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Assessment of soils and sediments from Birdoswald Spur, Birdoswald Roman fort, Cumbria (site code CAS 590)

by

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Summary

Geoarchaeological investigations were carried out on soils from excavations by CAS on a spur at the Birdoswald Roman Fort (Cumbria). The excavations were carried out to investigate the causes of, and possible mitigating measures for, the erosion of the spur, which threatened the archaeology of the area and, locally, the Vallum ditch. Another aim was to test for the presence of a buried soil within the Vallum ditch.

Pedological observations of the soils around the spur and within the Vallum ditch showed that some of the soils of the area were characterized by a surface water table able to destabilize the landsurface, and that no in-situ *buried landsurfaces were detectable within the Vallum ditch section observed.*

Thus, no further analysis of the samples collected from this ditch section is recommended. It is suggested that an evaluation of the potential and risks of installing extensive suitable drainage systems is carried out, with investigations and monitoring of such system before and during the installation. It is recommended that both evaluation and monitoring are multidisciplinary - at least archaeological, pedological and geotechnical.

Keywords: BIRDOSWALD, CUMBRIA, HADRIAN'S WALL, SOILS, SEDIMENTS.

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Introduction

In October-November 1996 the Central Archaeology Service (CAS) started excavations on a spur at Birdoswald, the 11th fort from the east of Hadrian's Wall. The spur is being eroded along the western scarp facing the river Irthing. The excavation was aimed at understanding the causes of the erosion, its speed and extent, and the degree and type of threat to the archaeology of the area.

Information concerning the archaeology of the site is given by Wilmott (1996). Construction of Hadrian's Wall started in 122 AD with the construction of an earth wall - the *Turf Wall*. This was later superseded to the east of the fort by the stone wall construction.

The Vallum runs parallel to Hadrian's Wall, and from previous work it appeared that the inner ditch of the stone fort cut the filling of the Vallum ditch (Wilmott, 1996).

Aims

Some of the aims of the excavation described by Wilmott (1996) included: examining the mechanisms of erosion in the boulder clay cliff edge in order to attempt to suggest mitigation strategies which might be employed for management in similar cases (aim 7); to realize the potential of the threat where erosion damage is imminent (aim 1); quantifying the rate of future erosion (aim 4); establishing the extent of survival of the archaeological resource on the spur (aim 5); and monitoring the condition of the earthwork (aim 6).

Other aims more specifically linked to geoarchaeology included: aim 12 - investigating the existence and characteristics of buried palaeo-groundsurfaces beneath the Vallum mound and establishing the potential of this surface for soil and pollen analysis; aim 13 - comparing the preservation and content of the pollen record beneath the Vallum mound with that established beneath the turf wall; aim 14: establishing the potential for soil and pollen analysis in the Vallum ditch filling; aim 15: to produce an integrated environmental sequence for the area; and aim 16: methodological research on sample collection for pollen analysis from preserved ground surfaces.

Thus, specific aims of the present geoarchaeological investigation can be summarized in three main themes of research:

Theme 1: understanding the mechanism of

soil erosion threatening the integrity of the Vallum and possibly developing some hypotheses concerning mitigation;

Theme 2: investigating the existence and features of a palaeo-ground surface beneath the Vallum mount or in the surrounding area and establishing the potential for further geo-archaeological investigations and analysis.

Theme 3: assessing the potential for soil analysis in the Vallum ditch filling.

Site description

Birdoswald spur lies on the Upper Border Group of the Carboniferous Limestone Series (Dinantian), a complex of limestone, shales, sandstone and coal. At Birdoswald, the old subdivision in the "Birdoswald Limestone Group" above and "Craighill Sandstone Group" below (as implicitly accepted in the project design site description) has now been abandoned because the latter is not significantly more calcareous than the former.

The river Irthing flows on the SSW and W sides of the spur, and its course has gradually and constantly changed over time, eroding the local topography.

On the S-SW side of the spur, close to the course of the Vallum ditch, is a steep slope down to the Irthing. The slope of the spur is clearly unstable and undergoing intense erosion, threatening the integrity and the preservation of the Vallum ditch and of the grounds on this side of the fort.

That such erosion is caused by the gradually changing course of the river was the underlying hypothesis of the excavation.

Three trenches were dug by the CAS: a 20 m long trench through the Vallum ditch, along the cliff edge, 8 m back from the edge (Trench A); a 30m x 5m trench from the south wall of the fort, including parts of timber buildings and clear ground outside the fort (Trench B); and a 15m x 7m trench on the edge of the cliff in an area of timber buildings (Trench C).

Methods

Aluminium Kubiena boxes were collected from Trench A, a 20 m trench through the Vallum ditch, along the cliff edge, 8 m back from the edge.

Since, at the time of the last field visit of the author to the site, the section surface was still to be photographed by the archaeologists, the author could not personally collect undisturbed soil samples in Kubiena boxes. However, indication was given to members of the CAS team on the precise sample location recommended for each box, and on the required method for sampling.

Standard pedological observations of soil depth, colour, mottling, stoniness, structure and texture were carried out in the field for the major soil units observed in the area of the spur and its surroundings and were integrated with visual observations on the local landscape, topography and drainage system. Information concerning soils and drainage was also sought from Robert Palmer of the Soil Survey and Land Resource Centre in the University of York.

Selected features of soil samples within Trench A were described using the terminology of Hodgson (1976).

Results

Selected features within Vallum ditch.

Vallum ditch, NW facing section, part to the north east of the fort ditch:
Context 73: 7.5 YR,4/1 - 5YR 4/3, with few to common faint mottles, very few fine roots, 20-50 mm subangular blocky peds, very few micro packing voids, very few very fine to fine channels with oblique or random orientation. Abrupt lower boundary with Context 741. An iron pan of variable thickness, locally approximately 1 mm, divides this soil from Context 741. Permanent waterlogging in Context 73 was clearly indicated by the typical mottle pattern, but the dramatic iron precipitation indicates routes for oxygen along the 73/741 boundary. Though the pan edge is sharp, the soil immediately above it (up to 1.5 cm) is redder than further above 1.5 cm within the same context.

Vallum ditch, NW facing section, part to the north east of the fort ditch:
Context 741: 7.5YR 4/3 massive sandy clay, very friable when dry and moderately weak when wet, with few fresh and weathered angular and rounded gravels, no visible roots or root channels; very few micro to fine planes.

Vallum ditch, NW facing section, part to north east of fort ditch:
Sample 800 (Contexts 797/736)
Context 797 (Vallum ditch fill): 5YR 4/1 massive sandy loam with many sharp 5YR 4/3 mottles, moderately firm in the field, with very few fine roots, few random very fine channels. Abrupt boundary with grey/black peat below (Context 736).

Vallum ditch, NW facing section, part to south west of fort ditch:
Samples 493 and 495: Context 746 (in Sample 493) contained 5-15 % root channels, was uniformly grey with faint mottles resulting from seasonal waterlogging. However, Sample 495, collected at the same south west side of the ditch was a sandy clay loam containing mottles typical of permanent waterlogging.

Vallum ditch, south facing section:
Monolith box 814. Black (10YR 2/1) humified peat with broken abrupt boundary with the base of the Vallum ditch fill (Context 737) below.

Vallum ditch, south facing section:
Monolith box 814. Context 737 (base of Vallum ditch fill): 10 YR 3/2 (moist), 10YR4/2 (dry) massive sandy clay loam with common faint to prominent, sharp to diffuse mottles; friable when moist and moderately firm when dry; very few gravels; very few small irregular iron nodules. No spatial pattern or features correlatable to pedogenesis.

Soil distribution

The distribution of the local soils in the area of the spur and surrounding is summarized in Figure 2. Here, two main soil units can be identified: the Brickfield association (B), the Newport association (N).

Brickfield Soils

Most significant is the information obtained concerning the soils around the fort and on the spur where excavation of Trench A was carried out. These soils, indicated with B in Figure 1, are characterized by a sandy loam upper layer with a few mottles (approximately upper 20/30 cm) followed by another sandy loam layer with more mottles

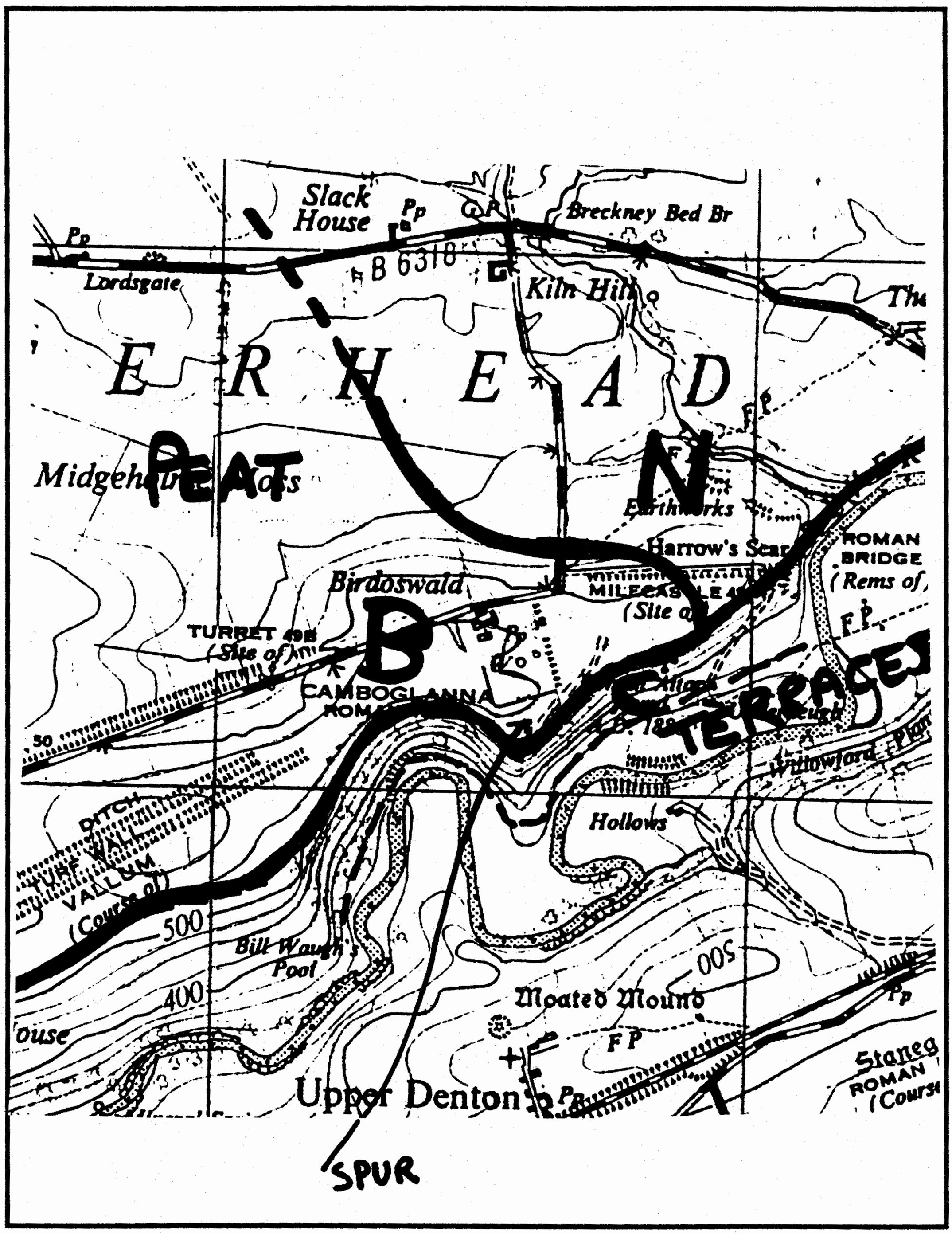

Figure 1. Location of peat and soils B and N. Scale: 1: 12,500.

(approximately at 20/30 cm to 60/70 cm), followed at depth by a clay loam on reddish boulder clay. This is a surface water gley soil profile of the Brickfield association and, significantly, *is characterized by its very slow permeability in the clay loam layer.* In other words, these soils are characterized by a permeable surface layer (sandy loam) over an impermeable subsurface layer (clay loam) at lower depth, this resulting in surface waterlogging and in the formation of a *surface water table*. In such soils, excess winter rainwater moves away laterally at shallow depth (Jarvis et. al.1985; R. Palmer, personal communication).

Clearly, these soils are deeply affected by the local rainfall and are unstable on steep slopes or adjacent to them, particularly during and after the rain season

Newport Soils

Soils of the Newport Association are distributed in different areas surrounding the spur (Figure 1). Soils north of and adjacent to Birdoswald spur, including those in the area near the Roman bridge at Harrow's Scarr, are characterized by a sandy loam surface horizon in the upper 30/40 cm, followed at depth by loamy sand between 30/40 cm and 1 m, with glaciofluvial deposits more concentrated towards the west. These soils have no mottles and are freely drained.

Further north, still in the vicinity of the Roman Bridge, the same soils become more sandy in the subsurface layers, and more gravelly at depth, due to the presence of the intrusive rocks of the Whin Sill. Also here, soils have no mottles and are freely drained. Thus, there is no seasonal (and even less permanent) waterlogging and *no excess winter rainwater lateral movement* in any of soils marked with N in Figure 2.

This means that the stability of these soils is not dramatically affected by water and the latter is quickly drained away after precipitation.

Peat

Towards the western part of the boundary between Newport and Brickfield soils, is the peat of the Midgeholm Moss. The characteristics of peat in the area and in the samples collected during the excavation are described elsewhere (Weir, 1996).

Discussion

Theme 1

In order to understand the mechanisms of erosion in the area it is important to understand the nature of the soils and their susceptibility to erosion. Depending on the nature of the soils on and adjacent to the spur, other agents, not just the river, could cause erosion and failure of the slope.

The nature, conditions and water status of the soils on the spur have an enormous influence on the stability of the site. The descriptions in the previous paragraph highlight that the soils on which the site is located, particularly on the spur where the fort is built, consist of permeable surface horizons overlying much less permeable or impermeable layers. This can cause surface water movement and weaken the soils which can therefore be easily eroded at the edge of the spur.

Suitable drainage measures may reduce this threat. For example, surface waters could be drained towards the sides of the spur which are not adjacent to the meander (i.e. drained towards West). This would entail excavations in the area.

Waterlogging clearly occurs in the subsurface horizons, and has a twofold effect: (a) it allows preservation of stratigraphy and in particular gives good organic preservation at a level above the permanent water table, but: (b) local soils are made unstable and more easily eroded on the eastern side of the spur, this causing a disruption of the earthworks described above.

To understand which of these two effects is more important in terms of the management of the archaeological resource, it is important to obtain geotechnical measurements of the slope stability and the hydraulic conductivity of the local soils, and carefully evaluate the results from different angles, possibly discussing them with other specialists (archaeologists, geotechnics experts and plant specialists).

Theme 2

The Vallum ditch fill appears very heterogenous, irregular and composed of discrete parts of mineral and organic material. No trace of past pedogenesis was noticed during field observation.

The samples collected did not show any evidence of soil features, horizonation or pedogenesis. Though some samples contained fine roots or root channels, their overall location and spatial patterns suggest that they result from recent processes and therefore are not diagnostic of a paleogroundsurface.

Thus, there is no evidence for buried soils in this part of the Vallum ditch.

Organic preservation

Organic preservation is unlikely to be good near the boundary between Context 746 and the iron pan but could be good above the first 1.5 cm from the pan, if the latter is continuous. In the rest of the samples, permanently waterlogged areas are irregularly alternated with seasonally waterlogged areas and it is unclear whether there is any potential for organic preservation.

Clearly, the Newport soils, marked with N in Figure 1, favour organic preservation, because of the presence of a surface water table leading to waterlogging. However, these soils are also very unstable at significantly steep slope angles, because the surface water table and the possible lateral water movement renders the layers slippery.

Conclusions and recommendations

It appeared clear that the very nature of the soils around the Vallum ditch (soils B) and their susceptibility to erosion is largely responsible for the threat to the archaeology of the area. Impermeable shallow layers in the soils on and around the spur allow the formation of a surface water table which is a cause of soil instability and erosion.

Suitable drainage measures could mitigate the threat to the spur but possibly, depending on the installation, could also disturb other archaeological deposits. An archaeological and multidisciplinary evaluation of the potential and risks of installation of suitable and extensive drainage systems would clarify the advantages/disadvantages of such an installation, and archaeological monitoring during the installation would help preventing further damage.

No trace of buried soils, buried land surfaces or palaeo-pedogenesis were observed in the excavation site of the Vallum ditch visited and in the samples collected. Thus no further soil analysis of the samples obtained from the Vallum ditch is recommended.

Retention/disposal

Soil samples will be retained at the EAU only if specifically requested by the CAS.

Archive

All data and reports will be retained in the EAU and available for consultation.

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