

# LARGE SCALE MAGNETIC SURVEY AND ARCHAEOLOGICAL MAPPING. THE GROSETTO AND SIENA PROJECTS

Riccardo Francovich<sup>1</sup> - Stefano Campana<sup>2</sup> - Cristina Felici<sup>3</sup>

<sup>1</sup> Medieval Archaeology, Department of Archaeology and History of Arts, Università di Siena - [francovich@unisi.it](mailto:francovich@unisi.it)

<sup>2</sup> Landscape Archaeology, Department of Archaeology and History of Arts, (LAP&T), Università di Siena a Grosseto - [campana@unisi.it](mailto:campana@unisi.it)

<sup>3</sup> Ph.D. candidate, Department of Archaeology and History of Arts, (LAP&T), Università di Siena - [felici@unisi.it](mailto:felici@unisi.it)

## 1 From conservation and historical questions to a new strategy

In order to improve the quantity and above all the quality of the archaeological record, and to both sharpen and broaden the scope of our researches, we established the Laboratory of Landscape Archaeology and Remote Sensing (LAP&T). The aim of the unit is the progressive introduction of remote earth observation systems, along with the enhancement of surface collection techniques through the application of new instruments and methods of data collection and documentation, for both the archaeological and the environmental records. Our approach is conceived as multi-scale, from the macro-environment (the region) through the local environment (the catchments area) to the point-environment (the individual site). We aim to be able to respond with varying degrees of refinement both to matters of conservation and to individual archaeological or historical problems of a specifically scientific nature (CAMPANA and FRANCOVICH 2003). So far, we have put in train the following approaches: survey and documentation through oblique air photography; high-resolution satellite imagery; historical air photo coverage; large-scale geophysical survey; digital photogrammetry. **R.F.**

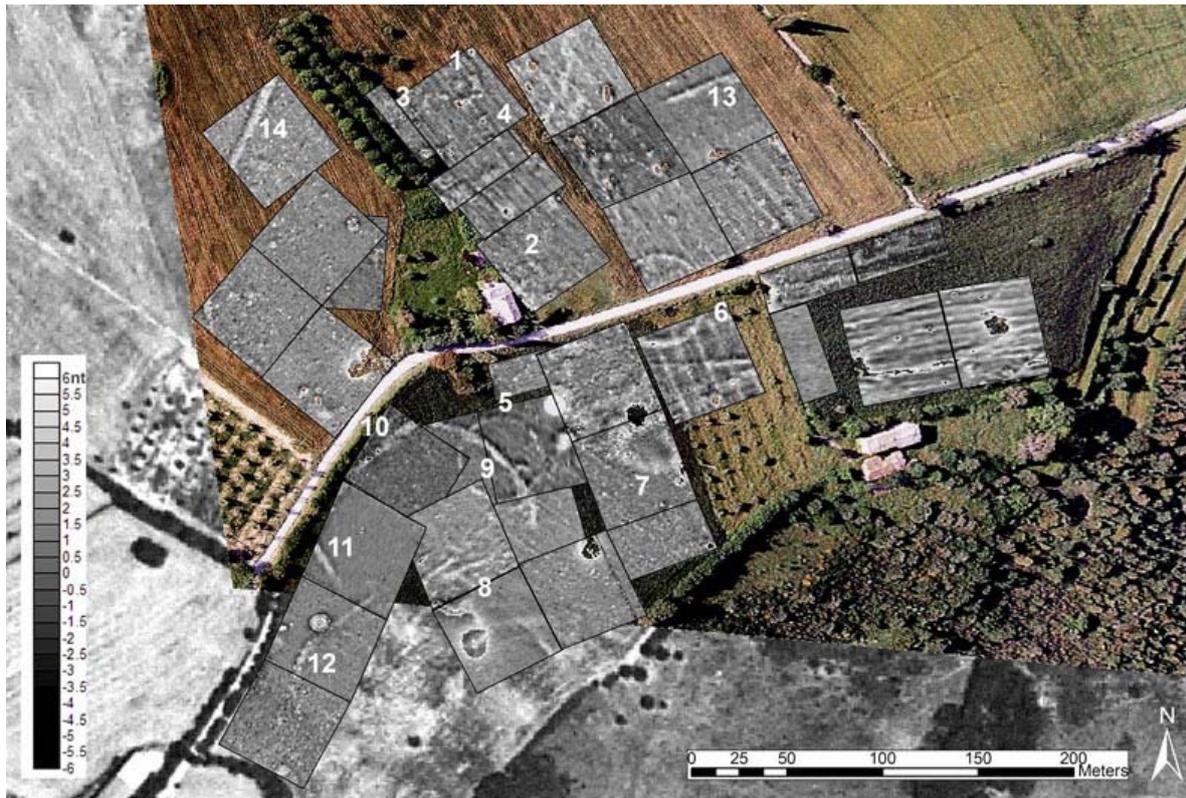
## 2 An integrated approach to the application of large-scale magnetic survey

The gradiometer comes closest to satisfying one of our key requirements, the survey of large areas in a limited amount of time. From 2003, during field survey in the Val d'Orcia, we have progressively implemented a system of data acquisition and processing which allows us to collect and analyze the measurements for one hectare of ground in a single day's work at 50 cm intervals along traverses 1 meter apart. So far, we have covered 22 sites in about 20 hectares of surface survey. The general trend of the results suggests that the degree of detail achieved is sufficient to identify with a reasonable level of accuracy the extent of the underground deposits and (depending on the nature of the evidence) of their internal articulation. So as to better explain the role of these methods in our work we will briefly discuss two case-studies from the provinces of Siena and Grosseto. **S.C.-C.F.**

### *Romitorio (San Quirico d'Orcia - SI)*

The site at Romitorio formed part of one of the sample areas within the project to create an Archaeological Map of the Province of Siena. In this area Late Medieval documents record "*uico nomini oracolo Santi Ampsan*" (714-715). The church has generally been related to the place-name of Sant'Ansano, today attached to a farm close to Romitorio (SCHIAPARELLI 1929, n. 19). Surface collection undertaken from 2001 onwards has brought to light a wide range of archaeological material, interpreted as belonging to a village of the Late Republic – Early Imperial period (1<sup>st</sup> century BC – 1<sup>st</sup> century AD). This had taken over an area used from at least the Archaic, Etruscan and Hellenistic periods (6th – 2nd centuries BC), for domestic settlement in the latest period and perhaps as a sacred site in the early phase. This latter conjecture is based on the presence of a few fragments of painted tiles which have parallels in types found at cult centres. The same area has also produced material related to later phases of the village during the Imperial period, from the 4th and 5th centuries AD. There is no archaeological evidence for later phases of occupation. The site was surveyed from the air in 2001 and 2004, and both recent and historical vertical photographs were examined. These studies produced no evidence except traces related to the previous existence of agricultural field divisions. In all probability the absence of evidence can be related to the nature of the clay subsoil, which is unfavourable to the development of cropmarks or soilmarks (MUSSON, PALMER and CAMPANA 2005). Even a winter flight in 2004 after a light snowfall (which usually

produces conditions that are ideal for the detection of low earthworks) failed to produce any positive evidence. Geophysical prospection of the area, covering a total of 7.35 hectares, yielded more positive results, however – far better, indeed, than we had expected (*Fig.1*). In the field immediately east of the farmhouse at Romitorio regularly-arranged traces can be seen, some of them indicating the outlines of buildings, the varying alignment of which shows them to be of more than one chronological phase (*Fig.1, nos. 1-4*). There were no clear traces that could be directly attributed to the religious building attested in the documents (PIRO, CAMPANA and FELICI 2005). In the fields to the south and east, however, there were other traces that posed new and unexpected problems of interpretation. In particular, two magnetic anomalies characterised by linear dipoles took the form of regular circles, each measuring 50 m in diameter (*Fig.1, nos.5-6*). Their



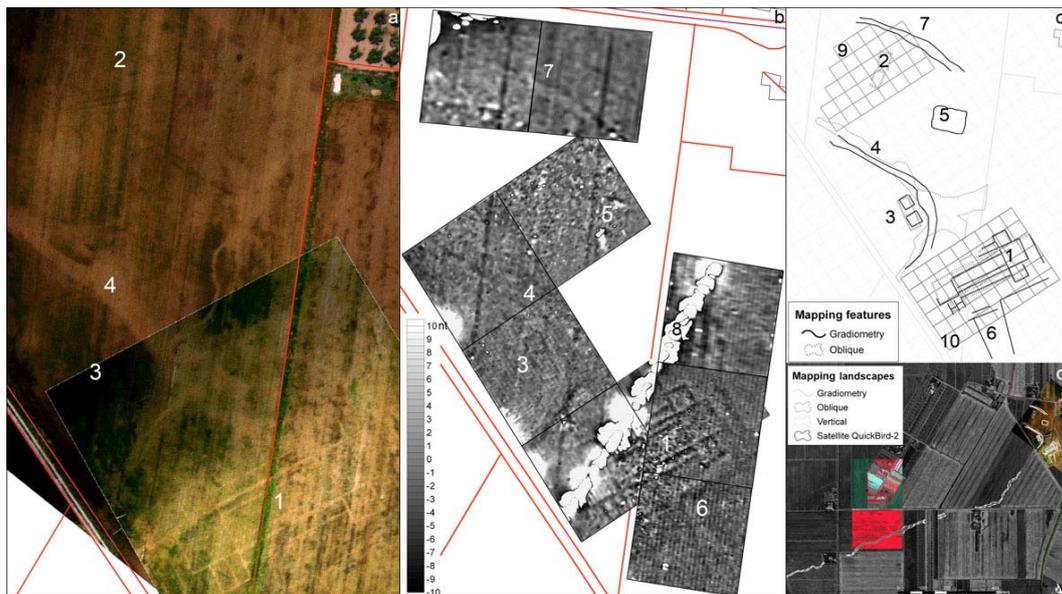
*Fig.1*

morphology and topographical position (on the top of a hill dominating the surrounding countryside) can be paralleled in the Siena area, and more generally in Etruria, in funerary monuments. Tentatively, the evidence could be interpreted as belonging to two Etruscan tombs, completely flattened by long-term ploughing and now only showing as alterations in the local magnetic field. The picture becomes clearer, and the conjecture more secure, when account is taken of painted bricks found during field survey surface collection in the area. Other circular anomalies, less distinct and incomplete, can be seen in the graphical representation of the site (*Fig.1, nos.7-8*), though the dimensions are variable and the interpretation uncertain. Further elements emerge from analysis of the magnetic data, including linear dipoles which extend for a total of 320 m in all (*Fig.1, nos.9-13*). The dimensions and overall pattern of these anomalies suggest that they might belong to agricultural boundaries or they could equally well be a curvilinear enclosure or one or more track ways. One of them cuts, or is cut by, the southernmost of the two large circles. If the interpretation of the latter as Etruscan tombs is considered valid, the linear dipoles should presumably be attributed to later phases – Late Etruscan, Roman, Late Antiquity or Medieval. In our view there were only two ways of resolving these uncertainties – the application, in the zones most in doubt, of other methods of geophysical prospection, or archaeological excavation. In the case of excavation it would be sufficient to two trial sections, the first at the point of intersection between the southern circular anomaly and the ‘field boundary’, the second at the east end of the

anomalies that resemble those seen at Pava. In summary, the gradiometer survey has played a primary role in the investigation, adding information about many phases of the settlement evidence revealed by field survey and surface collection. It has also supplemented and reinforced the suggested use of the site as a ritual area. **C.F.**

*Aiali (Grosseto – GR)*

In the locality of Aiali, on the lowland between Grosseto and the Roman town of Roselle, aerial survey, beginning with that carried out during the Aerial Archaeology Research School at Siena in 2001, has allowed the recognition of an area within which the growth of the wheat varies in such a way as to reveal an articulated group of traces that make up the plan of a complex of structures interpreted as a Roman villa (*Fig.2, no.1*). Ground-truthing carried out during the course of 2004 involved targeted field survey and surface collection within a predefined grid (sampling interval 10 m). The ground survey and the study of the collected material (still in progress) has confirmed the



*Fig.2*

archaeological character and the interpretation of the air photographs, demonstrating a high level of correspondence between the aerial evidence and concentrations of archaeological finds. The collected finds range in date from the 2<sup>nd</sup> century BC to the middle centuries of the medieval period, with a peak between the 1<sup>st</sup> and 6<sup>th</sup> centuries AD. In 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 repeat-flights at intervals of between 2 and 4 days to document their development. This procedure allowed the clear identification of new traces that had not been visible in earlier years, including an abandoned river-course and two new structures adjacent to the main complex of buildings (*Fig.2a, nos.2-4*). In the autumn of 2004, it proved possible to collect 2 hectares of gradiometer data at intervals of 50 cm along profiles 1 m apart. The result showed a series of magnetic anomalies which closely replicate the traces visible on the oblique air photographs (*Fig.2b, nos.1,3,4*). In addition to confirming, very precisely, the evidence seen from the air, the magnetic survey added a series of anomalies that fill in many of the gaps in the main building complex (*Fig.2b, no.1 and Fig.2c, no.1*). The central part of the villa consists of a rectangular structure measuring about 70 x 25 m, oriented north-east/south-west, 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 obscures the hides the archaeology along its length without reducing the general readability of the structure (*Fig.2b, no.8*). 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 (*Fig.2b, nos.5-7*). Some tens of metres to the north-

east and south-east of the main complex a series of linear anomalies (*Fig.2b, no.6 and Fig.2c, no.6*), more or less aligned with the main structure, seem likely to represent an enclosure, perhaps with an entrance-way. To the north there is a weaker anomaly (-5nT), approximately rectangular but not aligned on the villa and thus presenting problems of interpretation. Both the magnetic and aerial surveys produced poorer results in the north-western part of the field, where the ground survey and girded surface collection (*Fig.2c, no.9*) yielded considerable amounts of structural material and ceramics, covering a chronological range from the 2<sup>nd</sup> century BC to the 6<sup>th</sup> century AD, with a final phase in the 10<sup>th</sup>-11<sup>th</sup> centuries AD. Bearing in mind the present stage of the research it would be premature to attempt a detailed interpretation. It is enough at this stage to outline a few methodological points. The case-study shows that the various methods applied in the search for understanding of the site have made a considerable contribution, resulting in a remarkable increase in both the quantity and quality of the archaeological information available to us. In contrast to the previous example, near Romitorio, the site was first discovered from the air rather than through field survey. This is a well-known weakness in sample field-survey, here overcome through the integration with aerial survey which (subject only to 'aerial visibility') allows us to collect data on a regional scale while at the same time permitting 'real-time' analysis of the results through repeated flights over the same site. **S.C.**

### **3 Conclusions**

The magnetometer survey represents an advance of great importance to our researches, most of all in areas characterised by the widespread presence of clay, in non-arable zones and more generally in areas where aerial visibility is poor. But we have seen that, even where there are ideal conditions for good returns from aerial survey, gradiometer survey has played a significant role. In addition to confirming the evidence recovered from the air the gradiometer data has added new and otherwise unseen evidence. The Aiali case-study demonstrates some limitations of the method in the disturbance created by the sub-surface presence of modern magnetic materials, and in the failure to recover sub-soil evidence to match the surface finds in the north-western part of the field. For this and other reasons we are determined to increase the range of geophysical instruments at our disposal.

### **Acknowledgments**

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