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Land use and environmental history of Waun Llanfair, an upland landscape above Penmaenmawr, North Wales:

The Palaeoenvironmental Evidence

By Astrid E. Caseldine and Catherine J. Griffiths

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Cover: Part of the Waun Llanfair basin (foreground) and the hilltop settlement of Dinas Garreg Fawr, looking north-west.
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The Palaeoenvironmental Evidence from Waun Llanfair

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The nature of the environment when funerary and ritual monuments were constructed is of primary importance when considering interpretation of their landscape context. Earlier and contemporary human impact on the vegetation and contemporary land use may have influenced their location and their visibility in the landscape The uplands of Wales are rich in archaeological remains, especially funerary and ritual sites, and, fortunately, peats and peaty soils, presenting an opportunity to elucidate the environmental conditions associated with the monuments. Whilst most palaeoenvironmental investigations in Wales concerned with the Holocene take at least some account of archaeology in the interpretation of the palaeoenvironmental record, rather fewer have focused specifically on the environmental context of funerary and ritual monuments (e.g Chambers 1982, 1983) or involved integrated pollen and archaeological investigations associated with funerary and ritual monuments. Some of these studies have included the investigation of nearby peat deposits, for example Mynydd y Drum (Chambers *et al* 1990, Dorling and Chambers 1990) and Peny y Fan and Corn Du (Chambers and Lageard 1998) in south Wales, Carneddau (Walker 1993a, 1993b) in mid Wales and Brenig (Hibbert 1993a, 1993b) in north Wales, whilst others have been confined to investigations at the archaeological sites, for example Fan Foel (Caseldine and Griffiths forthcoming) in south Wales, Corndon Hill (Britnell *et al* 2008) in mid Wales and Capel Eithen (Chambers 1999) and Llandygai (Dimbleby 2001) in north Wales.

This combined archaeological and palaeoenvironmental study arose from an earlier survey of monuments in West Conwy and North Gwynedd (Smith 2002) undertaken as part of a larger project by the Welsh Archaeological Trusts of prehistoric funerary and ritual monuments throughout Wales. The palaeoenvironmental element of the investigation attempts to ascertain the nature of vegetation change in the area and the role of anthropogenic activity in modification of the upland landscape. Even within a single upland area there may be local differences in the landscape history and to gain an insight into any spatial variation in the vegetation present pollen sequences were taken from three locations as well as samples from deposits associated with the monuments excavated. Multiple pollen sequences within an area may enable variation in the vegetation and vegetation mosaics to be identified at a local scale, as well as variation in the impact of human activity (Smith and Cloutman 1988, Dumayne-Peaty and Barber 1998, Fyfe *et al* 2003, Davies and Tipping 2004, Woodbridge *et al* 2012). From the close proximity of the monuments to the pollen sites it was hoped that human modification and management of the landscape contemporary with the archaeological remains would be detected and that, aided by radiocarbon dating, a chronological record of land use history and environmental change would be obtained.

Although the study originated from a survey of prehistoric funerary and ritual monuments, archaeological remains investigated included burnt mounds and walls as well as cairns. Nearby in the wider upland area notable monuments include the Druid's Circle stone circle and Graig Llwyd stone axe factory. In the wider region, in the lowlands, sites include Parc Bryn Cegin with archaeological remains dating from the Early Neolithic through to the eighteenth and nineteenth centuries.

Site selection and sampling

The palaeoenvironmental evidence comprises records from three pollen columns from shallow peaty deposits in the area and spot samples and small columns from buried ground surfaces associated with the monuments excavated (Fig. 2 map survey and sampling sites**)**. The first pollen site (WLF1) was located towards the centre of an area of peaty gley soils at SH71626 73767 and an altitude of 373 m in the gently sloping basin. The second site (WLF2) was to the southeast of the first at an altitude of 386 m. The third site (WLF3) was located in a small deeper hollow of peat in an area of peaty soils on the plateau above the basin at SH72135 74057 and an altitude of 415m. The monuments excavated and sampled for pollen comprised three cairns (11, 470 and 485), two burnt mounds (466 and 467) and two field walls (15943 and 15944). In addition charcoal evidence was obtained from four of the monuments, burnt mound 467, burnt mound 466, cairn 485 and cairn 470 and charred plant remains from cairns 485 and 470.

Methods

Pollen

Sub-samples were taken from the pollen columns and spot samples and prepared following standard procedures (Moore *et al* 1991). This included acetolysis to remove cellulose as well as treatment with hydrofluoric acid and fine sieving to remove minerogenic material. *Lycopodium* spores were added as a marker and to enable pollen and charcoal concentrations to be calculated (Stockmarr 1971). Pollen and spores were identified using the keys in Moore *et a*l (1991) and Andrew (1984) as well as a modern reference collection. Fungal spores indicative of grazing activity (van Geel 1978, Van Geel *et al* 1981, Van Geel 2003) were also identified and counted. A sum of 300 total land pollen grains was counted where concentrations were sufficiently high but where concentrations were low the count was based on 300 *Lycopodium* spores. Results are shown as percentage total land pollen (TLP) for land pollen types whilst aquatics, spores and fungal spores are expressed as percentage TLP plus the respective group. Microscopic charcoal was counted and is expressed as concentration data. Pollen nomenclature is modified from Moore *et al* (1991) using Bennett (1994, Bennett *et al* 1994). The diagrams were prepared using TILIA (Grimm 1991-93) and TGView (Grimm 2004). An exaggeration factor has been applied to some of the pollen curves and the charcoal concentration curve in Fig. 2 (WLF1 selected taxa) to show certain changes in the vegetation more clearly. Stratigraphically constrained cluster analysis using CONISS (Grimm 2004) was used to aid zonation. The results are presented in Figs. 1-14 and summarised in Tables 1-13.

Plant macrofossils

The bulk plant macrofossil samples were sieved through a stack of sieves to recover charred plant remains. The finest mesh used was 250µm. In addition pollen sievings from the three pollen sites were also examined for plant macrofossil remains. The remains were examined using a Wild M5 stereomicroscope and identified with the help of identification texts (e.g. Berggren 1969, 1981, Schoch *et al* 1988, Anderberg 1994, Cappers *et al* 2006) and a seed reference collection. The charred plant macrofossil results are given in Table 14 and the results from the pollen sievings are included in the stratigraphic descriptions. Nomenclature is based on Stace (1995) which was also used for ecological information.

Wood and charcoal identification
In the case of wood, transverse, radial longitudinal and tangential longitudinal thin sections were cut and examined using a Leica DMR microscope with transmitted light source, whilst charcoal samples were fractured to produce clean sections and examined with a Leica DMR microscope with incident light source. Identification was by reference to wood anatomy texts (Schweingruber 1978, Schoch *et a*l 2004). The wood results are included in the stratigraphic descriptions and the charcoal results are given in Tables 15-17. Nomenclature follows Stace (1995).

Radiocarbon Dating
Samples were taken from the pollen columns using standard procedures and submitted to either Beta Analytic Inc. in Florida or the Scottish Universities Environmental Research Centre at East Kilbride for radiocarbon dating. Two conventional radiometric and four AMS dates were obtained for WLF1. Two AMS dates were obtained for WLF2 and three conventional radiometric dates for WLF3. An AMS date was obtained for the pollen column from adjacent to Wall 15944. Details of the samples and the results are presented in Table 18. The presence of carbonaceous spheroids have been used to date the upper part of the diagrams based on a date of 1850±25 (Rose and Monteith 2005, Rose and Appleby 2005). An age-depth model based on linear interpolation between calibrated dates forms the basis for the estimated age chronology of the pollen columns. Estimated age-depth relationships for the three pollen sites are presented as a secondary (age) axis on the pollen diagrams (Figs. 1-4).

Results
Stratigraphies
The detailed stratigraphies from the three pollen sites are as follows:
WLF1
0-2.5cm Turf
2.5-18.5 cm Dark brown (7.5 YR 3/4) fibrous peat with *Eriophorum* remains and *Sphagnum* moss present. Slightly darker *c* 15-17cms.
18.5 – 21.5 cm More humified less fibrous dark yellowish brown (10YR 4/4) peat with *Sphagnum* moss and *Juncus* seeds. Charcoal present..
21.5 – 34 cm Increasingly humified very dark greyish peat (7.5YR 3/2) with *Sphagnum* and other moss remains. Peat becoming silty from *c* 30cm.
34- 45.5 cm Dark yellowish brown (10YR 4/4) humic silt with plant remains visible.
45.5 – 50 cm Dark brown (10YR 4/3) humic silt with plant remains present.
50- 53 cm Dark brown (10YR 4/3) more organic humic silt with plant remains visible.
54- 69 cm Dark greyish brown (10YR 4/2) slighty humic silty clay with plant remains present. Sandy *c* 60cm. Occasional charcoal fragments, especially *c* 64-66cm. Wood fragments..
69-79.5 cm Dark greyish brown (2.5 Y 5/2) gleyed clay with bluish hues. *Alnus* wood present.
79.5-81 cm Clay with gravel-sized stones and sand. Wood fragments.

WLF2
0-5 cm Dark reddish brown (5YR 3/4) slightly humified *Sphagnum* moss peat.

5-12 cm Fresh dark reddish brown (5YR 3/4) fibrous peat becoming more humified with depth. *Sphagnum* moss, *Juncus* and *Erica tetralix* seeds. Charcoal.
12- 20 cm More humified very dark brown brown (10YR 3/2) fibrous peat with stoney layer *c* 18-20cm *Juncus* and Erica tetralix seeds
20- 25.5 cm Less fibrous increasingly amorphous dark brown (7.5 YR 3/2) peat.
25.5- 31 cm Dark brown (7.5 YR 3/2) humic silt. *Juncus* seeds and charcoal.
31- 37 cm Slightly less organic dark brown (7.5YR 3/4) humic silt. *Juncus* seeds.
37- 40cm Dark yellowish brown (10 YR 4/4) silty sandy loam with stones.

WLF3
0-10 cm Fresh unhumified dark yellowish brown (10YR 4/6) *Sphagnum* peat..
10 – 23 cm Dark brown (7.5 YR 3/4) to dark reddish brown (5YR 3/3) and black (5YR 2.5/1) slightly humified *Sphagnum* peat with *Eriophorum* between 20-23 cm.
23-27 cm Band of black (7.5YR 2.5/1) humified *Sphagnum* and *Eriophorum* peat 7.5 YR 2.5/1
27-31 cm Very dark brown (7.5YR 2.5/2) humified *Sphagnum* peat. *Juncus* and *Erica tetralix* seeds.
31-33 cm Wood fragments in very dark brown (7.5YR 2.5/2) peat. *Juncus* and *Potentilla* seeds. Charcoal present.
33-37.5 cm Very dark brown (10 YR 2/2) humified fibrous peat. *Sphagnum* moss and *Juncus* seeds. Charcoal fragments.
37.5-49.5 cm Increasingly amorphous very dark brown (7.5 YR 2.5/2) peat with wood fragment and occasional roots/stems. *Betula* wood *c*. 47.5-49.5 cm. *Sphagnum* leaves, *Juncus* and *Carex* seeds. Charcoal fragments.
49.5- 68.5 cm Large wood fragments with monocotyledonous remains in amorphous blackish (7.5YR 2.5/1) peat. *Betula* wood *c.* 49.5-54.5 cm and 59.5-61 cm and *Salix* wood *c*. 65.5-68 cm. *Potamogeton*, *Juncus*, *Carex*, *Betula* and *Ranunculu*s seeds, charred *Erica* leaf, *Calluna* stems,
68.5 – 79 cm Amorphous very dark brown (10YR 2/2) organic silt with occasional small (2-3mm) gravel. Plant remains occasional. *Carex* and *Juncus* seeds.
79.5 87.5 cm Amorphous very dark brown (10YR 2/2) organic silt with occasional fine stems and small gravel. *Juncus*, *Carex* spp. and *Ranunculus* seeds and *Sphagnum* moss leaves.
87.5- 90 cm Very dark brown (10YR 2/2) organic silt with stems/root remains and small gravel. *Juncus* seeds.

The contexts examined from the archaeological sites are described in the site descriptions (px-x). Stratigraphic data from all the sites are included in the pollen diagrams, where appropriate.

Radiocarbon
Most of the results (Table 18) are satisfactory but three of the results from WLF1 require comment. The lowest sample (76 cm) from WLF1 gave an AMS date of 1688-1500 cal BC (Beta-235899: 3310±40 BP), considerably later than expected based on the pollen evidence.. The sample was *Alnus* wood and almost certainly must be intrusive from above. Similarly, an AMS date of cal AD 1641-1955 (Beta-239192: 200±40 BP) obtained on monocotyldon remains from a depth of 70 cm was clearly too recent and must have been intrusive ‘modern’ material. In contrast charcoal dated from a depth of 65cm appears to be residual. The AMS date of 5368-5207 cal BC 6290±40 BP (Beta-186680: 6290±40 BP) is earlier than that of a

radiometric date of 3964-3778 cal BC (Beta -241086: 5070±40 BP), which is in keeping with the pollen evidence, obtained from organic sediment at 65 cm..

Pollen

Pollen percentage diagrams have been prepared for both the three pollen sites and the pollen samples from the archaeological sites (Figures 1-14). The pollen zones for each diagram are described in Tables 1-13. The results indicate an opening up of the upland landscape with the plateau area and sides of the upland basin being cleared first but woodland persisting in the basin and upper valleys possibly into the first millennium AD.

Plant macrofossils

Charred plant remains were recovered from Cairns 485 and 470 (Table 14). A single hazel (*Corylus avellana*) nut shell fragment was found in the old land surface below Cairn 485 whilst hazelnut shell fragments were frequent in samples from the possible old ground surface and occupation layer of Cairn 470. Hazelnut shell also occurred in the occupation layer outside the cairn which also produced charred heather (*Calluna vulgaris*) flowers, a ribwort plantain (*Plantago lanceolata*) seed and a large grass (*Poaceae*) seed. A grass seed and culm nodes were also obtained from the old ground surface/occupation layer beneath the cairn. The results indicate hazel woodland and grass-heath vegetation communities in the vicinity of the cairn sites.

Charcoal

A small amount of sharcoal was identified from Burnt mounds 467 and 466 (Tables 15 & 16) and Cairns 485 and 470 (Table 17). Alder (*Alnus glutinosa*), hazel (*Corylus avellana*) and hawthorn (Maloideae) type were recorded in samples from burnt mound 467 and burnt mound 466, with the addition of birch (*Betula* spp.) in the latter. Oak *(Quercus* spp.) and hazel were found in the old land surface below Cairn 485 while birch was identified from the body of Cairn 470, hazel from the cairn body/occupation layer, oak, birch, alder and hazel from the occupation layer and possible ground surface and hazel from the occupation layer/subsoil. Although the assemblages are small the results fromm the monuments may reflect changes in the upland woodland vegetation. The presence of alder, hazel and woodland is indicated in the assemblages from both the cairns and the burnt mounds whereas oak is only represented in the cairn assemblages and may indicate a decline in oak woodland in the area by the time the burnt mounds were constructed. Similarly the occurrence of hawthorn type in the burnt mound assemblages might indicate a more open environment with scrub.

Discussion

Upland landscape history and human activity

Although the deposits investigated are relatively shallow, the period covered by the records is over ~7000 years and it is possible to identify changes in the vegetation that can be related to archaeological evidence for human activity in both the local area and the wider region. However human activity is not the only factor that has influenced vegetation development in the past and, along with land use, the vegetation in an area is influenced by other local factors including soils, topography, aspect, altitude, local climate and drainage, set against a wider climatic background. Hence, although the sites are all high altitude sites lying above 365 m and in a relatively narrow altitudinal range (365 m to 415 m), differences are discernible between the upland basin area and the plateau area above, reflecting differences in the local vegetation and pollen source areas. At the same time the broad sequence of environmental change is consistent with that recorded at other sites in North Wales, although the exact timing of vegetational change varies as does the nature and timing of human impact (e.g. Hibbert and Switsur 1976, Ince 1983, Mighall and Chambers 1995, Watkins *et al* 2007, Woodbridge *et al* 2012).

In an investigation of the pollen record from upland blanket peat pollen sites on plateaux it was suggested that the record may vary depending on the prevailing wind direction and the aerial pollen fallout (Price and Moore 1984). Multiple pollen sites may therefore demonstrate variation depending on the pollen catchment from the surrounding valleys. Given the location of Waun Llanfair the regional pollen input is perhaps most likely to have been influenced by the pollen input from the Afon Llanfairfechan valley and the coastal lowlands around Llanfairfechan and to the west, although the extent of any regional input will have been influenced by the local vegetation at the pollen sites.

Mesolithic and earlier Neolithic environment and land use history

The earliest vegetation record for this upland area, *c*. 350-435 m, is provided by pollen site WLF1 (Figs.1 and 2). The record commences during the Mesolithic, estimated *c* 5525 cal BC or maybe earlier. The evidence suggests that at around this time the woodland comprised hazel (*Corylus avellana*) with stands of pine (*Pinus sylvestris*) on the drier ground, while alder (*Alnus glutinosa*) perhaps occupied the lower-lying wetter ground of the basin and the valley sides below. An expansion in hazel and pine occurs at the expense of alder before alder expands again and then dominates the local area. Alternatively it is possible that the apparent expansion in pine and hazel could represent secondary pollen, perhaps derived from soils developed during an earlier woodland episode. Either way pine and hazel were important components of the earlier upland woodland.

Records from other sites in North Wales indicate that there was considerable variation in the distribution of pine during the early–mid Holocene. Its presence at Waun Llanfair may be partly due to it being able to compete more successfully with the lighter woodland cover of the uplands, compared with closed canopy woods in the lowlands, and may represent a later survival in this area until local hydrological and edaphic conditions favoured alder. Nevertheless, it was certainly present in the lowlands at Llandygai at *c*. 7050-6700 cal BC (GRN–27193: 7965±25), where burnt pine stumps below a henge bank have been interpreted as the result of a lightening strike (Lynch and Musson 2001). Equally, at Llyn Cororion on the Arfon Plateau at *c* 82.5m OD and *c* 2km from Llandegai, it has been argued that fire may have created an ecological niche for *Pinus* to exploit (Watkins *et al* 2007). There is only slight evidence in the microscopic charcoal record at Waun Llanfair for fire activity but confirmation that local burning was occurring during the Mesolithic is provided by a date of 5370-5200 cal BC on macroscopic charcoal, although this is from higher in the stratigraphy at which point the charcoal is considered to be residual. It is possible that fire, either natural or as a result of human activity, may have favoured pine and hazel in the local and extra-local area, at least initially. Apart from alder, pine and hazel, birch (*Betula*) woodland was also present, and maybe oak (*Quercus*), while at lower altitudes in the region elm (*Ulmus*) was a significant component of the mixed woodland but lime (*Tilia*) was rare.

The relatively high values (~ 40% TLP) for alder at the commencement of the pollen record suggests that it was already reasonably well established, at least in the wider area, and that the 'alder rise' (the point at which alder first begins to increase) occurred some time prior to the estimated date of *c* 5525 cal BC. This is consistent with the evidence from the Aber Valley where it is estimated that alder was already present by *c* 6000-5500 cal BP (Woodbridge *et al* 2012). At Nant Ffrancon (Hibbert and Switsur 1976) the 'alder rise' is dated to 5983-5626 cal BC (Q-900: 6880±100). Although at a lower altitude, 198m OD, this site lies further inland than Waun Llanfair whereas at Llyn Cororion, at *c*. 82.5m OD and nearer to the coast, a rapid expansion in alder is dated to *c* 6691-6456 cal BC (SRR-3471: 7745±65) (Watkins *et al* 2007) while on the relatively low lying Graeanog Ridge (Chambers 1998) alder was already abundant by c 7359 14C yr At Bryn y Castell, at c 364 m OD, a comparable altitude to Waun Lanfair but in southern Snowdonia, the alder rise is dated to *c* 5592-5524 cal BC (GrN-17585: 6680±45 BP) (Mighall and Chambers 1995).

Following the abrupt decline in pine, there is a marked increase in alder pollen. Although it is feasible that some of the alder pollen may have been transported up-valley from the lowlands, the occurrence of alder wood in the stratigraphy, although later in date, and the presence of alder type perforation plates (end walls of wood vessels) from the decayed remains of wood on the pollen slides supports the pollen evidence for its local presence and demonstrates the establishment of alder at *c* 365 m OD. A radiocarbon date of 3970-3770 cal BC (5070±40 BP) from organic sediment shortly after the increase in alder pollen is similar to that of 4950±37 BP (UBA-15757) from an *in situ* alder tree stump at just over 350 m OD near Pen-y-Gwryd in the Snowdonia uplands (Woodbridge *et al* 2012). In the Aber valley there is also strong circumstantial evidence for stands of alder, namely the dominance of alder pollen and presence of wood remains, although not identified, at pollen sites up to c 470 m OD but not at sites over 600 m OD (Woodbridge *et al* 2012). The site at Waun Llanfair (WLF1) lies within the altitudinal range suggested by McVean (1953) for alder in Britain of up to 488m OD and the maximum altitudinal limit of 503 m suggested by Wilson (1949).

Alder's requirement for specific ecological conditions, influencing its spatial distribution, has been noted in the past (Bennett and Birks 1990, Tallantire 1992). Damp soils are an important factor in determining the establishment of alder and it probably rose to dominance locally as wetter soil conditions prevailed in the basin, displacing pine and, perhaps to a degree, hazel, although the latter continued to be significant on drier ground on the upper slopes of the basin and above. It is possible that human activity may have played a part in the vegetation changes. The decline in hazel is accompanied initially by a slight increase in microscopic charcoal which is followed later by a distinct peak coinciding, with a relative low in hazel. The charcoal could reflect clearance activity involving fire or possibly domestic fires in the area, or natural fires resulting from lightening strikes. Whether or not fire was involved, removal of hazel woodland may have resulted in increased run-off leading to wetter soil conditions which in turn led to an expansion in alder woodland in the area.

Alder pollen tends to dominate when it is locally present (Janssen 1959, Waller *et al* 2005) and modern pollen studies have demonstrated the effect of the dominance of alder woodland on the pollen source area and representation of taxa (Bunting *et a*l 2005). Hence the pollen curves for certain significant taxa (Fig. 2) have been exaggerated to enable changes taking place in the surrounding landscape to be amplified and more easily detected.

The later distinct fire event and low in hazel is dated to 3970-3770 cal BC and there is some archaeological evidence from the upland area to support the view that human activity may have been a contributory factor influencing vegetation change around this time. The occurrence of ribwort plantain during the decline in hazel may also indicate pastoral activity. Charcoal from a working area comprising a concentration of axe-making flakes around an upright stone and sealed beneath a cairn close to the nearby Graig Lwyd axe factory is dated to 4340-3980 cal BC (5330±90 BP :SWAN-142) (Williams and Davidson 1998) but probably relates to activity pre dating the factory. It is suggested that the earliest date for the Graig Lwyd axe factory is in the first half of the fourth millennium BC, based on the analysis of radiocarbon dates using Bayesian statistics from Parc Bryn Cegin, Llandygai and other sites on Anglesey and the Llyn Peninsula, and that the dated charcoal from the cairn site was probably residual (Williams and Kenney 2011). It is suggested that the Parc Bryn Cegin timber structure was in use between 3760-3700 cal BC and 3670-3620 cal BC, (or 3800-3670 cal BC – 3690-3610 cal BC – dates are different in two publications), just marginally later than the date for the fire event and low in hazel. Equally the date for the fire event is marginally later than the early date from the axe factory. It is tempting to see the decline in hazel woodland as associated with early activity at the axe factory, or activity just before, if not the fire event. Certainly the dates from the archaeological evidence Similarly, a small decline in oak might reflect minor impact on local upland oak woodland, the area lies within the maximum altitudinal limits of c. 460m for oak at the present day (Wilson 1949, Clapham *et al* 1987), or the effects of human activity on lowland woods in the wider region discussed further below.

Coinciding with the possible impact on oak woodland ~ 3970-3770 cal BC is the beginning of a decline in elm, with values for the latter falling to less than 1% TLP shortly after. The date for the decline in elm is in keeping with dates from elsewhere in Wales and the rest of Britain for the ‘elm decline’, an event widely recognised throughout Britain and north-west Europe. It is generally thought to be largely attributable to disease but with other factors, including human activity, climate and soil degradation, maybe contributing to a greater or lesser extent depending on the individual site (Parker *et al* 2002). As at Llyn Cororion (Watkins *et al* 2007), an increase in lime suggests that soil deterioration and climate were not significant factors in the decline in elm in the wider region.

Although there is some debate about the role of human activity in the decline in elm, it is likely that the reduction in oak woodland at this time is attributable to human activity in the region, either as a result of land clearance for agriculture or its selection for construction purposes, as for example at Llandygai where it was used in the construction of buildings. As already mentioned, a Bayesian model has provided dates of 3800-3670 cal BC – 3690-3610 cal BC (or 3760-3700 cal BC to 3670-3620 cal BC) for the use of the early Neolithic building at Parc Bryn Cegin, Llandygai II (Kenney 2008) and a date on a charred hazelnut from the early Neolithic building at Llandygai I is similar (Lynch and Musson 2001) and that these dates for early Neolithic activity are broadly in agreement with the oak clearance episode dated to

3970-3770 cal BC. It is also possble that, although disease may have been the main factor in the decline in elm, any woodland clearance may have included the removal of healthy and diseased elms and hastened the demise of elm in the woodland landscape. Coincident with the decline in elm to very low levels is an increase in oak and lime suggesting regeneration of woodland in abandoned areas and/or the expansion of these species into areas formerly occupied by elm.

Further clearance and regeneration episodes may broadly relate to periods of activity at Parc Bryn Cegin, Llandygai, taken as representative of activity in the wider region and as a link with activity in the Waun Llanfair upland area through the presence of flakes from Graig Lwyd axe factory. The presence of Graig Lwyd flakes from dated sites at Parc Bryn Cegin sites, as well as dated sites on Anglesey and the Llyn Peninsula has been used to provide a chronological framework for the axe factory (Williams and Kenney 2011). A further decline in oak pollen indicates Neolithic clearance of oak woodland followed by clearance of lime woods, at which time oak may have colonised abandoned land and areas where lime previously existed, before another clearance episode involving oak These vegetation changes may coincide with a period of activity at Parc Bryn Cegin, Llandygai II with pits containing Peterborough pottery dated to 3360-3090 cal BC to 3330-2920 cal BC and Graig Llwyd flakes (Kenney 2008, Williams and Kenney 2011). Environmental evidence from Llandygai includes pollen evidence from a buried soil from beneath the bank of Henge A at Llandegai I, dated to around 3200-3100 cal BC, (Lynch and Musson 2001), which suggests the immediate environment when the monument was constructed was open country under pasture (Dimbleby 2001). Equally, the presence of oak and hazel charcoal from the ground surface under the bank is consistent with the Waun Llanfair pollen record for oak and hazel woodland Charred cereal and poorly preserved bone from the early Neolithic building and later pits at Parc Bryn Cegin attest to farming activity in the lowlands while anthropogenic indicators are largely absent from the pollen record at Waun Llanfair, probably at least partly because of the dominance of alder at the site.

It is also possible that the clearance episodes evident in the Waun Llanfair pollen diagram reflect clearance of upland oak woodland associated with activity at the axe factory, but otherwise there is only limited evidence to suggest the impact of humans on the upland landscape. Hazel woodland appears to recover following the decline *c* 3964-3778 cal BC (3970-3770) cal BC and remain at a fairly constant level, showing only a minimal decline before a return to former levels, whilst alder shows a a slight, but steady, decline. There is further dated evidence for human activity from the axe factory at Graig Lwyd itself, where charcoal from an axe-debris layer is dated to 3321-2908 cal BC (Beta-128505) and, along with the only datable artefact – a carved stone plaque, suggests axe-manufacturing during the later Neolithic, which may relate to the end of this period.

Although woodland dominates in the immediate area of WLF1, low amounts of heather (*Calluna*) and grass (Poaceae) pollen indicate the presence of open grass-heath vegetation communities in the area. The evidence is similar to that from the Afon Goch headwater valley, Abergwyngregyn, during the Mesolithic and Neolithic where alder woodland dominated the valley with open birch and hazel woodland extending onto the surrounding upland (Woodbridge *et al* 2012).

The later Neolithic and EarlierBronze Age environment and land use history

Much of the archaeological evidence in the Waun Llanfair area dates to the late Neolithic and Bronze Age. The relatively close proximity of the archaeology to pollen site WLF1 meant there was a possibility that activity associated with the monuments might be discernible in the pollen record. The pollen record fromWLF1 suggests that alder woodland with an understorey of ferns and species such as meadowsweet (*Filipendula*) and nettle (*Urtica*) continued to prevail in the wetter area of the basin as well as with oak oak in the upland valley woods, while open hazel and birch woodland with heathland and grassland occurred on the drier upper slopes in the area. However, there is evidence for human impact on the upland hazel woods with a distinct decline estimated as occurring during the late Neolithic *c*. 2770 cal BC . At the same time there is a minor peak in microscopic charcoal concentrations, relecting either fire activity some distance away or possibly more local, small-scale activity. Although there is a brief expansion in alder, perhaps into some areas previously occupied by hazel, followed by a decline alder and perhaps a very minor recovery in hazel, the general trend suggests a decline in hazel woodland and an expansion of grassland and birch woodland. There is also slight evidence for an increase in heathland and the presence of ribwort plantain (*Plantago lanceolata*) indicates grazing activity. The decline in hazel, along with a brief decline in birch and the later decline in alder, may relate to later Neolithic activity pre-dating and contemporary with the construction of Cairn 470, lying *c* 540m to the south-west of WLF1. Dates of 2866-2574 cal BC and 2621-2472 cal BC were obtained on hazel charcoal from the occupation deposit below the cairn as well as a date of 2870-2570 cal BC from birch charcoal from the cairn body itself, while a date of 2338-2135 cal BC (SUERC-27870) from birch charcoal from the occupation deposit is considered to date the construction of the cairn. Activity at other cairns may also date to this period, while a date of 2881-2633 cal BC on hazel charcoal from Burnt Mound 467, a burnt mound around 120m to the northeast of WLF1, probably reflects the incorporation of charcoal from an earlier soil in the make-up of the burnt mound and earlier activity, at least fire activity, in the vicinity of the site.

Away from pollen site WLF1 and the influence of local alder, the pollen record (Fig. 3/14) from the ‘occupation’ levels containing Graig Lwyd flakes and flint from below stone B of Cairn 470 suggests an open environment with grasses and grassland herbs, including ribwort plantain and buttercups, and occasional heather in the immediate vicinity of the cairn site with open hazel woodland and alder nearby and oak and birch in the surrounding area. Occasional spores of *Sordaria* spp., a fungus type commonly associated with animal dung, although it also occurs in decomposing vegetation (van Geel 1978, Van Geel *et al* 1981, Van Geel *et al* 2003), supports the evidence for a predominantly pastoral economy. The spores occur in the deposit containing Graig Llwyd flakes and flint while a peak in charcoal occurs at the surface. Barley *(Hordeum*) type pollen is also present at the surface and in the deposit immediately pre-dating cairn construction and could hint at cultivation but this type includes certain wild grass species as well as barley. The presence of both microscopic and macroscopic charcoal indicates burning and identification of the latter (Table 18) confirms the local presence of oak, hazel, birch and alder, while frequent charred hazelnut shell fragments (Table 19) from occupation deposits beneath and outside the cairn provide further evidence for the presence of hazel. Similarly charred grass remains from the occupation deposits beneath and outside the cairn and a charred ribwort plantain seed and charred heather flowers from the occupation layer outsde of the cairn are consistent with the pollen record for grassland communities and heathland in the local area.

A Late Neolithic date is also assigned to Cairn 485, *c*. 420m to the north-east of WLF1, on the basis of artefactual evidence, including Graig Llwyd stone. A pollen sequence (Fig. 12) from the old land surface beneath the cairn indicates a change in the upland landscape from hazel woods with grassland and associated weeds, as well as some heather, to one in which grass-heath communities dominate following a decline in hazel.. Pollen (Fig. 13) from immediately below a sizeable cairn stone also suggests hazel woodland and grass and heather vegetation. The increase in heather and grass at the top of the sequence may indicate the conditions contemporary with construction of the cairn and reflect a deterioration in soil conditions and soil acidification. Again the presence of *Sordaria* spp. fungal spores support the pollen evidence for the presence of livestock and grazing activity. The record is in agreement with that from WLF1 where, although values are low, representation of heather increases following the decline in hazel. Charcoal was scarce from Cairn 485 but again indicates the presence of oak as well as hazel woodland in the area (Table 17) while a hazelnut fragment is further evidence for the presence of the latter.

A third cairn, Cairn 11, may also date to this period although there are no radiocarbon dates or artefacts to confirm this. The pollen sequence (Fig. 10) from below the cairn, located *c*. 500m to the east of WLF1, displays a sequence similar to that from Cairn 485 with hazel woodland and grass-heath communities and frequent weed taxa, followed by a change to a more open grass-heath environment as hazel declined, but with stronger representation of hazel and heather. Grassland herbs are also much reduced. Prior to this there is some possible evidence for cereal cultivation although the cereal (*Hordeum*) type pollen could be derived from wild grass species rather than barley. The assemblage from spot samples (Fig. 11) from beneath stones A and B also suggest hazel woodland and grass-heath vegetation. The presence of heather in these samples indicates some soil deterioration and the assemblages are similar to those at the beginning of the expansion in heather recorded in the pollen sequence.

As well as the evidence from the cairns there is also evidence from one of the walls that was excavated which may date to this period but could be later. The wall, 15493, lies to the west of Cairn 11 with the excavated trench (2) around 180m to the southwest. The wall incorporates two cairns and was thought probably to be built after the cairns but associated. The record from sample 27 (Fig. 6) from the remnants of the possible buried soil is perhaps most informative with the evidence suggesting grass-heath communities with hazel woodland followed by a decline in hazel and expansion in heather communities. Ribwort plantain suggests grazing activity. An increase in charcoal coincident with the higher heather values perhaps indicates some attempt at land management. High heather values in the pollen levels (Fig. 7) from the subsoil possibly reflects contamination by later material, perhaps during construction of the wall. The sequence from the possible buried soil resembles the later record from Cairn 11 and is consistent with the suggestion that wall was constructed after the associated cairns.

Essentially, it seems that when the cairns were constructed a mosaic vegetation landscape occurred, depending on the local conditions. It is likely that alder woodland occupied the wetter area of the basin and the valley slopes below, while hazel woodland and grass-heath communities predominated on the surrounding drier ground but with stands of birch and oak woodland present as well. Livestock grazing was the main land use although there are possible hints of cultivation. A grass-heath environment with hazel scrub in the vicinity of the cairns is consistent with the record from many other upland cairn site areas in Wales, including the Brenig Valley (Hibbert 1993a, b) and Moel y Gerddi (Chambers *et al* 1988, Chambers and Price 1988) in north Wales, Carneddau (Walker 1993a, 1993b) in mid Wales and Pen-y-fan cairn and Corn Du cairn in the Brecon Beacons (Chambers and Lageard 1998), Fan Foel cairn (Caseldine and Griffiths forthcoming), and Nant Helen, Mynydd y Drum (Chambers *et al* 1990) cairn site in the uplands of south Wales. Early Bronze Age activity has also been detected at the early Bronze Age site at Llyn Morwynion (Caseldine *et al* 2001) in southern Snowdonia as well as Bryn y Castell (Mighall and Chambers 1995) and on the Migneint plateau (Blackford 1990).

In the wider region in the later Neolithic –early Bronze Age there appears to have been a recovery in elm, lime and possibly pine in the lowland woodlands around this time. A slight decline in oak woodland evident in the record from WLF1 may relate to local upland activity or activity in the lowland region, or both. Evidence from a pit group containing Grooved Ware pottery with dates between 29000-2670 cal BC and 2880-2580 cal BC, at Llandygai II demonstrates late Neolithic activity in the lowland region broadly contemporary with these vegetation changes.Throughout the Neolithic the evidence from WLF1 suggests human impact on mixed deciduous woodland with changes to the woodland composition following abandonment of cleared areas. Charcoal concentrations are low during this period and may reflect domestic fires or fires associated with funerary and ritual activity rather than fires associated with clearance activity or land use management. The low incidence of anthropogenic indicator species is probably because of the dominance of alder locally, as demonstrated by the much stronger representation of herb taxa, notably ribwort plantain, in the records from the archaeological monuments.

Slight changes in the pollen record from WLF1 may reflect activity associated with the construction of burnt mounds in the local area. A further impact on hazel and alder woodland is suggested by a gradual and then more marked decline in hazel and a slight oscillation in the alder curve. The more marked decline is dated to c. 1920-1690 cal BC. Immediately prior to this there is a distinct peak in microscopic charcoal. Dates of 2141-1937 cal BC and 2133-1902 cal BC on hazel and alder charcoal, respectively, from Burnt Mound 466, approximately 400m to the northwest of WLF1 date the mound to this period. Hazel and alder woodland continues to decline while grassland and ribwort plantain increase after 1920-1690 cal BC and may be associated with an expansion pastoral activity in the area evidenced by Burnt Mound 467, lying around 120m to the northeast of WLF1, where hazel charcoal gave a date of 1610-1420 cal BC. Whereas hazel and alder woodlands seem to be reduced, birch woodland appears to expand during this period.

The pollen record from beneath burnt mound 466 is dominated by alder pollen, presumably reflecting the close proximity of alder woodland to the site prior to and around the time of the mound construction. Some vegetational changes are, however, evident in the short profile. Initially a slightly more open environment is suggested with stronger evidence for heather and greater representation of grassland herb taxa, including ribwort plantain, before an expansion in alder woodland. A decline in these taxa and oak and birch may be partly due to the filtering effect of alder as alder woodland increased locally. Immediately below the mound, a slight reduction in alder and hazel, coincident with high charcoal values, and increase in grassland perhaps reflect impact on local woodland and clearance contemporary with or shortly before construction of the mound. Alder and hazel are the main taxa represented in the charcoal record from the mound (Table 17) but birch and hawthorn (Maloiodeae) type are also present. Although the assemblages are small, there is a slight difference between the assemblage from the ground surface at the base of the mound, which is dominated by alder, and that from the upper mound, which is dominated by hazel and includes hawthorn type as well as birch and alder. This may indicate reflect a change in the woodland available for exploitation, or at least in the nearest available.

The record from burnt mound 467 is from deposits making up the basal deposits of the mound, with the basal level from the possible remnant of the old land surface and the later levels reflecting activity contemporary with or after construction of the mound. A more open environment with grasses and weed species including ribwort plantain and dandelion type (Lactuceae) is suggested in the vicinity of the mound but alder is still relatively well represented whilst hazel values are low. Again impact on local hazel woodland is demonstrated by the presence of hazel charcoal dated to 1610-1420 cal BC from the base of the mound. An earlier date of 2890-2630 cal BC from hazel charcoal below the topsoil probably represents residual material incorporated into the make-up of the mound. As at burnt mound 466 alder and hawthorn type are also present in the charcoal record and the absence of oak in either assemblage compared with those from the cairns may suggest that any local oak woodland had been removed by this time. The difference between the pollen records from the two mounds suggests continuing impact on the landscape and is consistent with the record from WLF1. This is followed by a minor recovery in alder, hazel and birch and a slight decrease in grassland, although ribwort plantain continues to be represented at a similar level. The changes may reflect local minor vegetation changes following the end of the period of burnt mound activity.

There is further dated archaeological evidence for activity in the area from Cefn Coch Circle. Radiocarbon dates of 2200-1450 cal BC (NPL-11) and 2130-1300 cal BC (NPL-10) from the old land surface at Cefn Coch and a date of 1680-930 cal BC from a Bronze Age pit lie within the period of declining hazel woodland represented in the record from WLF1. The latter part of this period is also contemporary with the early record from pollen site WLF3 lying *c*. 600 m slightly to the southeast of Cefn Coch.

The evidence from WLF3 (Fig. 4) commences shortly before 1610-1320 cal BC (Beta-211080) and provides a higher resolution environmental record than that from WLF1, as well as demonstrating spatial variation in the upland vegetation and landscape and providing stronger evidence for land use activity. This site lies at a higher altitude than WLF1, at 415m OD. Whereas the pollen records from WLF1 and the burnt mounds and the radiocarbon date of 1690-1500 cal BC on alder wood from WLF1 demonstrate the presence of alder woodland in that area, an open environment dominated by grasses, sedges, heather and grassland herbs is suggested at WLF3 and that clearance had already largely taken place on the plateau. This is in agreement with the evidence from WLF1 which suggests an earlier episode of hazel woodland clearance in the area. There is however evidence for hazel, birch and alder woodland in the area and oak woodland with occasional elm, ash and pine in the wider region.

Relatively intensive activity, essentially pastoral, is suggested by frequent herbaceous taxa indicative of grassland and the presence of fungal spores, including *Sordaria*, *Sporormiela* and *Podospora* species, indicative of animal dung. Again there is some tentative evidence for cultivation of barley, perhaps at a subsistence level, but the cereal type does include particular wild grasses. An increase in microscopic charcoal at the beginning of this period, immediately prior to ~1610-1320 cal BC, may also reflect deliberate human activity in the area broadly contemporary with activity at Cefn Coch 'Druid's Circle' and burnt mound 467. Although fire activity appears to decline briefly, it then returns to a similar level which continues until 1260-900 cal BC at which time heather increases. Prior to this heather values are low and grass appears to dominate the open environment but from 1260-900 cal BC onwards there seems to be a close relationship between increases in heather and increases in charcoal, suggesting the use of burning to manage the landscape.

Spores of *Mougeotia* sp.(Algae) also coincide with the increase in charcoal levels at the beginning of the record. These occur in small pools or wet soils and can play a pioneer role after a local rise in the water table (van Geel 2003). The presence of pondweed (*Potamogeton*) also confirms local wet conditions, while sedge (Cyperaceae) pollen and sedge (*Carex* spp.), rush (*Juncus* spp.) and buttercup (*Ranunculus* sp.) seeds also reflect the local vegetation communities. The evidence could indicate a climatic shift to cooler and/or wetter conditions or changes in hydrology in the area as a result of human activity, or a combination of both.

In the wider region, at the upland site of Afon Goch, Abergwyngregyn, there is some limited evidence for Bronze Age activity but it is not until c 1000 cal BC that woodland cover begins to decline significantly (Woodbridge *et al* 2012), while at the lowland site of Llyn Cororion major impact on the vegetation occurred after *c* 3200 14C yr BP (Watkins *et al* 2007).

Later Bronze Age and Earlier Iron Age environment and land use history

Whereas alder woodland appears to persist in the area of WLF1 into the later Bronze Age, although some of the alder may be from valley woods, a slight increase in birch woodland is also evident. Woodland levels seem to remain at a similar level whereas in the area of WLF3 there seems to be an increase in woodland. At the latter an expansion in birch woodland is also apparent, its local presence confirmed by birch macrofossil wood remains in the peat, reflecting hydroseral development. The development of local willow (*Salix*) woodland, indicating continuing wet conditions in the local area, is also indicated in the pollen and macrofossil records. Further evidence for wet conditions is indicated by pollen of pondweed and starworts (*Callitriche*), pondweed fruits and an increase in *Sphagnum* moss. An increase in heather communities could suggest an increase in soil deterioration in the area. The changes are dated as commencing c 1260-901 cal BC and encompass the period of the major climatic event ~850 cal BC (Sub-boreal/Sub-atlantic) related to reduced solar activity (van Geel and Mauquoy 2010). Equally a slightly earlier major climatic shift c 1395 to 1155 cal BC has been identified on Dartmoor and considered to be contemporary with abandonment of the reaves (Amesbury *et al* 2008). Along with the expansion in woodland locally at WLF3, the result of less browsing down of any young trees, there is also a reduction in heather, grass and herb taxa, fungal spores indicative of dung and microscopic charcoal, suggestive of less activity. However the levels of the grazing indicator ribwort plantain, though reduced, do not suggest total abandonment of the upland area but that, as on Dartmoor after abandonment of the reaves, seasonal grazing continued. Although there is some cereal type pollen in the record from WLF3, which could indicate cultivation of barley, it is less frequent than at the beginning of the record and, if cereal rather than other wild grasses, could indicate cessation of upland cereal growing.

The period of increased birch woodland is followed by a phase of reduced birch woodland in the area during the earlier Iron Age, estimated as occurring c 500-400 cal BC at WLF1 and WLF3. This is consistent with low birch values in the period prior to 360-0 cal BC at WLF2 (Fig. 3), a pollen site lying about 150m to the southeast of WLF. A general increase in birch woodland in the area after this is represented in all records. Again, although pastoral activity clearly continued, activity was perhaps not as great as prior to *c* 1000 cal BC.

Archaeological evidence for Iron age activity in the wider area, possibly relating to these environmental changes, is attested by Braich y Dinas Iron Age hillfort, although this has been destroyed by modern quarrying. Elsewhere in Wales, at Moel Llys-y-coed in the Clwydian Hills, renewed clearance has also been attributed to the establishment of hillforts in the area (Grant 2008). In addition to Braich y Dinas there are also a number of remains of roundhouses and field systems on the slopes and lower-lying land below 300m OD, fringing the uplands. Examination of the pollen evidence for the possible impact of climate deterioration on land-use during the first millennium in Britain has led to the suggestion that there was not wholesale land-use change resulting in land abandonment although there was regional variability, including possibly a greater likelihood of abandonment of sites above 150 m in Wales (Dark 2006). From the evidence from Waun Llanfair, although there may have been reduced land use activity, it clearly still continued and presumably relates to transhumance and grazing of stock from settlements fringing the uplands. In the nearby Aber Valley there are no consistent or significant changes in the pollen records to signify land use change or abandonment (Woodbridge *et al* 2012). Further down the valley at Cors Wern Goch there is evidence of human impact and pastoral activity dating to the late Bronze Age/early Iron Age (Hughes and Grant 2005, 2006). Major impact on the vegetation at another lowland site, Llyn Cororion, also occurs around this time with the appearance of cereal and a continuous charcoal record (Watkins *et a*l 2007), perhaps indicating a shift to a greater use of lower altitudes. From examination of pollen evidence from an upland and a lowland site in north east Scotland Tipping *et al* (2008) have argued for a restructuring of agricultural activity and intensification of agriculture in the lowlands driven by population increases but by no means abandonment of the uplands for grazing, although cereal cultivation ceased.

Later Iron Age and Roman environment and land use history

Following a period of reduced land use activity there is evidence for increasing clearance activity. The timing of this clearance activity varies depending on the site and the pollen source area. The pollen signal from WLF3, the highest site, suggests increasing clearance commencing in the later Iron Age, initially of birch in the local area, followed by alder in the wider region in the Roman period. The presence of cow-wheat (*Melampyrum*) pollen, associated with the decline in birch, is indicative of woodland clearings (Moore *et al* 1986) and possibly suggests grazed woodland (Behre 1981) At WLF1 the beginning of extensive clearance and a steady removal of alder woodland in the basin is also estimated as beginning in the Roman period and continues into the medieval period. The smooth decline in alder evident in the record from WLF1 may represent a spatially smoothed pollen signal as there was an opening up of the regional landscape and the alder values may have been enhanced by pollen from the Afon Maes y Bryn and Afon Llanfairfechan valleys and lowlands. A decline in alder also registers at WLF2. In the wider region there is evidence for human impact on oak, elm and hazel woodland. Pastoral agriculture appears to have continued to be the main land use, although the evidence from WLF1 and WLF3 does not suggest an increase in activity whereas that from WLF2 does. A Roman road lies to the south of the study area and links the area with the Roman fort of Canovium in the Conw valley while much of the evidence from Braich y Dinas hillfort dates to the 1st and 2nd century AD and . Smith (forthcoming) suggests that the economy was largely based on stock-raising which is in accord with the pollen evidence

Elsewhere in the region the pollen record from Afon Goch, Abergwyngregyn, suggests an intensification in activity during the mid- to late- Iron Age and through the Roman period (Fyfe and Law 2008, Woodbridge *et al* 2012), while at Llyn Cororion a progressive decline in woodland occurs during the later Iron Age (Watkins *et a*l 2007). This intensification in activity during the later Iron Age and Roman period is also recorded elsewhere in Wales (e.g Smith and Cloutman 1988, Chambers *et al* 1990, Walker 1993b, Caseldine *et al* 2001) as well as other parts of Britain (e.g. Dumayne and Barber 1994, Wimble *et al* 2000, Fyfe *et al* 2003, 2004, Chiverell 2006).

The Early Medieval to Post Medieval/Present environment and land use

All three pollen sites indicate some woodland regeneration in the early medieval period although the nature of it varies from site to site, reflecting different pollen source areas and spatial variation in woodland in the area, and suggest recovery in one or more of birch, hazel and oak. In addition an increase in heather at WLF3 may reflect a further deterioration in soils as a result of climatic deterioration, a change in land management practices, or a combination of both. Soil deterioration combined with reduced grazing pressure would have favoured the growth of heather and there is evidence from the Migneint for a climatic deterioration around this time (Blackford and Chambers 1991). Equally, an increase in microfossil charcoal possibly suggests the use of fire as a deliberate management tool and the burning of heather in an attempt to increase browse, while the occurrence of macrofossil charcoal confirms local fire activity. This is accompanied by a slight increase in birch and hazel, suggesting some regeneration of birch and hazel scrub as a result of reduced grazing levels. However, herbaceous taxa and Poaceae levels indicate grazing activity remained significant. The evidence from WLF1 and WLF2 possibly suggests an increase in birch locally, while alder declined in the wider area. The record from WLF1 also suggests an increase in oak woodland during the early medieval in the wider region and possibly reduced farming activity.

In the Aber Valley, a similar change is recorded at all the sites with an increase in arboreal pollen in the early Medieval period but later changes are not evident at all the sites, including a recovery in woodland at one site dated to c 1250 AD (Woodbridge *et al* 2012). At this site high charcoal values associated with the replacement of grass by heather may also indicate a change in land management practices. At Cors Wen Goch in the lower valley there is also evidence of a regeneration phase commencing during the late-Roman to early-post Roman period (Hughes and Grant 2005, 2006). A recovery in woodland is recorded at a number of other sites in Wales during the early medieval period (e.g. Smith and Cloutman 1988, Grant 2008)

Following regeneration of woodland during the early medieval period, further woodland clearance and regeneration in the region, particularly of alder and birch woodland, is evident in all three pollen records, reflecting deliberate clearance or changes in grazing pressures preventing regeneration. Again representation varies depending on the location of the pollen site, the pollen catchment and the influence of local pollen. The evidence from WLF3 suggests renewed removal of birch and hazel by cal AD 990-1214 and a further expansion in heather and grassland communities accompanied by herbs, such as ribwort plantain and tormentil type, and fungal spores indicative of dung indicating pastoral farming. Relatively high microscopic charcoal levels coincide with the increase in heather and suggest the continued use of fire to manage the moorland. There is also oat-wheat (*Avena-Triticum*) type pollen present indicating arable activity. The farming evidence may reflect activity associated with several long huts of possible 9th-12th century date and terraced fields to the west of the study area, below 350m. There is, however, a brief birch and hazel regeneration episode, estimated c 1334 cal AD. A peak in birch pollen also occurs in the record from WLF1 and is dated to 1219-1392 cal AD, at which time both birch and hazel start to decline. However the resolution of the diagram means that the earlier clearance of woodland dated to cal AD 990-1214 at WLF3 is not detectable, but there is evidence of oak and alder being cleared, which might relate to the settlement evidence. Similarly, the commencement of a decline in birch, following a regeneration episode, is recorded just before a date of. 1288-1405 cal AD at WLF2. This is also accompanied by a peak in charcoal concentration and an inwash of small stone, indicating local clearance activity. It is possible that that the regeneration episode may reflect a decline in activity as a result of the impact of the Black Death, which arrived in 1349, on the rural economy, or the Owain Glyndŵr rebellion which started in 1400. However, it is difficult to relate changes in the pollen record with complete certainty to known historical events because of the wide age range of radiocarbon dates (Dumayne *et al* 1995) and even if there was a brief recovery in woodland, pastoral farming indicators continue to be well represented.

Other possible medieval evidence includes a couple of possible medieval shepherding huts on the moor nearby, as well as sheepfolds near the eastern end of wall 15944. It is around this time that some of the field walls in the area may have been constructed, including wall 15944. An increase in grass pollen at the top of the pollen record from Wall 154944 is identifiable in the three pollen site records and is estimated as dating to *c*. the 16th century or later, and hence the wall pre dates this. A date of cal AD 1286-1400 from the base of a humic silt, thought to be contemporary with construction of the wall, suggests a fairly rapid accumulation rate. The relatively high alder values are comparable to those at WLF1 around this time and perhaps suggests that alder woodland persisted in the area, including the Afon Maes y Bryn and upper Afon Llanfairfechan valleys into medieval times. Contrasting with both WLF1 and WLF2, birch values are low, which suggests birch woodland was growing, or had been growing, closer to WLF2. The decline in birch at WLF2 and peak in charcoal is also dated to this time as is a small inwash of stone and all may be related to activity associated with construction of the wall. Otherwise, as suggested by the other pollen sites as well, woodland in the region was much diminished. Pastoral farming continues to be the dominant land use, although occasional cereal pollen grains of oat-wheat and rye (*Secale cereale*), indicate cereal growing in the wider area and perhaps at a higher altitude more locally. The presence of *hemp* (*Cannabis*) type pollen shortly after cal AD 1286-1400 is consistent with the evidence from Llyn Cororion for the growing and retting of hemp in medieval times (Watkins *et al* 2007). The evidence from Waun Llanfair is also similar to that from Ynys Ettws, Nant Peris, where there is evidence for pastoral farming contemporary with a hafod (summer dwelling) and also some evidence for cereal cultivation (Caseldine 2006). A later phase of settlement, possibly a shepherd's or cowherd's shelter, is associated with possibly an increase in grazing activity.

A change from grass-heath to grass dominance occurs throughout the area, ~ fifteenth to 17^{th} centuries. A combination of factors related to management practices may have played a role, in particular high stocking densities of sheep which in turn resulted in increased nutrient input. Burning, pollution and drainage may also have played a part, at least in maintaining grass dominance over heather. A change from heather moor to grassland has been recorded at other upland peat sites in Wales including Cefn Gwenrffrwd in mid Wales where a change from a heather community, dated to the medieval period, was followed by grass and sedge communities in the post-medieval period (Chambers 1983), as well as other sites (e.g. Chambers *et al* 1990, Smith and Green 1995, Walker *et al* 1997, Chambers *et al* 2007a, 2007b). A marked decline in heather has also been recorded at a number of lake sites and dated to between 200 to 400-500 years ago and interpreted as indicating an intensification of grazing pressure, the earliest declines being in N wales(Battarbee *et al* 1988, Stevenson *et al* 1993). The presence of cereal pollen in the later pollen records may reflect intensification of agriculture at lower altitudes or an increase in cereal growing on marginal land in the uplands in reponse to social and economic factors such as the Naploeonic wars.

Finally there is a return to a more wooded landscape, if limited in extent, in the wider region. The initial increase in pine, elm, oak and ash probably reflects small-scale planting of timber trees in the region during the sixteenth and seventeenth centuries with a marked increase in afforestation and commercial planting from the mid eighteenth century onwards.

Conclusion

The palaeoenvironmental record from Waun Llanfair demonstrates the impact of human activity on the landscape from Neolithic times onwards and provides a chronological record which can be related to activity associated with construction of the monuments in the area. The evidence suggests that following the establishment of alder on the wet soils of the basin alder woodland persisted in the basin and upper valleys possibly until into the first millennium AD, although minor clearance of alder occurred in prehistoric times contemporary with the monuments. On the drier slopes of the basin and the plateau, clearance of hazel woodland in particular occurred with two main phases of clearance activity which can be broadly related to activity in the later Neolithic and earlier Bronze Age associated with the monuments excavated. There may also be an earlier episode of activity associated with early Neolithic activity at the Graig Lwyd axe factory site as well as impact on oak woodland in the wider area contemporary with activity at the axe factory during the Neolithic. Pastoral activity was the main land use and, although there was possibly a reduction in activity during the Late Bronze Age/ early Iron Age climatic deterioration, it still continued.

There is also some tentative evidence for a decline in upland cereal cultivation at this time. Following further clearance during the late Iron Age- Roman period some woodland regeneration occurred during the early medieval period, pastoral activity continued and possibly increased. Increased grazing levels continued during the medieval period and into post medieval times. There is some evidence to suggest that fire may have been used as a management tool to encourage new growth and increase browse, especially of heather, particularly in medieval times and later, but also possibly during prehistoric times.

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Figure captions

Fig.1 Relative pollen percentage diagram for Waun Llanfair pollen site 1.
Fig.2 Relative pollen percentage diagram (selected taxa) for Waun Llanfair pollen site 1.
Fig.3 Relative pollen percentage diagram for Waun Llanfair pollen site 2.
Fig.4 Relative pollen percentage diagram for Waun Llanfair pollen site 3.
Fig.5 Relative pollen percentage diagram for pollen column from adjacent to Wall 15944 (Trench 1).
Fig.6Relative pollen percentage diagram for sample series 27 from Wall 15943 (Trench 2).
Fig.7 Relative pollen percentage diagram for sample series 29 from Wall 15943 (Trench 2).
Fig.8 Relative pollen percentage diagram for pollen column from Burnt mound 467 (Trench 3).
Fig.9 Relative pollen percentage diagram for pollen column from Burnt mound 466 (Trench 4.)
Fig.10 Relative pollen percentage diagram for pollen column from Cairn 11 (Trench 5).
Fig.11 Relative pollen percentage diagram for spot samples S52 and S54 from Cairn 11 (Trench 5).
Fig.12 Relative pollen percentage diagram for pollen sample series 61-63 from Cairn 485 (Trench 6).
Fig.13 Relative pollen percentage diagram for sample 66 from Cairn 485 (Trench 6).
Fig.14 Relative pollen percentage diagram for pollen column from Cairn 470 (Trench 7).

Table 1 Local pollen assemblage zones for pollen site 1.

WLF1.1 80cm -71cm *Corylus-Pinus-Alnus*
Corylus, *Alnus* and *Pinus* dominate the zone. *Quercus* and *Ulmus* are present in low amounts. Poaceae and Cyperaceae values are low and other herbaceous taxa scarce. Pteropsida (monolete) indeterminate spores occur in significant amounts. Charcoal is scarce.
Interpretation: Hazel woodland with stands of pine and alde woodland.
WLF1.2 71cm- 53cm *Alnus-Corylus*
A sharp increase in Alnus (*c*.50-70% TLP) and decline in *Pinus* characterises the opening of this zone. *Corylus* values fluctuate but show a gradual decline. *Quercus*, *Ulmus* and *Tilia* values remain low but fluctuate and *Betula* increases very slightly. Herb taxa values decline before increasing towards the end of the zone. *Plantago lanceolata* is present. Pteropsida (monolete) indeterminate spores are abundant and *Polypodium* spores are frequent. Significant peaks in charcoal concentrations occur.
Interpretation: Alder woodland dominates locally with hazel and birch in the surrounding area. Oak, elm , lime and pine woodland are also present in the wider area. Increase in pastoral activity towards end of zone. Episodes of fire activity.
WLF1.3 53cm-34cm *Alnus-Betula*-Poaceae
Alnus continues to dominate but begins to decline later in the zone. Poaceae and Cyperaceae increase while *Corylus*, *Quercus*, *Ulmus* and *Tilia* decrease. *Betula* increases then declines before increasing again. Herb taxa are slightly more frequent, including *Plantago lanceolata* and *Filipendula.* Pteropsida (monolete) indeterminate and *Polypodium* spores fall markedly. Charcoal concentrations are low.
Interpretation: Alder woodland continues to dominate locally. Sedges increase locally. Hazel woodland declines further. Birch woodland increases before declining and then recovering.Grassland increases as do grazing indicators.
WLF1.4 34cm-29cm Poaceae -*Alnus- Betula*
This is a transitional zone in which arboreal *Betula, Alnus* and *Corylus* taxa decline while Poaceae and Cyperaceae and *Calluna* increase. *Plantago lanceolata* and *Potentilla* begin to increase. *Cerealia* type pollen, including *Avena-Triticum*, is present.
Interpretation: Decline in woodland and increase in grassland and heather locally and in wider region. Increase in pastoral activity and cereal growing
WLF1.5 29-18cm Poaceae-Cyperaceae
Poaceae dominates with other herb taxa , notably *Plantago lanceolata*, *Potentilla* and Rubiaceae , more strongly represented. Cyperaceae and *Calluna* both decline. Arboreal taxa values fall significantly.   *Cerealia* type pollen is present.
Interpretation: Open landscape with grazing activity. Some cereal cultivation.
WLF1.6 18-4cm Poaceae-Cyperaceae- *Pinus*
Poaceae continues to dominate but fluctuates. Cyperaceae values recover. *Calluna* values, though low, increase but then decline. A reduction in *Plantago lanceolata*, *Potentilla* and Rubiaceae occurs. *Cerealia* type pollen, including *Avena-Triticum*, is present Arboreal taxa, including *Pinus*, increase.
Interpretation: Open grassland in area. Afforestation in wider region. Cereal cultivation in wider area.

Table 2 Local pollen assemblage zones for pollen site 2

WLF2.1 40-36 cm *Alnus*

The zone is dominated by *Alnus*. *Corylus* and *Betula* are the other main arboreal taxa represented. Poaceae values are relatively low as are *Calluna* values. Herb taxa relatively scarce.

Interpretation: Woodland comprising alder, birch and hazel. Grass-heath in the wider area.

WLF2.2 36-22 cm *Betula-Alnus*

An increase in Betula marks the beginning of this zone although *Alnus* percentages remain relatively high. Poaceae and *Corylus* values are similar to previously. a peak in Plantago lanceolata occurs. Charcoal concentrations increase.

Interpretation: Birch and alder present locally. Hazel and grass-heather vegetation in surrounding area. Pastoral activity. Fire activity, possibly to manage moorland.

WLF2.3 22-14 cm *Betula*

This zone begins with a peak in Betula pollen while at the same time Alnus values fall. Poaceae percentages display a slight increase. *Plantago lanceolata*, *Potentilla* and Rubiaceae are all consistently present. *Calluna* representation is slightly stronger. A peak in charcoal concentration occurs at the beginning of the zone.

Interpretation: Birch woodland locally. Grass-heath communities and possibly an increase in livestock grazing. Burning activity contiunes.

WLF 2.4 14-4 cm Poaceae

Abundant Poaceae pollen characterises this zone. Arboreal taxa are present in low amounts but include *Pinus*. Decrease in herb taxa. Charcoal concentrations fall.

Interpretation: Expansion in grassland. Possibly decrease in grazing activity. Removal of local woodland followed by the beginnings of renewed afforestation in the region.

Table 3 Local pollen assemblage zones for pollen site 3.

WLF3.1 90-70 cm Poaceae-Cyperaceae-*Betula-Corylus*

Poaceae and Cyperaceae together with *Betula* and *Corylus* characterise this zone. *Plantago lanceolata* is well represented. *Pteridium* spores are frequent. Charcoal concentrations increase then decline briefly before increasing again. *Cerealia* type pollen quite frequent in occurrence.

Interpretation: Local grass and sedge communities. Birch woodland locally. Hazel and alder in area and oak in wider region. Widespread grazing activity. Possible cereal cultivation in wider area. Local burning actvity.

WLF3.2 70-42 cm *Betula*-Poaceae

This zone is distinguished by higher *Betula* percentages. *Calluna* values also increase while *Salix* is present in noticeable amounts. Poaceae and Cyperaceae values are marginally lower. Herb taxa continue to be well represented but *Plantago lanceolata* values are slightly less and *Potentilla* values slightly greater. *Cerealia* type pollen is scarce. Aquatic taxa increase in frequency as does *Sphagnum*. Charcoal fluctuates then increases sharply at the end of the zone.

Interpretation: Increase in birch and willow woodland locally. Other woodland remains at a similar level. Expansion in heather. Continued grazing activity but perhaps reduced. Possibly decline in cereal cultivation. Increase in fire activity later in zone. Possible use of fire to manage heather.

WLF3.3 42-26 cm Poaceae-*Calluna*

The opening of the zone is characterised by declines in *Betula* and *Corylus,* though they increase briefly, and increases in *Calluna* and Cyperaceae. Poaceae values continue at a similar level to those in the previous zone. *Plantago lanceolata* and *Potentilla* increase slightly. *Cerealia* type pollen present including *Avena-Triticum* group.Aquatic taxa are scarce and *Pteridium* decreases. Charcoal values quite high throughout zone.

Interpretation: Increase in grass-heath communities. Reduction in oak and alder woodland but brief minor episode of birch and hazel regeneration. Pastoral activity possibly increases slightly. Cereal cultivation in wider area. Fire activity, possibly as a management tool.

WLF3.4 26-10 cm Poaceae

An abrupt rise in Poaceae, accompanied by declines in arboreal taxa, *Calluna* and Cyperaceae, marks the beginning of this zone but arboreal taxa, including *Pinus* and Fraxinus, increase during the zone. *Plantago lanceolata* and *Potentilla* remain well represented and Rubiaceae values also increase. *Sphagnum* values fall. A peak in charcoal occurs at the beginning of the zone. *Cerealia* pollen is present including *Avena-Triticum* group.

Interpretation: Replacement of heather by grassland vegetation. Pastoral activity continues but some cereal cultivation in wider area.

WLF3.5 10-8cm Poaceae- *Pinus*

A decline in Poaceae pollen and increase in arboreal pollen, notably *Pinus* and *Fraxinus*, characterises this zone. Charcoal concentrations are very low.

Interpretation: Increasing afforestation in wider region. Pastoral activity continues.

Table 4 Local pollen assemblage zones for pollen column from adjacent to Wall 15944 (Trench 1).

WLFT1.1a 30-28cm *Alnus*-*Calluna*-*Corylus*
Alnus, *Calluna* and *Corylus* dominate the zone. Poaceae values are very low although a range of herbaceous taxa are present.
Interpretation: Heather – grass communities with alder and hazel woodland. Livestock grazing activity.
WLFT1.1b 28-12cm *Alnus*-Poaceae
Tree pollen values maintain a similar level but *Corylus* and *Calluna* values decline at the start of the zone and Poaceae values increase. Herb taxa continue to be frequent. Aquatic taxa occur. Charcoal concentrations are marginally higher.
Interpretation: Grass–heath vegetation with alder woodland in the area. Grazing activity continues.
WLFT1.1c 12-4cm Poaceae-*Alnus*-*Plantago*
Poaceae values remain similar to previously but *Alnus* values decline while *Calluna* values increase during the zone. *Plantago lanceolata* values are slightly higher. Charcoal concentrations are lower.
Interpretation: Declining alder woodland in area and slight expansion in heather communities. Pastoral activity continues.
WLFT1.2 4-2cm Poaceae
Arboreal taxa percentages decrease further and Poaceae values rise sharply. *Plantago lanceolata*, *Potentilla* and Rubiaceae increase. Charcoal concentrations increase slightly.
Interpretation: Removal of alder woodland in the area and expansion in grassland and pastoral activity..

Table 5 Local pollen assemblage zones for sample series 27 from Wall 15943 (Trench 2).

WLFT2-27.1 Sample 25 *Corylus*-Poaceae
Corylus is frequent with open ground taxa reasonably well represented.
Interpretation: Grass-heath vegetation with hazel woodland. Pastoral activity.

WLFT2-27.2 Samples 21-23 *Calluna*-Poaceae
Corylus declines. *Calluna* and Poaceae dominate the assemblage with frequent herb pollen, including *Plantago lanceolata*. Charcoal increases.
Interpretation: Clearance of hazel woodland and expansion in heather communities. Grazing activity. Increase in fire activity.

Table 6 Local pollen assemblage zones for sample series 29 from Wall 15943 (Trench 2).

WLFT2-29.1 *Calluna*- Poaceae

One zone is recognised which is dominated by *Calluna* followed by Poaceae. *Plantago lanceolata* pollen is frequent. Arboreal pollen values are low. Charcoal values decline.

Interpretation: Open grass-heath communities. Livestock grazing activity

Table 7 Local pollen assemblage zone for pollen column from Burnt mound 467 (Trench 3)**.**

WLFT3-1	Poaceae - *Alnus*

Poaceae and *Alnus* dominate the assemblage. Lactuceae pollen is well represented. Charcoal is frequent.
Interpretation: Grassland with alder woodland in the vicinity. Grazing activity.

Table 8 Local pollen assemblage zone for pollen column from Burnt mound 466 (Trench 4.)

WLFT4-1 11-15 cm *Alnus*

The assemblage is dominated by *Alnus* (52-77%TLP) with *Corylus* values ~10%TLP and Poaceae values between 11-26% TLP. Charcoal concentrations peak at end of zone. Plantago lanceolata values decrease.
Interpretation: Alder woodland with opening of woodland in the area of the mound prior to mound construction. Decline in grazing activity.

Table 9 Local pollen assemblage zones for pollen column from Cairn 11 (Trench 5).

WLFT5.1 19.5-4.5 cm *Corylus*
The zone is characterised by high *Corylus* percentages (~60% TLP), while other arboreal taxa values are low. Poaceae values are around 15% TLP with *Calluna* values less than 10% TLP. *Plantago lanceolata* is well represented.
Interpretation: Open hazel woodland with evidence of grazing activity.

WLFT5.2 4.5 -0 cm *Calluna-Corylus*
Calluna values rise abruptly at the beginning of the zone. *Corylus* declines during the zone. *Plantago lanceolata* values are lower.
Interpretation: Decline in hazel woods and expansion in heather communities. Decrease in grazing activity.

Table 10 Local pollen assemblage zones for spot samples S52 and S54 from Cairn 11 (Trench 5).

WLFT5 – S52 *Corylus*
The assemblage is dominated by *Corylus* (~60% TLP). Poaceae values are around 15% TLP and Calluna values are around 5% TLP. Plantago lanceolata is well represented.
Interpretation: Hazel woodland with grass-heath communities and grazng activity.

WLFT5 – S54 *Corylus*
Corylus values are ~ 40% TLP. Open ground taxa make up around 40% TLP, largely Calluna (~20% TLP) and Poaceae (~15% TLP). Plantago lanceolata is relatively frequent.
Interpretation: Open hazel woodland with heather and grassland communities. Grazing activity.

Table 11 Local pollen assemblage zones for pollen sample series 61-63 from Cairn 485 (Trench 6).

WLFT6.1 70-65 *Corylus*

Corylus dominates the zone but declines while *Calluna* and Poaceae increase. *Plantago lanceolata* values are relatively high.

Interpretation: Hazel woodland with open grass-heath communities. Grazing activity.

WLFT6.2 60 Poaceae- *Calluna*

Calluna and Poaceae increase as *Corylus* decreases. *Plantago lanceolata* representation is similar to previously while Rubiaceae increases.

Interpretation: Removal of hazel woodland and expansion in grass-heath communities. Grazing activity.

Table 12 Local pollen assemblage zone for sample 66 from Cairn 485 (Trench 6).

WLFT6- 66.1 *Corylus*

The assemblage is dominated by *Corylus* .Poaceae and *Calluna* make up ~30% TLP. *Plantago lanceolata* and Rubiaceae are relatively well represented.

Interpretation: Hazel woodland with grass-heather communities and grazing activity.

Table 13 Local pollen assemblage zone for pollen column from Cairn 470 (Trench 7).

WLFT7.1	Poaceae-Corylus

Poaceae and *Corylus* are the dominant taxa. *Plantago lanceolata* values are relatively high. *Cerealia* type pollen present in upper part of zone. Charcoal concentrations fluctuate with a distinct peak.
Interpretation: Open grassland with grazing activity. Possibility of cereal cultivation in wider area. WLFSome hazel woodland.

Table 15 Charred plant remains from Cairns 485 and 470.

Cairn	**485**	**470**	**470**	**470**	**470**
Sample	**64**	**72**	**702**	**704**	**705**
Context	**67**	**77**	**76 & 78**	**75 & 76**	**75 & 76**
*Corylus avellana*L. (Hazel) shell frags	1	35	2	60	106
Calluna vulgaris (L.) Hull (Heather) flower	-	2	-	-	-
Plantago lanceolata L. (Ribwort plantain)	-	1	-	-	-
Poaceae (Grasses)	-	1	-	1	-
Poaceae culm node	-	-	-	1	1
Organic indet.	-	-	-	2	1

Table16 Charcoal identifications from Burnt Mound 467

Sample	**3**	**5**	**6**	**7**	**8**	**10**	**Total**
Context	**102**	**102**	**104**	**104**	**104**	**104**	
Alnus glutinosa (L) Gaertner (Alder)	-	6	-	-	3	1	**10**
Corylus avellana L. (Hazel)	2*	4	1*	9	-	1	**17**
Maloideae type (Hawthorn, rowan, crab apple, common whitebeam, wild service-tree)	-	-	-	1	-	-	**1**
Total	**2**	**10**	**1**	**10**	**3**	**2**	**28**

*Includes charcoal used for AMS dating

Table 17 Charcoal identifications from Burnt Mound 466

Sample	**43**	**45**	**45**	**46**	**47**	**48**	**Total**
Context	**42**	**43**	**44**	**44**	**44**	**44**	
Betula spp. (Birch)	1	-	1	-	-	-	**2**
Alnus glutinosa (L) Gaertner (Alder)	3	1	5	3	3*	2	**17**
Corylus avellana L. (Hazel)	7*	-	2	-	-	-	**9**
Maloideae type (Hawthorn, rowan, crab apple, common whitebeam, wild service-tree)	1						**1**
Total	**12**	**1**	**8**	**3**	**3**	**2**	**29**

*Includes charcoal used for AMS dating

Table 18 Charcoal identifications from Cairns 485 and 470

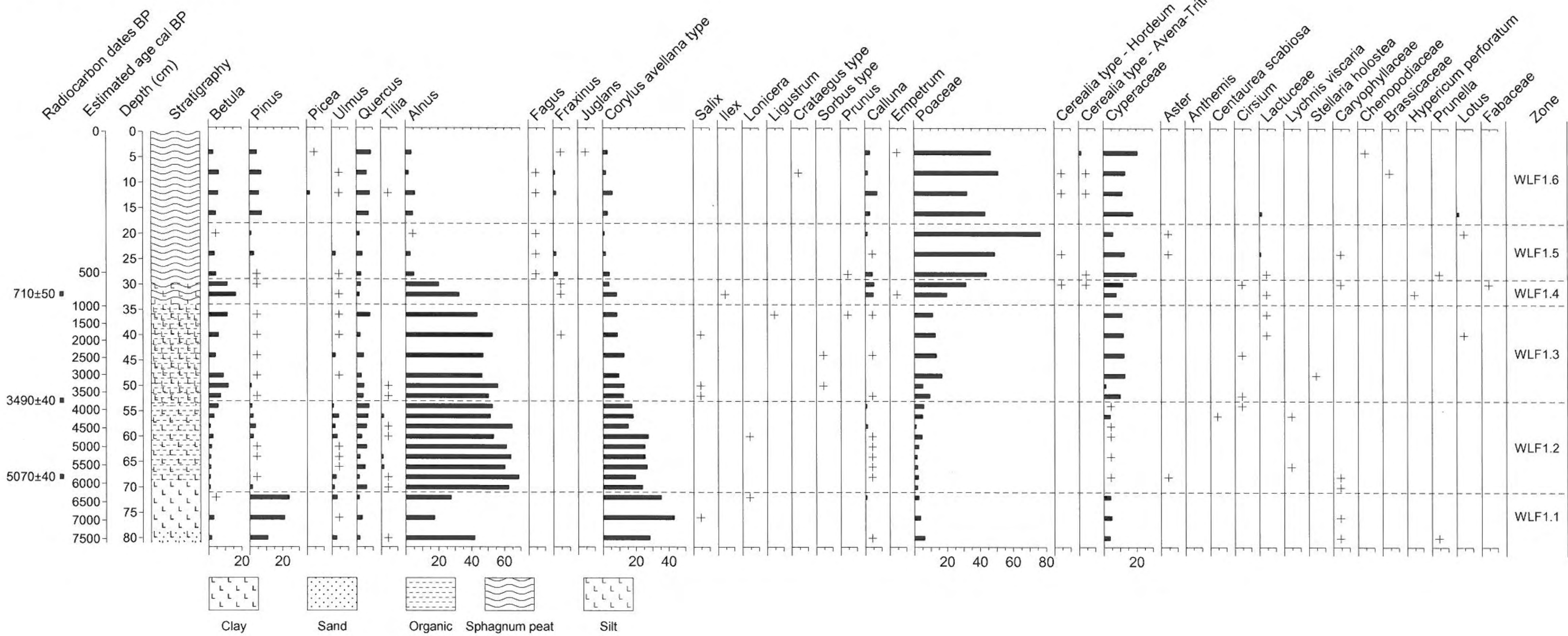
Cairn	**485**	**470**	**470**	**470**	**470**	**470**	**470**	**470**	**470**	**Total**
Sample	**64**	**71**	**73**	**704**	**705**	**709**	**78**	**77**	**712**	
Context	**67**	**74**	**74 & 76**	**75 & 76**	**75 & 76**	**76**	**76 & 78**	**72**	**76 & 80**	
Quercus spp. (Oak)	4	-	-	6	1	-	-	3	-	**14**
Betula spp. (Birch)	-	1*	-	-	8	-	1*	-	-	**10**
Alnus glutinosa (L) Gaertner (Alder)	-	-	-	1	-	-	-	2	-	**3**
Corylus avellana L. (Hazel)	1	-	1*	3	1	1*	-	-	1*	**8**
Total	**5**	**1**	**1**	**10**	**10**	**1**	**1**	**5**	**1**	**35**

*Includes charcoal used for AMS dating

Table 19 Radiocarbon dates from pollen columns.

Laboratory Code	**Site**	**Depth (cm)**	**Uncalibrated Age BP**	**Calibrated Age Range (BC/AD)**
Beta-235899	WLF1	75.5-76.5	3310±40	1690-1500 BC
Beta-239192	WLF1	69.5-70.5	200±40	1640-1955 AD
Beta-241086	WLF1	67.5-68.5	5070±40	3970-3770 BC
Beta-186680	WLF1	64.5-65.5	6290±40	5370-5200 BC
Beta-186679	WLF1	52.5-53.5	3490±40	1920-1690 BC
Beta-199873	WLF1	31.5-32.5	710±50	1220-1400 AD
Beta-239194	WLF2	35.5-36.5	2110±40	360-0 BC
Beta-239193	WLF2	18.5-19.5	620±40	1280-1410 AD
Beta-211080	WLF3	87-88	3190±50	1610-1320 BC
Beta-235898	WLF3	67.5-68.5	2870±60	1260-900 BC
Beta-235897	WLF3	40.5-41.5	950±60	990-1220 BC
SUERC-27555	WLFT1	22-23	630±35	1280-1400 BC

WAUN LLANFAIR 1



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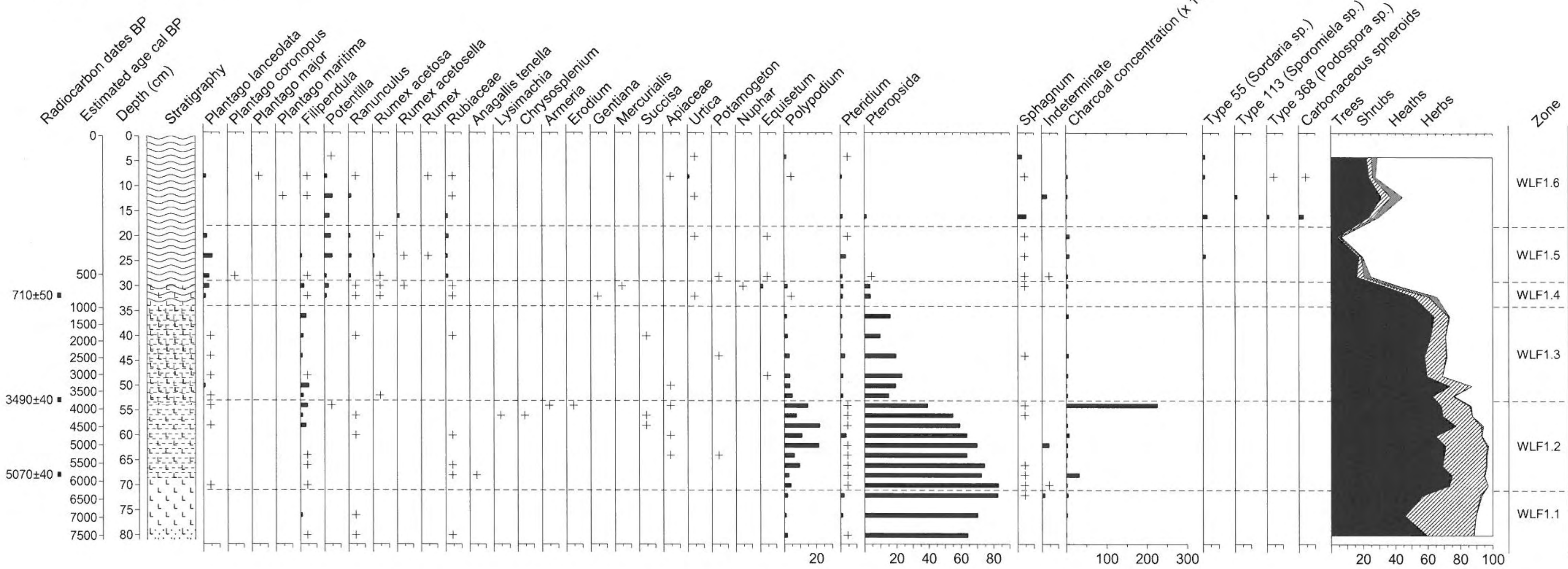

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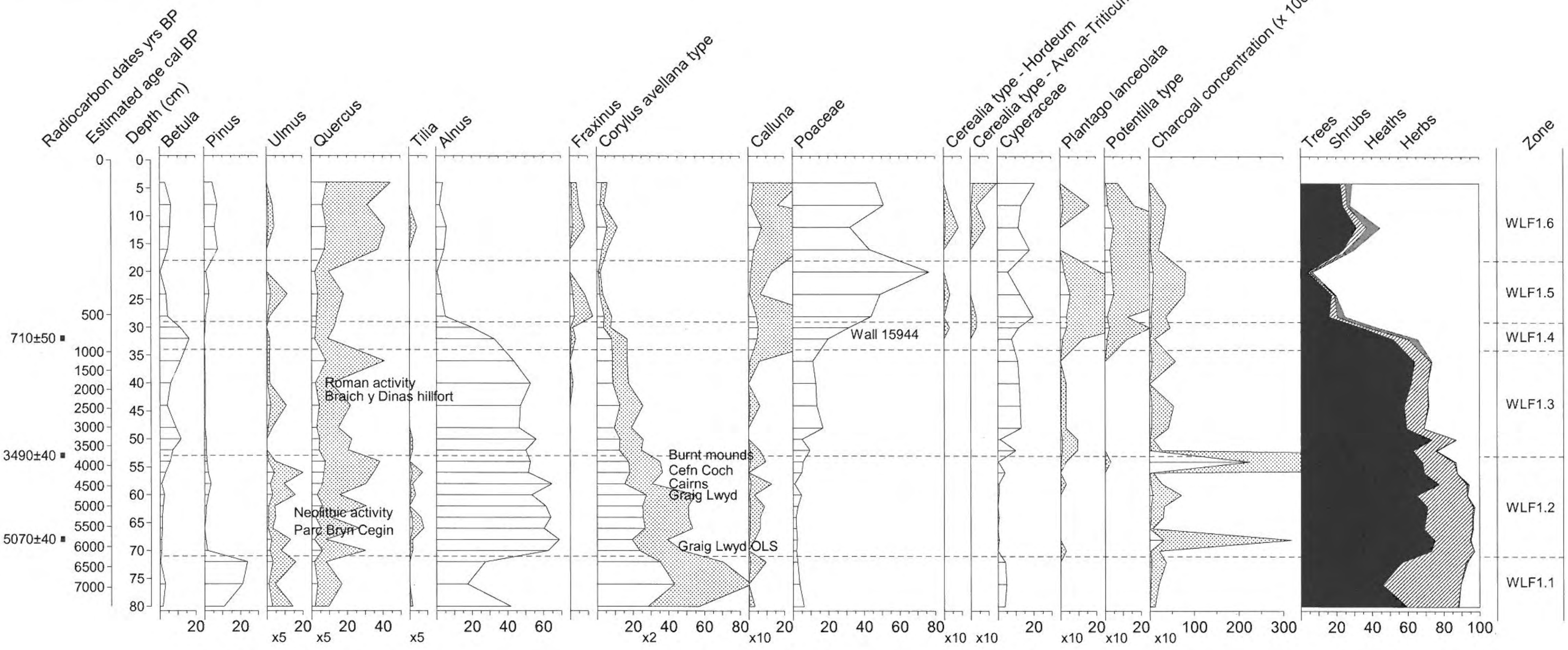

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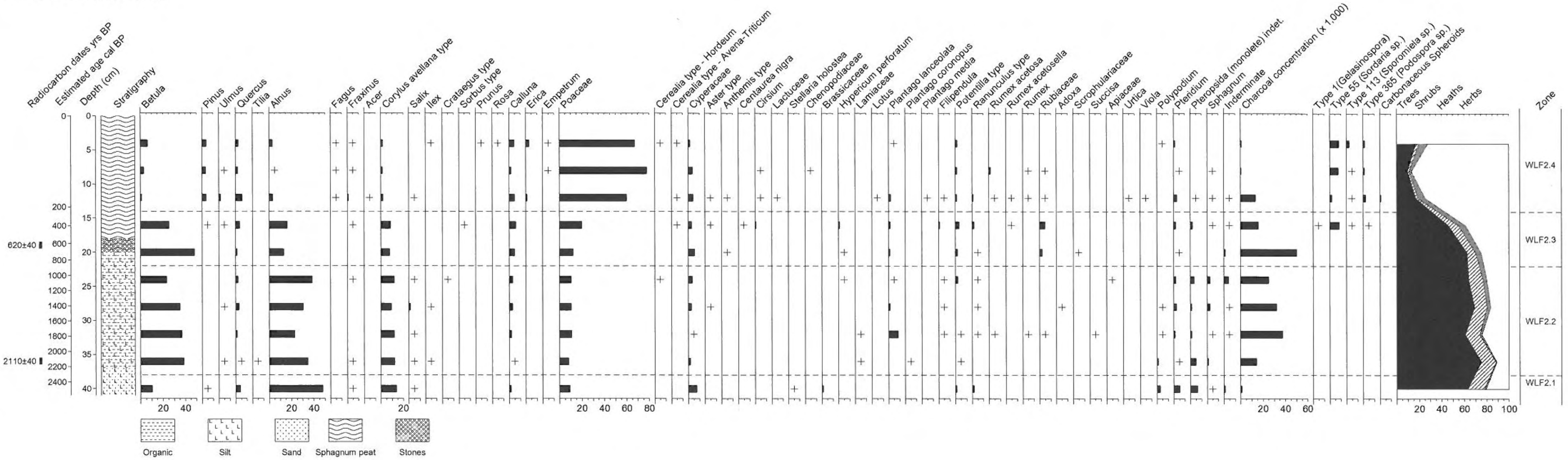

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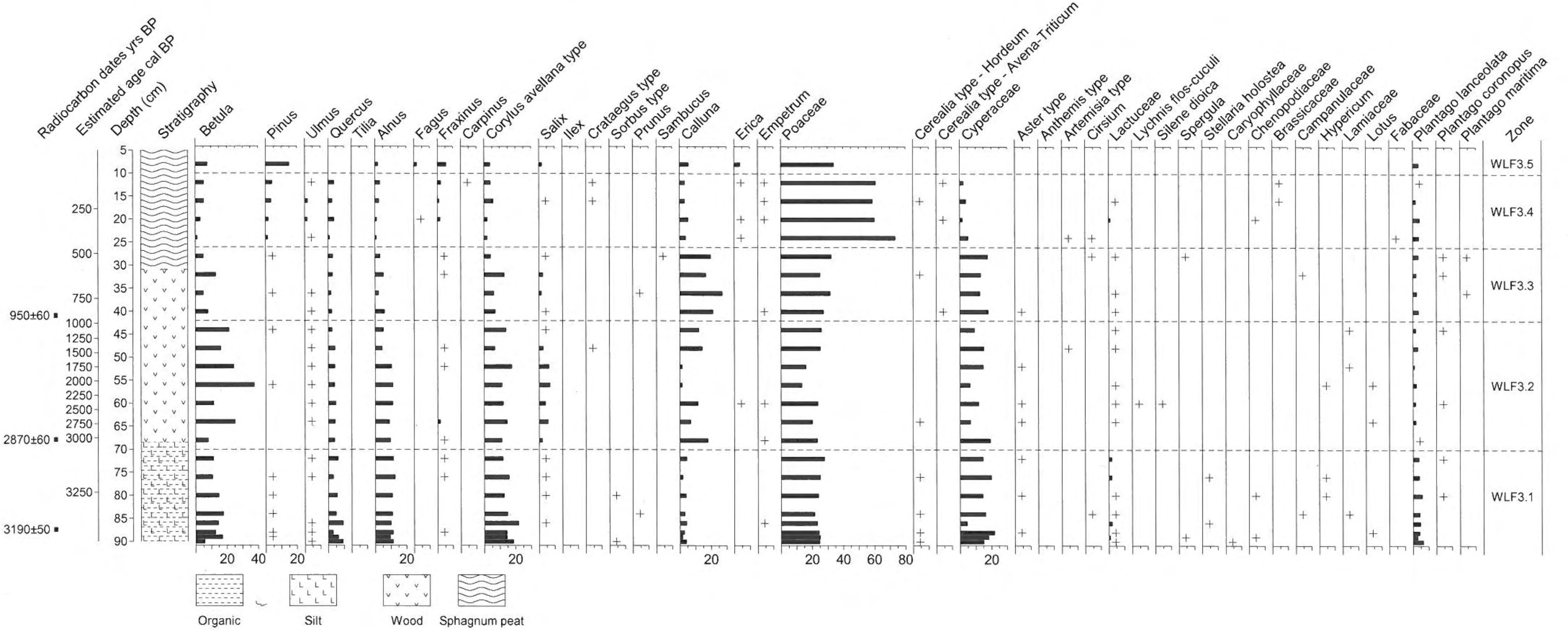

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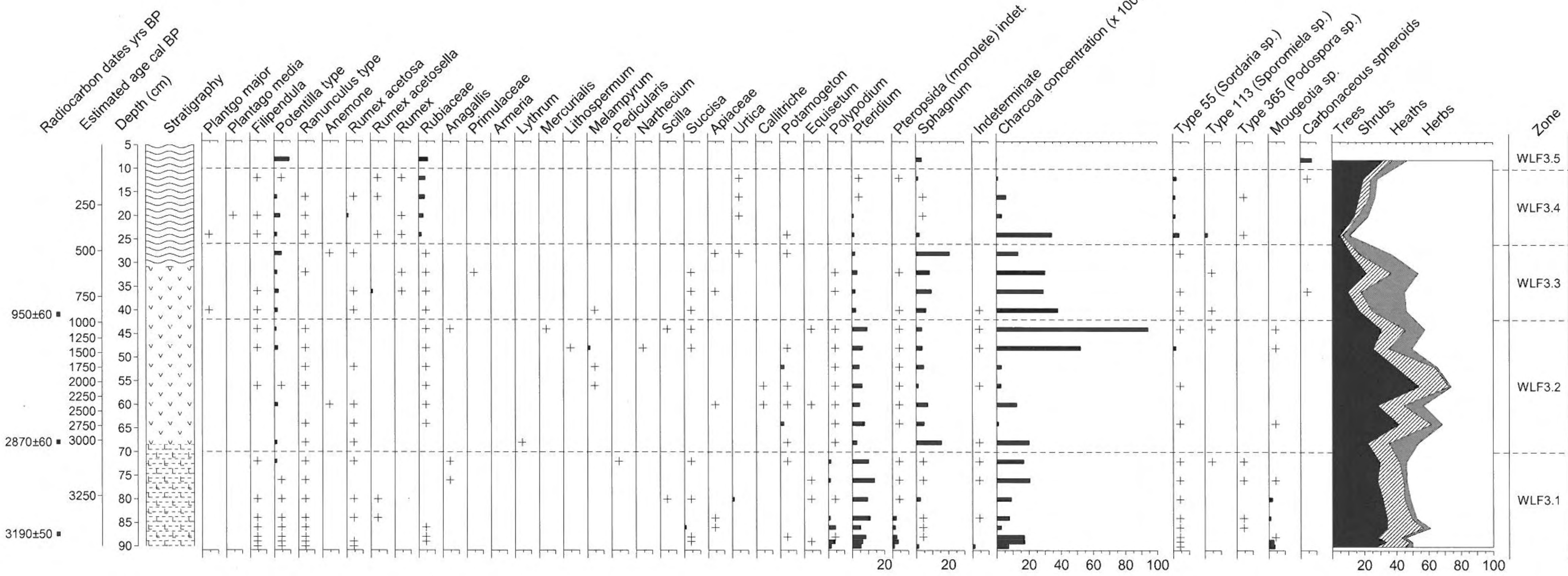
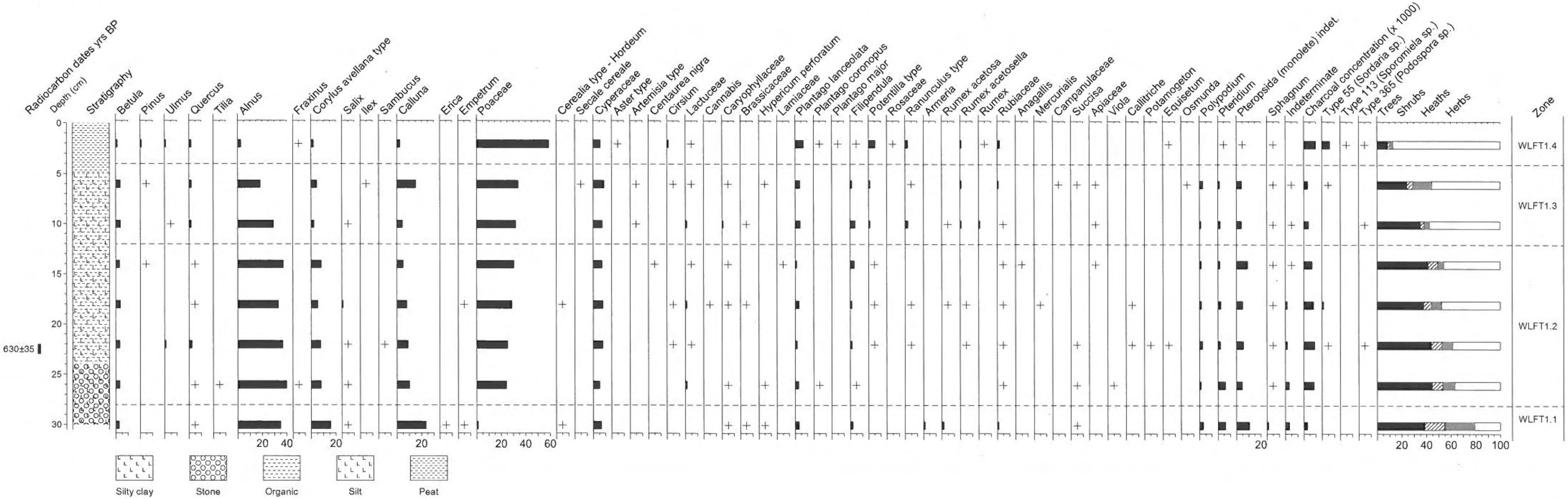


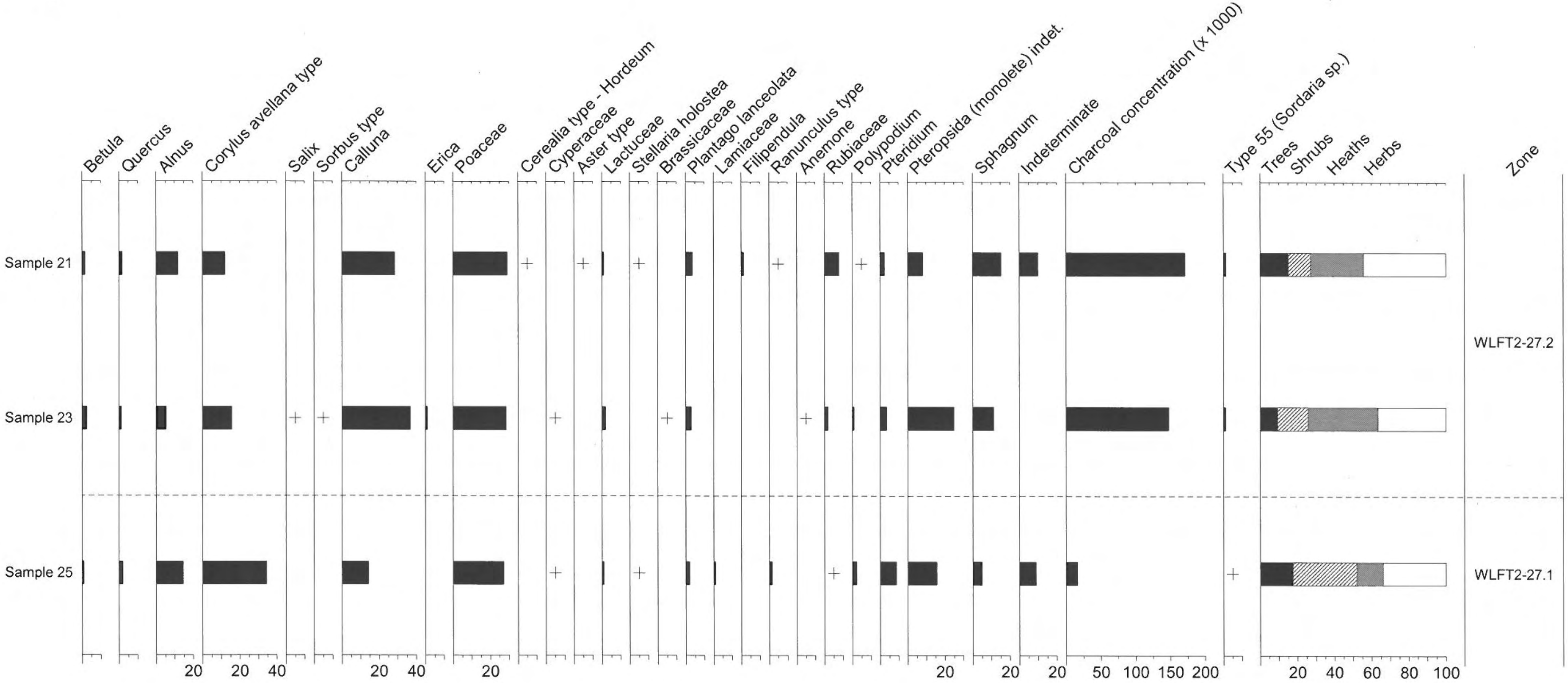
Wall 15944



Radiocarbon dates yrs BP
Depth (cm)
Stratigraphy
Betula
Pinus
Ulmus
Quercus
Tilia
Alnus
Fraxinus
Corylus avellana type
Salix
Ilex
Sambucus
Calluna
Erica
Empetrum
Poaceae
Cerealia type - Hordeum
Secale cereale
Cyperaceae
Aster type
Artemisia type
Centaurea nigra
Cirsium
Lactuceae
Cannabis
Caryophyllaceae
Brassicaceae
Hypericum perforatum
Lamiaceae
Plantago lanceolata
Plantago coronopus
Plantago major
Filipendula
Potentilla type
Rosaceae
Ranunculus type
Armeria
Rumex acetosa
Rumex acetosella
Rumex
Rubiaceae
Anagallis
Mercurialis
Campanulaceae
Succisa
Apiaceae
Viola
Callitriche
Potamogeton
Equisetum
Osmunda
Polypodium
Pteridium
Pteropsida (monolete) indet.
Sphagnum
Indeterminate
Charcoal concentration (x 1000)
Type 55 (Sordaria sp.)
Type 113 (Sporomiela sp.)
Type 365 (Podospora sp.)
Trees
Shrubs
Heaths
Herbs
Zone
630±35
WLFT1.4
WLFT1.3
WLFT1.2
WLFT1.1
Silty clay
Stone
Organic
Silt
Peat

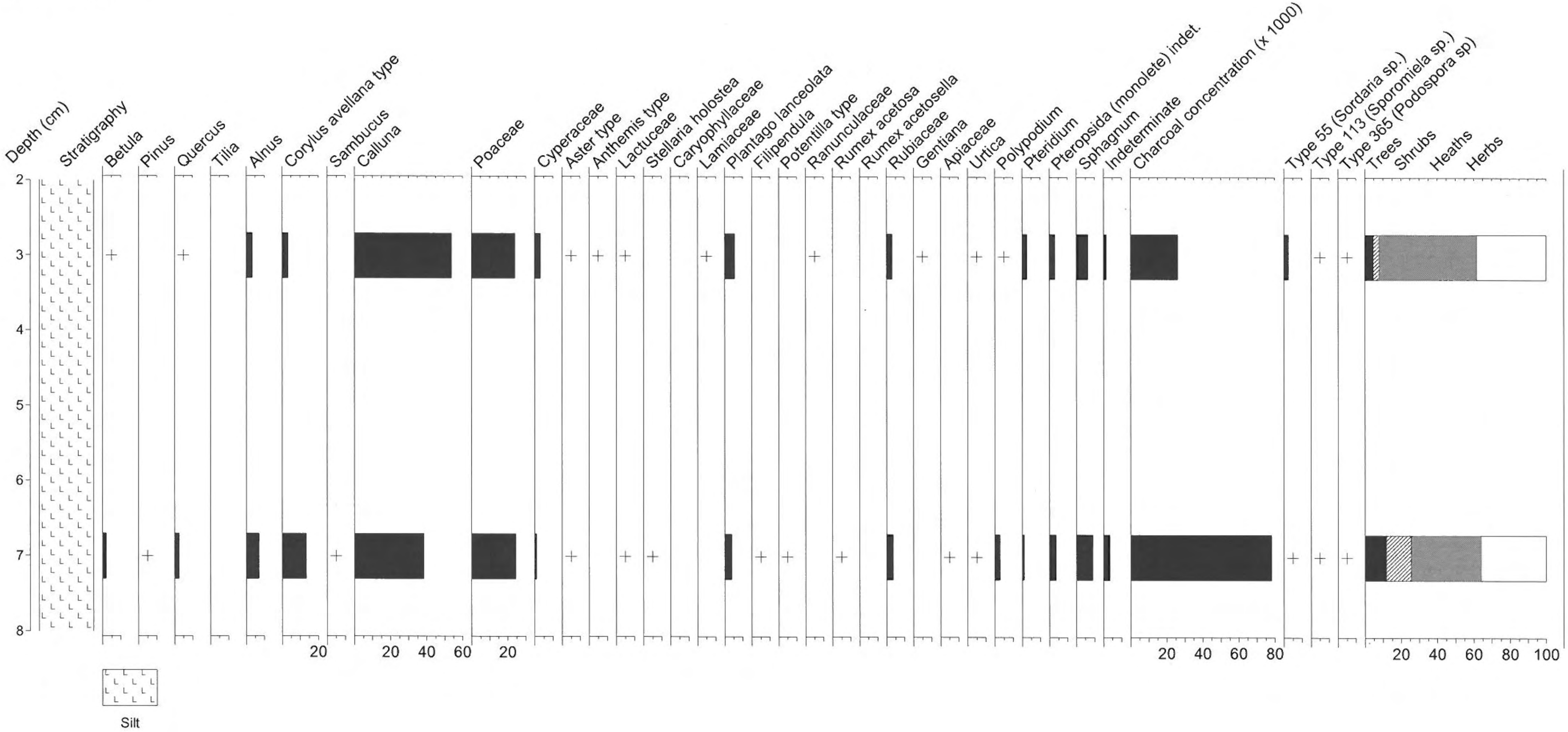
Wall 15943

Sample 27

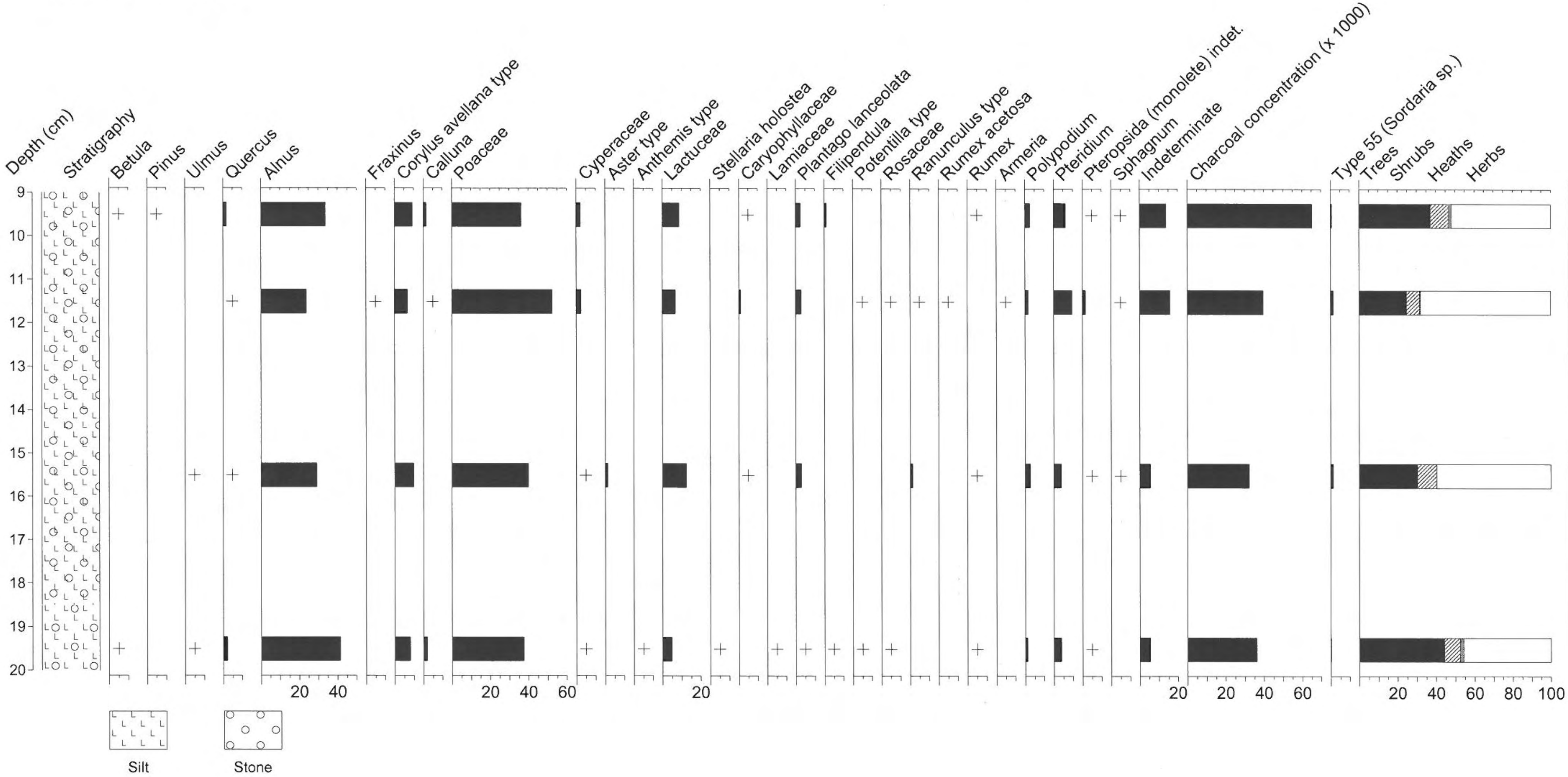


Wall 15943

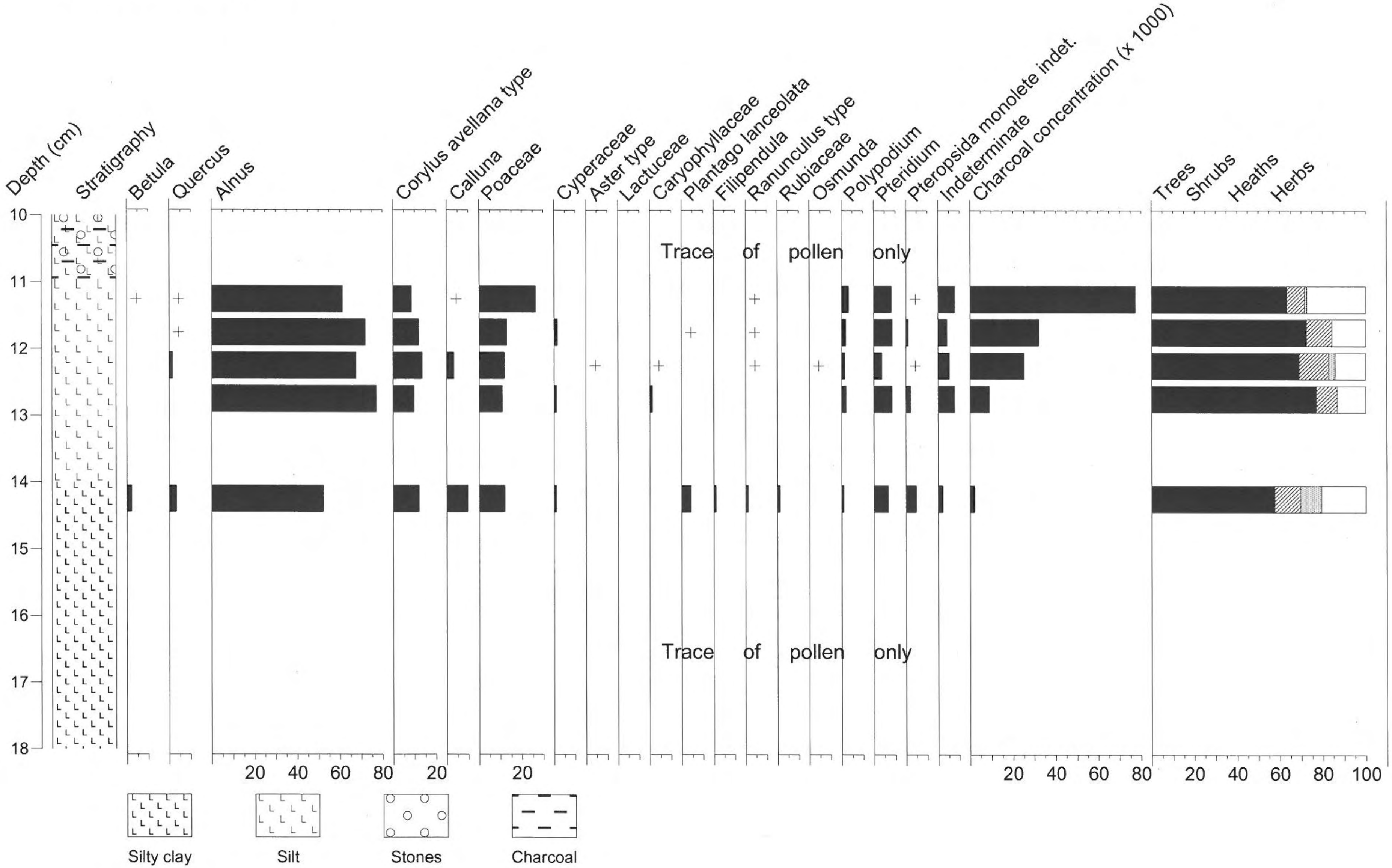
Sample 29



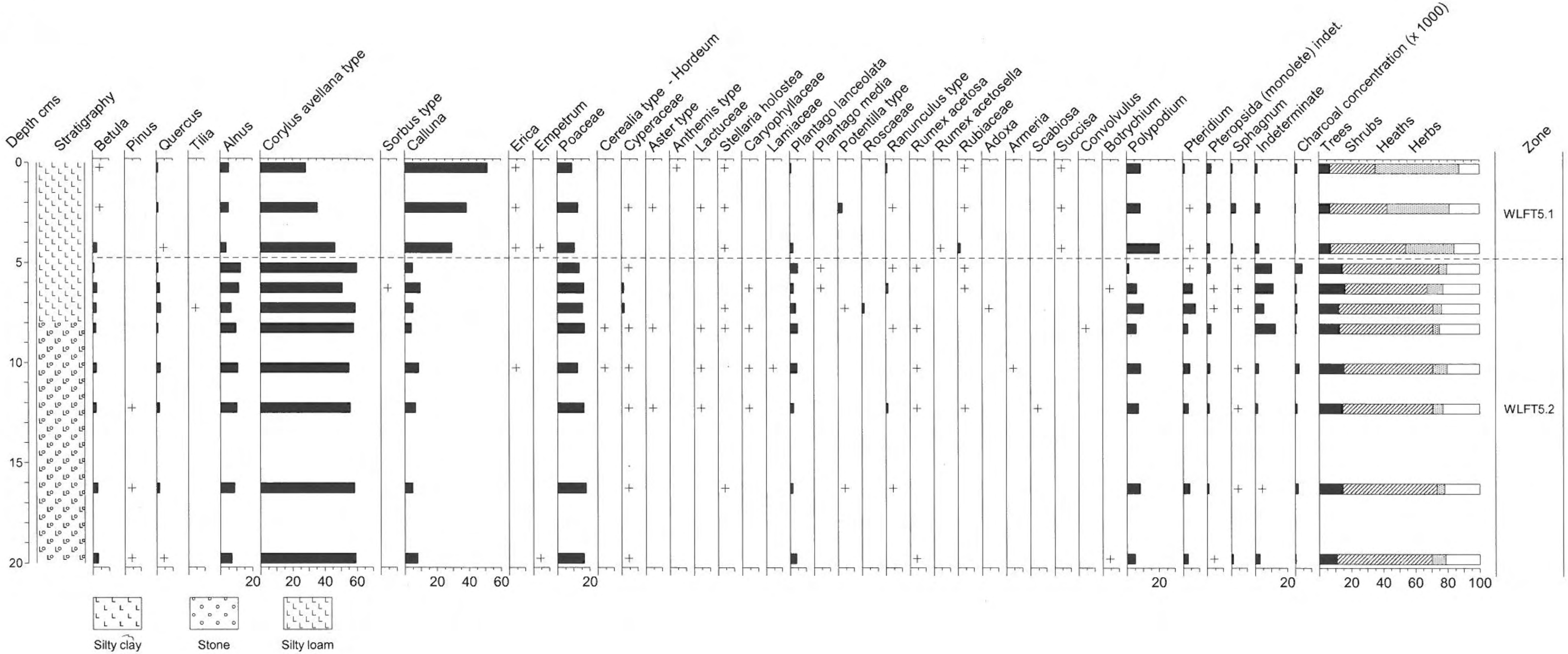
Burnt Mound 467



Burnt Mound 466

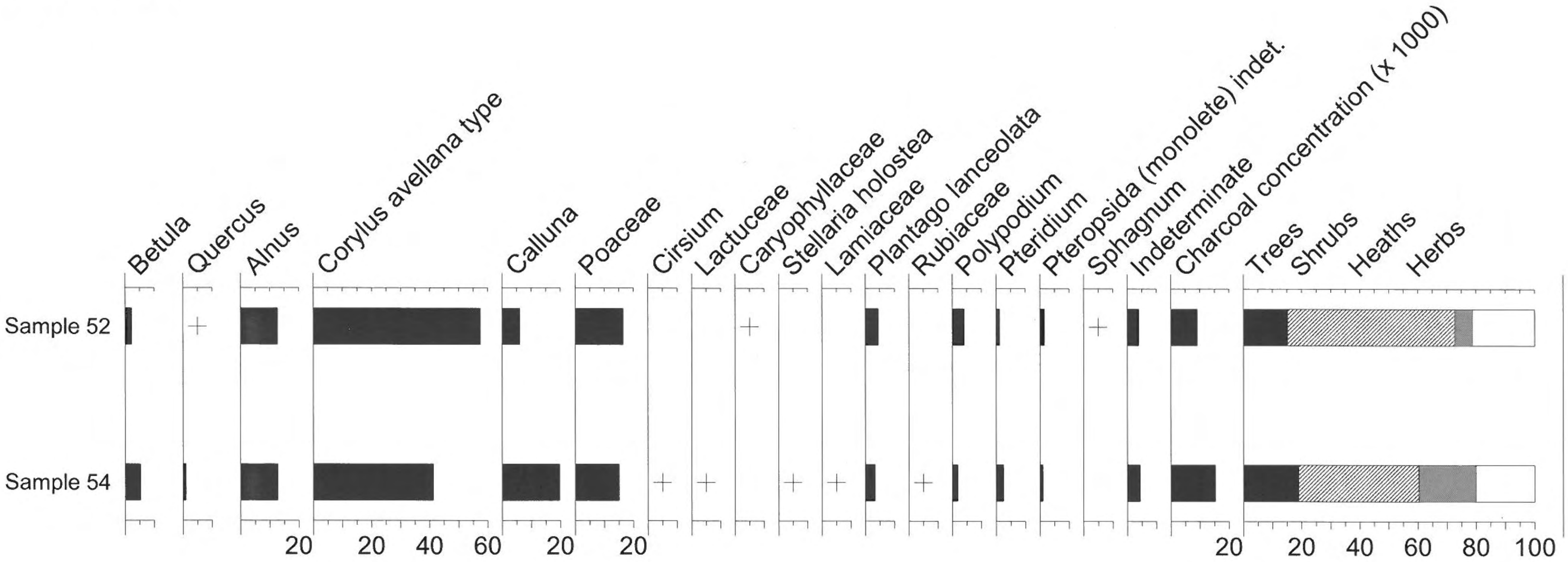


Cairn 11

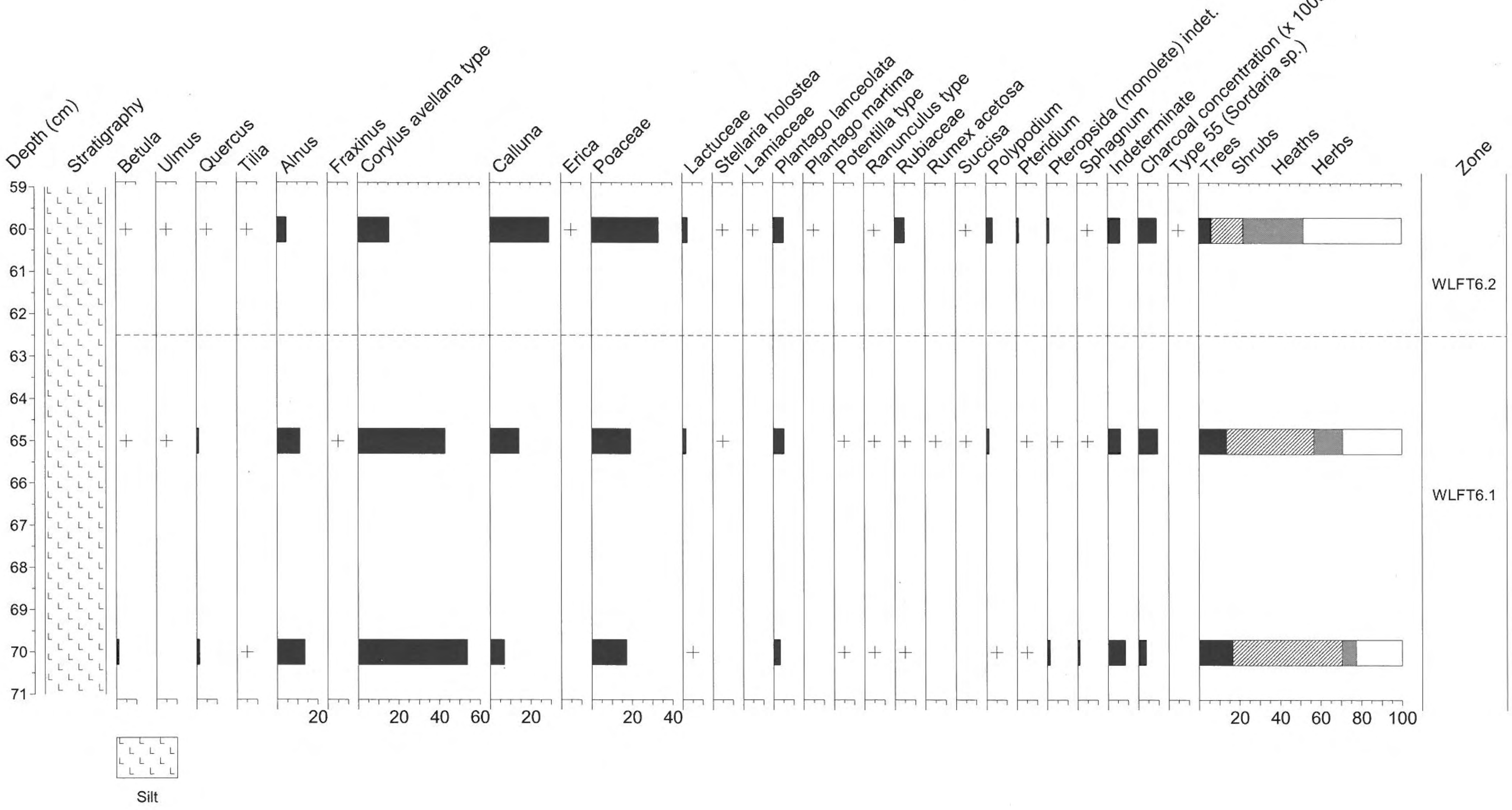


Depth cms
Stratigraphy
Betula
Pinus
Quercus
Tilia
Alnus
Corylus avellana type
Sorbus type
Calluna
Erica
Empetrum
Poaceae
Cerealia type - Hordeum
Cyperaceae
Aster type
Anthemis type
Lactuceae
Stellaria holostea
Caryophyllaceae
Lamiaceae
Plantago lanceolata
Plantago media
Potentilla type
Roscaeae
Ranunculus type
Rumex acetosa
Rumex acetosella
Rubiaceae
Adoxa
Armeria
Scabiosa
Succisa
Convolvulus
Botrychium
Polypodium
Pteridium
Pteropsida (monolete) indet.
Sphagnum
Indeterminate
Charcoal concentration (x 1000)
Trees
Shrubs
Heaths
Herbs
Zone
WLFT5.1
WLFT5.2
0
5
10
15
20
20 40 60
20
20
20 40 60 80 100
Silty clay
Stone
Silty loam

Cairn 11


Betula
Quercus
Alnus
Corylus avellana type
Calluna
Poaceae
Cirsium
Lactuceae
Caryophyllaceae
Stellaria holostea
Lamiaceae
Plantago lanceolata
Rubiaceae
Polypodium
Pteridium
Pteropsida (monolete) indet.
Sphagnum
Indeterminate
Charcoal concentration (x 1000)
Trees
Shrubs
Heaths
Herbs
Sample 52
Sample 54
20
20 40 60
20
20
20
20 40 60 80 100

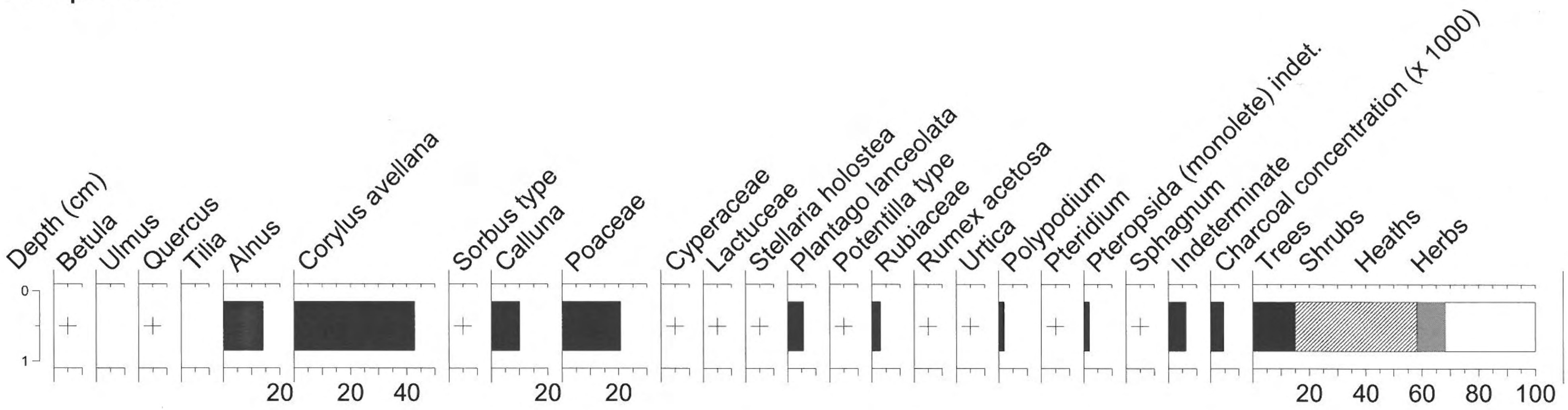
Cairn 485



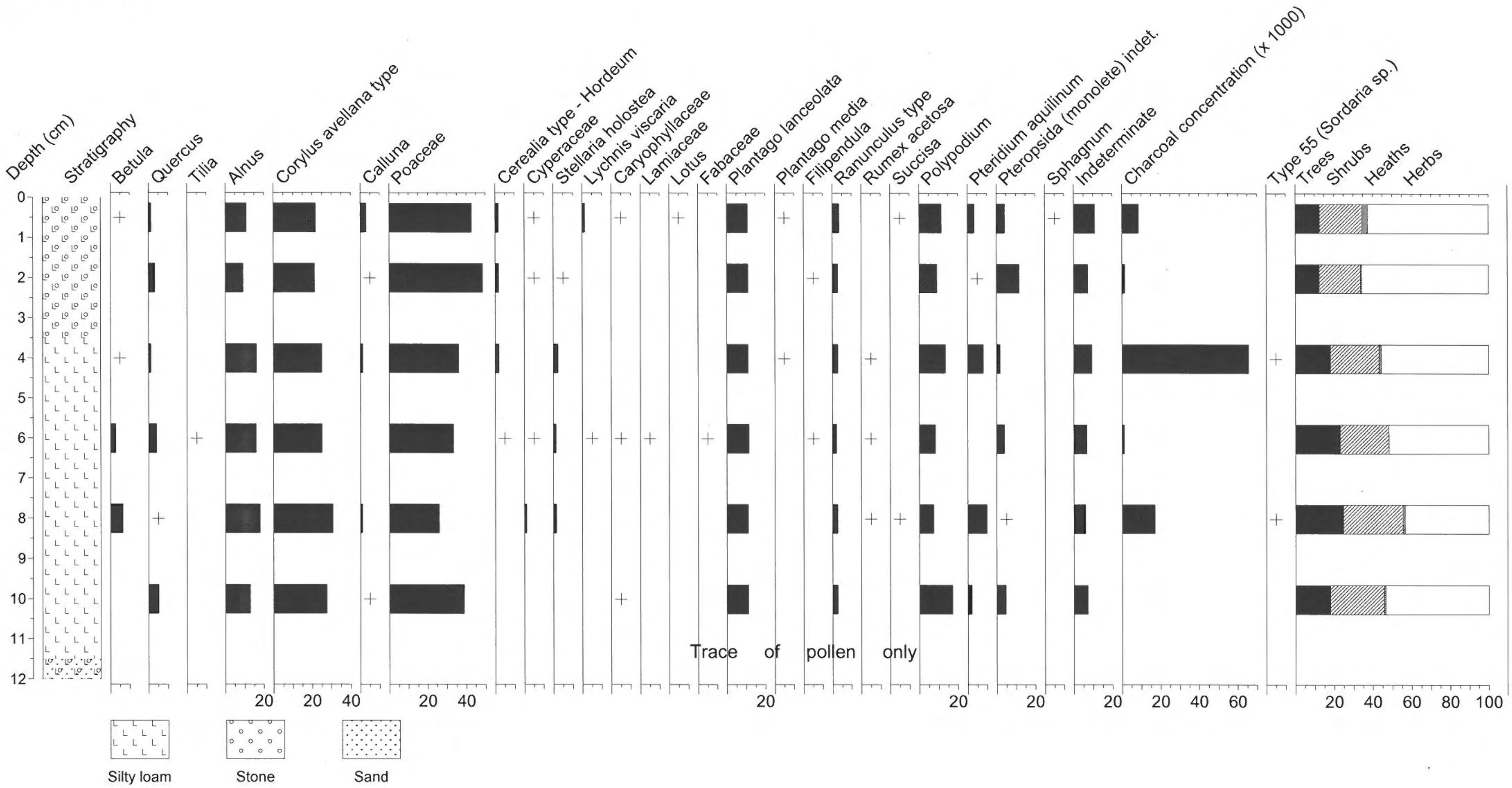
Depth (cm)
Stratigraphy
Betula
Ulmus
Quercus
Tilia
Alnus
Fraxinus
Corylus avellana type
Calluna
Erica
Poaceae
Lactuceae
Stellaria holostea
Lamiaceae
Plantago lanceolata
Plantago martima
Potentilla type
Ranunculus type
Rubiaceae
Rumex acetosa
Succisa
Polypodium
Pteridium
Pteropsida (monolete) indet.
Sphagnum
Indeterminate
Charcoal concentration (x 1000)
Type 55 (Sordaria sp.)
Trees
Shrubs
Heaths
Herbs
Zone
WLFT6.2
WLFT6.1
59
60
61
62
63
64
65
66
67
68
69
70
71
20
20 40 60
20
20 40
20 40 60 80 100
Silt

Cairn 485

Sample 66



Cairn 470



Depth (cm)
Stratigraphy
Betula
Quercus
Tilia
Alnus
Corylus avellana type
Calluna
Poaceae
Cerealia type - Hordeum
Cyperaceae
Stellaria holostea
Lychnis viscaria
Caryophyllaceae
Lamiaceae
Lotus
Fabaceae
Plantago lanceolata
Plantago media
Filipendula
Ranunculus type
Rumex acetosa
Succisa
Polypodium
Pteridium aquilinum
Pteropsida (monolete) indet.
Sphagnum
Indeterminate
Charcoal concentration (x 1000)
Type 55 (Sordaria sp.)
Trees
Shrubs
Heaths
Herbs
Trace of pollen only
Silty loam
Stone
Sand

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Gwynedd Archaeological Trust

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