TERRA NOVA

The Geoarchaeology of Deposits at Ripple, Tewkesbury

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Summary

A geoarchaeological study was carried out at to evaluate deposits from a site at Ripple nr Tewkesbury. Soils are typical alluvial gleys of the Hollington series above a fluvioglacial sand and gravel surface. The deposits were analysed to gain a better understanding of the processes involved in their depositional and post-depositional history in order to assess the potential for further analysis.

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Aims

This project aimed to evaluate the geoarchaeology of a site adjacent to the River Severn at Ripple in order to clarify the origins of the deposits and help assess the archaeological potential of the site.

Certain questions were raised during the excavation:

1. Why is there so much less alluvium in the area of trenches 3 and 4 than there is in the area of trenches 5 and 6?

2. Why are the features in trenches 2 and 4 so poorly defined when they produce such strong cropmarks?

3. In trench 5 what general trends in alluviation, stasis and post-depositional change can be identified from the various records (particularly those of the sondage)?

4. How might those general trends in trench 5 have affected the survival of man-made features? For example, the definition and depth of pit 547 suggests that it has survived intact, but pits 516/540 and 538 are much shallower and more poorly defined, suggesting a considerable loss of upper stratigraphy.

5. For trench 6 what can the records and the monoliths combined tell about the context in which the two parallel ditches (621 and 632) were excavated, re-cut and finally filled?

6. What caused the banking up of alluvium visible in the northern part of the section in trench 6? Is this related to a channel flowing along the tree-line to the east (former osier beds)?

7. To make a general assessment of the potential of the site for further work.

Scope of Report

This report is the result of a single day visit to examine sections and to collect samples for laboratory study. The site records are necessarily brief and only a small amount of preliminary analysis has been carried out in the laboratory in order to identify the potential of the deposits and construct a provisional geoarchaeological interpretation. The deposits have shown some potential to reveal more detail, a potential that has not been met in this limited investigation which has resulted only in an outline description and analysis of the deposits. This report identifies the need for further work and suggests methods of analysis which will be of value in interpreting this site.

Background

Location

The site is situated at NGR SO 868370, adjacent to the M50 to the southwest of the village of Ripple.

Geology

The British Geological Survey "*South solid 1:625,000*" and "*Tewksbury sheet 216 solid and drift edition 1:50,000 series*" show the bedrock to consist of Triassic mudstones overlain by alluvium.

Topography

The site lies on an area of flat land to the east of the River Severn at about 10m above OD.

Land Use

The site is at present in area of farmland and used for the growing of arable crops.

Soils

The site is mapped by the Soil survey of England and Wales, "*sheet 3 Midland and Western England* 1:250,000" map as lying on typical alluvial gley soils of the Hollington series.

Hydrogeology and Hydrology

The site lies on the floodplain of the River Severn where it is regularly inundated. Pedological evidence for persistent waterlogging has been found by our investigations in the form of orange mottles which have formed as the result of redoximorphism. Further evidence of continuous waterlogging in deeper sediments has been found in the form of a blue grey colour to the sediments as a result of reduction.

Method

The site was examined from sections during a day visit and samples were taken by the site archaeologists for later analysis. These samples consisted of 4 monoliths collected in plastic guttering.

Monoliths 10, 11 and 12 form a continuous sequence taken through the centre of a ditch cut, its fill and the overlying alluvium up to the base of the subsoil, from an east facing section midway along trench 6. Monolith 10 at 75cm in length contains the lowest section of the sequence, monolith 11 at 100cm in length contains the middle section of the sequence and monolith 12 at 45 cm in length contains the uppermost part of the sequence. Monolith 23 was also taken through a ditch cut, its fill and the overlying alluvium to the base of context 606, from the east facing section at the southern end of trench 6.

The monoliths contained within the plastic guttering were allowed to dry slightly then cleaned with a sharp knife to provide smooth flat surfaces to enable closer inspection of finer detail not visible in the sections on site. Magnetic susceptibility readings were taken every 5cm up the sequence using a Bartington MS2 meter and type F field coil.

Observations

Examination of the sediments in the trenches showed them to be Devensian sands and gravels overlain by sandy and silty fluvial Holocene deposits. Magnetic susceptibility values were low and typical of natural Holocene alluvial deposits in this area. It was observed that in trenches 3 and 4 to the north of the site there was considerably less alluvium overlaying the natural gravels when compared to the depth of alluvium in trenches 5 and 6 in the south of the site. In some areas well preserved wood and other materials were found in waterlogged conditions that had prevented their decay.

In trench 3 there was about a metre of alluvium overlaying the natural gravels, the first 30 – 40 cm consisted of a grey-brown silty clay loam containing black manganese concretions and orange mottles indicating persistent water logging. Magnetic susceptibility readings varied between 4 – 18 SI. Above this the brown silty clay loam had a prismatic structure changing to blocky near the surface where the effect of ploughing was evident. Very fine roots were found and magnetic susceptibility readings were between 4 – 12 SI with the higher readings of 8 – 12 SI at the surface.

Ditch features were noticed at the base of trench 3 when it was excavated. The features were very poorly defined and difficult to see and it was very unclear as to the context from which the ditches may have originally been cut. These features were thought to relate to strong cropmarks on air photographs of the site.

In trench 4, as in trench 3, it was observed that there was about a metre of alluvium between the gravels and the topsoil. The first 60 cm were light grey in colour and silty clay loam in texture containing occasional very fine roots and dark organic patches. Manganese oxihydroxide concretions were observed together with orange mottles indicating persistent waterlogging. Magnetic susceptibility readings taken in the field measuring 7 – 8 SI were consistent with natural background readings. Towards the top of this unit a thin moderately well sorted gravel layer was observed. This was not an extensive feature and appeared to cover the area of a shallow depression. It was suggested on site that this may well have been deliberately deposited. There were no apparent artefacts within this layer and magnetic susceptibility readings were 9 – 12 SI at the top of the layer. The upper 40cm consisted of a light brown silty clay loam with a blocky structure with the effect of ploughing evident down to 30cm from the surface. Magnetic susceptibility readings were between 7 – 10 SI.

For the sediments in trench 5, analysis was only possible by examination of the records and photos taken by the archaeologists as it was not possible to examine the trench on the day of the visit. This has limited the conclusions that may be drawn regarding the processes involved during and after deposition of the alluvium. From these records it appears that trench 5, which is located at the southern end of the site, has about 2m of alluvium overlying the gravels while the trenches in the northern part of the site have only about 1m overlying the gravels.

From a sondage in the eastern end of trench 5 a drawing was made of an east-northeast facing section in which the excavators have identified 2m of alluvial silty clays. The lower third was a silty clay with gravel at the base. Colour was mainly orange-brown with evidence of mottling with manganese flecks and concretions. Roots were described as frequent and the sediment appeared to be well sorted with no stones. The middle third was heavily orange mottled and grey in colour, described as having occasional manganese flecks and frequent well sorted organic remains. The upper third consisted of a light brownish-red turning to light bluish-grey coarse silty clay.

There was evidence of reduction and mottling, and organic remains were recorded as frequent and well sorted but poorly preserved. Further examination by the excavators has shown that the poor preservation had significantly reduced the potential for palaeoenvironmental analysis. The upper 30cm consisted of the subsoil and topsoil. All horizons were very diffuse and pedogenesis was evident throughout the profile.

Various man-made features were observed within trench 5. Pit 547 the base of which was recorded at a depth of 7.79 OD was described as well defined and contained a well preserved piece of wood. Whereas pits 516, 540 and 538 were described as shallower and much less well defined. A sample of the wood found within trench 5 (WK-14296) was dated to 2410 – 2130 cal B.C. The depth of the pit compared to its width suggests that this is the result of human activity rather than a naturally formed depression.

The strong variations in colour in the sondage section appear to be the result of changes in the colour of the alluvium being deposited across the valley onto which have been superimposed the effects of subsequent reduction and oxidation. Two grey, reduced bands stand out and may represent strata in which organic matter has accumulated – either by redeposition or by in-situ pedogenesis and plant growth – providing an organic substrate for reducing biota to act on the deposit. If this is the case then the section tells us that there have been phases of organic accumulation, probably under wetter conditions or periods of slower accumulation, and of organic decay, under drier but not fully aerobic conditions, for which evidence is now only available as these secondary indications. Further study is likely to clarify the sequence of events which these strata represent. The presence of mineral stratification derived from changing parent sources is not surprising since this has been previously recorded and discussed for the Severn valley. The clarity of the change, however, indicates that further study may provide evidence of the way in which the valley has evolved.

Trench 6 situated at the southern end of the site consisted of gravels overlain by around 2m of alluvial silts and clays. Four monoliths were taken from this trench, monoliths 10, 11 and 12 contained a continuous sequence through the northernmost ditch of two parallel ditches that appear to run from roughly east to west. Monolith 23 was taken through the southern ditch.

Monoliths 10 – 12 were taken through a sequence of deposits at about 9m OD starting with fluvial glacial sands and gravels passing through an archaeological ditch which appeared to have been re-cut sometime in antiquity then the overlying alluvial sediments. Above the natural gravels there was 15cm of a red loamy sand containing sub-angular stones with a diffuse upper boundary. The 130 cm above this were a mid brown silty clay loam with patches of sandy clay loam.

It was difficult to discern the boundaries between the ditch fills and the overlying alluvial sediments. Fine root pores could be seen throughout along with dark patches of concretions and occasional pale yellow sandy concretions. Deposits immediately above this were heavily mottled by hydrated iron oxihydroxide representing reduction and oxidation due to persistent waterlogging within the profile. This suggests that the water table has remained high throughout these deposits since they were laid down, but not to the extent that worm action and rooting hasn’t been able to take place. The 20cm above this were heavily flecked with manganese and contained fine root pores. The upper 35cm of monoliths 10 – 12 were also a mid brown silty clay loam containing fine root pores, manganese concretions together with dark and orange mottled patches. Pedogenesis was evident and fissures could be observed from prismatic structure.

The deposits of the ditch fill appear poorly sorted Magnetic susceptibility readings for all three monoliths ranged between 5 – 10 SI and are consistent with natural background values. There was little evidence of archaeological artefacts with just the occasional small piece of charcoal.

Monolith 23 taken through the southern ditch and throughout its 95cm length consisted of a silt clay loam occasionally becoming slightly sandier and red brown in colour. The sediment contained occasional stones varying from sub-angular to round and was poorly sorted indicating that the fill was the result of dumping or slumping rather than deposition within moving water. Flecks of manganese and darker patches of concretions were evident throughout the monolith indicating prolonged waterlogging. Disturbance by later rooting and possible faunal pores would have further destroyed any boundaries between layers such as the ditch fills and the overlying alluvial sediments. Magnetic susceptibility readings were between 6 and 13 SI and were consistent with normal background values.

Discussion

The site is a complicated palimpsest of features both natural and archaeological above a fluvioglacial sand and gravel surface. The deposits broadly indicate that at the close of the Devensian fluvioglacial deposition was followed by fine mineral alluviation in the valley bottom through the Holocene. The deposition of these alluvial sediments would have gradually filled depressions within the undulating gravel surface. As flood waters rose and covered the valley bottom, depressions within the gravel surface would have inundated to greater depths by water containing a greater amount of suspended sediment. A greater depth of alluvial deposition would then have occurred over these depressions compared to higher areas of the fluvioglacial surface, eventually resulting in a flatter floodplain.

The sediments are characterised by mottling and the effects of chemical reduction indicating prolonged waterlogging, but not to the extent that pedogenesis, worm and root action have been completely excluded, especially from the surface soils which will have remained drier than the deposits below through the drier months of each year.

The deposits within the ditches were poorly sorted and heavily disturbed by rooting and soil biota. These ditches are therefore likely to have been filled by dumping and slumping rather than by deposition by stream flow.

The excavation found that there appears to be less alluvium over the gravels in the north than the south of the site and observations made during the excavation suggested that this is because the gravel surface rises from south to north. The existing borehole records for the site show, however, that this rise is complicated by more local undulations, including some significant depressions. This is important in our interpretation of the archaeological evidence and the planning of future research since the form of the underlying fluvioglacial surface will probably be reflected in the nature of the evolving Holocene surface above and, therefore, in the ways in which that surface determined the mosaic of environments across the valley and resources for past societies to exploit.

The features observed in excavation in trenches 3 and 4 in the north were poorly defined and difficult to discern and yet according to the archaeologists had produced strong cropmarks. The upper parts of the cuts of the features have been heavily disturbed by worm and root action and other soil formation processes, especially lessivage (the downwards movement of fine matter in suspension). The fills are difficult to distinguish from the sediments into which the ditch was cut. Both the ditch fills and the surrounding sediments show evidence of mottling by hydrated iron oxihydroxide representing reduction and oxidation due to persistent waterlogging within the profile. Although similar in appearance, the nature of the ditch fills are different enough from the surrounding sediments into which the ditches are cut to affect the growth of crops above. The lower fills, in particular, are of different textures to their surroundings and are likely to have affected the ability of plant roots to extract water from the soil in different ways, leading to variations in growth and maturation.

There is no evidence to suggest that there was any extended periods of stasis, represented by palaeosol surfaces, between periods of alluvial deposition, and there were no increased readings of magnetic susceptibility to suggest a buried surface. However throughout the profile the rate of alluviation was slow enough to allow root and soil organisms to mix the upper profile and thus destroy any fine alluvial stratigraphy deposited in floods. The excavators recorded the presence of organic remains, which proved, on further analysis to be poorly preserved. The presence of redoximorphism show that there was prolonged waterlogging within the profile.

In trench 5 the post-depositional processes mentioned above have caused the loss of definition to the shallower features whereas deeper features such as pit 547 are far less susceptible to those processes, because waterlogging has been more persistent, and features have therefore survived in a better state of preservation. The piece of wood found in the base of pit 547 has been dated to 2410 – 2130 cal B.C. which places it within the late Neolithic to Beaker period.

The two parallel ditches exposed in trench 6 are both cut into and have an upcast deposit on the underlying gravels. Layers identified on site suggest that the ditches have been re-cut at least once in antiquity with the last cut removing all evidence of previous fills. Both ditches are then subsequently overlain by alluvial sediments which, it has been suggested, had been banked up towards the southern end of trench 6. Our observations on site, however, suggest that this accumulation is natural, rather than anthropogenic and, although the evidence is weak, it appears to relate to flooding from the main river channel rather from subsidiary drainage. Further studies of the mineral suites may, however, resolve this question.

Conclusions

The site consists of mainly fine-grained alluvia, derived from the diverse geology of the Severn catchment upstream and deposited in flood over a fluvioglacial surface rising – with undulations – from north to south and eastwards, inland from the river.

These deposits have been variously altered by human activity and further altered by lessivage and redoximorphism under persistently wet conditions. The alluvia have been well mixed throughout by soil forming processes, indicating that flood episodes were not able to bury any incipient palaeosols under new alluvium, beyond the reach of surface soil processes. This implies that, while deposition may have been episodic, the episodes were not extremely rare events, each contributing a high proportion of the alluvial accumulation. Instead it seems more likely that even the deepest alluvial accumulations reached no more than a few centimetres since subsequent pedogenesis has been able to entirely destroy any sedimentary structure.

Some depositional evidence does, however, survive as broad changes in the particle-size distribution and variations in mottling which may reflect brief palaeosol development. Further study of the deposits may therefore tell us more both about the source of the sediment – and thus the history of erosion upstream – and the processes by which the alluvia were deposited.

Such evidence will not, however, be precisely dateable because of the degree of pedogenetic mixing and the loss of precise stratigraphic associations between the archaeological features and their sedimentary context.

It is likely that the loss of this stratigraphic detail, through redoximorphic colouring and lessivage will be common to the whole site although micromorphological study of the feature fills and their surrounding deposits may identify variations which survive and which may therefore be used to trace boundaries even where they are not immediately visible.

Some evidence of the sedimentary history of the valley floor appears to survive as buried terrace surfaces, which complement those exposed. Thus a broader and fuller study of the whole sedimentary profile across and along the valley may provide crucial evidence of the Holocene valley evolution to parallel those of the Trent, Thames and other major river systems across the country, allowing us to put the archaeological history of the site into its wider landscape context.

This might, most efficiently be carried out by a combination of a broad electromagnetic conductivity survey and electrical resistance tomography, to map the changing bedrock depth and palaeochannels, followed by a carefully targeted survey in which intact cores are recovered for laboratory recording and palaeoenvironmental analysis. These data can then be combined to provide a detailed three-dimensional computer model of the deposits over a wide area which can then guide excavation.

The depth of the alluvium and the lack of magnetic susceptibility contrast between the fills and alluvial contexts of the archaeological features encountered at this site explain why the magnetometer survey was ineffective. These same factors mean that it is similarly unlikely that more sensitive magnetometers or other instruments will produce better results (since textural and electrical contrasts are likely to be similarly lacking) and there may be no way for geophysics to successfully map the buried features themselves.

Very detailed electrical resistance tomographic survey might detect the very largest features but this is only likely where they penetrate the underlying fluvioglacial deposits which have very different hydrological and physical characteristics to the alluvia above.

Further Study

It is unlikely that we will be able to recreate a very detailed stratigraphic history of the site because of the destructive effects of redoximorphism, bioturbation and lessivage. Further geoarchaeological survey and study are likely, however, to be worthwhile because there is evidence in the broad and detailed structure of the deposits which represents the general history of alluvium sources, deposition and post-depositional change.

We recommend, in particular, that a combined geophysical and coring survey be used to create a 3-Dimensional stratigraphic model over a wider area, in order to guide future, more specific investigations, and that a combination of textural, micromorphological and mineral analyses be used to investigate the fine structure of the deposits and their mineral constituents.

A Note on the Identification of Environmental Evidence: This report is the result of a geoarchaeological study of the mineral and organic deposits and soils. In the course of examining the deposits pollen, diatoms, and other forms of environmental evidence are occasionally found and recorded. However, the samples have not been prepared specifically for the recovery of these materials and no attempt at species identification has been made. This report is not intended to be, and should not be used as, a substitute for full pollen, diatom and other environmental assessments made by suitably qualified specialists. The aim of this report is rather to comment on the nature of the deposits themselves and as contexts for the survival of archaeological and environmental information, to provide relevant information to the other specialists.

Appendix 1: The Meaning of Magnetic Susceptibility

Magnetic susceptibility (χ) is a measure of the degree to which a material will become magnetised in the presence of an external magnetic field. The magnetic susceptibility of many natural soils increases slightly towards the surface. This is the Le Borgne effect (Le Borgne, 1955) and is probably caused by slight changes in magnetic mineralogy caused by the greater availability of oxygen at the surface.

Burnt soil material, domestic debris and ceramics typically have high magnetic susceptibilities. Ferrous metals have susceptibilities which are even higher. The degree to which an archaeological or natural deposit is contaminated with these materials can be determined by measuring its susceptibility, either in the field, using a small, portable detector, or under more controlled conditions in the laboratory.

Laboratory instruments also allow us to calculate the frequency dependence (fd) of the susceptibility. This is a measure of the percentage difference between the susceptibility of a sample to magnetic fields which are alternated at two different frequencies, 0.465 and 4.65 KHz – known as low frequency (lf) and high frequency (hf). respectively. Samples containing magnetic minerals of different types show different χ_{fd} values – although the interpretation of these differences is, as yet, a matter of debate. It is thought that very fine magnetic particles, derived from burning and soil formation, alter the magnetic susceptibility of samples in a way which alters with the frequency of the inducing field.

Simple studies of the relationship between particle size, particle type and susceptibility can often help us to understand how the magnetic properties of archaeological deposits arise. Such studies are easily achieved during excavation projects and may prove a valuable part of future excavation practice, especially on urban sites.

The use of magnetic susceptibility measurements is discussed in Walden, J., Oldfield, F., and Smith, J. (1999) *Environmental magnetism: a practical guide*. Quaternary Research Association, technical guide no. 6, London, pp.243.

Le Borgne, E. (1955) *Susceptibilite magnetique anormale du sol superficial.* Annales de Geophysique, **11**, 399-4