Intra-Site Analysis of the Palaeolithic Site of Isernia La Pineta (Molise, Italy)

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Abstract. The site of Isernia La Pineta is characterised by the presence of several anthropic layers set within a complex stratigraphic sequence. The highest concentration of palaeontological and palaeoethnological finds is documented on archaeosurface 3a, which has so far been explored over an area of several hundred metres. In order to develop the investigations concerning the processes and stages of its formation, a context of *intra-site* spatial analyses has been applied, using a GIS application. In the specific case of Isernia La Pineta, this application has also encouraged experimentation with new computerised documentation techniques.
Keywords: *intra-site* spatial analysis, GIS, archaeosurfaces, Lower Palaeolithic

1. Introduction

The remarkably rich, complex archaeological assemblage unearthed in the Palaeolithic deposit of Isernia La Pineta represents an ideal opportunity for applying a global computer system, in this case a *Geographical Information System*. This application helps researchers to solve problems such as handling the sheer quantity of data; moreover, from an inter-disciplinary viewpoint, it contributes to resolving interpretative aspects regarding the significance of accumulations and concentrations of materials highlighted during excavations.
Besides methodological reasons, the use of a GIS as integrated system was directed toward the processing of various types of *intra-site* analyses, applied to the archaeosurface richest in remains (3a) as well as the deposits covering it (3 colluvium). The aim was to analyse and tentatively interpret the distribution patterns of the archaeological remains, from both two-dimensional and three-dimensional viewpoints. Distribution phenomena were identified by thematic mapping, while trends of concentration/dispersion of materials were obtained through multi-dimensional analyses and stratigraphic relationships, and by visualising longitudinal and transverse profiles: preliminary 'guidelines' thus emerged for drawing up models of material deposition and of human presence in the deposit in relation to all the evidence considered.

2. The Deposit

Isernia La Pineta is included in the continental Pleistocene deposits forming the Pleistocene sediments of the Isernia-Venafro infra-Apennine basin, situated in the Upper Volturno valley. The base is characterised by mainly sandy-muddy lacustrine sediments (Unit 5) covered by an altered, eroded travertine bank (Unit 4), on top of which lies the oldest archaeosurface (3c). This is buried by muddy-clayey alluvial deposits, max. one metre thick (3b), completely devoid of remains apart from the presence of unidentified vegetable remains. The level represents the deepest part of a series of fluvial and pyroclastic deposits, divided into different facies (Unit 3). Lying on 3b is the second archaeosurface, by far the richest in remains explored in Sector 1, indicated as 3a. Abundant evidence connected with human activity is present here, comprising thousands of selected, deliberately fractured faunal bones, together with limestone and flint lithic tools (Sala 1996; Peretto 1994, 1999). This archaeological level is buried by a mudflow rich in pyroclastic material, connected with intense volcanic activity. This is followed in rapid succession by fluvial deposits of clay, mud and gravel, about 3 metres in thickness. Within these sediments a third archaeosurface has been detected, indicated as 3S10. At the top (Units 2 and 1), pedogenetic alteration phenomena are clearly evident, covered by levels of volcanic ash (Cremaschi 1983; Cremaschi and Peretto, 1988).
The radiometric analyses (K/Ar) performed on sanidine crystals collected from the sediments covering palaeosurface 3a have given the date of 0.736±0.04 MA from the present (Delitala *et alii*, 1983). This is in good agreement with the datings performed at the Amsterdam laboratory (Sevink *et alii*, 1981): 0.68±0.06 MA and 0.73±0.07 MA for a sample collected from *a marker bed from the fossiliferous horizon*. Datings carried out on tuffs from Unit 1 (K/Ar) provided dates of 0.55±0.05 MA and 0.47±0.05 MA at the Rome laboratory, and 0.57 MA at the Amsterdam laboratory.
Recent 40Ar/39Ar datings performed on sanidine crystals coming from the sediments containing 3a have given an age of 610±10 and 606±2 Ka (results from two laboratories, Nice and Geneva) (Coltorti et alii, in press).

3. New Methods of Collecting Data

The construction of a pavilion covering the excavation site, completed in 1999, has made it possible to set up a permanent, computerised theodolite for recording the coordinates of the archaeological remains, with the organisation of a computer-based workstation.

This equipment has directed research work towards a fresh approach in the utilisation of computers for archaeological excavation: i.e. the processing of information does not represent the final phase, but instead follows the work throughout its various stages, from excavation to the final interpretation.

The aim is to obtain a more immediate management and utilisation of the data at our disposal, in order to assess the informative and analytical qualities of an information system applied directly onsite. This has involved a reorganisation of documentation methods, attempting above all to speed up data collection, as the times involved in excavations of complex, abundant archaeosurfaces tend to be extremely long (Arzarello *et al*. 2003).

The first stage in the computerised recording of data consisted of a review of the already-existing database (Peretto et al. 2000), utilising the present systems of RDBMS (*Relational Data Base Management System*), in this case the *Microsoft Office* package *Access*.

The database contains the same number of tables as the typologies of forms used for cataloguing the material (excavation, lithic artefacts, fauna); each table contains specific data, but which can be connected with one another. The photographic archive has been separately structured, arranged according to the subject (excavation, sifting, washing, restoration, etc.).

From 2002 onwards, the system used for acquiring excavation planimetries has been specifically organised to speed up the various documentation stages. In view of the considerable amount of remains and the need to display them – particularly those from the richest archaeosurface, 3a – it was decided to follow an excavation protocol which requires the use of digitally restituted photography, thus ensuring a precise registration of the position of finds despite their high concentration. The support of the total station also favours recording of the planimetric coordinates of the remains. An important step at the excavation stage is that of documenting the orientation and inclination, in degrees, of each find, which goes to form the basis for its computerised image performed in *AutoCad.* The digital photograph, in fact, which adopts a specially designed software package for restitution (*Rollei Metric*), is later acquired in *AutoCad*; the individual finds are redrawn, vectorialised with a layer identified by specific code number, then reproduced in their exact location, just as they were found on the excavation surface. This method has undoubtedly reduced planimetric documentation times, has provided an optimal answer to the management of deposits similarly dense in archaeological material, and has considerably reduced the errors that may occur in manual drawing during excavation, by several different hands.

The particular, almost unprecedented situation offered by a museum with excavations on view to visitors has made it possible to test and improve the informative qualities of the computerised equipment.

4. The Intra-Site Analyses

The decision to use a *Geographical Information System* for handling the excavation data and as a means of processing the spatial analyses has favoured the organisation of an immense quantity of information. Indeed, thanks to its characteristics of creating links between alphanumeric and graphic data, GIS is, so far, the most appropriate computer-based instrument for the global, simultaneous treatment of all information concerning an archaeological excavation. Besides, thanks to its topological functions, it allows a computerised model to be created which is able to reproduce the relationships between the diverse elements of a system – in this case, a Lower Palaeolithic site– and it can be constantly reutilised and modified as investigations progress.

The logical and physical structure used in the description and organisation of the informative levels is aimed at achieving the following research objectives:

- conversion of archives on paper;
- two-dimensional and three-dimensional location and visualisation of all remains unearthed;
- treatment of the archaeological material as spatial variables;
- spatial queries to attempt to reconstruct natural and/or anthropic post-depositional processes – where these have been responsible for transformation of the original deposits – and the modalities of human presence at the sites, by taking apart the spatial distributions and putting them together again, as well as the creation of single or combined maps and thematic sections;
- statistical inference of spatial data (analyses of frequency and density) to detect the likely presence of significant associations and relationships between the different categories of materials, potentially indicative of the presence of functional areas.

The logical structure has been specifically devised so that it does not reflect any subjective interpretation in the organisation of the spatial data. The starting-point, then, is based on the opportunity of structuring the spatial data and variables just as they have been recorded during excavations, without projecting onto them any interpretative content.

In order to achieve the objectives listed above, the spatial analyses taken into consideration were directed towards the drawing-up of thematic maps, frequency and relationship maps, density maps, longitudinal, transverse and oblique sections, together with the projection of remains found.

Archaeosurface 3a of Sector 1, the layer yielding the most finds, was investigated over an area of ca 200 sq. m; the remains were sometimes greatly concentrated and superimposed (Fig. 1). Part of this archaeosurface (approx. 70 sq. m.) was removed and partially reconstructed, for exhibition purposes, in the Museo di Santa Maria delle Monache at Isernia, while the remaining part has been restored onsite, and can be visited inside the excavation pavilion (Fig. 2). Since the remains have been left in place for exhibition purposes, an exhaustive record of data throughout the entire archaeological level. Further limitations are imposed by the removed portion of the same archaeosurface, due to the fact that the quotas have been recorded by

Fig. 1. Isernia La Pineta. Archaeosurface 3a. Sector 1, quadrant 1, squares 20–22/30–33 (photograph: A. Guerreschi).

Fig. 2. Isernia La Pineta. Archaeosurface 3a, Sector 1. Shown in grey: area removed and partly reconstructed in the Museo di Santa Maria delle Monache at Isernia; in white: untouched area, presently on view inside the excavation pavilion..

photogrammetric survey, but have not yet been transformed into numerical information and entered into the present data-bank. For the same reasons, analysis of the spatial distribution of remains is presented exclusively two-dimensionally.

The archaeosurface directly overlies the travertine in the SW part of the explored area, whereas – proceeding towards NE – it rests on layer 3b, of fluvial-lacustrine origin. Diverse depositional mechanisms of non-anthropic nature have caused materials to become dislocated; this appears to have been partly caused by a series of settlement movements connected with the fracturing and alteration of the underlying travertine (Unit 4), also allowing the formation of circular-shaped sunken areas close to one another, measuring an average diameter of 3–4 metres.

These factors have damaged the integrity of archaeosurface 3a in certain areas, so that the faunal remains are sometimes broken in many pieces due to compression and stretching; these data are of fundamental importance when it comes to drawing the final conclusions on the distribution and meaning of the entire archaeological layer.

Fig. 3. Isernia La Pineta, archaeosurface 3a, Sector 1. Distribution of all finds.

The finds of archaeosurface 3a unearthed till now number 18,166, of which 1,915 are in limestone, 1,907 in flint, 6,934 in bone and 7,410 in travertine: the last-mentioned group do not present any traces of utilisation or intentional modification (Fig. 3). From a planimetric viewpoint, the overall distribution of remains does not appear uniform throughout the entire surface; in fact, densely concentrated areas alternate with others where the presence of both lithic and faunal remains is less significant.

It should be pointed out once again that part of archaeosurface 3a has been removed and part is still in its original location, with only the surface exposed, so that it has not been investigated throughout its thickness. Since the concentration and dispersion of materials are affected by the interpolation of their vertical distribution, it is only in the case of the entirely excavated area that the clustering phenomena can effectively reproduce the situation. Consequently, although distribution of the various categories of remains is visualised with maps reproducing the entire extension of the archaeosurface, analysis of their reciprocal spatial relationships must be constantly related to the different excavation situations.

On the basis of the analyses so far conducted on the different spatial trends of the remains, considered according to each raw material, the distributive features of the archaeosurface can be summed up as follows:

the geological settlement connected with the underlying travertine (Unit 4) present in quadrants 2 and 3 – which caused the formation of sub-circular sunken areas – have clearly compromised the location of materials, even if their physical state testifies that considerable stretching, compression and deformation took place;

the overall distribution trend is more homogeneous in the area still in its original location, whereas the completely removed portion delineates different situations, i.e. parts where the concentration and clustering of remains is considerable with respect to others where the materials are dispersed and diminish noticeably in size. The latter phenomenon can be clearly seen in the eastern part of the removed area, and appears to reflect the distribution trend of the finds within the level. A thinning-out of materials can also be observed in the portion left intact, in its northward direction. In the latter case this trend may be connected with its partial excavation; nevertheless, it should be noted that the sondage performed immediately outside the pavilion, along the northward directrix, has documented a general and gradual decrease in the number of archaeological remains in this direction. Whether this distribution trend between the unremoved area and the sondage is discontinuous or not may only be ascertained as investigations progress;

if the distribution trends are considered according to the raw material, the most significant evidence can be found in the remarkable number of flint remains in quadrant 2 compared with both the other categories and with the rest of the archaeosurface (Fig. 4). The great majority of these have been knapped; the quantity of unknapped pieces is numerically insignificant. A similar situation, though much less

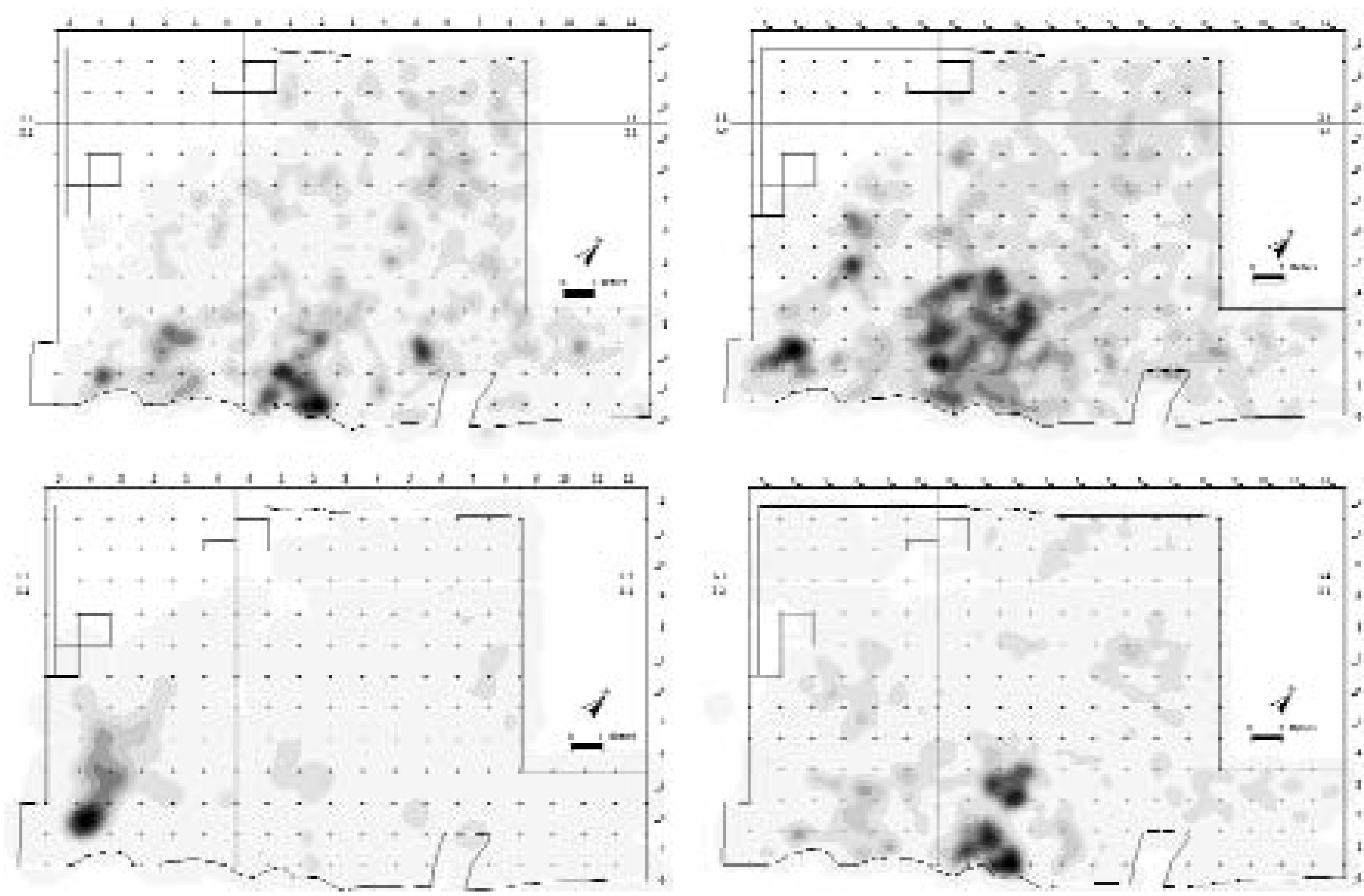

Fig. 4. Isernia La Pineta, archaeosurface 3a, Sector 1. Top left: areas of density of limestone finds; top right: areas of density of palaeontological remains; bottom left: areas of density of flint finds; bottom right: areas of density of travertine finds.

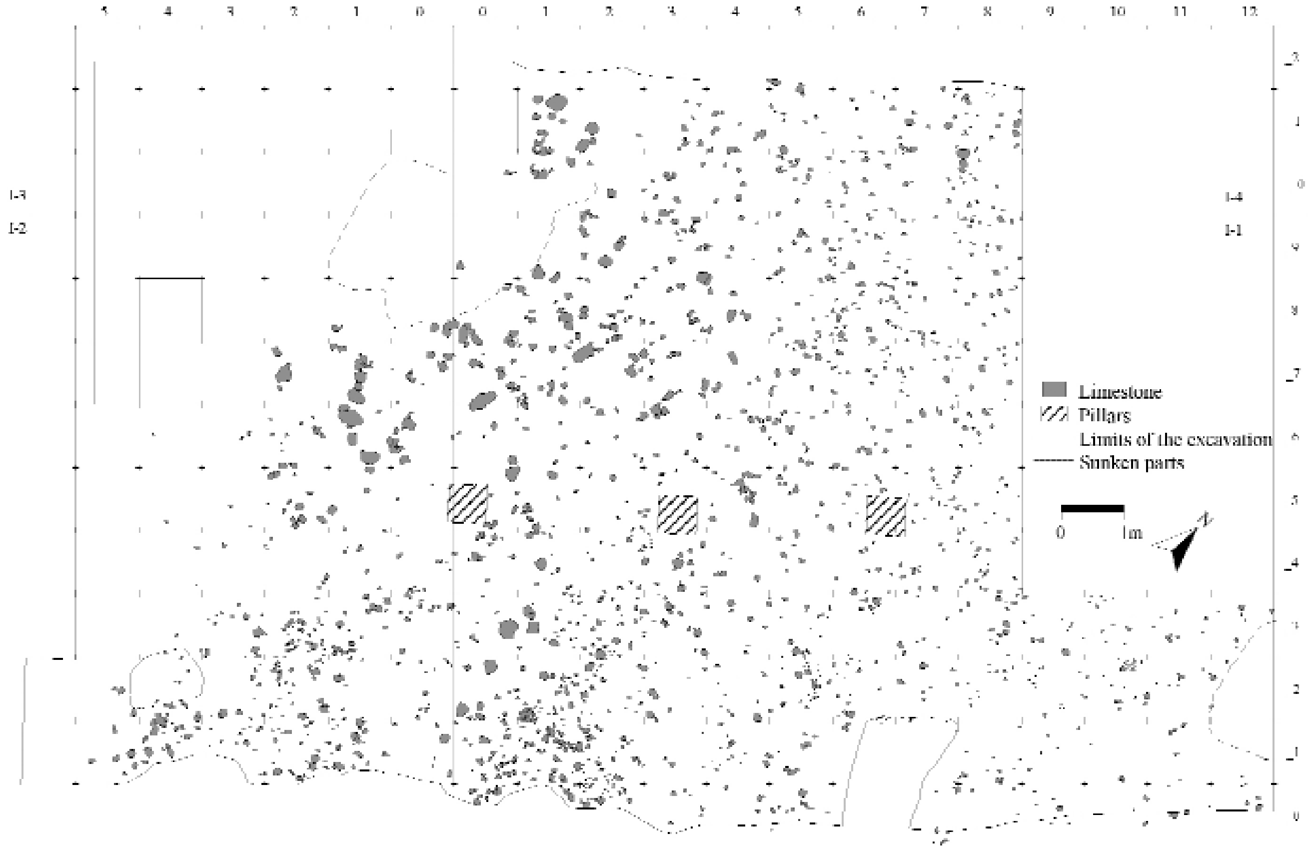

Fig. 5. Isernia La Pineta, archaeosurface 3a, Sector 1. Distribution of limestone finds.

significant, is present in an area very close to border E of the untouched portion. In the rest of the archaeosurface the ratios between the various raw materials remain generally constant; the limestone finds present a distribution difference based on dimension (Fig. 5), also observed (to a lesser extent) in unknapped flint and travertine blanks. The largest-sized finds are located along a N–S direction in the W part of the archaeosurface left in place; proceeding eastwards, however, the dimensions of remains in limestone decrease noticeably;
the palaeontological remains do not appear to be placed differently according to a dimensional scale. A particular concentration is visible within an area of approx. 16 sq. m. very close to the W margin of square 1, whose circular edges are in fact delineated by the diverse excavation situations. While it is not possible to pose questions about the meaning of this accumulation in relation to the area left in place, there is nonetheless a clear difference between this area and the remaining part of the removed portion, which does not present either particular concentrations or marked superpositions. This concentration of palaeontological remains, however, also corresponds to the area revealing maximum density of travertine, limestone and flint, excluding – in the last case – the area of square 2 mentioned above;
spatial analysis in relation to different species is greatly compromised by the high percentage of undetermined finds. Considering the distribution of the three most representative species – bison, elephant and rhinoceros – their overall diminution is clearly visible close to the N–E border of the portion left in place, and eastward in the removed portion, apart from the presence of bison cranial remains between squares 77–79 and 88 of square 1. Elephant remains do not present noticeable distributions in relation to the anatomical part, whereas there is a striking concentration of bison crania especially in the maximum density area of the removed portion, although their number is considerable also throughout the rest of the archaeosurface (Fig. 6). Even more noteworthy is the presence of rhinoceros crania and single teeth, particularly if one considers the numerical disproportion of the latter compared to other anatomical segments. Rather unusual the distribution of rhinoceros remains on the whole, mostly located in the removed area.
Besides, the distribution of remains in archaeosurface 3a appears dislocated, at least superficially, from its original

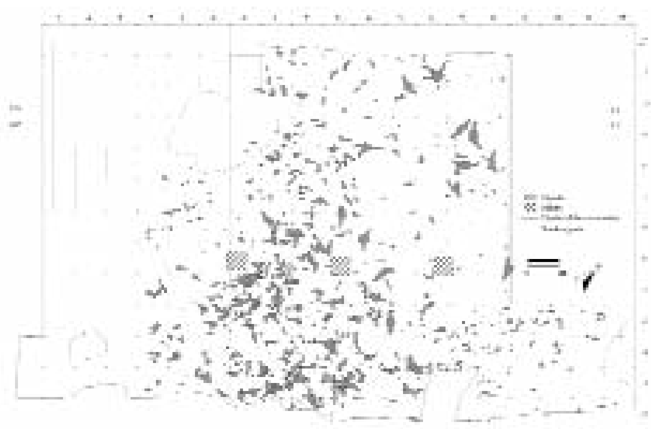

Fig. 6. Isernia La Pineta, archaeosurface 3a, Sector 1. Distribution of bison finds.

Fig. 7. Isernia La Pineta, 3 colluvium. Transverse section showing the projection of all remains.

position due to the arrival of the debris-flow (3 colluvium), which covers it (Fig. 7).

This layer has proved extremely rich in archaeological finds (7,391 remains over 46 sq. m. of area explored). Further enlightenment on this area and its relationship with archaeosurface 3a is expected from the continuation of exploration work.

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