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The spatial organization in Hornillos 2 rockshelter during the Middle Holocene (Jujuy Puna, Argentina)

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ABSTRACT

This paper analyzes the spatial organization of two layers corresponding to the first half of the Middle Holocene from the Hornillos 2 rockshelter (Susques, Jujuy Province). Some important issues taken into account are the good preservation of the site and the sedimentary deposition processes which coincide with paleoclimate aspects. Correlation of different archaeological lines of evidence allows interpretation of the connection between several activity areas and their occupational intensity. There is a trash heap related to a short occupation period at the beginning of the Middle Holocene and a main zone of intense activity ca. 6200 yrs BP. These facts are in accordance with the archaeological expectations proposed for certain periods of the Middle Holocene.

1. Introduction

The caves and rockshelters in the Andean area have been intensely occupied for approximately the last 12000 years when groups of hunter-gatherers started to colonize the region. The caves occupied in the Junin Puna in Peru, such as Pachamachay (Rick, 1983) and Tuina rockshelter, and the San Lorenzo cave in the Puna of Atacama in Chile (Núñez, 1992), are examples of this early choice. Several investigations have been carried out in many caves and rockshelters in the Argentine Puna which have revealed the diversity in use and function of these locations through time, for both hunter-gatherers and later for the llama herders (Aschero, 1984; Fernández Distel, 1986; García, 1991; Aschero et al., 1993–1994; Dransart, 1997; Aschero and Yacobaccio, 1998/99; Hernández Llosas, 2000; López, 2008; Yacobaccio et al., 2010; Catá, 2011).

The Puna is a semiarid region characterized by a low primary productivity, intense solar radiation, high daily thermal amplitude, high temporal and spatial variation in rainfall with frequent deficits which cause prolonged droughts. These conditions produce a high spatial and temporal variability in the critical subsistence resources (Yacobaccio, 1997; Muscio, 1999). As a consequence of these conditions, the Puna is a high risk environment (Yacobaccio, 1994; Muscio, 2004; López, 2008; Morales, 2010) because it is difficult to anticipate the stochastic variability (Winterhalder, 2007).

Paleoenvironmental research indicates that the end of the Pleistocene exhibited arid and cold conditions following a very humid phase (Tauca phase). Many authors consider the cold phase as similar to the Younger Dryas (Núñez and Grosjean, 1994; Núñez et al., 1997, 2002; Morales, 2010). During the Early Holocene, there was an increase in humidity because of reduced insolation due to the orbital cycle and the absence of El Niño (ENSO) events (Bradbury et al., 2001; Mayewski et al., 2004). These conditions enabled the development of more wetlands which allowed a more even distribution of resources than at present (Sylvestre et al., 1999; Baker et al., 2001; Morales, 2010). After 10,000 cal BP, the level of the Pleistocene lakes gradually began to decrease, and rapidly dried out in some cases (for example, the salt flat of Uyuni in Bolivia). This process was accompanied by a probable increase in temperature and a shrinkage of the wetlands, reaching its maximum aridity during de Middle Holocene in the period 7200–6700 cal BP (Bradbury et al., 2001). The paleoenvironmental evidence indicates that the Middle Holocene was a period of important climatic changes at a macroregional level which provoked a great aridity in the Puna region, although with short periods of intense storms (Núñez and Grosjean, 1994; Núñez et al., 1997). These changes displaced the meadows and nutrient concentration zones to a sparse regional distribution (Yacobaccio and Morales, 2005; Tchilinguirian, 2009; Morales, 2010). Morales (2010) predicted that occupations would be expected below 4000 m asl during the 8000–7000 yrs BP time span, and above this elevation during 7000–6000 yrs BP.

In this region, the caves and rockshelters became key places for human life (Yacobaccio, 1991, 1994; Muscio, 1999; López, 2008;

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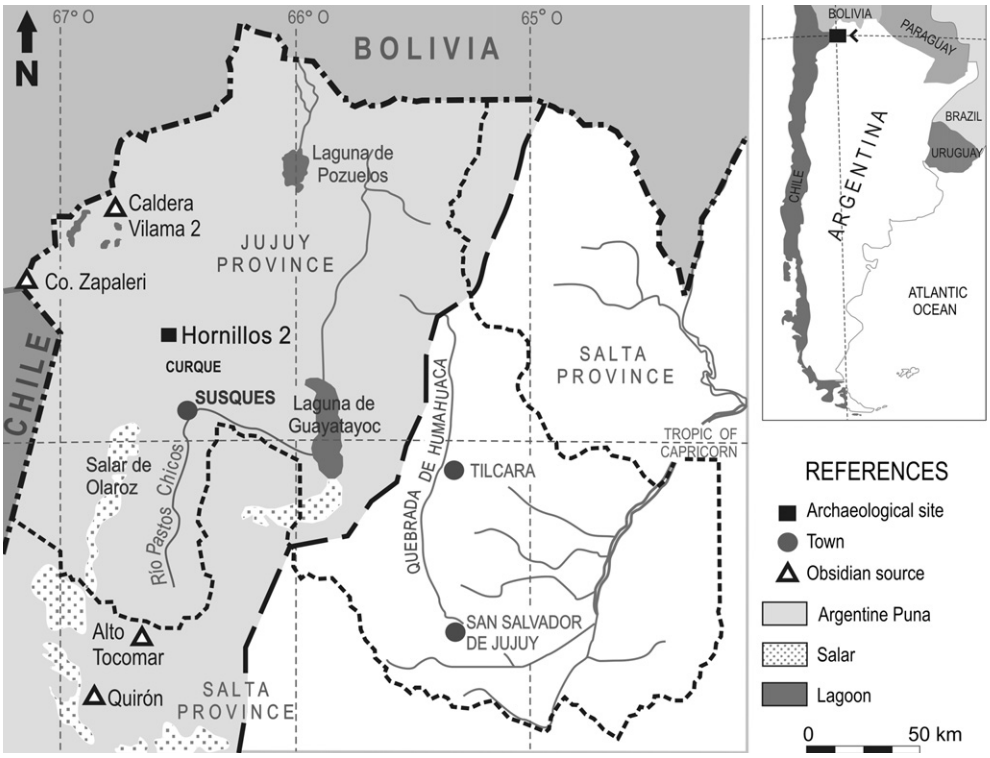

Fig. 1. Geographical location of Hornillos 2 rockshelter.

Morales, 2010; Catá, 2011) especially those which had permanent resources such as water and firewood in the surrounding areas. The hunter-gatherers of de Middle Holocene surely chose these *loci* to carry out several kinds of activities such as techno-economical, rituals and ceremonial ones (Yacobaccio et al., 2008; Catá, 2011). The climatic changes must have somehow affected the social, economic and technological organization of these groups (Aschero, 1994; Aschero and Martínez, 2001; Yacobaccio and Morales, 2005; López, 2007). Suggested activities during this period include specialization in camelid hunting, the beginning of their domestication, the introduction of cultivated plants such as quinoa, oca, squash and maize (Aschero, 1994; Yacobaccio et al., 1997–98; López, 2008), and a reduction in the residential mobility and occupation on a seasonal or permanent basis (Pintar, 1995; Aschero and Martínez, 2001; López, 2007; Yacobaccio, 2007; Morales, 2010). Consequently, the use and function of the caves and their internal spatial organization changed (Catá, 2011).

The comprehension of this connection between humans and space is essential to understand the hunter-gatherer life. In general, there are still few spatial studies for the Puna (Aschero et al., 1993–94; Lavallée et al., 1995; Aldenderfer, 1998) and future studies are a goal to be developed in the archaeology of the South-Central Andes. Nevertheless, for analyzing the spatial organization of the archaeological sites, a certain conservation and deposition context is necessary. Hornillos 2 rockshelter presents favorable conditions and a scarcely modified stratigraphic sequence which enables a reliable spatial analysis.

The objective of this paper is to discuss the spatial organization of the activities performed by the human groups within this rockshelter establishing the changes in the use and function through time. Therefore, the spatial distribution of archaeofaunal and lithic material and features, such as ash lens, deposited during the hunter-gatherer occupation in the Middle Holocene were investigated.

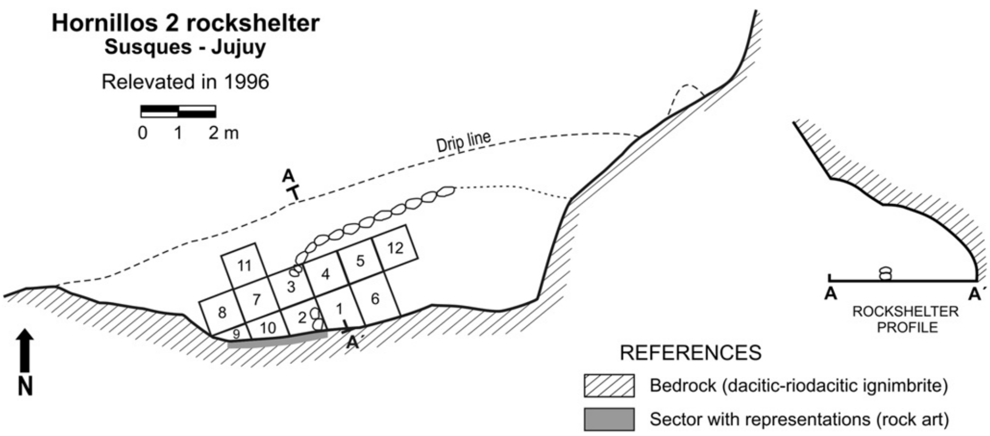

Fig. 2. Excavation grid of Hornillos 2.

Table 1
Radiocarbon dates of the stratigraphic sequence (Oxcal v 4.2).

Level	Laboratory	Date (BP)	Date cal BP (±1 sigma)	Material
2	Beta-111392 (LSC)	6190 ± 70	7180–6990	Charcoal
2	UGA-7829 (LSC)	6340 ± 110	7340–7160	Charcoal
3	UGA-7830 (LSC)	7430 ± 80	8350–8180	Charcoal
3	UGA-8722 (LSC)	7760 ± 160	8780–8380	Charcoal
4	LP-757 (LSC)	8280 ± 100	9410–9130	Charcoal
6	UGA-8723 (AMS)	9150 ± 50	10390–10230	Charcoal
6	UGA-8724 (AMS)	9590 ± 50	10980–10780	Wood
6d	UGA-13550(LSC)	9710 ± 270	11650–10550	Charcoal

The integration of data obtained from the distributional analysis with those from geological studies – mineral and sediment analysis, local topography, geomorphic processes, structure and hydric regime – of the site and neighboring areas optimizes the quality of the evidence. As Butzer (1982: 40) stated, “The goal is to elucidate the environmental matrix intersecting with past socioeconomic systems and thus to provide special expertise for understanding the human ecosystems so defined”.

1.1. The site

Hornillos 2 (23°13′47″S, 66°27′22′ W) is a small cave with a rockshelter with a surface of 42 m^2 (20 m width and 5 m maximum depth). It is located 22 km NNW of Susques town (Fig. 1) at the base of a dacitic-rhyodacitic ignimbrite wall, on the right bank of Agua Dulce creek, at 4020 m asl. The SW-NE orientation of this narrow and protected valley is relevant because the site receives good insolation during most of the day. Currently, 11 m^2 (26% of the total surface) has been excavated (Fig. 2) revealing ten levels (1, 2, 3, 4, 5, 6, 6a, 6b, 6c, 6d,) up to 118 cm depth in grid 8. The radiocarbon dates obtained from the material from five layers resulted in a coherent chronological sequence which corresponds to the Early and Middle Holocene (Table 1). The archaeological record mainly consists of fauna remains, lithic artefacts and debris, ecofacts, vegetable remains and pigments. It also has mobiliar art and cave paintings of camelids, a bird and anthropomorphic motifs painted on the main wall of the rockshelter (Yacobaccio et al., 2008, in press).

1.2. Local geo-environment

The paleoclimate conditions which characterized the Middle Holocene produced significant geo-environmental variations in the Argentine Puna (Tchilinguirian, 2009). At Hornillos 2 rockshelter, the geomorphic and hydrogeological intervening processes left their fingerprint on the sedimentary matrix of the stratigraphic levels. Furthermore, the location of the rockshelter, in the floodplain and on the bank of the course of the Agua Dulce creek, which belong to an endorheic basin, produced unique deposition situations. The site stratigraphic arrangement was intimately related with the hydrologic dynamic of the stream of seasonal regime, and with the drought periods where the eolian contribution prevailed (Fig. 3, Table 2). The results of the sedimentary and local geological analysis enabled recognition of the kind of input and characterization of the depositional environment for the complete sequence.

In transverse section, the floodplain shows a convex lobular topography due to the formation of a vertical accretion bar, with graded bedding structure (upward fining), with some isolated blocks, whose period of formation has not yet been determined. This morphological feature produces a slight positive topographic relief, longitudinal and parallel to the axis of the stream, in the alluvial plain, with a gradual slope towards the southern bank where the site is located. During most of the time of site formation, the base level of the site must have remained below the level of the alluvial plain, at least since the onset of the Late Holocene. Thus, the

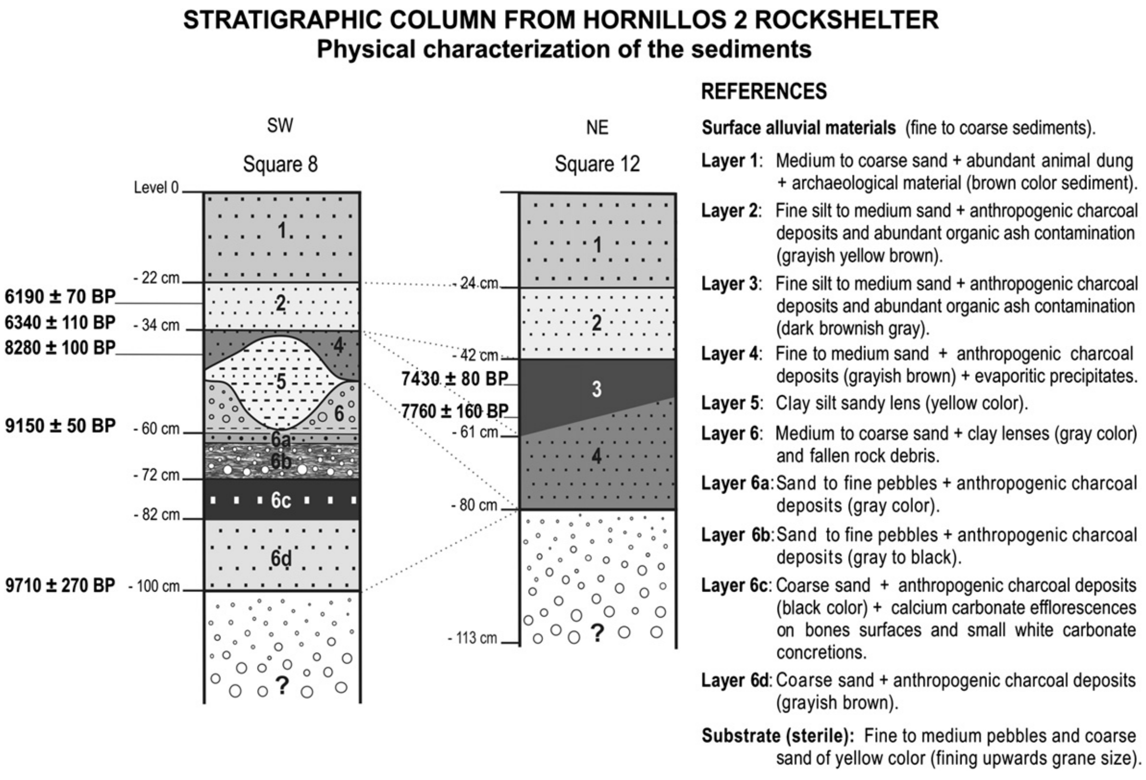

Fig. 3. Stratigraphic sequence from Hornillos 2.

Table 2
Sedimentary and geo-environmental characterization of the stratigraphic sequence.

Period	Date cal BP (±1 σ)	Layers	Sedimentary matrix – depositional processes
Pleistocene–Early Holocene	11.650–10.230	6d, 6c, 6b, 6a, 6	Sand + fine gravels – alluvial and fluvial sediments – (graded stratification with fining upward grain size – flood situations – humidity environmental conditions).
		5	Clay silt sandy lens (channel filling – shallow flooding during a wettest period).
	9410–9130	4	Alluvial and eolian sands (more arid conditions than previous ones).
Middle Holocene	8780–6990	3, 2	Fine to medium floodplain sands + silts, particularly layer 2 (probably with eolian input). This depositional environment coincides with the driest conditions described for the period.
Late Holocene to present	–	1, surface level	Coarse to fine sands + animal dung (regime with strong seasonality, summer rains). Outside the rockshelter: convex floodplain, heterogeneous coarse sediment in longitudinal single bar of vertical accretion, fine sediments filling braided channels.

site was subjected to successive episodes of aggradation and degradation depending on flooding and the intervening erosive processes (hydric and eolian). According to Farrand (2001: 33), the height of a rockshelter above the level of a local stream will exert an important control over the entry of fluvial sediment into the site. Consequently, the fact that Hornillos 2 rockshelter with its floor at a lower level than the valley surface allowed the fluvial sediments to accumulate, and to alternate with the archaeosedimentary material, thus producing facies variations (lateral and vertical) and filling the previous topography, as for layer 5 (see Fig. 3). This mixed provenance of sediments requires a detailed compositional analysis (utilizing grain size and mineralogy) to distinguish between the various sources (bedrock, eolian and colluvial natural sources), as well as for recognition of sediments produced by anthropic and animal action.

2. Methodological aspects

The interpretative models of the spatial organization patterns generally assume synchronous deposition of archaeological material. Nevertheless, most of the sites, especially caves and rockshelters, are palimpsests of multiple overlapping occupations (Binford, 1983; Galanidou, 2000). In other words, the archaeological record of a locality can be considered as a stratigraphic continuum which can be divided into smaller units given its degree of complexity, time of accumulation and number of involved events (Binford, 1981). Thus, the archaeological record is the outcome of one or several occupation events where various types of activities are carried out by human or nonhuman agents.

The anthropogenic zones of activity can be inferred from the indirect testimonies produced by all actions that transform

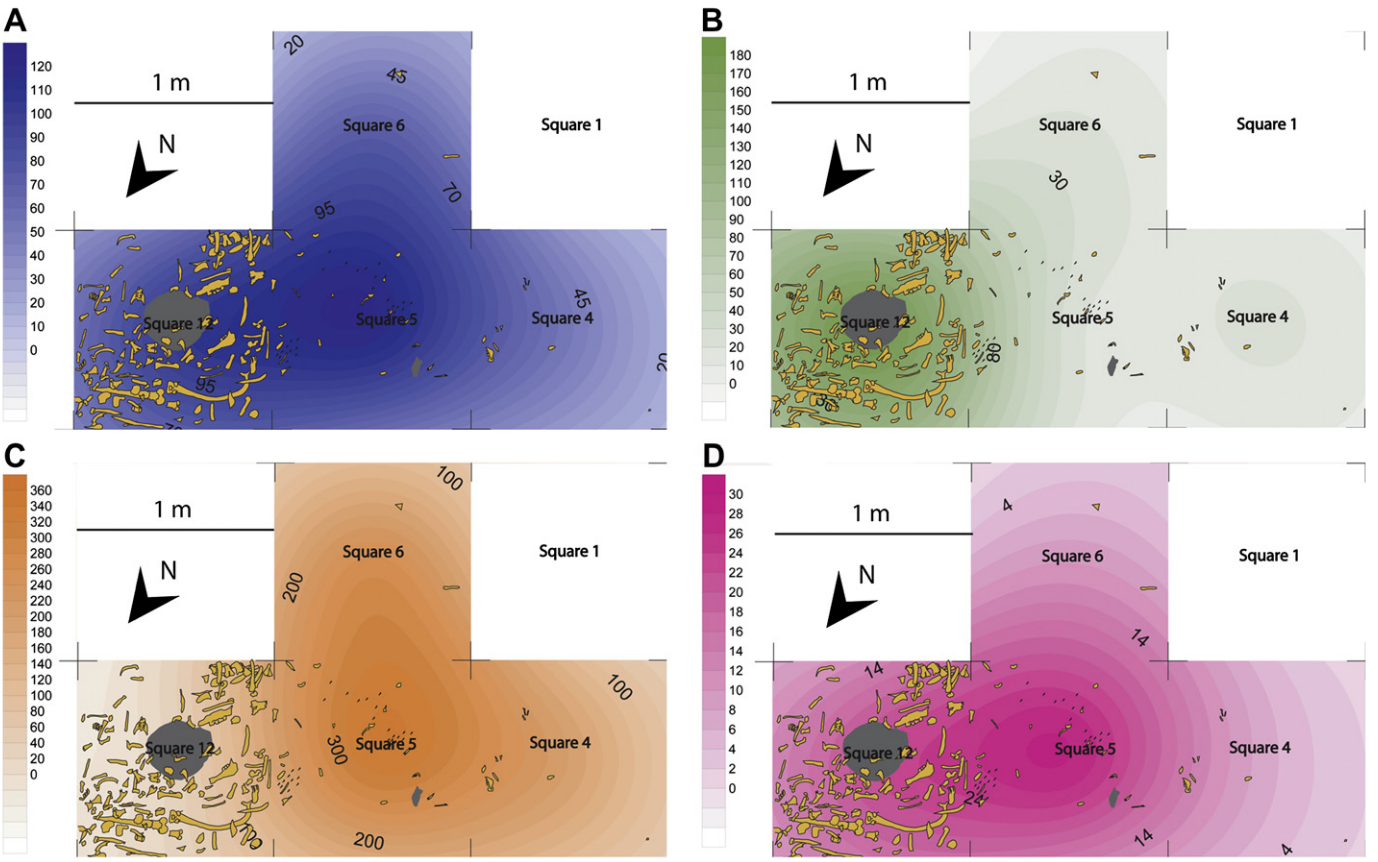

Fig. 4. A. Distribution of the bone material assigned to Artiodactyla ($n = 345$). B. Distribution of the bone material assigned to Chinchillidae ($n = 248$). C. Distribution of thermoaltered bones ($n = 829$). D. Distribution of bones with anthropic marks ($n = 67$). E. Distribution of the quartzite lithic material ($n = 182$). F. Distribution of the andesite lithic material ($n = 120$). G. Distribution of the obsidian lithic material ($n = 234$). H. Distribution of the silicified rocks lithic material ($n = 178$).

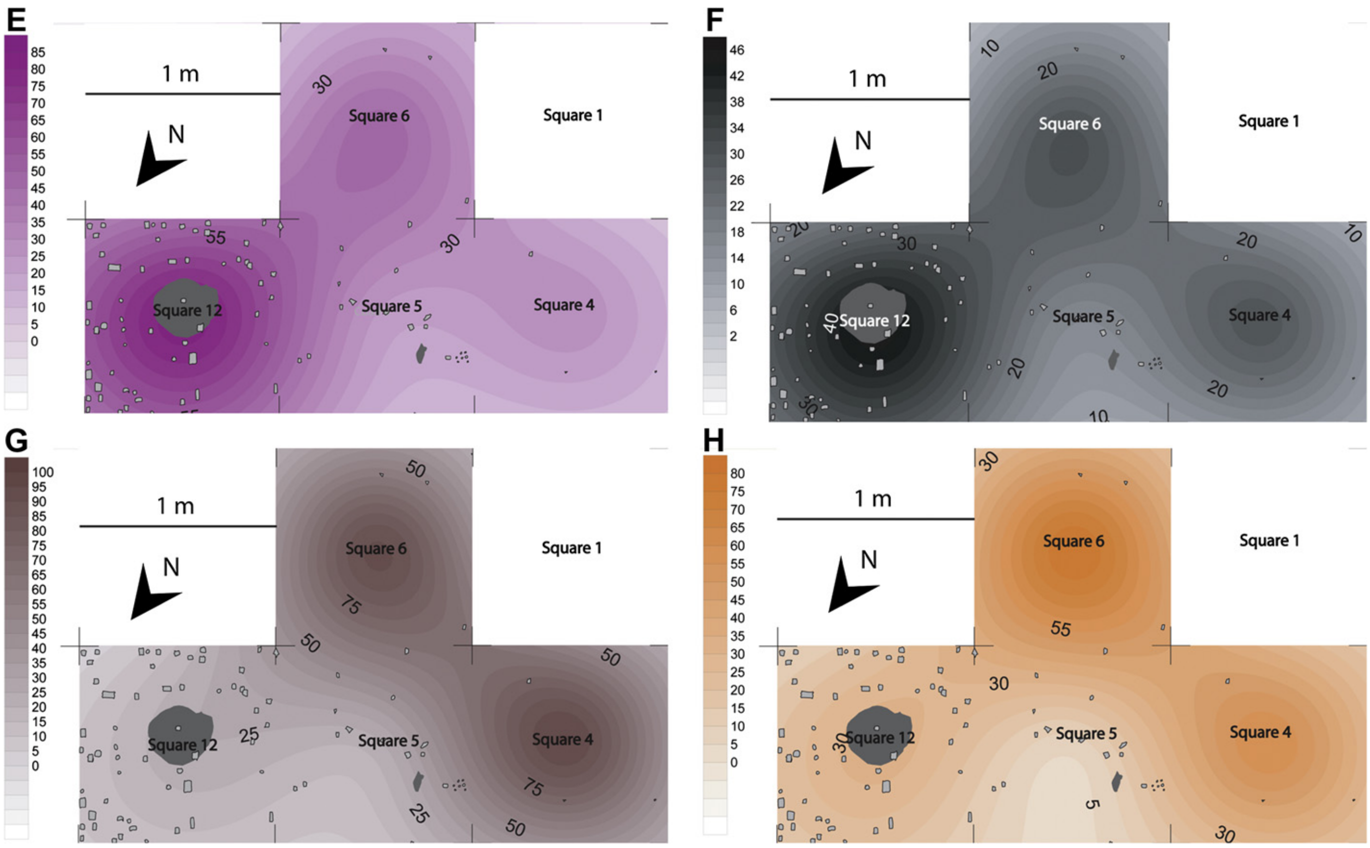

Fig. 4. (*continued*).

various raw materials (e.g. shaping a projectile point, extracting marrow, and igniting wood) which leave consequent waste with diagnostic features. The connections between zones of activities can correspond to the functional rules of the sequence of transformation (or *chaîne opératoire*) carried out *in situ*. Some activities can be strictly segregated, while others can overlap. In many cases, the time and space dedicated to the execution of the *chaînes opératoires* may be separated so as not to saturate the main zone of activities (Pétrequin and Pétrequin, 1988; Julien et al., 1999). In this way and during the formation of the archaeosedimentary matrixes (Butzer, 1982), there are two possible types of activity areas: 1) zones of specific activities repeatedly used by individuals and/or groups with a stable behavior during the course of time, 2) a palimpsest of various activities more or less close in time.

The archaeological visibility will be conditioned by the level of waste concentration in certain areas, but also by the degree of disturbance produced by postdepositional agents (Binford, 1983; Galanidou, 2000). In the formation of the archaeological record, the following variables will condition the spatial interpretation of the materials and the features found: the continuous time of human occupation (uninterrupted occupation), the intensity of the activity (in archaeological terms), the systematization of reoccupation, the period of abandonment between the different occupations, and the connection between these latter. The degree of difficulty in interpreting the archaeological record will depend on the averaged character of the record and the resulting equifinality of the combination of these variables.

In order to analyze the spatial organization and interpret the activity areas, a two-dimensional projection of the material (lithic and faunistic) and features (hearths, holes) found during the archaeological excavation of the rockshelter was carried out. A database which includes the mapped findings and the sieved material was constructed, both recorded by natural layers and in a 1 × 1 m grid. The analyzed material comes from layers 2 and 3, each considered as one unit of temporal analysis, and corresponds with the occupations of the rockshelter during the Middle Holocene. For the lithic material, the frequency of the flakes and microflakes was taken into account depending on the raw material. For the archaeofaunal material, the frequencies of the identified bones by taxon were considered (according to order and family), and also the burned materials and the bone remains with marks of anthropogenic origin (Grayson, 1984; Mengoni Goñalons, 1988; Bonnichsen and Sorg, 1989; Behrensmeyer, 1991; Gifford-Gonzalez, 1991).

The data was projected on isodensity curves for each layer. The method of gridding was used to construct these curves, calculating each grid node values using the Radial Basis Function algorithm (Babakan et al., 2008). This algorithm is an accurate interpolator that generates smooth edges, good representations and shows the spatial variability of the data set (Kamcili, 2001; Babakan et al., 2008). The software program used was Surfer 8.

The compositional analysis of the sedimentary matrix and the rock fragments was done by using a stereomicroscope and petrographic microscope with polarized light for the optical determination of individual sand clasts using grain mounts. The field work included stratigraphic, geological and geomorphic controls which were complemented by the information of the Geological Report of Susques (Nullo, 1988) and with images obtained from the Google Earth Pro program (1:100,000–1:20,000). This information was used to determine the environmental conditions acting in the formation of the layers, regardless of their archaeological content.

3. Results

Table 2 summarizes the results of the sedimentary matrix analysis and the depositional processes occurred while the rock-shelter layers were formed. During the deposition of layers 2 and 3, the local climate conditions became more arid, as throughout the Puna region. This aspect was reflected mainly in the silt sandy sediments accumulated, partly an eolian contribution (a mixture of fine alluvial and eolian sediments).

The plan view of layer 3 (4 m^2) stands out because it shows a dense accumulation of bones and lithic artefacts in grid sector 12, where an ash lens was also found (Fig. 4A–H). Regarding the bone material (n = 1438; 359,5/m^2), those attributed to ungulates (Artiodactyla) are concentrated in grids 5 and 12, while those

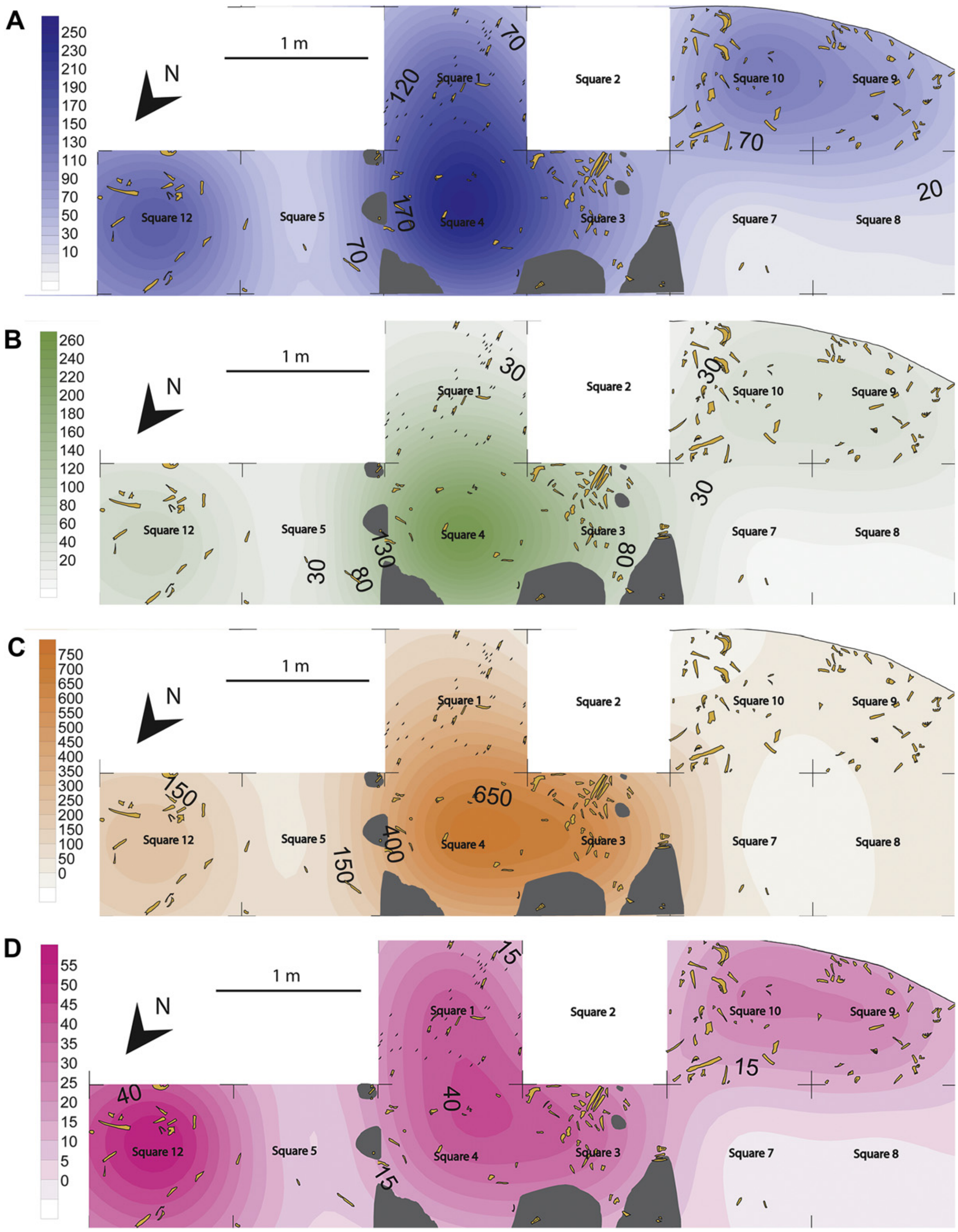

Fig. 5. A. Distribution of Artiodactyla bones (n = 888). B. Distribution of Chinchillidae bones (n = 458). C. Distribution of thermoaltered bones (n = 1861). D. Distribution of bones with anthrotopic marks (n = 224). E. Distribution of the quartzite lithic material (n = 899). F. Distribution of the andesite lithic material (n = 462). G. Distribution of the obsidian lithic material (n = 438). H. Distribution of the silicified rock lithic material (n = 531).

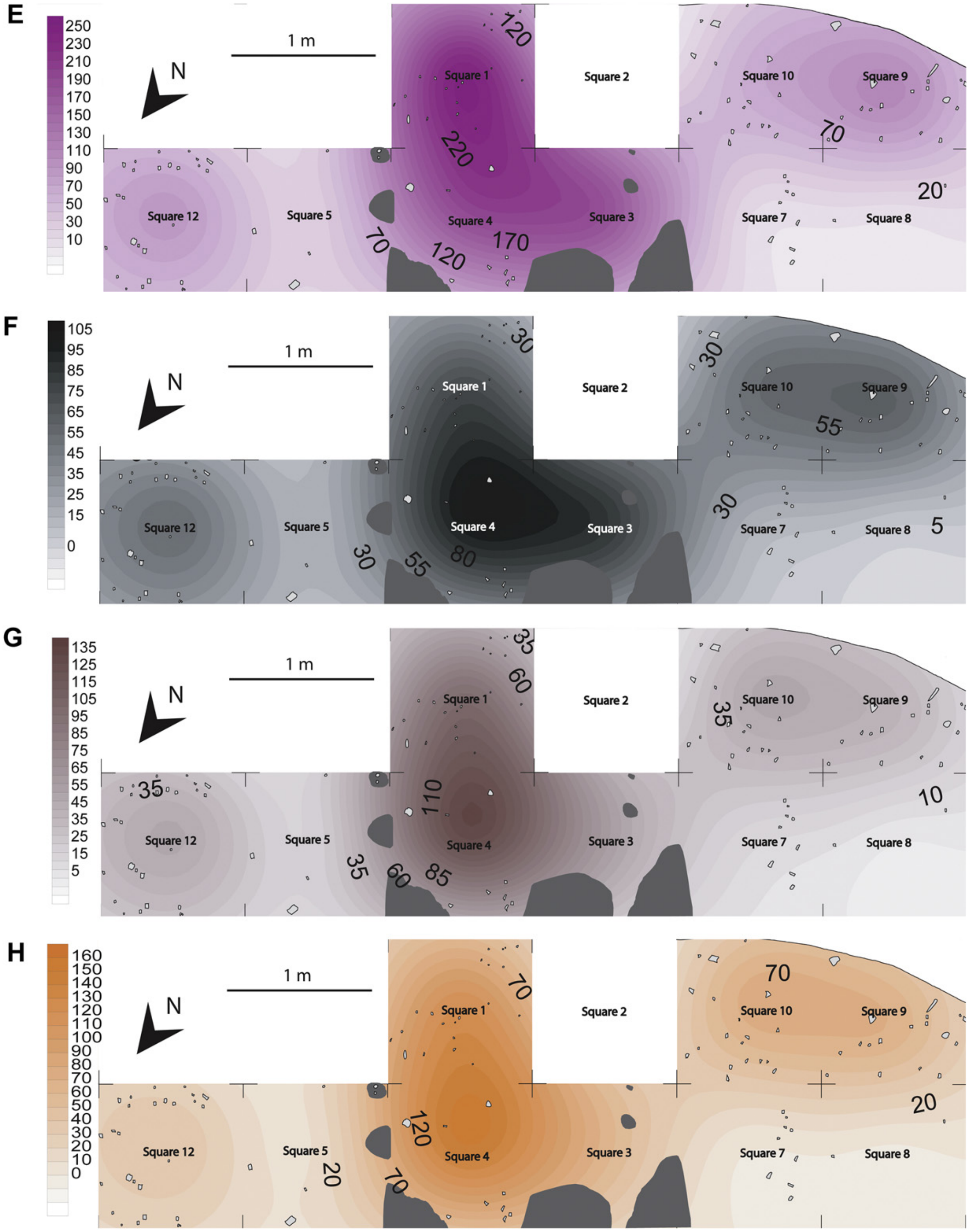

Fig. 5. (*continued*).

assigned to Chinchillidae are only present in the last grid (Fig. 4A and B respectively).

The bones with burning traces (the burned faunal material includes all the bones with a certain degree of burning, from burned to calcined) are concentrated out of the zone where the ash lens is (Fig. 4C), predominantly in grid 5 and partly in 6. Regarding the bones with anthropic marks, the highest frequencies are also found in grid 5, though the distribution spreads into grid 12 (Fig. 4D).

Regarding the lithic material ($n = 714$; 178,5/m^2), the quartzite (Fig. 4E) and andesite (Fig. 4F) debris is mostly accumulated in grid 12, though lesser concentrations are also observed in other zones (grids 4 and 6). Obsidian (Fig. 4G) and silicified rocks (Fig. 4H) debris are also moderately concentrated in grids 4 and 6, and do not appear in grid 12.

Layer 2 has a larger extent (9 m^2) than layer 3. In grids 3 and 4, a zone surrounded by 6 ash lenses stands out (Fig. 5A–H), and other zones are empty (grids 5, 7 and 8). As shown in Fig. 5A and B, the concentration of ungulates and Chinchillidae faunal remains ($n = 3427$; 380/m^2) is notable in the zone surrounded by ash lens, especially in grid 4. The most important concentration of burned bones is located in the zone surrounded by hearths (Fig. 5C). On the other hand, the largest accumulation of material with anthropic marks appears outside the zone delimited by the ash lenses, mainly in grid 12 (Fig. 5D).

Regarding the lithic material ($n = 2330$; 258,9/m^2), the distributions of concentrations of andesite and quartzite artefacts overlap and are complementary between grids 1 and 4 (Fig. 5E and F). There are more bounded zones in grid 12 and near the rockshelter wall. The obsidian and the silicified rocks debris follow the same distribution, having a greater concentration in grid 4 (Fig. 5G and H).

4. Discussion

Evidence shows the performance of spatial and temporarily independent activities during the deposition of layer 3. For example, the use of a hearth in grid 12 would not be related to the accumulation of bone and lithic material found in that same space, as they do not show any sign that would indicate they had been in direct contact with fire. The burned material is distributed outside the combustion zone and concentrated in an adjacent zone. Therefore, the accumulation of remains in grid 12 would most likely correspond with a trash heap area of anthrotopic origin generated over some time. The absence of patina in lithic debris and also the absence of weathering and marks of canids and rodents on the bones are also relevant. More spatially concentrated activities were also carried out, such as those related to the processing of ungulate bones and a very moderate combustion, which was not enough to leave an extended ash trace, both in the zone of grid 5. A spatial association exists between the cut marks and the burned bone. In grids 4 and 6, tasks related to the knapping of raw material were done, especially bifacial shaping and pressure on silificied and obsidian rocks (Hoguin and Yacobaccio, 2011). It is interesting to take into account the spatial association between these two kinds of raw materials, and between quartzite and andesite artifacts.

In layer 2, the zone delimited by grids 3 and 4 is surrounded by hearth and shows the greatest concentration of vestiges, which are distributed in a differential way according to the raw material in the case of the lithic debris. This distribution pattern responds to a selection of anthropic origin and not a natural one, even though postdepositional rodent bones have been identified in grid 1, and also bioturbation features such as holes made by fossorial rodents in grid 4. From this evidence, the area surrounded by hearths must have been one of the main zones of activity, where tasks such as the final shaping of instruments and the processing of ungulates and Chinchillidae for human consumption were carried out. The primary tasks of processing, preliminary flaking and rock knapping must have been done in adjacent zones, as usually recorded from various archaeological sites (Julien et al., 1999), and ethnographic cases (Binford, 1983). The analysis of lithic material seems to strengthen this interpretation though the presence of two quartzite cores and flakes with cortex (Hoguin, 2008, 2010).

Although the number of hearths used depends on the size of the groups that utilized them and on their intensity and systematic reuse, it also depends on the cultural choices (Binford, 1978; Galanidou, 2000). Therefore, in layer 2, three different hypotheses (because they are equifinal) can be proposed: 1) a lengthy occupation, 2) a systematic reoccupation, perhaps seasonal, and 3) an occupation by a larger human group (compared with layer 3).

Several kinds of activities need fire: food cooking, glue heating to haft a tool, and thermal alteration of rocks to improve their quality. On site, the assembly of cut marks, fractures and burned bone, especially for layer 3, is related to the processing, cooking and consumption of camelids and vizcachas. The consumption of meat and bone marrow is predominant in the layers of the Middle Holocene, especially in layer 2 which is larger than layer 3, as noted by the association of bones with cut marks, fracture and burning.

Some activities (such as resting) do not have archaeological visibility, not so much for having transformed a perishable raw material but precisely for not having transformed any raw material. In the case of layer 2, the zones which are very close to the principal zone of activity lack the presence of material, which could be related to circulation zones. Another empty zone, located against the wall between grids 9 and 10, could be the outcome of an activity with no vestiges. There are also secondary activity zones adjacent to the main zone.

Comparing the layers of the Middle Holocene, there is a great difference in both the extents and the average density of the material per square meter. Between layers 3 and 2, the surface passes from 4 m^2 to 9 m^2 of extent respectively, with 359.5 (layer 3) to 380 (layer 2) fauna vestiges and 178.5 (layer 3) to 258.9 (layer 2) lithic artifacts per square meter. This could be linked to a different intensity of use in these occupations. Layer 3 would be the product of specific events and of a short occupation, while layer 2 would reflect a more extensive and intensive occupation of the space (*sensu* Binford, 1983).

5. Conclusions

The archaeological record shows that, throughout the years, some spatially restricted activities carried out at a site can overlap or be disturbed by anthropic or natural cleaning. The remainder of the occupations generally responds to the archaeological record subsequent to the abandonment. This abandonment can be short or long term, and generally lacks high visibility in the sedimentary sequence (Butzer, 1982). The archaeological record is an averaged one and represents the sum of events that may result from more or less continuous use over the years. The site formation processes and the spatial distribution of the materials constitute the first step in the interpretation of the archaeological record in terms of activities, use of the space and the events throughout time.

The rockshelters and caves are key places where important activities in the hunter-gatherers way-of-life were carried out. Nevertheless, throughout time the latter could have had different functions, especially during important climate fluctuations as in the case of the Middle Holocene layers at Hornillos 2. Layer 3 shows a short and logistic use by a specialized group in certain tasks, as is inferred from the results of the lithic technology analysis (Hoguin and Yacobaccio, 2011) and the archaeofaunal study (Catá, 2011). This kind of short occupation coincides with the fact that a greater use of the regional space above 4000 m asl would not be expected compared to sites below this elevation during 8000–7000 yrs BP (Morales, 2010). The Hornillos 2 layer 3 case perfectly illustrates this observation, given that the rockshelter is located at the limiting altitude (4020 m asl). Layer 2 indicates a larger occupation that must have used the rockshelter for several activities and during a longer time than the previous layer, as would be expected for this altitude during 7000–6000 yrs BP (Morales, 2010). Intrasite and spatial organization studies of caves and rockshelters are necessary to improve the archaeological research about human populations of hunter-gatherers. Furthermore, they are complementary with the spatial analysis based on *loci* outside them, as this provides information about the distribution of human populations on local and regional scales.

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