Seeing the unseen. Buried archaeological landscapes in Tuscany

S. Campana & R. Francovich

Department of Archaeology and History of Arts, University of Siena at Grosseto, Italy

ABSTRACT: The Department of Archaeology at Siena has been engaged for several decades in the testing of new methodologies, new approaches and new instruments for construction of the archaeological record. In relation to landscape archaeology and in particular with the South Tuscan landscapes the low level of visibility and heavy clay soils have directed us towards those techniques of remote sensing that leave a wide choice to the archaeologist in the periods for carrying out data capture. Source-integration now represents the prime focus of our research. In an area like that of South Tuscany without this approach we foresee little possibility of obtaining results which will have a real effect on our understanding of the development of the landscape across time.

1 INTRODUCTION

A recent review of the research carried out over the past twenty years and more by the Department of Archaeology and History of Arts at the University of Siena made clear the vast amount of material that has been placed on the record for southern and central Tuscany, upward of 10500 sites (Francovich & Valenti 2001). Work in the field of archaeological cartography has been based on surface collection in sample areas and the stereoscopic analysis of vertical air photographs. Despite the encouraging results in these areas we feel that, the information available to us is still in some respects insufficient for a better understanding of the ancient and medieval landscapes of the area. While some general trends seem quite clear, we still find great difficulty in tackling chronological periods such as pre-and proto-history, the Middle Empire and the High Medieval period. There are also specific historical problems that are central to our researches. We might point, for instance, to the decline of the great rural estates of the Roman period, the re-occupation of villa settlements in late antiquity and to the development of upland settlements (Francovich & Hodges 2003). In addition to this kind of problem there are others which call into question the basic methods upon which our work has been based. In the case of field survey and surface collection the tightening of state regulations on the conservation of underground deposits is creating ever greater difficulties, both in the collection and in the interpretation of the evidence. In this regard, while there is truth in Tim Potter’s assertion that the most productive period of research through surface collection had already come to an end in the late 1970s (Potter 1985), this has to some extent been contradicted by the achievements of more recent generations of research workers. The positive results of more recent work are attributable mainly to developments in the theory and application of the discipline (Cherry 1983). In the case of air photo analysis it is certainly true that the historical coverage of vertical photography constitutes an indispensable resource. But it is undeniable that the vertical coverage was collected for essentially non-archaeological purposes, without any consideration of the factors that influence the visibility of archaeological evidence when viewed from the air. In making these observations we do not in any way imply that we should altogether reject surface collection or the study of vertical air photographs, both of which remain among our
most productive techniques for recognising little-known or previously undiscovered sites. But we must at the same time acknowledge the problems and to bring forward affective solutions.

R.F.

2 ARCHAEOLOGICAL VISIBILITY AND THE TUSCAN LANDSCAPE: HEAVEN FOR TOURISTS, HELL FOR LANDSCAPE ARCHAEOLOGISTS!

A critical review of our research methods means firstly a new analysis of the background. The territory that we are studying covers about 10,000 Km², a substantial area on a ‘regional’ scale, with a wide variety of landscape types. Within this area the various factors that influence archaeological visibility, whether from the air or on the ground, interact with one another to produce spaces that are characterised by high or low levels of visibility, with a wide variety of gradations in between.

The factors that determine archaeological visibility are many, but three take precedence over the rest: historical factors, land-use and agricultural practices, soil-type and seasonal climatic conditions.

The first problem that we encounter in central-southern Tuscany is historical in origin. Both in Italy and elsewhere the countryside of this part of Tuscany is known for its lack of industry or other modern development, its fields of waving corn, its olive groves and vineyards, its winding white roads and groups of farm buildings. This is an image of a rural landscape, its natural character virtually ‘fossilised’ to the present day. But in practice this characterisation is entirely false, since it ignores the dramatic and sometimes violent changes that have transformed the original character of the area. A striking example can be seen in the Val d’Orcia, a district that covers an area of about 500 Km² to the south-east of Siena, today characterised by an expanse of gently rolling hill-country dominated by cereal cultivation and (in the southern parts) by vineyards. This kind of monoculture, however, is the result of the great and often radical transformations started in the Fascist era and continuing in the post-war years and on to the present day (Fig.1, view of the landscape of Pienza from Felici 2004). The Val d’Orcia, in the past, was an area of summer drought, winter floods, bleak and dominated by biancane and calanchi (Mangiavacchi 2004). Its morphology, its heavy clay soils (too hard for widespread cultivation using by the traditional pre-mechanised methods) restricted agricultural activity and productivity. Similar patterns can be seen in the areas of Maremma and Chianti, now radically changed by land-improvement and extensive monoculture.

In relation to land-use one must also bear in mind that Tuscany, of all the regions of Italy, is the one with the highest percentage of its surface covered in woodland, about 50% in all. Woodland constitutes a serious impediment to ground-based survey and is even more obstructive in terms of aerial visibility. Our work so far leads us to say that about half of the region is characterised by a low levels of archaeological visibility, whether from the air or on the ground.

![Figure 1](image.png)
The areas given over to agricultural crops for the most part occupy heavy clay soils, occasionally interspersed with sand and subjected in the past to heavy land-improvement projects. These types of soils are generally unfavourable to most types of Remote Sensing because of their poor drainage.

The areas with a higher level of archaeological visibility are principally those of the alluvial plains and river courses, in particular the valleys of the Arno, Ombrone, Chiana and Orcia. In some of these areas there are further problems because of the depth of the alluvial soil and recent human intervention, such as land-drainage schemes and present-day developments in industry and housing (Agnoletto 2002).

It should by now be clear that the study of archaeology in Tuscany presents numerous problems. To achieve significant results in such a context we cannot simply apply the techniques developed and used in different contexts. Rather, it is necessary to develop a new approach, a new strategy related to specific research objectives and to the physical and cultural characteristics of the area under study.

3 A STRATEGY IN SEARCH OF SOLUTIONS

In order to face most of these problems, 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. Though still at the stage of ‘work in progress’ we are already putting into effect a new strategy of research. This is flexible, open-ended and based on the conviction that only through the integrated application of a wide range of research methods and information technology will we be able to confront the complexities inherent in the study of the landscapes of the past (Campana and Francovich 2003). 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 archeological or historical problems of a specifically scientific nature. So far, we have put in train the following approaches:

Aerial survey and documentation through oblique air photography. From the 2000 we started a programme of aerial survey averaging 45 hours of flight per year collecting more than 12000 oblique air photographs. The flexibility of the method in allowing us to respond to the development of archaeological traces with extreme rapidity is of great benefit and importance. The correct application of this technique offers an extraordinary contribution to the search for new sites and for the continuous monitoring of the cultural heritage (Musson et al. 2005).

High-resolution satellite imagery. The introduction of satellite imagery was aimed in the first place at providing a total, continuous and objective view of a whole area at a particular moment of the year as planned by the archaeologist. The second feature is the capacity to provide multispectral data to monitor plant health and to detect water-stress in vegetation where it cannot be seen by the naked eye (Campana 2002).

Enhancement field walking survey techniques. The applications of field-walking is aimed at the systematic investigation of sample areas and at the verification of the remotely sensed evidence. The application of GPS and PDA technology greatly improve the quality of the research (Campana & Francovich, 2005).
Large-scale magnetic survey. In 2003 we tested a system of data acquisition that allowed us to cover one hectare per day at a resolution of 60 cm along traverses which were each set 1 m apart. So far we have only acquired data for 20 hectares surveying 22 archaeological sites (Campana et al. 2005).

Field Data integration: PDA technology. The merging of PDA and GPS technologies goes far beyond the level of increased fieldwork efficiency, enabling data integration directly in the field and at best allowing the systematic application of strategies and methodologies developed in the past (Campana 2005b).

Though we are not yet in a position to present definitive results, we have started to use further methods and instruments that we are confident will play a significant future role in offsetting the present gaps in our strategy for the study of the ancient landscapes of Tuscany:

- digital photogrammetry
- lidar (in partnership with NERC Airborne Research & Survey Facility)
- georadar (in particular applying the TerraVision system)
- geoelectrical survey
- electromagnetic survey.

4 INTEGRATED LANDSCAPE ANALYSIS: CASE-STUDIES

A serious gap in the process of reconstructing the palimpsest of information from the past is the lack correspondence between remote-sensed data and work on the ground. It often happens that the information recovered during surface collection consists of wide-spread scatters of pottery and building materials which prove to be quite undetectable on the satellite imagery, on vertical air photographs or in the course of oblique air photography. Less all-pervading but equally problematical is the reverse situation, where visible traces on the remote-sensed data do not correspond with the recovery of archaeological material at ground level, or at least not with material on the scale that one has been led to expect. This situation, while on the one hand allowing a quantitative increase in the information available, on the other represents a limiting factor in our understanding of the archaeological evidence, indeed a substantial impediment in relation to our stated objectives. The possibility of allocating to a pottery-scatter a sort of ‘radiogram’, more or less representative of what is happening beneath the ground, would represent a significant gain both in our understanding of the site and in its possible future conservation. So as to better explain our results we will briefly discuss three case-studies representative of different landscape facies, the relative methodological approach and the results of our researches.

Località Pava (San Giovanni d’Asso - SI) – The site at Pava, in the community of San Giovanni d’Asso, lies within one of the sample areas in the project for the creation of an archaeological map of the Province of Siena. In this vicinity documents relating to a dispute between the bishops of Siena and Arezzo in 714-715 AD, indicate the existence of the parish church of ‘San Pietro in Pava’ (Schiaparelli 1929). The exegesis of the document allows us to surmise the earlier existence of a cult shrine building, indeed the priest Audo testifies that his predecessors already owed allegiance to the Aretine episcopate, suggesting the possibility of two previous generations of priests and hence the existence of a cult building from at least the middle of the 7th century. We also know that San Pietro in Pava stood close to the River Asso, in the locality named in the Extent of 1320 as ‘Pieve Vecchia’, not far from the present-day Pieve a Pava. The building is again attested in 1029, though by this time it was probably reduced to a ruin, abandoned and replaced by the nearby sister church of Santa Maria in Pava, which in 1045 appears in the documents under the title of ‘pieve’. However, other documents record that it was still the responsibility in 1320 of the rector “Ser Finus presbiter plebis Pievevecchia”. In 2001, during preparatory field survey in connection with the Archaeological Map of the Province of Siena, there were identified close to this location the remains of a substantial complex dating from the Roman imperial, with traces of continuity, perhaps uninterrupted, until at least the 6th century AD. The complex was most probably associated with the road that at this crossed the River Asso by means of a ford. The presence, along with pottery and building materials, of numerous human bones favoured the hypothesis of distinct phases of
use of the site, both domestic and funerary. Moreover, the substantial quantities of human bone suggested a large number of graves, for which there might well be a connection with the previously-attested parish church of San Pietro in Pava (Felici 2003). In summary, from the field survey there emerged many indications for the existence of a settlement complex of considerable importance: pipes for the circulation of hot air in a baths complex, cocciopesto (also attributable to some form of hydraulic plant), numerous coins, a bronze horse of very fine workmanship, and human bones. The site also examined through the analysis of existing vertical air photographs and through new aerial survey. Both, however, proved negative, most probably because of the nature of the underlying clay subsoil. A flight in the winter of 2004, after a light snowfall, also failed to produce positive results.

Gradiometer survey was also undertaken, covering an area of 2 hectares (Fig 2.1). The magnetic anomalies in the areas where surface collection had produced pottery and human bones were particularly interesting. Represented graphically (Fig 2.2a) the data reveals a rectangular outline measuring roughly 20 x 10 m, oriented E-W and interpretable as a building (a church to judge by the dimensions, orientation and bones? or a baths complex on the basis of its dimensions and the presence of heating pipes?). Further traces, parallel and at right angles to this rectangular anomaly, could perhaps be parts of the same structure, or external divisions.

Lastly there were two strong dipoles, interpretable as kilns or furnaces (Fig 2.2a). In July and August 2004 a first season of excavations investigated the western part of the site, in the area that had produced the strongest evidence by way of surface finds, bones and gradiometer results. Removal of the topsoil allowed the identification of archaeological deposits precisely matching the results of the magnetometer survey. The rectangular shape proved to represent a religious building of the 5th to 6th centuries AD (Fig. 2.2b) and one of the magnetic dipoles (the only one fully investigated at this stage) coincided with a furnace probably used for the firing of bricks (Fig. 2.2d). This case-study presents a situation in which the cognitive process was pursued through the integration of differing methods, allowing the progressive enhancement of our understanding until the final stage in the form of excavation. Admittedly, though the analysis of historical air photographs and the more recent survey from light aircraft did not produce positive results. But the gap was filled by the information obtained from magnetic survey, allowing us to establish a connection between the results of surface collection and a particular plan-form, approximate and perhaps covering several different periods but rich in measurable features and interpretative clues. The match between the magnetic anomalies, the surface remains and the excavation data constitutes a starting point for the elaboration of the interpretative keys that are indispensable for the comprehension of similar situations that differ from the present case only in respect to the lack of excavation opportunities or evidence.
**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 “iucico nomini oracolo Santi Ampsani” (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). 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 (1st century BC – 1st 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, et al. 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. 3). 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. 3, nos.1-4). There were no clear traces that could be directly attributed to the religious building attested in the documents. One possible indication, however, lay in the presence towards the north of fairly well-defined rectangular anomaly, lacking any circular element that could be related to an apse but with an eastnortheast-westsouthwest orientation and with dimensions of 20 m X 10 m (Fig. 3, no.1) that are similar to those of the church at Pava.

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. 3, nos.5-6). Their 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. 3, 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. 3, 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 cutted 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. The development of these ideas owes much to the integration of the two methods of investigation – without the evidence from field survey the interpretation of the magnetometer evidence might have seemed weak or illusory, and vice versa.

Figure 3.

_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.4, 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 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 2nd century BC to the middle centuries of the medieval period, with a peak between the 1st and 6th 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. 4a, nos.2-4). In the autumn of 2004, as part of fieldwork connected with the Master’s degree in Archaeology at the University of Siena at Grosseto, 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. 4b, 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. 4b, no.1 and Fig. 4c, no.1).

The central part of the villa consists of a rectangular structure measuring about 70 m X 25 m, oriented north-east/south-west, at each end of which are four square rooms 10 m X 10 m across.
A break in the magnetic data is caused by a disused iron pipe, which obscures the archaeology along its length without reducing the general readability of the structure (Fig. 4b, 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.

Figure 4.

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. 4b, nos.5-7). Some tens of metres to the north-east and south-east of the main complex a series of linear anomalies (Fig. 4b, no.6 and Fig. 4c, 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 (the result of the last one could change in the future surveys) produced poorer results in the north-western part of the field, where the ground survey and girded surface collection (Fig. 4c, no.9) yielded considerable amounts of structural material and ceramics, covering a chronological range from the 2nd century BC to the 6th century AD, with a final phase in the 10th-11th 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. Magnetometry and aerial photography, however, showed negative results in the north-western part of the field, as compared with field survey and surface collection. As the scale is increased the situation remains the same – only vertical air photography and satellite imagery will allow us to follow the course of the abandoned river course first seen in the immediate vicinity of the villa.

S.C.
CONCLUSIONS

There are few fields of scientific research which make simultaneous use of so many and so widely varying methods and instruments as does archaeology, and in particular landscape archaeology. In this brief review of the work carried out by LAP&T at Department of Medieval Archaeology at Siena we hope to have shown that the progressive introduction of research techniques has responded in each case to specific needs, so as to overcome or at least to ameliorate the difficulties of the context in which we work, to respond to historical and archaeological questions at the heart of our research into the region, and to make a real contribution to the care and monitoring of the historic environment.

As regards the further strengthening of our research, in technological and methodological terms, we accept that we still much to understand, in particular in relation to the possible contribution of satellite imagery, in relation to the environmental conditions that influence the visibility of archaeological evidence in the various parts of Tuscany, and as regards the acquisition and processing of gradiometer as an indication of below-ground deposits. It is also fair to point out that, in the case of some sites revealed through field survey and surface collection, all of the methods described above have been rendered inapplicable or unproductive because of the presence of disturbing factors. The problem consists, at least in part, in our current reliance on a single technique of geophysical investigation. Amongst our priorities for the coming years we must look to the possibility of filling this gap by bringing into use (alongside the gradiometer) both resistivity and georadar techniques.

Finally, we must do something to address our present inability to deal in any significant way with the 50% of Tuscany that is covered in woodland. In this connection there are promising results from experiments in the United States and Great Britain in the use of lidar, an airborne laser-scanner that can record with great accuracy the surface morphology, ‘seeing through’ woodland cover and revealing in great detail the underlying micro-relief (Holden et al. 2002; Shell 2005). In this context the Department of Medieval Archaeology is already involved in a Culture 2000 project (European Landscapes: Past Present and Future) which will hopefully allow the acquisition in 2005 of lidar data for three sample areas in the provinces of Siena and Grosseto, through the good services of colleagues in England. Moves in the same direction, in terms of penetrating both tree-cover and the ground surface itself, can be perceived in the COSMO SkyMed project undertaken in partnership with the Italian Aerospace Agency, involving the creation of a series of satellite equipment with wide-aperture RADAR sensors (SAR) giving a ground resolution of as little as 1 m.

In conclusion, although we can point to significant progress in our understanding of the archaeological and landscape evidence, we must not become over-optimistic. We must always bear in mind that, however great our own resources, the archaeological resource itself is subject to a constant and irresistible process of degradation. It is our belief that, in our efforts to delay this process and at the same time to address specific historical problems, a leading role can be played by broadening the range of remote sensing techniques that we use, along the lines suggested above, and by applying them systematically and extensively in our regional research-work. We are confident that these approaches will greatly increase our capacity to understand the archaeological resource, despite the difficulties still represented by questions of archaeological visibility.

S.C. & R.F.

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