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Archaeological Impact Assessment vs Rescue Archaeology: The Brebemi Project (Italy)

Evaluación de Impacto Arqueológico vs Arqueología de Rescate: El Proyecto Brebemi (Italia)

S. Campana
University of Siena, Department of Archaeology and the History of Arts,
Lecturer in Landscape Archaeology
Head of the Landscape Archaeology and Remote Sensing Laboratory

Abstract
The work presented in this contribution forms part of the BREBEMI project, in reaction to a major motorway construction development linking the towns of Brescia, Bergamo and Milan in northern Italy for a total length of about 120 km. For the first time in Italy a set of non-invasive procedures was used systematically in order to reduce archaeological risk in advance of motorway construction. This innovative project relied on the methodical collection of information from historical and geographical documentary sources, along with geomorphological analysis, the examination of existing vertical air photography, the collection of new data through targeted aerial survey and oblique air photography, the acquisition of LiDAR data along the whole of the motorway route (160 kmsq at a resolution of 4 hits per sqm) and the systematic collection for very substantial areas of geophysical data, both magnetic (AMP) and geoelectrical (ARP) – a total, of 438 hectares of AMP and ARP data (mesh 0,5x0.5 m and 0.5x0.08 m). Test excavations were planned and carried out systematically to verify anomalies and the Superintendency for the Region of Lombardy also initiated random trenching for a total of 5% of the surveyed area. A GIS platform for the project was designed to manage and integrate all of the data at every stage of development (from data acquisition in the field to interpretation and field checking) as well as to demonstrate overall patterns and to create predictive models. The objectives of the project were to reduce as far possible uncertainty about the presence of archaeological remains along the route and in particular to identify areas which ought to be protected from destruction because of the presence of either upstanding or buried archaeological remains.

Key Words: Rescue/salvage archeology, Preventive archeology, Archaeological impact assessment, remote sensing, large scale continuos geophysical prospection, motorway.

Resumen
El trabajo presentado en esta contribución forma parte del proyecto Brebemi, surgido como respuesta a la construcción de una importante autopista de 120 km de trazado que une las ciudades de Brescia, Bergamo y Milán, en el Norte de Italia. Por primera vez en Italia se han empleado de forma sistemática un conjunto de técnicas no invasivas para reducir el riesgo de impacto arqueológico antes de la construcción de la autopista. Este innovador proyecto se ha basado en la recopilación sistemática de información en fuentes documentales históricas y geográficas, unida al análisis geomorfológico, el estudio de las fotografías aéreas verticales disponibles, la recopilación de nuevos datos a través de prospección aérea y fotografía aérea vertical específica, la toma de datos de LIDAR a lo largo del trazado de la autopista (160 km^2 con una resolución de 4 *hits* por m^2) y la recolección sistemática en amplias áreas de datos geofísicos, tanto magnéticos (AMP) como geoeléctricos (ARP) -un total de 439 hectáreas de datos AMP y ARP-. Se programaron y realizaron sondeos para comprobar anomalías y la Superintendencia Arqueológica de la Región de Lombardía también efectuó trincheras aleatorias en un total del 5% del área estudida. Se creó una plataforma SIG para gestionar e integrar todos los datos en cada fase del proyecto (desde la toma de datos en campo hasta la interpretación y comprobación de los sitios) así como para comprobar patrones generales y construir modelos predictivos. El objetivo principal del proyecto era reducir lo

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máximo posible la incertidumbre sobre la presencia de restos arqueológicos a lo largo del trazado de la autopista, y concretamente, identificar áreas que deberían ser protegidas de la destrucción debido a la presencia de restos arqueológicos, tanto visibles como enterrados. Las enseñanzas obtenidas en este proyecto son especialmente importantes para cualquier trabajo arqueológico realizado en enclaves Patrimonio Mundial.

Palabras clave: Arqueología de rescate, arqueología preventiva, evaluación de impacto arqueológico, prospección, métodos geofísicos, autopista.

Introduction

The Italian term Archeologia Preventiva (AP) can be translated into English as Archaeological Impact Assessment (AIA). As the Italian law on this matter has yet to be finalized, it is still a little difficult to illustrate the way in which AIA is applied in Italy. However, we can start from the consideration of the purpose behind the law and a statement of what AIA is **not**.

- The new law aims to develop planning processes to minimize unforeseen problems during development and emergency rescue work.
- AIA is **not** rescue or salvage archaeology (RA/SA), its goal being that of containing and minimizing the needs for these responses.

Rescue Archaeology consists of archaeological survey and excavation carried out in areas threatened by urban development or, on occasions, already under construction. The development may include, but is not limited to, motorway and major construction works. Unlike traditional survey and excavation work, Rescue Archaeology is undertaken under pressure of time. It is carried out primarily on sites that are about to be destroyed or, occasionally, as a protective measure to preserve archaeological sites located beneath urban areas. The term Rescue Archaeology and its practice are largely restricted to Europe, North America, South America and East Asia. In Italy the term Rescue Archaeology is virtually synonymous with rescue **excavation**, in the form of a vast number of small-scale 'test' excavations [1]. Currently, the relationship between Rescue Archaeology and AP/AIA can be considered as an archaeological hot potato, a problem difficult to deal with in Italy. It represents a real cultural challenge which might lead to new lines of thought in the field of archaeology, conservation and heritage management. It is predicted that most of the funding destined for use within archaeology in Italy in the near future will be devoted only to AIA. This will most likely lead to financial speculation on the part of powerful lobbies and large investors.

If Rescue Archaeology was born with the interest of reducing the destruction of archaeology caused by urban development and land-use, AIA's starting point is completely different: it comes from the planning process. In this new perspective archaeology should be considered a key point in landscape planning alongside geology, hydrology, environmental impact and such like. It should be clear that Archeologia Preventiva and Rescue Archaeology are completely different approaches – they are indeed entirely opposite reactions both in theory and in practice. Essentially, Archeologia Preventiva **replaces** Rescue Archaeology, leaving interventions through rescue work as being necessary only when diagnostic and predictive archaeology has failed, giving to rescue archaeology – rightly – the distinctiveness of 'emergency' work.

At present, at the beginning of each public construction project in Italy which raises any kind of public concern, such as the construction of a new urban development or the

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modification of existing structures, an Archaeological Impact assessment, with related report, is a compulsory requirement [2]. Three main steps are necessary to complete such a report.

- The collection of background data from existing archaeological publications, historical cartography, toponymy and palaeomorphological studies etc.
- The interpretation of vertical air photo evidence (without, unfortunately, any reference to oblique photography from exploratory reconnaissance) and, when possible or useful, the collection and analysis of LiDAR data. In some cases further analysis might be required for individual target areas through geophysical prospection or small-scale test excavation.
- The preparation of an 'archaeological risk assessment' map, followed by targeted test excavations or larger-scale examination through mechanical stripping of the surface deposits.

The new law gives Italian archaeology the opportunity to start afresh with a new approach to methodologies developed in the field of landscape archaeology over the past forty years.

Unfortunately, the Superintendency, the government institution in charge of conservation of Italian heritage assets, which has unlimited power in this field, is currently interpreting the law so that the emphasis is still on rescue excavations, in the form of large-scale surface stripping by machine with only small-scale excavations using established archaeological methods.

The example illustrated by this paper comes from the BREBEMI Project in northern Italy, this being the acronym used to denote a motorway construction project linking the cities of **BRE**scia, **BE**rgamo and **MI**lan over a length of approximately 100km. The project was started before the new law came into effect. The Superintendency of Lombardy, with almost unlimited power within the region, required the motorway contractors to carry out 'excavation by surface stripping' over the ***whole*** of the area affected by the motorway construction. The request was logistically and financially nonsensical from the point of view of the contractors, as it would have increased the cost of the project to an unmanageable degree. As a result, the construction company contacted the author and his colleagues at the University of Siena and asked them to find an alternative approach which might subsequently be acceptable to the Superintendency.

2. Landscape, research design, research team building and management

The motorway is being constructed through the typical landscape of the Po Valley, with its extremely flat morphology and sand-and-gravel soils, heavily affected by intensive arable cultivation through the systematic use of heavy-grade tractors and deep ploughing over at least the last sixty years. The area also has substantial concentrations of industrial and related residential development (Figure 1).

For the first time in Italy the influence of the new law gave an opportunity to make systematic and innovative use of a range of non-invasive techniques to minimise the risk of archaeological damage in advance of large-scale motorway construction. The project design therefore envisaged the systematic collection of historical and geographical data and interpretations from documentary sources, along with geomorphological studies, the analysis of vertical historical air photographs, the initiation of new oblique aerial survey, and LiDAR acquisition along the whole of the motorway corridor, in some cases including a substantial buffer zone on either side. Also included was the systematic collection of geophysical data, both magnetic and geoelectrical, across large and contiguous areas

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of between 200 and 750 hectares respectively, building on an approach successfully tested in Italy, France and above all in the United Kingdom [3]. Systematic test excavations were also planned to verify anomalies identified by any or all of these techniques. Independently, the regional Superintendency designed a pattern of random test trenches amounting to a 5% sample of the motorway corridor.

Within the BREBEMI company a GIS environment was designed to manage and integrate the collected data at all stages of the project, from data acquisition in the field to interpretation and field checking, so as to assess any significant trends in the collected data and to develop archaeological models. The aim of the project was to reduce the degree of uncertainty about the presence (or ***potential*** presence) of archaeological remains by identifying areas that ought ***not*** to be subjected to disturbance by the construction works in the light of the demonstrated presence of either surface or sub-surface archaeological remains.

The Laboratory of Landscape Archaeology and Remote Sensing at the University of Siena already had experience in using each of these survey methods but saw the BREBEMI project as an extraordinary opportunity to add its weight to an important culture-change in the theory and practice of preventive and rescue archaeology in Italy. A decision was therefore taken to involve some of the most highly skilled and specialized companies, institutes and research workers from across Europe. The Laboratory used Archeolandscapes Tech and Survey Enterprise (ATS), a spin-off company of the University of Siena, to act as project coordinator and to manage the following activities:

- Aerial survey, in collaboration Klaus Leidorf, of Luftbilddocumentazion from Germany, and Chris Musson from the UK.
- Interpretation and mapping of information from vertical aerial photographs, by the Laboratory's own staff.
- LiDAR processing and interpretation in collaboration with Prof Dominic Powlesland of the Landscape Research Centre and University of Leeds in the UK.
- Processing and interpretation of magnetic data, again in collaboration with Prof Powlesland.
- The collection and interpretation of geoelectrical and magnetic data by SoIng s.r.l. (Italy)
- GIS and topographical survey, integrated archaeological data interpretation, selective ground truthing and test excavation by ATS s.r.l.

The collection of information from historical and geographical documentary sources was carried out by the University of Bergamo under the direction of Prof J. Schiavini, as were place-name and geomorphological studies.

The geophysical prospection (Figure 2) involved the use of magnetic and geoelectrical instruments (respectively ARP and AMP, Automatic Resistivity Profiling© and Automatic Magnetic Profiling©) developed by Geocarta, a French spin-off company of CNRS, the National Centre for Scientific Research. Geocarta, under the scientific direction of Michel Dabas, also exercised quality control over the collected data and remained on call to provide general assistance throughout the whole process from fieldwork to data processing and interpretation [4]. The initial collection of the data was undertaken by SoIng of Livorno, an official partner of Geocarta with long-standing experience in geophysical survey for environmental projects.

Altogether, the project management involved the co-ordination of a team of about 25 research workers from Tuscany, Northern Italy, France, Germany and the UK, carrying out a wide variety of interlinked

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work in a very short period – about 4 months or 80 working days (Figure 3).

3. Results

Bearing in mind the large size and peculiar shape of the survey area, this paper concentrates for the most part on a sample area, representative of the landscape as a whole in terms of known archaeological data, geomorphological complexity, the availability of geophysical and other survey data, and ground truthing. This sample, measuring about 20km in linear extent, lay between Caravaggio and Urago d'Oglio, roughly bounded by the Rivers Oglio and Serio. The research work itself was divided into two main steps: the collection of existing knowledge, and the survey work in the field.

- Place-name registers and historical maps, including historical cadastral maps and the national maps of the Istituto Geografico Militare (University of Bergamo – CST).
- The Archaeological Map of Lombardy, with related updates (University of Bergamo – CST).
- Maps of springs, palaeo-river channels, fluvial ridges and fluvial terraces (University of Bergamo – CST).
- The interpretation and mapping of information from historical and contemporary vertical air photographs, principally the GAI series of 1954 and the CGR series of 2007 (LAP&T and the University of Bergamo – CST).
- New aerial prospection and air photography along the motorway route in the spring and summer of 2009 (ATS Enterprise in collaboration with Klaus Leidorf from Germany and Chris Musson from the UK).
- The capture, processing and interpretation of LiDAR data (collection and initial processing by CGR of Parma, with further analysis and interpretation by ATS Enterprise in collaboration with Prof Dominic Powlesland in the UK).

The collection and mapping of the sites published in the Archaeological Map of Lombardy [5], with subsequent updates, produced evidence of 118 already known archaeological sites within the 2km wide buffer zone, representing a density of about 2.38 sites per square kilometre, relatively high in comparison with the national average. Even so, this obviously constituted only the tip of the iceberg in terms of the ***potential*** number of sites within the survey

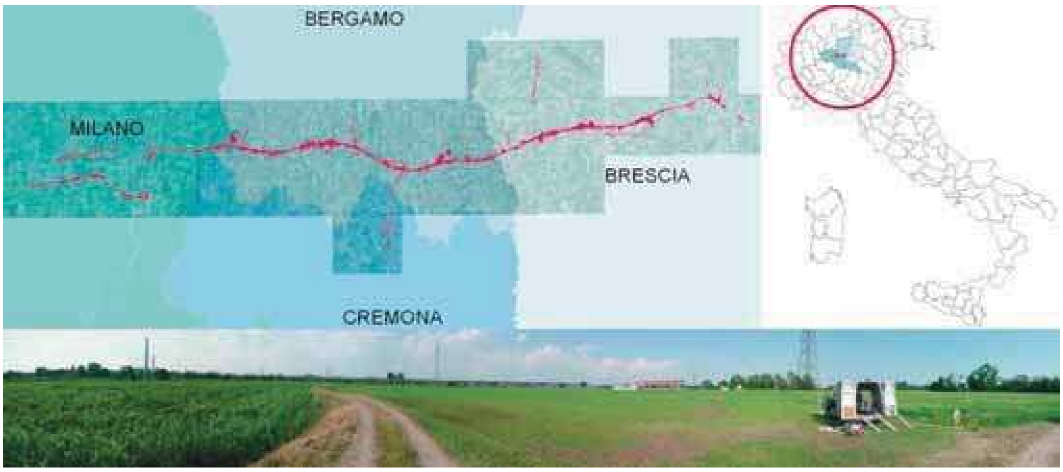

Figure 1. General overview of the motorway path and outline of the landscape pattern (north at the top).

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Figure 2. Geophysical instruments used during the survey. Left: the Automatic Magnetic Profiler (AMP© Geocarta), capable of recording up to 20ha each day. Right: the Automatic Resistivity Profiler (ARP© Geocarta), capable of recording up to 4ha each day. To increase productivity within the project two ARP instruments were often used simultaneously.

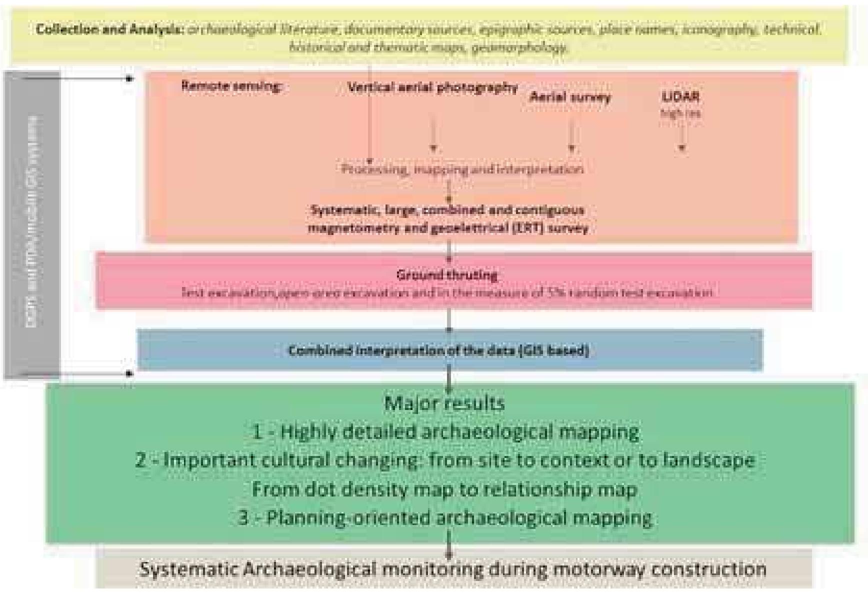

Figure 3. Pipeline of information and activities within the BREBEMI project.

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area. Recent studies in Tuscany, Lazio and Puglia [6] have suggested that, in the absence of systematic survey projects, the 'published' archaeology as represented in the archives of the Archaeological Superintendency, represents no more than 1% to 5% of the 'real' archaeological potential. If applied to the BREBEMI motorway this would suggest the possibility of between 2000 and 12000 archaeological sites and find-spots within the buffer zone.

The first stages of the analytical work

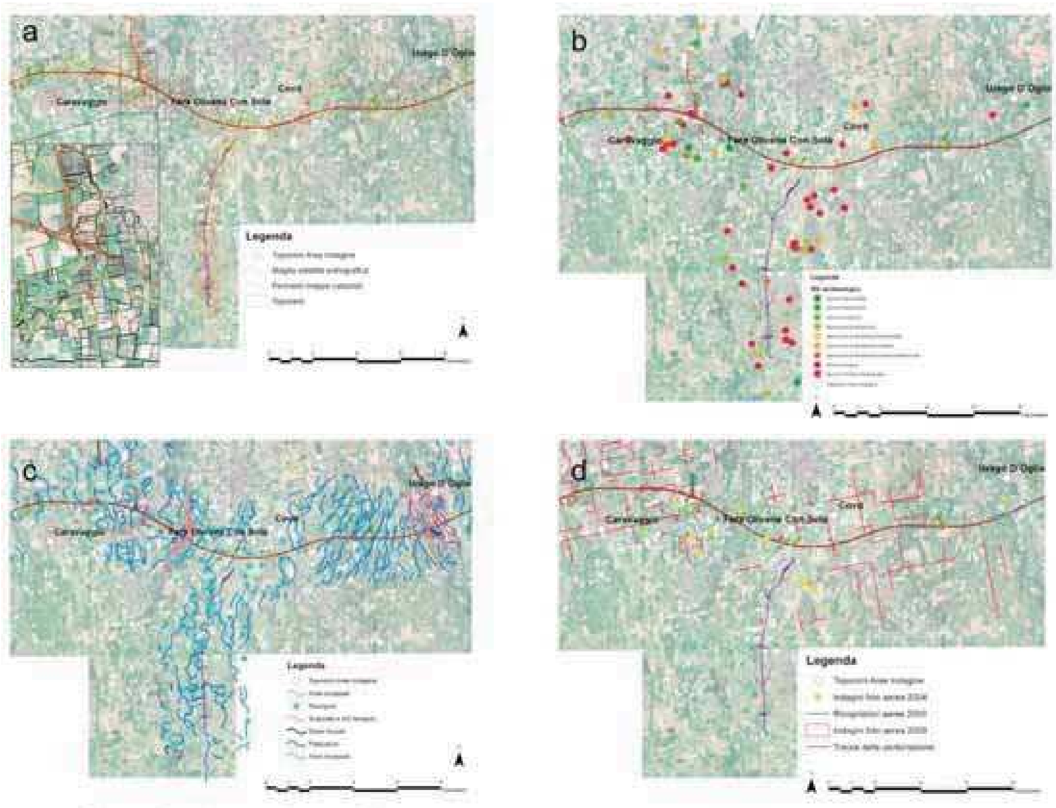

Figure 4. Mapped evidence for part of the survey area.

a) Historical cadastral map recording 3650 potentially relevant place-names and 154km of field boundaries within the 1km-wide buffer zone on either side of the motorway corridor.
b) Distribution map of known sites and related archaeological evidence (118 in all, including 50 within the sample area.
c) Map of springs, palaeo-channels, fluvial ridges and fluvial terraces, clearly showing the hydrogeological volatility of the area.
d) Distribution map of features detected through exploratory aerial survey and oblique air photography.
e) The first step involved the collection and entry into a GIS environment of all the available information about a 2km wide buffer zone centred on the motorway corridor, from archaeological sites and finds to geomorphology and the evidence of existing aerial photographs etc. This involved the collection of the following information and material (Figure 4).

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went some way towards confirming this suspicion. For instance, the new aerial survey and the analysis of the historical air-photographs added another 76 'sites' of various kinds, substantially enriching the landscape picture and in some cases providing very detailed information about the sites concerned. An equally important contribution from the air-photographic studies lay, as expected, in the reconstruction of the centuriation grid, knowledge of which is essential in Italy to the better understanding of the landscape and settlement patterns of the Roman and later periods

In some cases, for example at a location close to Bariano (Figure 5), oblique aerial photography produced really striking results, bringing to light very detailed evidence of post holes, graves, round barrows and other previously unknown archaeological features but at the same time allowing the motorway construction company to take protective measures so as to avoid major logistical problems and significant waste of money during the eventual construction work.

The project also involved the capture 150sqkm of LiDAR data at a resolution of 4 hits per square metre, covering the full length of the motorway corridor along with the 1km buffer zone on either side. As noted above, the morphology of the area is to all intents and purposes completely flat and the land use devoted for the most part to intensive cereal and maize production. The collection of LiDAR data was essentially aimed at identifying barely perceptible ridges, elevated areas and depressions, many of them perhaps related to former water courses. The first stage of data processing, to create a basic digital terrain model, was carried out by CGR of Parma, the survey company which undertook the initial data capture. The second step involved collaboration between ATS Enterprise and Prof Dominic Powlesland in the UK, using his own visualization software, LidarViewer. This allowed the identification of 509 potentially significant features, consisting of 173 depressions, mainly interpretable as palaeo-river channels on the basis of their size,

Figure 5. Newly discovered cropmark features near Bariano. From left to right: archaeological features associated with ancient road systems, the centuriation pattern, large round barrows and graves. Centre: detail of one of the cemeteries, and settlement evidence including a ditch, post holes and probable *grubenhause*. Right: the relationship between the site and the planned route of the motorway.

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continuity and sinuous shape, along with 336 ridges or 'elevated' areas, at least some of them interpretable as fluvial ridges.

The collected information showed a clear tendency for known archaeological 'sites' to occupy fluvial ridges and other 'elevated' areas within the plain. This is not to imply that these 366 raised areas correspond to a similar number of archaeological sites, only that these areas have a higher potential for the recovery of traces of past human activity. For instance, overlaying the LiDAR data for Bariano on the aerial survey for the area shows that there is a clear correspondence between the features detected from the air and a terrace or ridge bordered on either side by two shallow depressions or 'valleys'. An alternative interpretation would see the air-photo features as potentially continuing across the ***whole*** of the fields concerned but only being ***visible*** as cropmarks on the thinner and potentially drier soil of the ridges compared with the deeper and less responsive soil in the flanking depressions.

There can be no clear rule of interpretation about such situations but there are many other instances within the survey area where there is a clear relationship between topographical features in the LiDAR data and known or suspected archaeological sites established through documentary, place-name and cartographic research or through geophysical prospection or air-photo studies. With all due caution it is fair to stress the importance of carefully analysed LiDAR data, even in apparently 'unpromising' situations, in the process of archaeological prospection and indeed within the archaeological process as a whole.

Turning now to the second part of the process, and in particular the collection of geophysical measurements and related ground truthing, both the BREBEMI partnership and the Superintendency demanded a high level of reliability in the interpretation of the geophysical data. This is what prompted LAP&T and ATS Enterprise to involve Geocarta in the systematic collection of ARP (magnetic) and AMP (geo-electrical) data on a field-by-field basis across the whole length of the motorway area. A total of 217ha of magnetic data and 215ha of geo-electrical data was collected, processed and interpreted. Ground truthing of the first 150ha was carried out through more than 200 test excavations, to a linear extent of about 5220m (2.6 hectares) of 'targeted' interventions and a further 5000m (2.2ha) of random excavations. Before looking at the results it is worth making some general comments on the kind of high-speed geophysical prospection involved in this case.

- High-speed prospection instruments demand high-speed processing and (more problematically) high-speed archaeological interpretation and mapping.
- The process of archaeological interpretation was more difficult in this case because of the peculiar shape of the survey area, a strip 100-150m wide along the full 100km length of the motorway.
- The prospection instruments for the most part performed extremely well but the use of a prototype instrument for collecting the magnetic data appears to have introduced a certain amount of noise into the dataset. This noise has been reduced substantially in the more recent AMP instruments.
- The background noise, along with the physical and cultural peculiarity of the survey area, in particular the low magnetic contrast and perhaps other factors not yet identified, resulted in the identification of a large number of dipole clusters that were difficult to interpret, reducing the perceived reliability of the geophysical results.

Despite these problems we remain convinced that the systematic high-speed collection of geo-electrical and magnetic data

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is theoretically a right and proper procedure within such projects. In practice, however, there were too many occasions in this particular physical and cultural context where the magnetic data did not materially help archaeological interpretation.

Even allowing for these problems the geophysical prospection enabled the identification of a large range of both positive and negative evidence for the presence or likely absence of buried archaeological features. A quite relevant example has been identified at Antegnate, near Bergamo (Figure 6). The magnetic survey revealed several anomalies, in particular a large number of circular features or ‘ring-ditches’. The size, shape and distribution of these finds close parallels with probably the most widespread and numerous class of archaeological monument in Europe, the ‘round barrow’. Similar features are found in other part of the world too. At its most basic a round barrow consists simply of a roughly circular or oval mound of soil raised over a burial situated at its centre. Beyond this there are numerous variations which may employ, as in our case, a surrounding ditch. Field verification of the features at Antegnate was extremely interesting. Test excavation by caterpillar did not produce any material evidence at all, whether of negative features or of pottery or bone etc. To identify the suspected features properly the stripped soil had to be cleaned very carefully by trowel. Only when this was done were the archaeological features revealed, as illustrated in Figure 6. On the basis of this example mechanized stripping on its own, without this careful extra work, can be expected to be extremely selective and inefficient in its detection of certain types of evidence, such as the indistinct traces of ditches, post holes and pits etc.

Despite the problems encountered it should be emphasised that the interpretation of the geophysical data in most cases achieved a higher level of interpretative reliability when combined with information from other datasets such as those derived from documentary sources, cartographical studies, aerial photography and LiDAR prospection. In the most favourable cases it is undoubtedly possible to achieve a full and detailed interpretation of the survey data. Despite degrees of uncertainty in other instances it is certainly possible to construct a reasonably reliable map of archaeological risk and potential which can then be subjected to ground-truthing by properly conducted test excavation or more substantial stratigraphical investigation in advance of the construction of the motorway.

4. Conclusions from the BREBEMI case history

Over a period of no more than 4 months of multi-faceted investigation it proved possible to collect and interpret a vast amount of data, greatly enriching archaeological understanding of this particular stretch of landscape. The collected evidence and its interpretation also helped the motorway contractor to plan in advance for archaeological work which might otherwise have necessitated delays and extra expenditure during the construction work through the discovery of unforeseen archaeological sites and deposits.

The first 438ha of geophysical prospection and ground-truthing showed up some critical comparisons with the ‘caterpillar’ prospection system adopted by the regional Superintendency. In this context it is important to stress that while geophysical prospection and interpretation improve in reliability every year it is not possible to say the same for the method of rescue investigation adopted by the Superintendency, using mechanical stripping rather than prior survey and targeted stratigraphical excavation. Another key point is that it is not possible to verify the results of the excavation work initiated by the Superintendency – every archaeolo-

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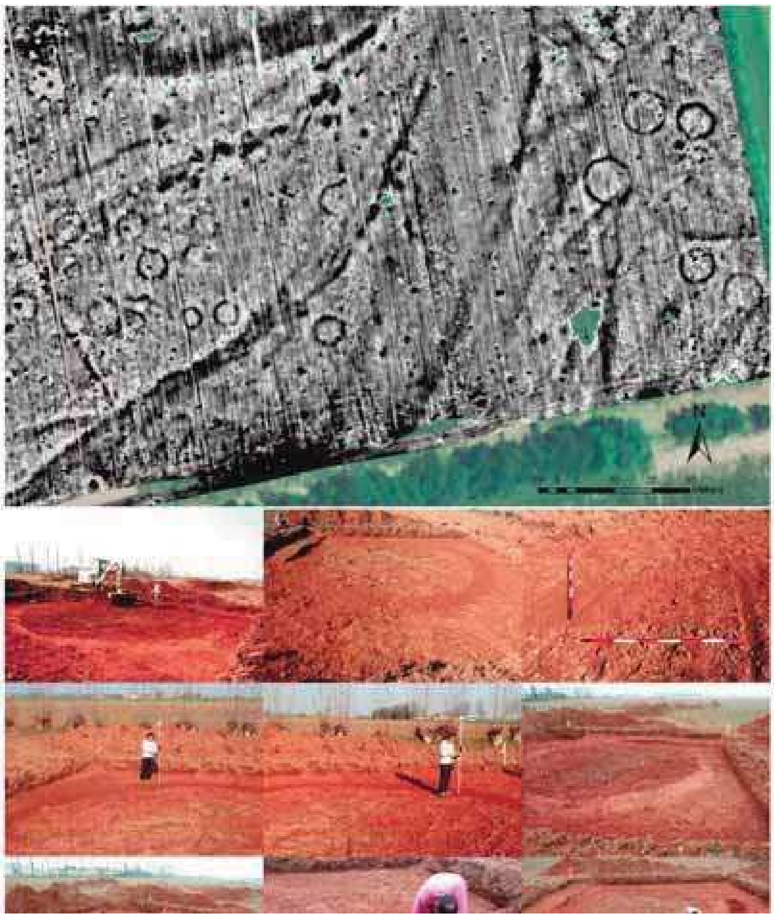

Figure 6. Extracts from the magnetic map represented with values ±15 nt, with related interpretation and ground-truthing by excavation (north at the top). Top left: circular features with numerous parallels throughout Europe as (mainly Bronze Age) round barrows, with ground-truthing confirming this interpretation.

gist knows that excavation destroys the evidence upon which it relies, especially if it is not carried out within a suitable methodological framework. By contrast it is entirely possible – and desirable – to use stratigraphical excavation to verify and interpret potential archaeological features recorded initially through geophysical or other forms of non-invasive prospection.

There is a clear contrast here between the approach of LAP&T and ATS Enterprise within the BREBEMI project compared with the traditional approach advocated by the regional Superintendency. Fortunately an 'outside' assessment of the relative merits of the two approaches, based on depositions in writing and in person by both parties, was made by the Technical and Scientific Committee for Italian Archaeology, consisting of leading academics along with the General Director of the Superintendency at national level. After a detailed analysis of the two approaches the Committee was unanimous in its conclusion that the

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strategy proposed by LAP&T and ATS, and the survey and ground-truthing work subsequently undertaken, represented the most advanced approach to this kind of preventive and rescue archaeology so far attempted in Italy and that this case study should represent a model for future projects of infrastructure and building development.

One final observation is perhaps in order. The greatest improvement in rescue and preventive archaeology will surely come not from technological development alone but from a more consistent application of the kind of 'total archaeology' and 'global' historical approach advocated at the beginning of this paper. This change of approach is imperative because we need first to understand the local context by working closely with local archaeologists and historians in the attempt to improve our capacity to interpret and test the 'global' dataset assembled from multiple survey techniques. Only then will it be possible to reduce the archaeological risk and maximize the archaeological returns from preventive and rescue archaeology.

5. Final remarks on the relationship between Ra and AIA

In the basis of our experience in the BREBEMI project it is clear that rescue archaeology of the kind preferred (and still pursued) by the regional Superintencency suffers from many shortcomings:

- 'Surface stripping by caterpillar' is selective and inefficient in the detection of certain types of evidence, especially negative features such as ditches, pits and some types of graves etc.
- This is an anachronistic approach to archaeology, site-based or even worse find-based or 'object-based'. It takes no account of the cultural context (cultivation patterns, field systems, infrastructure, relationships etc) or of environmental evidence (riverbeds, ridge-and-furrow cultivation etc.).

Moreover, it is important to emphasize that this kind of 'rescue archaeology' approach is the heritage of a culture that has never understood the wider significance of the change to a stratigraphic way of 'thinking' archaeology and of writing history – based primarily on the observation of relationships and not the recovery of individual objects. Deprived of their original context, after all, such objects lose virtually all of their potential meaning. The strategy implemented in the BREBEMI project, as well as in other case studies elsewhere, represents the concrete expression of the transposition into the landscape context of this stratigraphic approach – one might almost say culture. It matters little if here and there some details are lost – this is in no way different from the situation on an archaeological excavation if we fail to see or understand a stratigraphical relationship. Undoubtedly the loss of those details does not in itself invalidate the basic methodology.

Besides, we should highlight that there are at least two other main issues related to current rescue archaeology practice in Italy.

- Excavation by surface stripping has an inherent limitation: ***it is not repeatable***, meaning that it is impossible to verify how much archaeology has been lost
- Moreover, this kind of approach produces an unceasing 'state of emergency', generating stressful working conditions that are completely inimical to the effective study, understanding and preservation of the potentially available evidence. This does not meet even the minimal requirements for making good choices and carrying out high-quality work.

It is obvious, of course, that more experience and further case studies are needed and that the strategy, methodology and technology put to work in the BREBEMI project could be improved upon. Nevertheless, in contrast with the outdated methods even-

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tually imposed upon the motorway development, we feel that the approach that we took in our work:

- matched up to the most advanced European practice in the field of preventive archeology;
- proved highly efficient, allowing us to record objectively positive and negative man-made features as well as natural evidence, providing precise information and a seamless continuity to a level of detail well adapted to the archeological requirements;
- provided systematic, continuous and integrated mapping of a broad range of evidence;
- finally, our strategy was (and is) testable, repeatable, scientific and capable of refinement, in contrast to Superintendency's approach of 'excavation by surface stripping' which inevitably triggers a short-circuit in any cycle of research.

It has to be admitted, of course, that the academic sphere suffers from its own shortcomings. Academic research in landscape archaeology is largely based on remote sensing, survey by field-walking and surface collection, and archaeological excavation aimed at securing detailed information of particular kinds or at particular locations. At the same time, before we can commit ourselves to the inevitably destructive process of excavation, we need a firm indication of the existence of buried archaeology. As a result within academic archaeology generally we do not excavate where the prospection data is mute. It is essential at this point to stress the completely different perspective taken by 'preventive' archaeology. We can of course apply the same kinds of strategies and methods that we use in academic research, but there is a fundamental difference: the whole of the endangered area will come under excavation of one sort or another even if the archaeologist's usual survey tools have failed to reveal positive evidence of buried archaeology. The difference in a few words is that academics excavate only where some specific evidence is available, with the result that they almost never systematically test areas where the basic survey methods have failed to produce positive evidence of settlement or other kinds of human activity.

For instance in the BREBEMI case study – probably using the highest intensity of survey techniques available at the time – we may inevitably find that some important evidence of human activity escaped our search, as might have been the case with some forms of burial and with other activities that left only the most ephemeral of evidence.

The opportunity for systematic verification of the prospection datasets should be properly recognized, at least from the methodological point of view, as the main challenge and at the same time the greatest opportunity. Thanks to the possibility of verifying the correspondence (or otherwise) between massive datasets and thousands of hectares of archaeological excavation, the methods of archaeological prospection and of excavation could be greatly improved in a relatively short time. It is possible for instance to go back to the data and to check whether problems of apparent non-detection are related to instrument sensitivity or resolution, or perhaps derive instead from some misunderstanding or omission in data interpretation [7]. Another interesting approach to this kind of issue suggested from pioneering experiences in the UK and Italy [8] is the implementation of geophysical survey ***after*** removal of the plough-soil (Figure 7).

It is widely recognized that topsoil represents the main source of noise in geophysical data. Moreover some methods, such as magnetometry, gain greatly from a reduction in the distance between the sensor and 'discontinuities' in the subsoil. The example presented in Figure 7 shows clearly the potential of geophysical methods for providing opportuni-

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ties to document and explain the evolution of large areas and relatively complex societies. Serious attention is needed to both of these possibilities. The opportunity for systematic and large scale ground-truthing through the kind of large-scale excavation work which followed the geophysical survey at Cook's Quarry can present the archaeologist with the chance to learn and understand more about issues of archaeological visibility, 'emptiness' and the inevitable but sometimes unacknowledged limitation of our current remote sensing techniques.

Postscript

Sadly, the regional Superintendent for Lombardy, Dr Raffaella Poggiani Keller – as is her right within the present organizational structure in Italy – ignored the National Committee's opinion, suspending further work by the BREBEMI consultancy and applying her own method of surface stripping to the rest of the motorway. On the basis of this example it will clearly take time for more advanced methods to attain a widespread application elsewhere. Nevertheless, through the impact of the new law and the example of this and other projects over the past few years the ground has surely been prepared for a culture-change in the official approach to preventive and rescue archaeology within Italy.

Implications for the management of World heritage sites

It might be asked what relevance this has to the management of World Heritage sites. The answer is that even within these areas some forms of destructive development occasionally become necessary to meet the needs of present-day society. Whenever this happens, as it inevitably will, the need for a carefully structured and meticulously executed 'preventive' approach is absolutely vital, as is the conduct of any resulting excavations to the very highest standards of stratigraphical excavation. Only in this way will it be possible to preserve, or to recover through excavation, the hidden archaeological evidence that is an essential part of any designated World Heritage site.

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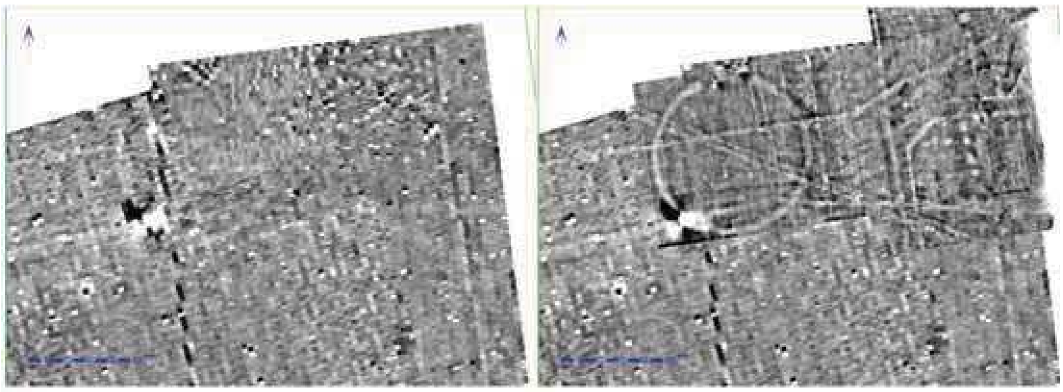

Figure 7. Left: the apparently blank survey of an area at Cook's Quarry, West Heslerton, in the UK, shows almost nothing before removal of the plough-soil. Right: by contrast, the re-survey after removal of the plough-soil reveals clear evidence of a circular 'hengiform' structure, a Bronze Age trackway and a Late Bronze Age/Early Iron Age field system. (Reproduced by courtesy of Prof Dominic Powlesland, Landscape Research Centre, West Yorkshire, UK.)

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