Chapter 5: Chronostratigraphy

5.1 Original chronostratigraphic model

The chronostratigraphic model proposed in Phase I was produced based upon a number of criteria including distance from the modern channels, relative altitude, geomorphological position and correlation with adjacent area, particularly Hemington Fields. As was noted in the Phase 1 report "The key question of archaeological significance is the depth of the Holocene sand and gravel and whether it overlies Devensian gravels. The fundamental problem is that the Devensian and Holocene gravels are very similar in grain size, clast lithology, shape and even fabric due to the derivation of the later from the former. This means that it is rarely possible to differentiate them from borehole records. It is, however, possible to differentiate between the two from quarry faces due to the presence of archaeology, different coloration (due to Fe staining) and sometimes a different sedimentary structure. From the observations at Hemington it is hypothesized that the Devensian gravels underlie all the later phases of floodplain sedimentation with the exceptions of areas of scour near the present channel". Despite these uncertainties the model was used for the sampling of the palaeochannels for both the analytical studies and the OSL and radiocarbon dating programmes.

The palaeochannels segment the area into a series of levels:

High	38.7m OD
Middle	34.0m OD
Low	28.2m OD

It is apparent from flood photography (Brown *et al*., 2005) that high magnitude floods within the contemporary flood frequency-magnitude distribution can inundate both the lower and middle levels, but not the high surfaces. The high level is also seen to correlate to the south and southwest with the large area of Beeston terrace as mapped by the BGS. However, both the LiDAR and GPR show broad shallow channels excavated into the surface of the terraces and by analogy elsewhere (Fyfe *et al*. 2004) these are most likely channels formed during the final stages of gravel deposition during the Lateglacial. There are, however, in this reach some deeper narrower channels, which bisect the terraces and have been shown to be of early to mid Holocene age (Brown *et al.* in press). The middle level is characterised by gravel overlain by a variable thickness of overbank sandy silts and clays. It correlates with similar floodplain parcels to the east including meander cores at Hemington. It also has later Prehistoric and Roman archaeology on its surface. It is bisected and eroded into by the southerly of the two major palaeo-Trent meander loops traversing the target area. The complex form of this palaeochannel is its significant depth of sediment and its truncation of later Roman channels, all indicating a late prehistoric age. The series of scroll bars on its inner (northerly) floodplain suggest that over time it moved in a southwesterly direction and on this basis the meander core is also ascribed to the late Prehistoric period. This palaeochannel and floodplain is truncated by the large partially water-filled Trent palaeochannel. There are many similarities in altitude, form and location between this channel and the medieval channels associated with the Old Trent at Hemington. The width of the meander belt and its sinuosity are similar to the Sawley palaeochannel that is of Roman-6th Century age, but a correlation cannot be proven. Closer to the channel there are a number of old channels sub-parallel to the modern Trent. In some cases the connections are only severed by an artificial levee. This zone also contains engineered river sections and channels such as the Sawley Cut and straightened sections of the Soar.

The comparison between the chronostratigraphic model and the model based upon all the dating evidence is discussed in Section 9.1.

5.2 Radiocarbon dating of palaeochannels

For full details of all the individual ^{14}C dates see Appendix A. A spectrum of palaeochannels of varied age were selected for radiocarbon dating as described in Section 3.2. These have been plotted spatially (Fig. 5.1).

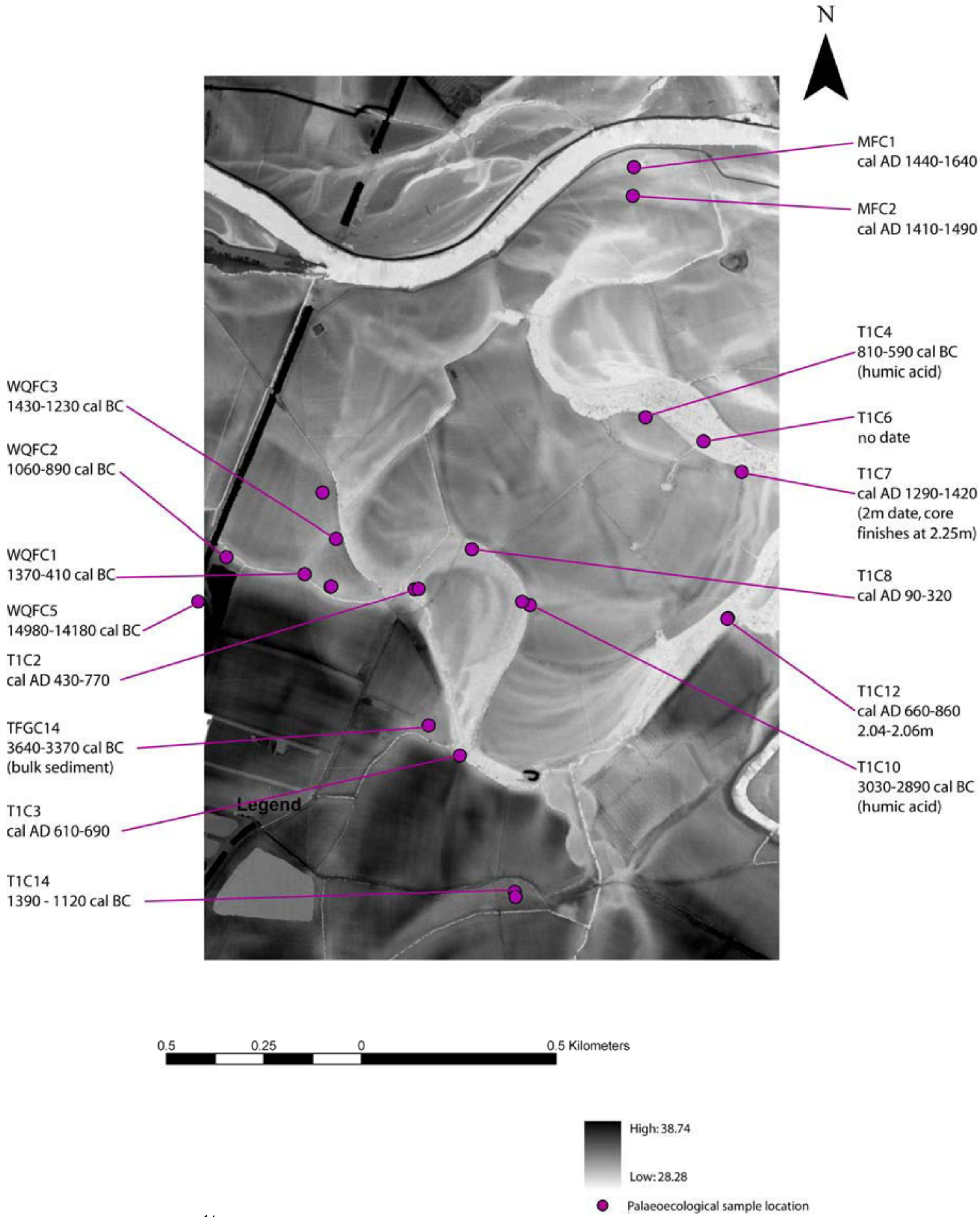

Fig. 5.1: The ^{14}C dates plotted at core/sample locations.

As can be seen from the dates there is a general tendency for the dates to be younger to the northeast of the target area with the oldest (Prehistoric) dates clustered at the southern end of the area. However, there are outliers and several of the cores from adjacent palaeochannels have significantly different basal dates (e.g. T1C4 and T1C7). This suggests that there has been re-occupation of channels by main channel water flow during the Post Roman and medieval period and that the sequence may not be as simple as had at first been envisaged (see Phase I). The general tendency is also for the dates to increase in age with increasing height OD (Fig. 5.2).

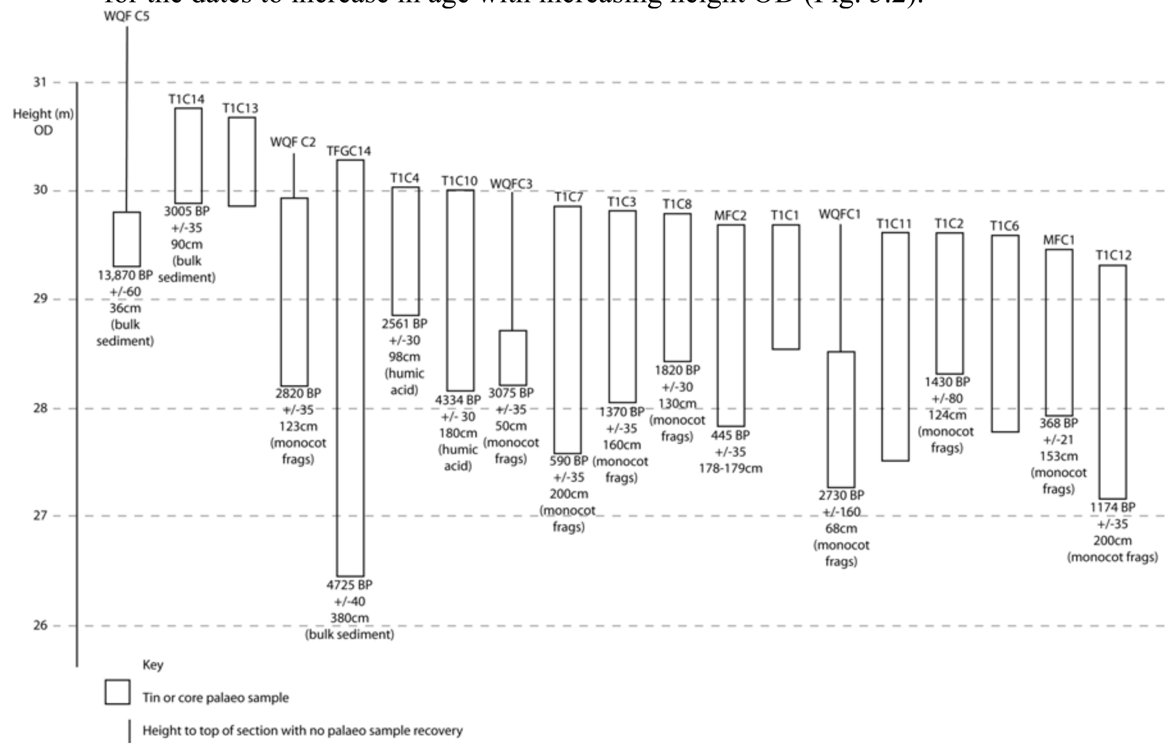

Fig 5.2: A plot of the cores with basal dates against surface height OD.

Figure 5.2 clearly shows that all the dates except one that are older than 2,500 BP occurred from sequences with surface heights of over 30 m OD. This is supportive of the notion that there was a major phase of incision in later Prehistory probably in the Late Bronze or early Iron Age.

5.3 OSL dating of intervening valley floor

The full OSL dating report is given as Appendix A. The OSL dates have been plotted at sample locations (Fig. 5.3). There is again a distinctive spatial pattern with a southeast-northwest age gradient. Here the oldest dates clustering on the southern terrace or around the most south eastern meander loop. There are, however, exceptions and most notably GEO25, which is in a meander core. This date and GEO18 suggest that the meander cores pre-date the sediments at the base of their defining palaeochannels. This is typical of the re-occupation of meanders by later channel avulsions, which leave the old meander cores as un-eroded islands in the floodplain. The OSL dates have also been plotted against surface height OD (Fig. 5.4).

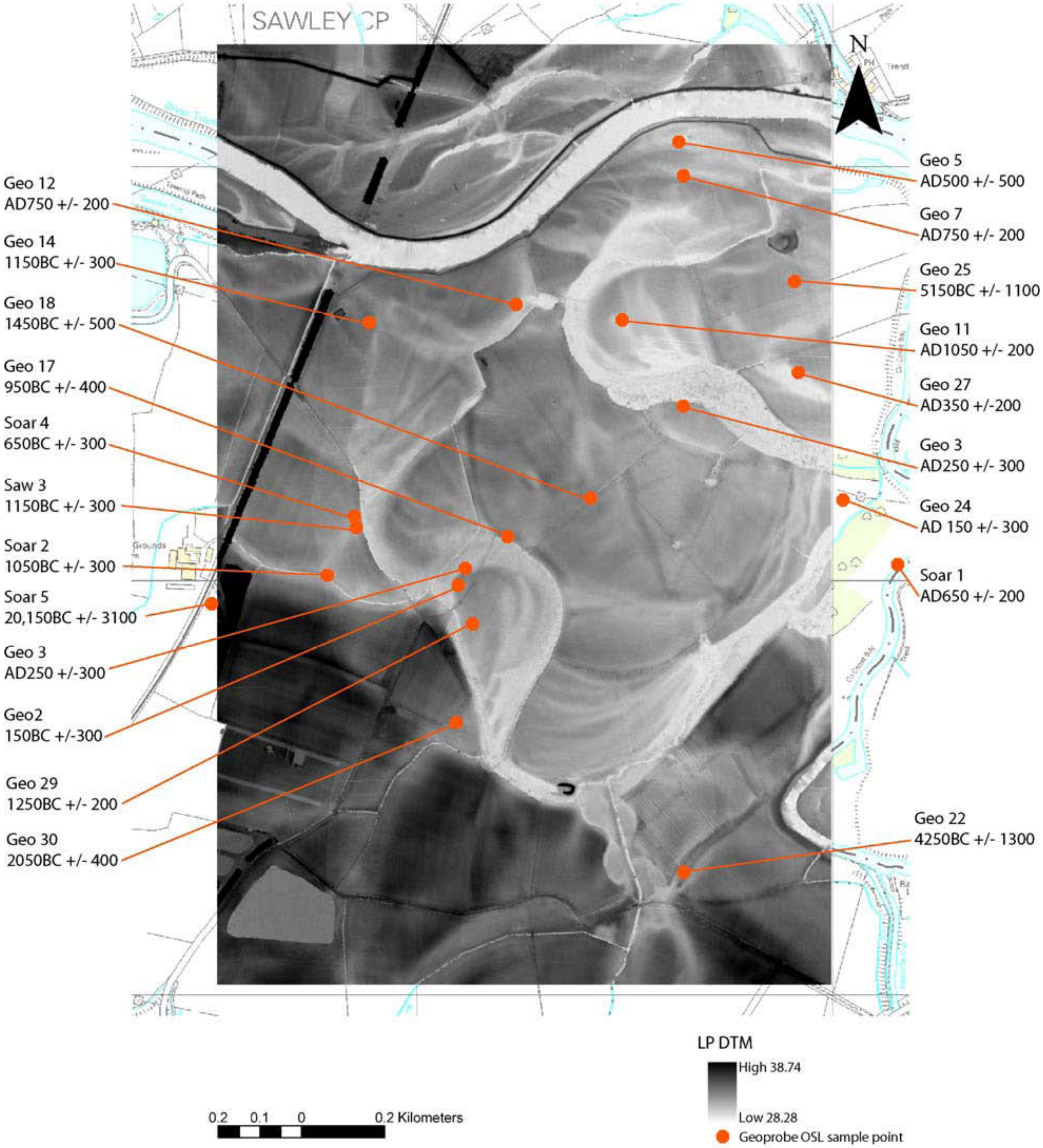

Fig 5.3: The OSL dates plotted at sample locations.

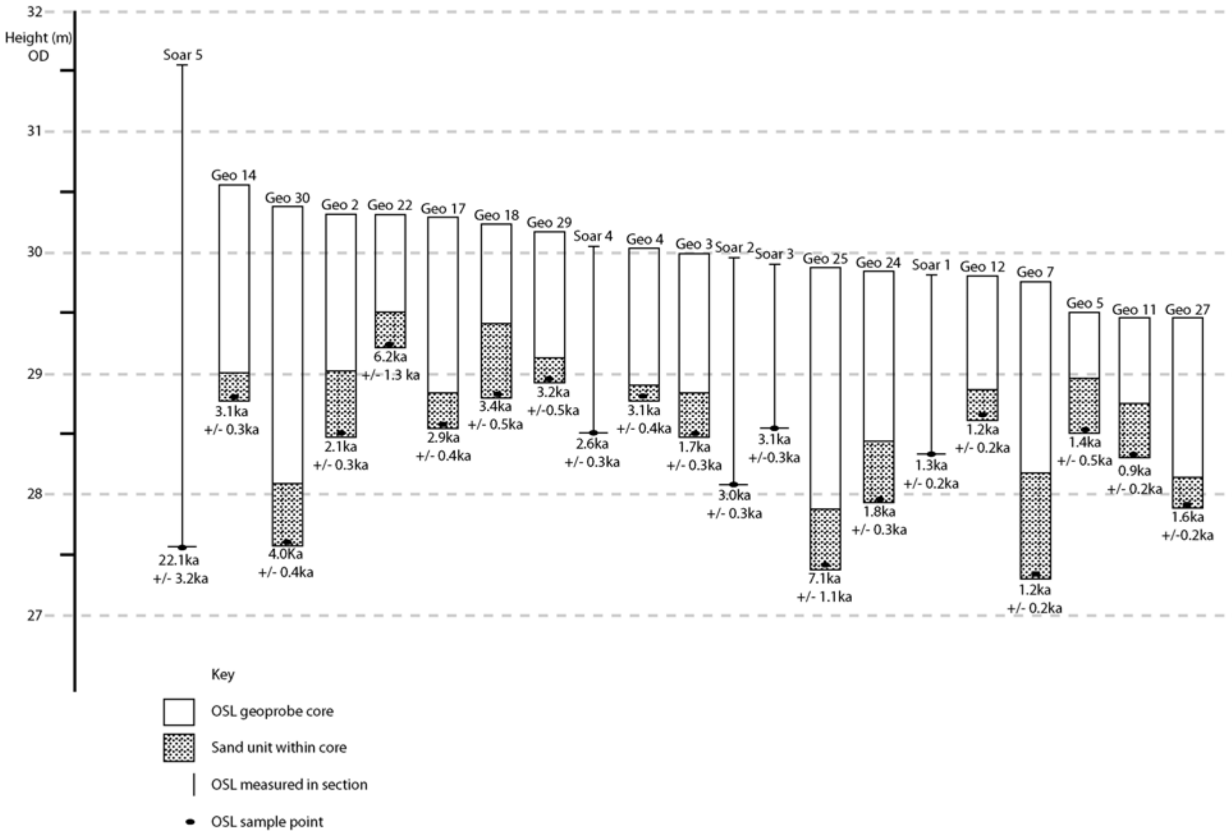

Fig 5.4: The OSL dates plotted by height.

Figure 5.4 also shows the pattern, but is less clear than for the ^{14}C dates. This is because the OSL samples come from a wider variety of geomorphological positions and not just channel fills. Several are from overbank sands sitting on gravels at the edge of channels or in meander cores. The result is an alternation of young and old dates at a variety of heights OD. This also suggests a complex model of overbank sedimentation, channel infilling, channel abandonment and re-occupation and further overbank sedimentation. In theory overbank sedimentation onto gravels could be out of phase with the channel infilling as this occurs principally when the channel has avulsed to another location. Analysis is underway to test this possibility.

5.4 Dendrochronological dating of trees

The discovery of large tree trunks and other timbers in the Warren Farm Quarry during stratigraphic investigations offered the opportunity for sampling for dendrochronological dating. In all 8 trunks all of oak (*Quercus* sp.) were sampled by Dr R. Howard and taken to the Dendrochronology Laboratory at the University of Nottingham. The trees were interbedded within the sands and gravels, which on the basis of both geological geomorphological field mapping and analysis of LiDAR were assumed to be part of T1 (Hemington Terrace), aggraded during the mid Holocene. The main group of trunks were found in the middle of the quarry (Fig. 5.5) and although it is likely that all the tree trunks had been moved slightly during mineral extraction, it appears from the available evidence that the majority were originally within 1-2 m of the Mercia Mudstone rockhead. All the recorded trunks had intact root boles and none showed evidence for anthropogenic modification (e.g. tool marks), which suggests that they were incorporated into the channel through natural processes of river bank erosion and tree throw on the floodplain. None of the sampled trunks were more than 50m apart.

Fig 5.5: Photograph of the tree trunks from Warren Farm Quarry that were dendrochronologically dated.

Sample number	Total rings	*Sapwood rings	First measured ring date	Last heartwood ring date	Last measured ring date
LOK-Q01 84		h/s?	------	------	------
LOK-Q02	202	h/s?	2871 BC	2670 BC	2670 BC
LOK-Q03	165	h/s?	2818 BC	2654 BC	2654 BC
LOK-Q04	102	h/s?	2790 BC	2689 BC	2689 BC
LOK-Q05	188	h/s?	2883 BC	2696 BC	2696 BC
LOK-Q06	105	h/s?	2623 BC	2519 BC	2519 BC
LOK-Q07	107	h/s?	2735 BC	2629 BC	2629 BC
LOK-Q08	118	no h/s	2928 BC	------	2811 BC
h/s? = the last ring on the sample is at or approaching the heartwood/sapwood boundary					

Tab 5.1: Details of samples from Warren Farm Quarry on the river Trent in Leicestershire.

Dendrochronological analysis indicated a high degree of cross matching of 6 of the samples. Combined, they provide a 300 year site chronology very firmly dated between 2928BC and 2629BC (Tabs. 5.1 and 5.2). In contrast, sample 1 does not date at all and suggests that it may either be of an entirely different date for which there is no reference material; however, it may be possible to date this material in the future as more reference samples become available. Sample 6 does not cross-match with this main group of six samples, but does date independently with a last ring date of 2519BC (Tabs: 5.2 and 5.3).

Reference chronology	Span of chronology	*t*-value	Reference
England National	***4989 - 1681 BC***	12.5	(Hillam pers comm)
Shardlow Quarry, Derbys.	2942 - 2610 BC	10.9	(Tyers 2000)
East Anglia: regional	3196 - 1681 BC	9.5	(Brown pers comm)
Langford Quarry, Notts.	2979 - 2125 BC	7.9	(Hillam unpubl)
Colwick Hall 1	3054 - 2697 BC	6.7	(Brown pers comm)
Stourport on Severn, Worcs.	2869 - 2698 BC	6.5	(Hillam pers comm)

Tab 5.2: Results of the cross-matching of site chronology LOKQS Q01 and relevant reference chronologies when first ring date is 2928 BC and last ring date is 2629 BC.

The secure chronology from Warren Farm Quarry, Lockington, suggests active sand and gravel deposition of Terrace 1 sediments during the mid-late Neolithic period. This timescale of deposition accords well with other dendrochronological analyses undertaken regionally including those at Hemington (Salisbury pers com.), Shardlow Quarry, less the 5km upstream (Garton *et al*., 2001) and downstream at Colwick (15km downstream; Salisbury *et al*. 1984) and Langford (30 km downstream; Howard *et al*., 1999).

Reference chronology	Span of chronology	*t*-value	Reference
Wootton Quarry, Isle of Wight	3463 - 2557 BC	6.0	(Hillam 1994)
England National	***4989 - 1681 BC***	5.8	(Hillam pers comm)
East Anglia: regional	3196 - 1681 BC	5.0	(Brown pers comm)
Langford Quarry, Notts.	2979 - 2125 BC	5.4	(Hillam unpubl)

Tab 5.3: Results of the cross-matching of sample LOK-Q06 and relevant reference chronologies when first ring date is 2623 BC and last ring date is 22519 BC.

The dendrochronological analyses also agree well with the OSL and radiocarbon chronologies developed for the study area. For example organic rich channels incised into the sands and gravels in the quarry have yielded Bronze Age ^{14}C dates (e.g. WQFC1; WQFC2; WQFC3). OSL dating of supra-bar sand exposed within the quarry have also yielded age estimates of between 1050 BC ± 300 (Soar 2) and 650 BC ± 300 (Soar 4).

5.5 Summary

The core analyses, the OSL and ^{14}C dating all show that the area has a complex set of deposits of a variety of ages but with spatial patterning. Both the distribution of dates and the complexity of some of the core sequences suggest that this may have been caused by the re-occupation of palaeochannels and complex avulsions rather than a simple migratory pattern. This spatial patterning is described in chapter 9.