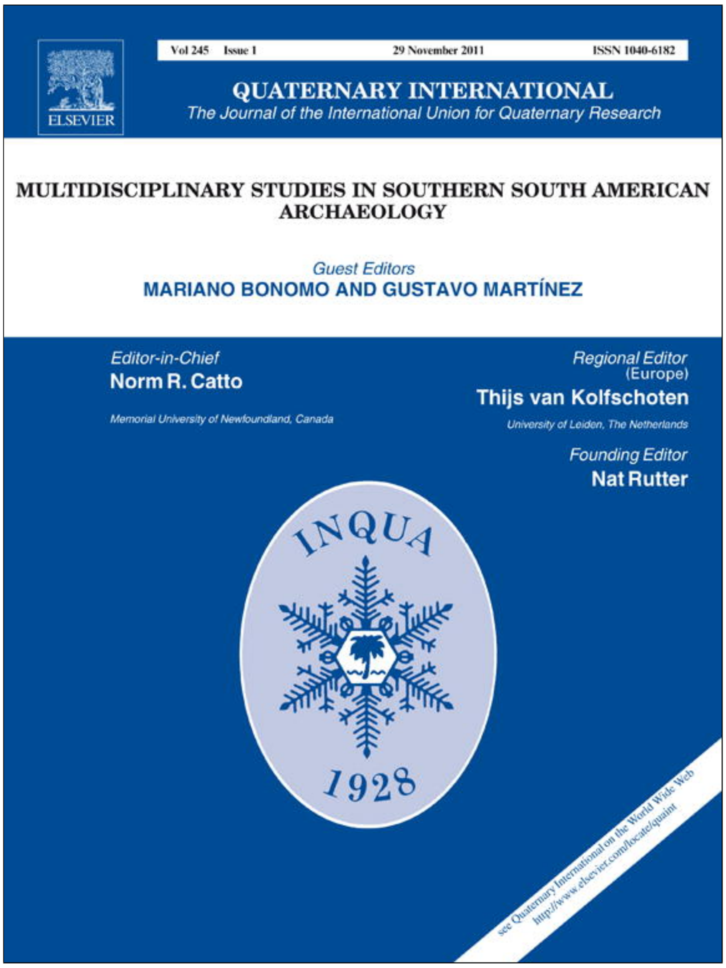
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The study of Archaeofauna at Middle Holocene in Aep-1 rockshelter, Santa Cruz, Argentina: Taphonomic implications

Laura Miotti*, Laura Marchionni

CONICET and Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Paseo del Bosque s/n, (1900), La Plata, Argentina

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ABSTRACT

The taphonomic history of the Middle Holocene archaeological component at the AEP-1 site was studied based on the analysis of bone modifications of the archaeofaunistic assemblage and the features of the geological matrix. Such indicators represent excellent examples of the agents and generating processes of the archeological context at the Piedra Museo AEP-1 rock shelter, located in the Deseado Massif, Santa Cruz Province, Argentina. The present day environment is the remains of a paleolagoon, within the arid basaltic plateau. The analyzed zooarcheological context comes from stratigraphic unit 2 (SU 2), which constitutes the IIA horizon of a local paleosol. The pedogenetic process started to develop beginning in 7000 BP. The SU 2 matrix of the palaeosoil is of eolian origin, with a pedogenetic reorganization, where root and insect activity are highly developed. Therefore, the study of bioturbations and diagenesis (i.e. etching, stained and differential weathering of bone specimens) were analyzed. However, the large number of postdepositional bone modifications was not enough to obliterate the marks of human activity on bone material made during the Middle Holocene, which supports the previous hypothesis that the site could have been an area of multiple activities with *loci* of secondary and final processing of prey.

1. Introduction

Over the last decades, archaeologists have tried to explain why bone accumulations adopt different forms in each site. In America, this topic is associated with the archaeology of hunter-gatherers, and with special focus on paleoindian mass kill sites (Binford, 1981; Speth 1983; Todd 1987). In South America, this issue has been discussed at length and from several multidisciplinary perspectives in Pampean and Patagonian archaeology (Gutiérrez, 1998, 2004; Martínez, 1999; Miotti et al., 1999; Bonomo and Massigoge, 2004; Kaufmann and Gutierrez, 2004; Miotti and Salemme, 2005; Barberena, 2008; Santiago, 2009).

In all those works, the focus was placed on the search for answers regarding the heterogeneous distribution of bones, such as bone beds or piles. On the other hand, several contexts show high variability in the taxonomic abundance and skeletal parts in each taxon. What does the presence of an overrepresented sample of a certain taxa mean? Were the human hunter-gatherers always the accumulating agents? Or, put plainly and directly, why were these bones here? As Lyman (1994, pp. 168) stated, "Large ISD (index of skeletal disjunction) or IFD (index of fragment of disjunction) values denote significant dispersal, but do not identify the agent(s) or process(es) responsible for that dispersal." Notwithstanding, cultural indicators on bone surfaces, in addition to the lowest percentages of carnivore and rodent traces, as well as the effect of flooding to certain extent, allowed inference of patterns and agents, processes of accumulation in which the main factor could have been human purpose. To answer these and other taphonomic questions, this paper considers the bone surface modification patterns (C and N transforms sensu Schiffer, 1988) and geoarchaeological information as basic evidence for reading the main processes and agents that produced the zooarcheological context corresponding to stratigraphic unit 2 (SU 2), Middle Holocene, at the AEP-1 site in Piedra Museo. This locality is within the Deseado Massif, Santa Cruz province, Argentina at S 47° 53′42″ and W 67° 52′ 04″ (Fig. 1a).

The site is located on an arid plateau, where temporary lagoon basin and streams are frequent. The Massif is crossed by gullies and temporary rivers that provide it with meltwater only during the thawing of the surrounding volcanic plateaus (Fig. 1b). AEP-1 is a small rock shelter on the shore of a current salt closed basin, the result of a continuous aridization process in extra-Andean Patagonia throughout the Holocene (Fig. 1c).

* Corresponding author.
E-mail addresses: lmiotti@fcnym.unlp.edu.ar (L. Miotti), lau_marchionni@yahoo.com.ar (L. Marchionni).

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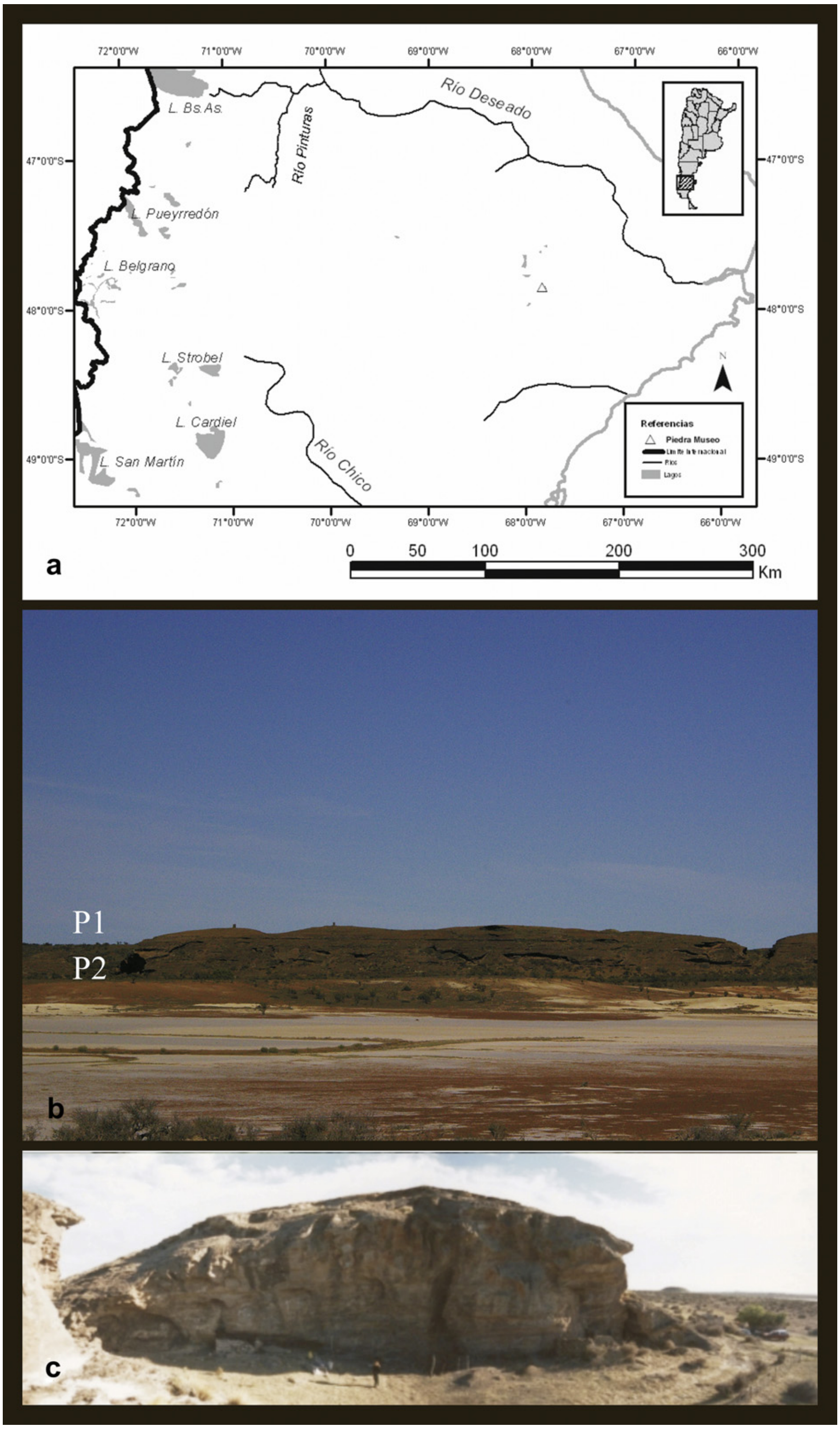

Fig. 1. Geographical location of the site and spatial scales: a) regional, b) local, and c) site.

This site appeared as a reliable sign for the studies of the First Americans because it recorded Paleoindian occupations developed between *ca.* 11–9 ka BP. This archaeological component is included within lower pedogenetic horizons of the same paleosol to which the Middle Holocene fauna analyzed in this paper belongs (Miotti, 1992, 1996, 2004). Such a configuration – two different zooarchaeological resolutions within the same paleosol – is important because it signals differences and similarities regarding depositional environments, the process of formation of archaeological record, and its relationship with the surrounding site and region paleoenvironment. The similarities between both archaeological contexts at the site were represented by the same sedimentary matrix of eolian origin. In this respect, both the archaeological components of the late Plestocene and Middle Holocene were deposited in an arid environment.

The differences that could be observed in the zooarchaeological samples of both components were represented by their vertical separation (60 cm on average), and because they appeared in two different paleosol horizons. While the lower zooarchaeological assemblage was distributed between III and IIB horizons, the Middle Holocene assemblage was located in the IIA horizon (Fig. 2). In the latter, the biological activity was much higher than that found in the lower horizons, where physicochemical processes, such as greater sedimentary pressure, carbonate leaching and manganese staining, gained more importance.

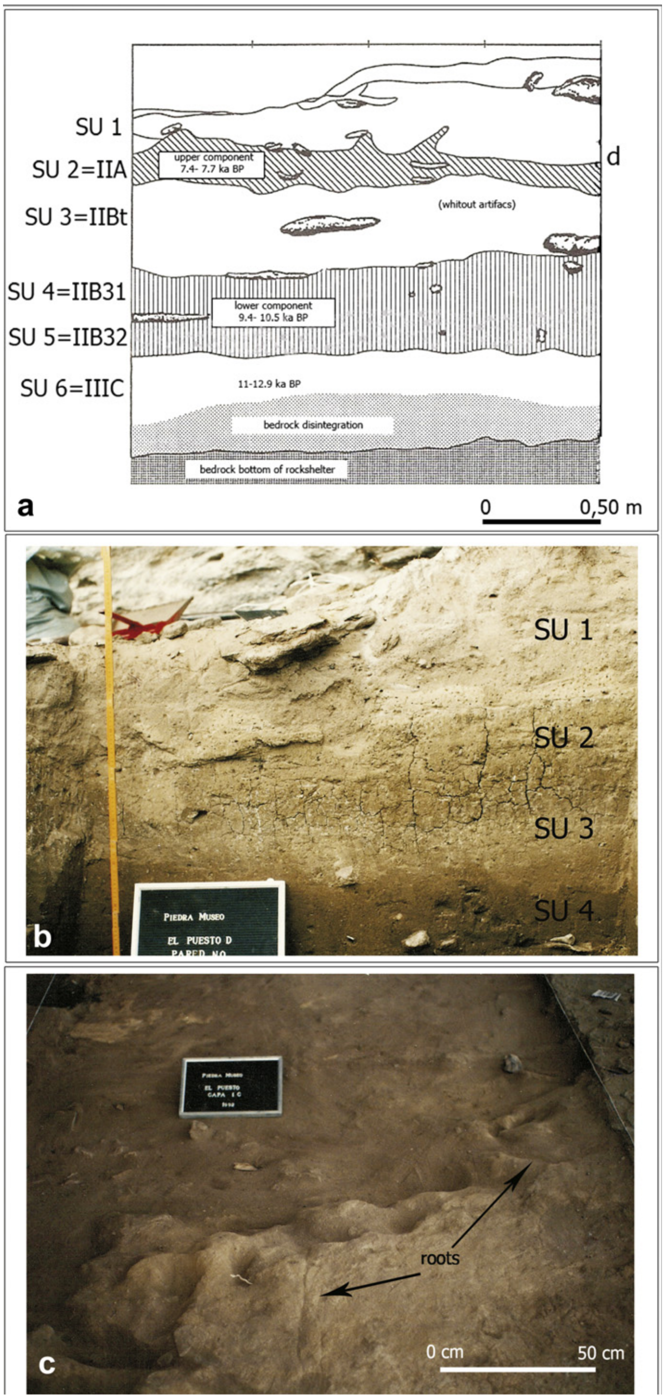

Fig. 2. a) stratigraphic profile scheme; b) stratigraphic profile photo; c) upper surface of SU 2 at C square showing erosive unconformity with micro waves, and lower right angle, a concentration of fine roots in the matrix is visible.

Macro and microscopic analysis of bone modifications were correlated with previous geoarchaeological, chronological and palaeoenvironmental information (Zárate et al., 2000; Borromei, 2003; Miotti et al., 2003). The aim was to discuss the depositional and postdepositional agents and processes involved in the formation of the Middle Holocene deposit.

2. Materials and methods

The spatial scales of analysis employed were those formulated by Zárate et al. (2000), which include four levels of spatial resolution. In order of size, these are the regional scale (200 km^2), the zonal scale (10 km^2), the local scale (400 m^2) and the site scale (8 m^2). Such scales indicate the degree of energy of the natural processes in the different environments (intra-site and surrounding basin). In this respect, special emphasis was placed on the relationship between the sedimentary matrix of the zooarcheological sample with its bone modifications, since the stratigraphic genesis of the rock shelters was of local parent and regional external material, which was a strong environmental indicator (Farrand, 1985, 1993).

On a site level, as described below, the focus was on the zonal soil profile stratigraphy of the lagoon basin of Piedra Museo in the arid region of the Deseado Massif, which provided the necessary features in order to infer the role played by the main soil components (organic and inorganic) on the archaeological record. These peculiar soils develop only in small wetland within arid regions (springs of fresh water, wetland, lagoons, streams, all of them came from by ground water) produce several postdepositional modifications of the archeological settlements of the Middle Holocene (Farrand, 1985, 1993; Waters, 1992; Haynes, 1993). The geoarcheological background used in this study was that put forward by Zárate et al. (2000), and as regards local paleoflora, the information provided by Borromei (2003) was used. In addition, multidisciplinary studies like glaciological, sedimentological, geomorphological, sea level change and volcanological analyses were carried out in Patagonia, generating great palaeoenvironmental proxy data, which considered this interval as Middle Holocene in the Patagonia region between 7.5–3.5 ka BP. Among some of the most important works are those written by Heusser and Rabassa (1987), Zárate et al. (2005), Rabassa (2008), and the references therein.

Regarding the zooarcheological sample taken into account for the analysis of bone modifications, long guanaco (*Lama guanicoe*) bones were used ($n = 329$), which was the most representative species in the settlements between 7670 ± 110 (LP-450) and 7470 ± 140 (OXA-8529) ^{14}C BP in the rock shelter.

The assessment and record of bone surface modifications were performed both by means of naked eye observation and a Nikon SMZ 800 binocular microscope, with magnifications from 10× to 60×. For the identification of the different morphologic patterns, the methodological logic proposed by Gifford-Gonzalez (1989) and the comparative method of Marean (1995) were employed. These patterns indicate the presence and absence of the different human and non-human agents or processes (Binford, 1981; Johnson, 1989; Lyman, 1994; Borrero, 2001; Brain, 2004; Mondini, 2004; Fano Martínez et al., 2005; Martin, 2007). The assessed modifications were: weathering (Behrensmeyer, 1978), fragmentation degree (Lyman, 1994), break patterns, cut marks (Binford, 1981; Johnson, 1985, 1989; Lyman, 1994; Gutiérrez, 2004; De Nigris, 2004), thermal alteration (Buikstra and Swegle, 1989), root (Lyman, 1994; Montalvo, 2002), rodent (Bocek, 1986, 1992; Lyman, 1994) and carnivore traces (Capaldo and Blumenschine, 1994; Pickering and Toth, 2004; Martin, 2007; Thompson and Lee-Gorishti, 2007), and carbonate and manganese staining (Karkanas et al., 2000; Gutiérrez, 2004).

AEP-1 was studied in the 1990s. 44 m^2 of surface in squares of 2 × 2 m were excavated. In each square, three-dimensional measures were taken, and the sediments were sieved with wire netting between 1.3 and 0.7 cm. Bones of the lower Pleistocene component were stabilized with PVAC; however, bones of SU 2 have not been stabilized yet. The main reason for this decision is that the taphonomic analyses are underway. However, the stabilization of these specimens will be necessary once the taphonomic studies have been performed to include well-consolidated materials in the archaeological collection.

Long bones are good indicators to identify carnivore activity, as they show nutrients both in the medullary cavities and in the epiphysis soft tissue. Such occurrences are the main reasons why humans and carnivores show a preference for such anatomic units (Haynes, 1980; Gifford-Gonzalez, 1993; Cleghorn and Marean, 2004). Therefore, not only carnivore marks but also anthropic action on long bones were expected. On the other hand, long bones are indicators of secondary association in conditions of high energy environments, produced by water, including rivers, flooding, meltwater, etc. (Voorhies, 1969; Farrand, 1985). Based on these and the above-mentioned features, these skeletal parts were selected for analysis in this paper.

3. Regional setting

The most comprehensive spatial levels are those of the regional and zonal scale. The first level is bounded by San Miguel farm to the west, Bosque Petrificado Natural Monument (MNBP) to the north/northwest and El Sargento farm to the southeast. The zonal scale corresponds to the locality of Piedra Museo. On a regional and zonal scale, the emerging formational units were described and profiles were performed following a transect technique. The landscape in the excavated archeological site is characterized by "[…] plateau landforms dissected in successive reactivation cycles by the excavation of the drainage system of the Elornia stream" (Zárate et al., 2000, pp. 56). The area has a semi-desert climate and is covered with shrub-like steppe. The region is under the influence of western winds, which generate rain in the mountain range (800 mm); in the area of interest, rain amounts to less than 200 mm/y. The average temperature is between 6 °C and −8 °C.

Elornia gully represents the most conspicuous feature in the monotonous plateaus, and in the Piedra Museo area it is a large flood plain environment, an indicator of the body of water that once occupied the area during the final Pleistocene. This temporary flood region is characterized by an absence of vegetation and, consequently, it is subject to intense deflation processes (Rabassa, 1997; Zárate et al., 2000).

3.1. Geoarcheological context

On a local and site scale, "Piedra Museo is located in an area of outcrop of Eocene marine sedimentites with a thickness of 12–15 m" (Zárate et al., 2000, pp. 57) and whose surface can be mapped around 12 km^2. Two pediment levels were identified both to the NE and to the W of AEP-1, which indicate the existence of two cycles of planation surface generation separated by an episode of reactivation and deepening of the gully base level (Fig. 1b). Towards the bottom of the outcrop are basal concavities which gave origin to the shelters. AEP-1 is located in the base of the outcrop (Fig. 1b and c). This cut is 20 m wide on average, and it may have been a continuous drain line in the past.

The stratigraphy of the site was described according to the type profile located on the NE wall of the L grid, where samples were taken for the sedimentological, minerological and palynological analyses. This profile was selected based on the lateral continuity and vertical

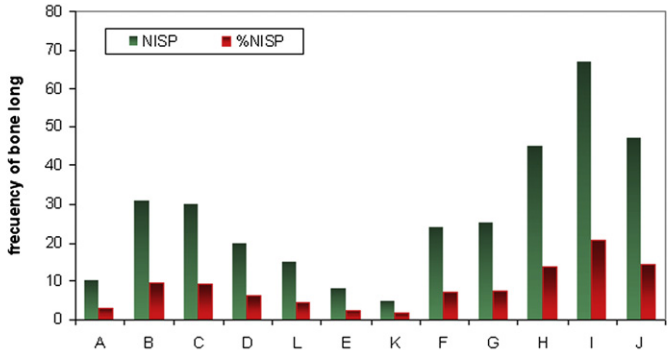

Fig. 3. Long bone frequencies in each square, expressed in NISP and %NISP.

variations of the texture and color attributes, which enabled the identification of six stratigraphic units referred to as layers. The bottom of layer 1 represents an erosive unconformity, whereas the boundaries between layers 2–6 are transitional, and color variations among them are time-transgressive in connection with the granulometric changes of the stratigraphic succession (Fig. 2a and b).

The granulometric composition of layer 1 showed a clear difference compared to the subsequent layers, containing brown sand (10Y/R5/3) with fine gravel and coarse sand. Layers 2–6 correspond to the morphological sequence of a soil profile developed from certain parent material (basin and extra basin) that reflected a mixed type of almost constant granulometry. Each of the 2–6 layers constituted pedologic horizons of an edafic sequence truncated by erosion. Layer 2 or SU 2 was the IIA horizon; a very fine sand, locally clayey, loose and crumbly, yellowish brown (10Y/R5/4) with an average thickness of 15 cm, and transitional to a laminar structure. Layer 3 (SU 3) was the IIBt horizon, made of brownish olive clay (2.5 YR 4/4 to 10 YR 5/3) with scarce cutans; it had an average thickness of 20 cm. The base had calcareous lumps and carbonate, which was more obvious toward the walls of the shelter's most external squares. Layer 4 (SU 4) was the IIB31 horizon of the soil profile, and it was a grayish or brownish sandy clay (10 YR 5/3), with an average thickness of 20 cm and a gradual and gentle base. Layer 5 (SU 5) was the IIB32 horizon, and composed of dark brown clay (10Y/R 4/3) with an average thickness of 15 cm. Bioclasts from the bedrock, and a gentle gradual basal transition, are present. Layer 6 (SU 6) corresponded to the IIIC horizon of the

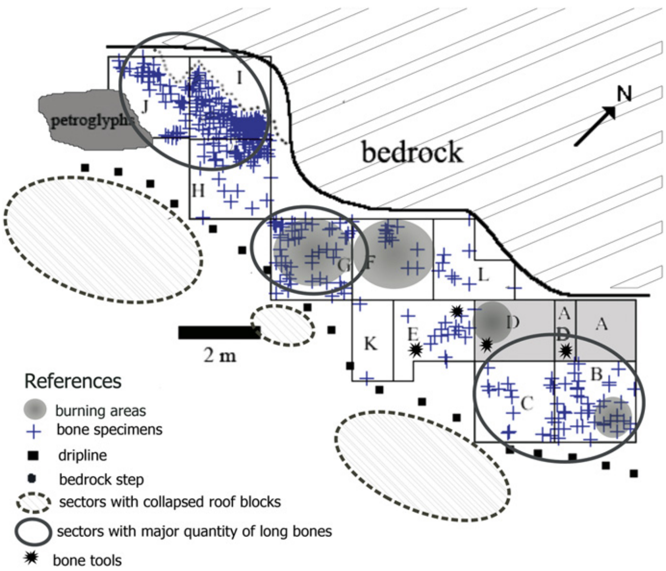

Fig. 4. Horizontal distribution of faunal assemblage in SU-2 at AEP-1 rock shelter (modified from Marchionni et al., 2010).

soil profile, and it was a dark yellowish brown sand (10Y/R 3/4) overlying the coquinoid basal sedimentary rock.

The detritus sediments of the profile could come from the intrabasin contribution of eolian nature, and from the roof collapse and landslide of the shelter's weathered rock. The latter had a higher representation in the SU 3 and upper SU 4 layers, which would correspond to the early Holocene, after 9 ka BP.

The texture and morphological analysis of the shelter's soil profile indicated that SU 2 had been reworked under local conditions (intrabasin) of deficient drainage, with shallow flood areas and alternating redox reactions. This is mainly demonstrated by the presence of Fe and Mn lumps and spots (Rabassa, 1997; Zárate et al., 2000) as well as by the undulating surface of the SU 2 upper surface, which was the result of poor drainage conditions (Fig. 2c). This type of local soils in arid areas was found in several archeological contexts of the final Pleistocene, and a good correlate is the archeological analysis carried out by Vance Haynes for Murray Spring (see Fig. 4 in Haynes, 1993). The spots caused by the pedogenetic redox processes of the profile match the spotting observed in the bones.

4. Zooarcheological context

The SU 2 archeofaunistic assemblage involved 2331 bone specimens (NSP), of which 1765 (76%) were assigned to certain taxonomic level (Table 1). Most specimens identified on a specific level corresponded to *L. guanicoe* (guanaco) with a NISP = 473, which showed a distribution of 26.8%, while NISP = 1157 (65.5%) corresponded to higher taxonomic categories, such as Class Mammalia (Table 1). While the latter could correspond to large mammals, such as guanacos, the high fragmentation degree did not allow for a more accurate taxonomic assignation.

Bone modifications were studied mainly based on long bones of guanaco considering that this taxon is the most abundant and taking into account the other taphonomical attributes expressed above. On the other hand, 425 specimens of guanaco correspond to apendicular skeleton (long and short bones). Within this subsample, 329 specimens are long bones. These anatomical parts are detailed in Table 2 (modified from Marchionni et al., 2010). Long bones were selected to carry out bone modification analyses (macro and micro) given that, "…the quantification of long bone shafts is essential for the accurate quantification of elements…and scavenge of carnivores" (Cleghorn and Marean, 2004, pp. 48). Likewise, they are good indicators to evaluate cultural action (press processing, consumption, etc.). All bones were observed by the naked eye; however, 80 specimens have been analyzed by means of a binocular microscope with magnifications of 10–60.

This faunal assemblage is heterogeneously distributed throughout the AEP-1 area. Long bones were distributed in two main sectors of the excavation (Figs. 3 and 4). The sector that showed the highest degree of accumulation was the area of the rock shelter that included the I, H and J grids and where the roof covered a broader surface of ground and the external *ca.* 9 ka BP landslide blocks would have provided greater protection for the internal area, leading to a better preservation of archaeofaunistic materials (Fig. 4). In these squares, faunal accumulations reached higher percentages than in those grounds without external blocks. Likewise, long guanaco bones

Table 1
Taxonomic abundance of SU 2 in AEP-1.

	SU 2	
	NISP	NISP%
Bird indet.	67	3.8
Rheidae	55	3.12
Mammal indet.	1157	65.55
Canis sp.	1	0.06
Lama guanicoe	473	26.8
Conepatus sp.	1	0.06
Dusicyon sp.	4	0.23
Zeadyus pichiy	3	0.17
Unionidae	1	0.06
Seashell indet.	3	0.17
	1765	100

Table 2
Anatomic units of *Lama guanicoe* (guanaco) in SU 2 of AEP-1.

Element	NISP	MNE	MNI	% Survival	MAU	%MAU
Skull	5	3	1	33.33	3.00	42.86
Bulla	–	–	–	–	–	–
Mandible	4	2	1	11.11	1.00	14.29
Atlas	–	–	–	–	–	–
Axis	–	–	–	–	–	–
Cervical v.	9	2	1	4.44	0.40	5.71
Thoracic v.	1	1	1	0.93	0.08	1.19
Lumbar v.	3	1	1	1.59	0.14	2.04
Sacrum	–	–	–	–	–	–
Sternebrae	–	–	–	–	–	–
Rib	–	–	–	–	–	–
Px. rib	7	7	1	3.24	0.29	4.17
Scapula	1	1	1	5.56	0.50	7.14
Px. humerus	1	1	1	5.56	0.50	7.14
Ds. humerus	5	4	3	22.22	2.00	28.57
Humerus shaft	22	2	1	11.11	1	14.29
Humerus	1	1	1	5.56	0.50	7.14
Px. radius/ulna	2	2	1	11.11	1.00	14.29
Radius/ulna shaft	17	1	1	5.56	0.50	7.14
Ds. radius/ulna	5	5	4	27.78	2.50	35.71
Radius'ulna	–	–	–	–	–	–
Pelvis	1	1	1	5.56	0.50	7.14
Femur	–	–	–	–	–	–
Px. femur	–	–	–	–	–	–
Ds. Femur	–	–	–	–	–	–
Femur shaft	9	2	1	11.11	1.00	14.29
Patella	–	–	–	–	–	–
Px. tibia	2	1	1	5.56	0.50	7.14
Ds. tibia	2	2	1	11.11	1.00	14.29
Tibia shaft	19	4	3	22.22	2.00	28.57
Px. Metacarpal	4	4	2	22.22	2.00	28.57
Metacarpal	–	–	–	–	–	–
Cuneiform	3	3	2	16.67	1.50	21.43
Scaphoid	5	5	3	27.78	2.50	35.71
Lunar	3	3	3	16.67	1.50	21.43
Magnum	7	7	5	38.89	3.50	50
Pisiform	5	4	4	22.22	2.00	28.57
Trapezoid	1	1	1	5.56	0.50	7.14
Unciform	3	3	2	16.67	1.50	21.43
Carpal	–	–	–	–	–	–
Px. Metatarsal	8	6	3	33.33	3.00	42.86
Metatarsal	–	–	–	–	–	–
Ds. Metapodial	35	14	4	77.78	3.50	50
Calcaneus	6	3	2	16.67	1.50	21.43
Astragalus	3	3	3	16.67	1.50	21.43
Cuboid	2	2	2	11.11	1.00	14.29
Ento cuneiform	10	10	7	55.56	5.00	71.43
Fibulare	14	14	9	77.78	7.00	100
Navicular	10	9	7	50	4.50	64.29
Tarsal	–	–	–	–	–	–
Sesamoid	19	19	2	13.19	1.19	16.96
1st phalange	44	22	4	30.56	2.75	39.29
2nd phalange	44	24	4	33.33	3.00	42.86
3rd phalange	26	25	4	34.72	3.13	44.64
Shaft fragments	55	–	–	–	–	–
	473	224				

were represented with the highest percentages, accounting for over 20% in the I grid. The second highest concentration was in squares B and C, with a value that reached almost 10% of long bones in each (Figs. 3 and 4).

Lastly, there was a third accumulation area, although smaller than the previous two, that linked the west and east sectors of the site (Fig. 4) and formed a narrow gallery with little shelter from the rock roof. This sector comprised squares G and F, with a high percentage of guanaco bones, but with a low proportion of long bones that did not show the high accumulation recorded in the other two sectors (Figs. 3 and 4).

5. Results

The analyzed bone surfaces showed multiple processes and agents that had taken place before, during, and after the burial of the materials coming from SU 2. The methodology employed enabled the identification of effects resulting both from human activity of secondary processing (Miotti and Marchionni, 2008; Marchionni et al., 2010), consumption, and discard of guanaco bone pieces between *ca.* 7.7 and 7.4 ka BP and from its subsequent spatial reorganization through pedogenesis. The main aim of the present work was to assess the modifications in connection with the site-specific geoarcheological context (Zárate et al., 2000).

A high proportion of bones with clear signs of anthropic activity including cut marks, helical fractures associated with impact blow, and notching to open long bones was recorded. On the other hand, 3 tools made from guanaco and canid long bones were associated to this assemblage, which were reported in a previous paper (Miotti and Marchionni, 2008). Low proportions of carnivore and rodent traces were found in this assemblage. These and other agents and processes that had an impact on the bone assemblage will be detailed in the following section.

5.1. *Weathering and differential preservation*

Exposure time of the assemblage was assessed through weathering. Although Behrensmeyer's (1978) stages 1–4 were recorded, the trend showed dispersion between the lowest stages (1 and 2). More than 75% of the specimens were grouped in those categories, with a lower proportion (18%) in stage 3, falling abruptly towards stage 4 (<2%) and without evidence of stage 5 weathering (Fig. 5). This situation showed a relatively good preservation of bone surfaces regarding weathering factors as a result of the fast and synchronic burial of the materials. However, the small percentage of specimens in more advanced stages revealed the existence of cyclic flooding, covering and drying bones in differential ways, and heterogeneous preservation was indicated by the high exfoliation of some of the bone surfaces.

A noteworthy situation could be observed in 17 specimens (% NISP = 21) of bone fragments which presented well-preserved

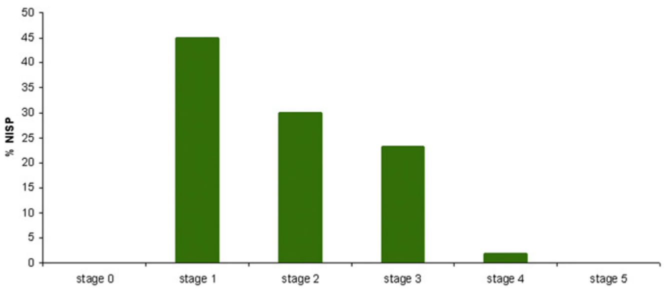

Fig. 5. Weathering tendency expressed in %NISP based on Behrensmeyer's (1978) stages of archaeozoological sample of SU 2.

cortical surfaces, generally in stages 1 or 2. These materials were distinctly characterized by the presence of deep cracks or fissures which did not correspond with what would normally be expected for the state of their surfaces (Fig. 6b and c). This did not appear as a constant pattern in the assemblage and it could have been the result of a local pedogenetic process in deficient drainage conditions, net roots of herbaceous plants, and cycles of flooding and drying (see Fig. 2a–c). Cyclical changes in humidity of the sedimentological matrix could have increased the postdepositional fragmentation of buried bones (splitting, cracking and differential weathering).

5.2. *Processing marks*

With the exception of 3 unfused metapodium trochleas belonging to young individuals, all other analyzed bones were fractured. No specimens longer than 15 cm were observed; on the contrary, over 53% of the fragments showed maximum lengths of ≤5 cm. Helical fracture, typical of fresh bone processing of the long bone assemblage, occurred in 26% of the materials. This could indicate bone marrow extraction or the usage of such anatomic units as raw material for the production of tools (Table 3 and Fig. 7a–d; Miotti and Marchionni, 2008). In this sample, the helical fracture showed the basic attributes that defined the anthropical pattern, such as the existence of smooth and plain surfaces, with converging fronts, and generally accompanied by attributes such as impact points, grooves, negative flake scars, hackle and chop-marks, and chattering. All were related to the stress wave produced by dynamic load over green bone surface (blow). In other words, they were associated with human kinetic energy in breaking processes. On the other hand, cut marks may or may not have been associated with fracture surfaces (Johnson, 1985; Lyman, 1994 and references therein), but in every case, these marks were essential in order to infer human activity.

In addition to the helical fractures, other modifications of human origin were recorded. Among them, a NISP of 17 over 80 (Fig. 8) specimens showed cut marks that would indicate some kind of processing of the anatomic units (Table 3 and Fig. 7e–h) and that 10 fragments showed surfaces that had been altered by exposure to fire.

The remaining specimens showed fracture types that combined those produced on fresh and dry bones. This is due to the fact that not all bones adopt a helical pattern when they are fractured while still fresh; such is the case of metapodials. In many cases, these elements showed other types of fractures, apart from those caused on bones while still fresh (typically helical or curved), which are the result of fractures in the dry state (Table 3). This pattern included several other shapes such as the longitudinal, oblique and transverse fracture of rough or chipped surfaces (Johnson, 1985; Lyman, 1994 and references therein). The combination of fractures in the same specimen may suggest that they were produced diachronically, and it also indicated the action of different agents for each drying stage of the materials. Among the most plausible causes were changes in humidity, sediment pressure, trampling, and even recovery, removal and laboratory analysis.

Other key indicators of use and fragmentation of long bones were the bone tools and preforms that were found. For further details on this topic, refer to Miotti and Marchionni (2008). The complete index (MNE/NISP, Lyman, 1994) for anatomical units of guanaco, as the degree of fragmentation, was estimated at 0.48, which indicated high fragmentation.

5.3. *Bioturbation and diagenesis*

The largest number of natural modifications (N transforms) that were recorded corresponded to those caused by the action of roots, which appeared in 47 specimens (Fig. 8). In many cases, such traces

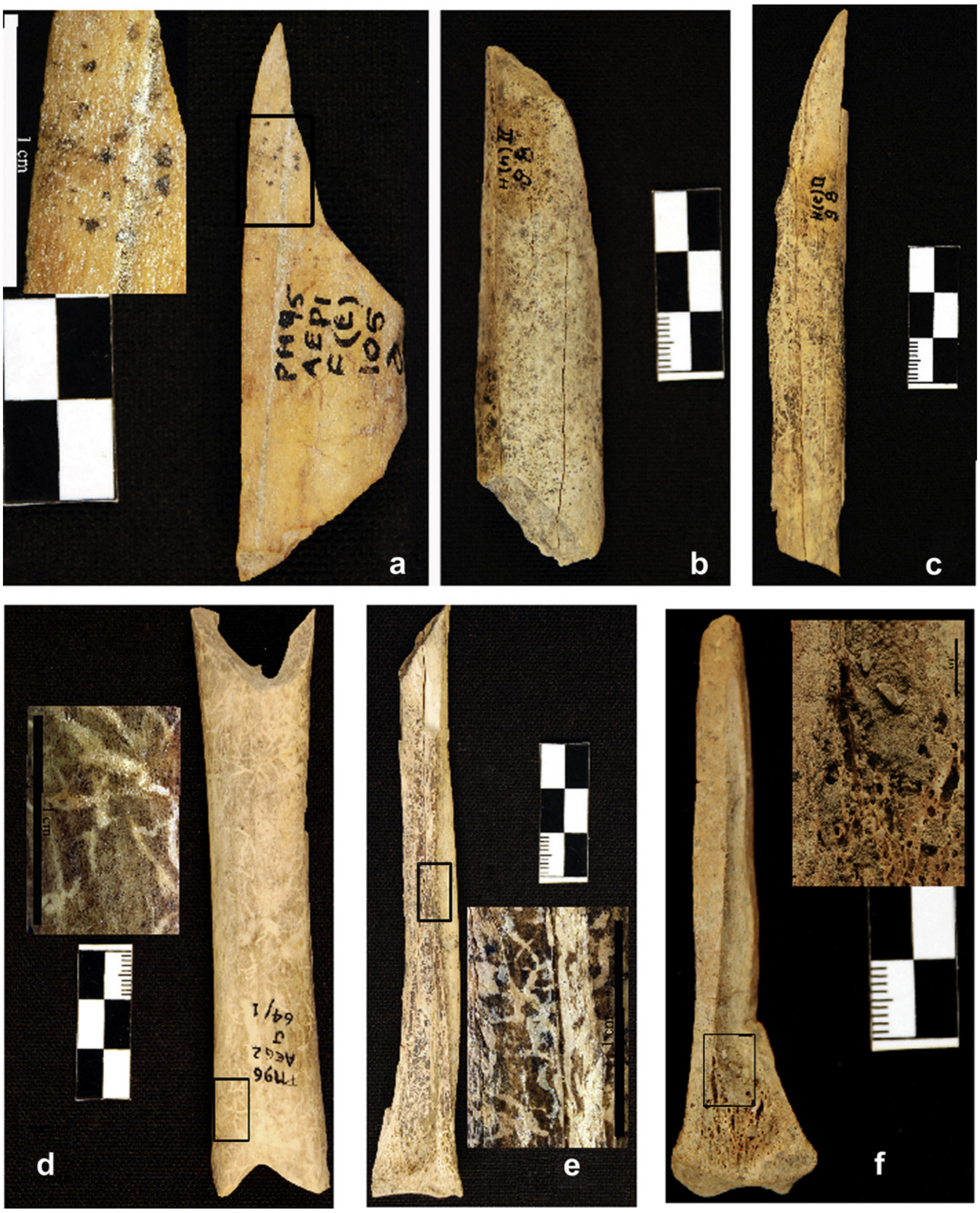

Fig. 6. N-transform; a and b) manganese stained; b and c) differential weathering; d and e) etching roots; f) crushed shell come from bedrock and carbonate deposits.

covered the entire bone surface. Etching roots could generally be seen as small, surperficial, irregular dendritic grooves, forming "U" shaped channels that were shallow and narrow (Johnson, 1985; Lyman, 1994), distributed both along the cortical and medular surfaces of bones and, in many cases, they even covered surfaces and fracture edges. This etching performed a dendritic design. As regards their color, such grooves were generally clearer than the bone surface (Fig. 6 d and e). In the cases where the surfaces were stained by manganese oxides, the color differences between grooves and cortical surfaces of bones were more marked. This trace pattern corresponded to the root system of gramineae and herbaceous plants, typical of soils with deficient drainage and frequent flooding. In this case, and according to Lyman (1994), and Montalvo (2002), traces were interpreted as the marks produced a long time after burial and related at the moment of environmental stability which started paleosol formation after 7 ka BP. In other words, edaphisation may have started approximately 500 years after the site was abandoned by humans (Fig. 2).

Several other well-known biological groups (i.e. fungi, bacterial activity, larvae, and worms) were observed within the bone material and in the sediment (IIA). However, their effect has not been measured yet.

Modifications caused by other agents, such as carnivores and rodents, were also assessed. However, their appearance was very infrequent and of little impact (Fig. 8) in comparison with other modifications, given that they did not seem to have been important agents in the formation and transformation of the assemblage. Except

Table 3
Fracture patterns expressed in NISP: H) helical; L) longitudinal; O) oblique; T) transverse; LO), LOT), LT), and OT) combined patterns.

Stage of bone drying	H	L	O	T	LO	LOT	LT	OT	Total
Green	16	2	0	1	3	4	9	1	36
Drying	0	2	0	1	1	1	6	0	11
Both	3	1	0	5	7	7	2	0	25

Fig. 7. C- transform; a–h) helical fractures; e, f, and h) cut marks; g) chop mark.

for the existence of three specimens that had been damaged by teeth belonging to carnivores, the remaining modifications that could be ascribed to the action of such agents were of little importance and corresponded to very small bone fragments that did not hold the necessary attributes to be taken into consideration, and consequently, it seemed more appropriate to leave them undetermined at present. These traces had the same color as the cortical surfaces of bones, and this attribute allowed the inference that carnivore agents could have scavenged the assemblage before its burial.

Something similar occurred with marks produced by teeth belonging to rodents, which were very diffuse in 7 samples (Fig. 8). In SU 2, no galleries or rodent caves were found during excavations.

5.4. *Manganese and $CaCO_3$ deposits*

Thirty specimens were found to have been modified by manganese dioxide (Fig. 8). These modifications appeared as dots and spots of greater size whose concentration, distribution, and location were variable among the specimens, which meant that no clear pattern could be defined for them (Fig. 6a and b).

Fifteen specimens showed calcium carbonate encrustations (Fig. 8). These carbonate coatings generally became visible when the specimens were observed under a microscope and they appeared as fine films deposited in the medullary canal of the bone or in the soft tissue. The presence of bedrock crust (bioclasts) was

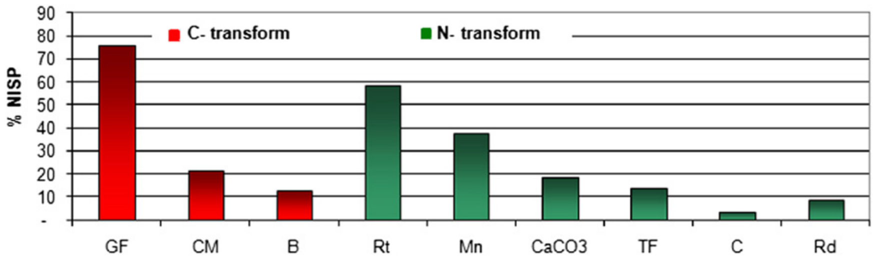

Fig. 8. C y N transform; GF: green bone fractured; CM: cut marks; B: burning; Rt: etching roots; Mn: manganese; $CaCO_3$: carbonates; TF: taphonomic fracture; C: carnivore damage; Rd: rodent damage.

also found in certain occasions, formed by redeposited ground valves (Fig. 6 f). These manganese and carbonate processes could be related to pedogenetic re-works.

6. Discussion

The integration of the results among the bone modifications ascribed to the anthropic activity, such as the high degree of fragmentation of long fresh bones (Fig. 7a–d, Fig. 8, and Table 3), together with the presence of cut and chop-marks (Fig. 7e–h, and Fig. 8), preforms and tools (Miotti and Marchionni, 2008), and the distribution of materials in ground plan (Fig. 4) close to combustion areas (hearths) (Cattáneo, 2002) and related to the most protected areas of the shelter (Fig. 4), indicated that the shelter must have been a secondary and final guanaco processing area during the Middle Holocene. Furthermore, the results of the analysis of the correlation coefficients between %MAU of this bone assemblage, and both bone density and %MGUI (Marchionni et al., 2010) placed the assemblage as a product of reversed utility of prey, or as Class 2 according to Lyman (1994). To this can be added the information obtained regarding bone modifications (C-transforms) and subsequent N-transforms produced by several pedogenetical agents, especially focused on roots. Nevertheless, these natural processes did not obscure the anthropic signals. In this sense, the archaeofaunistic context of SU 2 was a product of human activity during the final stages of prey processing in the shelter. Such activity corresponded with an intense exploitation of anatomic units which, like metapodiums, would be of low return in terms of meat and fat quantity (for further information, refer to Marchionni et al., 2010).

The indicators of intentional anthropic activity and accumulation in the different areas of the site are accompanied by a very low representation of damage marks from carnivores and rodents which could have affected the deposit following human discard. However, it is remarkable that the context was altered postdepositionally by pedogenetic bioturbations and diagenesis mainly from roots (cracking, splinting) that transformed not only bone surfaces (root etching), but also produced major breaking of bone fragments.

Primarily, there is a noticeable transformation of bone surfaces by pedogenetic activity. The regional, local and site geo-archeological context indicated that the archeological deposit formed towards *ca.* 7.5 ka BP over arid/semiarid conditions. It was later covered with eolian and basin sediments, in a low energy environment, and around 7 ka BP basin conditions were of greater stability, allowing for the formation of a local soil that matched the polynical column of the site (Borromei, 2003). The SU 2 corresponding to the IIA horizon suggested high organic activity of marsh and gramineae plants – a result of the poor drainage of the local soils of arid areas- whose roots would have been the main modifying agents of the burried bone assemblage. Such complex root systems would have helped to remodel the land, deepening the areas with greater flooding. This process intensified an undulating microtopography (see Fig. 2a–c) which favored the differential weathering of the bones that were subject to shallow flooding and alternating drying conditions. However, the low energy of this marsh environment was not enough to produce the strong removal of the buried materials, although it would have contributed to split further the original high bone fragmentation produced by previous human activity. This stability cycle was interrupted towards the late Holocene, when new arid conditions took place, with a constant trend continuing into present times. In the profile this was represented by SU 1, which is the present eolian sediment without evidence of pedogenetic process (Fig. 2a and b).

The presence of etching and breaking roots in bone specimens, and of manganese staining and carbonate encrustation spots (by dissolution of carbonates of bedrock) support episodes of flooding. The activity of roots, although it may have traced the assemblage, and would have built a microenvironment causing the first diagenetic alterations (Montalvo, 2002), did not produce any critical horizontal displacement. This led to the conclusion that the pedogenetic impact was unable to obliterate any key anthropic evidence of bone accumulation in that shelter.

The low proportion of carnivore traces was interpreted as postdepositional activity before the assemblage was buried. The same colour of bottom and surface of the traces indicated that the elapsed time between human discard and burial context was brief. In this sense, the scavengers would have had low impact in the spatial distribution of the SU 2 assemblage.

Something similar could be formulated as regards rodent action. However, in this case the taphonomic attributes of the traces were not clear, and the action of rodents appears to be of low impact and postdepositional only, but it is uncertain whether if it was before or after the burial context.

With reference to similar taphonomic scenarios, references were found in works based on the supra-regional scale by Magallanes (Barberena, 2008 and references cited therein) and in the Andean foothills (Mengoni Goñalons, 1999; De Nigris, 2004), where the transforming agents of zooarchaeological contexts in caves that lacked soil formation were thoroughly analyzed. There are few examples of buried contexts in current soils that appear in open sites of the Magallanes basin and that belong to late Holocene (Barberena, 2008). In the case of the Cueva Cóndor 1 site, the author highlights the postdepositional relevance that Mn (between 5 and 12%) and carbonates (*ca.* 1.7%) would have had due to water circulation in the context. However, the percentage of carnivore action was low (lower than 0.5%), which was exactly what was found in this study (see Fig. 8). The biggest difference regarding the Piedra Museo case was that the Cueva Cóndor 1 context had an eolian silt-clay sedimentary matrix, which showed no evidence of having been transformed by pedogenetic processes, while in Piedra Museo the action of water and roots derived from a pedogenetic readaptation. In this respect, these examples show the great variability of the taphonomic records that had an effect on the different zooarchaeological contexts of this extra-Andean Patagonic region, which could have resulted in similar attributes regarding bone surface modifications.

A further case that bears resemblance with this one is De Nigris (2004), analyzing the zooarchaeological contexts of the CCP7 site, located in the Andean foothills. Although the author recorded postdepositional action by carnivores and rodents, she did not take into account other N transforms, such as the action of roots or Mn, among others. She did make clear, however, that in such contexts the action of predators would be between 0.9 and 8.4%, and a little higher for rodents, but still lower than 15%.

In both contexts (Cóndor 1 and CCP7) and differently from this study, the zooarchaeological materials were found in eolian sedimentary matrixes, and not in paleosols. This is the reason why the action of roots as the main factor for postdepositional modification was not remarkable in these papers.

In order to find more accurate correlations with the taphonomic component of Middle Holocene in Piedra Museo, it is necessary to establish a comparison with other taphonomic studies carried out outside the Patagonian area in Wet Pampa sites. The cases that bear the closest resemblance are those of the Interserrana area and which are related to paleosol development and zooarchaeological contexts where the predominant taxon was the guanaco and where the actions of roots, Mn and carbonates play variable roles in the taphonomy of such sites (Holliday et al., 2003; Martínez and Osterrieth, 2003; Bonomo and Massigoge, 2004; Gutiérrez, 2004; Massigoge, 2009).

7. Conclusions

The site, basin, and extra basin archeological information indicated that the SU 2 settlements took place before the geomorphological stability of the landscape (paleosol). The buried faunal context was reorganized as a result of pedogenetic bioturbation and diagenesis (root etching and dissolution, and redox reactions accelerating coating of carbonates and stains of manganese). Flooding and drying cycles, typical of these local soils, could have been factors of re-deposition. However, the spatial distribution of long bones showed a random arrangement without a longitudinal alignment which could indicate a flow of water (Voorhies, 1969). On the other hand, unconformity between SU I and SU 2 support the idea that microenvironmental conditions suffered a dramatic and sudden change of flooding in the rock shelter (Fig. 2). Based on this feature, flooding was a factor of very low impact to produce any critical displacement of bones.

The increase of the faunal assemblage in SU 2 in connection with final Pleistocene/early Holocene settlements (SU 6 and SU 4–5) did not necessarily imply greater settlement intensity during the Middle Holocene, but greater prey processing activity. In this study, a major processing of leg bones was recorded. The IFG (index of fragment of disjunction, in the sense of Lyman, 1994) was higher than the same index recorded in lower components of the site (Miotti, 2004, pp. 158, Fig. 4; Miotti and Salemme, 2005; Marchionni et al., 2010).

Soil surface stability about 7 ka BP following Middle Holocene human settlements could have broadened the palimpsest effect, but the analyzed zooarcheological and taphonomical attributes, together with the geoarchaeological features indicated that the materials were not transported. C and N transforms of the zooarcheological context, as well as the spatial distribution of the overall SU 2 archeological context, and their brief temporal dispersion (^{14}C datings) minimized the hypothesis of an accretional deposit. Therefore, between 7.7 and 7.4 ka BP, under dry environmental conditions, the shelter was used as a *locus* of multiple activities with evidence of secondary prey processing, food consumption and final discard. Other activities, such as the production bone tools and ornaments, also took place in the shelter (Miotti and Marchionni, 2008). About 7 ka BP, the effective humidity of the basin increased and started to develop a local soil, it reworked eolian sediments in the rock shelter and caused bone modifications in the buried context.

Although different taphonomical analyses are underway, several still remain. However, undoubtedly the independent geoarcheological analyses and bone modifications are key methodological tools for the interpretation of archeological contexts which, in this case, have contributed to moving forward with the interpretation of the AEP-1 rock shelter's taphonomic history.

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References

Barberena, R., 2008. Arqueología y biogeografía humana en Patagonia Meridional. Colección Tesis Doctorales, Sociedad Argentina de Antropología, Buenos Aires.
Behrensmeyer, A.K., 1978. Taphonomic and ecologic information from bone weathering. Paleobiology 4 (2), 150–162.
Binford, L.R., 1981. Bones: Ancient Men and Modern Myths. Academia Press, New York.
Bocek, B., 1986. Rodent ecology and burrowing behavior: predicted effects on archaeological site formation. American Antiquity 51 (3), 589–603.
Bocek, B., 1992. The jasper ridge reexcavation experiment: rates of artifact mixing by rodent. American Antiquity 57, 261–269.
Bonomo, M., Massigoge, A., 2004. Análisis tafonómico del conjunto faunístico del sitio arqueológico Nutria Mansa 1 (Pdo. De Gral. Alvarado). In: Martínez, G., Gutiérrez, M., Curtoni, R., M., Berón, M., Madrid, P. (Eds.), Aproximaciones contemporáneas a la arqueología pampeana. Perspectivas teóricas, metodológicas, analíticas y casos de estudio. Facultad de Ciencias Sociales, UNCPBA, Olavarría, pp. 93–111.
Borrero, L., 2001. Regional taphonomy: background noise and the integrity of the archaeological record. In: Kuznar, L.A. (Ed.), Ethnoarchaeology of Andean South America. Contributions to Archaeological Method and Theory. Ann Arbor, International Monographs in Prehistory Ethnoarchaeological Series, pp. 243–254.
Borromei, A., 2003. Palynology at Piedra Museo locality, Santa Cruz province, Argentina. In: Miotti, L., Salemme, M., Flegenheimer, N. (Eds.), Ancient Evidence for Paleo South Americans: From where the South Winds Blow. Texas A&M University Press, Centre for the Study of First Americans-Texas, pp. 113–119.
Brain, C.K., 2004. Fifty years of fun with fossils: some cave taphonomy-related ideas and concepts that emerged between 1953 and 2003. In: Pickering, R., Toth, N. (Eds.), Breathing Life into Fossils: Taphonomic Studies in Honor of C. K. (Bob) Brain. Stone Age Institute Press, pp. 1–24. Chapter 1.
Buikstra, J.E., Swegle, M., 1989. Bone modification due to burning: experimental evidence. In: Bonnichsen, R., Sorg, M. (Eds.), Bone Modification. Peopling of Americas Publications Edited Volume Series, Center for the Study of the First Americans. University of Maine, Orono, pp. 247–257.
Capaldo, S., Blumenschine, R., 1994. A Quantitative diagnosis of notches made by hammerstone percussion and carnivore gnawing on bovid long bones. American Antiquity 59 (4), 724–748.
Cattáneo, R., 2002. Una aproximación a la organización de la tecnología lítica entre cazadores-recolectores del Holoceno Medio/Pleistoceno final de la Patagonia Austral (Argentina). Ph.D. Thesis, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Buenos Aires, Argentina.
Cleghorn, N., Marean, C., 2004. The destruction of skeletal elements by carnivores: the growth of a general model for skeletal element destruction and survival in zooarchaeological assemblages. In: Pickering, R., Toth, N. (Eds.), Breathing Life into Fossils: Taphonomic Studies in Honor of C. K. (Bob) Brain. Stone Age Institute Press, pp. 37–66.
De Nigris, M., 2004. El consumo en grupos cazadores-recolectores. Un ejemplo zooarquelógico de Patagonia meridional. Sociedad Argentina de Antropología, Buenos Aires.
Fano Martínez, M.A., d'Errico, F., Vanhaeren, M., 2005. Magdalenian bone industry from el Horno cave (Ramales, Cantabria, Spain). In: Dujardin, V. (Ed.), Industrie osseuse et parures du Solutréen au Magdalénien en Europe. Memoire XXXIX de la Société Préhistorique Française, Charente, France, pp. 177–196.
Farrand, W.R., 1985. Rockshelter and cave sediments. In: Stein, J., Farrand, W. (Eds.), Archaeological Sediments in Context. Peopling of the Americas, vol. 1. Center for the Sutdy of Early Man Institute for Quaternary Studies, University of Maine at Orono, U.S.A, pp. 21–40.
Farrand, W.R., 1993. Discontinuity in the stratigraphic record: snapshots from Franchti cave. In: Goldberg, P., Nash, D.T., Petraglia, M.D. (Eds.), Formation Processes in Archaeological Context. Monographs in World Archaeology N° 17. Prehistory Press, Madison, Wisconsin, pp. 85–96.
Gifford-Gonzalez, D., 1989. Overview-modern analogues: developing and interpretative framework. In: Bonnichsen, R., Sorg, M. (Eds.), Bone Modification. Peopling of Americas Publications Edited Volume Series. Center for the study of the first Americans, University of Maine, Orono, pp. 43–52.
Gifford-Gonzalez, D., 1993. Gaps in Zooarchaeological Analyses of Butchery: Is Gender an Issue? In: Hudson, J. (Ed.), Interpretation of Faunal Remains. Center for archaeological Investigations, Southern Illinois University at Carbonale, Ocassional Paper 21, pp. 181–199.
Gutiérrez, M.A., 1998. Taphonomic effects and state of preservation of the guanaco (*Lama guanicoe*) bone bed from Paso Otero 1 (Buenos Aires Province, Argentina). Thesis of Master, unpublished, Texas Tech University, Texas, U.S.A.
Gutiérrez, M.A., 2004. Análisis tafonómicos en el área interserrana, Pcia. de Bs As. Ph.D., Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Buenos Aires, Argentina.
Haynes, G., 1980. Evidence of carnivore gnawing on Pleistocene and recent mammalian bones. Paloebiology 6 (3), 341–351.

Haynes Jr., V.C., 1993. Clovis-folsom geochronology and climatic change. In: Soffer, O., Praslov, N.D. (Eds.), From Kostenki to Clovis. Upper Paleolithic-Paleo-Indian Adaptations. Plenum Press, New York, pp. 219–249.
Heusser, C., Rabassa, J., 1987. Cold climate episode of younger Dryas age in Tierra del Fuego. Nature 328, 609–611.
Holliday, V., Martínez, G., Johnson, E., Buchanan, B., 2003. Geoarchaeology of Paso Otero 5 (Pampas of Argentina). In: Miotti, L., Salemme, M., Flegenheimer, N. (Eds.), Where the South Winds Blow. Ancient Evidence of Paleo South Americans. Center for the Study of First Americans and Texas A&M University Press Oregon State University, pp. 37–43.
Johnson, E., 1985. Current developments in bone technology. In: Schiffer, M.B. (Ed.), Advances in Archaeological Method and Theory, vol. 8. Academic Press, New York, pp. 157–235.
Johnson, E., 1989. Human modified bones from early southern plain sites. In: Bonnichsen, R., Sorg, M. (Eds.), Bone Modification. Peopling of Americas Publications Edited Volume Series. Center for the study of the first Americans, University of Maine, Orono, pp. 431–471.
Karkanas, P., Bar-Yosef, O., Goldberg, P., Weiner, S., 2000. Diagenesis in prehistoric caves: the use of minerals that form *in situ* to assess the completeness of the archaeological record. Journal of Archaeological Science 27, 915–929.
Kaufmann, C., Gutierrez, M.A., 2004. Dispersión potencial de huesos de guanaco (*Lama guanicoe*) en medios fluviales y lacustres de baja energía. In: Martínez, G., Gutiérrez, M.A., Curtoni, R., Berón, M., Madrid, P. (Eds.), Aproximaciones Contemporáneas a la Arqueología Pampeana. Perspectivas teóricas, metodológicas, analíticas y casos de estudio. Facultad de Ciencias Sociales, UNCPBA, Olavarria, Argentina, pp. 129–146.
Lyman, R.L., 1994. Vertebrate Taphonomy. Plenum Press.
Marchionni, L., Miotti, L., Mosquera, B., 2010. El uso de la fauna entre el Pleistoceno final y el Holoceno medio en la Patagonia extra-andina. In: De Nigris, M., Fernández, P.M., Giardina, M., Gil, A.F., Gutiérrez, M.A., Izeta, A.I., Neme, G., Yacobaccio, H.D. (Eds.), Zooarqueología a principio del S. XXI: aportes teóricos, metodológicos y casos de estudio, pp. 259–271. Ediciones del Espinillo, Malargüe, Mendoza.
Marean, C.W., 1995. Of taphonomy and zooarchaeology. Evolutionary Anthropology 4 (2), 64–72.
Martin, F., 2007. Tafonomía y Paleoecología de la Transición Pleistoceno-Holoceno en Fuego-Patagonía. Interacción entre poblaciones humanas y de carnívoros y su importancia como agentes en la formación del registro fósil. Ph.D., Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Buenos Aires, Argentina.
Martínez, G., 1999. Tecnología, Subsistencia y Asentamiento en el Curso Medio del Río Quequén Grande: Un enfoque arqueológico. Ph.D., Facultad de Ciencias Naturales y Museo de la Universidad Nacional de La Plata, Argentina.
Martínez, G., Osterrieth, M., 2003. The Pleistocene–Holocene stratigraphic record from early archaeological sites in caves and rockshelters of eastern Tandilia, Pampean Region, Argentina. In: Miotti, L., Salemme, M., Flegenheimer, N. (Eds.), Where the South Winds Blow. Ancient Evidence of Paleo South Americans. Center for the Study of First Americans and Texas A&M University Press Oregon State University, pp. 63–68.
Massigoge, A., 2009. Arqueología de los cazadores-recolectores del Sudeste de la Región Pampeana. Una perspectiva tafonómica. Ph.D., Facultad de Ciencias Naturales y Museo, UNLP.
Mengoni Goñalons, G., 1999. Cazadores de guanaco de la estepa patagónica. Sociedad Argentina de Antropología, Buenos Aires, Argentina.
Miotti, L., 1992. Paleoindian occupation at Piedra Museo locality, Patagonian region, Argentina. Current Research in the Pleistocene vol. 9, 30–32.
Miotti, L., 1996. Piedra Museo (Santa Cruz): nuevos datos para el debate de la ocupación Pleistocénica en Patagonia. In: Gómez Otero, J. (Ed.), Arqueología, sólo Patagonia. Publicación de la Secretaría Cultura de Chubut y CONICET, pp. 27–38.
Miotti, L., 2004. Quandary: the Clovis phenomenon, the first Americans, and the view from the Patagonia region. In: Lepper, B. (Ed.), New Perspectives on the First Americans. Texas A&M University Press, and The Center for the Study of First Americans co-publisher, USA, pp. 31–36.
Miotti, L., Marchionni, L., 2008. El uso de una materia prima no tradicional en la meseta: instrumentos más allá de las piedras. Proccedings of I Congreso Nacional de Zooarqueología Argentina. Malargüe, Mendoza, pp. 24–25.
Miotti, L., Salemme, M., 2005. Hunting and butchering events at late Pleistocene and early Holocene in Piedra Museo (Patagonia, Southernmost South America). In: Bonnichsen, R. (Ed.), Paleoamerican Prehistory: Colonization Models, Biological Populations, and Human Adaptations. Center for the Study of the First Americans, University of Texas A&M, USA, pp. 141–151.
Miotti, L., Vázquez, M., Hermo, D., 1999. Piedra Museo un Yamnagoo Pleistocénico en la Colonización de la Meseta de Santa Cruz. El estudio de la Arqueofauna. In: Soplando en el Viento. Neuquén-Buenos Aires. Argentina, pp. 113–136.
Miotti, L., Salemme, M., Rabassa, J., 2003. Radiocarbon chronology at Piedra Museo locality. In: Miotti, L., Salemme, M., Flegenheimer, N. (Eds.), Where the South Winds Blow. Ancient Evidence of Paleo South Americans. Center for the Study of First Americans and Texas A&M University Press Oregon State University, pp. 99–104.
Mondini, M., 2004. Formación del registro arqueofaunístico en abrigos rocosos de la Puna argentina. Tafonomía de carnívoros. Ph.D., Facultad de Filosofía y Letras, UBA, Argentina.
Montalvo, C.I., 2002. Root traces in fossil bones from Huayquerian (Late Miocene) faunal assemblage of Telén, La Pampa, Argentina. Acta Geológica Hispánica 37 (1), 37–42.
Pickering, R., Toth, N. (Eds.), 2004. Breathing Life into Fossils: Taphonomic Studies in Honor of C. K. (Bob) Brain. Stone Age Institute Press.
Rabassa, J., 1997. Geological and stratigraphical observations at AEP-1, Piedra Museo Locality, Unpublished report.
Rabassa, J., 2008. Late Cenozoic glaciations in Patagonia and Tierra del Fuego. In: Rabassa, J. (Ed.), The late Cenozoic of Patagonia and Tierra del Fuego. Elsevier, pp. 151–204.
Santiago, F., 2009. La ocupación humana en el norte de Tierra del Fuego durante el Holoceno Medio y Tardío. Su vinculación con el paisaje. Ph.D., Facultad de Ciencias Sociales-UNCPB, Olavarría, Argentina.
Schiffer, M., 1988. The structure of archaeological theory. American Antiquity 53 (3), 461–486.
Speth, J.D., 1983. Bone Kills and Bone Counts: Decision Making by Ancient Hunters. University of Chicago Press, Chicago.
Todd, L., 1987. Taphonomy of the horner II bone bed. In: Frison, G., Todd, L. (Eds.), The Horner Site: The Type Site of the Cody Cultural Complex. Academic Press, U.S.A., pp. 107–199. Chapter 5.
Thompson, J., Lee-Gorishti, Y., 2007. Carnivore bone portion choice and surface modification on modern experimental boiled bone assemblages. Journal of Taphonomy 5 (3), 121–135.
Voorhies, M., 1969. Taphonomy and population dynamics of Early Pliocene vertebrate fauna, Knox County, Nebraska. University of Wyoming, Contributions to Geology Special Paper N° 1.
Waters, M.R., 1992. Geoarchaeological foundations. Principles of Geoarchaeology. The University of Arizona Press, Tucson and London. 15–114.
Zárate, M., Blasi, A., Rabassa, J., 2000. Geoarqueología de la localidad Piedra Museo. In: Miotti, L., Paunero, R., Salemme, M., Cattáneo, G. (Eds.), Guía de Campo de la visita a las localidades arqueológicas. INQUA. UNLP, La Plata, pp. 56–64.
Zárate, M., Neme, G., Gil, A., 2005. Mid-Holocene paleoenvironments and human occupation in Southern South America. Quaternary International 132 (1), 1–3.