

Between necessity and economy: The archaeological field excavation at Gribaia (Sardinia, Italy)

A photogrammetrical solution to document a small archaeological heritage

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Abstract: Between May and June 2007, an archaeological excavation was carried out by the 'Soprintendenza per i Beni Archeologici per le Province di Cagliari e Oristano' (Agency for the Archaeological Heritage - Cagliari and Oristano Provinces) in the Late Neolithic site of Gribaia at Nurachi (Oristano). The archaeological excavation has taken a period of 20 days and brought into focus a new situation about the Sardinian Neolithic. In Italy the archaeological field excavations are often accused to produce a poor documentation and to pay little attention to the stratigraphic method, because they are carried out in a short time and with few resources.

The aim of this paper is to demonstrate how it could be possible otherwise. We want to expose an applied photogrammetrical solution (with the help of photos taken by a kite) to create the graphic documentation of the archaeological excavation. The new attempt made it possible to collect the information into a GIS platform, through the processing of photos after the end of the excavation. Since necessity is mother of invention, we want to expose how it has been possible to collect and revise the graphic documentation of a stratigraphical excavation after its end.

Zusammenfassung: Zwischen Mai und Juni 2007 wurde eine archäologische Ausgrabung von der Soprintendenza per i Beni archeologici per le Province di Cagliari e Oristano (Agentur für das archäologische Erbe der Provinzen Cagliari und Oristano) in der späten Jungsteinzeit Siedlung von Gribaia-Nurachi (Oristano) ausgeführt. Die archäologische Ausgrabung hat 20 Tage gedauert und brachte neue Erkenntnisse über die sardische Jungsteinzeit. Archäologische Not-Ausgrabungen werden in Italien schlecht angesehen, da sie aufgrund von Zeit- und Ressourcenmangel angeblich über eine schlechte Dokumentation verfügen und der stratigraphischen Methode wenig Beachtung / Aufmerksamkeit schenken. Diese Arbeit soll zeigen, dass der Vorwurf nicht gerechtfertigt ist. Wir setzten eine angewandte Fotogrammetrie -Methode ein (mit Hilfe von einem Drachen wurden Fotos gemacht), um die zeichnerische Dokumentation der archäologischen Ausgrabung zu erzielen. Nach dem Ende der Ausgrabungen machte es die neue Methode möglich, die gemachten Fotos zu verarbeiten und die von ihnen gewonnenen Informationen in einer GIS-Plattform zusammenzufassen. Die Notwendigkeit machte uns erfinderisch. Im folgendem möchten wir erklären, wie es möglich war, die Grafik-Dokumentation einer Ausgrabung nach seinem Ende zu sammeln und zu überarbeiten.

Keywords: Photogrammetry, GIS, Kite, Sardinia's Heritage.

The archaeological rescue excavation at Gribaia: a new Late Neolithic settlement.

Between May and June 2007, over a period of 20 days, the 'Soprintendenza per i Beni Archeologici per le Province di Cagliari e Oristano' (Agency for Archaeological Heritage - Cagliari and Oristano Provinces) has run a rescue archaeological excavation at the Neolithic settlement of Gribaia - Nurachi (province of Oristano, centre-west Sardinia).

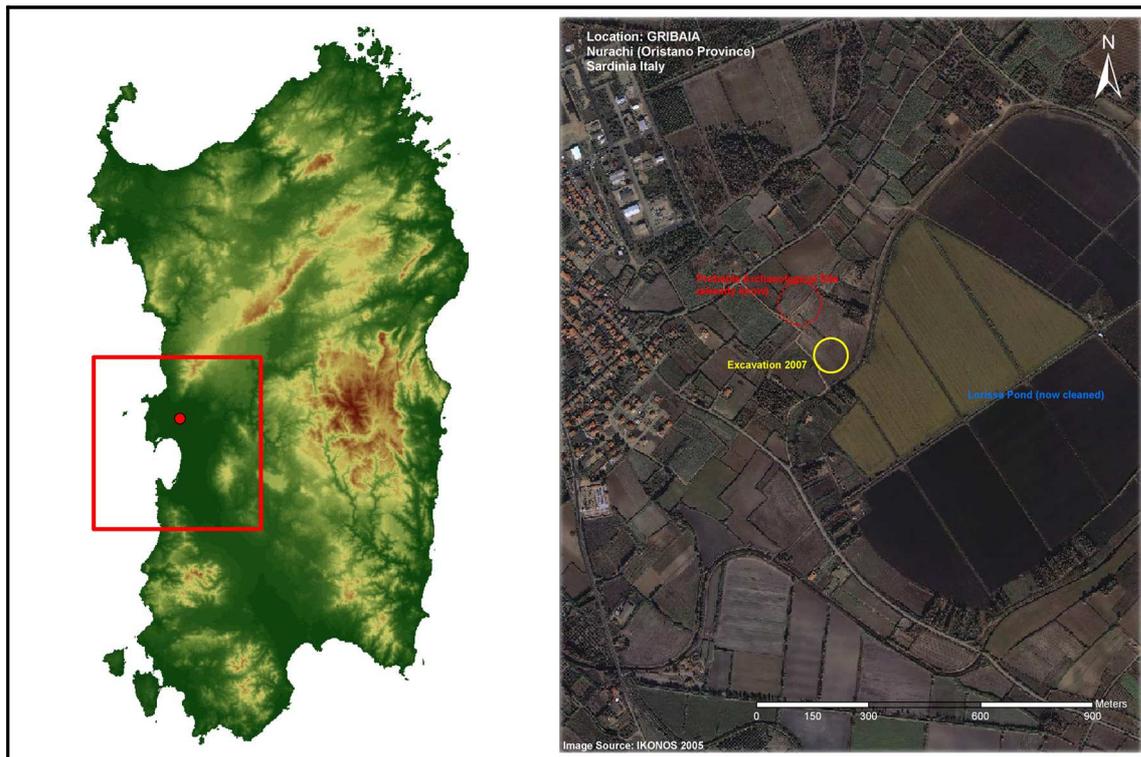


Fig.1 – Localization of the Neolithic settlement of Gribaia.

Although the archaeological site was already known because of the finding of pottery and female prehistoric figurines (ATZENI 1978, LILLIU 1999), a building procedure (without the permission of the Soprintendenza) allowed the construction of a rural house on the top of the hill occupied by a prehistoric settlement.

The Soprintendenza ordered to move the house to a lower point at least 150 meters away from the top of the little hill. The chosen point was characterized by a lesser amount of archaeological surface finds.

On the basis of the experience gained in the contexts of prehistoric Sardinia, we believed that the archaeological material on surface was not in situ, but rather the result of a scrambling for the frequent plowing.

First results of the excavation

The excavation for the foundation of the house revealed, under the layer of humus, a significant and well preserved archaeological context.

Inside the excavation (wide about 22 x 21 meters) there was a distinct area of 10 x 10 metres that was characterized by a cluster of pits filled of archaeological materials. The pits have become evident only after the removal of humus (stratigraphic layer 01) and, which uncovered the underlying layer (stratigraphic layer 02).

The first results were interesting and satisfactory.

In the south-eastern sector of the excavation there were 29 pits with an average diameter of 20/45 cm and 20/30 cm deep. 14 pits contained ceramic vases, 12 water mollusc shells, 2 splinters of obsidian, one was empty. A group of small stones was also identified, including a little piece of millstone, which was perhaps, contained in a pit.

In the north-eastern area came to light a larger pit filled with a lot of lumps of black or reddish clay, some of which with imprints of leaves and branches, which seems the dumping of plaster of a prehistoric dwelling.

The fragmentary remains recovered in the layer 2 belong to the same archaeological phase of the selected and intact vases found in the pits dug in the same layer 2.

The lower layer 2 contained ceramic fragments, animal bones, water mollusc shells, splinters of obsidian, a grinding stone. In addition, a piece of clay human figurine (7.2 cm wide, 6.5 cm high) was recovered.



Fig. 2 – A piece of human clay figurine from the layer 2.

All the remains are fragmented and scattered items, indicating an alteration of the terrain which took place already in prehistoric times.

The finds from both layers refer to the facies of the Sardinian Late Neolithic called San Ciriaco -IV millennium BC- (LUGLIÉ 2000). On the contrary, the surface finds at the top of the hill belong to later periods as the facies of Ozieri -Final Neolithic- and sub-Ozieri - Early Copper Age - (DETTORI CAMPUS, 1989; 1997).

The harsh reality of rescue archaeology in Sardinia – The need to make a fast decision

Following the special and new archaeological situation, as a consequence of the first results, curiosity and desire of new ways of research have emerged.

In the case of rescue excavation at Gribaia, the need to sacrifice the graphic relieving, in favour of a faster, but equally rich and efficient digital photo documentation, was evident from the first moments. As many archaeologists know, time is the major determinant in archaeological rescue excavation. We have to add the lack of funds and logistical support that should allow to plan the archaeological excavation.

Initially, the creation of a grid (1m X 1m), the use of an optical theodolite, a trekking GPS, and few co-workers were the only instruments available to implement the graphic documentation of the archaeological excavation.

Of course, after the excavation, it has been possible to create a digital graphic documentation on photogrammetric basis, through the help of a simple CAD software, even using the available optical theodolite, and then through a simple triangulation from fixed points that could anchor the elements of the excavation to be represented. The same is valid for the use of the available trekking gps.

The margin of error that it is exposed (GABRIELLI 2003; CAMPANA 2006), did not allow to obtain precise georeferentiation of the archaeological excavation, and likewise, the use of an optical theodolite and the triangulation of points, not less would have influenced the speed of the excavation, suggesting also a more usual archaeological drawing done according to the traditional methods.

A possible solution by the use of a kite

Only taking air photos from a kite, it was possible to create a digital graphic documentation, after the end of the archaeological excavation, and therefore without hindering the development of the same excavation.

Thanks to the generosity of an employee of the Soprintendenza Archeologica¹, we had the opportunity to use the kite and related equipment for taking photos.

The possibility to have air photos has been crucial to create a genuine digital graphic representation of the excavation on GIS platform. It have been possible, to the detriment of the simple CAD softwares, to report a database enriched in stratigraphic information and related to graphic design (both raster and vector).

The instrument used is a kite with an attached camera. The camera is connected through a device with remote control system to a monitor on the ground. Through this system, we could preview how and where to take pictures.

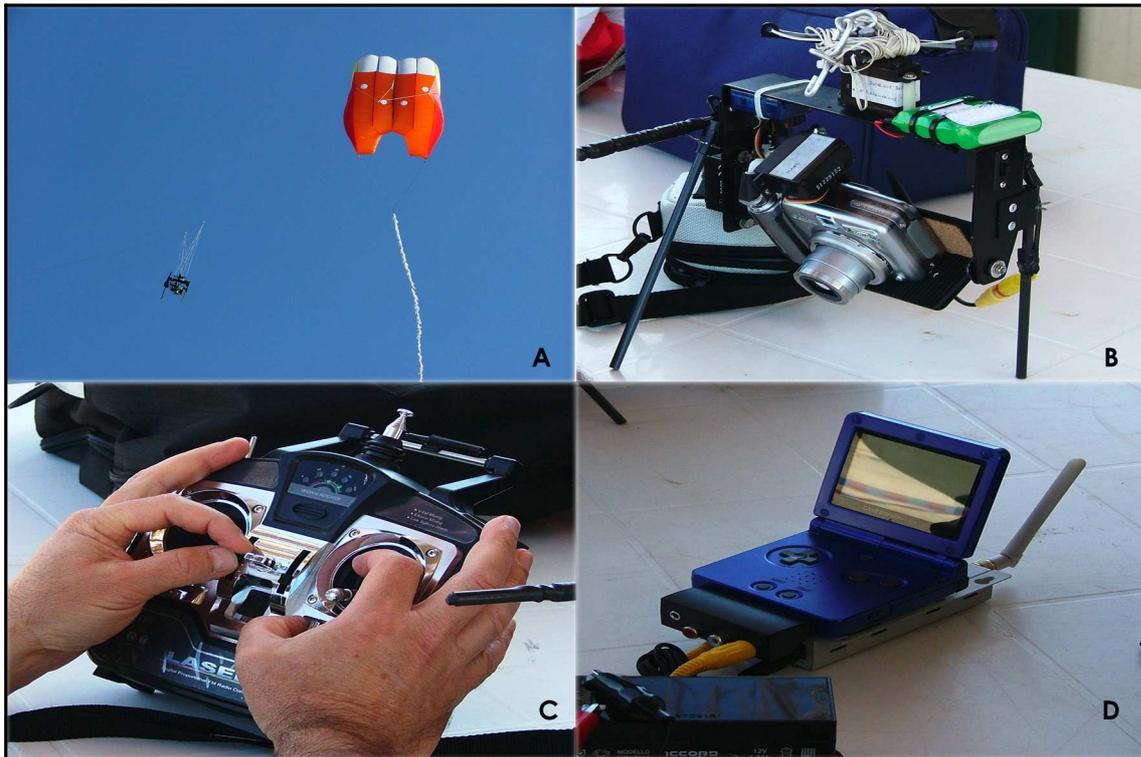


Fig.3 – The kite system: A) Sail, B) Camera, C) Joystick, D) Monitor.

It allowed performing oblique and zenithal photos at different heights up to a maximum of 250 m above sea level.

Thanks to the remote control we could know when the camera was in a zenithal position or in an oblique position.

The photos shoot not only the excavation area, but also the surrounding landscape, allowing the location of the excavation in the space and its consequent georeferencing.



Fig.4 – Photos taken by the kite: oblique and zenithal.

We know that an aerial photo-documentation, with excellent resolution, implemented simultaneously with the removal of the archaeological deposit, would permit however the creation of the entire graphic documentation, even after the archaeological excavation, but unfortunately this was not applicable in the situation here exposed.

Indeed the use of a kite requires for its optimal operation, the presence of at least two people, who must have a very good knowledge of the wind and of the use of the sails.

As the kite is exposed to the influence of the quality and quantity of wind, that even during the excavation of Gribaia influenced operations, the use of the kite forced the employed people to take advantage of favourable times, compatibly with the needs of the excavation.

Data processing.

The first step was to rectify an oblique image covering a space large enough, with the help of Air photo 3.2².

This operation made possible the photo-rectification through georeferencing of the excavation, on the basis of recognition of photographic fixed points on the CTR maps (Regional Technical Map) and on the Orthophoto maps in scale 1:10.000.



Fig.5 – Example of a rectified oblique photo

The photo-rectification and georeferencing of the images helped us locate the area of the excavation on the available maps and the subsequent georeferencing of the zenithal photos taken from above.

The steps outlined so far are very simple actions for those who are accustomed to the practices of oblique -image photo rectification and to the use of aerial photography with archaeological purposes. Given the paucity of available elements, the plan of the excavation was obtained by means of a standard grid system.

After recognition of the archaeological area, the most interesting space was included in a mesh grid of 1 m x 1 m.

Using a GIS platform, which tracks the georeferenced and oriented grid, on the basis of the zenithal photos, we created the first shape file, showing the perimeter of the part of the building excavation site where the archaeological area was found.

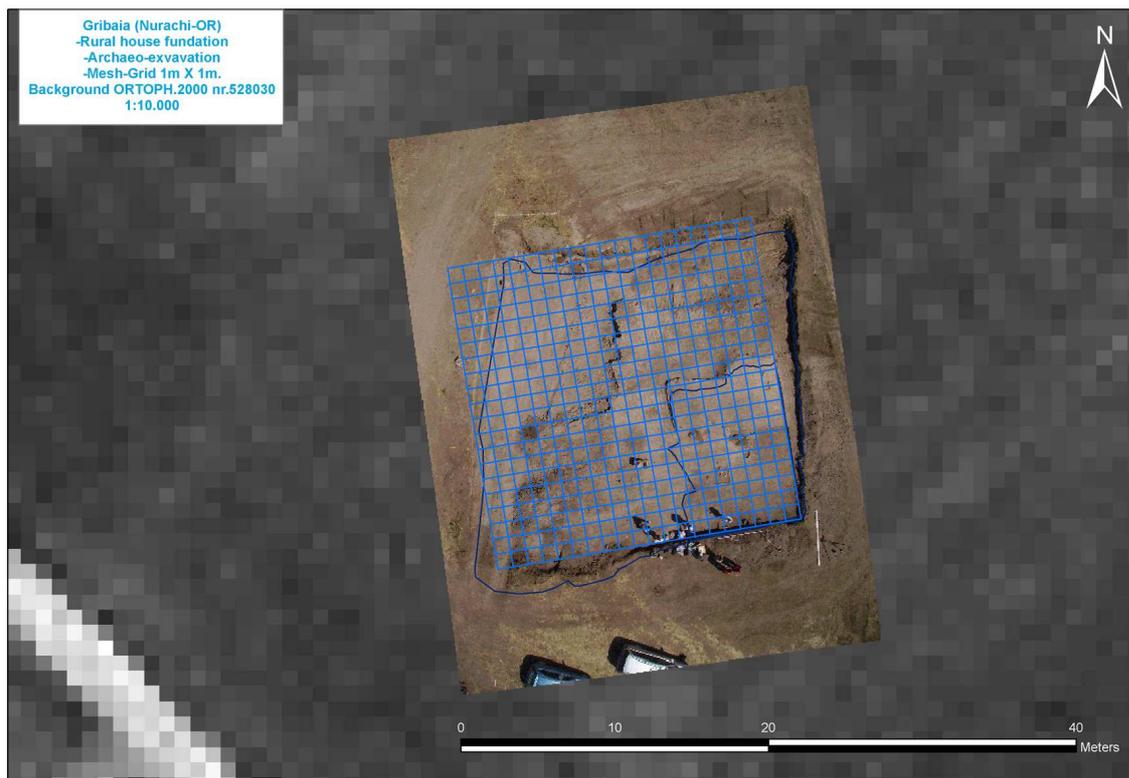


Fig.6 – Example of a rectified zenithal photo with the overlapping grid-shape.

After that, we created a second shape file with xy coordinates has been created: every corner of its square grid has a combination of absolute coordinates x and y, that we used in order to rectify all photos.

The photos taken during the excavation, which are the only visual documentation of the stratigraphic layers, are not zenithal and were not taken from the same height. It was necessary therefore to run a manual work of rectification.

This work was executed with the help of RDF, the free software produced by the University IUAV of Venice³.

RDF achieves to rectify digital images of objects or plans which could be considered as such. The projective transformation can be performed by analytical (calculation parameters with the method of least squares) or geometric methods.

Of course every single photograph must show the four corners of each square. The corners of the grid squares represented the set of points whose absolute coordinates were measured.

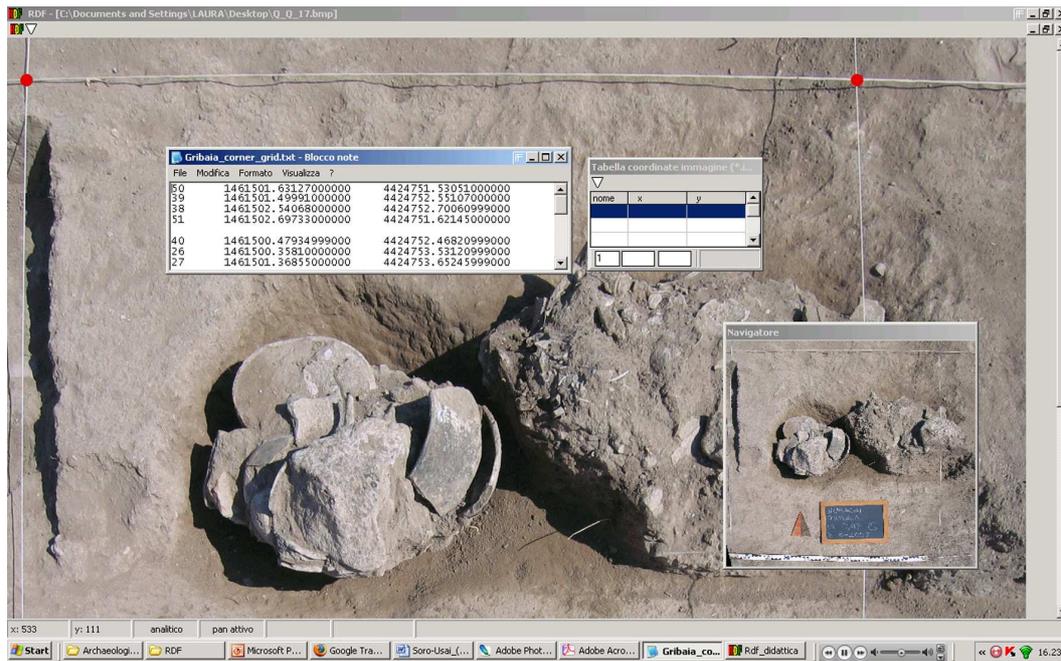


Fig.7 – Example of the RDF work.

In the rectified image it is possible to digitalise a set of points with absolute coordinates that can be exported in .dxf format.

With the help of this software, we created a photo plan of the stratigraphic layers; these are edited as vectorial files.

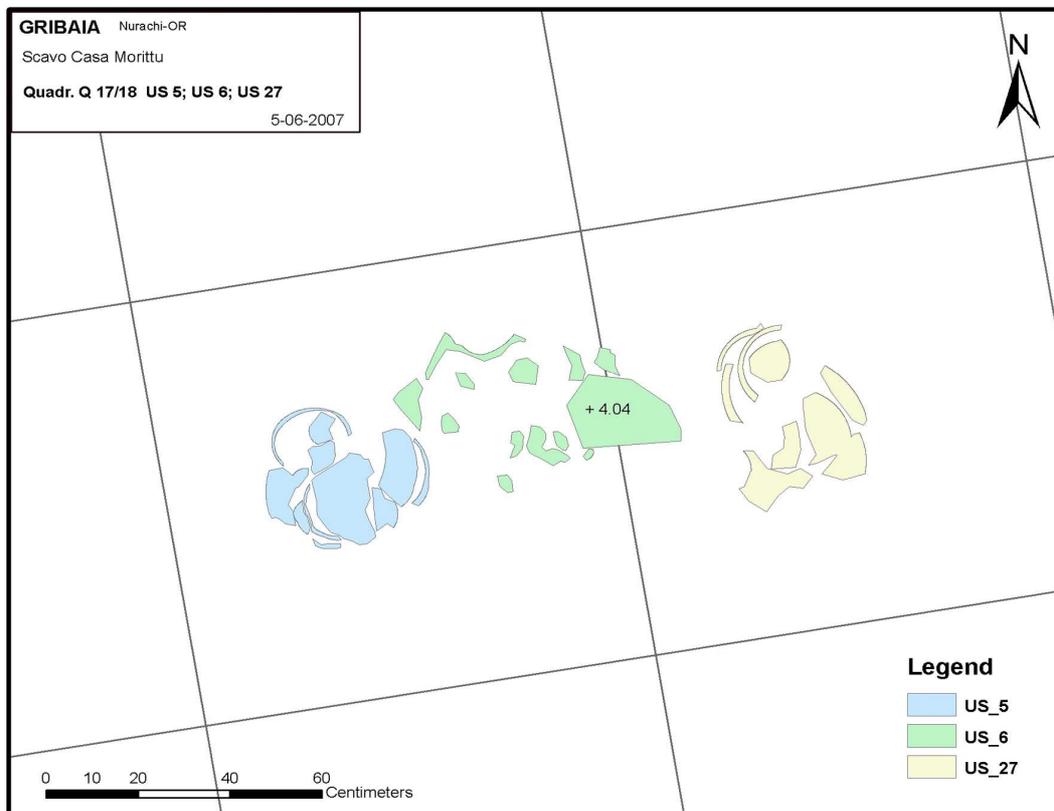


Fig.8 – Plan of three stratigraphic layer of the excavation.

Every shape file of stratigraphic layers was related to a referenced database that reports the file of stratigraphic layers. The stratigraphic layer sheet data can be viewed via the database on the GIS platform, via the "identify" (Esri) function, or via a hyperlink that opens the DBMS software used (File Maker Pro).

SCHEDA DI UNITÀ STRATIGRAFICA

LOCALITA **Gribaia**
 COMUNE **Nurachi**
 PROVINCIA **Oristano**
 ANNO **2007**

US **19**

AREA **Scavo casa Morittu** SETTORE **Sud** QUADRATO **N 15** QUOTE **+4,01,+3,94**

PIANTE **Gis** DISEGNI_SEZIONI FOTO **si**

MODO DI FORMAZIONE **Composizione**
 CRITERI DI DISTINZIONE **Sincronico**

DEFINIZIONE **Concentrazione di ceramiche; riempimento fossetta**

COMPONENTI Geologici Organici Artificiali
 pietre di piccole dimensioni; cardium (2-3 esemplari); qualche frammento osteologico; ceramiche; schegge di selce e ossidiana

MISURE **da Gis**

STATO DI CONSERVAZIONE **buono**

DESCRIZIONE

Fig.9 – A page of the related database.

Conclusion.

Everyday the experience in relation to archaeology reveals the impossibility of maintaining and protecting everything, so "to document" means "to protect".

The greater and more detailed is the level of documentation, the greater is the historical memory. Documentation is the first level of protection.

How much the use of the computer can reveal rather than hide, we believe that it is necessary to focus on what archaeology is, what its cultural value is (how much it can be helped without being obscured

by the computer), its direct impact on the society of every day, and the practical reality it has to deal with.

The technique we discuss on this paper has provided interesting results in relation to our needs; we therefore believe that the best way to evaluate the results is to assess the starting point.

The excavation in Gribaia started as one of many rescue excavations that are opened and closed every day.

In the Italian - and specifically Sardinian - situation, characterised by a lack of funds and resources for archaeology, the rescue excavations are not well considered and suffer a sense of inferiority.

In the widespread and undeniable cultural crisis afflicting Italy, archaeology is not spared. If we add the cultural crisis to the economic crisis, we get a most negative scenario.

We deduce that the conditions do not seem to be helpful for doing research nor for the desire to do it.

We think that it is important for us to express this discomfort. Under these complicated and worrisome conditions we had to find a restorative solution for the excavation at Gribaia.

Being aware of the lack of time and resources, we tried to devise a practical and efficient key for our case.

We took advantage of the generosity of a co-worker who provided free of charge his kite and other instruments and his imagination, despite the risk of having a fruitless outcome.

But we believe that our risk is equivalent to a scientific experimentation.

We knew from the beginning that the operation would have many limits on the reliability of the relief and they difficulties could be calculated.

Despite that, the final product is an added value to the archaeological documentation and subsequent interpretation of history.

For instance, the difference between in situ and in silico measurements was never larger than the difference between in situ measurements taken by different persons.

This is for us the greatest result. We believe that we have registered all the data relevant to the archaeological research.

For the first time in Sardinia, we have produced a GIS of a rescue archaeological excavation, tested on models developed, for example, by researchers of the Section of Medieval Archaeology at the University of Siena (FRONZA et alii 2006).

We believe that the use of kites for photogrammetric applications during archaeological excavations is the starting point for research and experimentation.

We ourselves are trying to improve the use and potential of kite and photogrammetry in another rescue archaeological excavation currently under way in central western Sardinia.

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¹ Thanks to Mr Gianni Mancosu, employee of the Soprintendenza Archeologica for giving us the opportunity to use his kite and his private equipment for archaeological purposes. Without his generosity, everything would have been impossible.

² The AirPhoto software is a part of the BASP (The Bonn Archaeological Software Package).

BASP is a non-profit software project for and by archaeologists which has been developed cooperatively since 1973. It now includes more than 70 functions for seriation, clustering, correspondance analysis, and mapping tools for archaeologists working with IBM compatible PC's under DOS and all versions of Windows. It also includes programs for three dimensional display of data, for finding rectangular structures in scanned excavation plans containing thousands of postholes, and for the rectification of extremely oblique aerial photographs and their superimposition on large-scale scanned maps under Windows NT/2000/XP/Vista and Windows 95/98/ME. (<http://www.uni-koeln.de/~al001/basp.html> *Not available anymore*)

³ http://circe.iuav.it/labfot/software/soft_rdf.html *Not available anymore*