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Imaging of Archaeological Remains at Barcombe Roman Villa using Microwave Tomographic Depictions of Ground Penetrating Radar Data

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The site of the Barcombe Romano-British villa lies in a field on the perimeter of Barcombe village in East Sussex, England. The site came to the attention of the Mid Sussex Field Archaeological Team (MSFAT) and the University College London Field Archaeological Unit (UCL, subsequently replaced by the Centre for Continuing Education of the University of Sussex, CCE) because it was in danger of disappearing altogether without being adequately recorded [1]. In common with many other UK sites of the period, the villa had been extensively robbed out in the centuries following its demise in order to provide building material for the adjacent village and its associated farms, a common problem with Romano-British sites in the UK [2]. In addition, the site is positioned on the ridge of a field in agricultural use and has therefore been extensively ploughed out. As a result, the archaeological evidence was sparse and the little that remained was being rapidly eroded.

In April 2001, a Ground Penetrating Radar (GPR) survey was carried out jointly by the Department of Engineering, Portsmouth and Utsi Electronics Ltd on behalf of the archaeological team in order to investigate the possibility of mapping both the villa and earlier prehistoric remains on the same ridge. Using a 40m by 60m grid laid out by the archaeological team, a Groundvue 1, with antennas of central frequency 400MHz, was used to survey along a series of parallel transects at intervals of 50cm. The sampling interval along the line of survey was 5cm and probing was carried out to 40ns. The results of the GPR survey, including a comparison with the evidence from the resistivity work, were published in 2002 [3].

The original GPR data were processed (using the ReflexW package) by applying background removal, adding time based gain, averaging over 2 traces in order to reduce noise resulting from the relative movement of the antennas across the ploughed field and finally applying a Bandpass Butterworth filter of 200 to 600MHz (the frequency range of the antennas used). The 2-dimensional plots were formed into a 3-dimensional cube and time slices extracted, on the basis of maximum signal return, at 16ns, 25ns and 29ns.
In this work, we show the reprocessing of the GPR data via a microwave tomographic approach based on a linear approximation of the inverse scattering problem [4]. In particular, the effectiveness of this approach ensures a reliable and high resolution representation/visualization of the scene very large in terms of probing wavelength. This has been made possible thanks to the adoption of the approach presented in [5] where the 3D representation was achieved by performing 2D reconstruction and after obtaining the 3D Cube from these 2D reconstructed profiles. In particular, the re-examination of GPR data using microwave tomography has allowed to improve definition of the villa outline and to detect earlier prehistoric remains.

[1] Rudling, D., & Butler, C. "Roundhouse to Villa" in Sussex Past & Present 95, pp 6 – 7, 2001.

[2] Utsi, E., Wortley Villa paper currently in preparation of EAGE special issue.

[3] Utsi, E., & Alani, A. "Barcombe Roman Villa: An Exercise in GPR Time Slicingand Comparative Geophysics", in Koppenjan, S., & Hua, L. (eds) Proceedings of the Ninth International Conference on Ground Penetrating Radar, 2002.

[4] F. Soldovieri, R. Persico, E. Utsi, V. Utsi, "The application of inverse scattering techniques with ground penetrating radar to the problem of rebar location in concrete", NDT & E International, Vol. 39, Issue 7, October 2006, Pages 602-607.

[5] R. Persico, F. Soldovieri, E. Utsi, “Microwave tomography for processing of GPR data at Ballachulish”, Journal of Geophysics and Engineering, vol.7, no. 2, pp. 164-173, June 2010