Two and Three-dimensional Soil Resistivity Tomography of a Drainage Feature at the Frilford/Marcham Romano-British Temple Complex

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August 1, 2003

1. Project Description and Purpose

Archaeological prospection, using an automated 3D soil resistivity imaging system, to locate a possible drainage feature (palaeochannel) associated with an amphitheatre-like structure on the grounds of the Frilford/Marcham Romano-British Temple Complex, Oxfordshire, England. A low altitude aerial photograph of the site shows clearly that the putative channel leads from the circular enclosure or structure towards the River Ock; this feature did not appear, however, in a magnetometer survey of the area (see Figure 1 in Locke et al. 2001).

Supervisory archaeologists: Gary Lock, PhD and Chris Gosden, PhD, Institute of Archaeology, University of Oxford

Prospection team: Brian Molyneaux, assisted by Mike Langford and Lorraine Lindsay-Gale.

2. Remote Sensing Technology

The Syscal Kid Switch 24 system produces a dataset that yields a 3-dimensional model of the resistance characteristics of a subsurface. The process is a form of tomography, in that the resulting model produces a set of horizontal slices (plan views at increasing depths) or vertical slices (profile views at the midpoint between each transect in the model in xz and yz directions) or a dynamic, fully functional 3DVR (virtual reality) model. Single transects may be processed to yield a 2-dimensional pseudosection.

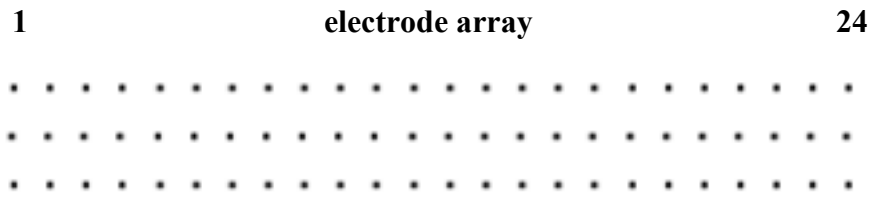
3. Project Area

The survey area was a narrow strip of pasture following the course of the River Ock. While changes in elevation near the river are very subtle, visual inspection suggested that the survey block was on a second or third terrace above the present floodplain. The partly excavated remnants of the Romano-British temple complex were immediately above (north of) the survey area in the same pasture; excavations by the Institute of Archaeology (Locke et al. 2001) indicate that these structures stood on a corallian limestone (Coral Rag) reef. Preliminary resistivity tests near the river showed that the near surface components of this deposit terminated above the first visible river terrace –

presumably eroded by the action of the river. The extent of the limestone in the resistivity survey area was unknown before the prospection.

Survey configuration

- dipole-dipole;
- 24 electrodes, spaced 3 meters apart;
- 3 parallel transects, 3 meters apart;
- total grid, 62 electrode points, covering an area of 69 x 6 meters.

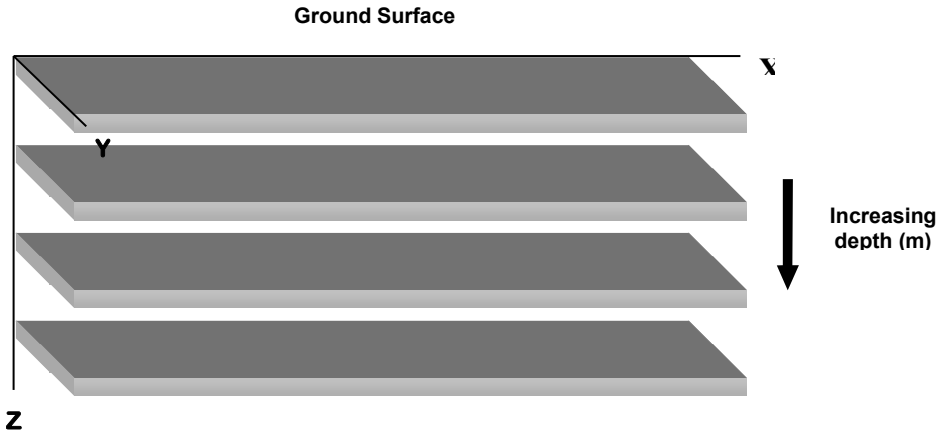


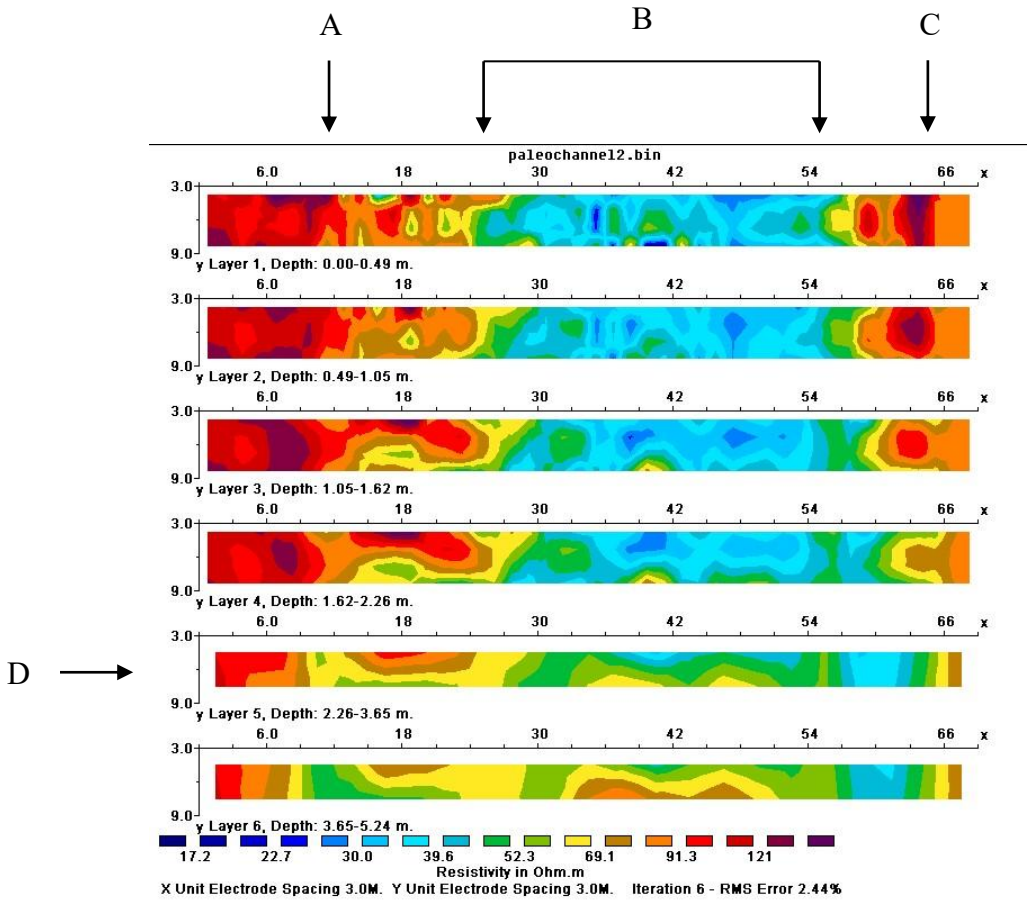
Tomographic Sections

Horizontal: seven layers (six illustrated), showing the plane view of subsurface features at depths from 0 to 5.24m; note that edge effects compromise the ends and sides of the model blocks with increasing depth.

Vertical: four planes, showing the profile view of subsurface features at measured distances within the survey area; note that edge effects compromise the ends and sides of the model blocks with increasing depth.

3D Inversion Model – Horizontal Layers





Areas A and C

Areas A and C are zones of high resistivity extending from near the surface to a depth of approximately 2.25m. Preliminary tests and excavation evidence nearby strongly suggest that this is a deposit of corallian limestone above sandy clays or other sediments.

Area B

Area B is a zone of moderate to very low resistivity between the resistive (limestone) layers. Given the relatively high contrast and steep cline at the boundaries, this area of approximately 33m appears to be a natural drainage feature, probably consisting of saturated alluvial deposits rather than limestone.

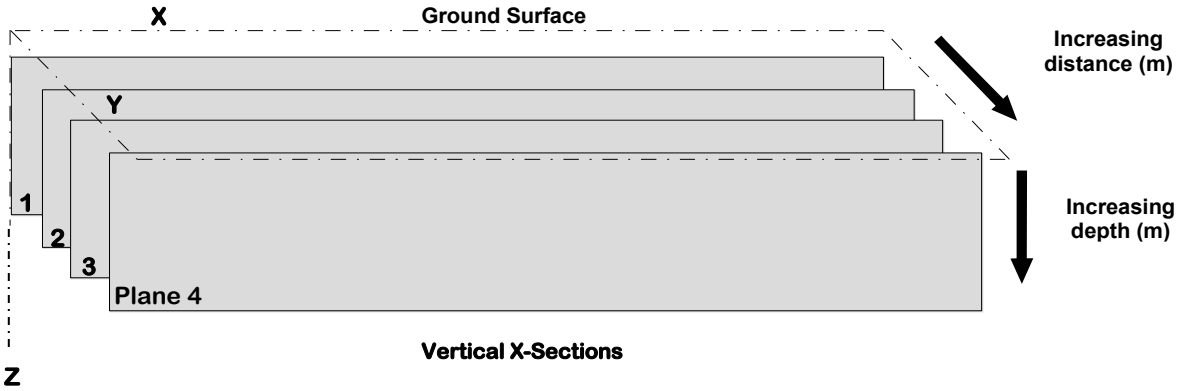
Area D

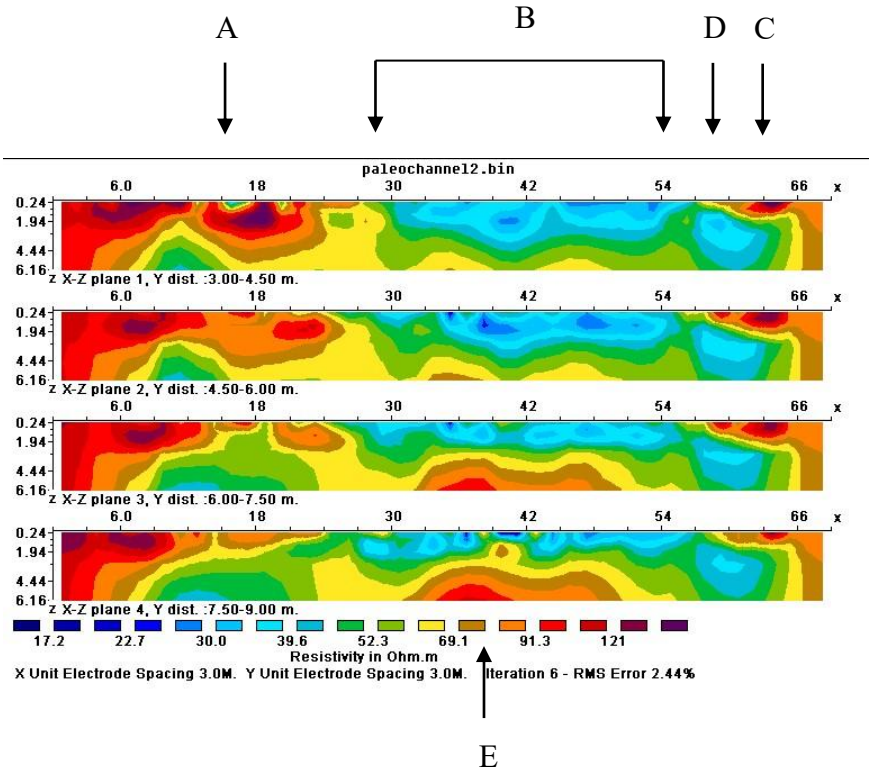
Area D, or Layer 5 of the model block, represents the bottom of the major drainage feature. There is six meter area at this, and deeper layers, that represents a narrower

continuation of the drainage. The increasing resistance of deposits below very likely represents deeper limestone or silt/clay/sand bedding.

3D Inversion Model – Vertical Cross-sections, XZ Plane

The following set of images represent vertical cross-sectional planes (slices) parallel to the transect lines taken every 1.5m between 3 and 9m.





Areas A to D

The vertical profile shows that the base of the highly resistive (limestone) Areas A and C is very uneven, supporting its interpretation as an eroded limestone reef, rather than a layer of redeposited limestone. The limestone clearly channels the drainage feature, Area B, as the sides and another highly resistive deposit forms the base (Area E), at approximately 5m below the surface. The profile also shows that the deeper channel of low resistance material, Area D, is beneath the limestone cap – a feature consistent with other resistivity surveys at the site.

Conclusion

The 3D soil resistivity prospection was a cross-sectional survey designed to locate a paleochannel or other drainage feature extending towards the River Ock from the amphitheatre-like structure in the Roman temple complex. The drainage channel proved to be an area of highly conductive soils and clays, probably saturated, between areas of carollian limestone. The conformation of the slopes in the surrounding terrain suggests that this channel followed a natural swale draining the surrounding fields.

It is very likely that this drainage feature progressively eroded the limestone – it is not clear, however, whether it was ever a visible body of water. As revealed in the aerial photographs, the feature appears to emanate from the walled enclosure. This strongly supports the interpretation of this enclosed area as a flush, a small mire that typically develops as a waterlogged area where spring water spreads over the ground (Oxfordshire (Nature Conservation Forum n.d.). In this case, water rising from aquifers may have perforated and eventually dissolved the limestone cap, creating a sinkhole-like feature and a drainage channel extending to the river.

5. References Cited

Lock, Gary, Chris Gosden, David Griffiths, Patrick Daly, Vuk Trifkovic and Tim Marston 2001 The Hillforts of the Ridgeway Project: Excavations at Marcham/Frilford, Oxfordshire.
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Oxfordshire Nature Conservation Forum n.d. Habitat Action Plan for Fens and Flushes.
http://www.oncf.org.uk/pdf/Fenflush.pdf.