Case study 33: Calcareous features from the excavations at Godmanchester, Cambridgeshire

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Introduction

Neolithic/Bronze Age enclosures of ritual significance and a large Romano-British agricultural estate contained unusual features with concentrations of calcium carbonate. These could not be explained on a gravel-based site and geoarchaeological investigation was needed to determine whether they are of an archaeological or natural origin.

The site consists of Pleistocene River gravels overlying Jurassic Oxford clay at around 3 to 5m depth. Modern alluvium forms a significant part of the topsoil. Oxford clay is highly calcareous and represents a potential source for calcium carbonate accretion under suitable hydrological conditions. Evidence that such conditions may have existed can be found in quarry-sections, where discontinuous calcium carbonate bands are occasionally found. These appear to be associated with distinctly fine sediment layers, but the true source of the carbonate (either contemporary with deposition or a subsequent hydrological effect) is not known.

The calcareous features found during the excavation include:

1. Calcareous subsoils – these were patches of calcium carbonate enriched subsoil found randomly over the site. They were discrete pockets, merging abruptly into normal coarse sandy soil at the edges.
2. Calcareous ditch fill – this feature consisted of a calcium carbonate enrichment found in a roughly elliptical patch in the central bottom half of a ring ditch fill. The feature was visible in all sections around approximately half of the ring ditch.
3. Calcareous layering – this was a single exposure of a series of calcareous bands, intercalculated down-profile with less calcareous material.

Methodology

Samples were taken of the calcareous subsoils, ditch fills and calcareous layering at the site (Figure 1). Samples were treated with hydrochloric acid to remove the carbonates; and subjected to particle size analysis by sieves and sedigraph. 125 to 63 μm fractions were retained for heavy mineral analysis. This involves extraction of the minerals heavier than tetrabromoethane (S.G. = 2.95) by centrifugation, and their identification by optical microscopy.

Figure 1: Sampling the calcareous ditch fill.

Results

In the calcareous subsoils the acid treatment had little effect on the particle size make up presumably due to the presence of carbonate cemented pseudo-particles evenly spread along the size range (Figure 2). There was a considerably higher stone content in the soil surrounding the calcareous features. The calcareous subsoils had higher green amphibole and chlorite content, while the surrounding soil was richer in zircon and garnet.

The heavy mineralogical analyses of the calcareous ditch fill showed higher garnet values in the calcareous fill and adjacent soil. The mineralogical diversity could be part of the chance variation that occurs in a fluvial deposition sequence, due to the changes in sorting as flowspeeds vary. Thin sections showed the calcareous zone to be a dense matrix infill frequently showing amorphous calcium carbonate lining pores in the fabric. The transition from calcareous to non-calcareous matrix was very sharp, occurring over a distance of 1 to 2mm. Outside the calcareous zone the fabric had similar coarse components, but was characterised by fine layers or oriented clay lining channels and pores.

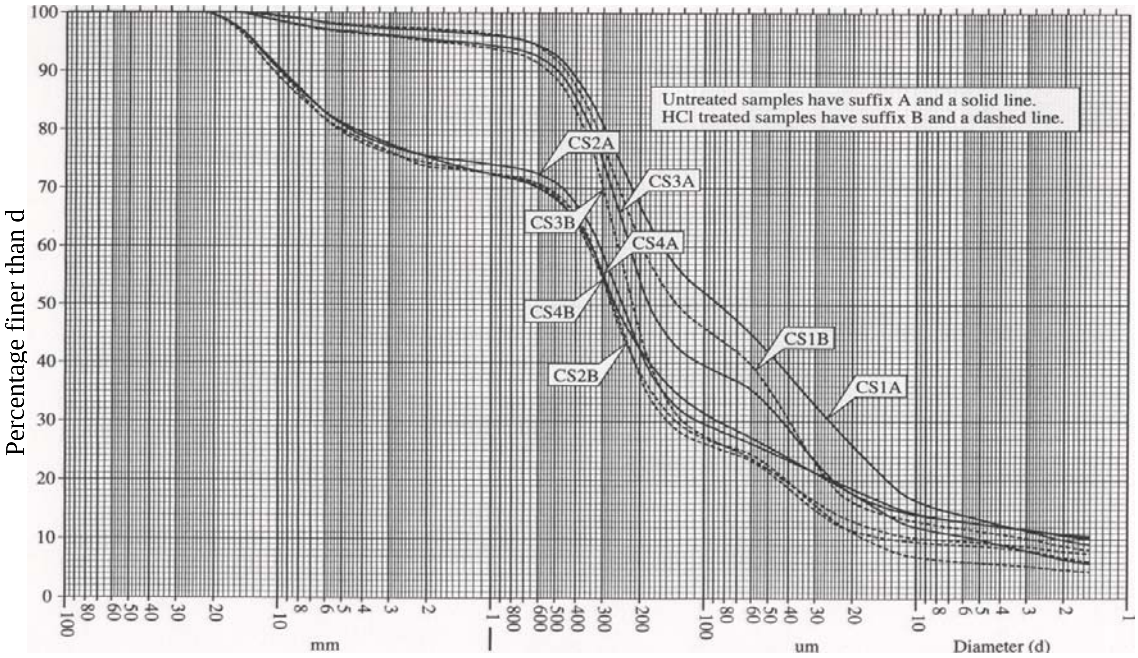

Figure 2: Particle size analysis from the calcareous subsoil.

The particle size analyses of the calcareous layering had a greater deal of calcareous sand, which dissolved out in acidification. The calcareous band samples have less stone and coarse sand, and resemble the calcareous subsoil samples. One had major sorting in the 100 to 20µm range. This makes it more typical of a modern river alluvium making it likely that the Pleistocene gravels have in some way been contaminated by the present river at this part of the site. The heavy mineralogical analyses showed garnet/zircon mineralogy in the non-calcareous samples. The calcareous bands contain much higher values of chlorite, clinozoisite, green amphiboles and tourmaline.

Discussion

The calcareous subsoil patches were probably from one depositional system though differences may be explained by:

1. The river gravels having slightly varied mineralogies associated with different size-grains. Post-depositional effects (e.g. ice-wedges) allowed a plug of fine sediment to penetrate the course surrounding gravel and this has subsequently acted as a channel for increased evaporation or a hydrological effect perhaps bringing up calcium from the Oxford clay below.
2. The mineralogical and particle size differences are the result of human activity, involving imported calcium carbonate (explaining their mineralogical variation) or imported sediment. In the latter case, the importation could only be from a local context.

The calcareous and non-calcareous parts of this ditch fill are of one origin. They are different from the surrounding soil because they have been transported a matter of metres from another river gravel stratum. The reason for the calcareous material occupying only a central zone of the ditch fill is problematic. If the red clay linings found in the slides represent the weathering product of the calcareous fabric, then it would be safe to assume that the current extent of the calcium carbonate infilling is less than at some time in the past. This would even imply that the whole ditch infill was at one time calcareous, and has been dissolving out ever since.

The calcareous layered area is clearly a man-made feature from its stratigraphy, and pits found nearby. This supports an industrial explanation but if this rationale was applied to the subsoil features, the implication would be that vast areas of the site had been contaminated with the waste. It is impossible to reconcile this view with the richness of the archaeology and the obviously natural examples of calcium carbonate concentrations that do exist.