# Roman frontiers and landscapes of occupation: road building and landscape change in the Hadrianic-Antonine frontier zone.

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## Abstract

Dere Street is the Roman road which ran north from Eboracum (York), crossing the Stanegate at Corbridge and continuing into what is now Scotland. The road served a military and economic purpose facilitating the transport of troops and trade north and south across the frontier zone. Here we present a well resolved palaeoenvironmental record within the Hadrianic-Antonine frontier zone that is tied directly to the archaeological evidence for Dere street. The evidence indicates limited woodland clearance during the Neolithic and Bronze Age followed by large scale woodland clearance at *c.* 890 BC, with woodland replaced by open grassland indicating that throughout the Iron Age land use was primarily pastoral. Dere Street was constructed in (AD 79-81) and when the Roman road builders arrived at Dun Law the landscape was largely open. Limited local timber resources meant that hazel scrub cover was probably used to construct the road with evidence to suggest that other timber resources were brought in from outside the site. The landscape at Dun Law was predominantly grazed during and post Roman occupation and there is some evidence for shifts in intensity of grazing from *c.* AD 950.

**Keywords:** Pollen analysis, Iron Age, Holocene palaeoevironments, Dere Street, woodland clearance, Scotland.

**Introduction**

Tacitus lamented that Scotland was "conquered then immediately thrown away" (Woolliscroft, 2000). However, the legacy of the Roman military presence can be viewed through the construction of a large number of forts, garrisons, and marching camps, to service and protect the army and fleet east-west along the Tyne-Solway and Forth-Clyde isthmuses, comprising the Hadrianic-Antonine frontier zone (Figure 1). At the peak of occupation, a Roman force of ~25,000 soldiers has been estimated although the cumulative period of occupation was limited to ~80 years (Hanson, 2003). The geography of the Roman conquest, particularly during the early stages (Flavian invasion *c.* AD 78-86) (Birley, 1999a), took in most of the prime agricultural land in the Central region of Scotland, Perthshire and reaching to Angus (Hanson, 2003).

The expansion of the Roman Empire was enabled by extensive road building to facilitate the transport of troops and trade. By the end of the 2nd century AD over 53,000 miles of roads had been constructed within the Roman Empire (Berechman, 2003) and many that persisted after the fall of the Empire, were still in use during the medieval period and some form the basis of modern roads. The Hadrianic-Antonine frontier zone of northern England - southern Scotland was served by the military road now known as Dere Street constructed in AD 79-81 (Figure 1). The eastern arterial route of Dere Street linked the legionary forts of Eboracum (York) and Inchtuthil (Perth) and was probably the most strategically important route in northern Britain (Inglis 1916).

There is a wealth of palaeoenvironmental evidence in proximity to Hadrian's wall (cf. Dark and Dark, 1996; Manning *et al*., 1997; Dark 2000; 2005), and from nearby lowland landscapes (Dumayne, 1993a; Dumayne and Barber, 1994; Tipping 1995) and along the Antonine wall (Boyd 1984; Dumayne-Peaty 1998; Ramsay 1995; Dickson and Dickson 2016). The interpretation of the timing and nature of vegetation changes across all of these sites is complex. Local variations noted in the vegetation records are influenced by the nature of the sites studied, local climate and soil/peat conditions (Dark 2005; Dumayne-Peaty and Barber 1998) as well as the intensity of local farming activity (Dumayne-Peaty 1998). The lack of chronological resolution in many of the extant paleoenvironmental records makes linking vegetation changes between sites and to the archaeology difficult. There is evidence for accelerated clearance of woodland or the beginning of clearance during Roman occupation around Hadrian's Wall (Dumayne, 1993a; Dumayne and Barber 1994; Dumayne-Peaty and Barber 1998). However, Dark (2005) suggests that clearance at Crag Loch close to Hadrian's Wall was already underway before the Romans began to construct the wall. Areas local to the Antonine Wall (Dumayne-Peaty 1998) suggest that woodland clearance coincided with the construction of the wall but other sites suggest that the Romans encountered a cleared and already functioning 'farmed' landscape (Boyd 1984; Dickson and Dickson 2016). Regional variation in woodland cover within the Hadrianic-Antonine frontier zone during Roman occupation is proposed (Dumayne 1993a; Dumayne-Peaty 1998).

However, the upland landscape within the Hadrianic-Antonine frontier zone into which the Romans marched during the Flavian campaigns is perhaps less well understood. Early palaeoenvironmental research suggested that the area was forested, and the woodland resources were then exploited and cleared by the Romans (Davies and Turner 1979). This view has since been challenged by evidence that indicates that Iron Age people had made substantial incursions in the woodland in the frontier zone prior to the arrival of the Romans (Dumayne 1993a). Tipping (2010) points to the restructuring of the agricultural landscape in the Cheviots being complete and nearly 200 years old before the Romans arrived and that there is no requirement to assume that Roman occupation triggered agricultural expansion and woodland clearance in southern Scotland or northern England.

Farming in the Iron Age would have been a mixture of arable (oats or wheat, barley and possibly rye) and pastoral with upland grazing and hay meadows for cattle (Tipping 2010). Sites in Northern England also suggest that by the Iron Age, farmed landscapes were well established and agricultural productivity continued throughout Roman occupation, with a focus on cereal production (spelt and barley) with cattle and sheep (Haselgrove 2016). Some sites along Hadrian's wall indicate the appearance of *secale cereale* pollen (rye) suggesting local cultivation to meet the needs of the Roman army (Dark 2005). There is some evidence for cereal production along the Antonine wall, but this is not intensive and does not appear to be intensified during Roman occupation (Dumayne-Peaty, 1998). Landscape around the Antonine wall was a complex mosaic of vegetation types (Dumayne-Peaty 1998; Dickson and Dickson, 2016) with the main land use during the Roman occupation being grazing; with the caveat that pollen production and dispersal tends to accentuate pastoral over cultivation activities (Tipping *et al*., 2008). Palynological evidence from the Cheviots points to an upland farming system that intensified in scale from the late Iron Age, with evidence of woodland clearance that would have required collective or community action, rather than individual farmsteads (Tipping, 2010). Surpluses of meat and grain may have gone to the Roman troops (Hanson 1997) and evidence suggests that within the Cheviots the range of resources were available (Tipping, 2010). However, it is questionable that the seemingly disorganised Iron Age Scottish field system would have had the capacity to meet the needs of such a large army. This leads to further consideration of the supply chain for the Roman army and the extent to which the occupied territories were exploited to meet the demand for food (cereal and meat), construction materials (turves, timber and dressed stone), metals and textiles versus imports from other regions of the Roman Empire (Tipping and Tisdall, 2005 and references therein).

Evidence for abandonment perhaps due to conflict with the occupying Roman forces (Whittington and Edwards, 1993) is also geographically restricted. Following the final departure of the Roman military forces from the Hadrianic-Antonine Frontier zone at the end of the Severan campaigns (AD 208-211) (Birley 1999b) palynological records indicate areas of woodland regeneration which may be due to settlement abandonment as the local agricultural economy, previously buoyed by the presence of the Roman army, collapsed (Dumayne-Peaty, 1999). The end of demands for timber for the construction and maintenance of military structures (Dumayne 1993b) may also have led to woodland regeneration. The end of the Roman period sees the end of rye cultivation and the replacement of some arable land with pasture at Crag Loch (Dark 2005), but there is no increased extent in woodland cover. While sites such as Fellend Moss and Fozy Moss close to Hadrian's Wall (Dumayne and Barber 1994) show woodland regeneration at the time of the post Roman Period, indicating land abandonment. This picture suggests that in some regions, land that is used to support the Roman military was now no longer productive and was abandoned. However, other areas (such as Crag Loch) that may have been used more for native settlement and food production, agriculture continued. Tipping and Tisdall (2005) and Tipping (2010) also argue for a greater degree of continuity in the landscape to the north of Hadrian's Wall suggesting instead that there was a down-scaling of agricultural production rather than a reduction in the native population.

It is difficult to make general statements about the nature of the vegetation change across the Hadrianic-Antonine zone as there should not be an expectation that all of these regions responded in the same way at the same time. The existing palaeoenvironmental records point to a complex picture of local and regional vegetation changes driven by local climatic and soil factors as well as human activity. Within the Hadrianic-Antonine frontier zone the nature of human activity and particularly the influence of the Roman occupiers becomes more difficult to identify. Most occupation events were short lived (Hanson, 2003), and the nature of these events varied, from the construction of the Antonine Wall in AD 142 (Hanson and Breeze, 2020) to the more seasonal short lived military expeditions and excursions later in the Roman occupation of the region. Palaeoenvironmental evidence integrated with the archaeological record can offer a more nuanced interpretation of the response of vegetation to human activity. To define responses in the vegetation to such ephemeral occupation requires robust chronologies and highly temporally resolved data sets (Dumayne *et al*., 1995; Dickson and Dickson 2016).

Here we present an upland palaeoenvironmental record with very good temporal resolution, using 17 AMS radiocarbon dates to support robust age-depth models. The site at Dun Law, in the Scottish Borders at OSGB NT 4643 5663, is where Dere Street crosses a small boggy area situated on a col at 430m a.s.l. between Dun Law and Turf Law, above the headwaters of the Windy Cleugh burn (Figure 2), an example of the Roman 'rigid adherence' to linear alignments (Poulter, 2011 p134). The small boggy area has a limited pollen source area and likely reflects local vegetation changes. Excavation of Dere Street revealed that the road armouring (agger) overlaid brushwood matting and a more substantial lattice structure of trunk wood used to support the engineered road across the soft ground. A detailed description of the archaeological excavation and the materials and structure of the road construction is provided by O'Connell *et al.* (2014). The palaeoenvironmental evidence generated from this site is directly associated with the construction of Dere Street and reflects the changing landscape pre-, during and post-construction of the Roman road.

**Methodology**

*Fieldwork and Sampling*

The archaeological investigations at Dun Law consisted of an 11m wide trench excavated across the line of Dere Street (O'Connell *et al*., 2014). This provided an open section across the peat-sediment infill, where the road crossed a relict palaeochannel (Figure 2). Overlapping 0.5m monolith tins were placed into the open section to obtain a 1.1m contiguous sample at the deepest (i.e. highest temporal resolution) point (DL113). A second section was opened 23m away from the archaeological excavation as part of the controlled removal of the peat within the area of the windfarm access track. Here a 1.85m peat profile was sampled using overlapping 0.5m monolith tins (DL3). The monolith tin sections were sealed in plastic bags and returned to the University of Stirling for analysis. Samples were stored at a constant 4$^{o}$C to inhibit microbial activity.

*Laboratory Analyses*

The stratigraphy of the samples and the sediments were described. The organic content was estimated by loss-on-ignition; 1cm thick contiguous samples were dried at 105$^{o}$C and then combusted at 550$^{o}$C ($LOI_{550}$). The percentage organic content for each profile is presented in Figure 3.

Fossil pollen samples were prepared using standard pollen preparation procedures (Moore *et al.*, 1991). 1cm thick samples were taken at 3cm and 4cm intervals from the onsite profile (D113) and the offsite profile (DL3) respectively. A minimum total of 300 land pollen (TLP) were identified from each sample excluding aquatics and spores. Cyperaceae is excluded from the TLP sum to minimise the mire taxa signal. Pollen and spores were mounted in silicone oil and identified using an Olympus BX41 light microscope at ×400 magnification with critical identifications made at ×800; assisted by a pollen reference collection and photomicrographs (Moore *et al.*, 1991). Pollen and spore nomenclature follow Bennett (1994). To enable the assessment of the total concentrations of pollen, tablets containing *Lycopodium clavatum* spores of known concentration were added to each 1cm3 sample and the spores counted alongside the fossil pollen (Stockmarr 1971). The concentration values (No. grains cm-3) and sediment accumulation (cm $a^{-1}$) were used to calculate the pollen and charcoal accumulation rate (influx: No. grains or particles $cm^{-2}$ $a^{-1}$). Charcoal particles between 10-180µm were also counted alongside the pollen and spores on the microscope slides as an indicator of past fire activity. The pollen percentage data was divided into local pollen assemblage zones (LPAZs) based on major changes in land pollen (land taxa >2% TLP) using stratigraphically constrained cluster analysis (CONISS) (Grimm, 1987). The percentage pollen results are presented using Tilia software version 2.6.1 (Grimm, 2011) in Figures 4 (D113, onsite) and 5 (DL3, offsite) and the pollen accumulation rates (influx) in Figure 6.

Separation of different groups of the Poaceae (grasses) is based on Andersen's (1979) quantitative key for Poaceae grains >35µm. Poaceae grains with an annulus diameter (anl-D) of less than 8µm are wild grasses. Cultivated grasses recorded at Dun Law were restricted to Group II *Hordeum*-type (Poeaceae anl-D 8-10µm) which contains *Hordeum vulgare* (barley) and *Triticum monococcum* (einkorn wheat) and its presence implies the practise of agriculture. However, we acknowledge the caveat that Group II pollen also includes nine wild grass species (Tweddle *et al.*, 2005).

To provide information about the depositional environment of the pollen each grain was assessed for its state of preservation using a hierarchy of five categories; normal, broken, crumpled, corroded, and degraded (Cushing 1967; Berglund and Ralska-Jasiewiczowa 1986). Pollen is best preserved in waterlogged (anaerobic) and acidic conditions and so corrosion and degradation suggest biochemical processes whereby pollen is 'digested' by microbial activity under drier aerobic conditions. Pollen grains that are broken and/or crumpled are likely to indicate damage due to mechanical processes such as through abrasion during reworking and transport. The assessment of the state of preservation of the pollen grains also has the dual purpose of indicating the extent of taphonomic alteration of the original pollen assemblage. Higher proportions of degraded pollen may result in the differential preservation of more resistant pollen and spores such as *Cichorium intybus*-type and Polypodiaceae and the loss of more fragile pollen such as Cyperaceae (Bunting and Tipping, 2000). The pollen preservation results are presented in Figure 7.

*Chronology*

The chronology of the two pollen records (D113 and DL3) is constrained by 17 AMS ages (Table 1). The conventional radiocarbon ages were calibrated to calendar years using CALIB 8.2 (Stuiver and Reimer, 1993) and age-depth models for D113 and DL3 were constructed using the Bayesian chronological package 'Bacon' (Blaauw and Christen, 2011), both implementing the IntCal20 calibration curve (Reimer *et al*., 2020). Three $^{14}C$ ages (SUERC33516; SUERC42265 and SUERC24031) lie out of sequence and have not been included in the age-depth models. The Bacon weighted mean ages (BC/AD) have been used to constrain the litho- and biostratigraphical data.

Table 1: Conventional radiocarbon ages and calibrated age ranges for Dun Law D113 and DL3. The IntCal20 calibration curve was applied (Reimer *et al*., 2020) using CALIB 8.2 (Stuiver and Reimer, 1993) as described in the main text.

| Depth (cm) | Material | $^{14}C$ yr BP 1σ | $\delta^{13}C$ | cal yr (2σ) | Lab Code |
|---|---|---|---|---|---|
| Dun Law D113 | | | | | |
| 0 - 1 | Wood | 1895±30 | -25.4 | AD 68 - 226 | SUERC-20196 |
| 10 - 11 | Wood | 1955±30 | -28.2 | 39 BC – AD 200 | SUERC-20198 |
| 26 – 27 | Bulk peat | 3376±26 | -28.8 | 1743 – 1546 BC | SUERC-42267 |
| 27 – 28 | Bulk peat | 3580±35 | -28.9 | 2031 – 1777 BC | SUERC-33513 |
| 35 - 36 | Bulk peat | 3961±26 | -28.9 | 2571 – 2348 BC | SUERC-42271 |
| 38 – 39 | Bulk peat | 4055±35 | -29.1 | 2845 – 2471 BC | SUERC-33514 |
| 49 – 50 | Bulk peat | 4460±40 | -27.4 | 3344 – 2936 BC | Beta-256719 |
| 85 – 86 | Bulk peat | 5100±35 | -29.6 | 3973 – 3797 BC | SUERC-24032 |
| 108.5 – 109.5 | Bulk peat | 5710±50 | -27.0 | 4695 – 4447 BC | Beta-256718 |
| | | | | | |
| Dun Law 3 | | | | | |
| 37 – 38 | Bulk peat | 1089±26 | -29.1 | AD 892 - 1019 | SUERC-42264 |
| 42 – 43 | Bulk peat | 1155±35 | -28.9 | AD 774 – 990 | SUERC-33515 |
| 62 - 63 | Bulk peat | 1650±35 | -28.5 | AD 262 – 538 | SUERC-24029 |
| 77 – 78 | Bulk peat | 1850±35 | -28.6 | AD 85 – 314 | SUERC-24030 |
| 98 – 99 | Bulk peat | 2760±40 | -27.6 | 997 – 821 BC | Beta-256721 |
| 133 - 134 | Bulk peat | (5815±35)[#] | -28.6 | - | SUERC-33516 |
| 134 - 135 | Bulk peat | (5736±27)[#] | -28.5 | - | SUERC-42265 |
| 163 - 164 | Bulk peat | (5365±35)[#] | -28.3 | - | SUERC-24031 |
| 166 – 167 | Bulk peat | 4205±35 | -29.4 | 2900 – 2668 BC | SUERC-33517 |
| 183 - 184 | Bulk peat | 4574±26 | -29.2 | 3491 – 3109 BC | SUERC-42266 |
| 184 - 185 | Bulk peat | 4610±40 | -28.3 | 3518 – 3125 BC | Beta-256720 |

# Radiocarbon ages in brackets were excluded from the age-depth modelling.

**Results and Interpretation**

*Stratigraphy:* The onsite profile from D113 indicates fluctuating amounts of mineral input (silts and sands) intercalated with peat from the base at *c.* 4630 BC until *c.* 3150 BC. After this time there is consistently more organic accumulation, albeit with some continued mineral input until the site is truncated by the construction of Dere Street. The increase in organic content in D113 at *c.* 3150 BC is closely contemporary with the onset of organic accumulation in the offsite profile DL3 at *c.* 3310 BC. There are two sustained periods of mineral inwash in DL3. The first focused on LPAZ DL3-2, between *c.* 2810 and *c.* 1400 BC; the input of reworked older carbon likely contributed to the older $^{14}$C ages that lie out of sequence within DL3-2. The second period of mineral inwash occurred during the first half of LPAZ DL3-4, between *c.* 890 BC and *c.* 440 AD, this was followed by increased peat accumulation until the present.

*Pollen preservation:* The pollen preservation profile from D113 suggests generally poor preservation, with the proportion of normal (well preserved) grains consistently below ~50%, albeit with slight improvements in LPAZs D113-3 and D113-4 but no radical changes in the nature of the pollen input. The pollen preservation profile from DL3 indicates that the proportion of normal grains was also consistently below 50% during LPAZs DL3-1 to DL3-3; probably caused by the input of reworked sediment within the palaeochannel, which can be seen in the fluctuating amounts of mineral input to DL3. This was followed by a marked increase in the proportion of normal pollen (>~70%) during LPAZs DL3-4 to DL3-6. It is probable that the construction of Dere Street impeded or diverted flow through the palaeochannel and allowed more stable peat accumulation at DL3.

**Dun Law 113: Below Dere Street ('On-Site') pollen results**

LPAZ D113–1 (*c*. 4630 – 3910 BC) *Corylus avellana*-type – *Pinus*: This zone lies within the palaeochannel and received fluctuating amounts of mineral input but with an overall trend to increasing organic content reaching a peak of ~70% at *c.* 4060 BC. Pollen preservation is consistently low during this LPAZ with normal grains constituting only ~30%. However, there does not appear to be over-representation of either mechanically deteriorated (broken and/or crumpled) or oxidised grains (corroded and/or degraded). The dominance of *Corylus avellana*-type (likely hazel) indicates a relatively dense shrub, potentially a woodland, surrounding the site with tall herbs such as *Filipendula* (meadowsweet) on or at the margins of the site. The lesser amounts of *Pinus* (pine), *Quercus* (oak), *Betula* (birch) and *Ulmus* (elm) probably reflect an open, though more mature, woodland on the drier slopes surrounding the site.

LPAZ D113–2 (*c*. 3910 – 2570 BC) *Alnus* – *Corylus avellana*-type: There is an increase in the proportions of *Alnus* (alder) from ~10% to ~40% and a corresponding decline in the levels of *Corylus avellana*-type. *Quercus* persists as before at ~7% throughout the LPAZ while *Pinus* and *Betula* persist in lower amounts before they virtually disappear towards the top of the LPAZ. *Ulmus* continues as previously but virtually disappears after *c.* 3250 BC*.* The tall herbaceous cover of *Filipendula* and Apiaceae (umbellifers) is reduced to trace amounts while Poaceae (grasses) very gradually increases, reaching ~25% by the top of the LPAZ. This suggests an overall closing of an alder canopy around a wetter site at the expense of the cover of hazel and herbaceous taxa. There are single grains of *Hordeum*-type (barley) but there is no sustained evidence for agriculture during this LPAZ.

LPAZ D113–3 (*c.* 2570 – 2080 BC) *Alnus*: This LPAZ is dominated by a sustained (for ~490 years) peak of *Alnus* (~70%) and there is a corresponding reduction in *Corylus avellana*-type and a near absence of all herbaceous taxa. This increase in alder is also matched by a similar peak in well preserved pollen in a probably wetter and more stable peat environment.

LPAZ D113–4a (*c*. 2080 – 610 BC) Poaceae – *Calluna vulgaris*: At *c.* 2080 BC there is a rapid reduction in *Alnus* (from ~72% to 27%) followed by a more gradual reduction to <10% at *c.* 1060 BC*.* With the decline in aboreal cover, including the virtual loss of *Quercus*, there is a more gradual rise in Poaceae. *Calluna vulgaris* (heather) also increases and there is an increase in the diversity of herbaceous taxa. The dramatic loss of arboreal cover is briefly compensated by a small increase in shrubs (*Salix* and to a lesser extent *Corylus avellana*-type) which is then reduced as increases in grasses and heathland suggests an opening up of the landscape and possible intensification of agricultural influences.

LPAZ D113-4b: (*c*. 610 BC – road construction (AD 79-81) Poaceae – *Calluna vulgaris*: This sub-LPAZ is a continuation of the previous pattern of vegetation changes but with a marked reduction in Polypodiaceae (polypod ferns) and there is a small step reduction in arboreal content reaching the absolute minima of the entire record. There is also a large peak in charcoal influx just below the brushwood matting (Figure 8, Context 105). The sediments at the top of DL113 enclose the brushwood matting (for approximately 7 cm). There are two occurrences of single Hordeum-type pollen grains, which in themselves are inconclusive, but there is a significant increase in the diversity of trace taxa associated with ground disturbance, e.g., *Plantago lanceolata* (ribwort plantain), Ranunculaceae (buttercup family), *Rumex acetosa* (common sorrel), and *Galium* (bedstraws) suggesting woodland clearance for pastoral as well as possible arable activity.

The archaeological evidence suggests that the Romans did not excavate a trench through the peat but instead laid a lattice of logs and brushwood matting across the surface of the mire. Analysis of the wood used to construct the brushwood matting suggests that branchwood of *Corylus avellana* was the most common wood used. In the lattice structure *Betula pendula* was the most common species with wood fragments that were large enough to suggest tree trunks were being used to construct this part of the road. *Alnus glutinosa* and *Fraxinus* sp (ash) also made up a small proportion of the wood used in the lattice (O'Connell *et al*., 2014). The high mineral content and the narrow age range between the brushwood and the overlying lattice framework and the interstitial sediment would suggest that either the material was deposited near instantaneously or at least reworked from beneath, as the brushwood and lattice were perhaps pushed down into the softer underlying sediments before the compact reddish-pink coarse sandy clay (Context 104) and cobbles (Context 101) were emplaced on top of the wooden framework (O'Connell et al., 2014).

**Dun Law 3: Section through palaeochannel (offsite)**

LPAZ DL3–1 (*c*. 3310 – 2810 BC) *Alnus* – *Corylus avellana*-type – Poaceae: The arboreal pollen assemblage is dominated by *Alnus,* with a single peak (~73%) at *c.* 3200 BC and a small amount of *Quercus* (~5%) and *Corylus avellana*-type around the site . However, a significant proportion of Poaceae (~30%) suggests that the tree/shrub cover was relatively open. Organic content is high (~80%) during this LPAZ and the proportion of normally preserved pollen grains fluctuates between ~40 and 50%. The proportion of corroded and degraded grains are more dominant which indicates a slightly drier mire surface. The large proportion of the more resistant pollen and spore grains such as Polypodiaceae may suggest that there has been some taphonomic alteration of the pollen assemblages leading to an over-representation of the more durable pollen types. However, there is a near absence of unidentifiable pollen grains in LPAZ DL3–1.

LPAZ DL3–2 (*c*. 2810 – 2050 BC) *Corylus avellana*-type – *Alnus* – Poaceae: Organic content declines rapidly to <40% and there is a corresponding reduction in arboreal pollen content; *Alnus* is reduced and shrubs (*Corylus avellana*-type and *Salix*) and grasses correspondingly increase. The decline of *Alnus* most likely reflects the loss of local alder carr and the corresponding increase of *Salix* (a lower pollen producer than alder) probably indicates a change in the nature of the local tree / shrub communities on the wettest soils. *Quercus* and *Betula* continue unchanged from before and are now joined by *Pinus* and smaller amounts of *Ulmus*. Although there is an increase in the diversity of arboreal and shrub cover and a reduction in grasses the increased presence of *Filipendula* and *Pteridium* suggests a degree of continued openness in the tree / shrub cover around the site. There is a small increase in the proportion of corroded and deteriorated pollen grains, and this probably reflects an increase in the input of reworked pollen along with the sediment from beyond the surrounding alder cover but within the confines of the small catchment of the palaeochannel. The input of older carbon is likely to have also resulted in the reversed radiocarbon ages from this section of the profile and thus the pollen evidence from LPAZ DL3-2 should be treated with caution.

LPAZ DL3–3 (*c*. 2050 – 890 BC) *Alnus* – *Corylus avellana*-type – Poaceae: From a minima at the top of LPAZ DL3-2 Alnus gradually increases to ~30%, largely at the expense of *Pinus* and the shrub cover (*Corylus avellana*-type and *Salix*) and Apiaceae. *Ulmus*, which has been little more than trace amounts (~2% of TLP) also virtually disappears at *c.* 1370 BC*.* During this time sedges appear more consistently, pollen preservation improves and organic content increases following a fluctuating trend towards 80%, all of which points towards a probable shift to wetter and more stable peat conditions. There are four occurrences of single *Hordeum*-type pollen grains during this LPAZ, but they are not contiguous and while there is a small increase in grasses there is limited presence of the taxa commonly associated with ground disturbance and cultivation.

LPAZ DL3–4 (*c*. 890 BC – AD 940) Poaceae – *Calluna vulgaris*: There is a gradual rise in grasses (>~50%) and heathland in response to the decline in arboreal taxa (<10% of TLP). The reduction in *Alnus* at *c.* 850 BC is abrupt, along with the near disappearance of *Pinus* and *Quercus*. *Betula* and *Corylus avellana* type persist a little longer into LPAZ DL3–4 and *Salix* and *Filipendula* make a brief resurgence at the start of this LPAZ before they decline at *c.* 190 BC*.* There is a corresponding increase in the diversity of those taxa associated with cultivation (e.g. *Cichorium intybus*-type (dandelion), *Plantago lanceolata* (ribwort plantain), Ranunculaceae (buttercup family), *Rumex acetosa* (common sorrel), and *Galium* (bedstraws). There are three *Hordeum*-type pollen grains between AD 280 and AD 940. However, at *c.* AD 530 there is a reappearance of *Filipendula*, *Salix*, *Caltha* and Cyperaceae which suggests an easing in grazing pressures and that the site became wetter, and this is also reflected in the shift to better pollen preservation as the proportion of normal grains consistently rise, reaching above 70% at the upper LPAZ boundary.

LPAZ DL3–5 (*c*. AD 940 – 1400) *Calluna vulgaris* – Poaceae – *Potentilla*: This LPAZ is similar to the preceding LPAZ DL3–4 but with a marked reduction in grasses and the ground disturbance taxa and a significant proportion of *Salix* and *Potentilla* (cinquefoils). There is a large fire event at *c.* AD 1100 perhaps as a result of the intensification of landuse around the site. Heather reaches a later brief peak to ~58% at *c.* AD 1340 which may have been a response to vegetation and / or muir burning.

However, the higher proportion of well-preserved pollen (normal >80%), increase in sedges and near continuous levels of peat accumulation during LPAZ DL3–5, suggests that increased mire surface wetness probably drove the expansion of heathland.

LPAZ DL3–6 (*c*. AD 1400 – present) Poaceae – *Calluna vulgaris* – *Potentilla*: Grasses increase, and heather correspondingly declines to values seen previously in LPAZ DL3–4 (>60% and ~20% respectively). *Salix* disappears but *Pontentilla* persists, along with *Sphagnum*. The continued high level of good pollen preservation, and small but increased presence of *Sphagnum* within LPAZ DL3–3b indicates that wetter conditions continued. However, the presence of three *Hordeum*-type pollen grains during this LPAZ together with the large increase in grasses and smaller increases in the proportions of *Plantago* and Ranunculaceae and a small increase in mineral input during the last ~600 years suggests that there was at least a modest increase in agricultural pressures on the land at the expense of the bog / heathland.

**Discussion and synthesis of the palaeoenvironmental records**

Comparison of the two records suggests that the onsite D113 profile provides a well-resolved palaeoenvironmental record from *c.* 4600 BC to *c.* 2000 BC, after which the sediment accumulation rate declines and there appears to be a jump of ~2000 years between ~30cm and the placement of the brushwood matting at ~11cm in the D113 profile. It is probable that the construction of the Roman road disturbed the peat beneath and so the LPAZ D113-4 should be interpreted with caution. The age for the emplaced wood at the top of the profile has been dated to *c.* AD 53 - 215 (2σ) (O'Connell *et al*., 2014), which is in close agreement with the historical age of late 1st century AD for the major phase of Roman road building.

The offsite profile DL3, while acknowledging the problematic input of reworked sediments within LPAZ DL3-2 (and so excluded from our synthesis), provides a higher resolution record of environmental change from *c.* 2080 BC, leading up to and during the construction of the road, followed by the post-Roman landscape to the present (Figure 8). A summary of the main features of the changing landscape at Dun Law will be described in time-slices. The main focus of this paper is to provide a context for the later occupation of the region by the Romans, the period of occupation, with withdrawal of Roman troops to Hadrian's wall, and then the final withdrawal of the Romans from mainland Britain. To provide a background for these later landscape changes the interpretation of the palaeoenvironmental record starts with a discussion of the evidence for the Neolithic and Early Bronze age landscape around Dun Law.

*Neolithic and early Bronze Age woodland c. 4600 – 2000 BC:*

The landscape around Dun Law at *c.* 4600 BC was initially wooded, dominated by *Corylus avellana*-type. The presence of *Betula*, *Quercus*, *Ulmus*, *Salix*, Poaceae, and tall herbs suggests a relatively mature wooded landscape characteristic of the southern Scottish woodlands pre-Neolithic disturbance (Tipping 1995). The small, but significant proportions of *Pinus* (~10-15%) is unusual for this location in the Scottish Borders region. Tipping (2010) records similarly rare local stands of pine in the Cheviots up until *c.* 4500 BC and suggests that pine may have been able to compete with other tree species on poorer soils or disturbed soils on steeper slopes. Alder is continuously present from the base of D113 at *c.* 4600 BC, though the arrival of alder elsewhere in southern Scotland and north-east England has been dated to *c.* 5100 BC (Tipping 2010). The later expansion of alder at *c.* 3910 BC may reflect the upland nature of the site at Dun Law and the local differences of substrate moisture. Alder carr thrives close to wet boggy sites (McVean, 1956) and its arrival appears to be at the expense of the percentages of hazel. However, the influx values from D113 suggest that despite small fluctuations the surrounding hazel cover was largely unchanged. The large peak in *Alnus* at *c.* 3250 BC in D113-2 likely correlates to the expansion of *Alnus* at the base of DL3-1.

The large peak in alder at *c.* 3250 BC is closely contemporary with the elm decline in D113-2, although *Ulmus* appears to persist in very low to trace amounts until *c.* 1500 BC in DL3. However, with such low proportions it is probable that a primary decline is not recorded, and elm was rare and / or not growing locally. The timing of the Dun Law elm decline is later than elm declines recorded at *c.* 4280 BC (Din Moss) (Hibbert and Switsur, 1976), and at *c.* 3460 BC (Yetholm Loch) (Tipping, 1992), both in the Cheviot Hills and both similar to Dun Law, in that there is no clear evidence for an anthropogenic cause (Tipping 1996). Other elm declines are recorded although less well dated in the western uplands of the Scottish Borders at *c.* 4200 BC and *c.* 3500 BC (Catherine Hill and Burnfoothill Moss respectively) (Tipping and Milburn, 2000). It is likely that the decline of elm from the region was a diachronous event with primary elm declines spanning between *c.* 4150 and 3500 BC (Tipping, 2010) and elm persisted in favourable locations for 100s of years but its virtual disappearance from the landscape always precedes the major woodland clearance during the later Iron Age.

Three occurrences of single *Hordeum*-type pollen grains across this period (D113-1 and D113-2) provide tentative evidence for cereal cultivation. However, the lack of widespread indicators of ground disturbance or persistent fire activity may suggest that the pattern of gradual woodland decline and expansion of shrubs and grasses at Dun Law (towards the top of D113-2) represents simple small-scale clearances of wood, perhaps followed by periods of shrub regeneration. There is no unambiguous evidence for a climatic cause for the loss of pine and so, similar to the loss of elm, the loss of woodland diversity may represent limited incursions into and small-scale clearances of the woodland by human activity.

Bronze Age woodland change *c.* 2000 – 890 BC:

There is peak expansion of alder (~70% of TLP) in LPAZ D113-3 to the virtual exclusion of all other taxa between *c*. 2640 – 1990 BC and there is a more moderate expansion during LPAZ DL3-3 between *c.* 2000 and *c.* 850 BC*.* While similar in nature these two expansions of alder are distinctly different in timing. It is tempting to wiggle match the two records and disregard the timing. However, both events occur within well-dated sections of our age-depth models and so here we argue that the differences likely reflect local small-scale variations in the alder carr. Oak and hazel appear to continue through LPAZs D113-3 and DL3-3, although grasses gradually increased in the latter along with four occurrences of *Hordeum*-type pollen. This may be the first signs of woodland disturbance and perhaps the precursors of the wider woodland clearance later in the pollen record.

*Iron Age woodland clearance and the eve Roman occupation c.* 890 BC - AD *78-86:*

At the LPAZ boundary between D113-3 and D113-4a the large peak of alder rapidly declines. The onsite (D113) woodland clearance, increase in heath, and decline of polypod ferns is *c.* 1000 years earlier than the same vegetation changes at the offsite (DL3). However, the temporal resolution in the D113 profile is much reduced as the age-depth model rapidly flattens at this point. This strongly suggests a hiatus in the record most likely caused by the construction of Dere Street and thus we continue our environmental reconstruction using the offsite (DL3) record.

In the early Iron Age, there is a dramatic phase of woodland clearance from around 890 BC with woodland replaced by the expansion of grass and heathland. Willow appears to make a brief resurgence as the alder carr is reduced, but by *c.* 240 BC only alder, hazel and birch are thought to have had a limited local presence. The woodland-loving polypod ferns also decline from around 240 BC*.* There is an increase in the diversity of herbaceous taxa, particularly those indicative of ground disturbance, common sorrel, bedstraws, and plantains all suggest an increase in agricultural activity. This vegetation change at Dun Law is dramatic and the landscape never regains the woodland cover it had in the late Bronze Age. The rapid and extensive decline in woodland and its replacement with grassland and other herb taxa, indicative of disturbance and grazing, points to a shift in the intensity and the nature of farming at Dun Law. *Hordeum*-type pollen is still present during the Iron Age but here it is suggested that livestock grazing, and perhaps intensive grazing, became the main agricultural activity in the area. A landscape palaeoenvironmental reconstruction of the lowland and upland landscapes in the Bowmont Valley, northern Cheviot hills (Figure 1) (Tipping 2010), describes a landscape that was subjected to a rapid and abrupt woodland clearance from *c*. 250 BC indicating a radical restructuring of the agrarian landscape before Romans arrived in the area. A similar restructuring of agricultural activity appears to have taken place in the early Iron Age in the upland landscape around Dun Law.

*The Roman Occupation (AD 78-86 – c. AD 400):*

The palaeoenvironmental records from Dun Law indicate that the Romans arrived into a landscape that was already denuded of woodland. The landscapes around Dun Law were productive and grazed and had been for at least 350 years before the Romans were established in Scotland during the Flavian Period AD 78 - 86. Dere Street was thought to have been constructed in the late first century AD to facilitate the movement of troops during the Flavian Period and then during the reconquering of Scotland around AD 140 (Hanson and Breeze, 2020). The timing of woodland clearance at Dun Law probably occurred sometime *c.* 890 to 250 BC, or perhaps even earlier as suggested by the record from D113. Regardless, the pollen record obtained from beneath Dere Street confirms that the road at Dun Law was constructed across an open landscape. Manning *et al.* (1997) used the stratigraphic relationship of Roman archaeology to confirm that Hadrian's wall at Vindolanda was also constructed in an open landscape with agricultural land mainly exploited for grazing animals. Similarly, when constructing the Antonine wall palaeoenvironmental evidence suggests that the Romans arrived into an already deforested landscape (Dumayne-Peaty, 1998; Tipping and Tisdall, 2005).

For those tasked with constructing Dere Street the lack of extensive local woodland would have meant that substantial timber resources had to be brought in, but that constructing a road across an open landscape would have been relatively easier with less time and effort spent clearing woodland from the route of the road. The archaeological evidence uncovered at Dun Law shows that the more structured lattice work (context 104) within the road was constructed from large diameter trunk wood mainly of birch (O'Connell *et al.*, 2014). At Dun Law the pollen diagram suggests that birch was largely absent from the local area by the time Dere street was constructed which suggests that the birch wood used in the lattice work was probably brought to the site by the Roman road builders. The presence of holes made by *Xestobium rufovillosum* (death watch beetle) confirms that dead wood was used in the construction of the lattice structure (O'Connell *et al.*, 2014). The presence of this beetle species, that is presently absent from Scotland, supports the interpretation that wood was brought to the site to construct this section of the road. Furthermore, Tipping (2010) also suggests that woodland resources from the Cheviots at that time would have been insufficient to meet the demands during Roman occupation.

The brushwood used in the construction of the road (context 105) was noted to be mainly cut branch wood of hazel. The pollen diagram suggests that locally hazel would have been present and available to build the road. The lack of uniformity of the age and diameter of all the wood used in the construction of the road suggests that the wood was draw felled with no evidence for management of the woodland resource and for the selection of wood of a certain size (O'Connell *et al*., 2014). The limited arboreal and shrub cover at Dun Law is consistent with the Roman roadbuilders using whatever local wood was available for the brushwood matting. Once completed, Dere Street was used as a key military route for the movement of both troops and supplies. After the initial expansion, the Romans withdrew from Scotland to the Tyne-Solway isthmus around AD 87 (Hanson, 2003), and Hadrian's wall was constructed in AD 120's (Breeze and Dobson, 1987). A further expansion northward into Scotland from AD 139 and the construction of the Antonine Wall re-established Dere Street as an important supply route within the Hadrianic-Antonine frontier zone (Hanson and Breeze, 2020).

After the AD 160s the Roman troops were withdrawn from southern Scotland, at least as far as Newsteads in the eastern frontier zone (Breeze, 2012), and Hadrian's Wall became the established frontier of the Roman Empire in Britain (Breeze and Dobson, 1987). However, until *c.* AD 390 Dere Street would have been used to facilitate troop movements for the Roman army's frequent forays into southern Scotland as part of organised campaigns or short-lived battles with the native Scottish tribes. Dere Street continued to be used long after the Romans left mainland Britain in AD 410 and its use during the Medieval Period is testament to the skill of Roman roadbuilding (O'Connell *et al.*, 2014).

The archaeological record for native Iron Age settlement in the region is limited but finds such as pottery and silver coins point to perhaps an uneasy political relationship between the occupiers and the native tribes (Fraser, 2009; Hunter 2009). The supply of food to the occupying troops may have been under duress, but the increased local demand may have presented economic opportunities (Harding 2004). Our palaeoenvironmental record from Dun Law can add to this discussion around the potential increase in agricultural activity in the landscape around the time of Roman occupation. The pollen evidence from Dun Law suggests that the farming activity that likely began in earnest between *c.* 890 and *c.* 250 BC was maintained throughout the period of Roman occupation of the area. Evidence within the cleared upland landscape of Dun Law for intensification of land use during the Roman occupation is difficult to identify. Dumayne-Peaty (1998) suggests that Roman occupation probably encouraged the continuation of pastoral activities but that there is no evidence for an expansion of agriculture on the landscape. However, native people may have had surpluses that they could trade. Tipping (2010) suggests that within the Bowmont valley surpluses of meat and grain may have contributed to the Roman supplies whilst intensification of production or the production of rye cereal has been suggested for landscapes that are closer to Hadrian's wall (Dumayne 1993b; Manning *et al*., 1997; Dark 2005).

*Post Roman Occupation (c. AD 400 – present):*

During the post Roman period the Hadrianic-Antonine frontier zone likely continued to be an important region for the movement of people and goods. The pollen evidence from Dun Law suggests that an open grazed grassland persisted after the Roman withdrawal and it is probable that Dere Street continued to be used until at least Medieval times. However, from around *c.* AD 500 there is a small recovery in willow and birch, and herbs associated with disturbance and grazing, such as ribwort plantain, decline but others such as common sorrel increase. Tall herbs that are intolerant of grazing such as meadowsweet also appear again after *c.* AD 500. This suggests that while grazing continued and the landscape remained open there may have been fluctuations in the intensity of grazing and / or the establishment of willow and meadowsweet in the wetter areas. It is also probable that the final withdrawal of the Roman army from mainland Britain resulted in a reduced demand for food stuffs and locally an economic decline (Tipping 2010). The open landscape around Dun Law dominated by grassland and heather persisted until the present and the upland area has continued to be a valuable grazing resource.

**Conclusion**

There are few palaeoenvironmental records that are closely related to archaeological sites. Here we present two vegetation records, constrained by robust age depth models, that combined provide valuable insights into the upland landscape encountered by the Romans along Dere Street. The vegetation records provide unambiguous evidence that the Romans constructed Dere Street within an already cleared landscape, one that had a well-established agricultural system that was perhaps mainly focused on pastoralism. This area had been cleared over ~950 to 250 years before the Romans arrived, with the clearance representing a rapid and transformative effect on the agricultural landscape during the Late Iron Age. The pollen data supports the interpretation that the brushwood matting used in the road construction was locally sourced to assist the crossing of boggy ground, but the absence of more substantial trees necessitated the transport of larger birch trunk wood from elsewhere. Within our pollen records there is no unambiguous evidence that the influx of troops and the demand for local supplies led to the intensification of grazing or change in land use. Here it is suggested that the native peoples did not abandon their farms or land as the Romans advanced and occupied this frontier zone, instead they continued farming as they had done and perhaps would have been able to supply the Roman army with surplus. However, there is perhaps some evidence to suggest a reduction in grazing after *c.* AD 500 perhaps reflecting a reduction in demand. The effect of Romanisation on the native peoples of the upland areas is difficult to determine as archaeologically the record of Late Iron Age settlement is limited. The palaeoenvironmental evidence suggests that within the Hadrianic-Antonine Frontier zone there was a mosaic of pasture, heathland, and localised woodland. Our evidence from Dun Law suggests that there was little change in the agricultural landscape and farming economy during the Roman occupation and that any Romanisation was limited.

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No potential conflict of interest was reported by the authors.

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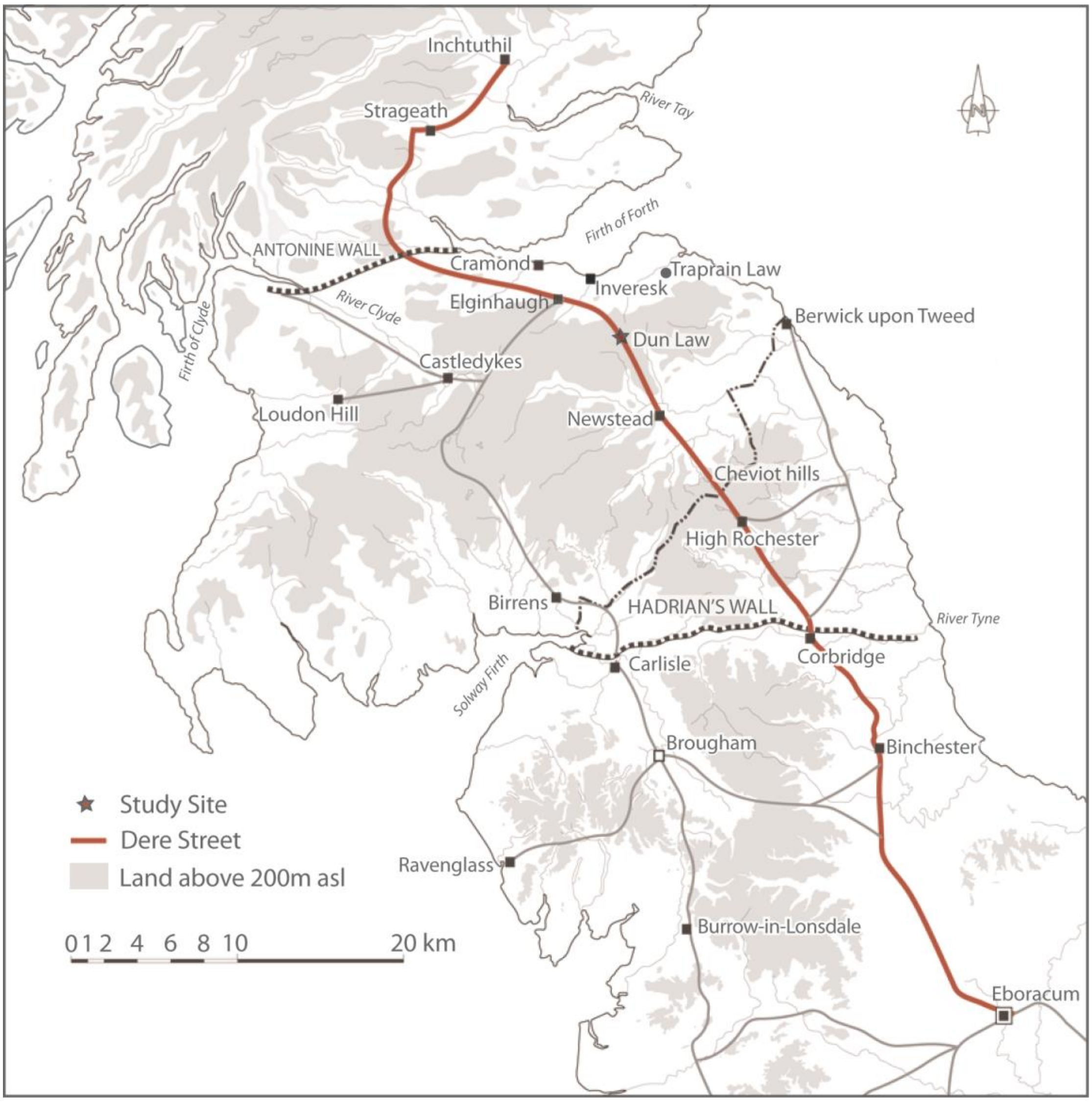


Figure 1: The route of Dere Street from Eboracum (York) in northern England, through the Hadrianic – Antonine frontier zone to Inchtuthil on the River Tay in present southern Scotland. Dun Law is located in the southern uplands of Scotland north of the Roman fort Trimontium at Newstead (Adapted from O'Connell *et al*., 2014).

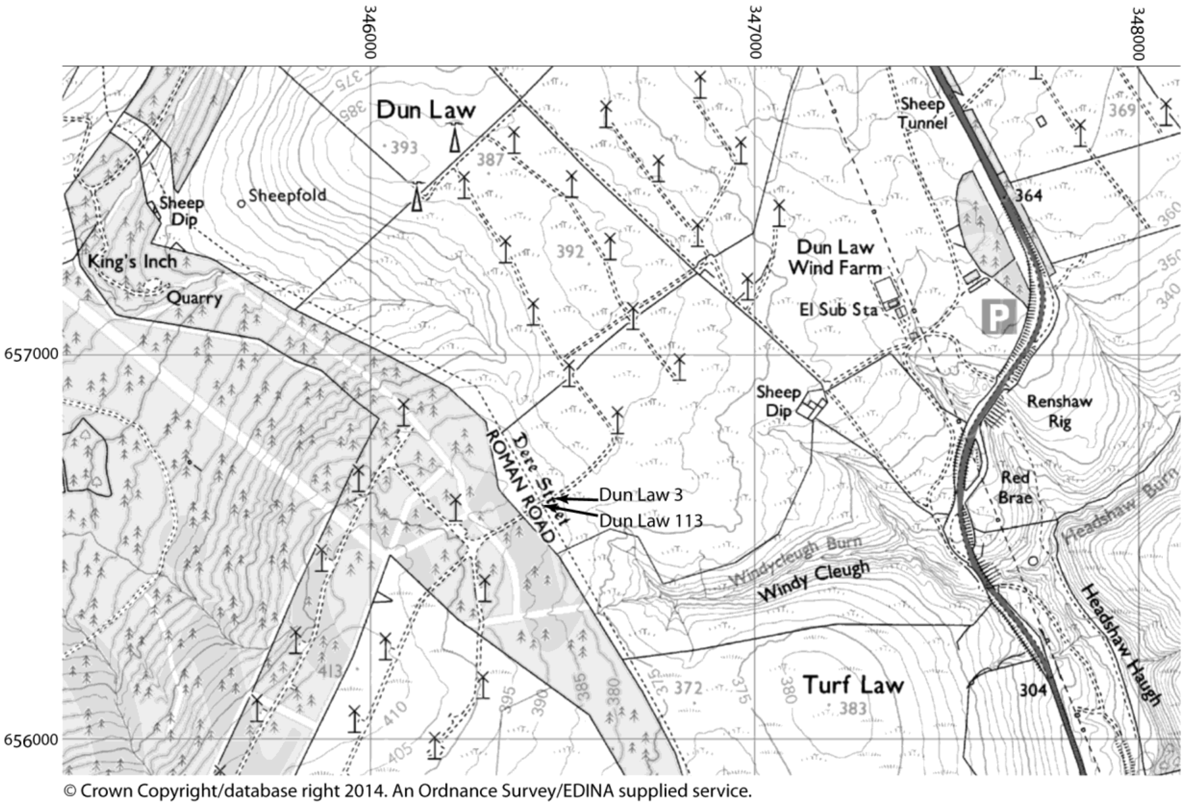


Figure 2: Dun Law and the location of the excavation site crossing Dere Street. Dun Law 113 (D113; onsite) was a peat / sediment section from beneath the remains of the Roman road and Dun Law 3 (DL3, off site) was a peat / sediment section 23m east of the road excavation in the headwaters of the Windy cleugh Burn.

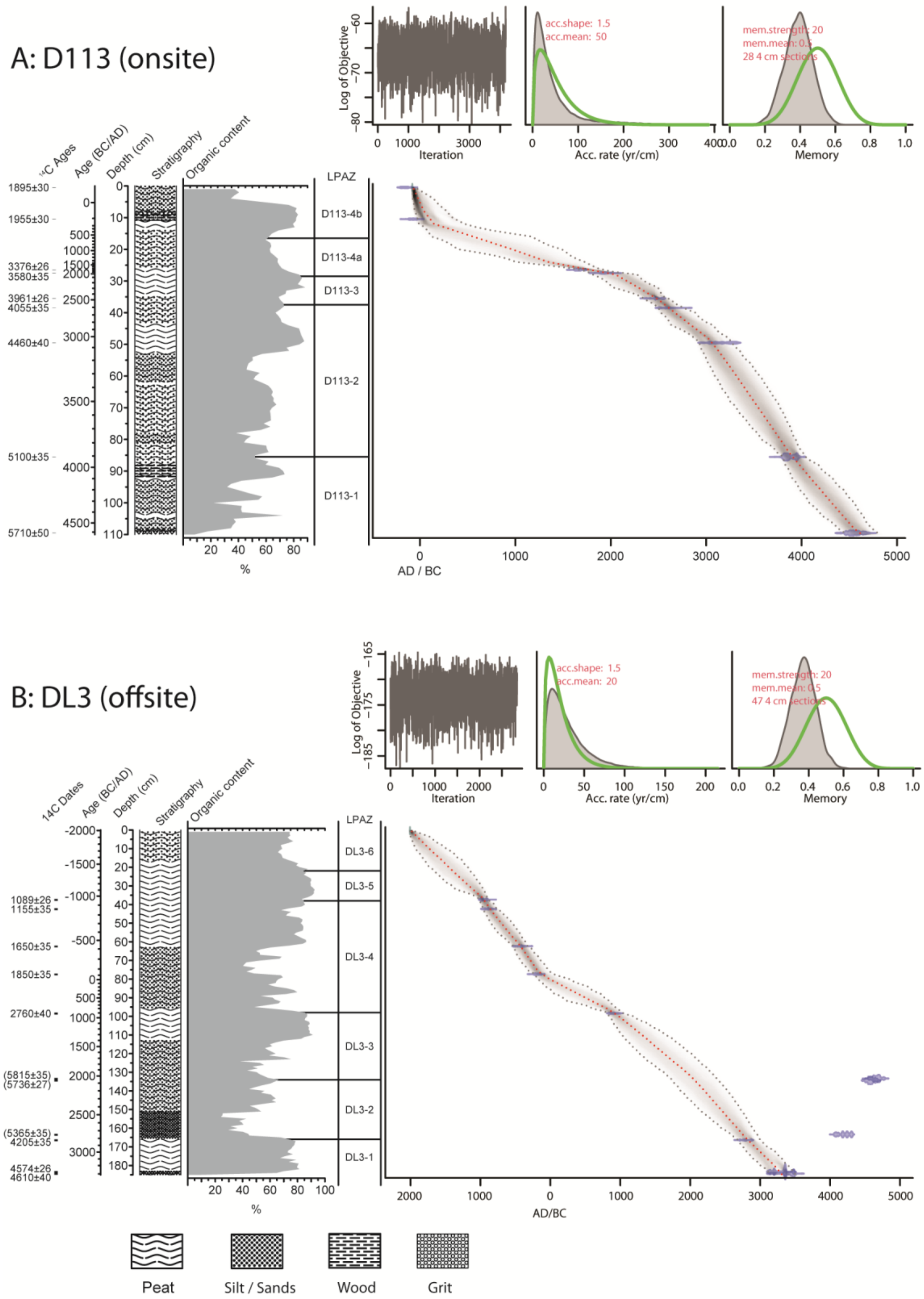


Figure 3: The Dun Law 113 (D113) and Dun Law 3 (DL3) profiles: sediment stratigraphy, organic content determined by $LOI_{550}$, and the LPAZs determined from the percentage pollen diagrams for D113 and DL3 by CONISS (Figures 4 and 5 respectively) alongside the R Bayesian Bacon age–depth models (Blaauw and Christen, 2011).

D113 (on site)

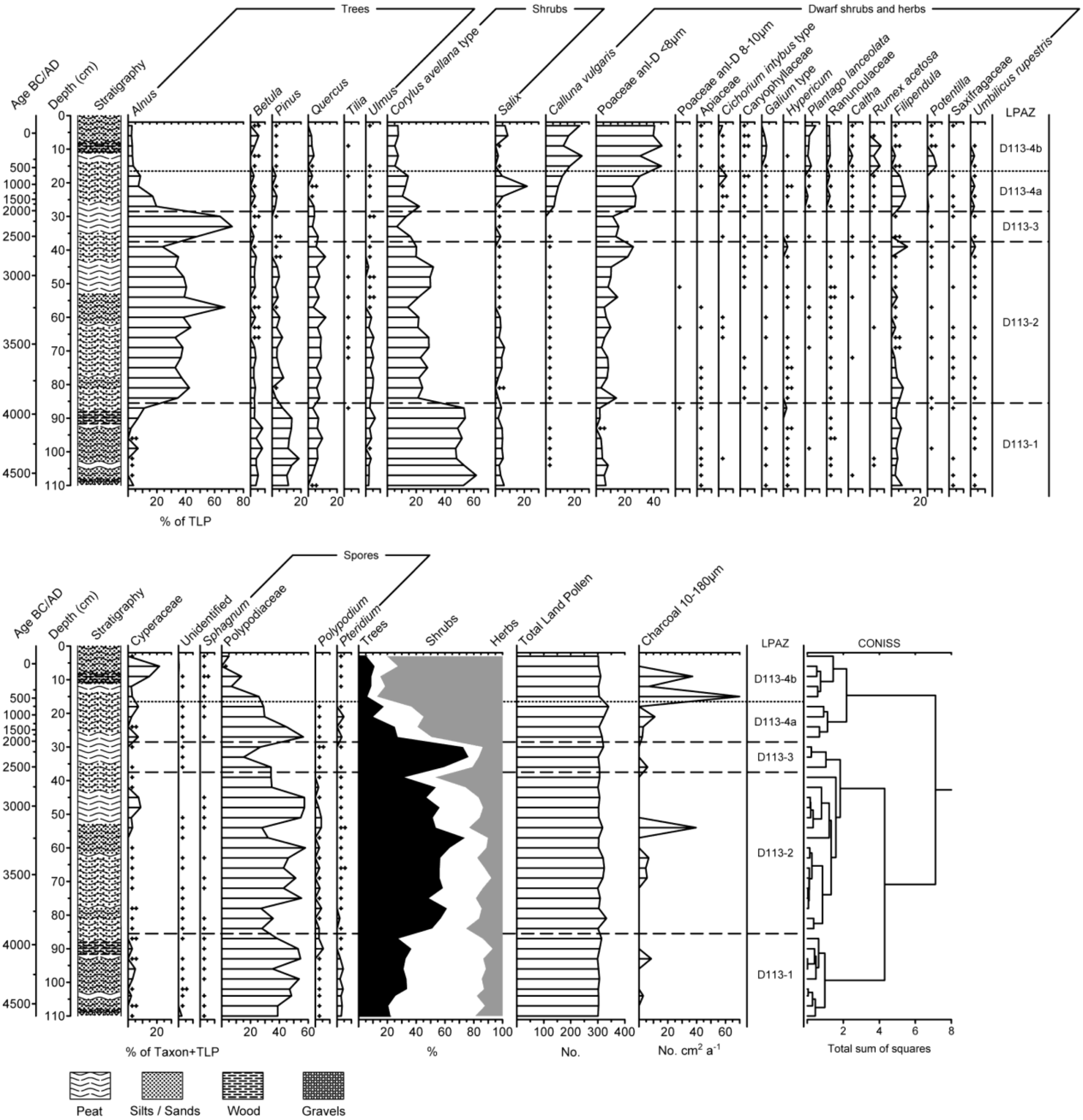


Figure 4: Dun Law 113 (D113) summary percentage pollen and spore diagram. Rare pollen taxa of ≤2% are represented by a + (≤ 1%) or ++ (≤2%).

DL3 (off site)

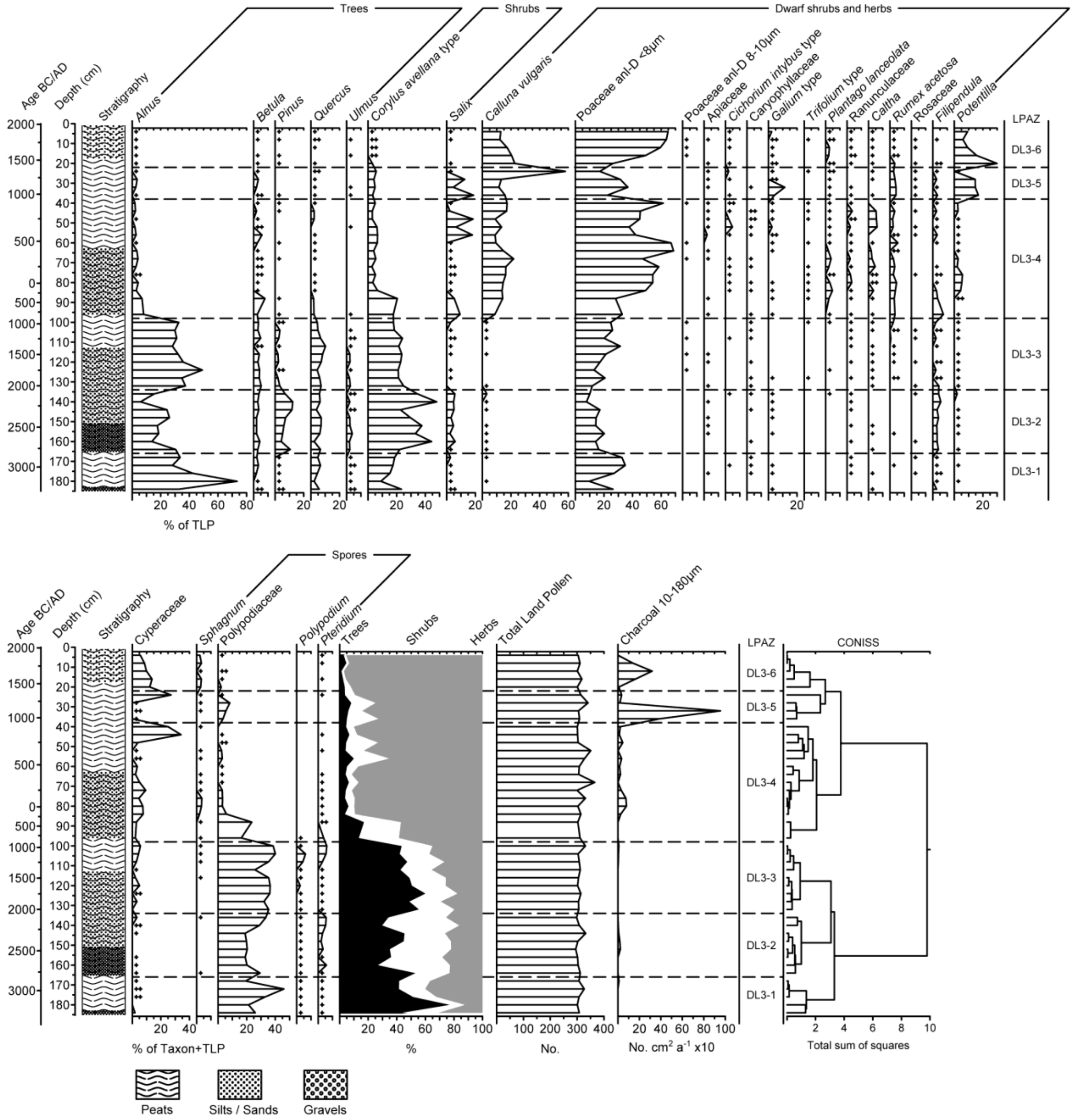


Figure 5: Dun Law 3 (DL3) summary percentage pollen and spore diagram. Rare pollen taxa of ≤2% are represented by a + (≤ 1%) or ++ (≤2%).

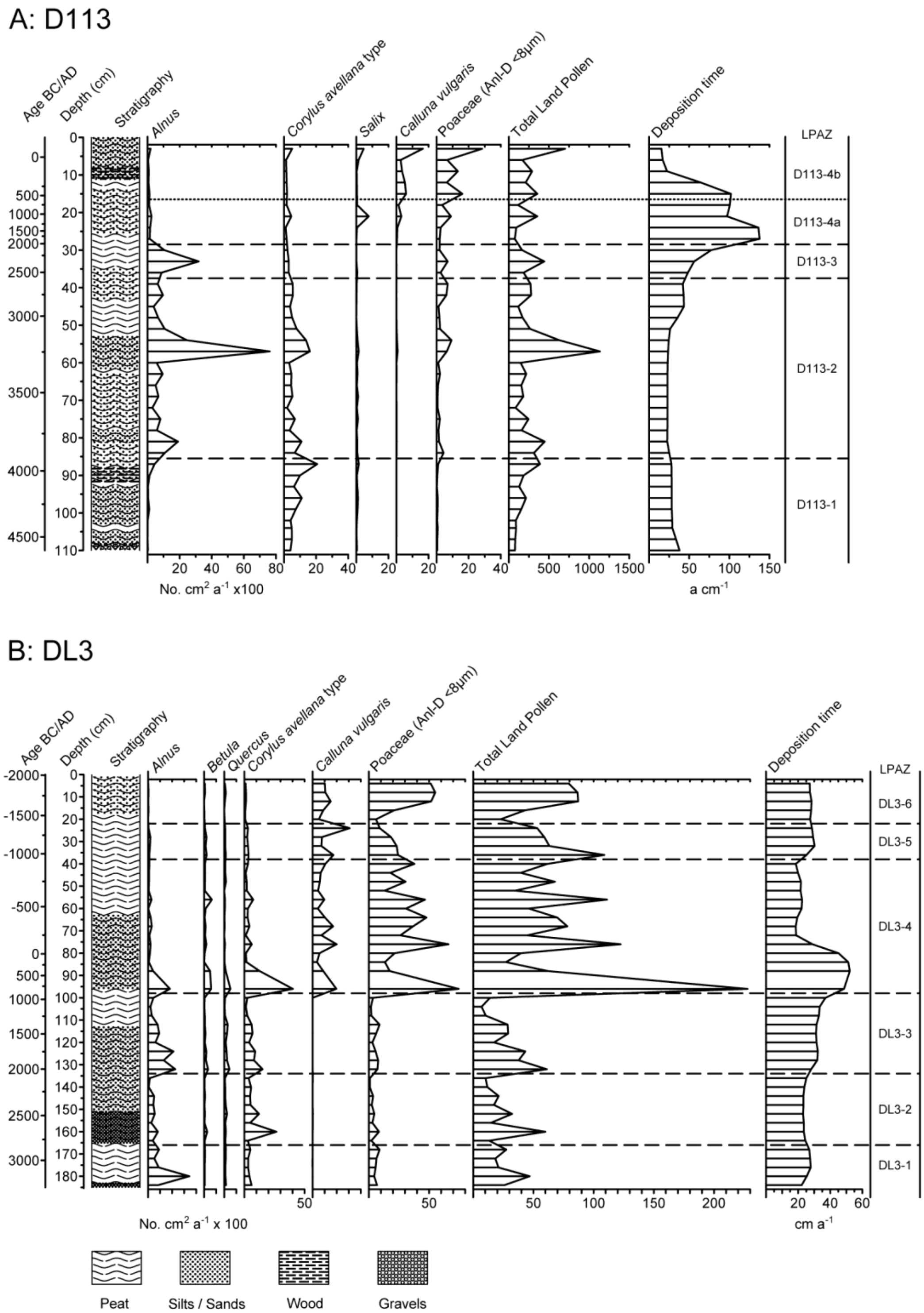


Figure 6: A: Dun Law 113 (D113) and B: Dun Law 3 (DL3) pollen accumulation rate (influx) for selected taxa.

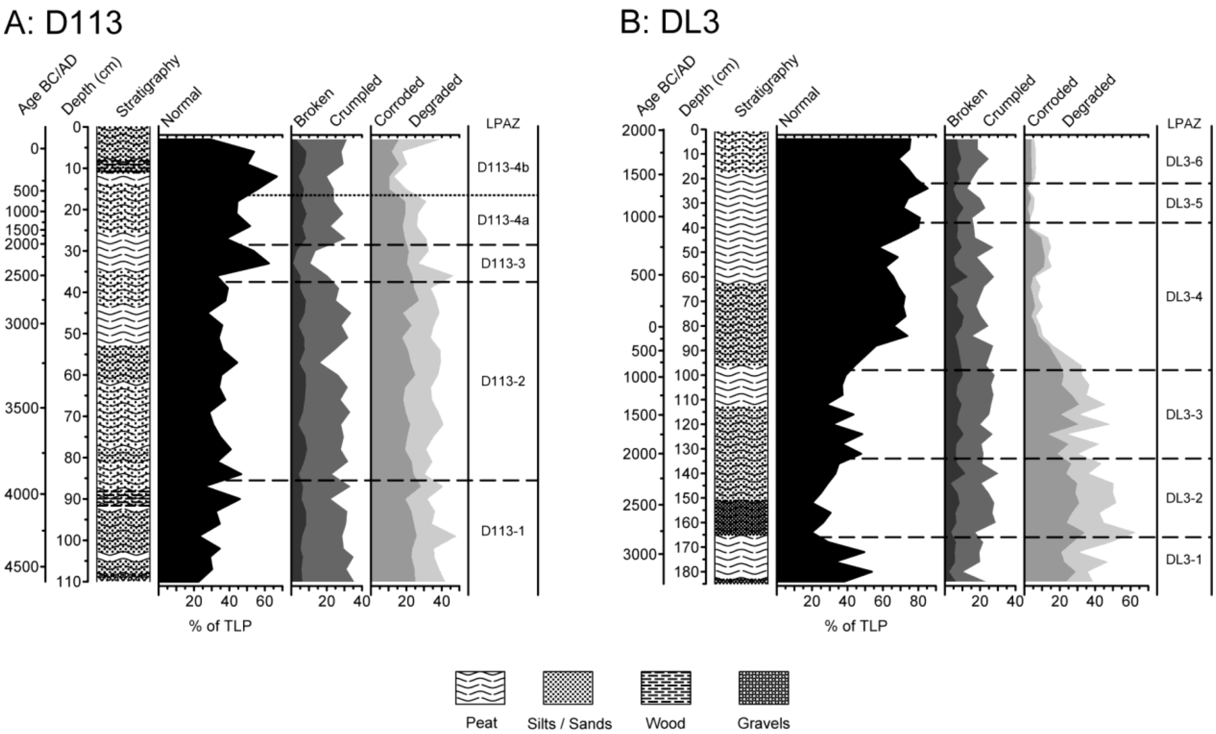


Figure 7: A: Dun Law 113 (D113) and B: Dun Law 3 (DL3) percentage pollen preservation diagram.

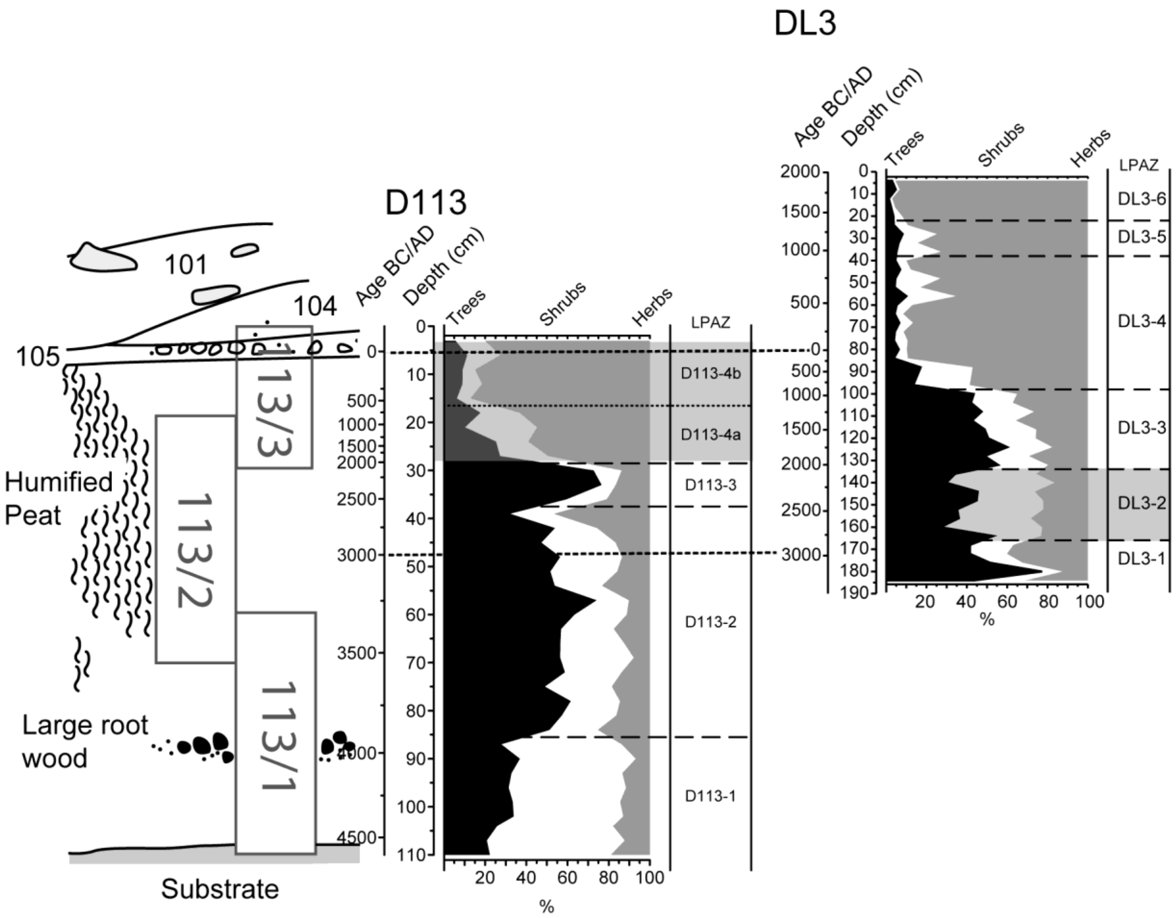


Figure 8: Summary drawing of the sediment / peat section at Dun Law 113. Context 101 is the cobble layer interpreted as the statumen (Berechman, 2003). Context 104 is a reddish-pink sandy clay layer, and identified as a probable pavimentum (O'Connell *et al*., 2014). Context 105 is the brushwood matting. The tree-shrub-herb summary diagrams are placed alongside to indicate how the two profiles relate to the Roman road. LPAZs DL3-2 and D113-4a and b, are grey-shaded to indicate these zones should be interpreted with caution; LPAZ DL3-2 due to uncertainty in the nature of the sediment accumulation and LPAZ D113-4 due to likely disturbance from the construction of the Roman road.