Pollen analysis of palaeochannel sediments, Watermead Country Park, Leicestershire (Accession no. A57.1996)

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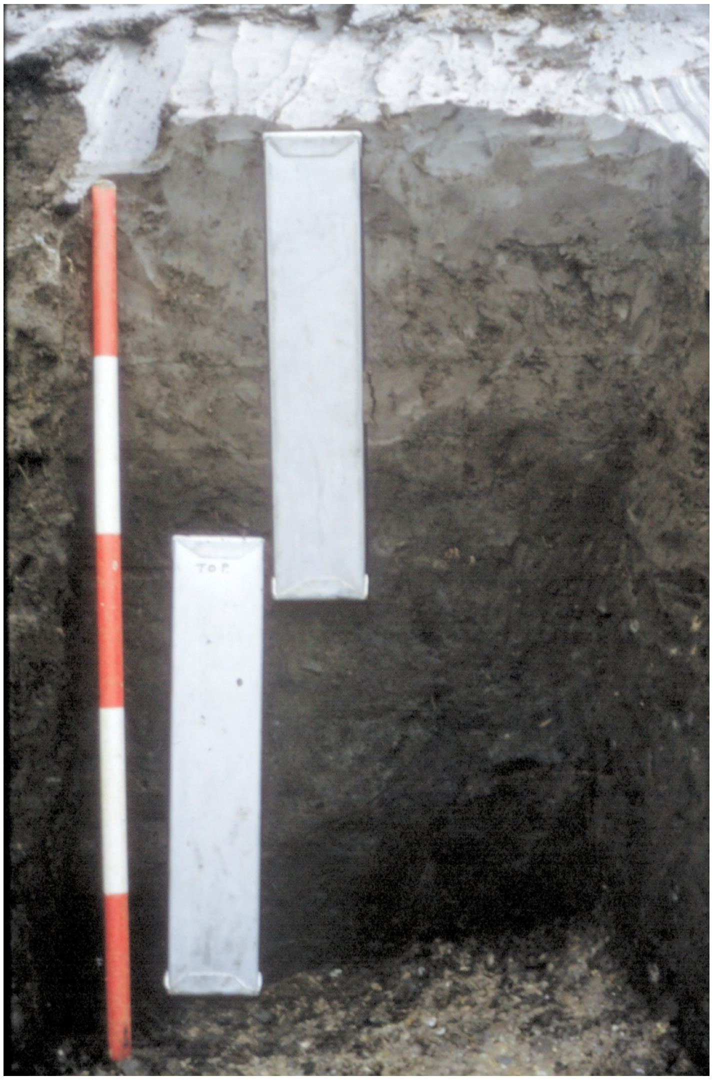
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1. Preamble and Site Characteristics

Three monoliths were collected by ULAS from excavations in 2002. The monoliths were assessed and a low resolution set of samples takes and subsequently a high resolution set sampled from the base of Monolith 113 and top of monolith 114 where the pollen and spore concentrations were highest. The monoliths come from the southern end of a large palaeochannel cut into the underlying gravels which was a minimum of 5m in width and probably *c.* 10m and which was probably a secondary channel of the River Soar.

2. Pollen Methods and Radiocarbon Dating

Standard preparation procedures were used on 1 ml of sediment (Moore *et al.* 1991) from a vertical sample of 5 mm. The samples were sieved (180 microns and 8 microns) and mounted in silicone oil. Identification was at 400 magnification and 1000 magnification for critical features. The University of Exeter and the analysts' personal reference slides were used for critical identifications. The pollen types recognised follow Bennett (1994) and plant taxonomy follows Stace (1991). A pollen sum of 500 land pollen grains was used excluding aquatic types and spores.

Radiocarbon dating was using the Oxford Accelerator facility and overseen by A. Bayliss. The calibrated date ranges were calculated by the maximum intercept method using the program OxCal v.3.5 (Bronk Ramsey 1993) and the INTCAL98 dataset (Stuiver *et al.* 1998). The results have been included in a Bayesian model which combines the available relative and absolute dating information (Buck *et al.* 1996). In this case the relative information is the stratigraphic/vertical sequence. The analysis results in an overall index of agreement (A=95.4%) which indicated that the radiocarbon dates are consistent with the stratigraphic sequence. This is important as the subsequent discussion will show.

Lab. No.	**Sample**	**Depth From Top of monolith cm**	**Alt. m OD**	**∂C^{13}**	**RC^{14} Years BP**	**calibrated years BC/AD (95% prob.)**
OxA-12484	Col 8, Mon. 113 Top	43-45	46.09-46.07	-29.5	1,048± 28	AD 900-1,030
OxA-12550	Col. 8, Mon 114A Top	4-6	46.08-46.06	-27.9	1,044 ± 24	AD 900-1,030
OxA-12635	Col. 8, Mon 114B Mid	12-15	46.00-45.97	-29.3	1,698 ± 30	AD 250-430
OxA-12773	Col. 8, Mon. 114, Bottom	21-24	45.91-45.88	-27.7	2,256 ± 28	400-200 BC

Table 1: AMS radiocarbon sample results.

The dates are consistent with the burnt mound being located on an active channel bank and the construction of the early Saxon Bridge across a channel late in its active life.

3. Stratigraphy

The monoliths sampled for this report were taken from Section 9. The stratigraphy of this section is given in Figure 1and Table 2. The section shows the easterly margin of the palaeochannel.

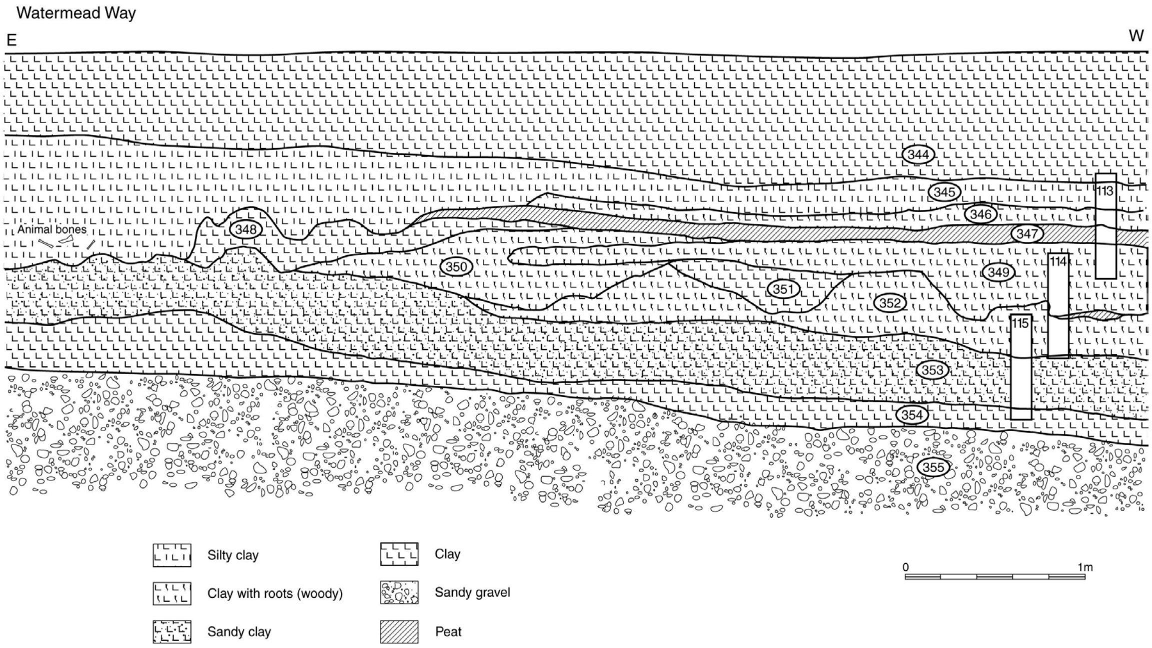


Figure 1: A stratigraphic section from Watermead Country Park, Section 9. (From J. Last)

The stratigraphic description for section 9 is given in Table 2 by context as per communication with J. Last (10/2/2000). As can be seen from Figure 1 the three monoliths 113, 114 and 115 were all located close together with substantial stratigraphic overlaps. The only sedimentary context with sufficient pollen to count was 349 (dark bluish brown clay with very frequent root fibres and some woody roots) and so the pollen diagram presented here is taken from the basal 19 cm of monolith 113 and the top 25 cm of monolith 114 (Table 2). There is a vertical overlap between the monoliths of 0.09 m. Unfortunately the upper overlap boundary coincides approximately with a stratigraphic change and this has complicated interpretation of the pollen and spore sequence.

Context	Description
0344	Smooth, dark grey alluvial clay with very frequent rust coloured staining giving a mottle appearance. Some reed/root fibres.
0345	Smooth dark brown silty clay with plenty of organic matter. Towards the

	East end the peaty material has much less clay in it at the base of what looks like a channel cut but the interfaces between the clayey layer and more peaty base is very poorly define
0346	Paler, more grey-brown than contexts 344 and 345. A mixture of mostly smooth grey clay but with plenty of organic reed/root material.
0347	A very clearly defined layer of dark, almost blackish brown very peaty material. Some clay/silt content, but mostly organic material. Some well dispersed coarse grains of white sand.
0348	Very smooth, moist alluvial clay. Pale bluish grey with a hint of green. Root fibres visible, but no obvious reeds. Slightly mottled with occ. Blackish flecks.
0349	Moderately dark bluish brown clay with very frequent root fibres and some woody roots. Quite mottled with linear patches of cleaner, paler clay.
0350	Slightly greenish pale blue grey clay. Mottled with reed/root fibres. Looks like the 'mottled layer' seen below the Burnt Mound site, but this is some distance away.
0351	Very similar to context 349, but paler clay (slightly less woody organic material)
0352	Very similar to context 350 but without the greenish mottled hue. Basically pale blue grey clay with very frequent reed/root material and plenty of woody roots.
0353	Pale blue grey clay but mixed with pinkish sand. The sand sometimes lenses in cleaner layers of sand but is mostly mixed with the clay. Some woody roots poss. Penetrating from context 352, but not as freq. As context 352.
0354	Coarse sand mixed with pinkish clay (marl?) but this layer is very mixed with lenses of both blue/grey clay and lenses of much purer white sand. Moderately woody roots (esp. at west end poss. Penetrating from context 353)
0355	|Natural gravels, the top of the 'orange sandy gravel'.

Table 2: Sediment descriptions by context from Section 9. (from J. Last)

The monoliths come from the fill of a palaeochannel cut into fluvial gravels (355). Above this is a coarse sand mixed with clay which is reworked local Marl from the Murcia Mudstone (354). Above this is a pale blue-grey clay mixed with some sand (353). Above this are three similar units (352, 351 and 350) which are greenish pale blue-grey clay in places mottled and with variable quantities of wood and plant roots. Only towards the centre of the palaeochannel occurs a dark blue-brown clay with roots and wood (349) which is overlain by a clay and rich dark brown peat (347) with a pale blue-grey-green mottled clay towards the eastern edge of the palaeochannel. Both are overlain by a dark brown silty clay (345) with organic matter and the whole fill sequence is capped by a dark grey alluvial clay with mottling (344). This clay appears to overlap the edges of units 352-346 and so can be interpreted as an overbank unit deposited after the infilling of the palaeochannel.

Ht mOD	Depth from top of monolith Tin (m)	Sediment description (incl. T-S notation where appropriate)
Monolith 113		
46.52	0-0.26	Stiff olive grey mottled clay with monocot. Root channels
46.26	0.26-0.36	Stiff dark brown silty peat, fibrous and mottled: Sh3, Th1, nig. 3
46.16	0.36-0.40	Dark grey-brown organic rich clay slightly mottled: Sh4, nig. 2-3
46.02	0.40	Base of monolith tin
Monolith 114		
46.12	0-0.19/0.30	(Sloping boundary from 0.19-0.30 m) Thick sticky dark grey clay with organic flecks and highly degraded wood: H4 Elas0
45.93/45.82	0.19/0.30-0.46	Light mottled grey - orange brown slightly sandy clay becoming increasingly sandier with depth and oxidised/Fe replaced vertical woody roots in section
45,52	0.46	Base of monolith tin
Monolith 115		
45.85	0-0.02	Thick sticky dark grey sandy clay
45.83	0.02-0.53	Thick sandy grey - orange brown mottled clay with abundant root material throughout
45.32	0.53	Base of monolith
Monolith 105		
	0-0.28	Thick sandy grey clay with vertical brown-orange mottles abundant vertical wood base to top becoming sandier with depth

	0.28-0.43	Well sorted fine to medium sand with red - brown horizontal laminations with some silt and horizontal root material
	0.43-0.45	Sand and gravel (clasts up to 2cm diameter): quartz, quartzite, sandstone, chert
	0.45	Base of monolith
Monolith 106		
	0-0.34	Thick grey slightly mottled clay with a trace of fine sand and possible horizontal laminations
	0.34	Base of monolith

Table 3: The stratigraphy of the monoliths 105, 106, 113, 114 and 115. Troels-Smith notation used where appropriate.

The radiocarbon dating shows that context 349 was deposited between *c*. 250 cal AD and cal AD 1,000 (Late Roman to Medieval). The underlying unit (352) appears to have been deposited in the Late Iron Age and there maybe a hiatus between the two units covering part or all of the Roman Period.

The sequence represents a typical multi-unit palaeochannel infill sequence revealing alternations of more and less organic rich silts and clays, although it covers a time period not often represented in such sequences. Hiatuses in this type of sequence are extremely common (Brown 1996; Brown 1999; Brown and Hatton 2002) and the most likely hiatuses (above the basal hiatus) here are probably between context 353 and 352 (sampled in monolith 115) and between 349 and 347 sampled in monolith 113. The sediments between the hiatuses have accumulated relatively slowly with an average accumulation rate of unit 349 of 52 yrs cm^{-1}. From the dates it is estimated that the combined pollen sequence (both diagrams) cover a minimum period of *c.* 1800 years. The stratigraphy and dates are consistent with a channel which was functioning but probably not the main channel in the late Iron Age to early Saxon Period when the bridge was constructed. During this time it was taking flow, including floods, but also silting up (a net positive sediment flux). By the Late Saxon Period the organic nature of the sediments and *in situ* plant grown suggests that the channel had been abandoned taking only overbank and backwater-flood deposition. The suggestion that the Saxon Bridge may have been built to an island (Courtney pers. com.) and by implication that the River Soar had at least two channels during the Saxon Period is in accord with the stratigraphic model given above.

4. Results of Pollen Analysis

*This report only covers Monolith 113 and 114 which were subject to high resolution counting (*Figure 2*).*

Monolith 114

The pollen spectra from the 18cm of silty clay sampled can be divided into two local pollen assemblage zones.

p.a.z. WW114a

This zone is dominated by trees and particularly one species – *Pinus* (*sylvestris*). There is very low representation by any other tree types although *Betula*, *Corylus*, *Tilia* and *Ulmus* are all continuous present. An interesting aspect is that *Quercus* is hardly present and only increases in the zone above. Poaceae, Cyperaceae, Lactuceae and *Pteridium* are present at low levels and *Polypodium* increases throughout the zone. Charcoal is relatively low but increases towards the top of the zone, although there is a spike of high concentration near the base of the zone.

p.a.z. WW114b

The boundary between p.a.z. 114a and 114b is located on the basis of a continuous decline in *Pinus* and a rise in *Alnus*, *Quercus*, Poaceae, Cyperaceae and Lactuceae. The zone is one of transition from a *Pinus* dominated environment to a local environment dominated by *Alnus*, *Quercus*, Poaceae and Cyperaceae. Other changes include the appearance of *Sorbus* t., Asteroideae und., Lactuceae, and high *Polypodium*. No cereal types were encountered.

Monolith 113

p.a.z. WW113a

This zone is marked by a transition over about 10cm from a tree dominated environment to one dominated by Cyperaceae, Poaceae and other herbs. The trees are dominated by *Pinus* with low levels of *Quercus* and *Alnus*. Outside the pollen and spore sum there is also a decline in *Polypodium* and significant levels of *Pteridium*. This zone correlates with p.a.z. 114b. The boundary between p.a.z. 113a and 113b coincides with the change in stratigraphy from an inorganic silty clay to a silty amorphous peat with rootlets. This may represent a hiatus, however, the change in pollen and spore content is not abrupt and it is more likely that it just represents a reduction of water in the palaeochannel and a local hydroseral succession.

p.a.z. WW113b

Cyperaceae, Poaceae and other herbs dominate the zone. *Pinus* decreases to typical background levels at the base of the zone and there is very low representation of other tree types. The principal herb is Lactuceae . which increase significantly at the top of the zone. The dominant spore is *Pteridium* with low levels of *Polypodium*. Of particular note is the appearance of cereal type pollen towards the top of this zone which includes *Hordeum* t. and *Avena*/*Triticum* t.. Whilst the *Hordeum* t. includes the grass *Glyceria* which is often found in very wet areas of floodplain the *Avena*/*Triticum* t. is restricted to these genera and so is definitely indicative of arable cultivation. Another significant change in this zone is the peak of charcoal both <50 µm and >50 µm.

5. Discussion of the Overlap between Monoliths 114 and 113.

In order to correlate the two monoliths sampling was continued through the basal 0.09 m of 113 which is the altitudinal overlap. The monoliths are separated in horizontal distance by 0.13m (Ripper pers. com.). Whist the two zones p.a.z. 1114b and p.a.z. 113a do correlate and the *Pinus* curve matches almost perfectly there are significant differences. This is remarkable given the very small distance of horizontal separation. Most obviously 114b has much higher *Alnus* and *Quercus* and lower Cyperaceae. There is little difference in *Pinus*, other trees or the other herb types. This suggests the difference is principally in very local pollen with monolith 114 being closer to an *Alnus* tree and the floodplain woodland and 113 being further away from trees and therefore more dominated by surrounding Cyperaceae. This is consistent with the location of the cores with 114 being towards the eastern edge of the palaeochannel. This suggests that the *Alnus* and *Quercus* woodland was growing on the eastern side of the channel.

This level of intra-local variation is not normally identified from archaeological pollen diagrams but is well known from the literature on forensic palynology (Horrocks and Walsh 1999; Brown *et al*. 2002). Whilst in this case it can provide valuable additional information (see below) it does imply that even cm scale changes in core location up-sequence could produce intra-local pollen changes unrelated to changes in the local vegetation.

6. Changes in the Environment Surrounding the Palaeochannel

As the sequence commences in the late Roman Period, the palaeochannel contains open standing water with little or no aquatic flora. The remarkably high levels of *Pinus* (90%+) imply that the floodplain surrounding the palaeochannel was covered by pine dominated woodland perhaps with some birch and hazel. In the distance there must be some mixed deciduous woodland with lime and elm. Fires are occurring in this woodland as marked by the in-wash of charcoal at one level. It is very difficult to identify an under storey but ferns were present including bracken and the occurrence of ivy suggests there were gaps in the woodland. The top of monolith 114 and base of monolith 113 cover a dramatic change in the local vegetation dated to *c*. cal AD 300-950. Pine decreases at an almost constant rate (assuming a near linear sedimentation accumulation rate) and is replaced by an open environment dominated by sedges, grasses and bracken. Whilst the increase in sedges and grasses could partially be an artefact of hydroseral succession (the rise of sedges) the decline of pine cannot be. Grasses also peak whilst pine is declining across the zone boundary. Bracken has been shown to a be a significant component of the floodplain flora in the eastern Midlands before extensive overbank alluviation altered soil conditions but elsewhere this phenomenon has been of Late Bronze or Iron Age date (Brown and Meadows 1997). The difference between the overlap zones also suggests that alder and oak were growing on the eastern edge of the palaeochannel either on the other side of the floodplain to the excavated area or on a riverine island.

There are strong indications of human activity after pine has declined with the appearance of cereals including either rye or wheat and probably barley as well as disturbance indicators such as Chenopodiaceae, although unusually the ribwort plantain does not increase. The appearance of these cereals is immediately preceded by a peak of charcoal. The sequence closes indicating an open floodplain environment dominated by sedges, grasses and bracken nearby arable cultivation and some deciduous woodland in the distance.

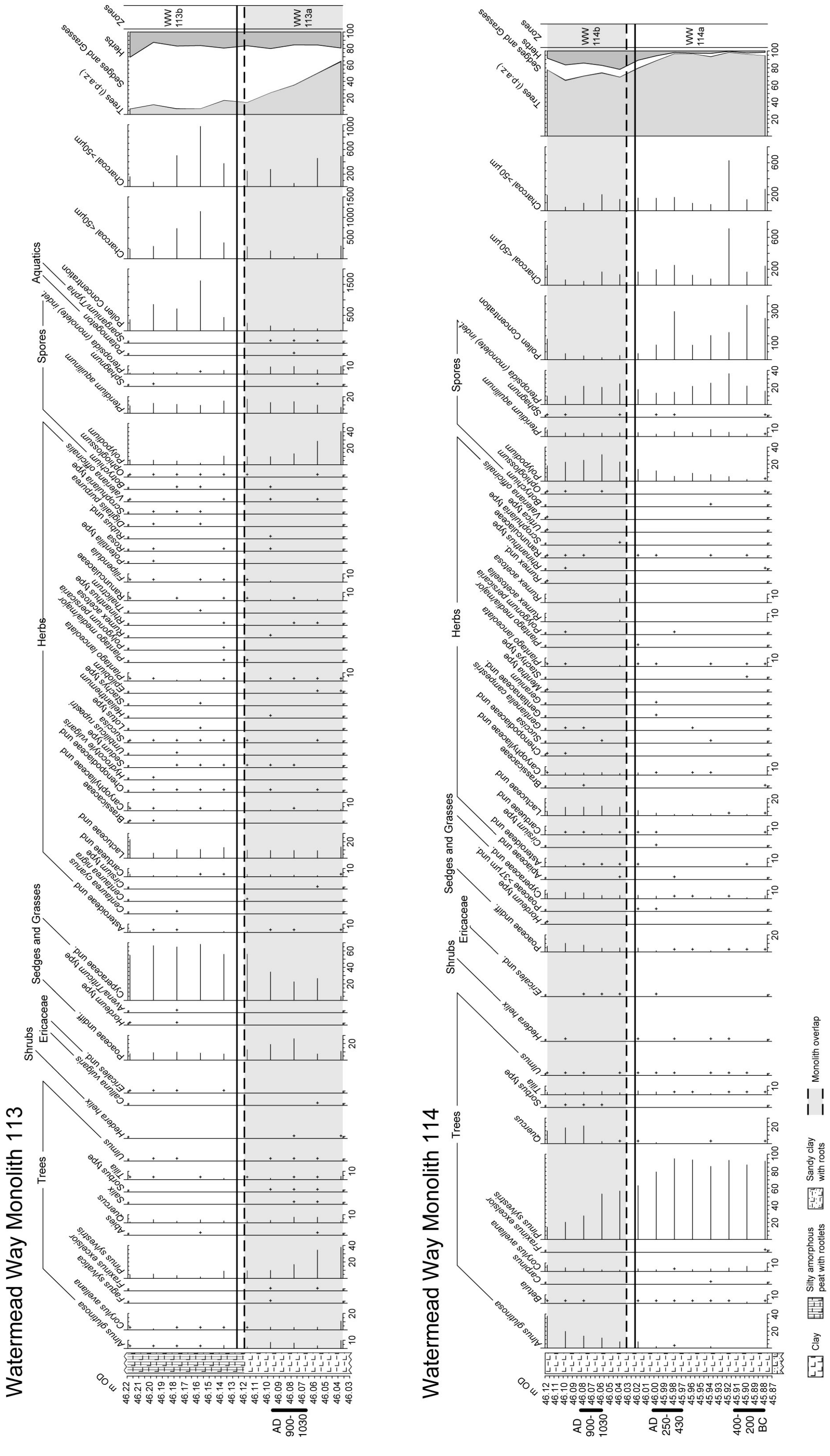
7. Discussion and Regional Comparison

There are two unusual aspects to these diagrams. Firstly the partial pollen correlation and radiocarbon dates show that the two sequences do overlap in time. The differences between the two overlapping parts of each diagram shows that even over cm a pollen diagram from a small water body such as a pond of oxbow lake can partially reflect the pattern of vegetation surrounding the site. This allows a 2D reconstruction of the landscape in this case but has the potential to allow 3D or even 4D reconstructions in the future. The slight but significant difference in the overlapping part of the diagrams suggests that alder woodland existed on the eastern side of the channel zone but sedges and grasses dominated on the western side. This may reflect a cleared island or the clearance of the western side of the floodplain.

The second unusual aspect of the sequence is the very late decline in pine. There is documentary evidence of the survival of a significant forest about 3 km to the west which is later represented by Charnwood Forest (Fox and Russell 1948; Squires 1981; Courtney 2003). The nearest semi-continuous sequence to Watermeade Way is from Narborough Bog which lies approximately 14 km upstream. It is a complex site with two periods of relatively extensive peat formation on the floodplain (Brown and Hatton 2002). The upper bog pollen diagram shows a maximum of *Pinus* of 25% at *c*. 7000 uncal. BP which then declines over 0.35m to 5% by *c*. 4300 uncal. BP when cereal type pollen first appears. At Sidlings Copse, the regional type site for the East Midlands (Day 1991; Greig 1996) Pinus is restricted to an early Holocene peak and decline by *c*. 9,000 BP. However, there are diagrams which show higher levels of over 10% land pollen in England (see below). Nearer but further south from another palaeochannel at Grendon in the Nene Valley the main pine decline is dated to *c*. 3990 cal BC with continuing levels of 10-20% total land pollen until around 1,400 cal BC after which pine is present at around 10% TLP although there is a rise again to 20% in the upper zone (Gr 4d) which has an estimated date of *c*. 540 cal BC, although this is not directly dated (Brown and Hatton 2001). It does, however, provide some support for their being pine refugia which survived into the Iron Age in the East Midlands.

The latest site known to the author (and J Grieg pers. Com.) is Hartlebury Common in the West Midlands where the decline does not occur until *c*. 2,610±70 uncal BP which calibrates to 918-414 BC (2 sigma) with a pronounced probability peak at 800 cal BC (Brown 1984). Here is has been explained as an outlier caused by sandy soils which were of low fertility and probably of little agricultural value in the late Prehistoric period. The timing of both the peak in pine and its decline is well known to be highly diachronous across England. Several sites in East Anglia have relatively late declines including *c*. 5000 BP at Haddenham (Peglar 1993) and West Heath Spa London (Greig 1991) and lower values but distinct declines at Diss Mere at *c*. 1800 BP and *c*. 500 BP. There is, however, a problem with theses records as pine is well known to be widely distributed as a pollen type and values at *c*. 10-20 % can be interpreted as long-distance transport from the continent blown into a deforested environment. But the much higher values at Watermeade Way, Hartlebury Common and probably some East Anglian sites suggest the persistence of pockets of pine into the late Holocene. In most cases the late declines seem to be associated with locally favourable sandy or gravely soil conditions associated with low fertility, droughtyness and fire-prone. If this is the explanation at Watermeade Way then the pine must have been growing on the adjacent terrace surface.

Figure 2: The Pollen Diagrams from Monoliths 113 and 114 from Watermead



8. Conclusions and Implications

Monoliths from Section 9 at Watermeade Way have revealed a short but very unusual pollen record. Given the small size of the palaeochannel this is likely to reflect the local vegetation on the floodplain, terrace and slope edge. The combined diagrams cover the period from the Late Iron Age to the Medieval and show the decline and replacement of pine dominated woodland by grasses and cereal cultivation around AD 250-430. This is the latest decline in pine woodland yet known in England and at present can only be explained by a local favourable soil conditions adjacent to the pollen site. This has several implications;

1. Some small populations of pine may have survived in refugia through the Iron Age-into the Roman period.

2. Pine woodland seems to have been left standing from during the later Bronze Age and Iron Age when most woodland was cleared. There are of course several possible explanations for this ranging from it being a resource of some particular value to the no-value hypothesis.

3. The low but persistent post-deforestation levels of pine seen in many English pollen diagrams which is normally interpreted as of regional origin (including the continent) may also contain a component from small outliers of the once regional mid-Holocene pine forests.

The second unusual aspect is the differences revealed as the scale of cm between the two adjacent pollen spectra. This has two implications;

1. Even at the cm scale the location of a pollen core from a small water body such as a pond or oxbow lake can partially reflect the spatial pattern of vegetation surrounding the water body. This provides the possibility of 3D-4D pollen analysis but of very small areas.

2. Where the distance between the monoliths or cores is greater pollen correlation may not be an accurate way to chronologically relate sequences.

Watermead has therefore provided some unique data on the variation in vegetation in late Roman to Medieval Midland England and provided some valuable insights into the scale of vegetation reconstruction appropriate to small palaeochannel sites.

9. Acknowledgements

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10. References

Aaby, B. and Berglund, B. E. 1984. Characterisation of lake and peat deposits. In B. E. Berglund (Ed.) *Handbook of Holocene Palaeoecology and Palaeohydrology*, Wiley, Chichester, 231-246.

Bennett, K. D. 1994. *Annotated catalogue of pollen and pteridophyte spore types of the British Isles.* Department of Plant Sciences, University of Cambridge.

Bonk Ramsey, C. 1998. Probability and dating. *Radiocarbon* 40, 461-474.

Brown, A. G. 1984 The Flandrian vegetation history of Hartlebury Common Worcestershire. *Proc. Birmingham Natural History Soc.* 25, 89-98.

Brown, A. G. 1996. *Preliminary report on pollen samples from Wollaston, Northamptonshire.* Unpublished report to Northamptonshire Archaeology.

Brown, A. G. 1999. Characterising prehistoric lowland environments using local pollen assemblages. *Quaternary Proceedings* 7, 585-594.

Brown, A. G. 2000.Floodplain vegetation history: clearings as potential ritual spaces? In A. S. Fairbairn (Ed.) *Plants in Neolithic Britain and Beyond*, Neolithic Studies Group Seminar Paper 5, Oxbow Books, Oxford, 49-62.

Brown, A. G. in press. The environment. *Raunds Area Survey*, English Heritage/ Northamptonshire County Council.

Brown, A. G. in prep. *Final report on pollen samples from Wollaston, Northamptonshire*. Unpublished report to Northamptonshire Archaeology

Brown, A. G. and Hatton, J. 2002 *Pollen analysis and vegetation history of Narborough Bog, Leicestershire.* Unpub. Report for University of Leicester Archaeological Services.

Brown, A. G. and Meadows, I. 1997. Environmental analysis of a Neolithic/early Bronze Age palaeochannel of the river Nene at Turnells Mill Lane, Wellingborough, Northamptonshire. *Northamptonshire Archaeology* 27, 185-191.

Brown, A. G., Smith, A. and Elmhurst, O. 2002. The combined use of pollen and soil analyses in a search and subsequent murder investigation. *Journal of Forensic Sciences* 47, 614-618.

Buck, C. E., Cavanagh, W. G. and Litton, C. D. 1996. *Bayesian Approaches to Interpreting Archaeological Data.* Chichester, Wiley and Sons.

Courtney, P. 2003 Between two forests: the social and topographic development of Medieval Anstey. Trans. *Leicestershire Archaeological and Historical Society* 77, 35-81.

Day, S. P. 1991 Post-glacial vegetation history of the Oxford Region. *New Phytologist* 119, 445-470.

Fox, L. and Russell, P. 1948 *Leicester Forest.* Leicester.

Greig, J. 1991 From lime forest to heathland – five thousand years of change at West Heath Spa, Hampstead as shown by the plant remains. In D. Collins and D. Lorimer (Eds.) Excavations at the Mesolithic Site on West Heath, Hampstead 1876-1981. British Archaeological Reports (British Series) 217, 89-99.

Greig, J. 1996. Great Britain - England. In B. E. Berglund, H. J. B. Birks and M. Ralska-Jasiewiczova and H. E. Wright (Eds.) *Palaeoecological Events During the Last 15,000 Years: Regional Syntheses of palaeoecological Studies of Lakes and Mires in Europe*. Wiley, Chichester, 15-76.

Horrocks, M. and Walsh, K. A. J. 1999. Fine resolution of pollen patterns in limited space: differentiating a crime scene and alibi scene seven meters apart. *J. Forensic Science* 44, 417-420.

Moore, P. D., Webb, J. A. and Collinson, M. E. 1991. *Pollen Analysis* (2nd edition). Blackwell, London.

Peglar, S. M. 1993 The development of the cultural landscape around Diss Mere, Norfolk, UK during the last 7000 years. *Review of Palaeobotany and Palynology* 76, 1-47.

Squires, A. E. 1981 History of the Charnwood Forest Landscape. In J. Crocker (Ed.) *Charnwood Forest: a changing Landscape.* Loughborough, 20-159.

Stace, C. 1991. *New Flora of the British Isles.* Cambridge University Press, Cambridge.

Stuiver, M., Reimer, P. J., Bard, E., Beck, J. W., Burr, G. S., Hughen, K. A.., Kromer, B., McCormac, G., van der Plicht, J. and Spurk, M. 1998. INTCAL98 Radiocarbon age calibration, 24,000-0 cal BP. *Radiocarbon* 40, 1041-1083.