Computer-based recording systems of Pleistocene deposits with large mammals

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SUMMARY: The computerised recording of archaeological or paleontological sites, rich in proboscidean bones, present a particular challenge to excavation teams. The need of precise mapping of very large bones at a relatively fast pace, and of integrating provenience and visual data with faunal analysis and other archaeological or taphonomic data causes problems. In archaeological sites total stations are used for automatic recording of Cartesian coordinates for individual objects and for topographic mapping; they are not normally used for imaging purposes. At the Lower Palaeolithic sites of Ambrona and Torralba we have used a recording method which allows the integration of accurate images with speedy collection of provenience and other data. The total station is used to register the multiple points forming the outline of single proboscidean bones or other large bones, while small bone fragments and lithic artefacts are recorded with single coordinates in the traditional manner. In the field lab, graphic tablets and AutoCAD™ software are used to produce bone images at the desired scale and to plot them in distribution maps. The management of spatial, faunal and other analytical data is accomplished with a GIS program (ArcView™).

1. Background

This article reviews the specific problems that originate at large open-air archaeological sites with faunal assemblages characterised by the presence of large mammal bones in clusters of variable densities. These features demand the synchronised excavation of several square meters, thus increasing the risk of errors, during the materials' spatial recording, which may result from cumulative small variations in the reference grid system. Other difficulties arise when trying to integrate assemblage data with their macro and micro-stratigraphic context, and, more generally, in the global management of archaeological data in the field.

For these reasons we consider inappropriate to use at these sites recording methods traditionally implemented in caves and rockshelter (Laplace & Meroc 1954). They are based on the physical division of work areas, treating each square meter as a single and unique record unit since cartesian coordinates have separate origins for each square. Thus individual items are provenienced in reference to a single square. Clearly the system is inconvenient when dealing with large objects spanning over more than a square meter.

In fact the volume of proboscidean fossil bones, and other large mammals, and their distribution over large areas requires that we use a recording system that treats the whole archaeological site as a single spatial unit. The use of a total station provides the accuracy we need during the data recording. The total station is used to register the spatial location of all the archaeological record (Parcerisas & Mora 1995), lithic and bone remains, but also to record all the stratigraphic sections, all topographic mapping data, the location of geological samples, and any other information relevant to the taphonomic and archaeological analysis of the site.

This results in an integrative understanding of the nature of the archaeological data. We can easily see the relationships between the simple facts of the archaeological observation (the real entity that is been observed: lithic remains, bones, etc) and their attributes (i.e., the properties that have been deduced upon their study, such as stratigraphic position, typological classification, etc.). The attributes result from the analytic method used for their study, and can be modified during the course of further research. Therefore the data should be under a management system that recognizes their diversity and would allow change. It should also be able to adjust to the specific properties of the project and allow the simultaneous analysis of different attributes and of the spatial position of the remains to which these attributes refer.

In order to create this network of relationships between attributes and spatial provenience, it is necessary to digitize the contextual information available especially for large bones. Because of their size they may display complex features: simultaneous position in more that one stratigraphic unit, different degrees of alteration and abrasion, discrete topographic phenomena, etc.

In sum, the recording method should perform, in a synchronised manner, three tasks: 1) verification of the archaeological data by means of cross analysis; 2) detailed maps of items, and 3) the creation of a data base that could be used to create models and to test working hypotheses.

2. The Recording System

Between 1993 and 1999 we have developed a data recording system applied, among other archaeological sites, to the Middle Pleistocene sites of Ambrona and Torralba (Spain).

The procedure consists of four stages: 1) data acquisition and recording on a magnetic support, 2) data transfer to a personal computer and exporting to a database program, 3) spatial information digitalisation, and finally, 4) integration of all the data and the creation of specific maps.

2.1 Data acquisition and recording

All the spatial data are obtained with the aid of the total station, or electronic teodolite with an optical distance measurement device. Its use, more and more frequent in archaeological projects, allows the storage over a magnetic support (hard disk, PCMCIA card, etc.) the measurements and Cartesian coordinates (x, y and z) of each selected point.

In one single work session, with only the need of selecting identifying *strings*, we can record diverse data from independent locations within the excavation area. In relation to the number of points need to be taken and the time investment required for the task, the first thing to do during the data acquisition phase is topographic mapping. The mapped surfaces may correspond to the preliminary stage of the excavation areas, or the area left at the time fieldwork concludes – in this case we are documenting and checking the excavation process. They can also correspond to paleo-surfaces, or stratigraphic interfaces. This kind of data, together with the recording of stratigraphic sections, provide useful information on the geometry of layers and can help us understand the site formation processes and their effects on the archaeological materials.

However, it is during the recovery of the archaeological items that a wide variety of recording procedures is needed. The size of the object to be registered, and whether this item will be promptly removed during the fieldwork or left in situ for future museum purposes, will determine the procedure.

For all the small items or those that do not need a real drawing, we take a single point (less commonly we take two points as the upper and lower coordinate of the object) and we assign to it a number and name of the layer. Numbers are, of course, unique and given sequentially to all the objects that belong to the same archaeological level, independently from its provenience within the site.

For those remains that due to their size or other circumstances required realistic drawings (mainly large bones), these can be done in two different ways, depending on the urgency for the conclusion of the task. The more elaborate procedure includes the realistic sketch of the bone using a scale that allows for some details while making the task relatively easy. Bones are drawn individually on separate sheets; there is no need of positioning objects in relation to others nearby (as in traditional archaeologcal mapping by hand) because accurate plans will be reconstructed later by the drawing software.

Once the sketch is finished we record the spatial position of several points of the bone and mark them on the drawing for clear identification. Points should be placed on distinctive morphological features of the bone.

In the lab, and after stage two of the recording system, we get a map of points that are lined out together with the aid of the bone sketch. The day after, when we return to the field, we can verify the accuracy and reliability of the resulting drawing, and if necessary make the required changes to improve it. This recording process, needs one or two days to be completed but it guarantees a high quality and precision of the final drawing without the need of having an experienced artist at the site. From the drawing we can obtain detailed information on the bone morphology and dimensions, orientation, length and width of fractures, distance between fragments and other features deemed relevant. This information allows us to relate these or other features with the morphology of the substrate or other archaeological remains that may have not been detectable during the excavation process.

The abbreviated version of this procedure requires a more precise sketch, because this will be the final drawing to be digitized. Each one of these sketches should be done on separate sheets of millimeter paper. It is advisable to draw the bone aligning its longer axis to the paper squares, to check measurements and proportions more easily. For relatively small bones natural size may be the more appropriate scale to be used.

Once the sketch in finished, we take only two co-ordinates, placed at clearly identifiable points distant from each other, preferably the two more distant points on the bone longer axis.

These two coordinates will be used to calibrate the graphic tablet, verify the bone real dimensions and its position and orientation.

This second procedure is faster than the previous one, but the main disadvantage is that the final result will depend on the ability of the draftman. However, we think that with a minimum of effort and supervision from the archaeologist in charge, similar quality levels can be achieved.

2.2 Data transfer and organisation

All the data recorded during a day of fieldwork are saved in ASCII format and stored in daily independent files. This allows future file revisions, as needed. These files are then processed with a database application (IO) that undertakes the tasks of distributing the information contained in each daily file into four general database files. For our convenience we name these general files Ua, To, Ge and Fo.

The *Ua* file contains all the information related to the archaeological items: stratigraphic unit, coordinates and a preliminary material and morphological classification of the remains. This file provides an inventory of the materials recovered on daily bases.

This file can be related to other database files in a hierarchic structure, going from a more general to a theme specific information files. The other files contain data on taxonomic and taphonomic attributes of bones, technological and raw material determinations for stone artifacts, photographic information, etc.

The *To* file includes all the data obtained from topographic mapping of the excavation surface at the beginning or end of the fieldwork, as well as stratigraphic sections. Two-and three-dimensional topographic mapping of paleo-surfaces, and other surfaces can be obtained from these files. We can put on these maps the archaeological items contained in the Ua file, and their drawings.

The *Ge* file contains the spatial location of all the pollen and sediment samples.

Finally, the *Fo* files contain the reference points used in all the drawings, whether these are bones, structures or other remains. The drawing files contain several points for each object, allowing two-dimensional, and eventually three-dimensional, representations. They also provide information on the object orientation and depth. see above. The 2 original points of each bone are related with a particular file for every bone . In fact you have 2 kinds of data base: first the general data base of the archaeological site in wich every item are identified by two 3D coordinates, and a second kind of data base: each particular bone with a variable number of 3D coordinates are an independent data base.

2.3 Digitalization of spatially-referenced drawings

In the lab, all the drawn archaeological remains are vectored using a graphic tablet with draw assistant software; we use AutoCAD™. Each drawing is independently digitized in the graphic tablet using the coordinates stored in the Fo file, providing the object position, dimension and orientation.

For a more effective use of the resulting AutoCAD™ file, each bone is stored in an independent "layer". The reference label is a code combining information regarding the object stratigraphic unit, its number and distinctive features.

This reference label is added to the Ua and Fo files. Therefore, all the independent database files can be related to the spatial entity represented by the drawings.

Digitalization of all the archaeological remains is quite laborious. However, this time-consuming task provides visual representation that can be related to any of the attributes contained in other files.

2.4 Data management and mapping

A standard geographic information system (GIS), Arcview™, is used for data management purposes. It is a simple and easy to use software program, that can be installed in almost any computer. At this point, all the information is organized in files and management is almost automatic. The existing literature on the topic explains extensively the use and features of GIS programs (Lock & Stancic 1995).

3. Final remarks

The automated system we have described is based on the recording of coordinates for all archaeological items (bones and stone artifacts), geological and other data that may contribute to an understanding of the site formation and nature.

Large proboscidean remains requires the use of a total station to produce drawings that are closer to reality as possible. At the same time, this recording system creates data files that can be related using the object spatial references and can be managed using any GIS program.

The system requires hardware and software that is readily available in the market, and only requires the development of specific software routines to speed up some of the more tedious data management processes.

Compared to other existing archaeological data recording systems, as terrestrial photogrammetry, our proposal turns out to be cheaper, easier to use and more accurate.

4. References

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