Integration between different remote-sensing surveys to characterise Aiali archaeological site (Grosseto, Central Italy)

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Abstract
To enhance the knowledge of the Aiali site (Grosseto, Central Italy), finalised to the location and conservation of the unknown buried structures below the actual studied levels, a scientific collaboration between Landscape Archaeology, Department of Archaeology and History of Arts, (LAP&T), Università di Siena a Grosseto and the Institute of Technologies Applied to Cultural Heritage (ITABC-C.N.R.) has been developed, during the time 2005-2006 and it is still in progress (Campana et al, 2006a).
The site has been studied analysing a set of vertical aerial photographs and making aerial surveys from 2002 to 2004, with the aim to locate buried structures. Together with these information, a large scale geophysical surveys, employing a differential magnetic method and a GPR survey, have been carried out between 2004 and 2006.

Integrated Remote sensing surveys
As usually we started working on the oldest available aerial photograph, that in this case is the national coverage of 1954. Unfortunately any feature was visible on the historical flight because the site was used for olives cultivation. Nevertheless the soil use changed to grain cultivation between years ’50 and ’70 we didn’t find any features on verticals acquired in 1976, 1996 and 2001.
The site has been detected in spring 2001 with an aerial survey, (Campana et al. 2006b). During 2004 from the end of May to the middle of June, throughout the ripening season of the crop, the site was monitored from the air to record the aerial visibility of the cropmarks, using repeating-flights at intervals of 2 and 4 days. This procedure allowed the clear identification of new traces that had not been visible in earlier years (Fig.1).

During 2004, a gradiometric survey, collecting data at intervals of 0.50 m along profiles 1 m apart was carried out. The results showed a series of magnetic anomalies which match the traces visible on the oblique air photographs (Fig.2). The clearer visible anomaly consists of a rectangular structure (possible roman villa) measuring about 70 x 25 m, oriented north-east/southwest, at each end of which are four square rooms 10 x 10 m across. A break in the magnetic data is caused by a disused iron pipe, which masks completely the possible presence of walls. On the evidence of the aerial photographs, which show continuity across the line of the pipe, we can assume that the below-ground archaeological deposits are essentially undisturbed. It is fair to suggest that in the absence of the pipe the gradiometer data would have produced equally positive results. Further magnetic anomalies can be seen in various parts of the field which were previously blank . Some tens of metres to the North-East and South-East of the main complex a series of linear anomalies, more or less aligned with the main structure, seem likely to represent an enclosure, perhaps with an entrance-way.

In 2006 high-resolution GPR surveys (conducted in collaboration with Dean Goodman, Archaeometry Laboratory, LA, CA, USA) were applied over four areas to test the potential of this technique. For the measurements, a GSSI SIR3000, equipped with a 400 *MHz* bistatic antenna with constant offset were employed. At each site radar profiles were collected alternatively in reversed and unreversed directions across the survey grids. The horizontal spacing between parallel profiles at the site was 0.5 *m*. Radar reflections along the transects were recorded continuously across the ground at 40 *scan* s^{-1}, with a stack = 3; along each profile, markers were spaced every 1 m to provide spatial reference. The gain control was manually adjusted to be more effective. All radar reflections within 50 *ns* (two-way travel time) time window were recorded digitally in the field as 16 bit data and 512 samples per radar scan. Referred to as time slice processing, the anomaly maps can be generated at various time/depth windows across the recorded radargram dataset. Time slice data were created using the spatially averaged square wave amplitudes of the return reflection. These averaged square amplitudes were then gridded using a Kriging routine (Piro et al., 2003, Goodman et al., 2001). Other line noises, parallel to the profile collection direction, were removed using a moving filter with customized threshold settings. Filter thresholds were set to signal levels just below the average reflections from buried Roman walls. In *Area AB* total number of 162 parallel profiles, stretching S-N, have been collected with the instrument configuration indicated above. After the pre-processing, all collected GPR profiles have been used to calculate the time-slices related to this area. Figure 3 shows the timeslice in the depth range 1.05 – 1.38 *m*. In this slice a linear radar reflections are clearly visible. These kind of anomalies are due to the presence of portion of walls still present in the ground.

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