A GIS intra-site application to the Early Palaeolithic site of Garba IV (Melka Kunture, Ethiopia)

Application d'un SIG intra-site au gisement Paléolithique ancien de Garba IV (Melka Kunture, Ethiopie)

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Abstract : A GIS intra-site application to the taphonomic interpretation of the Developed Oldowan site of Garba IV (Melka Kunture, Ethiopia) allowed the automatic data processing of more than 12,000 lithic artefacts and faunal remains lying on a 100 square meters paleosurface dating to about 1.5 my. It is possible to obtain different thematic maps and sections visualizing finds on the paleosurface either individually or in association with any other type of information in order to reconstruct the processes involved in the formation of the deposit and the modalities of the different phases of the site occupation.

Résumé : L'application d'un Système d'Information Géographique destinée à l'interprétation taphonomique du site de l'Olduwayen évolué de Garba IV (Melka Kunture, Ethiopie) a permis l'élaboration automatique des informations relatives à plus de 12.000 pièces lithiques et fauniques dispersées sur une paleosurface de 100 mètres carrés datée à environ 1.5 Ma. Ce système a permis d'obtenir différentes cartes et sections thématiques et de visualiser les pièces sur la paleosurface soit individuellement soit en association avec toutes les autres données ; ceci afin de reconstruire les processus qui ont été impliqués dans la formation du dépôt et les modalités de l'occupation du site.

Introduction

The Developed Oldowan site of Garba IV is one of the most interesting sites of Melka Kunture, due to the extension of the excavated area, to its chronology and to the abundance of lithic and paleontological finds, which make it one of the largest Lower Pleistocene deposits of Eastern Africa (Piperno & Bulgarelli 1975). Excavated from 1973 to 1982, it comprises 5 archaeological layers (C, D, E, F, G) referable to a late phase of the Oldowan dating to about 1.5 my. A right hemimandible attributed to a 3/5 years old *Homo erectus* child was found in a 4 square meters excavation undertaken in level E.

An area of about 100 square meters of the level D was systematically explored. It yielded a very dense concentration of nearly 10,000 artifacts and over 2,700 faunal remains (Fig. 1), mostly of Bovids (*Pelorovis oldowayensis*, *Connochaetes taurinus*, *Damaliscus* cfr *agelaius*), Antelopes (*Gazella* sp.), Equids (including *Stilohipparion*), Suids (*Kolpochoerus limnetes*, *Metridiochoerus andrewsi*, *Phacochoerus modestuy*), Hippopotamus (*Hippopotamus amphibius*), Elephants, Giraffes and a Primate resembling the present-day gelada [*Theropithecus* (*Simopithecus*)] (Geraads 1979). The lithic tools are made from volcanic rocks (obsidian, basalt, lava, trachyte, tuff). There is an evident dichotomy in the choice of raw materials, as most of the flake tools are on obsidian, while the pebble-tools have been mainly obtained from other volcanic rocks (especially basalt). Lithic material comprises very few roughly shaped handaxes mostly on flakes, two cleavers, several pebble-tools and a large amount of flakes and retouched flakes.

The difficulty of organizing thousands of information related to the finds excavated on the level D suggested to utilise a Geographical Information System application in order to study the spatial analysis and the taphonomic interpretation of this paleosurface. The need to correlate the spatial distribution of evidence with the analytic study of each find makes spatial technology, and especially GIS, very useful in the study of pos sible significant associations of artefacts.

A three dimensional GIS application has been also recently proposed for the site of Swartkrans, in order to archive and visualize fossil, artefacts and geological data in their spatial context and to begin to distinguish taphonomic factors responsible for such an accumulation (Nigro *et al.* 2001).

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Figure 1 : Garba IV D. A view of the western sector.

The GIS application

This application could perform the following operations:

- visualization of all the remains as spatial variables;
- realization of thematic maps;-
- bidimensional and tridimensional spatial queries (topographical selections, removal of post-depositional noise) in order to reconstruct the post-depositional processes, due to both anthropic and natural events, which led to the formation of the deposit, and the modalities of the different phases of the site occupation;
- statistic inference of spatial data (spatial correlation and autocorrelation; trend surface analysis) to highlight concentrations and eventually significant associations or relationships between different finds.

The first step was to convert all the data gathered into a digital format, in order to give a structure to the information and to make it compatible with a digital processing. The existing documentation consisted on the catalogue of the finds written after each year of the excavation, on the plans of the excavated area and on a series of catalogues in which the typological and technological data related to the lithic industry and to the paleontological determination were reported. These archives were converted into a database allowing a wide range of single or multiple queries capable to group and to count the entire set of the data, a fundamental function for statistic analyses.

The next step consisted on the computerisation into a vector format of the original cartography of the plans of the excavated site. All the remains have been drawn on different plans and represented with different line styles to document overlaying objects on site. Each object was assigned an exclusive value (or primary key) consisting of its inventory number and the same key provided the link for importing the database (Fig. 2).

It is hence possible to interrogate simultaneously both the graphic plans of the finds and the information connected with them in the database. Information of an alphanumeric archive can be visualized in a new data table or in a thematic map. Different types of maps can be produced by visualizing finds on the paleosurface either individually or in association with any other type of information.

The high number of objects makes often difficult to interpret the thematic maps. The visualization of the density or dispersion of remains has been simplified by creating frequency maps with objects grouped by value range using SQL (Standard Query Language). The remains have been grouped and counted by grid square, using either the excavation grid square (1 x 1 square meters) or smaller squares (50 x 50 square centimeters) for more detailed studies of especially significant areas.

The spatial investigation was carried out not olny analyzing the horizontal but also the vertical distribution of finds in transversal and longitudinal sections on which the altitude of all the remains was projected. It is clear that such topological operations will be extremely helpful in reconstructing the modalities and phases of the formation of the site, as well as its post-depositional processes; it is also possible to highlight specific associations or distributions through the interfacing of data from different thematic sections with the horizontal maps.

The spatial analysis

The use of a GIS application has proved especially useful in the taphonomic interpretation of specific classes of materials showing

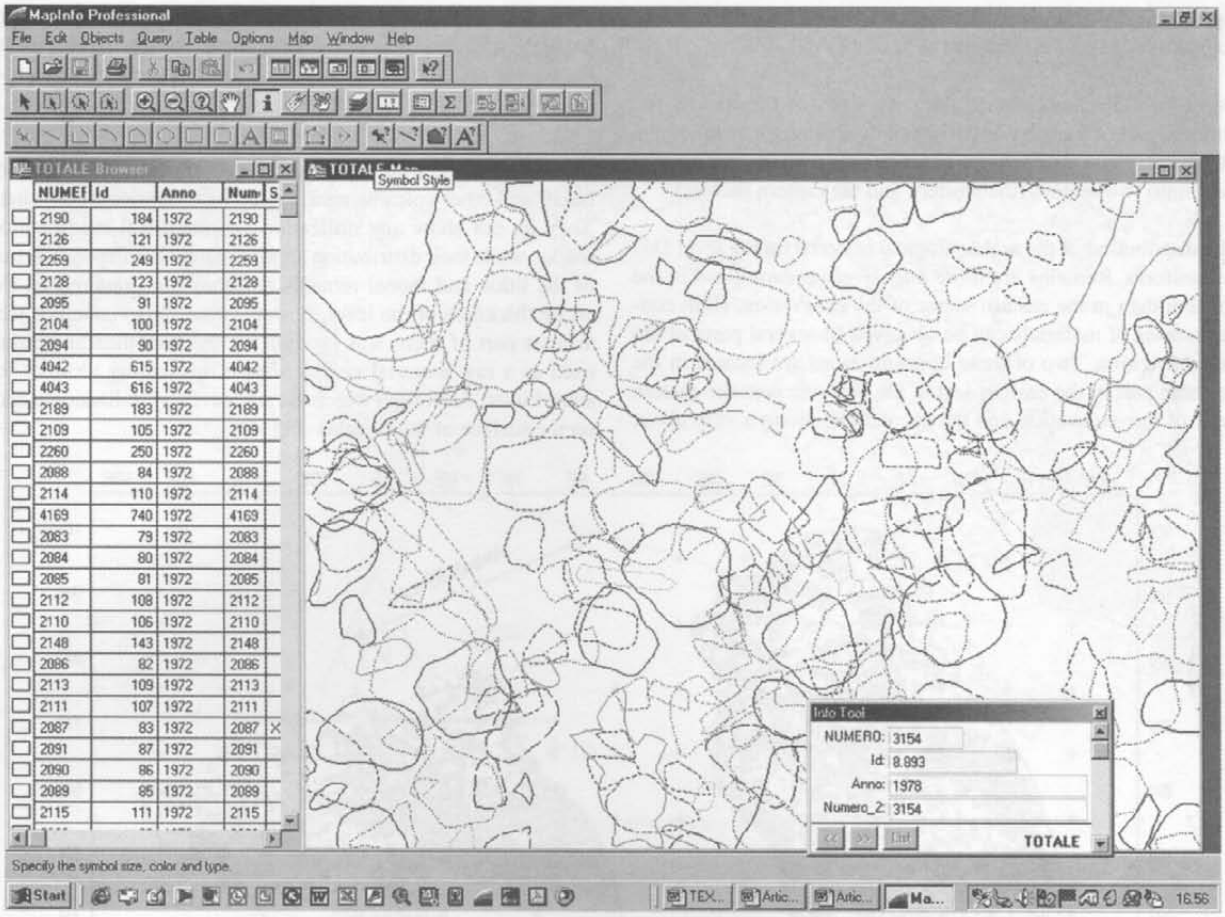

Figure 2 : The link between the graphic and the alphanumerical objects.

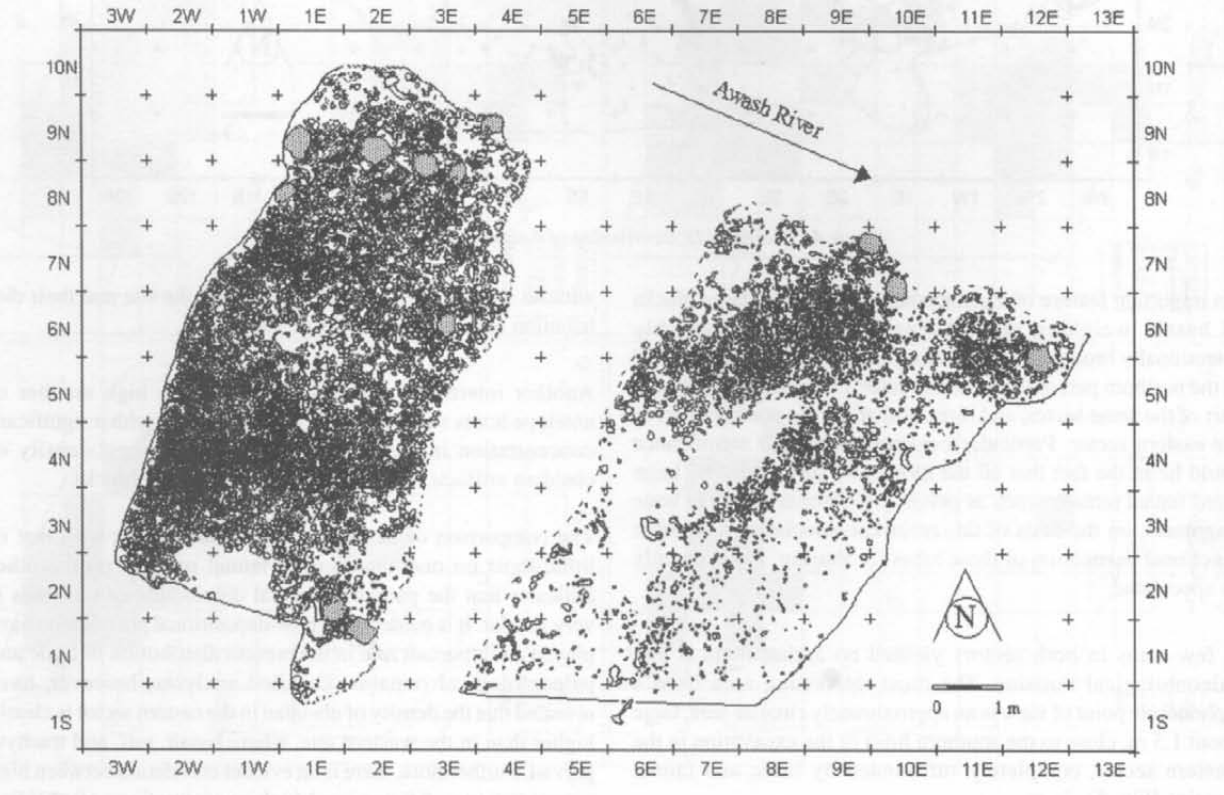

Figure 3 : Garba IV D. Distribution of the lithic industry and faunal remains (black) and of the large basalt blocks (dotted).

significant distributions, allowing us to reach some interesting considerations on the evidence of Garba IV D.

Due to its location close to the right bank of the Awash, the northern part of the site was destroyed by erosion for an unknown extension, while the excavated area has been divided by a small gully into two sectors (the western and the eastern sectors).

The distribution of the archaeological material on the level D is not uniform. Remains are more intensively accumulated in the western than in the eastern sector of the excavation. High concentrations of materials can be observed in several parts of the excavated area. Two of these concentrations are located in the northern part of the eastern sector, the first one near the eastern bank of the excavation and the second one along a strip about 2.5 m long and 1 m wide, oriented SW/NE. In the western sector, the highest frequency is found in the central part, especially along the western bank, where more than 500 finds are presents in a single square meter (Fig. 3).

Furthermore, the whole paleosurface is strewn with pebbles of basalt and other volcanic rocks, with the exception of obsidian. They do not show any utilization or intentional modification marks, while their distribution approximately corresponds to that of the lithic and faunal remains and they are scattered on the entire thickness of the level. It seems possible to conclude that at least part of them was brought by the hominids and either used as a raw material nearby source for making tools or for some kinds of activities which did not leave any utilization marks on the surface of the pebbles (Fig. 4).

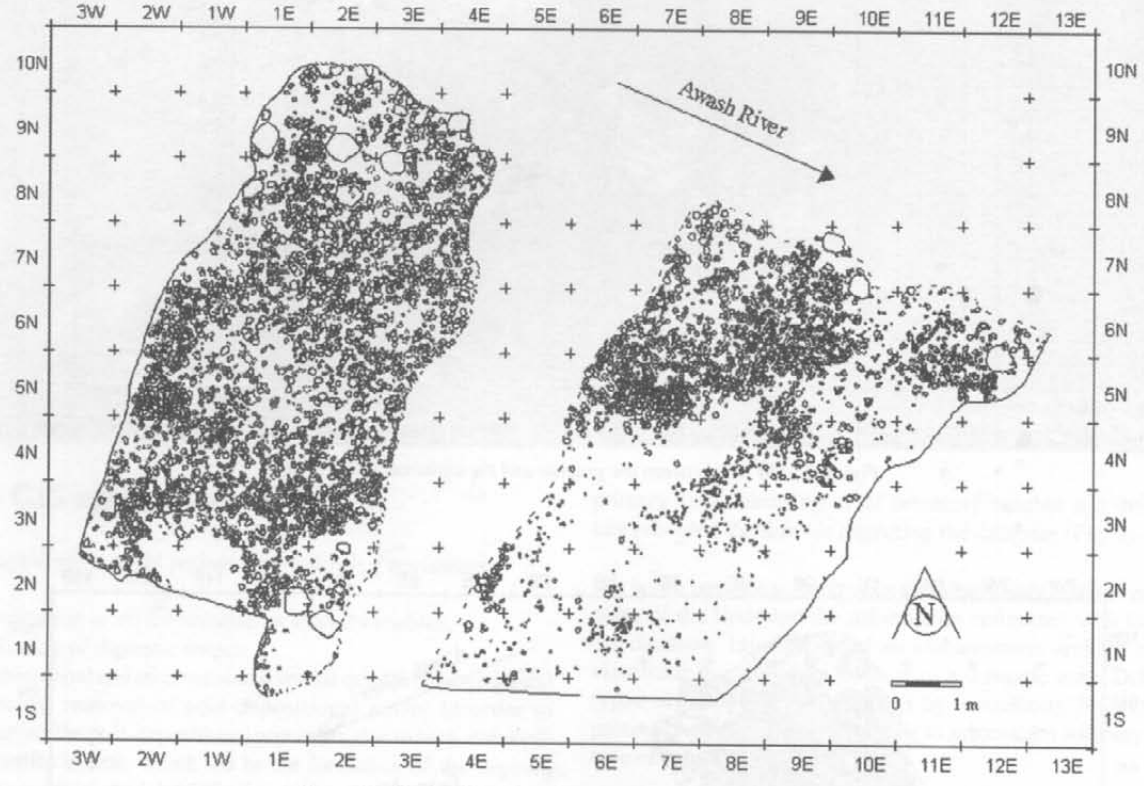

Figure 4 : Garba IV D. Distribution of the unmodified pebbles.

An important feature of the site consists on several large blocks of basalt, weighing several tens of kilos each, probably intentionally brought by the hominids. Most of them are located in the northern part of the western sector, two in the southeastern part of the same sector, and three of them in the northern part of the eastern sector. Particular evidence as to their significance could lie in the fact that all the blocks are surrounded by large sized faunal remains such as pelvis, jaws, horns and large bone fragments; on the basis of this recurrent association a possible functional destination of these areas for sharing food can only be speculated.

A few areas in both sectors yielded no archaeological and paleontological remains. The most interesting area from a taphonomic point of view is an approximately circular area, large about 1.5 m, close to the southern limit of the excavation in the western sector, completely surrounded by lithic and faunal remains (Fig. 5).

2,700 faunal remains and about 10,000 lithic tools are scattered without significative concentrations over the site and their distribution reiterate the one upper mentioned.

Another interesting aspect is the relatively high number of antelope horns strewn all over the surface, but with a significant concentration in areas also showing the highest density of obsidian artifacts, near some of the large basalt blocks.

The comparison of the total distribution of finds with that of lithic tools on one hand and of faunal remains on the other indicates that the pattern of spatial distribution of the finds is very similar. It is evident that post-depositional phenomena have played an important role in the present distribution of lithic and paleontological remains. Detailed analyses, however, have revealed that the density of obsidian in the eastern sector is clearly higher than in the western one, where basalt, tuff, and trachyte prevail. Furthermore, there is an evident correlation between high concentrations of fauna and high concentrations of obsidian artifacts, and between high concentrations of basalt pebble-tools and high concentrations of basalt flakes (Fig. 6).

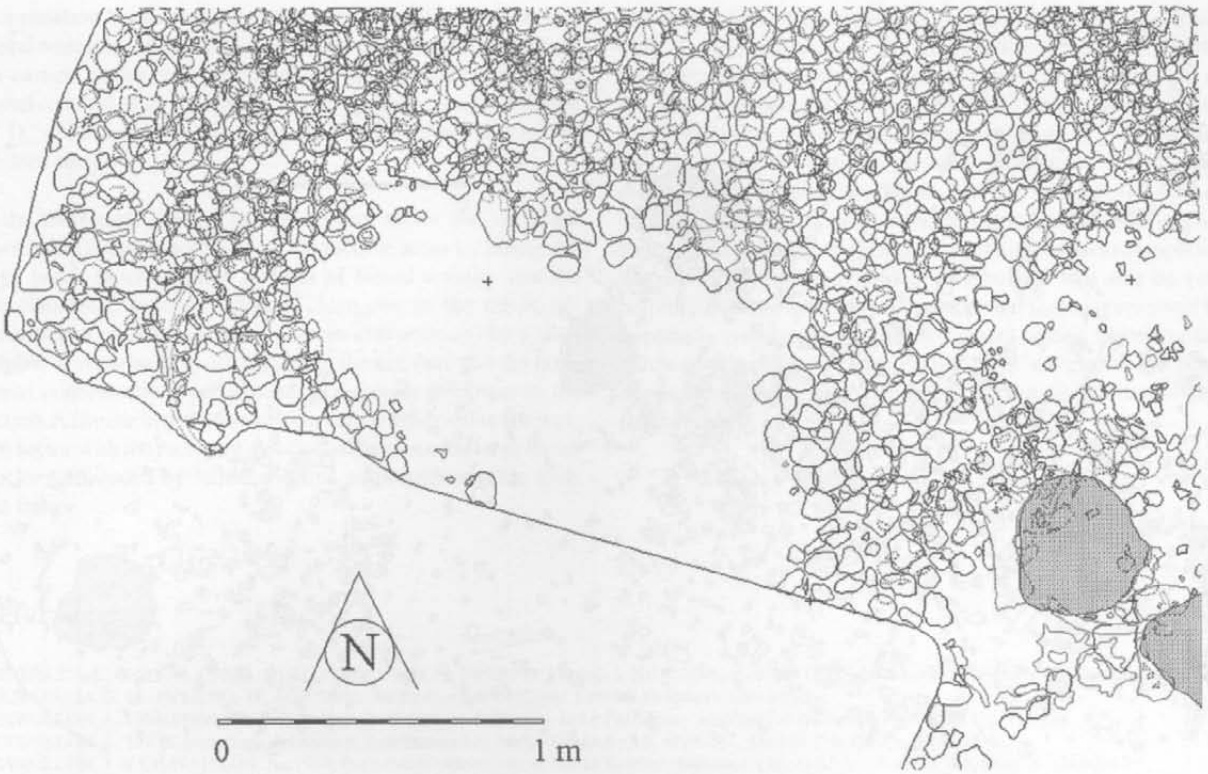

Figure 5 : Garba IV D. A detail of the semicircular area in the southern part of the western sector.

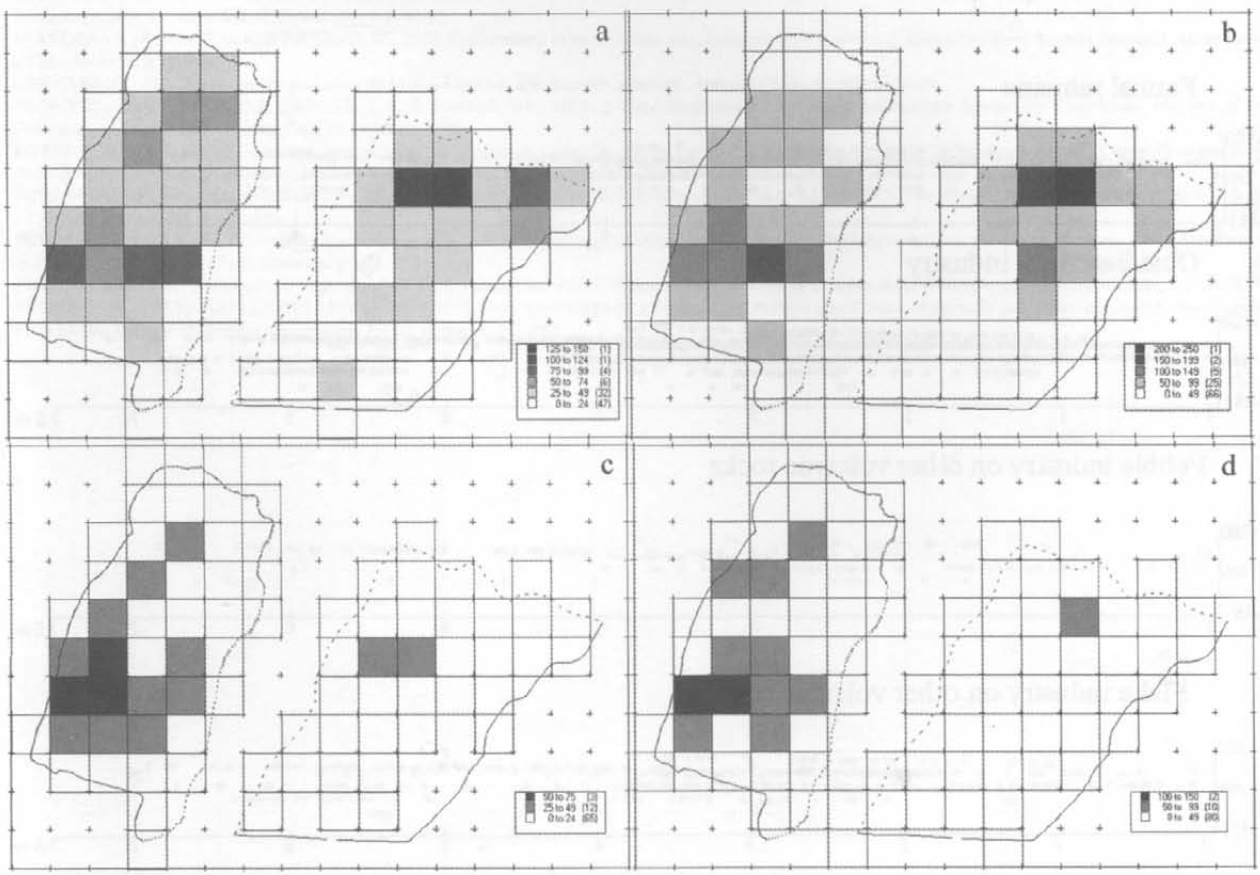

Figure 6 : Garba IV D. a) frequency of the faunal remains; b) frequency of the obsidian flakes, tools and cores; c) frequency of basalt pebble tools; d) frequency of the basalt flakes and tools on flakes.

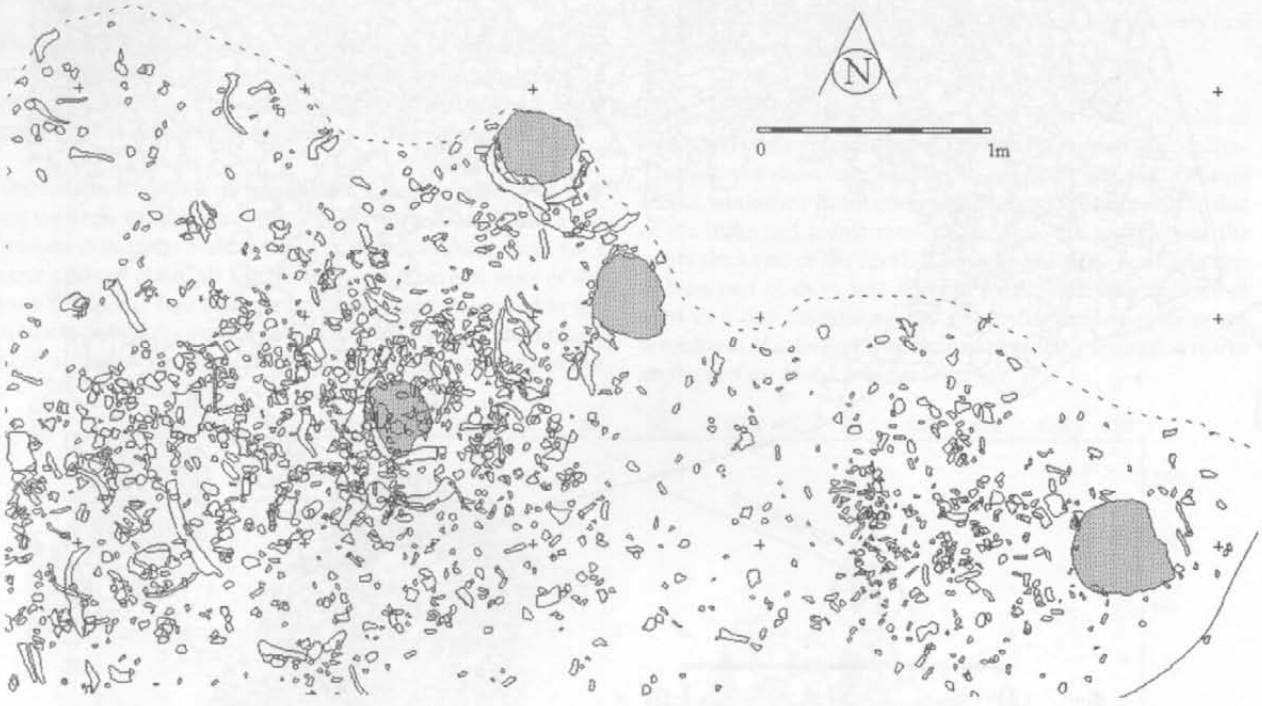

Fig. 7. Garba IV D. Obsidian tools, flakes and cores surrounding the large basalt blocks in the eastern sector.

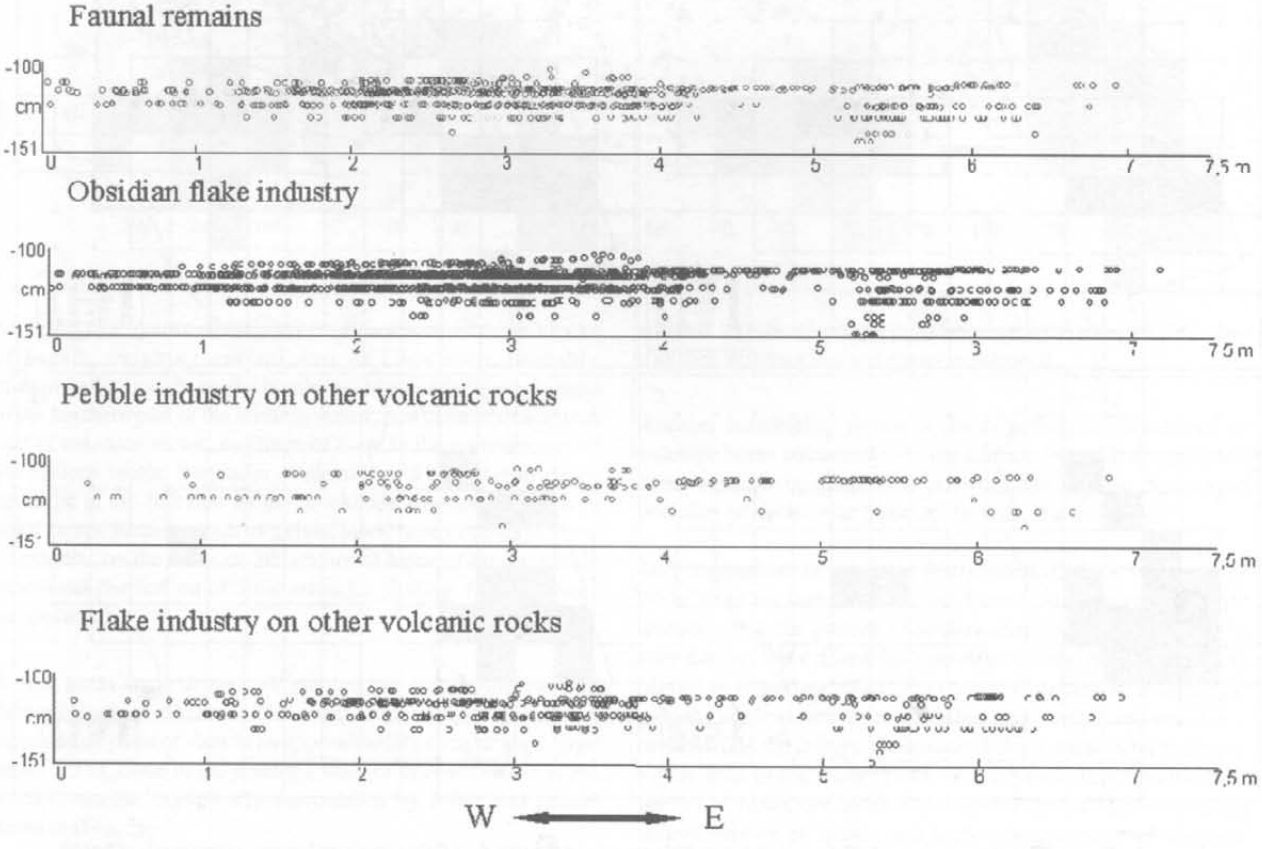

Fig. 8. Garba IV D. Transversal section relevant to the eastern sector.

A correlation between the distribution of obsidian artifacts and faunal remains is also perceivable in the north-central portion of the eastern sector, near the basalt blocks surrounded by large faunal remains (Fig. 7). This is a recurrent association at Garba IV D, which can also be observed in the northern part of the western sector.

In the transversal section of the eastern sector this recurrent association is even more evident. In fact the areas including the large basalt blocks, a high number of faunal remains and the obsidian flake industry, though close one to the other, are nevertheless clearly separated by areas characterized by a slow number of remains (Fig. 8). It is interesting to note that the horizontal concentrations correspond to a greater thickness in the section. A similar distribution pattern can be observed in the western sector with the recurrent association between the large basalt blocks surrounded by faunal remains and obsidian lithic tools and flakes.

The realization of thematic and general sections is useful not only for the analysis of the associations, but also for the interpretation of eventually distinct phases of frequentation of the site by hominids. At least three different layers can be distinguished in these sections. The next steps of this research will be aimed to continue the analysis of each layers using different methodologies. Thanks to the GIS application, it becomes possible to visualize the horizontal distribution of each layer and to point out to eventual association patterns comparing the results with those obtained until now. It will also be very helpful to use the refetting method to test if these layers could be eventually correlated to distinct settlement phases. Moreover this method will allow us to give the right weight to the post-depositional processes which led to the formation of this paleosurface.

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