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*depending on the specific project target

GEOPHYSICAL IMAGING OF ARCHAEOLOGICAL SITES AND DEPOSIT MODELLING

1. Background

Non-invasive geological and geophysical investigations are conducted in areas of archaeological interest to (1) determine how the soil was eroded/deposited in recent history (2) reconstruct how people interacted with landscape (3) determine likelihood of artefacts and their nature (4) plan further surveys in target areas. The North-East of England provides a rich archaeological background thanks to the varied and long history (prehistoric settlements, early and late bronze age, roman dominion, middle-age and early industrial remnants).

2. Aims and methods

- In this project, the student will conduct geophysical mapping and 2D survey of portions of one scheduled archaeological monument. The data collected will be used to produce tomographic images of the underground.
- The aim is to test the existing hypothesis on the origins of the artifact and on the past destination of the land, using the geophysical imaging and the support of the existing literature and historical background. These images can be interpreted in terms of the structure and nature of the underlying soil, rocks and archaeology. This will allow reconstruct the original topography, geology, and environment (e.g. rivers, wetlands) encountered by the past inhabitants and infer how they used it or adapted to it.
- The geophysical methods comprise magnetometry, electrical resistivity, GPR or seismic refraction; the specific method will be selected depending on the nature of the soil, the depth of the survey and the type of structure explored.
- The geophysical data will be analysed with advanced tools for inverse problems and computer-assisted modelling, using the Python-based pyGIMLi software (Geophysical Inversion and Modelling Library).

3. Target sites

The target site will be selected with the student and the supervisors. Possible options are:

- *The Flass Vale (Durham) bronze-age burial mound and surrounding grounds.*

For this project, well-drained sandy loam is abundant favouring the use of GPR. Previous explorations were conducted using ERT. There is scarse knowledge and documentation currently on this site. The mound is clearly a human artefact; however, diverging hypothesis exist on its nature and origin, possibly a burial site initiated in the bronze age. The surrounding grounds were used for sand extraction, they are currently forested but were open fields in the past. The project will explore both the mound structure and the larger context, including the depth of bedrock, using shallow and deep penetrating GPR.

- *The Vallum associated with Hadrian's Wall (North England).*

The Vallum is a large, linear earthwork, around 36 m wide, which was comprised of a ditch flanked by two earthen banks set back around 9 m from the edges of the ditch. It was an important part of the frontier defences, and, according to one current interpretation, it was designed to enforce a no-access frontier zone. The site is part of an on-going PhD investigtation using magnetometry and electrical resistivity. The project would complement the on-going research with GPR eploration with a deeper penetration depth.

- *Earthwork remains of an Iron Age promontory fort, Maiden Castle promontory, Durham.*

This is a classified Iron Age promontory fort, protected by steep natural slopes and man-made ditches. It was partly re-worked in two subsequent stages, latest of which in the middle ages. Limited excavations (1946) revealed a clay rampart with a wooden palisade; in the middle ages part of the rampart was cut away and a stone revetting wall built, where one of the stones bears a Medieval mason's mark. Wooden stakes were added to the retaining wall, the stakes were burnt when the fort was abandoned. The project would make use of electrical resistivity to sound the remanent structures to a depth of a few metres.

- *The Shap Stone Avenue megalithic complex and burial mounds.*

The stone circles, henges, cairns and other standing stones in the Shap area (Penrith) constitute one of three major complexes of megalithic monuments to be found in East Cumbria. The stones are often grouped at nodes of communication routes. The focus of some of the stones appears to be one or multiple burial mounds. The project will test the burial hypothesis by investigating the nature of the mound soil using GPR and electrical resistivity imaging.

3. Training

The student will receive training in the following areas: Geophysical tomography, inverse problems, python programming. The student will acquire advance knowledge of regional geology and geomorphology, historical and archaeological context, and methods used to interpret and acquire data for archaeological studies. He/she will develop skills in interpretation of soil and geological 3D structures, and how to relate them with the historical background and human archaeological artefacts. He/she will acquire experience in interacting with stakeholders as trusts, land cooperatives, and other non-profit cultural institutions and organisations. Practical experience will also be acquired regarding the logistics of fieldwork surveys.

5. Further reading & information

✦Deposit Modelling and Archaeology. Edited by C. Carey, A.J. Howard, D. Knight, J. Corcoran and J. Heathcote. ISBN 978-1-5272-2244-1. Short Run Press Ltd, Exeter, Devon, 2018. https://www.brighton.ac.uk/_pdf/research/set-groups/deposit-modelling-and-archaeology-volume.pdf

✦Using geoarchaeological deposit modelling as a framework for archaeological evaluation and mitigation in alluvial environments C. Carey, A.J. Howard, R. Jackson, A. Brown. Journal of Archaeological Science: Reports 11, pp 658–673, 2017.

✦Joint probabilistic inversion of DC resistivity and seismic refraction data applied to bedrock/regolith interface delineation. G. de Pasquale, N. Linde , A. Greenwood. Journal of Applied Geophysics, 170, 103839, 2019. DOI:10.1016/j.jappgeo.2019.103839.

✦Data acquisition, processing and filtering for reliable 3D resistivity and time-domain induced polarisation tomography in an urban area: field example of Vinsta, Stockholm. M.Rossi, T. Dahlin, P.-I. Olsson, T. Günther. Near Surface Geophysics, 16:23, pp. 220–229, 2018. DOI:10.3997/1873-0604.2018014

✦Breeze, DJ 2015. The Vallum of Hadrian's Wall, Archaeologia Aeliana, 5th series, 44

✦Wilmott, T. and Bennett, J. 2000 'The linear elements of the Hadrian's Wall complex: four investigations 1983-200', in T. Wilmott, Hadrian's Wall: Archaeological Research by English Heritage 1976-2000, London: English Heritage

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