

An application of GIS to intra-site spatial analysis: the Iberian Iron Age cemetery at El Cigarralejo (Murcia, Spain)

F. Quesada, J. Baena and C. Blasco

Departamento de Prehistoria y Arqueología, Universidad Autónoma, Campus de Cantoblanco 28049 Madrid SPAIN

23.1 Introduction

Since our team began to apply Geographical Information Systems (GIS) to spatial archaeology in 1987, two lines of work have been tested. The first has been devoted to speeding up and rationalising the management of the archaeological heritage through computerisation and designing a program for the archaeological map of the Madrid region; this is now fully operational in the Board of Culture of the Community of Madrid (Blasco, Baena & Espiago, forthcoming). The second approach is devoted to macrospatial research in archaeology and has enabled us to undertake various studies that have helped us relate sites with their surrounding areas and the local and more distant areas from which resources were obtained. It also enables the patterns of settlement in a particular cultural horizon to be discerned and the possible routes travelled to be traced by ascertaining how difficult they would have been to travel (Blasco & Baena, forthcoming; Blasco, Baena & Recuero, in press). Both approaches operate within a macrospatial context and their development has been closely related with the use made by physical geography of GIS.

However, until now we had not tested the application of these systems in mesospacial contexts, that is, in relation with the internal structure of sites, since it is very often too complex a tool for the data that have to be handled. Nevertheless, we thought GIS might prove very effective in certain sites containing a great many structures and artefacts where the processing of information might be relatively similar to that required in the case of urban geography or mapping the landscape in general, particularly protohistorical and historical sites.

In the Iberian cemetery of Cigarralejo near Mula (Murcia) we found the ideal characteristics for carrying out a first mesospacial study that could be the starting point for a more ambitious project devoted to spatial relationships in Iberian cemeteries, both in terms of the spatial arrangement of the various graves in the cemetery and their distribution in terms of the different categories of grave goods and chronology, and with regard to the dispersion of the grave goods within the grave itself or the geographical relationship between the cemetery and the settlement and the sanctuary often associated with it.

This study is, therefore, no more than a preliminary application of GIS in this field and will serve to prepare the way for more complete and integrated studies in which macro-, meso- and microspacial information will need to be interrelated. This will, without doubt, provide new

perspectives in the field of funerary archaeology. Furthermore, some of the results are immediately relevant to the educational work of museums, so we have also sketched out some examples that help to provide a glimpse of some of the many ways in which cultural information can be made accessible to the general public.

This study forms part of the research project *GIS applied to the Archaeological Heritage* (PS92-023) financed by the DIGICYT.

23.2 The El Cigarralejo site

As a result of a careful series of excavations, which began in 1947, El Cigarralejo (Mula, Murcia) is one of the best known Iberian cemeteries. More than 500 graves have been excavated, accounting for almost all the space in the cemetery. However, to date only 350 of them have been published in complete detail (Cuadrado 1987). Although the area that we shall now analyse does not cover the whole of the site, we think that our study is significant for two reasons:

- The area analysed is a representative sample of the cemetery as a whole, since virtually the same pattern of types and concentration of graves is reproduced in the rest of the area excavated.
- At least two sides of the area are defined by natural limits that coincide with those of antiquity: a natural barrier to the north (the steep back of the river Mula) and another to the east (a vertical chalk bank, which separates the cemetery from the town (Cuadrado 1987, 23). A track marks the approximate western limit of the cemetery, perhaps coinciding with the ancient Iberian path from the village down to the river. Thus it is only to the south, where modern terracing forms the boundary of an orchard of almond trees, that it is difficult to determine the end of the site, but even here it could not have extended many metres more before reaching the foot of the hill on which the Sanctuary is located (Cuadrado 1987, Plate I; Cuadrado 1950).

The funerary rite used was the usual one in the Iberian culture: cremation – outside the grave enclosure – of the body, which was dressed and adorned and often accompanied by objects such as weapons (Cuadrado 1987, 28); removal of the ashes, still hot, to the grave; and deposition of the cremated remains in an urn or directly in a grave or pit, together with a fairly large number of grave goods, in the urn and/or around it, almost always deliberately made unusable.



Figure 23.1: General plan of the site. The overlapping of graves makes a clear reading impossible.

The graves can be divided into two basic types: simple burials in an uncovered shallow pit or grave, and burials in a pit or grave covered by a quadrangular or rectangular tumulus of stones and mud-bricks with a small mud-brick tower on top of it, or even with a stone monument (a tower-like stele or pillar), decorated with anthropomorphic or zoomorphic stone sculptures.

Because of the shortage of available space, or for social, religious or other reasons, the 350 graves excavated are literally heaped together in a confined space of 742m² (Cuadrado 1987, 41). Most of them are marked with 'stone tumuli' of the kind described, measuring between one and seven metres along each side (the so-called 'princely tombs', Cuadrado 1968), and as many as eight levels of graves overlap each other, each of which can be perfectly distinguished because of the stone platforms covering them.

These overlapping levels – an average of four in the cemetery as a whole – considerably hinder excavation and interpretation, but are of great assistance in establishing the relative and absolute dating of the various burials. By combining the stratigraphic sequence of the superimposed graves with the dates provided by the abundant black-glaze imported pottery (Attic, proto-Campanian and Campanian) that appears in a large proportion of the graves, it has been possible to propose a fairly precise chronology for most of the graves, with margins of error of as low as 25 years (Cuadrado 1963).

The cemetery was used between the first quarter of the 4th century BC and the end of the 2nd century BC, although most of the graves can be dated to the 4th century BC.

The concentration of many graves within such a small space produces a great deal of archaeological 'noise', because the graves of different periods and characteristics have become intermixed (Figure 23.1). Any attempt to carry out a social analysis of the cemetery (horizontal stratigraphy, family clusters, hierarchical stratification of the community, sexual distinctions, etc.) has to start with the production of a great many thematic maps which will also take into account the different phases of the site. Carrying out such a task manually would be a tedious procedure, and subject to error.

Our study began by creating a database based on the topography and distribution of the graves in the site. It contains data on the location of each grave, chronology, type, area and volume of the tumulus, associated remains of sculpted monuments on the stone platform, categories of materials in the grave goods, sex of the human remains, number of objects and richness of the grave goods, using criteria we have already applied in other sites and will not repeat here (Quesada, 1989).

The spatial analysis of the cemetery at Cigarralejo was carried out by analysing existing data obtained from the excavation of the Cigarralejo cemetery. We have two types of information relating to this cemetery: firstly, the

planimetry of all the areas excavated, and secondly, a PC-designed and operated database for each of the structures.

Information was obtained using two different processes. The graphic base was obtained using ARCINFO digitisation modules, which enabled each of the structures to be recorded by defining them as lineal elements.

The existing alphanumeric database on the cemetery was in Data Interchange Format (DIF) and could thus be integrated using the same format in the ARCINFO structure. Once the databases (alphanumeric and graphic) had been integrated using a common field, it was possible to begin the spatial analysis. GIS usually start from a situation in which the cartographic or graphic data is organised or structured. This has not been the case in the example we have here, in which, because we are dealing with the all archaeological evidence, the graphic elements come from different periods, or characteristics are intermixed. On the other hand, we do have a structured alphanumeric data base which is segregated into numerous fields of information. In this way, one of the main objectives pursued in the application of GIS to this example consists in structuring and classifying that graphic information by using different selections made from the alphanumeric data base.

23.3 Equipment

With regard to the equipment, some of the existing equipment and programs belonging to the Cartography Service of the Autonomous University of Madrid were used. Both the software and the hardware are briefly described below:

23.3.1 Hardware

For the spatial analysis of the structures the following equipment was used:

- RT IBM Work Station
- AO IBM 6187 Plotter
- Calcomp 9100 AO tablet

To design the application we have been using a more versatile version of ARCINFO (6.11) and the following complementary hardware:

- RISC 6000 IBM Work Station
- Laser printer
- HP Scanjet IIC scanner

23.3.2 Software

In the case of software, we are using two different versions of ARCINFO (5.01 and 6.11) for internal reasons and above all because they have to be compatible with the TIFF image formats application.

23.4 Designing the application

The design and implementation of the application differs depending on the final user. We present below a brief description of the structure of each of the versions

currently being used: one application designed for scientific and research purposes, the other enables museums to store information and make it available to the public. In both cases, these applications are designed in the same programming languages as ARCINFO (AML).

23.4.1 Research application

The main options included in this application are the following:

- *Drawing option*: permits a graphic presentation of the data at any time.
- *Selection option*: permits simple or complex selections to be made of each of the structures to be shown visually.
- *Window (zoom) option*: enables close-ups of limited areas to be shown, either of pre-defined or user-defined spaces.
- *Consultation option*: permits immediate access to the alphanumeric data base by means of interactive user selection. This option offers the possibility of consulting the graphic content related with the grave in question (images, drawings of materials, photographs of the surroundings etc.).
- *Update option*: allows the alphanumeric data base to be updated interactively (form menu systems), or by the digitisation of the graphic data base.
- *Graphic output option*: allows planimetry to be produced on screen or in the form of a print-out.
- *Report output option*: allows reports to be produced from the alphanumeric data base, and some of the graphic windows associated with each structure (images, text files, etc.) to be printed.
- *Exit option*: allows the system to be exited.

23.4.2 Public access-museum application

In this case we have appreciably reduced the number of options available to the user, and modified the way they are presented. The options included, three out of the seven described in the paragraph devoted to the research application, are the Drawing, Window or zoom, and Consultation options.

23.5 Some preliminary results

Some preliminary results of the work done using the ARCINFO database are presented here for illustrative purposes. In doing so we should make two preliminary observations. Firstly, it should be remembered that the contour lines that appear as a reference in the plans relate to the surface of the land prior to excavation. There is no real 'floor' of the cemetery, but one for each period, due to the fact that more graves were constantly added and superimposed. Since it is impossible to know which graves were visible and which were not from the mid 4th century BC onwards, an attempt to reconstruct the topography of the cemetery at a given time is impossible. The surface topography is thus a frame of reference which

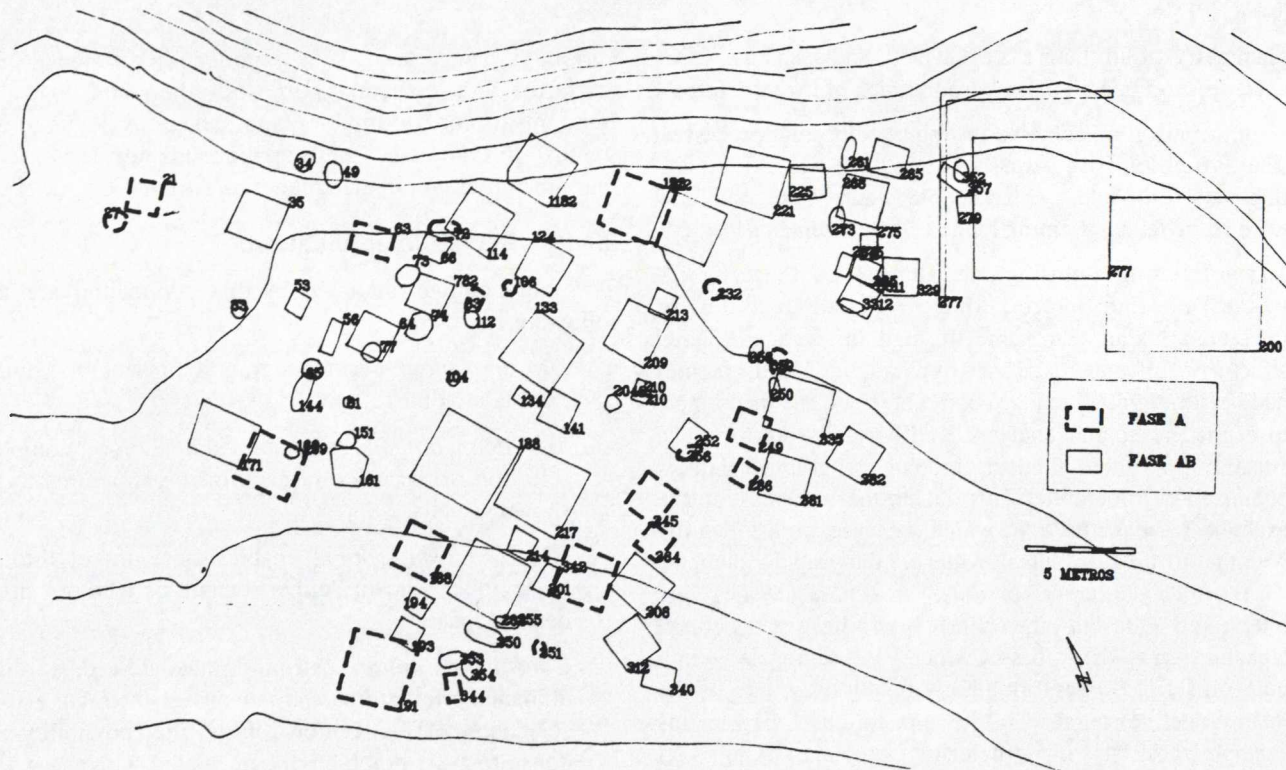


Figure 23.2: Graves datable to the first half of the 4th century B.C. Phase A (first quarter of the 4th century BC), Phase AB (first or second quarter of the 4th century BC).

does, however, give us an idea of the limits of the cemetery in antiquity, or at least of its northern boundary (the river Mula). Furthermore, it permits the spatially dominant position of the so-called 'princely tombs' 200 and 277 (Cuadrado 1968) to be clearly observed, not so much because of their height but because of their non-central position in an area close to the river bank.

A second observation that needs to be made is that the graves selected in the various plans on the basis of chronology (Figures 23.2–23.4) are not necessarily mutually exclusive in all cases, due to the inevitable imprecision in some dates (Cuadrado & Quesada 1989, 50–51 and 77)

The first and most evident feature visible, without the need to 'tidy up' the chronological layers of the cemetery (Figure 23.1), is that the square stone tumuli are positioned in a very similar way, their sides following the contour lines, so that the tumuli generally appear to be parallel with each other apart from a few notable exceptions (for example, graves 382 and 312, Figure 23.2). However, the uniformity of the positioning is only relative, and does not indicate any rigorous planning. This becomes apparent in the plan of the cemetery around 350 BC (Figure 23.2). We do not know what the cemetery would really have looked like later, as some of the mud-brick towers on top of the tumuli crumbled away in the course of time, raising the level of the ground (Cuadrado 1987, 35), so we can have only an approximate idea of the cemetery's appearance in its early days, before too much time had elapsed (a couple of

generations) and hardly any graves had been superimposed on older burials.

At that time, there were no paths or defined spaces between the tumuli, so we cannot speak of the arrangement of spaces. Only the two large graves Cuadrado calls the 'princely' tombs (200 and 277) are characterised by two notable features. One is their relative position, which is peripheral rather than central (in relation to the north, rather than the south, where there are more unrecorded graves); the other is the presence of a temenos formed by a low wall leaving a narrow (and possibly sacred) passage around grave 277 and perhaps 200. This reserved space (Figure 23.2) is exclusive to these two graves and a third (grave 127, Figure 23.9), datable to the third quarter of the 4th century BC and thus from a later period, which is situated amongst a great number of graves in the central area of the site. This latter case is striking, because grave 127 is not particularly notable either for its richness or the type of grave goods it contains. Its only outstanding characteristics are its temenos and the number of reused carved fragments incorporated into its tumulus, which, with an area of 9.8m², was one of the 10 largest in the cemetery.

It is also important to point out that graves overlapped each other right from the early days of the cemetery's use, even in the case of tombs built soon after each other and particularly well made. Thus grave 277 is slightly earlier than grave 200, whose stone covering overlaps it slightly (Figure 23.2).

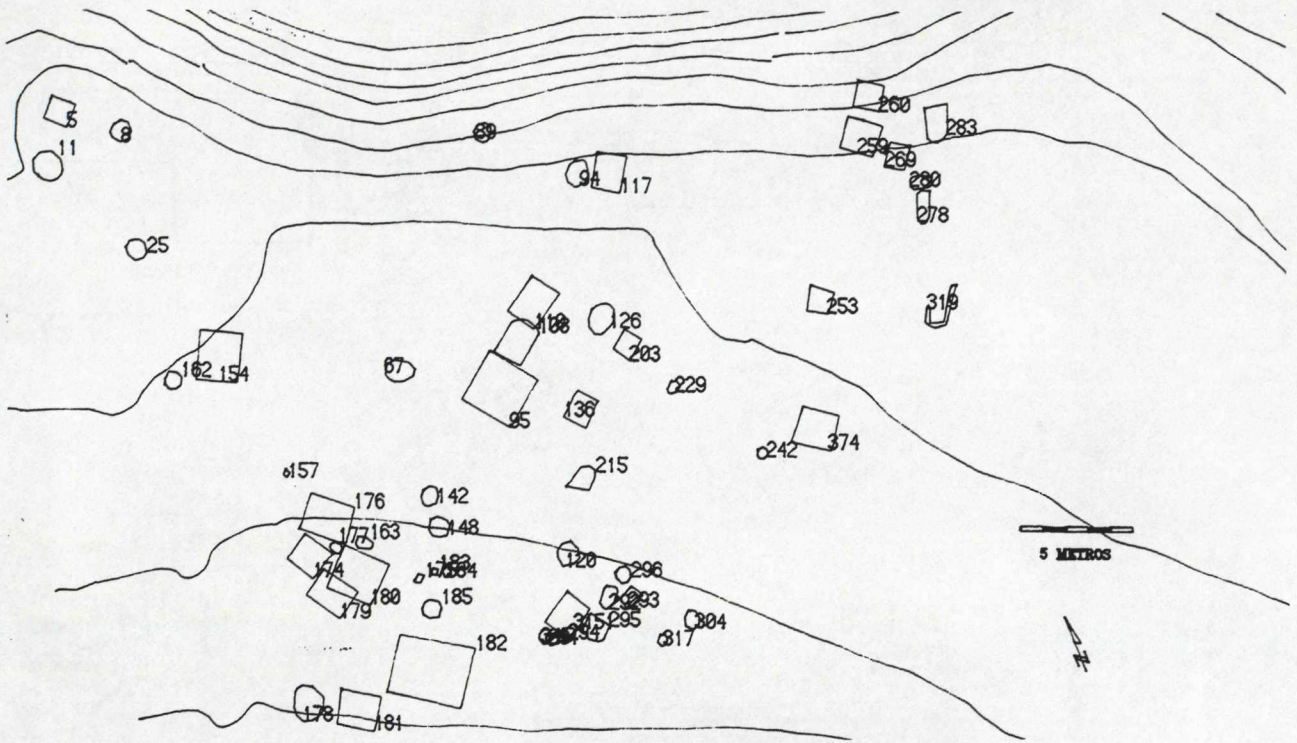


Figure 23.3: Graves datable to the 3rd century BC.

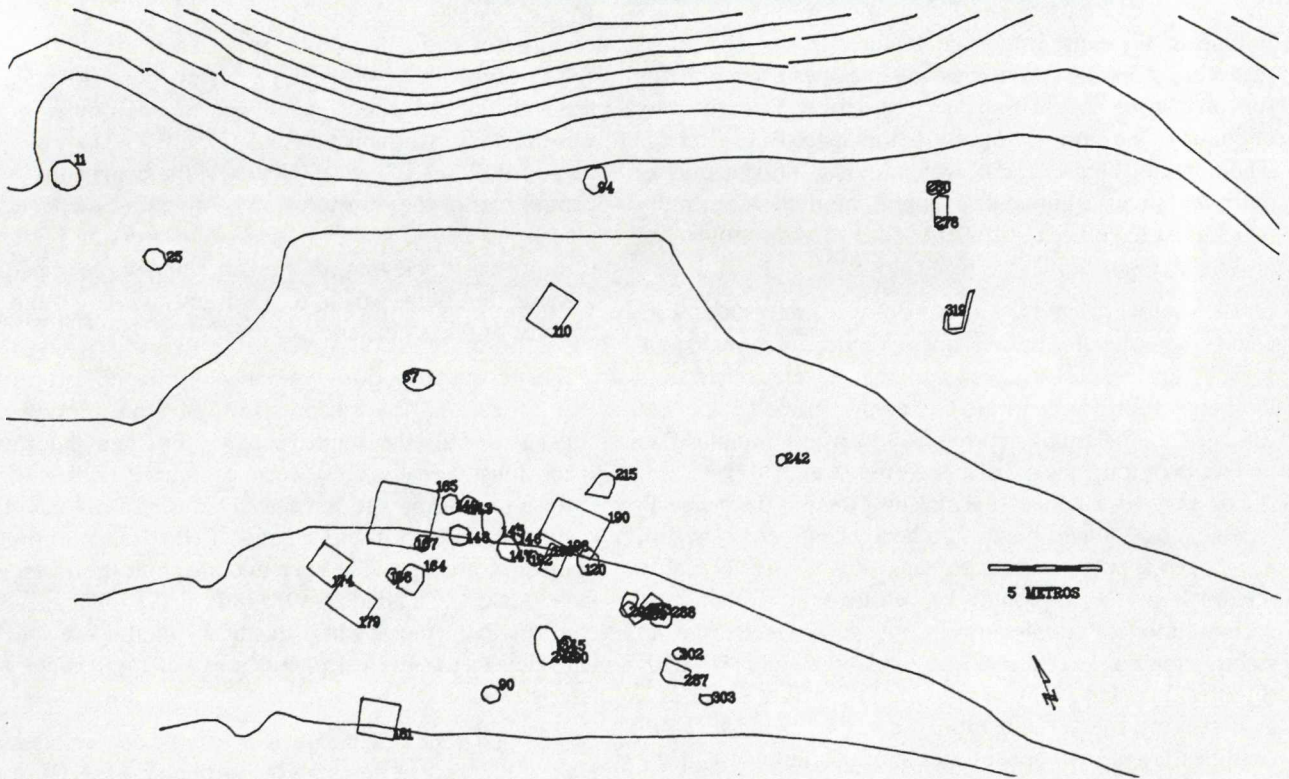


Figure 23.4: Graves datable to the 2nd century BC.

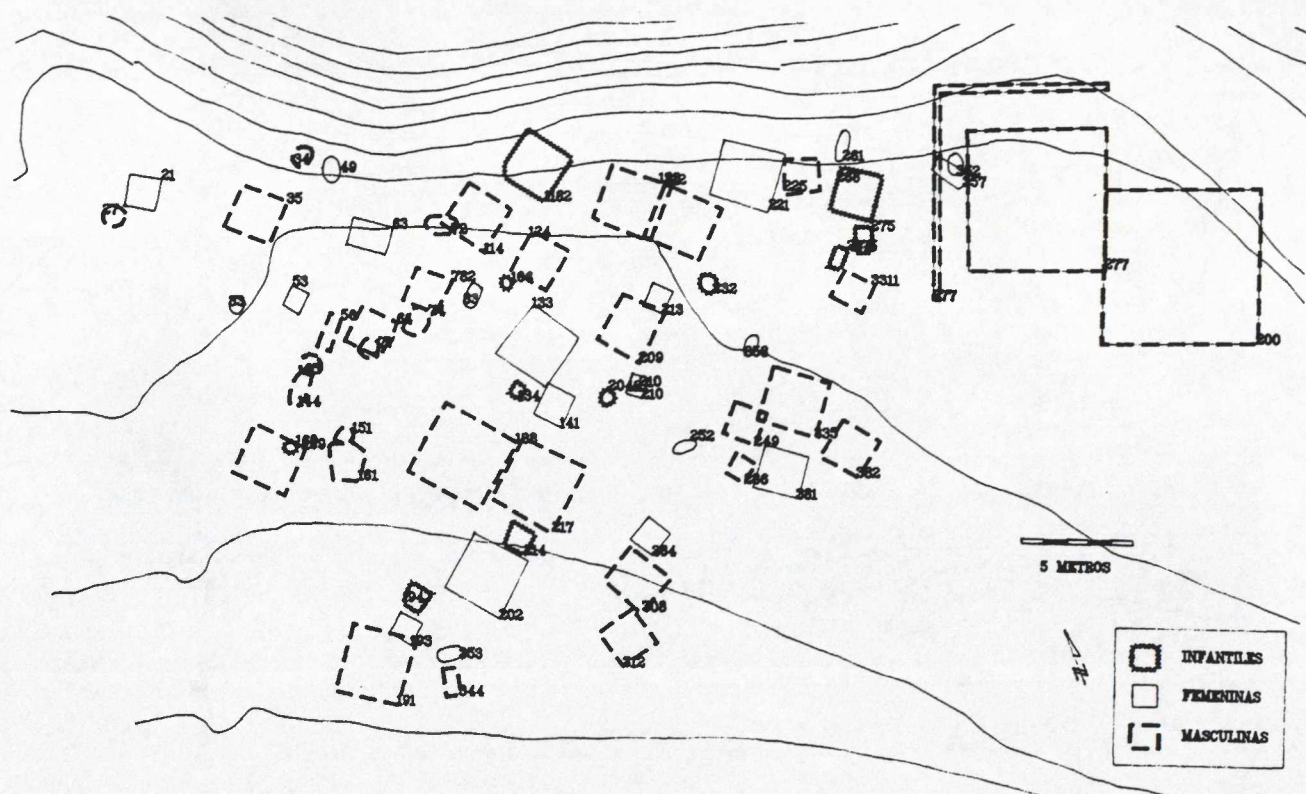


Figure 23.5: Graves of the first half of the 4th century BC. Probable distribution according to sex.

One of the most important features in our opinion is that the general boundaries of the periphery of the funerary space appear to have been defined from the very beginning, the graves initially being spaced out over the whole area (Figure 23.2), which made the creation of definite 'streets' unnecessary. In the mid-4th century there must have been sufficient space to walk around the cemetery (Figure 23.2).

The new graves in the cemetery's first phase were placed between the earlier ones (Figure 23.2), using up spaces between the stone tumuli that covered them, and frequently being forced in (for example, grave 123 next to 212; grave 72 partially on top of 114 whose tumulus had no less than four steps; 301 between 308 and 342, etc.). It is not easy to establish the reasons for this tendency to 'wedge' some graves between others when there must still have been empty spaces; perhaps it was due to family relationships. It could be easier to explain the accumulation of simple graves, many of which have no stone covering (Figure 23.2) and few grave goods (Figures 23.6 and 23.7), next to the low wall of grave 277, as if seeking shelter next to it. Graves 352, 357 and 279 (within the reserved space) are amongst the oldest in the cemetery and were partially destroyed by grave 277.

From the mid 4th century onwards the process of concentration and overlapping of graves became more acute. Graves continued to accumulate near grave 277 during the 3rd century (Figure 23.3), but by then they were even being placed on top of the temenos wall (grave 283). Other graves continued to be fitted in between older

tumuli (for example, grave 95 between graves 133 and 138). Some early 4th century graves must already have been abandoned and covered up, because other graves were already overlapping them (Figure 23.3) (grave 182 on 344, 117 on 123, etc.). However, the congestion of the central part of the cemetery can be noted in a tendency to place most of the graves in spaces towards the periphery (the present track towards the west and more especially towards the south, which, as has been said, is not the real boundary of the cemetery).

The process described continued during the 2nd century BC (Figure 23.4), since most of the graves are concentrated in the southern part. By then the central space must already have been completely full. In the eastern part of the site, excavated between 1984 and 1986 – and not covered in this study – a clear reduction in the number of graves can be seen and also that they were of a later date (Cuadrado 1985–86a, 1985–86b) which confirms both the southern boundary of the site and the tendency to use the peripheral areas of the cemetery for later graves.

The geographic database which has been created also makes it possible to analyse particular aspects of the cemetery, which we cannot discuss in detail here. These include the study of the spatial and temporal distribution of possible cenotaphs (empty graves in which the urn was sometimes replaced by a large stone). These cenotaphs are some distance away from the river bank, and are concentrated in an area which was clearly peripheral in the 4th century BC.

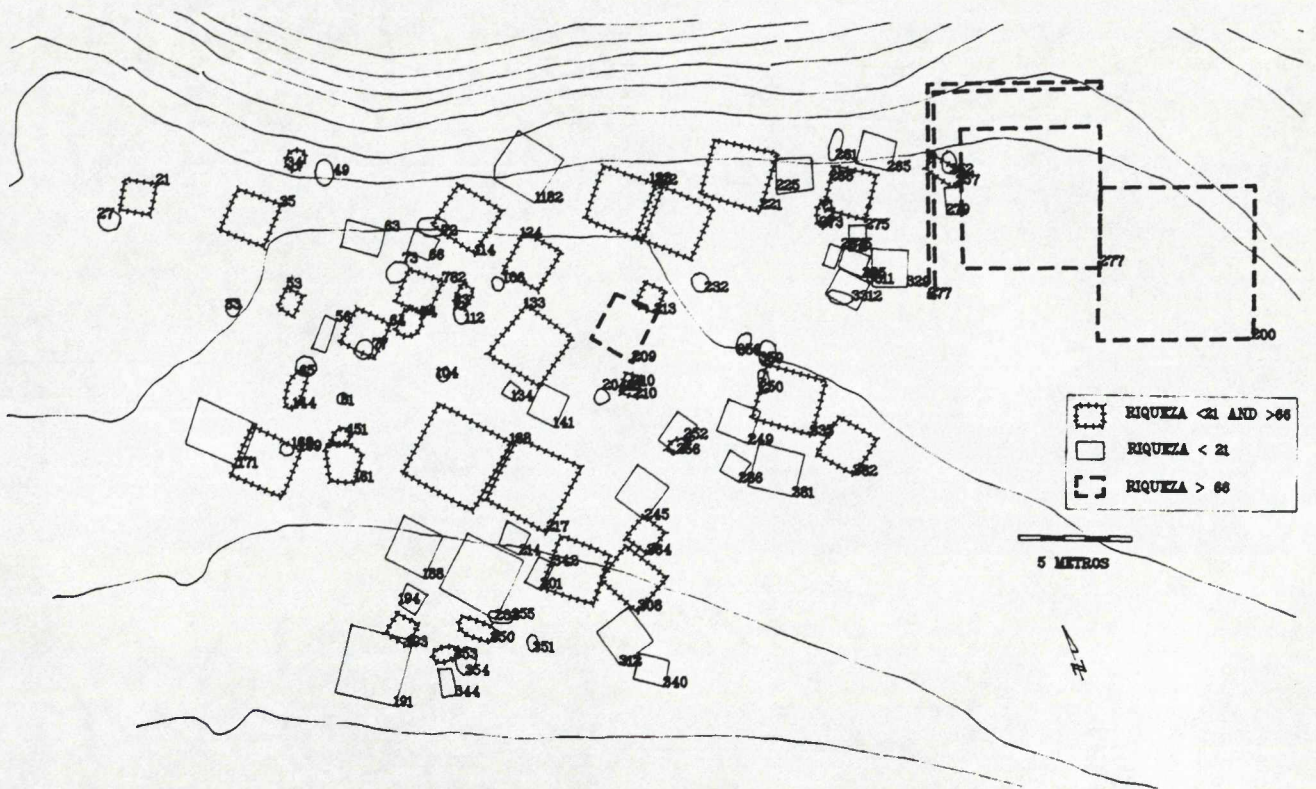


Figure 23.6: Classification according to richness (ie. units of wealth) of the grave goods in the graves of the first half of the 4th century BC.

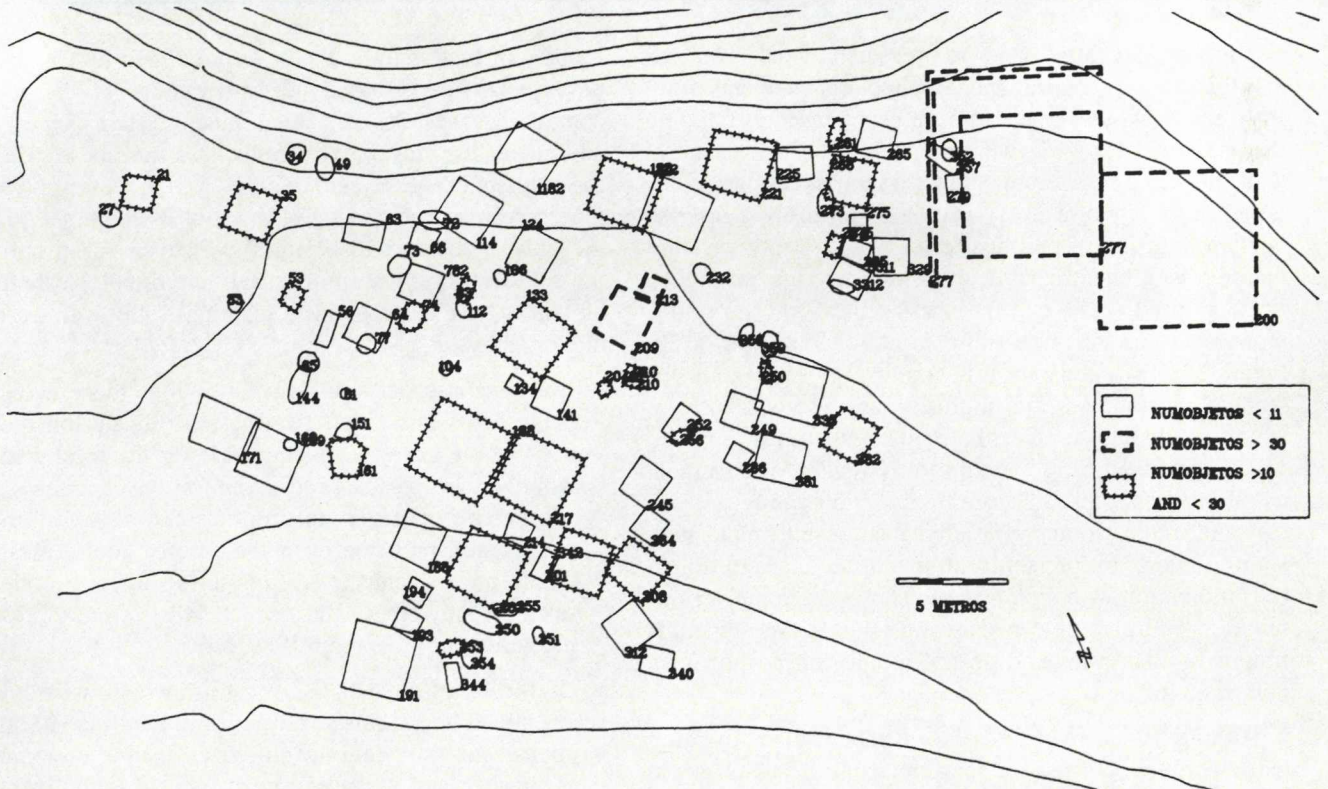


Figure 23.7: Classification according to richness (ie. number of items) of the grave goods in the graves of the first half of the 4th century BC.

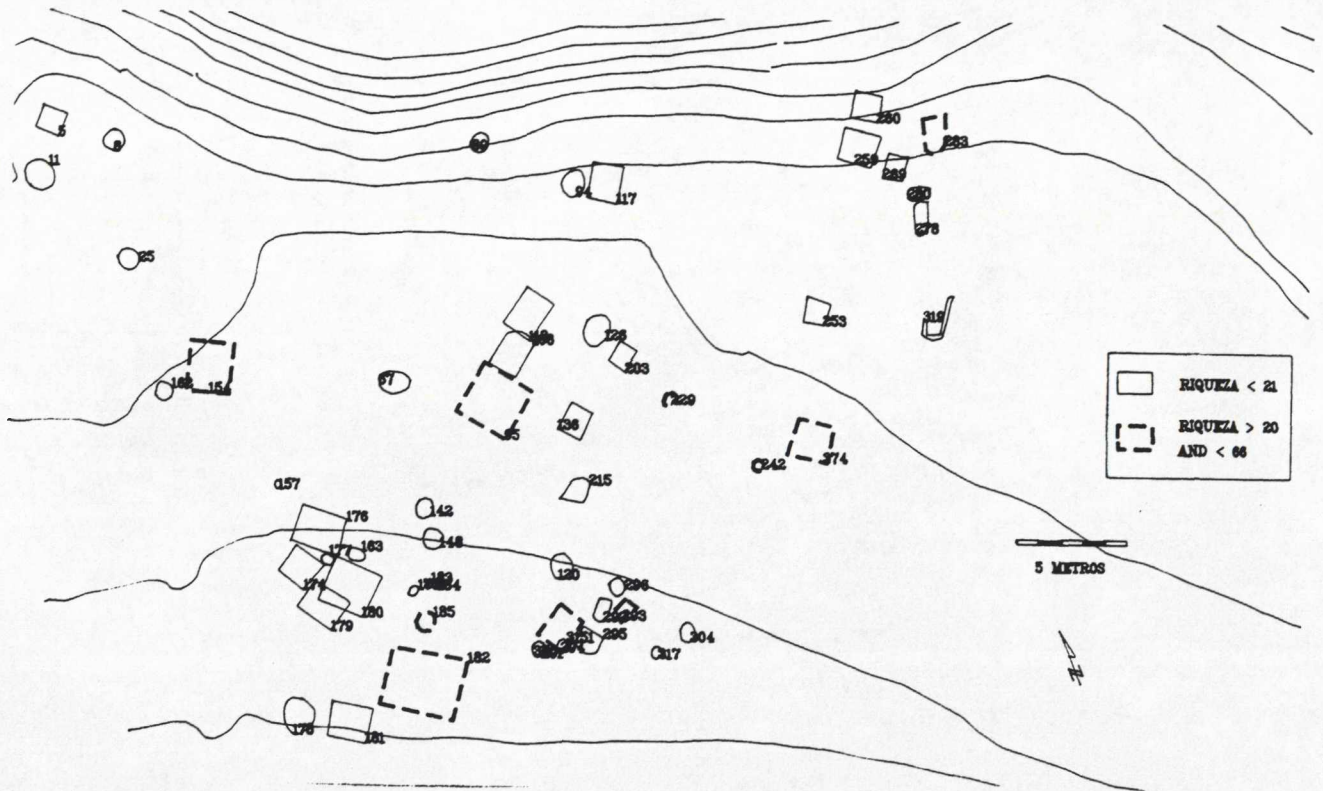


Figure 23.8: Classification according to richness (ie. units of wealth) of the grave goods in the graves datable to the 3rd century BC.

Another potential line of research would be the distribution of sculpted and architectural elements from early graves which appear to have been reused as building materials in later tombs (Figure 23.9). A significant fact is the appearance of architectonic fragments as part of the tumuli in early graves (grave 200, probably from the beginning of the second quarter of the 4th century, rather than earlier), but it is difficult to determine how much time elapsed between the destruction of the stone monument and its reuse (none at all? a long time?). In Figure 23.9 two apparently contradictory features can be seen. On one hand, the fragments are widely dispersed, which would suggest that the monuments destroyed were widely scattered, and perhaps also that a considerable length of time elapsed between destruction and reuse. On the other hand, zoomorphic elements are not found with anthropomorphic fragments, although the latter are found in combination with architectonic elements, in the various tumuli. The plan shown does not include the numerous fragments that are found on the tumuli but do not form part of them.

Although we cannot describe a complete study in detail here, it would obviously be feasible, using the database, to study complex relationships quickly and without difficulty, taking different criteria into account simultaneously. Thus for example, Figures 23.5–23.7 show different aspects according to the sex and wealth of the graves (employing in this case two different criteria – see Quesada 1994).

A study of the sex of the cremated remains is based on the problematic identification of the few fragments of bone

found. In this analysis the criteria defined by Cuadrado have been used, based on attributing grave goods containing weapons to men and certain types of adornment to women. The problem is that these criteria are only applicable to certain cases, which leaves some of the graves unattributed. The question is more serious if the grave goods/sex association, which has been upheld for decades, is refuted. Fortunately the osteological study of the Cigarralejo remains (Santonja 1989 with earlier bibliography) states that

‘we have been able to prove [...] that those cases diagnosed without doubt as male or female [on the basis of the grave goods] coincide for the most part with grave goods consisting of weapons or adornments, but that this rule is not followed in some cases, particularly in the case of adolescents, whose bone fragments are difficult to assign to one sex or the other and which we refer to as indeterminate’ (Santonja 1989, 55).

Of the cases studied, 42 remains, which were male according to their bones, have grave goods containing weapons, and only four identified as men according to their bones had ‘female’ grave goods (adornments). Inversely, 28 classified as women according to their bones had adornments and no weapons, and 12 had masculine anatomies but grave goods containing ‘female’ adornments. It is however possible that Santonja is excessively optimistic, because other studies tend to refute the grave goods/sex association, except perhaps in the case of weapons.

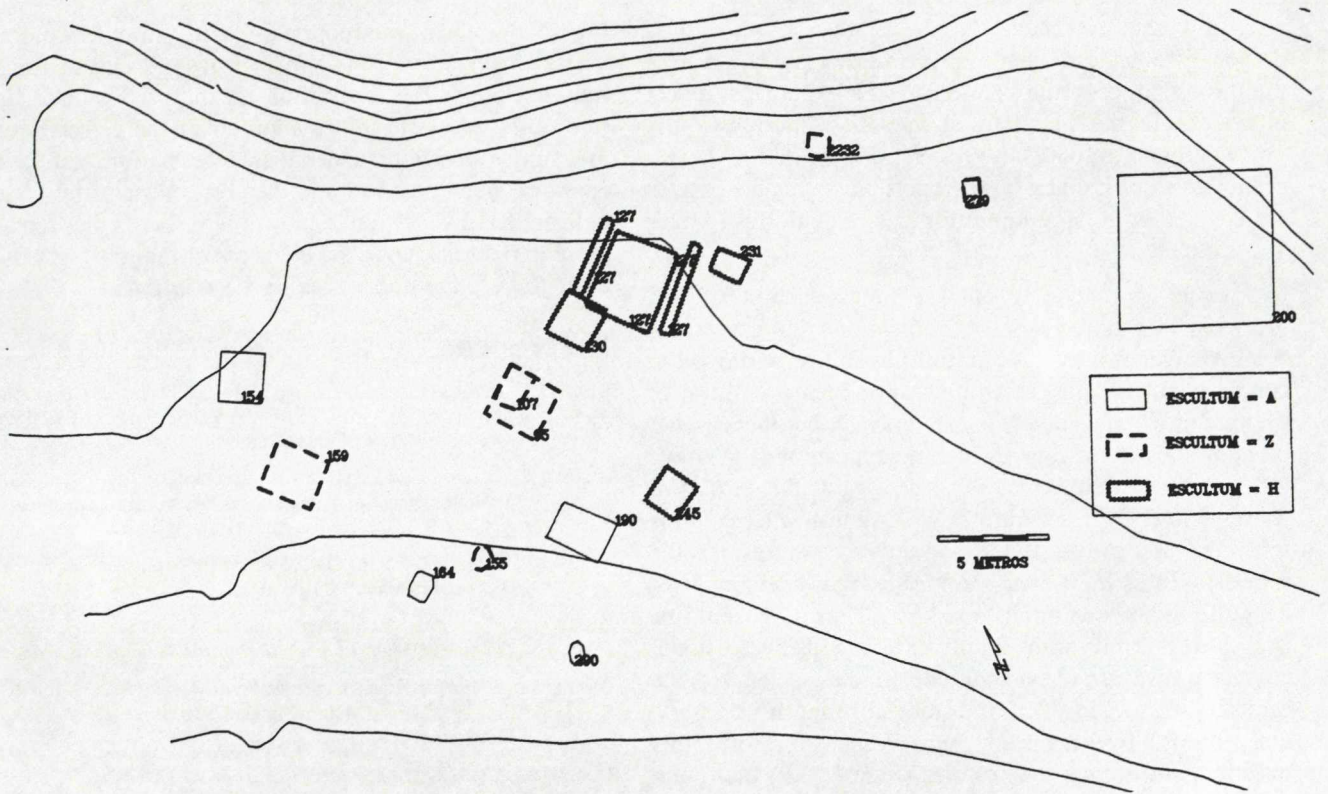


Figure 23.9: Distribution of types of sculpted and architectural fragments reused in the tumular stone coverings. A (anthropomorphic elements), Z (zoomorphic elements), H (architectonic elements).

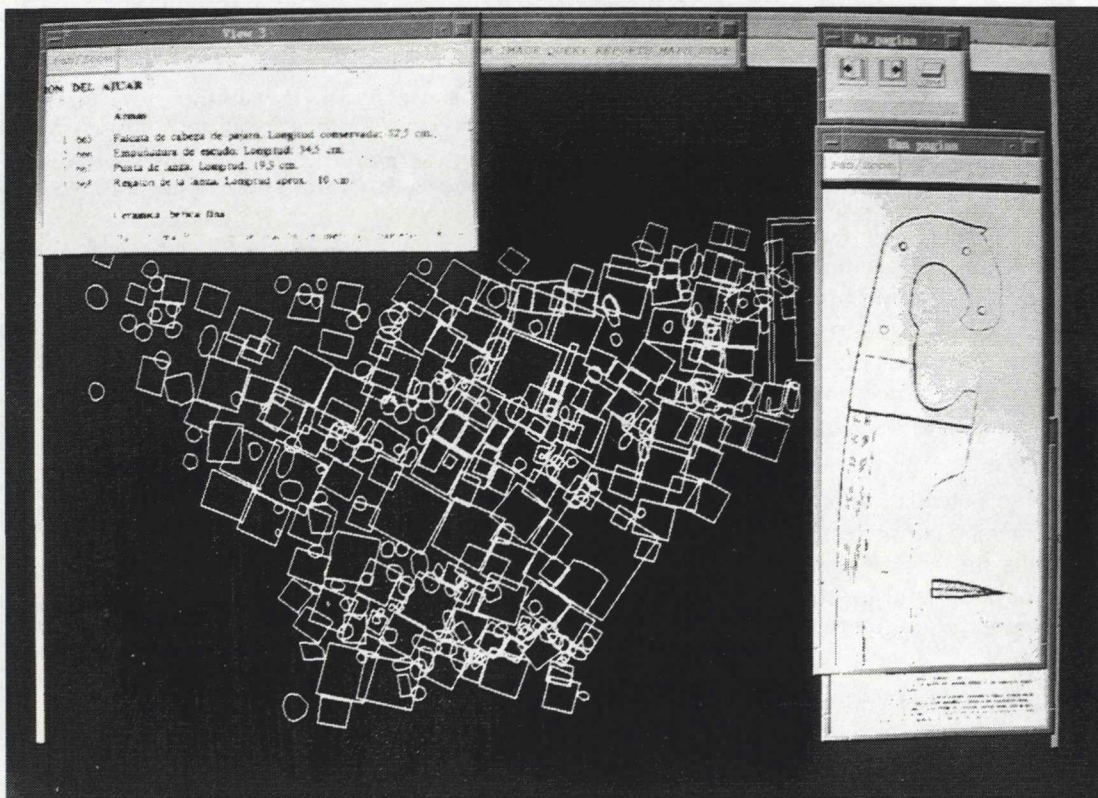


Figure 23.10: Types of window with information on graves. Interactive communication between the user (researcher or museum visitor) and the database.

In any case, the results obtained by the present method demonstrate features that deserve further study, such as the grouping of some 'clusters' which perhaps reflect blood ties in the first half of the 4th century BC (the graves around grave 335, 191, etc., Figure 23.5). It also seems significant that a high proportion of 'female' graves are covered with large tumuli or square platforms (graves 133, 202, etc.).

Another approach is to analyse the association between graves with tumular stone coverings and pit graves not covered with stones. An initial possibility would be to consider that the pit graves may have been 'satellites' of the tumuli (infant graves, poorer graves), but there would be numerous exceptions to such a supposition (e.g. grave 293, relatively rich, which is probably a double burial) or graves 350 and 353 (Figure 23.6). Another alternative is that many pit graves, which occupy spaces between the tumuli as best they can, were added considerably later near the tumuli for family reasons. Thirdly, it could be suggested that pits were simply excavated between stone-covered graves so they could be in the nucleus of the cemetery, dispensing with the stone covering if necessary. Only a case by case study can ultimately resolve this question, since there are features (Figure 23.2) that point in opposite directions.

Another line of research is that related with the hierarchical structure of this society. This can be undertaken from the study of the grave goods, the area and even the volume of the tumuli, values for all of which are stored in the database, and can be correlated with each other, or with other features (e.g. sex or chronology) all in terms of spatial distribution. By way of example, Figures 23.6–23.9 show the classification of wealth between the 4th and 3rd centuries BC using as defining value limits those considered significant in a previous study (Quesada 1994), although any others could be chosen. It can be seen that the 'units of wealth' and 'number of objects' criteria produce fairly similar overall results (Figures 23.6 and 23.7). A reduction both in the number of grave goods and in the size of the tumuli between the first half of the 4th century (Figure 23.6) and the 3rd century (Figure 23.8), which continues into the 2nd century BC can also be seen.

Together with these potential areas of research, which can be extended in almost any direction, the ARCINFO database also permits the consultation of graphic fields (Figure 23.10), which are useful for the researcher when comparing hypotheses suggested by the various

distribution plans, but more particularly in other contexts. These dialogue windows are primarily designed for the museum use of the application, so that visitors can have interactive access to information about the cemetery, can ask simple questions and obtain information, not in the form of numeric data or the very schematic spatial delineations like the ones shown here, but in the form of graphic fields showing the elements of the grave goods in each grave, plans or brief textual descriptions.

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