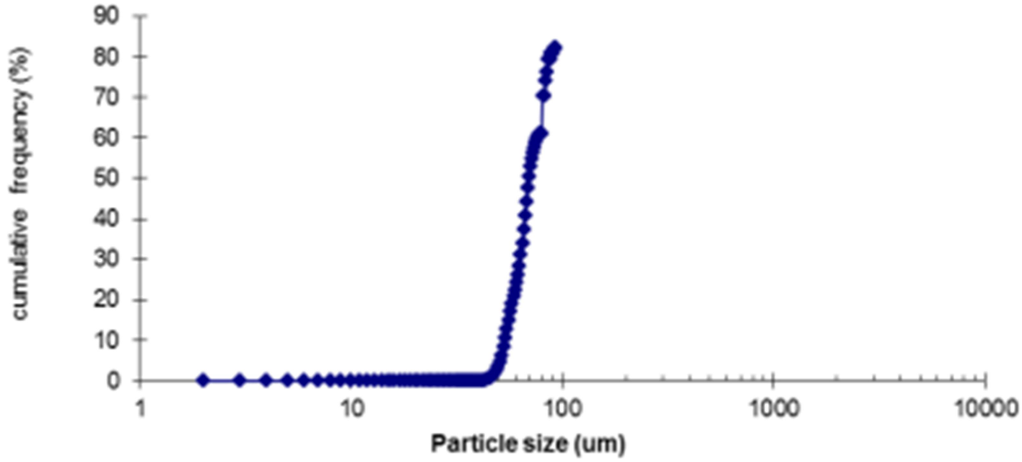


Figure 19.

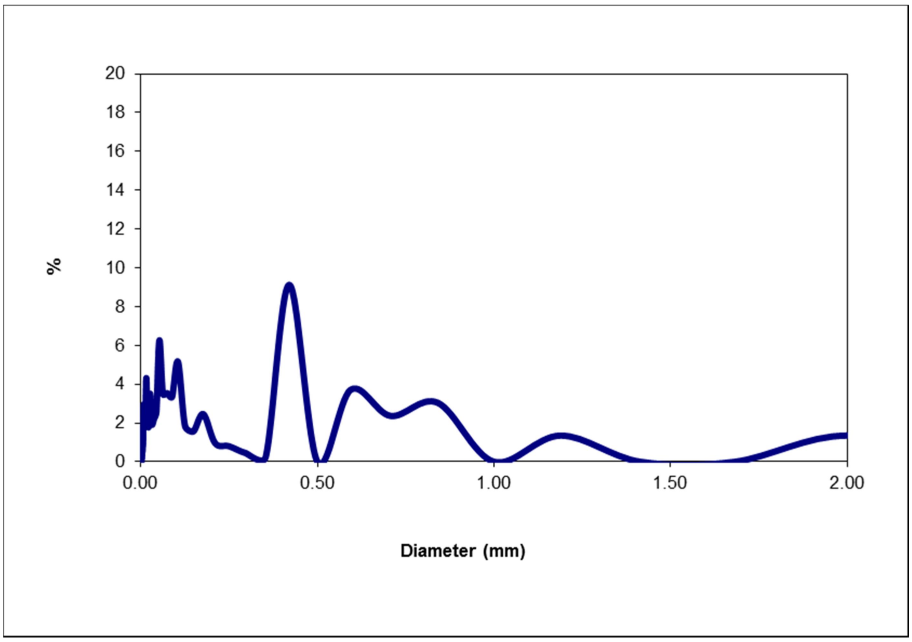


Figure 20.

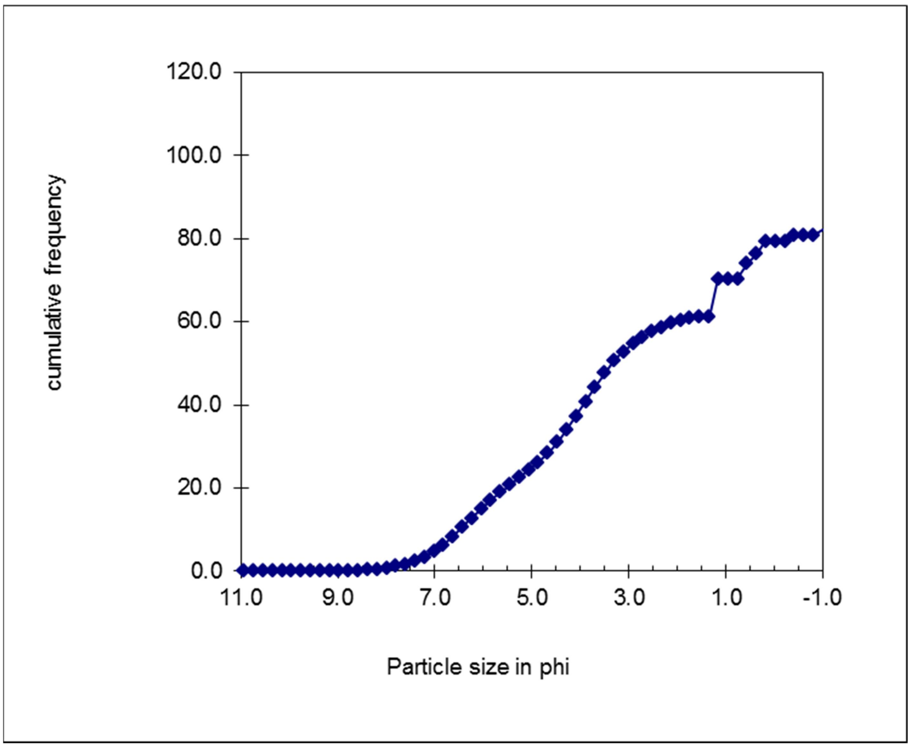
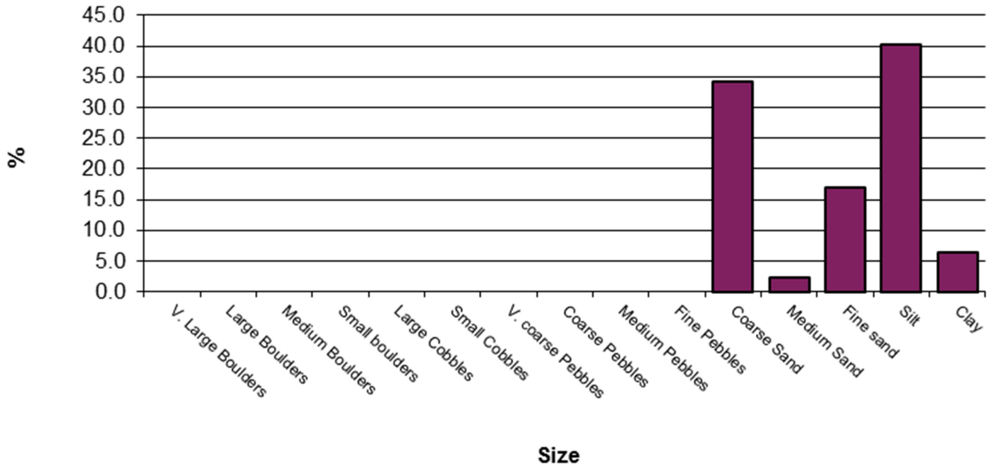
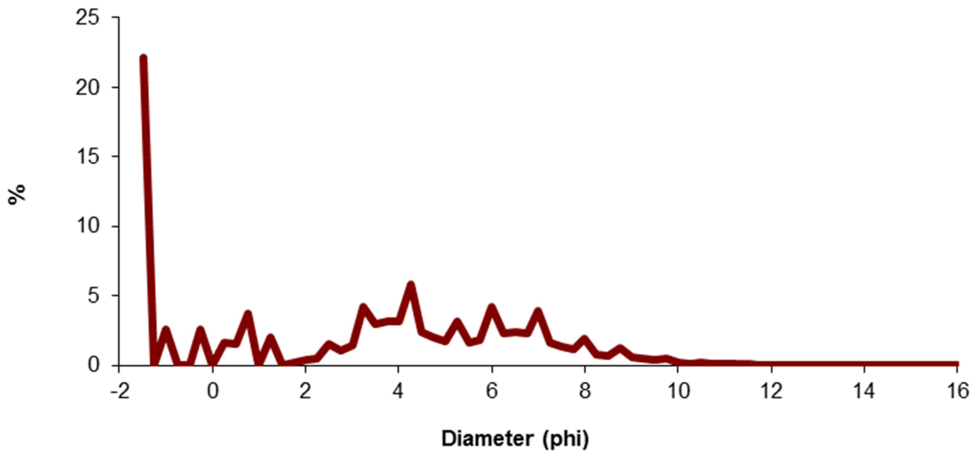


Figure 21.

Sample 107





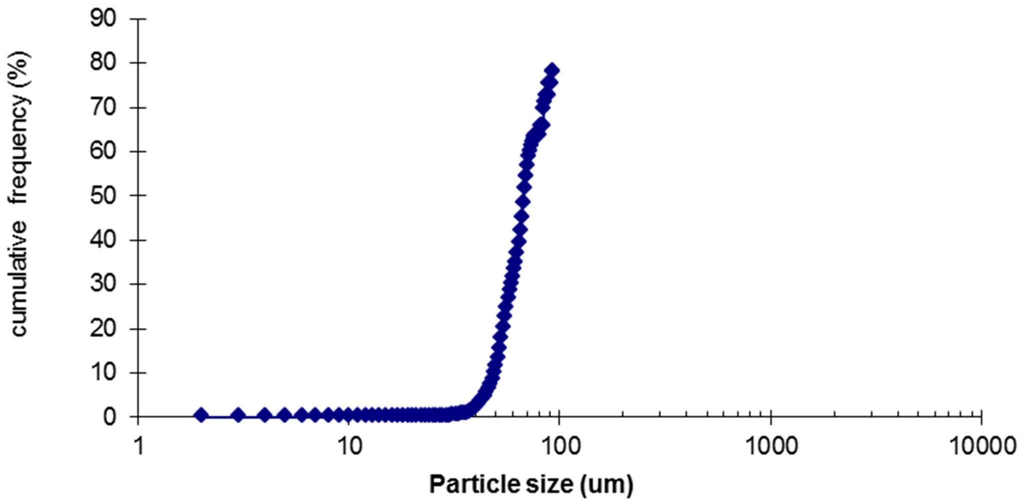


Figure 22.

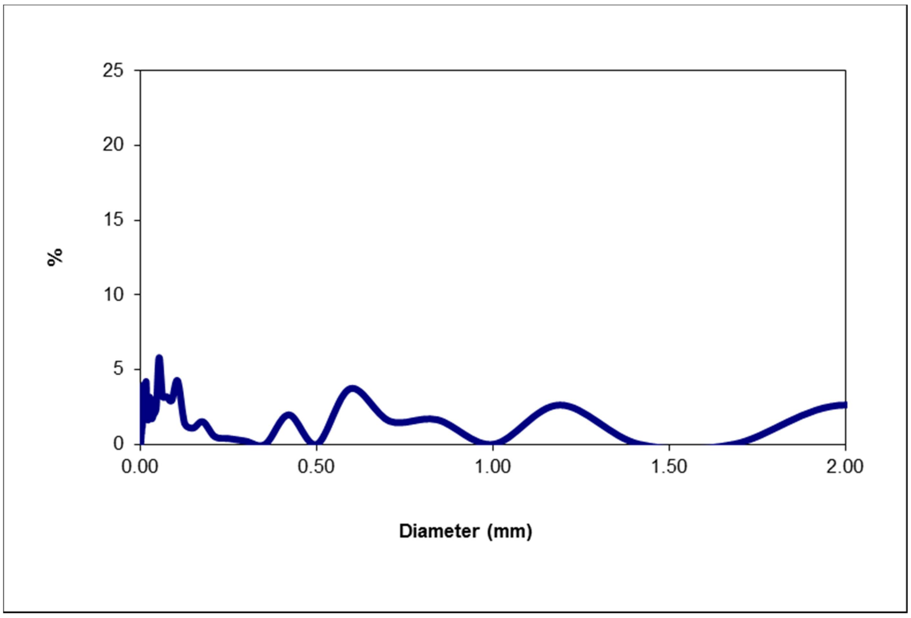


Figure 23.

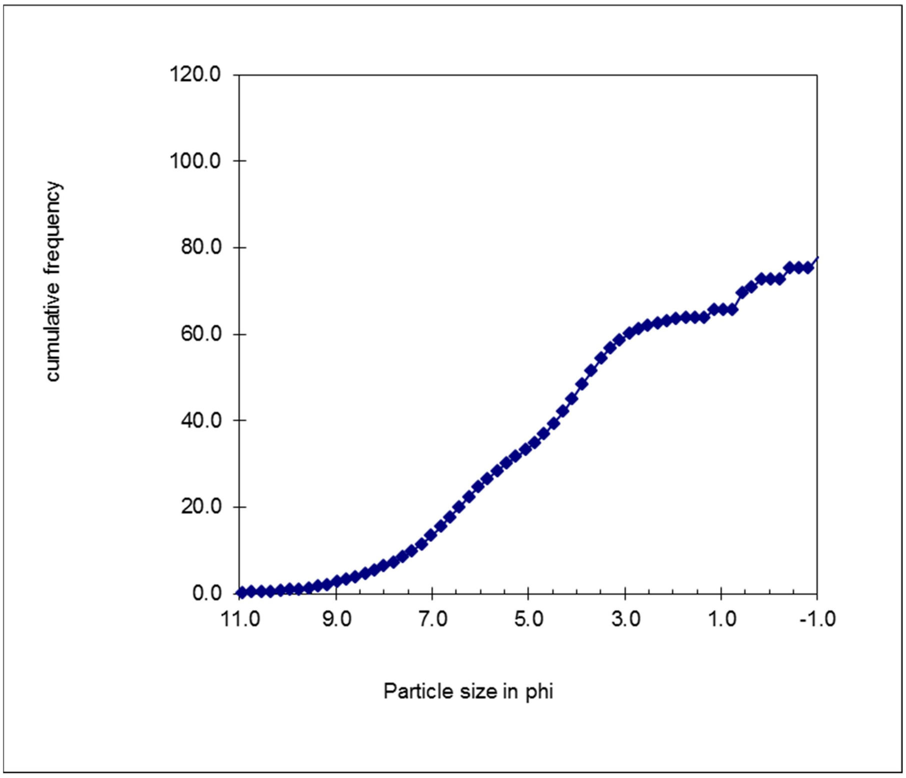
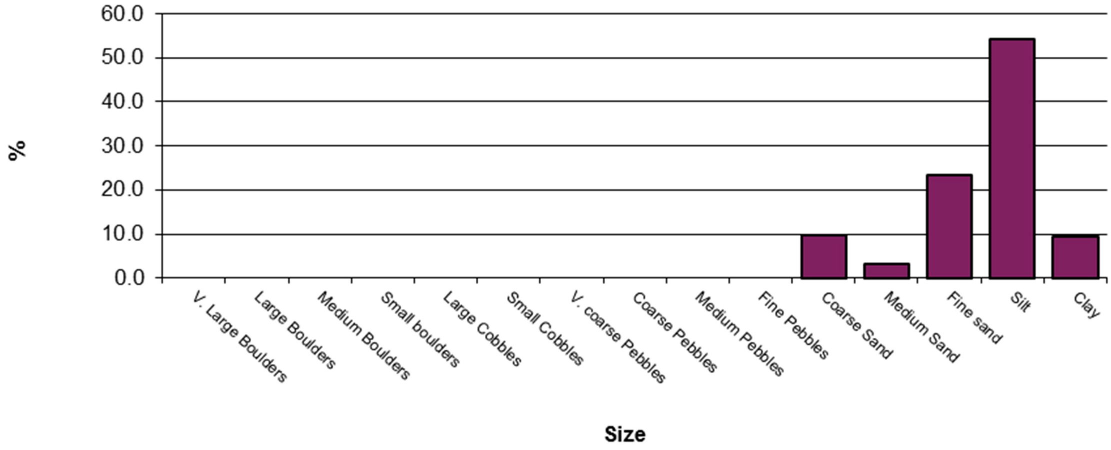
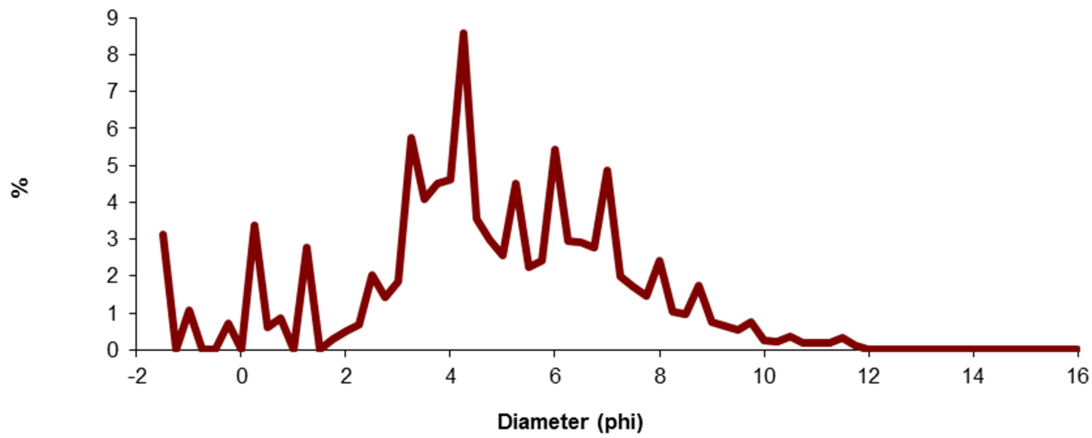


Figure 24.

Sample 110





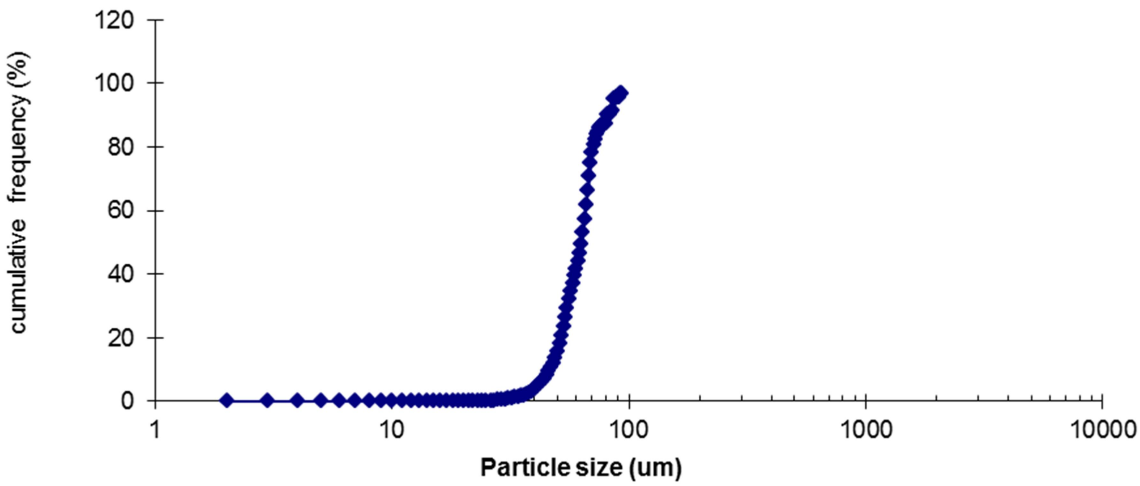


Figure 25.

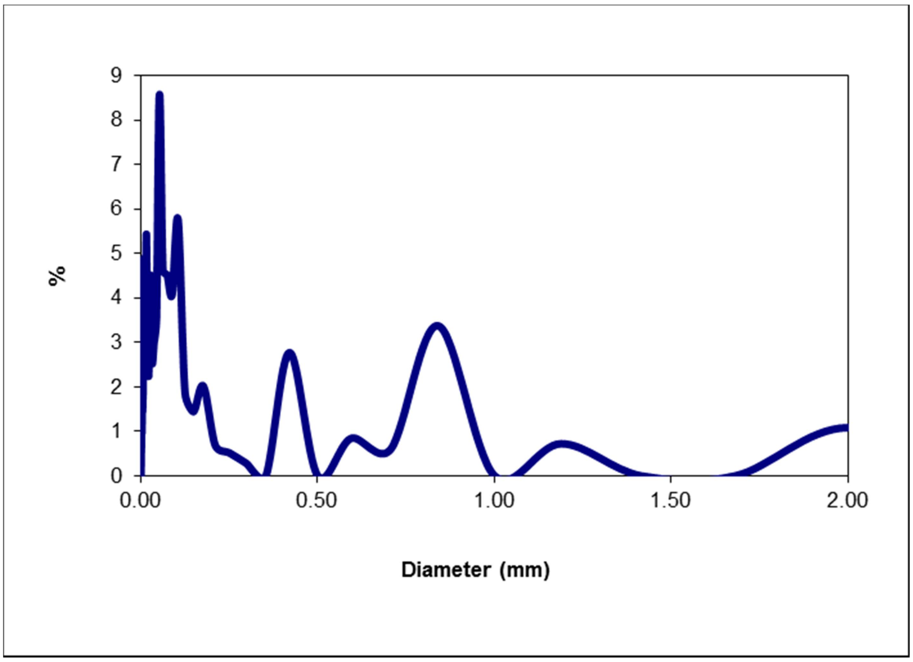


Figure 26.

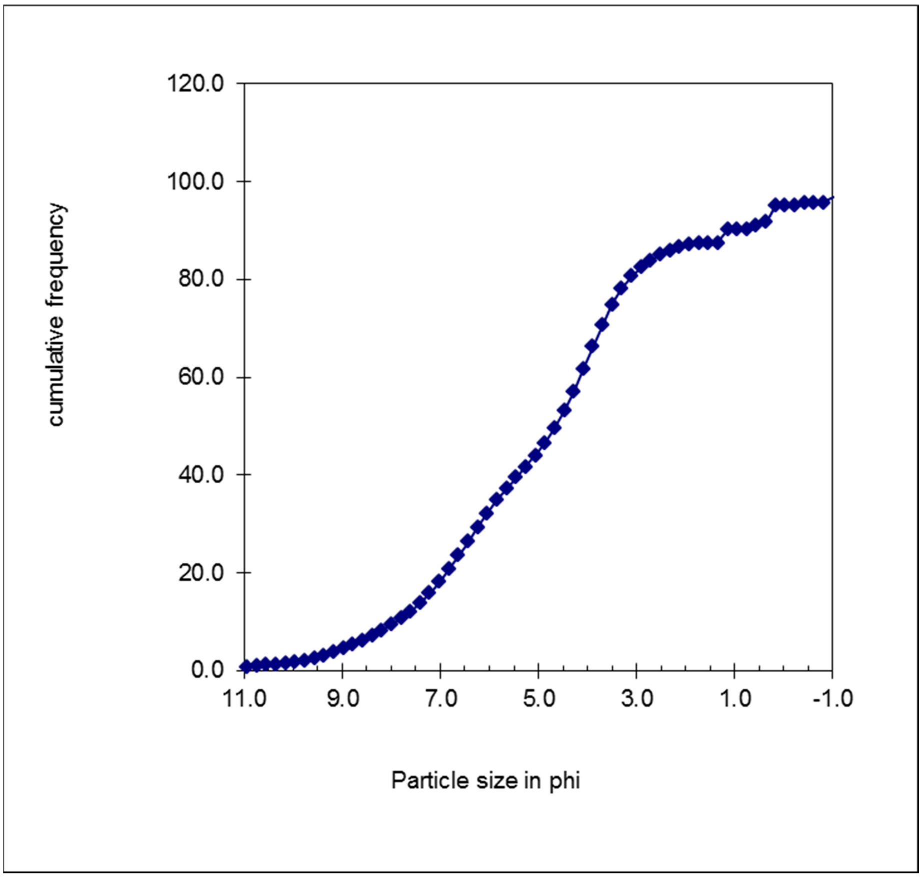


Figure 27.

Chapter four - Discussion

4.1 Soils and their properties

4.1.1 Magnetic susceptibility

Different minerals have different magnetic properties. Looking at the magnetic behaviour of the samples can help identifying which minerals are present in the samples of Skomer. The soil samples taken at Skomer Island include several diamagnetic components, such as calcium carbonate, organic matter and most likely quartz minerals. These components are in most cases not magnetically significant (Schwertmann and Taylor 1977, 73). However, when decomposing organic matter and mineral soil are in intimate contact, which is often the case in a mixed A horizon of brown earths, peaks in magnetic susceptibility do form (Schwertmann and Taylor 1977, 79). This could be an explanation for the relatively higher value of sample 102 compared to the rest. This would indicate that the soil in sample 102 originates from an old brown earth A horizon. It would however be contradictory with the values from sample 103. The magnetic susceptibility value for sample 103 is significantly lower than that of 102, but the organic matter content is nearly the double of sample 102's value. A possible explanation for this difference can be that sample 103 does not originate from a brown earth A horizon. Since both samples represent the two upper deposits on the mound, it would seem more likely that they both originate from brown earths. Another possible option to explain the difference in their magnetic susceptibility values would be that the magnetic susceptibility of sample 102 is influenced by (wall) debris running downslope. Slope processes are known to be able to cause an increase of the values. Following some examples from Schwertmann and Taylor, values show a trend of downslope enhancement (1977, 72). It might be the case that sample 102 was affected by this downslope enhancement either before or after deposition. A last option may be that sample 102 is showing a very slight reflection of the magnetic susceptibility of the underlying igneous rocks that Skomer is composed of (Goodman and Gillham 1954, 300).

Different types of magnetism and influencing factors

Other than diamagnetic minerals, four other types of minerals can occur in soils and influence the magnetic susceptibility depending on their level of presence. The first group is known as ferromagnetic minerals that have high values of magnetism but are not very common (Dearing 1994, 6). A second group, called ferromagnetic minerals, is very common and includes minerals such as magnetite or a few other Fe (iron)-bearing minerals (Dearing 1994, 6). Ferrimagnetic minerals have a high magnetic value as well. Canted antiferromagnetic minerals, the third group, contain lower values and include iron minerals such as haematite (Dearing 1994, 6). Paramagnetic minerals are very common in rocks and soils and only show magnetic moments which arise from the presence of Mn (manganese) or Fe (iron) ions (Dearing 1994, 6). Besides their composition and other factors, magnetic susceptibility values can also be affected within gleyed soils. Reducing conditions occur through the dissolving oxygen which is used by a broad spectrum of bacteria (Schwertmann and Taylor 1977, 82). This can cause magnetic susceptibility values to decrease, initiated by a decline in magnetic oxides through a chemical reaction (Schwertmann and Taylor 1977, 82). When soils are not gleyed, it is most likely that a persistence of ferromagnetic and antiferromagnetic oxides, which have once been formed in the soil, occurs (Schwertmann and Taylor 1977, 82). This resistance to weathering includes secondary magnetic oxides that could have been formed through fire or through normal pedogenic processes and appear to be similar to primary oxides (derived from bedrock) (Schwertmann and Taylor 1977, 82). Long-term survival of these two types of oxides can be altered when being subject to drainage systems or exist in depositional environments (Schwertmann and Taylor

1977, 82). Since at least samples 102, 103 and 108 represent deposited soils (by human activity), changes in magnetic susceptibility may have occurred throughout time. It is less likely the case for sample 107 and 110 (when considering these are buried soils).

4.1.2 The magnetic range of the samples from Skomer Island

Soils can be composed of the aforementioned different magnetic groups, which produce the overall magnetic susceptibility values for the bulk samples. The presence of different minerals and ions are defined by the composition of their parent material, which can then be affected by transport or other factors discussed. The values of Skomer's samples show little variety on a larger scale and fit within the magnetic value ranges, following soil types defined by Dearing (1994, 36): sedimentary rocks, medium/fine metamorphic rocks, paramagnetic minerals, acid igneous rocks and topsoils (see **figure 28**, appendix). The values of samples 107 and 110 are most likely to fall within the range of topsoils, paramagnetic minerals and sedimentary rocks. Sample 102 has the highest value and can also represent acid igneous rocks, although its value would be at the very minimum end of the average acid igneous rock magnetic values.

Multi-proxy analysis

When used in a combination with other proxies, magnetic susceptibility can reflect the sources of the sediments and their transport modes. In the case of the samples taken from Skomer Island, it is nearly impossible to understand the magnetic susceptibility values without looking at the results of the particle size analyses. Magnetic properties in rocks depend on the mineralogy of the magnetic particles they contain as well as their concentration. What not has been discussed yet is the possible effect of the size of particles that make up the soils.

4.2 Particle size analysis

4.2.1 Soil type determination

As mentioned in chapter two, for this research soil types were determined for every sample. Samples 102, 103, 108 north and 107 came out as definite coarse sandy loams. Sample 108 south results in silt loam, but lies very close to the border of a coarse sandy loam, while sample 110 appears to be a definite silt loam. These may well represent the most common soils found on Skomer Island and are also highly present on neighbouring Skokholm Island (Goodman and Gillham 1954, 299). With some exceptions briefly mentioned in chapter 3, Skomer contains a uniform, friable, sandy loam of the Brown Earth type (Goodman and Gillham 1954, 299). As described for Skokholm Island, these soils can show considerable variation in depth and stoniness (Goodman and Gillham 1954, 299).

4.2.2 Sorting of the soils

Considering that all samples display a soil texture of either sandy loam or silt loam, it seems very likely that the soil in and underneath the mound are of a local source. Furthermore, the particle size distribution shows very poorly sorted soils, which is not uncommon for these soil types. The sorting value of sample 107 almost reaches a state of 'extremely poorly sorted' which may indicate it being (partly) disturbed in the past or that it was indeed an old A2 horizon. Values of poorly sorted materials often indicate a short distance of travel before deposition, which causes the material to have too little time to distribute the different sized particles over a large area. Since the samples involve brown earths or sands, this rapid deposit is most likely caused by a deposit on a larger scale, such as meltwater, rather than river or sand deposits (University of Liverpool 2015).

4.2.3 Skewness of the samples

Next to the sorting, particle size analysis gives information on the skewness, referring to the quality or condition of either being distorted of, or lacking symmetry. Skewness tends to become increasingly positive as the grain sizes become finer, for example (Razik, Dekkers and Von Dobeneck 2014, 42). Skewness refers to the plotted normal distribution pattern of grain sizes expressed in phi values taken from the sample (see **figure 29** for an example) (University of New England 2015). The skewness values represent whether the mode (the value or group of values that occurs with the greatest frequency) is shifted towards the left (coarser particles) or right (finer particles). For all positive samples, the most frequent group of phi size values are thus representing a higher percentage of the somewhat coarser particles. Calculation results of sample 102 display a nearly symmetrical skewness and the rest of the samples contain a positive skewness. This means that sample 102 would have a bell-shaped distribution. The value of sample 102 might have been categorised in the wrong skewness, since values for a nearly symmetrical skewness are supposed to be -0.1 or below (sample 102 has a value of approximately 0.048). The remaining samples tend to contain a shift towards the coarser particles. However, when looking at the value of sample 110 (-0.05), it comes very close to becoming nearly symmetrical. Since the values are all very low and reasonably close to one another, there is again evidence for a wide variety in the particle size distribution of the soils.

4.2.4 Kurtosis of the samples

The kurtosis value of the calculated data shows whether the particle size distribution is bell shaped (mesokurtic), flat (platykurtic) or peaking (leptokurtic) (University of New England) when plotted in a histogram. This is based on measurements of the ratio between the so-called tails of the curve and the central portion (derived on the Gaussian formula) (University of New England). In the case of samples 102 to 107, the platykurtic values indicate that the tails are less well sorted than the central portion. The opposite applies to sample 110. When looking at **table 10**, it becomes clear that the very platykurtic soil samples will probably have two peaks, the highest in the coarser area, since the skewness is positive and a lower peak in the finer sized grain area (due to high amounts of silt in the soils). Sample 110 contains one peaking area, explained by the leptokurtic value in **table 11**.

4.3 The identification of layers 107 and 110

The varying magnetic susceptibility and particle size values thus support each other in indicating mixed soils that are most probably categorised to brown earths/sands. For the largest part of Skomer, a thin layer of gravelly (peri)glacial drift covers the igneous rocks and is of a mixed origin with a variable composition (Goodman and Gillham 1954, 300). This periglacial material probably represents the parent material for most soils on Skomer (Alexander 2014, 9). Since the soils can be composed of mixed origins and the samples from Skomer Island show poorly sorted conditions, it is almost impossible to trace back the parent material of the excavated mound and its underlying soils. The following possible theories are therefore based on the relative differences in the data between the samples themselves.

Based on the differences in soil values, it appears that layer 107 might well have been an old soil horizon of either a brown earth or brown sand soil. First indications can be interpreted from the magnetic susceptibility values. The values of layers 107 and 110 are significantly lower than the values of the mound deposits. If layer 107 was once the lower part of a top soil and layer 110 a part of the lower A or higher B horizon, it could be that they have had more influence from the parent material. This would be very likely, since the parent material contains high values of haematite (Goodman and Gillham 1954, 300). This might have lowered the values of 110 and 107. Another possible explanation could be that layers 107 and 110 were showing the commencing of podsolization. Examples of brown earth podsolization have been found on Skokholm Island, and layers 107 and 110 could well be old examples from Skomer Island. Podsolization of layer 107 and 110 would then be suggested by their paler colour due to leaching of the iron ions, which also results in lower magnetic susceptibility values.

All explanations so far are based on the theory that layer 107 represents the lower part of a presumably old A horizon and in the case of leeching perhaps an E horizon. It seems very unlikely that it represented the top of an old A horizon, since it contains a low presence of values in organic matter. Several explanations for these low organic matter contents of both layers 107 and 110 exist. A first possibility can be caused by the removal of turf for the round houses at the settlement. Soil overlaying layer 107, containing most of the organic matter, could have been taken and used for the creation of roofs of the round house(s). This would leave a partially disturbed layer 107 at the surface, being then (perhaps shortly after) covered with layer 108, which sealed it off from further influences. If layer 107 would have been higher up in the soil, the other possibility for its low contents can be caused by perhaps trampling of animals or humans of the area. This would have caused plants to die off or restrict growing and thus decrease the water retention of the soil and thus reduce organic content. The lack of pollen can further support the theory of layer 107 being a lower part of an old A horizon, since pollen could not have reached this layer before disturbance or only through bioturbation. The lack of pollen can however also be a result of the more neutral (and thus less acid) conditions of the soil and thus preventing most preservation of the pollen. A last addition to this theory is based on the particle size data. Layer 107 shows less extreme values in all particle size presence compared to layer 110, except for the dominant presence of coarse sand. This sand could have been deposited by the wind once layer 107 laid at the surface. It could also have been dropped during the removal of the top soil layer and mixed afterwards.

Although it is hard to state whether layer 107 represents an old top soil, or a lower part of an old A horizon, it does seem likely that is a buried soil underneath the mound. The soil data indicates a closer relationship of layer 107 with layer 110, than with the deposited layers on top of 107. One final piece of evidence that 107 is not a deposited mound layer is through the presence of a natural stony layer, which is often described as being a part of brown earths on Skomer Island (e.g Jenkins and Owen 1995, 10).

4.4 Past vegetation

4.4.1 Species information

In order to create a reconstruction of the past environment, several identified species are briefly discussed. The interpretations further in this chapter are partly based on the information gathered on these species. It is however only possible to gather very specific data when it concerns identifications made down to species level, as higher levels of identifications mean that different characteristics may apply. For instance: different species from the same genus can have varying characteristics or have different living conditions. The information would thus be too general in order to create a reconstruction of the past environment. Furthermore, some species are mentioned for other reasons. They could be indicators for anthropogenic activities or they are very unlikely to originate from Skomer. A final note of importance is that the information about *Corylus avellana* can be different from *Myrica gale*. Both species belong to the *Corylus avellana*-type as identified from the samples, but there is a higher chance that it concerns *Corylus avellana*, rather than *Myrica gale*.

Pinus sylvestris

The pollen of *Pinus sylvestris* (Scotch pine) species are very unlikely to origin from Skomer Island itself. According to basic prediction models, pollen grains can be transported horizontally by wind over a distance of 47 to 60 km within three hours (Williams 2010, 847). This speed can however triple in value when turbulence is taken into account. In a study by Campbell et al. (Campbell et al. 1999), pine pollen grains have been recorded that travelled a distance of 3000 km (Campbell et al. 1999, 29). *Pinus taeda* (Loblolly pine) trees are known to release an average of 81g of pollen per day for two to four weeks and is comparable with other *Pinus* species such as *P. palustris, P. serotine, P. echinata* and *P. elliottii (*Williams 2010, 846). If there would have been any pine trees on Skomer Island, a fair assumption would be that there would have been more *Pinus* pollen in the samples. Another reason to believe that the two *Pinus* pollen found in the samples were not from Skomer or the coastline of Wales, is based on the abiotic stress caused by the saltwater spray that causes an osmotic shock in *Pinus sylvestris* pollen (Bohne et al. 2005 in: Williams 2010, 847). This would mean that the germination would be reduced in pollen that are captured over open saltwater and that the growth of *Pinus* species would have been very unlikely.

Plantago lanceolata

Plantago lanceolata (ribwort plantain) has quite often been seen as an indicator for anthropogenic activities in means of signifying undisturbed grassland (Burrichter 1969 in: Behre 1981, 229). According to present day evidence, the presence of *P. lanceolata* can be indicating the recolonization of abandoned cultivated land (Behre 1981, 229). However, according to the information retrieved from the British Flora (Bonnier 1925, 400), the *P. lanceolata* species can be found in a wide range of habitats nowadays and are well spread over the British Isles (Tonsor 1985, 536). *Due that most P. lanceolata pollen have been retrieved from sample 103, would indicate that the environment already had interference in a period before the actual growth and distribution of the pollen grains occurred*. *Plantago lanceolata* is just like the *Pinus* species, a wind-pollinated species. It is classified into having a cosmopolitan distribution (Tonsor 1985, 422). As shown in **figure 30** (Tonsor 1985, 444), the pollen distribution of this species covers a much smaller range. Although the study carried out for getting these measurements used a windspeed of only 2.8 miles per hour (Skomer often has stronger winds), the fact that the *P. lanceolata* plant does not grow very tall, would still predict a relatively small range of distribution. *Plantago lanceolate* may be evidence of disturbed grounds within the heathland which could have been caused by grazing (Tinsley and Smith 1974, 555). Another option for its presence in the samples could be an indication of trampling by either animals (livestock or perhaps birds for nesting) or by people who may have created pathways through the landscape. There are several studies carried out where the percentage of *P. lanceolata* has been used as indicators of pasturelands. A common way to do this is by looking at the ratio of pastoral to arable species to identify any trends in farming practices (Buckland and Edwards 1984, 244). Both Steckan (1961) and Lange (1975) have used the ratio of cereal pollen to *P. lanceolata* pollen (Buckland and Edwards 1984, 244). Turner looked at the amount of Plantago pollen grains as a percentage of the total amount of *Plantago, Asteraceae, Cruciferae, Artemisia, Chenopodiaceae* and cereal pollen as an arable/pastoral index (Buckland and Edwards 1984, 244). For this research, it was impossible to use any of these ratios, as there is no cereal pollen in the sample. *Plantago lanceolata* could thus be the only indicator for grazing, but since it can also be categorised as a waste ground species, it does not necessarily indicate trampling or grazing (Buckland and Edwards 1984, 244). The percentages are either way quite low in the sample and the pollen cannot be used to exclude any of the options. The increase of *P. lanceolata* (along with the increase of bracken pollen) has been related to a local *Ulmus* (Elm) decline in several studies, which could give indications of human interference (Oldfield 1963, 25). Again, this technique cannot be applied on the samples of Skomer, as there are very few Elm tree pollen present (and only in sample 102), nor is there evidence for bracken. In the sample taken in the South there were pollen bracken pollen present, which may thus be indicating disturbance through human activity of the landscape and vegetation.

Fraxinus excelsior

Fraxinus excelsior (ash), a species known for being dominant in young and juvenile stages of forest produces anemophilous pollen as well. The common ash is not only known for being a pioneer species, since it can also be found in permanent forest components (Pautasso et al. 2013, 38). Following (Fraxigen 2005, 50) the average pollen movement of this species can range from 41m up to 328m. Values can heavily depend on the density of the stand trees together with the landscape, local environment and the proportion of flowering trees (Fraxigen 2005, 50-51). Due to the fact that only one *Fraxinus* pollen has been found in sample 102 only, it seems very unlikely that ash trees have been a part of the regions' past vegetation. Also considering the lack of any other type of probably regionally present tree pollen in the samples, no convincing evidence can indicate the presence of woodland in the area of hut group 8.

Corylus avellana

Two pollen of *Corylus avellana*- type were detected in sample 102 and 110. The proportional importance of the pollen within the samples are rather different, which is most likely due to the fact that in sample 110 the *C. avellana*-type pollen represents 8% rather than the 0.11% in sample 102. In this section, it is assumed that the *C. avellana*-type pollen belong to the *Corylus avellana* species, rather than the less likely *Myrica gale* species that are also classified in *C. avellana*-type. Even with the poor preservation of pollen in sample 110, the presence of *C. avallana* does not seem to be a convincing proof for the presence of hazel trees on Skomer Island. Following Negretti's (1983) estimated quantity of produced pollen in male catkins, an average of 2400 grains per anther can be expected (Negretti 1983 in: Tallantire 2002, 82). Per mm length of the male catkins, the average amount of produced pollen lays around 45000. Bad weather conditions such as heavy mist or drizzle can however cause the pollen to clump together and prevent an even and wide distribution (Konemann 1943 in: Tallantire 2002, 82). Even in case of bad pollen preservation in the sample and possible factors preventing good pollen dispersal, the expected total amount of *C. avellana* does not meet the eventual quantity found. It is however interesting that layer 110 contains this pollen species and a total pollen concentration of 550 is expected to be found in the entire subsample. The presence of the pollen in sample 102 can be of a fairly recent origin. As recorded from Skokholm (the island near Skomer), species such as *Fraxinus excelsior* and *Corylus avellana* are present on the island through artificial planting and are kept well-screened from strong winds by high stone walls in order to prevent them from dying off (Goodman and Gillham, 304). Since weather and wind conditions are fairly similar to those of Skomer Island, it seems most likely that the *C. avellana* pollen in sample 102 originates from a recently planted tree or shrub being guarded from strong damaging winds.

Salix

Salix species (willows) can be categorised as shrubs or trees. Just like the *Corylus avallana* trees, the pollen are derived from the male catkins, but in the case of *Salix*, pollen of most species are however often distributed by bees rather than being anemophilous (Reinhard, Hamilton and Hevly 1991, 122). The presence of the Salix pollen in every sample rather than 107 indicates that Salix species have been present in the period before the mound was formed (present in sample 110) and during the forming of it (as indicated by its presence in all samples from the mound). Taking into account that the pollen are most often entomophilous and are present in percentages ranging from 4.6 to 41.6, it seems to have been growing on the island since at least the Late Iron Age. With a pollen concentration of 2774 in sample 110, it is quite odd that sample 107 does not contain any *Salix* pollen (although the pollen preservation was very bad). This lack does however not have to mean it was not present in this layer, since the general quantity of pollen in layer 107 is low. A more interesting aspect can be the difference in *Salix* pollen concentration and presence percentage between layer 102 and 103. The percentage the pollen take up in sample 102 is around 6.88, whereas the percentage in sample 103 is only 4.6 of the total amount of identified pollen. It is possible that there has been a decline in *Salix* species from the period of the deposit of 103 compared to the possibly later deposit of layer 102, which appeared to be the most recent one. The difference in pollen concentration of 2077 to 5340 may confirm this hypothesis. It seems to have been more likely however that the time periods of the deposits of 102 and 103 are not much separated according to the archaeological information retrieved from the excavation and literature. Possibilities such as different locations of soil sources can explain the difference between the two top layers. Since the pollen contents of layer 108 are low, it is statistically speaking not reliable enough.

Calluna vulgaris

Calluna vulgaris (heather) can be categorised as dwarf shrubs and is often dominant in heathlands (Mahy, De Sloover and Jacquemart 1998, 1844). Their average height lies around 0.8m, but can vary between 0.3m and 1.8m (Mahy, De Sloover and Jacquemart 1998, 1844 and ETI Bioinformatics 2015). They are often found on moist to dry, acid soils in heathlands, but are also present in grasslands or in beginning stages of woodlands (Stace 2010, 572). Common heather often shows a colonizing behaviour and is widely spread in geographical and altitudinal sense (Mahy, De Sloover and Jacquemart 1998, 1850). This means that *C. vulgaris* is able to cope in highly varied environmental conditions. Studies have shown that the pollen dispersal of *C.vulgaris* can be carried out both by animals (especially honey bees and bumblebees, but also other insects) and by wind (Mahy, De Sloover and Jacquemart 1998, 1850). Strong winds can affect the pollen dispersal and may cause the deposition of pollen in unvisited flowers through inflorescence movement (Mahy, De Sloover and Jacquemart

1998, 1850). Following an examination carried out in 1996, the mean number of pollen grains on stigmas of wind-pollinated flowers varied from 0 to 596, where the total sample consisted of 8 plants (Mahy, De Sloover and Jacquemart 1998, 1846). This example shows that the number of pollen grains produced by anthers of *Calluna vulgaris* can reach high numbers, as is often the case in anemophilous pollen. Furthermore, it shows that pollen grains don’t necessarily reach the stigmas, causing them to be deposited and, depending on preservation, are found back in the sample. The high percentage of *C. vulgaris* (common heather) pollen (in sample 102 especially) indicates the presence of heathlands during at least the final part of deposition of the burnt stones on the mound.

Interpretation issues and potential biases in the samples

Contamination risks during the sampling of layers 102 and 103 were stated as 3 to 4 on a scale of 1 to 5. Several details argue for a lack of contamination. Firstly, *Tilia* pollen was found in sample 102. There are currently no *Tilia* trees present on Skomer today, indicating a low chance of contamination. Another suggestion for this assumption comes from the bracken that covered the entire surface of the mound and were removed by hand before excavation took place. No spores of these species were found in any of the samples, which supports the idea of no, or very little, contamination. A final piece of evidence is that the state of most pollen from all of the samples was very bad. Relatively much pollen were in a degraded state or were badly preserved. This suggests that it does not concern modern material, as that would be visible by the preservation state of the pollen in the slides.

Another significant factor that has to be taken into account is the difference between layers 102 and 103 on one side and layers 108, 107 and 110 on the other side. Since layers 108 and 107 are dated due to their finds, a guess of their age could be made. Samples 102 and 103 however did not contain any kind of material that could be dated.

Since the soil analysis cannot identify the original source of these two layers, it cannot be concluded where the deposits were taken from. Furthermore, it is not even possible to state that they represent material taken from one place. It might have been the case that soil from different locations was collected (from the surface or perhaps from deeper within the soil) and mixed before being deposited on the mound. This is very significant to take into account when interpreting the pollen from these samples. If the material would contain soils of different depths or locations, the catchment area for pollen would be much larger, both in distance as in time. Although samples 102 and 103 contain far out the most pollen from all the samples researched in this study, they can thus not give information on a specific time period or location. It would seem very likely that they represent brown earths, as most of the environment around the settlement exists of brown earths.

Not only should it be taken into account that the samples could represent different locations or time periods (although highly unlikely), the preservation of pollen could cause another bias in the sample. Havinga (1964) suggested the degradation of pollen due to oxidation of the exine (outer wall of pollen) when deposited in soils (Havinga 1964 in Moore, Web and Collinsons 1991, 22). Certain species are however much more sensitive towards oxidation, which can cause underrepresentation in the samples (Moore, Web and Collinson 1991, 22). Although it is impossible to trace back what pollen species were deposited in the layers of the mound originally, it must be taken into account that the species variety was much higher. Different preservation conditions of the different layers of or under the mound could thus also suggest an entire other past vegetation than the original one. Pollen that are deposited in soils, rather than peat bogs for instance, can also be moved by soil fauna such as earthworms. Even in the case that soil fauna would be absence, pollen can also percolate downwards (Moore, Web and Collinson 1991, 22). Considering the low amount of pollen present in the lower samples, the latter option seems very unlikely.

4.4.2 Reconstructing the past vegetation

Considering the high amount of *Calluna vulgaris* pollen, it seems most likely that parts of the landscape in the region of hut group 8 did contain heathlands where soils must have been more acid, due to the heather plants, than the soils deposited on the mound or than the layers 107 and 110. Since *Calluna* species are often dominant within a certain area, the heathlands can be considered poor in species, meaning that there was probably not a huge variety (ETI Bioninformatics 2015). *Vaccinium*-type (blueberry species) and Ericaceae (heather family) species could have been part of the heathland. Altitudinal effects could however have influenced the variety of species in heathland, as studies suggest that heathland (*Calluna* dominated) on higher altitudes contains a smaller variety of species than heathlands at lower altitudes (Usher 1992, 63). The presence of *Tilletia sphagni* in a lot of samples would further support the presence of dry to moist moorland in the region.

Tilletia sphagni

Tilletia sphagni are fungal spores of moss, which are often present in damp or wet places, such as wet woodland, moorland, besides streams and on bogs (Bioinformatics centre 2013 and Scottish Natural Heritage, 3). The spores were particularly abundant in sample 108 north, which may also indicate that the inhabitants of the area used soils from damper places to level the area of the mound. In case the soil of layer 108 was indeed tipped over from the other side of the wall, the presence of these fungal spores in the sample may also suggest the collection of mosses at the settlement, either brought there deliberately or perhaps with the collecting of other material such as stones. This can however not be checked with the sample material, as no direct indications are found for the presence of moss species present at the settlement.

Vegetation types on Skomer Island

It appears that during most of the period, the landscape was divided in mosaics of open rough grasslands, alternating with heathlands. More alkaline soils would have supported the open grasslands, which presence is suggested by the high amount of Poaceae (grass) pollen in almost every sample. It is however impossible to identify the grass species based on their pollen. They can originate from different habitats, including wetter areas. Examples of macrofossils have previously shown that grasses were growing in mixed fens, where high water tables are present (Barber 1988, 112). These kinds of conditions (wet) would be unsuitable for several tree species to grow on. Following the information in table 13, the soils supporting the open grassland, with possible stands of *Salix* shrubs, would have been more nutrient rich than the heathland, although stands of *Salix* shrubs may well have been located within the heathland. *Filipendula* (meadowsweet) species probably originate from damp valley bottoms or meadows of lower altitude (Stace 2010, 241). This would support the previous suggestions of the presence of damp soils in the area as well, previously indicated by *Tilletia sphagni*. *Taraxacum*-type species found in sample 102, 103 and 108 (north and south) also argue for the presence of meadows and waste places, but are also found in damp and dry sands and on cultivated grounds (Bonnier 1925, 472 and ETI Bioinformatics 2015). However, the ratio of heathland to a more open (grass)land, seems to be different between sample 102 and the rest. In all other samples the relative importance of Poaceae pollen and the occasional presence of *Plantago lanceolata* and Asteraceae species (aster family) indicate more open grasslands or perhaps cleared patches within the heathland. Although statistically speaking only sample 102 and 103 would be reliable enough to make these conclusions, the pollen percentages in samples 108, 107 and 110 suggest the presence of presumably heathland and open grasslands in periods prior to the existence of the mound and its early stage.

Heathland or grassland?

Samples 102 and 103 are the only samples containing statistically reliable amounts of pollen. In chapter four a brief comparison between their pollen percentages has been made on the basis of two bar charts (see **figure 31** and **32**, appendix). It appears that sample 102 shows a higher dominance of heathland in the area, since the percentage of *Calluna vulgaris* pollen is relatively high. Sample 103 shows a higher dominance of grass pollen (Poaceae) and lower values for the presence of heath. Both vegetation types were probably occurring similarly, but the difference in their dominance can tell several things about the samples. Since samples 102 and 103 both are the last deposits of the mound, it is possible that they represent the same time periods. If this would be the case, then the material is very likely to originate from different locations, perhaps where 102 was laying closer to heathlands and 103 closer to grassland. As previously discussed, there is a possibility that the material of samples 102, 103 or both come from different locations. If this were to be the case, than the pollen percentages can have larger catchment areas. Considering the fact that they are originating from brown earths, they do however represent the environment of Skomer (presumably the north) and non-modern material (based on their preservation).

4.4.3 Trees or woodland on Skomer Island

As visible in the tables, there is no evidence for the presence of extensive woodland on Skomer Island. The lack of trees can be supported by the lack of woodland ground flora species such as Cyperaceae (sedge family) or Juncaceae (rush family) (Tinsley and Smith 1974, 551). Another indication for the lack of trees in the environment of hut group 8 is given by the fact that herb species that are present in the samples hardly flower under shady conditions. Pollen production of ground flora such as herbs is thus interlinked with the density of trees at a certain area. Given the high percentage of non-arboreal pollen in the sample, the density of trees must have been very low to absent in the region surrounding the hut group (Tinsley and Smith 1974, 552). Only sample 102 may indicate the presence of several tree species in the vicinity, but these numbers are too low to give evidence of woodland. Instead, it appears to be more likely that several trees grew on Skomer. Although the percentage of *Tilia* pollen in sample 102 is very low, the species are insect-pollinated (Anderson 1976, 1203). This could indicate that at some point in Skomer's history one or several *Tilia* trees may have existed on Skomer.

Ancient woodland indicators that are currently present on the island today are *Hyacinthoides non-scripta* (bluebells) and *Oxalis acetosella* (wood sorrel) (Moore, Web and Collinson 1991, 188). If they would indeed indicate the presence of ancient woodland on Skomer Island, it could perhaps be from a period preceding the Iron Age and thus preceding the pollen samples. The lack of *Quercus* (oak) pollen in the samples from the mound and from the sample taken in the south of Skomer, supports the idea that there has not been much extensive woodland on Skomer for at least during the period of the Late Bronze Age and Iron Age. Whether this means that deforestation took place prior to this period cannot be said with certainty and could be researched by sampling and analysing pollen from earlier periods such as the Neolithic. According to

Evans, Skomer did once have woodland, but deforestation took place during the Neolithic (Evans 1986 in Rhind 2014, 2). Supporting evidence for this theory comes from Skokholm Island, which is Skomer's neighbour island. Several species such as *Pteridium aguilinum* (bracken) and *Allium ursinum* (ramsons) are indicator species for ancient woodland and suggest its presence in the past together with many bracken fungus species currently present on Skomer (Rhind 2014, 1-2). Furthermore, the name 'Skokholm' is believed to have a Scandinavian origin, meaning possibly 'wooded-island' or 'Island of stocks' or 'Island of logs' (Goodman and Gillham 1954, 300). Since the Scandinavian invasion took place in the 9th century, Skokholm (and perhaps Skomer as well) might have gone through phases of woodlands and clearance (Rhind 2014, 2). Since Skokholm does not contain any trees nowadays, it could have gone through stages of woodland and clearance similar to Skomer (Goodman and Gillham 1954, 300).

The absence or low amount of trees in the region could have also been caused by weather conditions, such as strong winds. It is less likely that they were affected by salt spray in the areas adjacent to the mound, as the species from **table 13** are not tolerant to salt in the soils. Salt spray was more likely to occur in parts closer to the shore or just very occasionally further inland (perhaps during gales).

4.4.4 Fungal spores

Besides the pollen and sphagnum spores present in the samples, all of the samples contained fungal spores of not more than five or six types at the most per sample. Although they were unidentifiable, their presence does indicate the presence of (dead) organic material.

Fungi are either parasitic or saprophytic. When a fungus is saprophytic it lives on dead organic material, whereas parasitic fungi depend for at least a part of their life-cycles on substances produced by living tissues. In either way, the majority of fungi will at one point show a change in growth habits which is reflected by the switch from a vegetative to a reproductive form (Robinson 1964, 3)

It is assumed that the environment plays a large part in this change since it is considered to occur when the use of available energy can be assured to support the production of a fair amount of reproductive units (the spores) before food supplies vanish and the parent mycelium dies. Spores are in general unicellular and contain one or more nuclei embedded in a mass of cytoplasm whilst being surrounded by a firm outer wall. After its deposition, environmental conditions will determine the time of germination or keep the spores remained in a state of dormancy. The classification of fungi is based on the variety of spore producing structures (Robinson 1964, 4).

Considering fungi are either parasitic or saprophytic, their spore presence cannot exclude the abundance of dead organic material, but it would be most likely the case. Furthermore, they indicate the presence of drier areas, where waterlogged conditions are not the case. They would thus have been rather originating from the open grasslands than from the heathland, as soils were more likely to be wet and more acidic in heathlands. Waterlogged conditions would prevent the fungi, that break down dead plant material, from doing so, as oxygen levels are often low (Scottish Natural Heritage, 3).

4.5 The landscape of Skomer and its possible use by its inhabitants

The landscape around the mound was that of low growing species, which would make the growing mound a visible feature in it. It is highly possible that the inhabitants of the island were pastoralists and let their livestock graze on the grasslands or perhaps even in the heathland near the settlement (e.g. Gardner 1991, 281). The find of the cattle tooth could be direct archaeological evidence of the presence of livestock during the Iron Age on Skomer. Furthermore, the field boundaries underlying the hut groups can support the theory that pastoralism was already occurring on Skomer during the (Late) Bronze Age (e.g. Fowler 1983, 188-189). Although little can be said about the vegetation during the Bronze Age, the few species found in sample 107 and 110 show presumable similarities with the mound deposit layers. This would mean that the landscape during the Bronze Age would have been useful for pastoralism. Heathlands in the vicinity of the settlement might have been exploited for several usages of heather plants. As is known about Northern people historically, heather plants can be used for fuel, bedding, thatching, insulation or fodder but also for making brushes, brooms, baskets or rope (Bonnier 1925, 297).

Through quarrying of stones that were eventually deposited on the mound, the adjacent area of the settlement must have known a certain level of disturbance as well. Although it cannot be said what distances the people travelled in order to find them, as most brown earths contain them naturally.

The lack of cereal crops in any of the samples taken from Skomer Island argues for the lack of at least extensive crop cultivation. The only (unreliable) indicator for cultivated soils would be the pollen of Asteraceae T*araxacum*-type. If it were really indicate cultivation, this would only count for the Iron Age period. No evidence on crop cultivation has been found for earlier stages.

4.6 Cefn Fford and Brecon Beacons

In addition to the conducted pollen analysis and the pollen diagram from the south of Skomer (**figure 35**), two more pollen diagrams are briefly discussed for comparison. Chambers (1984) published pollen diagrams of samples from Brecon Beacons and Cefn Fford (see **figure 1**, chapter one for location). Both sites are blanket peats at altitudes of approximately 600m and 715 in the south of Wales (Chambers 1984, 446). Due to the fact that the samples were radiocarbon-dated, but not calibrated, both were calibrated using clam 2.2 (Blauw 2010). Reversed dates were excluded from the age-depth models, and for (Cefn Fford) the curve was extrapolated to estimate the basal date. **Figure 33** and **34** (see appendix) show the calibration diagrams. In both cases, the sample that was located the closest to the surface overlapped with the dates of the mound and were used for comparison. Samples from further down are much older and are left out of this discussion. At Cefn Fford, the main change in vegetation is in the increase of Gramineae (Poaceae) pollen and the increase of sphagnum (Chambers 1984, 449). This is accompanied by a steep decrease in Ericaceae pollen and a small incline of *Plantago lanceolata.* Although tree pollen remain fairly consistent over time, their absolute presence in this sample is relatively low. This can be explained by the waterlogged conditions in the area of the blanket peat, which prevents forest regeneration (Godwin 1956 in Chambers 1984, 445). These results may seem to disagree with the pollen diagram of Brecon Beacons, since an increase in *Calluna* and *Empetrum* species would indicate the increase of heathland in the area. This followed a period where high levels of Cyperaceae (sedges) were present and *Calluna* levels remained low. The sample from Brecon Beans is probably a bit younger than that of Cefn Fford, which may explain their differences.

Blanket peats

The pollen diagrams show results from Blanket peats. Peat deposits can be described as accumulations of organic detritus of mainly plant origin. They develop in situations where the rate of organic matter production is higher than the combined rates of plant respiration, herbivore consumption and microbial decomposition (Moore, Web and Collinson 1991, 14). Peats often show waterlogged conditions or intervals of aerated and waterlogged periods (in the case of sphagnum heaths). In the first situation, pollen are preserved well due to the waterlogged conditions. In the case of occasional aeration, the contents and the intine (inner wall) of pollen can get lost relatively fast. The exine however remains and can be used for pollen analysis (Moore, Web and Collinson 1991, 17). Since catchment areas and preservation conditions in blanket peats is different than in soils (as is the case at Skomer), a direct comparison would not be accurate. The pollen diagrams do show trends of decline and increase of heathland and suggest the increase of open grassland towards earlier periods. Furthermore, the suggestion of grazing and perhaps pastoralism at Skomer can be supported by the suggested increase of grazing at Cefn Fford as well. Since pollen preservation, altitudes and weather conditions of the local area of a site all influence the results; further comparisons are left out (Moore, Web and Collinson, 12-13).

All proxies combined

As discussed in this chapter, the combination of the different analyses on the soil samples, suggest a local origin of the layers that are associated with the Iron Age and perhaps the Late Bronze Age occupation of Skomer Island. Although the mound cannot be categorised as a classic one, it did provide dates of potential occupation of the area. The magnetic susceptibility and loss-on ignition values indicated two buried soils underneath the mound. Results from the particle size analysis supported this idea further, but also showed the complex issues of Skomer's soil composition. Due to poorly sorted soils of the researched layers, their exact origin is untraceable. A local origin seems to be most likely the case, as results of soil analyses showed overlap with the brown soils that are present at Skomer today.

The presence of pollen varied widely amongst the samples. The percentage of organic matter seemed to be in direct relationship with the amount of pollen. The buried soils contained very little pollen. This made it unreliable to base an environmental reconstruction on. The calculated pollen concentrations did however suggest a higher presence of pollen in samples 107 and 110 than initially suspected and indicate a consistency in species. Samples 102 and 103 contained high amounts of pollen and suggested the presence of heathland and grasslands in the regional area of hut group 8. The change in dominance of grassland or heathland was initially indicated by samples 102 and 103, but this assumption would only be accurate if the deposits would contain soils from one location. Additional pollen diagrams from south Wales supported the idea of changes in vegetation over time where heathland and grassland would alternate in dominance. Furthermore, there appeared to be no direct evidence for the presence of woodland or stands of trees on Skomer during the Iron Age. Pollen samples from the excavation and from a separate study on pollen from the south of

Skomer showed an absence or very low percentages of tree pollen. Historical sources do however suggest the presence of woodland on Skomer in the past. It could have been the case that Skomer was cleared from trees during occupations prior to the existence of the mound. LiDAR data and aerial photographs that were recently collected indicate an occupation period of Skomer before the existence of hut group 8, based on underlying field boundaries in the area. These field boundaries, together with the presence of *Plantago lanceolata* also suggest practices of pastoralism during presumably the Bronze Age and Iron Age. The field boundaries could have been used to keep livestock within certain areas, whereas the pollen of *P. lanceolata* may indicate grazing. Together with the interpretation of several huts that were used to keep livestock in and the find of the cattle tooth in layer 108, the presence of livestock at Skomer cannot be denied. An important question that however remains is whether occupation of the Island was indeed divided up into intervals and what the causes for this may have been.

Chapter five - Conclusion

The poorly sorted soils at hut group 8 are presumably of a local origin and are interpreted as brown earths. Although their exact origin cannot be traced back, they do provide other significant t information in relation to the mound of burnt stones that was excavated. Layers 107 and 110 are believed to be buried soils underneath the mound and are associated with the Early Iron Age and perhaps even the Late Bronze Age. Due to their lack of pollen, it was impossible to conduct an environmental reconstruction solely based on layers 107 and 110. Furthermore, they appeared to be old top soils and may have been disturbed by human activity. Layer 108, dated to the Late Iron Age, represents the first deposit of the mound and seemed to be consistent in the presence of plant species with layers 107 and 110. Deposit 102 and 103 were located on the top of the mound and contained much pollen. Since their exact origin or composition could not be traced back, it is hard to state what time period they represent. They do however show a pattern of alternating dominance of heathland and grassland on Skomer Island.

Furthermore, an absence of tree pollen or cereal pollen was indicated from all discussed pollen samples. This may support the idea of pastoralism on Skomer (presumably during the Bronze Age and Iron Age). Pre-existing field boundaries underneath hut group 8 suggest earlier occupation of Skomer and show the potential of Skomer's archaeology. Due to the presence of rabbit and bird burrowing nowadays, many soils on Skomer are disturbed and could prevent a proper investigation on its archaeology. However, this research shows that disturbance has not happened everywhere on the island. There is much more to explore about Skomer's archaeology. Suggestions for further studies are micromorphological research on soil samples in order to investigate their exact composition. Pollen analysis on earlier periods can help investigating whether Skomer has known periods of woodland or not and can help to identify human impact on the landscape. A final important point of research would be the length of the occupation of Skomer and whether alternating periods of occupation and retrieval did exist. With the collection of the new suggested data, much more of Skomer's archaeological mysteries can be revealed and will add new significant insights to the unfamiliar, but fascinating archaeological background of the area.

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Appendix - Figures

1 Potassium Hydroxide Digestion
(Breaks up soil matrix and dissolves humic material)

Caution you must wear safety spectacles and gloves for the next procedure.

First turn on the water bath in the fume cabinet. (5-10 mins before you start)

1. Fill a 25 ml measuring cylinder with 3 ml of 10% v/v **Hydrochloric acid** (10 ml **HCl** into 90 ml **water**). Add sample (e.g. 0.5cm^3) until **HCl** is displaced to 3.5 ml. Transfer to a numbered Polypropylene test tube (15 ml) and stir sample.
2. Add a **Lycopodium** tablets and allow reaction to settle before adding a second tablet if required.
3. Ensure tubes have equal volumes of liquid by adding 10% **HCl**. Centrifuge samples for 2 minutes at 4500 rpm and pour off liquid without loosing any of the sample pellet into a polypropylene beaker containing 1l of water.
4. Add 5 ml of 10% w/v **Potassium Hydroxide** (10g **KOH** in 100 ml water). Place into test tube rack in a boiling water bath for 15 minutes, stirring every 5 minutes. Keep some **KOH** solution for later
5. Stir the sample and pour it through a 180 μm sieve down a funnel and into another numbered test tube, rinse the first test tube and sieve with distilled water to get as much pollen into the second tube.
6. Centrifuge samples for 2 minutes at 4500 rpm and decant liquid.
7. Add 5 ml distilled water stir, centrifuge for 2 minutes at 4500 rpm and decant liquid. Repeat water washing until the suspension is no longer dark.

If the sample is **clay** rich go onto **Pyrophosphate** treatment.
If the sample is **siliceous** go onto **Hydrofluoric acid** treatment.
If the sample is **not siliceous** go onto **Acetolysis.**

2 Pyrophosphate treatment
(extraction from clay)

1. If preceded by **KOH** digestion, wash with 5 ml distilled water, stir, centrifuge and decant.
2. Add 5 ml 0.1 M (c2.7 g in 100 ml H_2O) **tetra-Sodium pyrophosphate,** place the tube in a boiling water bath for 20 minute stirring vigorously and often, centrifuge at 3000 rpm for 5 minutes and decant liquid.
3. If large particles of siliceous material are present go on to **Hydrofluoric acid** treatment, if no silica present go onto **Acetolysis.**

Hydrofluoric acid treatment
(Removal of siliceous material)

All chemicals and samples must be kept in the fume cabinet at all times.

Caution you must wear a face visor, gauntlet gloves and plastic apron. Wear clothing which will cover all exposed skin for the next procedure.

1. The sample must be free of carbonates, suspend the pellet in 5 ml **10% HCL**, stir and centrifuge for 2 minutes at 4500 rpm and discard liquid. Repeat **HCL** washes until there is no reaction with carbonate.

If the sample is heavily contaminated with silica, leave in cold **Hydrofluoric acid** overnight (no.**2**), otherwise go straight to no.**4.**

2. Add 3 ml of **Hydrofluoric acid,** stir, cover the tube and leave over night in a fume cupboard. Next day centrifuge for 2 minutes at 4500 rpm and decant liquid.
3. Add 5 ml 10% **HCl** stir, centrifuge for 2 minutes at 4500 rpm and decant liquid
4. Add 3 ml **Hydrofluoric acid,** carefully stir and place tube in a hot water bath for 15 minutes. Centrifuge for 2 minutes at 4500 rpm and decant liquid
5. Add 5 ml 10% **HCl** stir and place tube in a hot (but not boiling) water bath for 15 minutes stirring every 5 minutes, centrifuge for 2 minutes at 4500 rpm and decant liquid
6. Wash sample with distilled water, stir, centrifuge for 2 minutes at 4500 rpm and decant liquid.

3 Acetolysis
(Removal of Cellulose)

All chemicals and samples must be kept in the Fume cabinet at all times.

First turn on the water bath in the fume cabinet. (5-10 mins before you start)

1. Suspend the pellet in 5 ml **glacial Acetic acid** (dehydration of sample), Stir, centrifuge for 2 minutes at 4500 rpm and discard the liquid.

Caution you must wear a face visor, gauntlet. Wear clothing which will cover all exposed skin for the next procedure.

The **Acetolysis** mix contains **concentrated Sulphuric acid** which will react violently with water, so please ensure all equipment is clean and dry)

2. Suspend the pellet in 5 ml **Acetolysis** mixture and stir.

The Acetolysis mix consists of Acetic anhydride mixed with **concentrated Sulphuric acid** in a 9:1 ratio. Measure out 72 ml of **Acetic anhydride** and pour into the dispenser bottle and carefully add 8 ml of conc. sulphuric acid 1 ml at a time, stir to ensure a good mix, before adding next ml, this a suitable volume for 16 samples.

3. Place the tube in a boiling water bath for 2.5 - 3 minutes, stirring often.

Turn down the water bath just before placing the tubes into it to prevent splashes of water reacting with the Acetolysis mixture.

4. Centrifuge at 4500 rpm for 2 minutes.
5. Remove tubes from centrifuge and Carefully decant liquid
6. Suspend the pellet in 5 ml **glacial Acetic acid** (to remove Acetolysis mix), stir, centrifuge and decant liquid.
7. Add a few drops of **10% KOH** (to neutralise acids) to the pellet, add 2 drops of stain to each sample then add 5 ml distilled water and stir, centrifuge and decant liquid.
8. Suspend the pellet in c5 ml distilled water, stir, centrifuge and decant liquid.

4 Mounting

Wash with c5 ml **Ethanol**, stir, centrifuge and decant liquid.

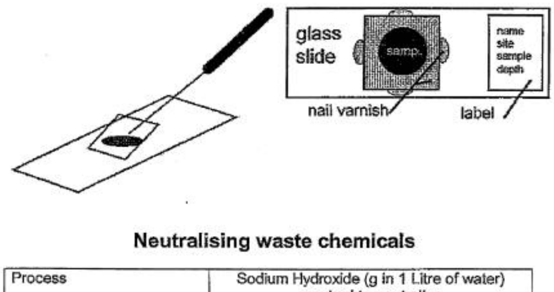
Wash with 1 ml **tert-butyl alcohol**, stir, centrifuge and decant liquid.

Add 1 ml **tetr-Butyl alcohol** to sample and **stir.**

To a small glass tube add c 0.5 ml Silicon oil from the small plastic dropper bottle, then transfer the pollen pellet and tetr-Butyle alcohol mix to the glass tube. Place the glass tube in the designated drying cabinet over night to let the alcohol evaporate.

Mounting

Place a small drop of sample on a slide and place a cover slip over the drop pressing down gently with pointer. Fix cover slip with a drop of nail varnish at each corner. To seal the cover slip use a generous amount of nail varnish or paint.



Neutralising waste chemicals

Process	Sodium Hydroxide (g in 1 Litre of water) required to neutralise		
	1 sample	8 samples	16 samples
KOH digestion & Acetolysis	7.6	61	122
Hydrofluoric acid treatment (2 HCL & 1 HF wash)	3.1	25	50

Figure 9. *Pollen preparation method as carried out for this research, following Faegri and Iversen (1992).*

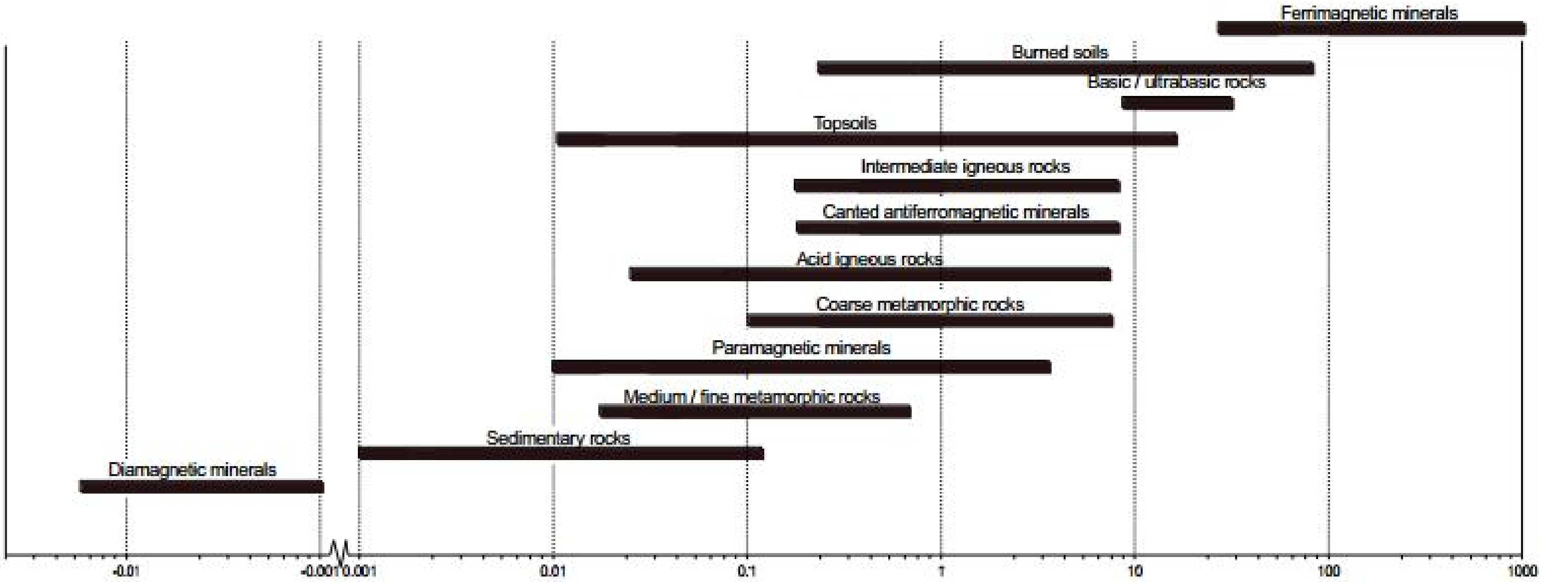
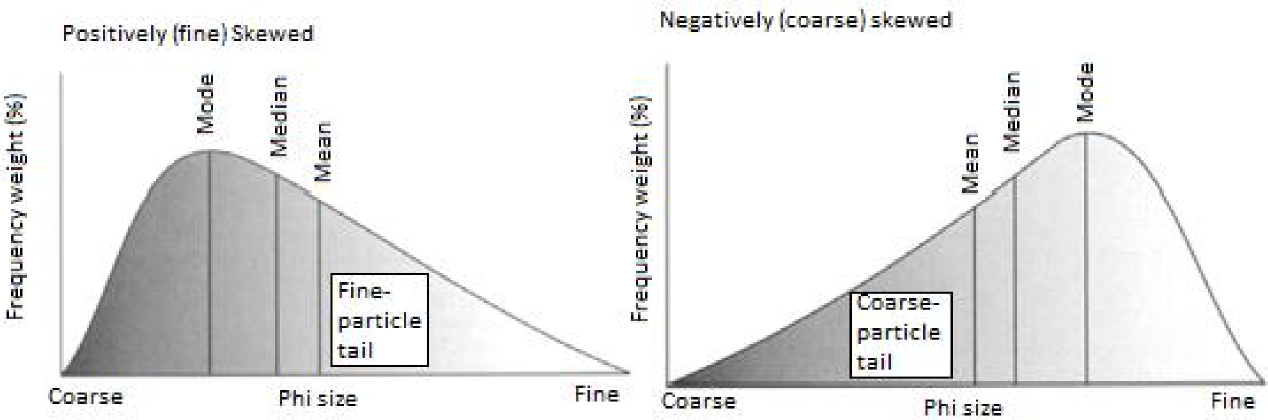


Figure 28. *Typical range of magnetic susceptibility values of environmental materials and minerals, measured at room temperature (Dearing 1994, 36).*



Sorting skewness: (from inclusive graphic skewness)

strongly fine- skewed	+1.00 to +0.30
fine- skewed	+0.30 to +0.10
near symmetrical	+0.10 to 0.10
coarse-skewed	0.10 to 0.30
strongly coarse-skewed	0.30 to 1.00

Figure 29. *Visualisation of skewness values (University of New England 2015).*

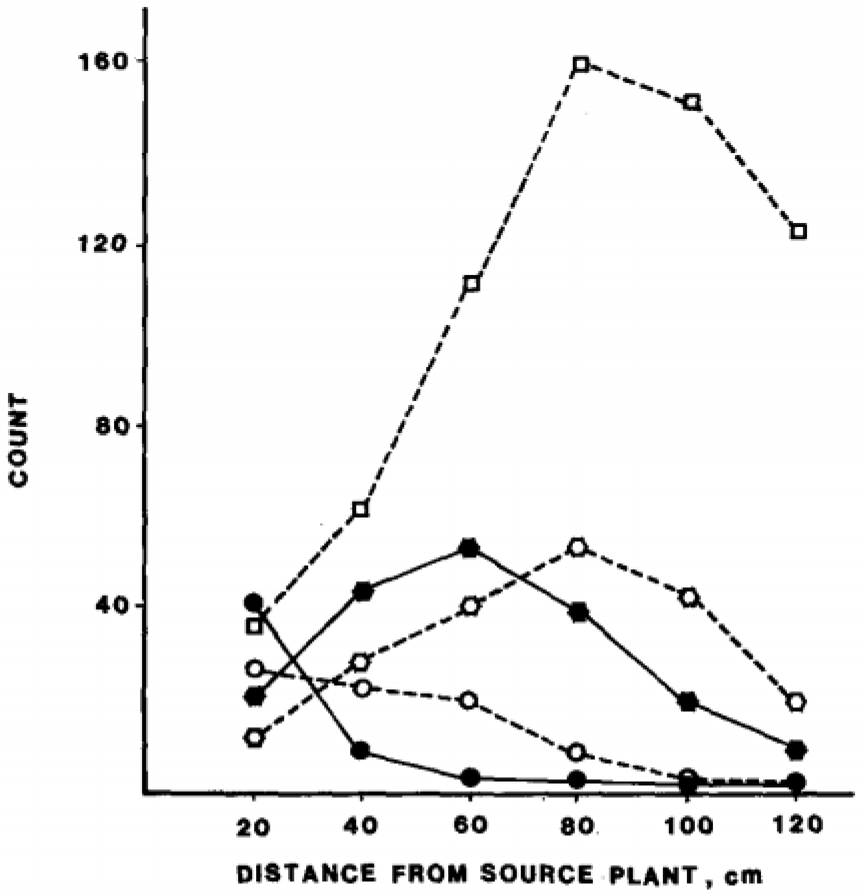


Figure 30. *Pollen dispersal of Plantago lanceolata, following the study of Tonsor (1985, 444).*

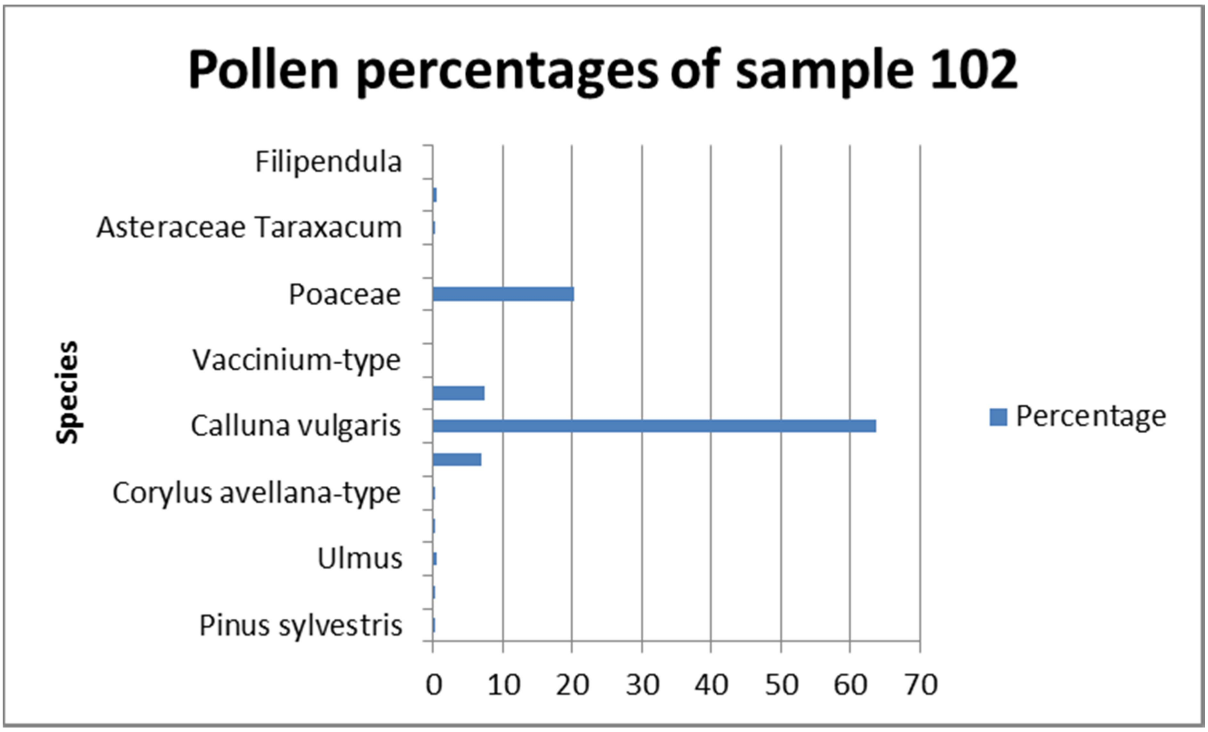


Figure 31. *Pollen percentages of sample 102.*

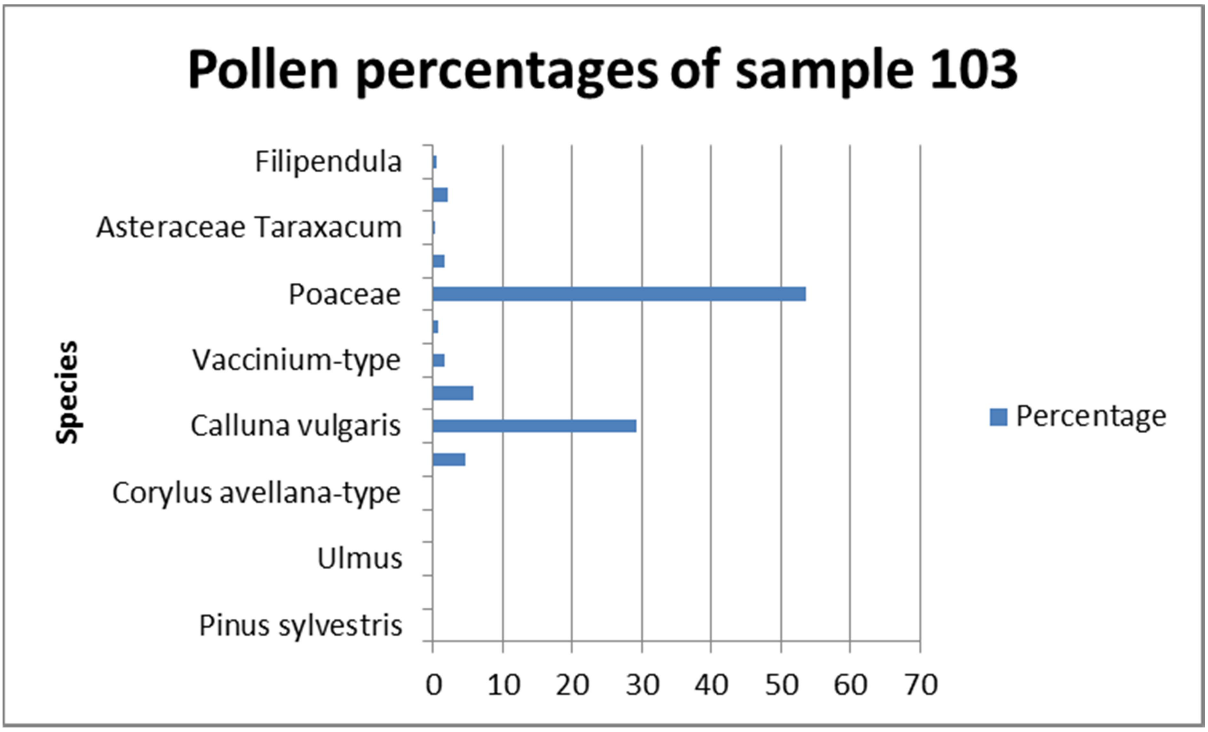


Figure 32. *Pollen percentages of sample 103.*

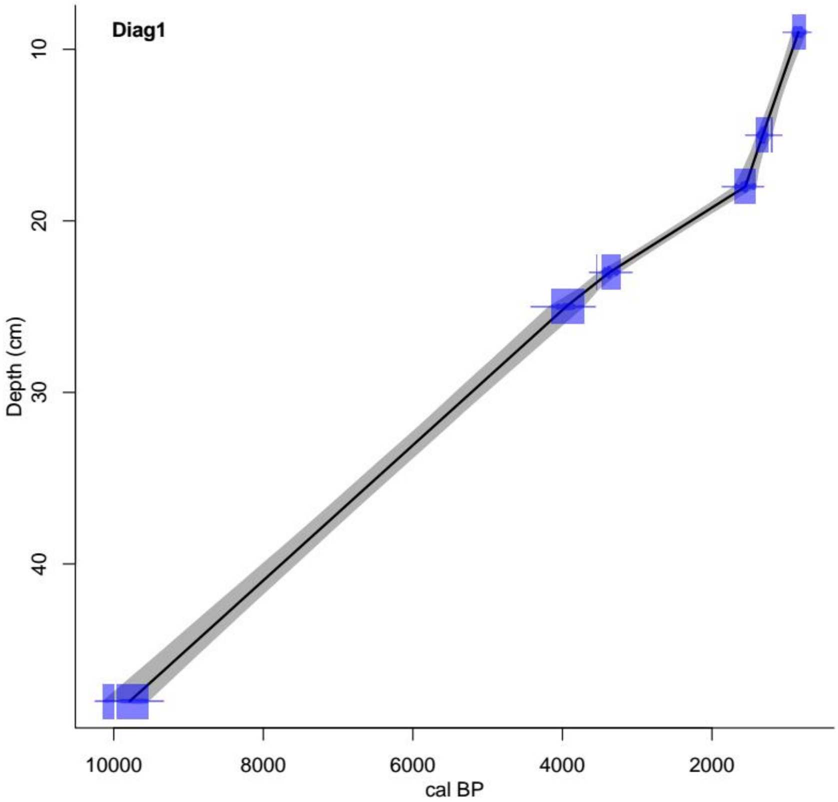


Figure 33. *Calibrated dates of Cefn Fford pollen diagram (Blauw 2010).*

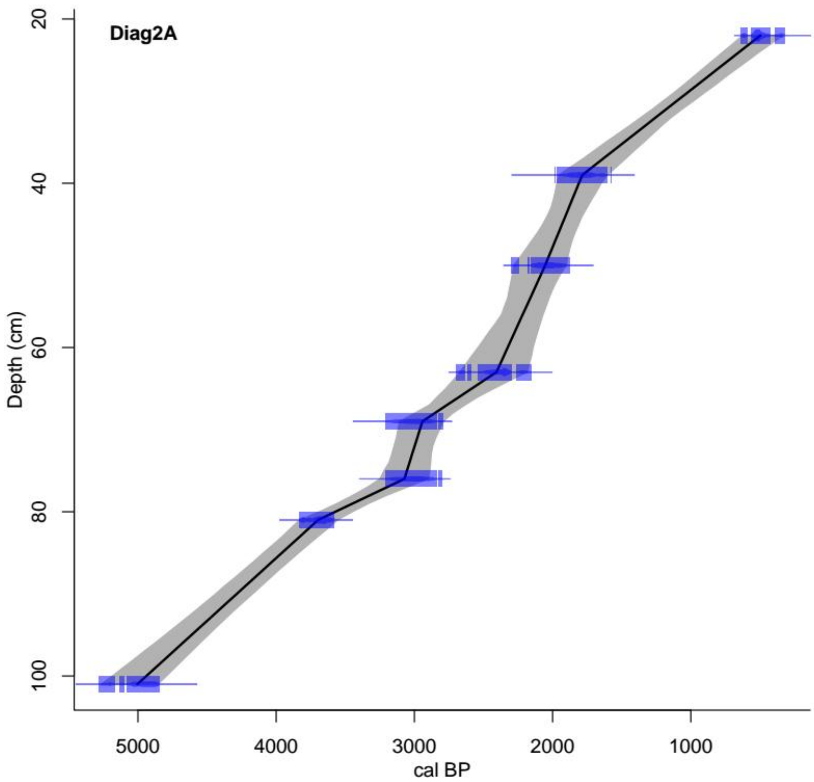


Figure 34. *Calibrated dates of Brecon Beacons pollen diagram (Blauw 2010).*

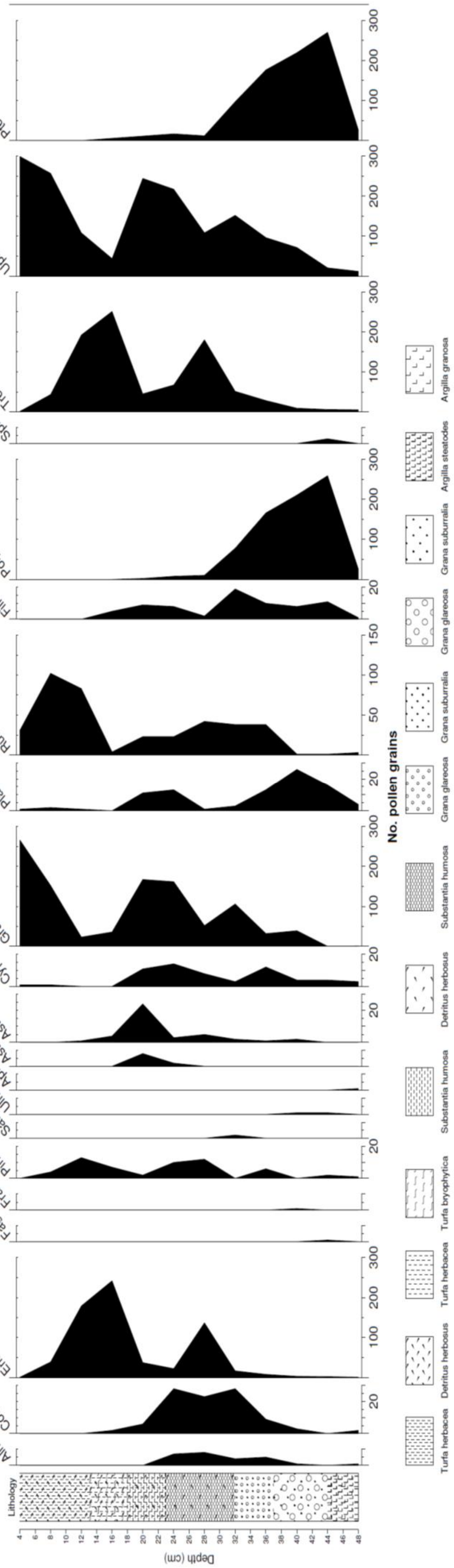


Figure 35.

Pollendiagram from the south of Skomer Island (Carpenter et al., author's personal copy).

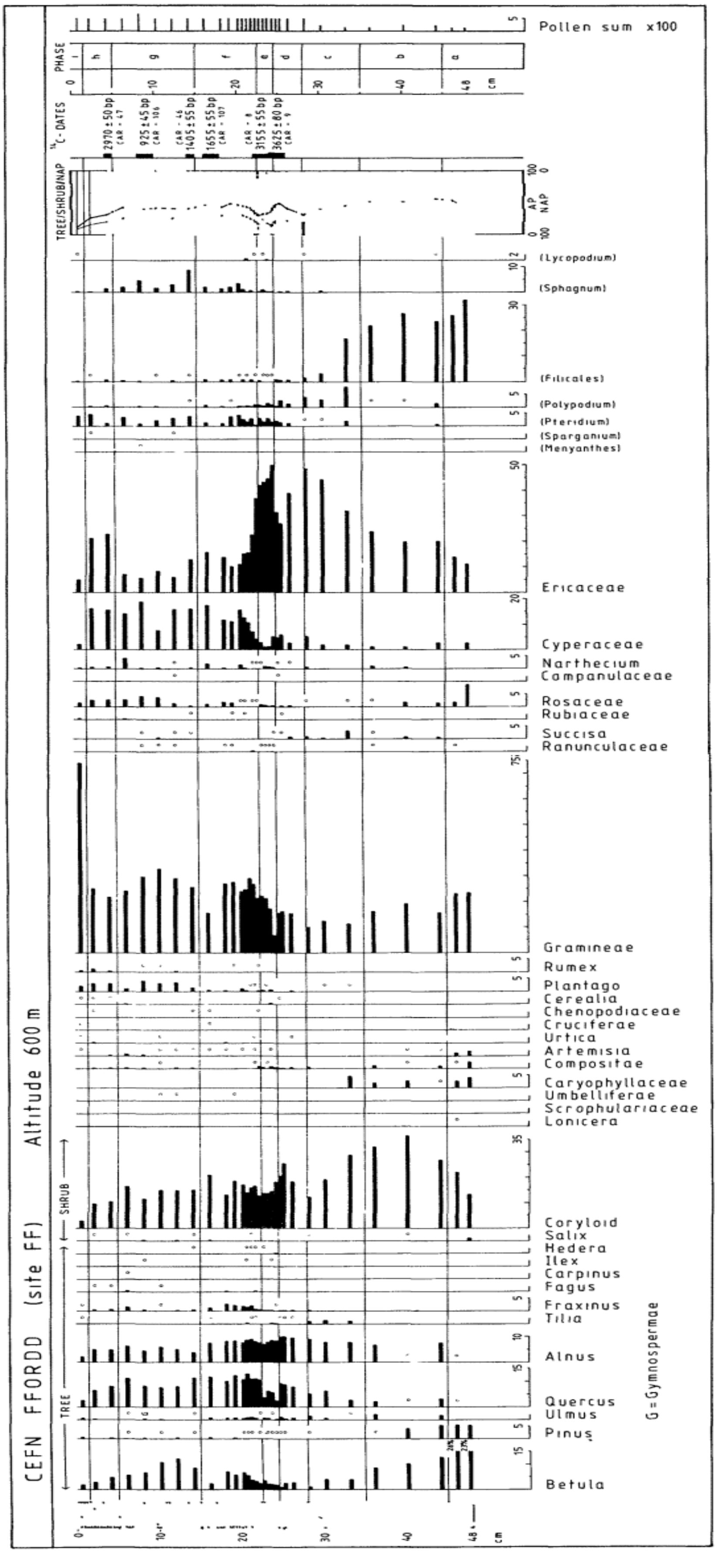


Figure 36. *Pollen diagram from Cefn Ford, South Wales (Chambers 1984, 450).*

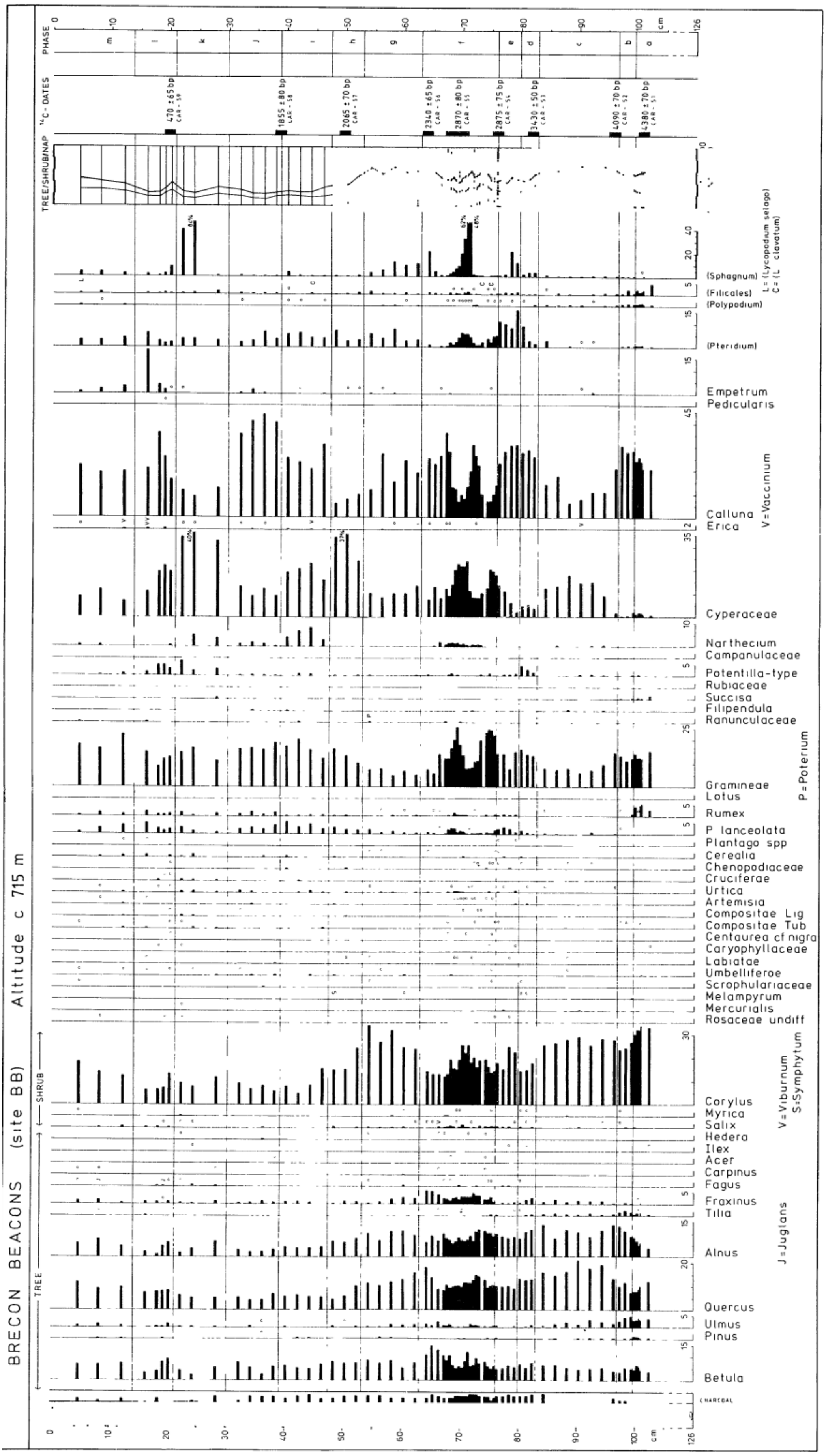


Figure 37. *Pollen diagram from Brecon Beans, South Wales (Chambers 1984, 452).*

Appendix – Tables

Step	Process
1.	Connect meter to power with transformer and sample well to meter with coaxial cable.
2.	Switch the machine on by switching the left hand knob to SI. The right hand knob can be set to either 0.1 or 1.0, depending on the necessary level of detail.
3.	Set the well to a low frequency.
4.	The small metal lever will be set to 'zero' for a couple of seconds before turning it to 'measure'. All reading should be around 0 in this time of process.
5.	The small lever is reset to the centre.
6.	First air reading done by pressing 'zero' and then 'measure'. This reading should lie around 0 again and is noted.
7.	The first sample measurement, followed directly by the second, both are noted.
8.	After removal of the sample, an air reading will be done and noted, followed by a re-set to 'zero'.
9.	Steps 6 to 8 are repeated for the remaining samples.
10.	After all samples are measured, they are weighed on a small scale and results are noted.

Table 1. *Preparation steps for magnetic susceptibility.*

Sieve size	Linked with particle size data (diameter value in the calculation sheet).
0.5	415
0.71	678
0.85	777
1	890
1.4	133
2	2009
4	3

Table 2. *Sieves used to hand-sieve subsamples for particle size analysis linked with the diameter value in the calculations.*

Sample number	Kubiena tin 1, top - depth	Kubiena tin 2, bottom – depth
1	1 – 2 cm	-
2	4 -5 cm	-
3	6 -7 cm	-
4	-	1 – 2 cm
5	-	4 – 5 cm
6	-	6 -7 cm

Table 3. *Depths of subsamples relative to the kubiena tins.*

Information on ecology and environment	Indicated by species:
Requirements of light	
Light requiring, rarely occurring in places with less than 40% light	*C. vulgaris*
Half light, half shadow species. Rarely found in places with less than 20% light	*C. avellana, F. excelsior* and *P. lanceolata*
Temperature	
Found in moderately warm environments	*C. avellana*
Soil acidity	
Occurring in very acid soils with pH values under 3.4	*C. vulgaris*
Occuring in acid to alkaline soils, never in very acid soils	*F. excelsior*
Nutrients in soils	
Soil is poor in nutrients and minerals. Species not tolerant to eutrofication	*C. vulgaris*
Soil is moderately rich in nitrogen. Often indicating patches of the species	*C. avellana* and *F. excelsior*
Salt tolerance	
Not tolerant to salt in soils	*C. vulgaris, C. avellana, F. excelsior* and *P. lanceolata*
Ecological group	
Moors, dwarf shrub heathland	*C. vulgaris*
Deciduous woodland / shrub heathland	*C. avellana*
Quercus and oak-dominated forests	*F. excelsior*
Meadows	*P. lanceolata*
Relative dominance	
Often dominant	*C. vulgaris*
Mostly occuring in patches/small groups	*C. avellana* and *P. lanceolata*
Always very dominant	*F. excelsior*

Table 13. *Information of ecology and environment, based on collected data of the species (Ellenberg 1991, 67-77). The information based on C. avellana does not include the other option of the Corylus avellana-type (Myrica gale).*