

# The Campo Laborde site: New evidence for the Holocene survival of Pleistocene megafauna in the Argentine Pampas

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## Abstract

Investigations have been carried out at the Campo Laborde archaeological site in the Argentine Pampas. Some issues related to Pleistocene extinctions and the survivals of some species of megafauna into the Early Holocene are discussed. At the site of Campo Laborde, abundant bones of giant ground sloth (*Megatherium americanum*), some from other Pleistocene fauna (*Doedicurus* sp. and *Neosclerocaliypus* sp.) and very few from extant fauna (e.g., vizcacha (*Lagostomus maximus*), Patagonian hare (*Dolichotis patagonum*), and peccary (*Tayassu* sp.), were found in association with two quartzite tools, 128 microlithic debris from different raw material and two informal bone tools. Each of the species is represented by only one individual and only one bone of *M. americanum* and one of *D. patagonum* show cut marks. Different lines of evidence suggest that Campo Laborde is a giant ground sloth procurement site on the border of an ancient swamp, where the prey was also initially butchered. One of the recovered tools is the stem of a broken bifacial projectile point, which would have been used as a hunting weapon. Based on the stratigraphic position, this site could date to the Early Holocene. Six AMS <sup>14</sup>C ages from *M. americanum* bone collagen, support this age although there is a wide chronological span between ca. 9700 and 6700 BP. The evidence obtained from Campo Laborde as well as from the La Moderna site indicates that some Pleistocene species such as giant ground sloth and some glyptodon (*D. clavicaudatus* and *Neosclerocaliypus* sp.), survived in the Pampas until the Early Holocene. Therefore, these megafauna coexisted with early hunter-gatherers for several millennia and were exploited.

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## 1. Introduction

Pleistocene megafauna extinctions and the survival of some species into the Holocene is currently a matter of debate in South America. The evidence of extinct megafauna species dated in the Early Holocene is scarce, but much of it comes from the Pampean region, where the chronology of the Late Pleistocene megafauna has always been problematic and controversial due to the wide range, and in some cases incongruence, of radiocarbon ages (Politis, 1984; Politis et al., 1995, 2003; Politis and Gutiérrez, 1998; Rossello et al., 1999, 2001; Gutiérrez et al., 2000; Cione et al., 2001; Steele et al., 2001). Based on the previous findings (Palanca et al., 1972; Fidalgo et al.,

1986), the Pampean region seems to be a key area to test the hypothesis for the Holocene survival of Pleistocene megafauna and to study the exploitation of these fauna by the early hunter-gatherers.

Recent investigations carried out at the Campo Laborde archaeological site provide new evidence for the presence of megafauna remains dated to the Early Holocene (Messineo et al., 2004; Messineo and Politis, 2007). The information obtained from this site will be summarized and discussed in this paper. The aim is to evaluate the contextual association between humans and megafauna, the chronology of this association, and how the site might have functioned in the settlement system of the early inhabitants of the region. Moreover, archaeofaunistic and taphonomic analyses have been performed in order to determine both the natural and the human agents involved in site formation of the bone and lithic deposit. Finally, the information obtained from Campo Laborde together with other early archaeological

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sites in the region, such as the La Moderna and Arroyo Seco 2, is discussed in order to approach issues related to the survival of some species of megafauna into the Early Holocene and the Pleistocene megafauna extinctions in the Pampean region.

A corollary purpose of this paper is to evaluate some models proposed to explain the massive extinctions of megafauna in the Americas (e.g., Borrero, 1984; Guthrie, 1984; Martin, 1984; Politis et al., 1995; Ferigolo, 1999). Specifically, we will focus on those models, which proposed that humans were the main causal factor of this process. These proposed models can be grouped into at least two main clusters. One group proposed that early arrivals of humans overkilled the megafauna in the very first phase of human dispersion and occupation of the continent (Martin, 1984; Alroy, 2001; Steadman et al., 2005; Haynes,

2006) while other authors see the human impact in the context of a particular environmental framework or habitat alterations (Borrero, 1984; Cione et al., 2003; Robinson et al., 2005; Hubbe et al., 2007), or with a differential influence depending on the fauna exploited (South American native families vs. North American immigrants families) (Politis et al., 1995) or the region considered (North America vs. South America) (Barnosky et al., 2004; Koch and Barnosky, 2006).

## 2. Campo Laborde site

The Campo Laborde site is located in the upper basin of Tapalqué Creek, at 37°00'36"S; 60°23'05"W (Pampean region, Argentina) (Fig. 1). The site was discovered by chance in 2000, when the landowner recognized in the

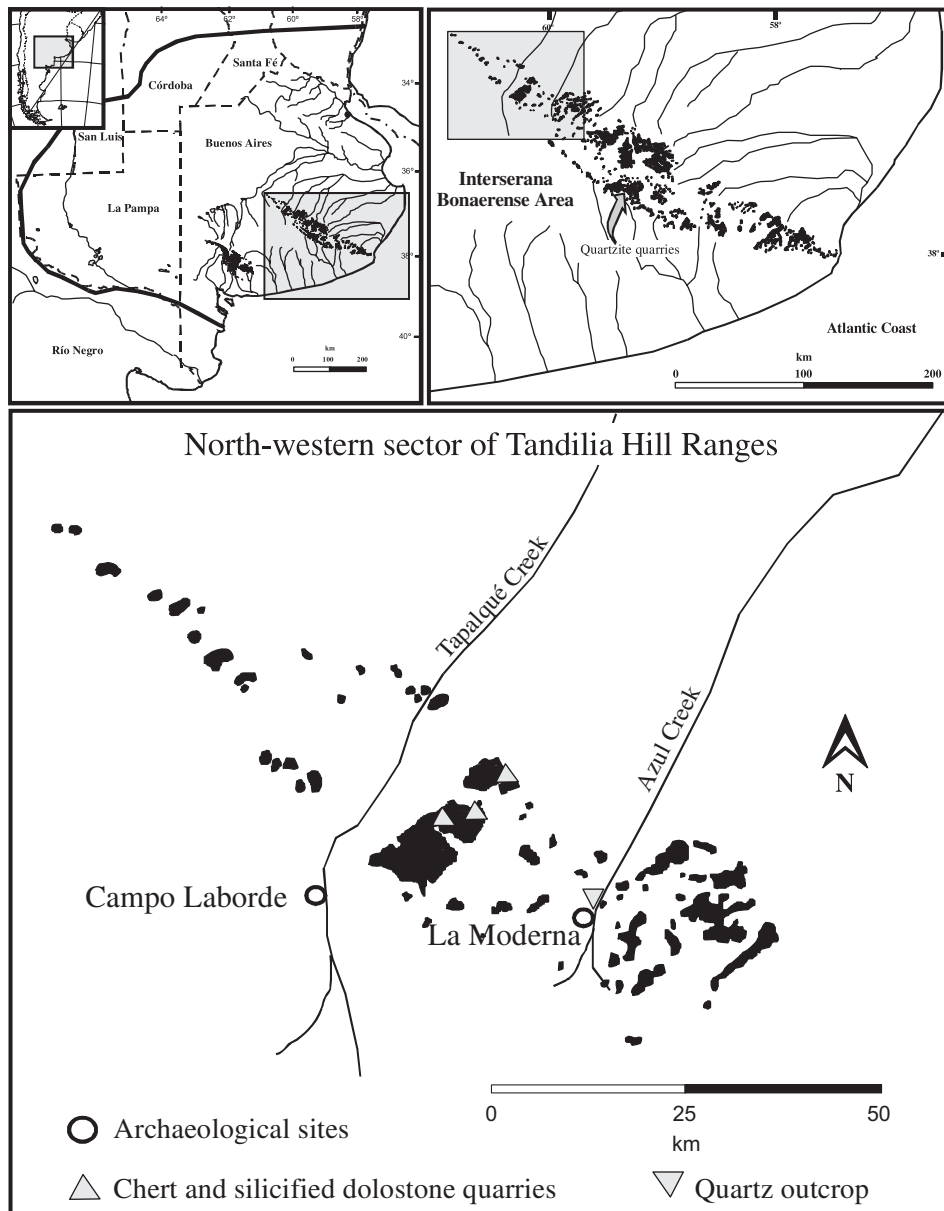


Fig. 1. Map showing the location of Campo Laborde and La moderna sites in the Pampean region.

profile a femur and vertebrae fragments, which he realized belonged to an extinct animal (Messineo et al., 2002, 2004). Between 2001 and 2003, 29 m<sup>2</sup> were excavated, and a great number of giant ground sloth (*Megatherium americanum*) bones associated with two formal tools and a flake of quartzite were recovered in paleoswamp sediments (Fig. 2). Additionally, 128 microflakes (smaller than 1 cm) from different lithic raw material (quartzite, silicifite dolostones, and chert) were recovered by wet screening (mesh 2 mm).

2.1. Geologic and paleoclimatic studies

Geologic studies carried out in the north profile of Campo Laborde show stratigraphic units typical of the Late Pleistocene–Holocene of the Pampean region. In the lower section of the profile (1.25–1.30 m below the surface),

lacustrine and paleolacustrine sediments correspond to the green Guerrero Member of the Luján Formation (see Fidalgo et al., 1973) are exposed. This unit has been dated to the Late Pleistocene, with its latest dates ca. 11 000 BP in stratigraphic sections at Tapalqué Creek (Carbonari et al., 1992; Figini et al., 1995, 1998; Tonni et al., 2001, 2003). (All dates will be given as uncalibrated <sup>14</sup>C BP unless otherwise indicated.) No archaeological evidence was recovered in the site from this unit (Fig. 3).

The archaeological deposit (e.g., bones and lithics) recovered in the paleoswamp (between 1.05 and 1.25–1.30 m below the surface) and the paleosol 4Ab located between 0.90 and 1.05 m below the surface were both found in the lower section of the Río Salado Member of the Luján Formation (Fig. 3). The Río Salado Member is a fluvial deposit representing an aggrading floodplain that corresponds to the Early Holocene (Fidalgo et al.,

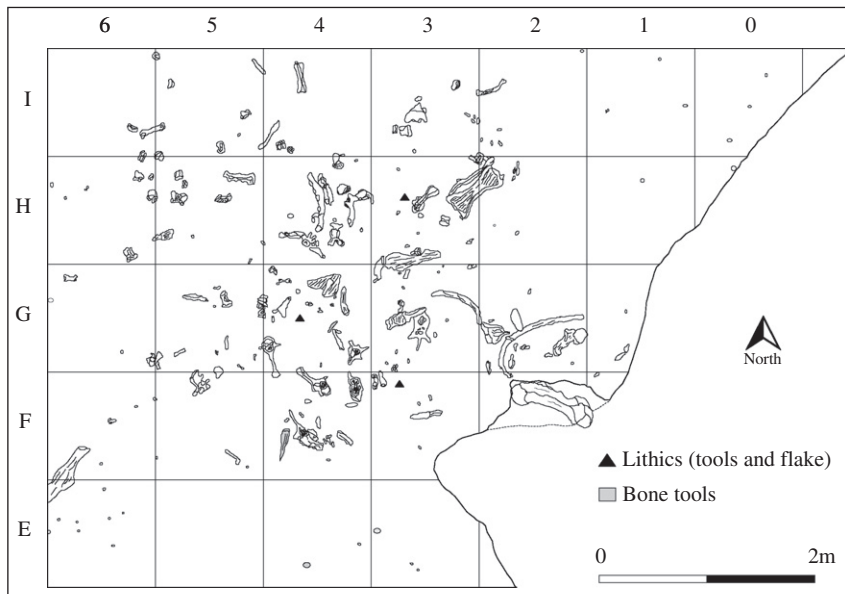


Fig. 2. Distribution of megamammal bones, lithic materials and bone tools in the site Campo Laborde.

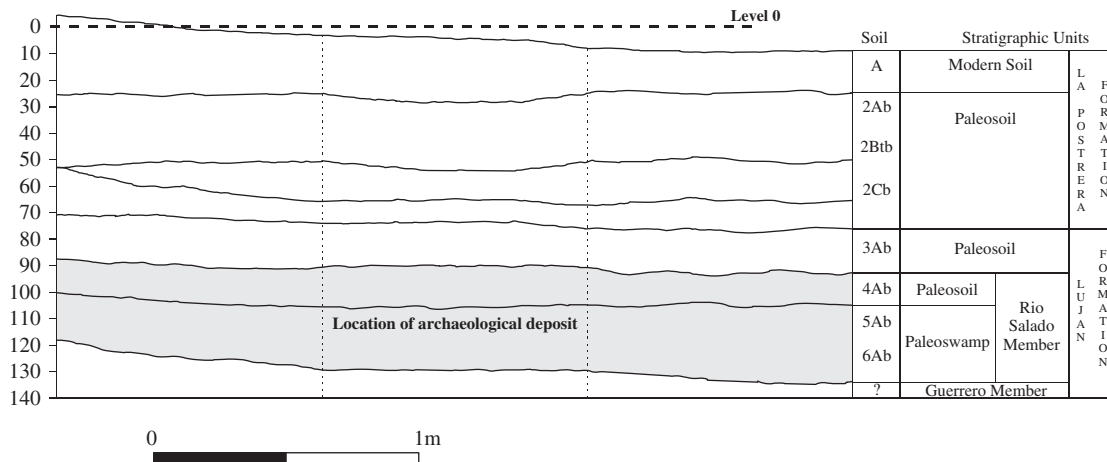


Fig. 3. Stratigraphic profile at Campo Laborde site.

1973; Carbonari et al., 1992; Figini et al., 1995). Above the archaeological deposits, there are two buried soils (2Ab and 3Ab). Soil 2Ab developed on aeolian sediments of the La Postrema Formation. The stratigraphic sequence is capped by the modern soil (A) (Fig. 3). No archaeological evidence was recovered from either of these upper sediments.

The paleoclimatic and environmental analyses with the malacological material of the site was performed by Pamela Steffan (2006). The presence of *Succinea meridionalis* and *Heleobia parchapii* in the Guerrero Member of the Lujan Formation suggests the development of humid or poorly drained soils during the Late Pleistocene. In the upper section of this member, there is a decrease of both terrestrial (*S. meridionalis*) and the aquatic species (*H. parchapii*), which suggest a moderate decrease of environment humidity. In the basal section of the Río Salado Member, where the archaeological deposit was located in the Early Holocene paleoswamp, a marshy environment with fluctuating humid conditions was recorded (Fig. 4). The malacological species recorded in the paleosol 4Ab indicate a change from marshy to lagunal environmental conditions (Steffan, 2006).

Other complementary studies have been conducted in the upper basin of Tapalqué Creek in order to understand the paleoclimatic events in the region from a broader perspective. Prieto (1993, 1996) carried out palynological analysis from sedimentary samples taken in sections from the Tapalqué Creek (between 500 and 1000 m away from the site). Three pollen zones from the Late Pleistocene and Early Holocene were recognized in the Empalme Querandías sections (Fig. 4). The EQ4 zone occurs prior to 10 700 BP as well as the upper part of the Guerrero Member. The flora of the Late Pleistocene consisted of a psammophytic

steppe which suggests a subhumid–dry climate (Prieto, 1996). The EQ3 zone corresponds to the Early Holocene between 10 000 and 8000 BP. The flora (hydrophytic vegetation) in this zone corresponds to a lagoon or marshy depression environment suggesting a subhumid–humid climate. At around 8000 BP, the flora in the EQ2 zone was characterized by Gramineae, suggesting the establishment of extended humid grassland. Formation of a soil in this zone likely constitutes the final phase of a cycle initiated in the previous zone (Prieto, 1993, 1996). The palinological evidence obtained in the EQ3 and EQ2 zones represented a similar environmental condition as inferred by evidence from the Campo Laborde site.

Different studies on the faunal records from the Late Pleistocene and Early Holocene have been used to determine the paleoclimatic changes, more specifically, in the Tapalqué Creek basin and in the Pampean region (Bargo et al., 1986; Tonni, 1992; Tonni and Cione, 1995; Tonni et al., 1999). Prado and Alberdi (1999) mentioned that the interval between 28 000 and 13 000 BP is characterized by fauna adapted to cold and dry habitats (Fig. 4). The faunal association at the end of the Pleistocene (12 000–10 000 BP) suggests a temperate and semi-arid climate which become more humid around 10 000 BP (during the formation of the Puesto Callejón Viejo paleosol). From 9000 to 7000 BP, the faunal record of the area reveals a dry episode (Prado and Alberdi, 1999).

2.2. Lithic studies

Two formal tools, a flake and 128 microflakes were found in close association with the megafauna bones. Fine quartzite is the dominant raw material at 49%, followed by chert at 25%, and silicified dolostone at 17%. Other raw

		Malacological (Steffan, 2006)	Palinological (Prieto, 1996)	Isotopic (Bonadonna et al., 1995)	Faunal (Prado y Alberti, 1999)
6 ka	Early Holocene Río Salado Member	Dry		Temperate humid	Humid
		Humid event	Humid grassland		
8 ka	Early Holocene Río Salado Member	Marshy to lagoon environment	Sub-humid humid		Dry and cold
		Marshy environment		Dry	
10 ka	Paleosol Late Pleistocene Guerrero Member	Humidity dismition	Sub-humid dry	Temperate humid	Temperate humid
		Humid or poorly drained soils		Cold and dry	Temperate semiarid
12 ka					Cold and dry

Fig. 4. Paleoclimatic events during Late Pleistocene and Early Holocene in the Pampean region (the grey zone shows the locations of archaeological deposit).

materials such as quartz and unidentified rocks are represented in low percentages (less than 5%). Although all raw lithic material comes from the Tandilia mountain ranges (Fig. 1), the silicified dolostone and chert are local rocks, with outcrops in the Sierras Bayas located between 20 and 30 km from the site (Barros and Messineo, 2004, 2007). The quartzite is non-local and the nearest quarry is at a distance of 110 km (Flegenheimer et al., 1996).

Among the two quartzite tools found in close association with the megafauna bones (Fig. 5) one tool (FCS.CLA.33) is interpreted as the base (probably the stem) of a broken lanceolate bifacial projectile point, and the other (FCS.CLA.183) is a marginally retouched unifacial tool or side-scraper made from a flake. Technomorphological analysis indicates that microlithic debris represents the final

stages of tool production and the resharpening of cutting tools, which were carried out at Campo Laborde.

### 2.3. Archaeofaunistic and taphonomic analyses

At the Campo Laborde site, 99 542 bones (number of specimens (NSP)—sensu Grayson, 1991) were recovered. There were 98 796 which are undetermined since they are small fragments whereas 746 bones were classified anatomically and/or taxonomically (NISP). In addition, 135 small fragments (less than 1 cm) of undetermined eggshell were found. Several taxa were identified, including extinct megafauna and modern Pampean fauna (Table 1). Microfauna and mesofauna species are currently under analysis; therefore, they will not be included in this discussion.

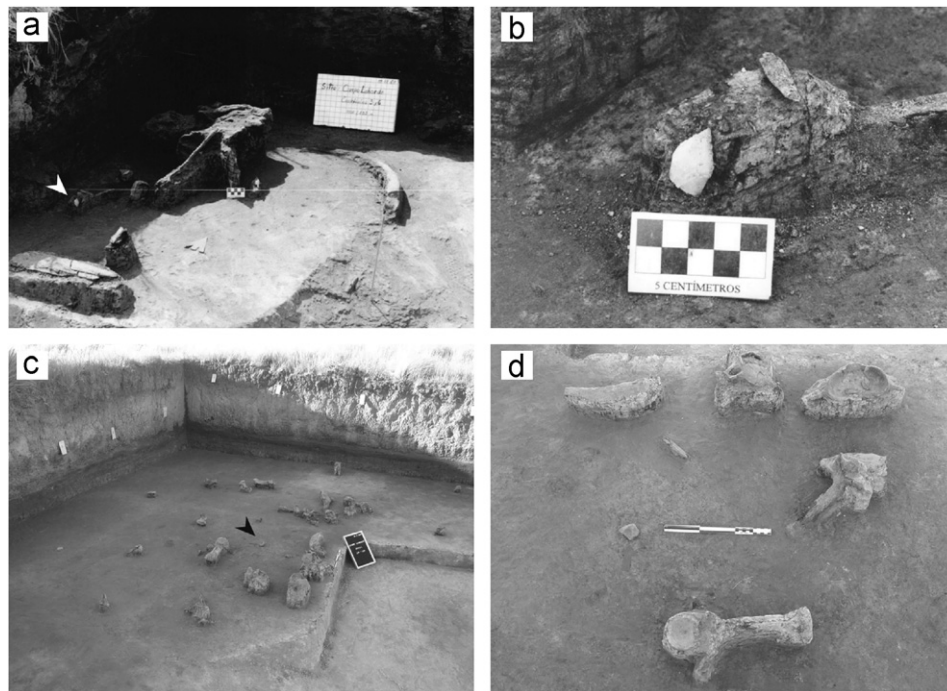


Fig. 5. Association between megamammal bones and lithics: (a) Base of projectile point associated with *Megatherium americanum* bones. (b) Close up of the base of projectile point. (c) Quartzite tool recovered during the third field work. (d) Close up showing the association between the tool and a *Megatherium americanum* vertebra.

Table 1  
Taxa represented in the Campo Laborde site

Clase	Family	Species	NISP	MNE	MNI
Megamammal	Megatheriidae	<i>Megatherium americanum</i>	108	79	1
	Glyptodontidae	<i>Neosclerocalyptus</i> sp.	1	1	1
Mammal		<i>Doedicurus</i> sp.	1	1	1
	Tayassuidae	<i>Tayassu</i> sp.	1	1	1
	Camelidae	–	5	5	1
Mesomammal	Chinchillidae	<i>Lagostomus maximus</i>	12	6	1
	Caviidae	<i>Dolichotis patagonum</i>	5	5	1
	Canidae	<i>Dusicyon</i> sp.	2	2	1
	Dasipodidae	<i>Chaetophractus villosus</i>	2	1	1
		<i>Zaedius pichiy</i>	8	5	1
Bird	Reidae	–	1	1	1

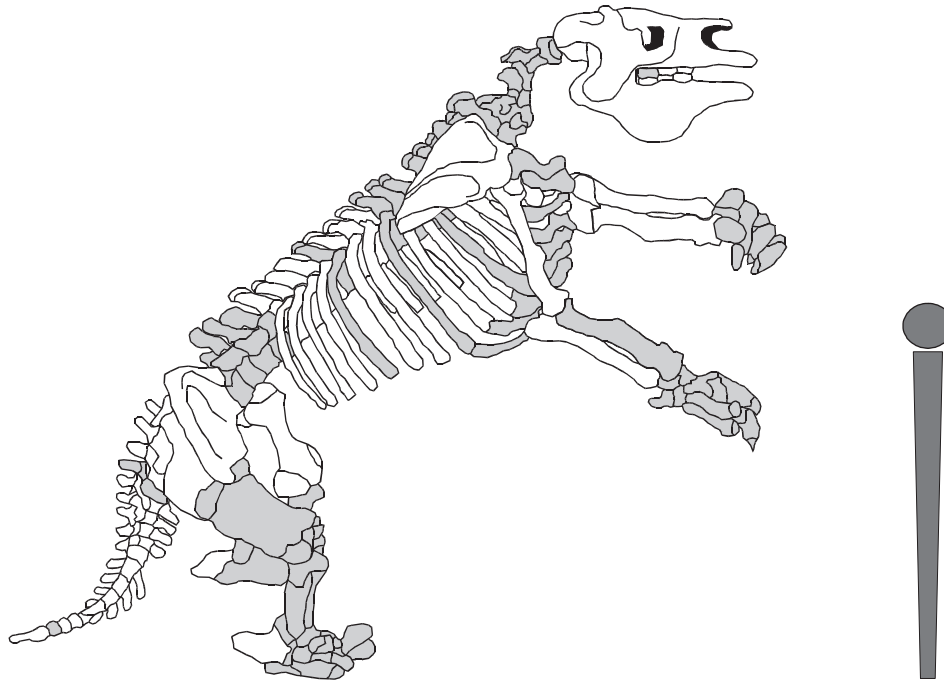


Fig. 6. Anatomical parts of *Megatherium americanum* bones found in Campo Laborde.

Remains from three extinct megafauna taxa were identified: giant ground sloth (*M. americanum* [Family Megatheriidae]), and two glyptodonts (*Neosclerocalyptus* sp. and *Doedicurus* sp. [Family Glyptodontidae]) (Table 1). The best represented species is the giant ground sloth (*M. americanum*) with 79 elements identified (NISP = 108). The anatomical parts recovered included axial elements such as ribs and vertebrae, and appendicular elements such as a femur, both tibias, a radius, metapodials, carpals, tarsals, and phalanges (Fig. 6). No cranial bones were found; only two pieces of teeth and four hyoid bones were recovered (see Table 2). Only one fragment of a distal epiphysis from a humerus from the *Neosclerocalyptus* sp. and a femur (shaft and distal end epiphysis) from *Doedicurus* sp. were recovered (Table 1). The analysis indicates that all of the megafauna species are represented by adult individuals (i.e., fused epiphysis). Fragments of dermal bones (NISP = 142) were also recovered in the deposit which were previously assigned to Mylodontidae (Messineo and Politis, 2007) based on the belief that only this family has this kind of dermal bones. However, recent studies indicate that the *M. americanum* might also have similar dermal bones (Alfredo Carlini, personal communication), and therefore this previous assumption has been reinterpreted.

The modern species are represented by a few bones: a tibia, a calcaneum, and three tarsal bones from Patagonian hare (*Dolichotis patagonum*), a maxilla, a mandible, a femur and some cranial bones from vizcacha (*Lagostomus maximus*), a radius-ulna from peccary (*Tayassu* sp.), a second phalanx from a bird (Rheidae), five bones from Camelidae (rib, patella, and carpals or tarsals), two teeth

Table 2

Anatomical parts recovered from the giant ground sloth (*Megatherium americanum*)

Anatomical category	Right	Left	Undeterminable/ axial
Teeth	–	–	1
Hyoids	1	1	2
Axis	–	–	1
Atlas	–	–	1
Cervical vertebrae	–	–	4
Thoracic vertebrae	–	–	6
Lumbar vertebrae	–	–	2
Caudal vertebrae	–	–	2
Rib	4	6	1
Sternabra	–	–	4
Radius	1	–	–
Metacarpal	3	1	1
Carpals	3	5	1
Forelimb phalanges	4	3	–
Innominate	–	–	2
Femur	1	–	–
Tibia	1	1	–
Patella	–	1	–
Tarsals	4	1	–
Metatarsal	1	1	–
Sesamoid	1	1	–
Hindlimb phalanges	1	1	–
Phalanges	2	2	–
Total	27	24	28

from an unidentified carnivore (probably *Dusicyon* sp.), and some plaques from *Chaetophractus villosus* (MNE = 1) and *Zaedyus pichiy* (MNE = 5). Each species, whether megafauna or modern, has a NMI = 1 (Table 1).

The taphonomic analyses were conducted on 86 appendicular and axial elements corresponding to megafauna bones with taxonomic identification and on 64 bone fragments larger than 5 cm from unidentified megafauna. The bone modification categories considered for the analysis were subaerial and chemical weathering, geological abrasion, chemical dissolution, root etching, carnivore and rodent activity, trampling, and cultural modification (see Methodology in Behrensmeyer, 1978; Haynes, 1980; Binford, 1981; Johnson, 1985, 2006; Lyman, 1994; Gutiérrez, 2004). The assemblage is dominated by weathering with different degrees of intensity (e.g., fibrous aspect in the bone's surface), which is related to subaerial and chemical weathering. Of the whole assemblage, 41% of the bone has an intense fibrous aspect, 28% has a moderate fibrous aspect, 17% has a light fibrous aspect, and only 13% is unmodified (e.g., these bones do not have any weathering).

Of the 46% of the bones, which have subaerial weathering (Fig. 7), 34% are categorized as having intense and moderate weathering. Some of the megafauna bones, which are located near the eroded unconformity, in the upper levels of archaeological deposit, show a different pattern of weathering in the upper section of the cortical surface (i.e., they exhibit exfoliation and extensive longitudinal desiccation cracks). This effect could be related to possible re-exposure (Fig. 8). A majority of the bones from the Campo Laborde assemblage show fracturing (59%), with at least 52% categorized as intense and moderate (Fig. 7). This effect is mainly found in the lower section of the bone cortical surface and is related to chemical weathering. Chemical dissolution is represented in low frequency (8%). The chemical weathering and dissolution on the bone assemblage would be related to the depositional environment (i.e., a water-saturated environment over a very long period of time with low drainage capacity and a high content of organic matter), which affected the bone surface.

Geological abrasion and carnivore activity are absent in the Campo Laborde assemblage. Root etching occurs in moderate frequency (41%) and all of the bones affected by root etching are categorized as slight. Root etching does not have a pattern and is isolated to the bone cortical surface. Rodent activity exhibits low frequency (8%) and only one fragment has evidence of trampling (0.9%). Inorganic calcium carbonate is represented in the assemblage at 86% (Fig. 7). Calcium carbonate is slightly

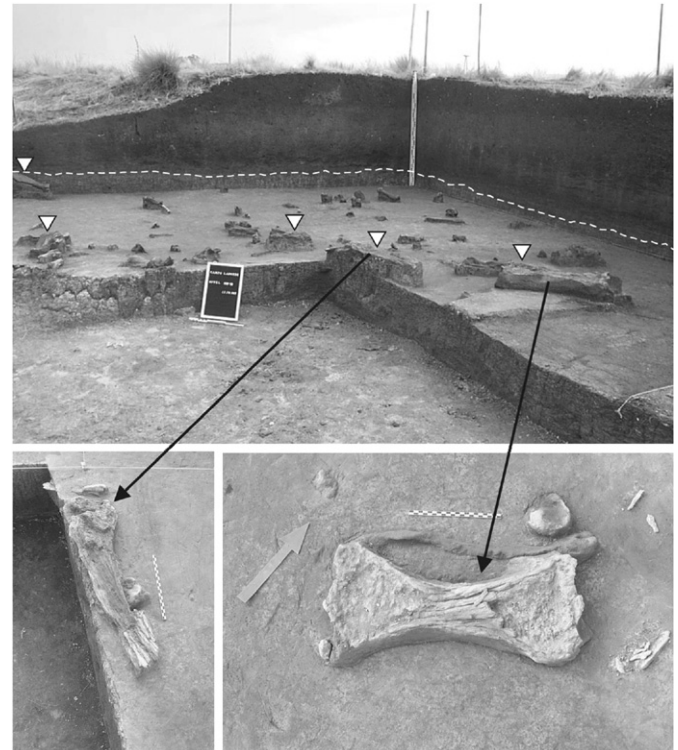


Fig. 8. Megamammal bones located near the erosive unconformity showing a possible bone re-exposition.

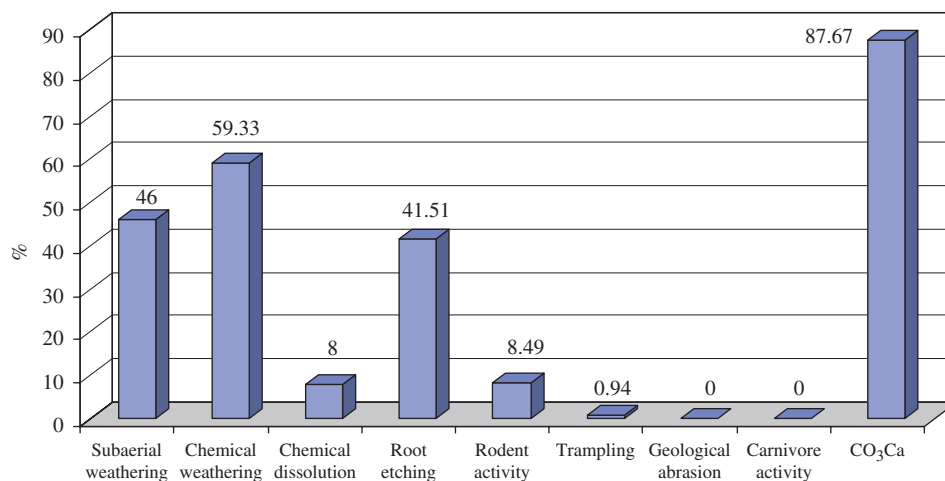


Fig. 7. Bone modification profiles for megamammal bones from the Campo Laborde site.

deposited on the cortical bone surface and in a few cases, on the interior of the trabecular tissue in broken bones.

The Campo Laborde assemblage exhibits low frequency of cultural modification, which is present on some bones of *M. americanum* and *D. patagonum*. These modifications are placed into different categories. First, a *M. americanum* rib (FCS.CLA.9) has sub-parallel cut marks in different parts

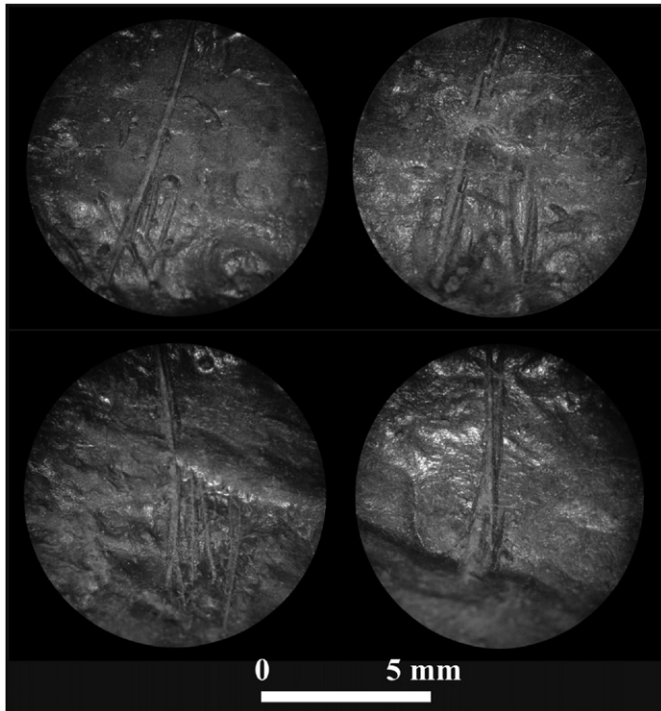


Fig. 9. *Megatherium americanum* rib with cut marks.

(Fig. 9) and a *D. patagonum* bone has cut marks in the shaft tibia (FCS.CLA.227). Second, while 80% of the megafauna bones are broken, the great majority of these (94%) are irregular fractures related to post-depositional process. However, one rib of *M. americanum* (FCS.CLA.179) has a helical fracture and four megafauna bones (FCS.CL.23, FCS.CLA.27, FCS.CLA.34, and FCS.CLA.100) are classified as helical fracture debris. In addition, three megafauna bone fragments (FCS.CLA.26, FCS.CLA.114, and FCS.CLA.1942) are probably flakes. Third, the left distal end of a *Megatherium* rib (FCS.CLA.47) and a bone fragment from an unidentified megafauna (FCS.CLA.184) are interpreted as informal bone tools. The first tool exhibits the fracture edge rounded and polished. The alteration is localized on a segment of the fracture edge with a differential polish. Adjoining segments of the fracture edge are unmodified (Fig. 10). The rest of the ribs (proximal and shaft parts) do not have edge modification (rounded and/or polish). A piece of this rib was sent to be AMS radiocarbon dated but could not be dated due to the lack of collagen. The edge of the second tool is rounded and polished with parallel striae and microflaking probably related to the use-wear. In addition, the shaft bone fragment has some negative flakes. Burnt bones were not present in the assemblage and the other species found do not show any evidence of human modification.

#### 2.4. Chronology

The chronology of the site has been controversial due to the great span of the  $^{14}\text{C}$  dates from megafauna bones (Table 3). Therefore, two other additional sources were

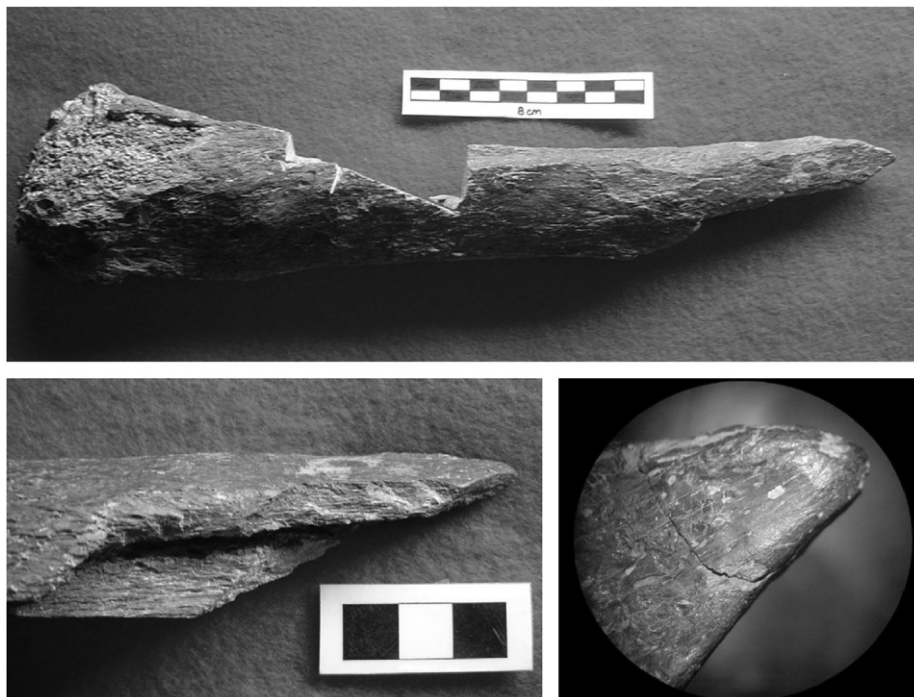


Fig. 10. *Megatherium americanum* rib interpreted as informal bone tool.

Table 3  
Radiocarbon dates from Campo Laborde site (calibrated ages  $1\sigma$  and  $2\sigma$ , Stuiver and Reimer, 1993)

Bone ID no	Laboratory no.	Depth from level 0	Sample	$^{14}\text{C}$ age (RCYBP)	Collagen %	Carbon %	Calibrated age ( $1\sigma$ )	Calibrated age ( $2\sigma$ )
FCS.CLA.1979	AA-71667	125	<i>Megatherium americanum</i>	$6740 \pm 480$	0.8	1.5	7157–8060	6545–8523
FCS.CLA.211	AA-71666	116.5	<i>Megatherium americanum</i>	$7630 \pm 460$	1.1	1.5	7999–9008	7611–9520
FCS.CLA.28	AA-55117	116.5	<i>Megatherium americanum</i>	$7750 \pm 250$	9	1.4	8361–8809	8039–9145
FCS.CLA.99	AA-55118	104.8	<i>Megatherium americanum</i>	$8080 \pm 200$	5.5	1.9	8703–9256	8537–9473
FCS.CLA.100	AA-55119	103	Megamammal undet	$8720 \pm 190$	0.4	21	9535–9934	9402–10,242
FCS.CLA.154	AA-71665	98	<i>Megatherium americanum</i>	$9730 \pm 290$	0.8	5.3	10,660–11,503	10,268–12,070

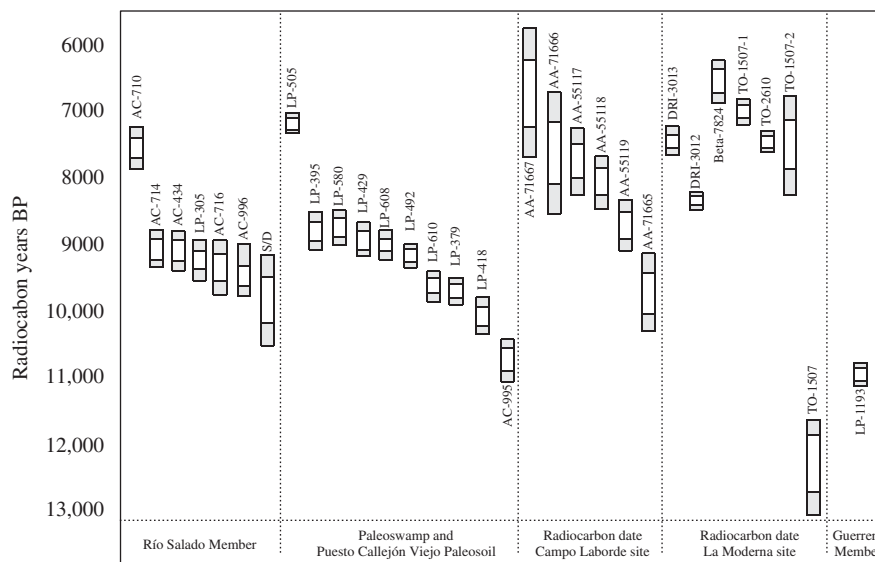


Fig. 11. Radiocarbon dates considered in this study ( $1\sigma$  and  $2\sigma$ ).

taken into account: local off-site radiocarbon dates obtained in the basin of the Tapalque Creek and OCR dates from a stratigraphic site column. Moreover, analysis of two organic sediment samples from the archaeological deposit is currently in process. Eleven samples of extinct megafauna bones were sent to the NSF-Arizona AMS Laboratory. Five samples of *M. americanum* did not have enough collagen, while six samples produced radiocarbon results with different ages.

Three radiocarbon ages were obtained from megafauna bones. Two radiocarbon ages from different ribs of *M. americanum* produced ages of  $7750 \pm 250$  BP (AA-55117) and  $8080 \pm 200$  BP (AA-55118). A third age was obtained from an unidentified megafauna bone which yielded an age of  $8720 \pm 190$  BP (AA-55119) (Table 3). Subsequently, three more radiocarbon ages were obtained from *M. americanum* bones. One of the bones, a metapodial, produced an age of  $9730 \pm 290$  BP (AA-71665). The second sample, a third metacarpal, yielded an age of  $7630 \pm 460$  BP (AA-71666) and the last age, a first phalange, gave an age of  $6740 \pm 480$  BP

(AA-71667) (Table 3; Fig. 11). Samples AA-55119, AA-71665, AA-71666, and AA-71667 did not have significant amounts of collagen (less than 1.1%). They also yielded low carbon percentages. Usual expected collagen yields are 2–20%. Bones that include less than this percentage of collagen are very poorly preserved and may not include original collagen or are probably highly contaminated (Stafford et al., 1987; Hedges and van Klinken, 1992; Cione et al., 2001). An additional problem reported by the laboratory is that in these samples, “collagen” appeared as sticky residue, rather than light, fluffy white material. With this low amount of collagen and very little of carbon when combusted, “it is difficult to say what in the samples is producing the date” (La Motta personal communication -11.13.07-). This situation would be the principal factor, which caused the great span in the radiocarbon dates. Based on these observations La Motta reported that “Unfortunately, it looks as this site does not have good collagen preservation, and better dates are unlikely” (personal communication -11.13.07-). For these reasons, all radiocarbon ages obtained should be

considered cautiously and the samples with better collagen preservation (AA-55117 = 7750 ± 250 BP and AA-55,118 = 8080 ± 200 BP) should be more reliable. These two dates also overlap better than the others and gave a weighted mean = 7974 ± 162 BP.

The second method used for estimating the chronology of the event was OCR dating. In the 2004, Douglas Frink visited the site and obtained 27 sedimentary samples from the stratigraphic profile to produce OCR dates. The OCR Carbon Dating procedure is an approach that measures site-specific rates of biodegradation of organic carbon, either as soil humic material or as charcoal. The effect of biochemical degradation is measured by the OCR<sub>DATE</sub>, a ratio of the total organic carbon to the readily oxidizable carbon in the soil (Frink, 1992, 1994). As a radiocarbon date estimates the soil horizons, the OCR date estimates represent a mean age (not an absolute age) of the carbon (Frink, 1995). Close interval sampling along a vertical soil column helps define the archaeological and temporal contexts of artifacts and associated features (Frink, 2003), and this procedure can serve as an approximation to determine the chronology of the deposit in which bones and lithic are found.

The sedimentary samples from which OCR dates were taken came from the north wall of the stratigraphic column of unit I-5 of the site (Fig. 12). The Guerrero Member was dated between 11 684 ± 351 and 13 147 ± 394 cal. BP. The archaeological context and the paleoswamp ranged between 9489 ± 285 and 11 377 ± 341 cal. BP, whereas the OCR dates obtained from paleosol 4Ab were between 9237 ± 277 and 9252 ± 278 cal. BP (Frink, 2005, personal communication).

The third source was the considerations of the 14C dates already available near the site. Different radiocarbon ages were obtained from the deposit of the Guerrero Member of the Lujan Formation in other profiles of the basin of Tapalqué Creek (Table 4). These ages indicate that this deposit dates between 21 940 ± 230 and 11 940 ± 80 BP

(bone). An age of 29 850 ± 1370 BP (LP-621) acquired on calcium carbonate was discarded because the sample has been contaminated by older carbonates (Carbonari et al., 1992; Bonadonna et al., 1995, 1999; Figini et al., 1995, 1998; Prieto, 1996; Tonni et al., 2003).

Seventeen radiocarbon ages based on mollusc shells, calcium carbonate, and total organic matter were obtained from the base of the Río Salado Member, the Puesto Callejón Viejo Paleosol and a paleoswamp, which correlates stratigraphically with the paleosol (Table 4; Fig. 11). Radiocarbon ages from the Río Salado Member from other profiles of the creek range between 10 750 ± 160 BP (at the base) and 7560 ± 160 BP (at the top), whereas the paleosol and the paleoswamp were placed chronologically between 10 070 ± 140 and 7180 ± 80 BP (González and Weiler, 1986; Bonadonna et al., 1995; Figini et al., 1995, 1998; Prieto, 1996; Tonni et al., 2001). The deposit of these sediments could be therefore dated to the Early Holocene (Fig. 11).

Although the disagreement in radiocarbon ages is far from being resolved due to poor collagen preservation in the megafauna bones, the group of ages obtained from the site roughly dates this component to the Early Holocene (ca. 9700–6750 BP), probably between 7750 and 8080 BP, and also correlates stratigraphically and chronologically to the different local geological units (Guerrero and Río Salado Member, Puesto Callejón Viejo paleosol) from Tapalqué Creek and with the OCR dates (although these dates are slightly older).

2.5. Site interpretation

The information presented above, allows evaluation of the contextual association between human activity and megafauna in the deposit as well as the site chronology and functionality of the site. The general bone modification profile (Fig. 7) indicates that the bone assemblage was affected by immediate environmental factors. The most common type of modification includes chemical and subaerial weathering. Chemical dissolution occurred in low frequency and the bones affected by root etching are categorized as being slightly modified. These effects are related to the microenvironment where bone was deposited, a poorly drained soil, and water saturation over a long period of time. Rodent activity had very little impact on modification of the bone assemblage. The lack of carnivore activity and trampling suggest very little disturbance of the bones when they were still exposed.

The Campo Laborde site is interpreted as an archaeological deposit formed by bone and lithics in primary association. This interpretation is based on the following evidence:

1. The close stratigraphic and spatial association of *M. americanum* bones and lithic artifacts and debris, which were deposited in a low energy environment (e.g., paleoswamp).

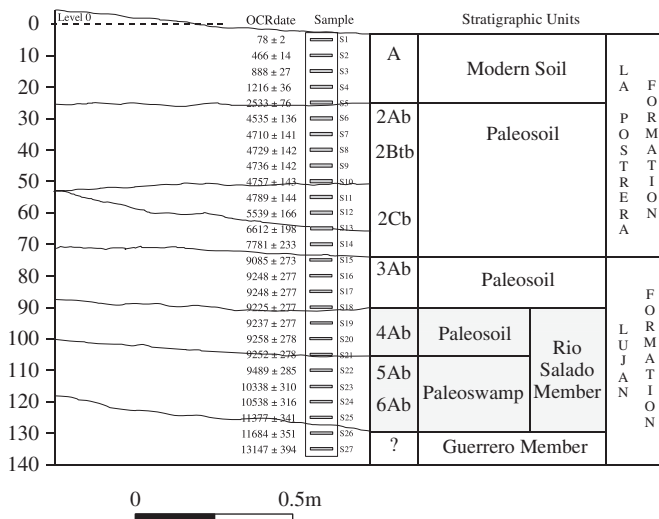


Fig. 12. OCR dates from the site.

Table 4  
Radiocarbon dates obtained from different stratigraphic units deposited for the Late Pleistocene and Early Holocene in the upper basin of Tapalqué Creek

Stratigraphic unit	Lab	Sample	<sup>14</sup> C (BP)	References
Río Salado	AC-710	Organic matter	7560 ± 160	González and Weiler (1986), Figini et al. (1995), Bonadonna et al. (1995), Prieto (1996)
	AC-714	Organic matter	9070 ± 140	
	AC-434	Organic matter	9100 ± 150	
	LP-305	Molluscan shell	9250 ± 140	
Member	AC-716	Organic matter	9330 ± 195	
	AC-996	Organic matter	9490 ± 150 <sup>a</sup>	
	S/D	Molluscan shells	9850 + 350–340	
	AC-995	Molluscan shells	10 750 ± 160 <sup>a</sup>	
Puesto Callejón	LP-505	Organic matter	7180 ± 80 <sup>b</sup>	Figini et al. (1995, 1998), Tonni et al. (2001)
	LP-580	Carbonates	8750 ± 130 <sup>b</sup>	
Viejo	LP-395	Molluscan shells	8810 ± 140 <sup>b</sup>	
	LP-492	Organic matter	9180 ± 90	
Paleosoil	LP-608	Organic matter	9020 ± 110 <sup>c</sup>	
	LP-610	Molluscan shells	9630 ± 110 <sup>c</sup>	
Paleoswamp	LP-429	Organic matter	8940 ± 130 <sup>d</sup>	Figini et al. (1995, 1998) Tonni et al. (2001)
	LP-379	Molluscan shells	9710 ± 110 <sup>d</sup>	
	LP-418	Carbonates	10 070 ± 140 <sup>d</sup>	
Miembro	LP-1193	Bone	11 940 ± 80	Carbonari et al. (1992), Figini et al. (1995), Bonadonna et al. (1995, 1999), Tonni et al. (2003)
	S/D	Molluscan shells	16 750 + 1500–1460 <sup>g</sup>	
	LP-955	Carbonates	17 020 ± 160	
	LP-272	Molluscan shells	17 680 ± 400	
	LP-296	Molluscan shells	18 280 ± 200	
	LP-292	Molluscan shells	18 600 ± 400	
	S/D	Molluscan shells	19 930 + 650–600	
Guerrero	LP-396	Molluscan shells	21 040 ± 450 <sup>e</sup>	
	LP-621	Carbonates	29 850 ± 1370 <sup>e,f</sup>	
	S/D	Molluscan shells	21 940 ± 230	
	S/D	Molluscan shells	21 940 ± 230	
Reservoir effect	LP-394	Molluscan shells	1100 ± 140	Figini et al. (1995)

<sup>a–c</sup>Samples coming from the same stratigraphic level.

<sup>f</sup>The age of sample is discarded because the dated calcium carbonate may have been influenced by older carbonates.

<sup>g</sup>Small size of the sample.

- The evidence of cut marks which are cultural and the dynamic impact on some giant ground sloth bones.
- The two informal tools made on giant ground sloth bones.
- The absence of significant disturbance or other post-depositional processes, which suggest that the deposit is *in situ*.

The analyses summarized above indicate that some bones of the *M. americanum* and *D. patagonum* show evidence of cut marks, which are probably related to processing activities. Five other bones exhibit helical fractures or are helical fracture debris. Finally, two bones of *M. americanum* are classified as informal tools, which have polish on the edge that has been interpreted as cultural. This faunal assemblage along with its contextual association with lithics, suggests that the Campo Laborde site is an archaeological site and

that humans were a central causal factor in the site formation.

Based on the evidence summarized above, Campo Laborde is interpreted as a giant ground sloth procurement site located on the border of an ancient swamp where megafauna were killed or scavenged and then butchered. The broken bifacial projectile point would be one of the hunting weapons. The microlithic debris was produced by the resharpening of cutting tools while the giant ground sloth was butchered. The wide representation of anatomical units, including axial and appendicular bones, suggests little transportation of bones outside the site. Given the size of giant ground sloth (body mass estimation ca. 6000 kg, sensu Fariña et al., 1998) and the amount of meat provided by only one animal, it is possible that only visceras and meat (after filleting) were transported from the butchering site to other human settlements. No evidence of *in situ* consumption was recorded, which logically corresponds

with the setting of the site which as the border of a swamp and which would not be a place typically occupied by more permanent human settlements or for a multiple activities camp. The contextual and taphonomic data suggest that the deposit is the result of a single event: the hunting or scavenging and the processing of a giant ground sloth rather than the accumulation of animal bones over time. Nevertheless, some bones could have been incorporated into the archaeological deposit as a result of natural causes. This could be the case for the few remains of *Neosclerocalyptus* sp., *Doedicurus* sp., and *Tayassu* sp.

The chronology of the deposit is still problematic, especially if the single event interpretation is considered as the most probable. Based on the stratigraphic position (a paleoswamp at the base of the Río Salado Member), the correlation with the chronology of the local stratigraphic units (the sequence of the Tapalque Creek dated between  $10\,750 \pm 160$  and  $7180 \pm 80$  BP), and the six radiocarbon ages from megafauna bone ( $9730 \pm 290$  to  $6740 \pm 480$  BP), it seems clear that the site dates to the Early Holocene (Fig. 11). However, the chronological span is too broad to match with a single event interpretation. This breadth would be explained basically through two main alternative hypotheses: (a) The main cluster (*Megatherium* bones associated with lithics) was deposited during a single event. Other bones (not dated yet) would have been incorporated into the deposit, but would not have significantly affected the assemblage. In this case, the range of the ages is the result of poor bone collagen content (a fairly common problem at early Pampean sites, see for example Cione et al., 2001; Martínez et al., 2004) and/or differential contamination of bones due to diagenetic processes. (b) The six ages are all correct and represent the death of each individual animal through time. Therefore, this deposit

would be attritional, consisting of several giant ground sloth carcasses from different periods.

The first possibility seems to be more probable now because different lines of evidence suggest that all bones from *Megatherium* belong to the same individual. This evidence includes (a) among 79 anatomical parts identified, there are no identical parts, a very unlikely situation if the deposit were attritional involving several individuals, (b) all bones are from the same ontogenetic age, all belong to an adult and all are fused, (c) all bones correspond to the same size of individual, in spite of the great variation in the size of *M. americanum* (see measures in De Iuliis, 1996; Brandoni, 2006). All bones indicated the same size when compared with the two complete skeletons of *M. americanum* (MLP-27.VII.1.1 and MLP 2-73) of the Museo de La Plata collection, (d) in spite of the fact that no bones have been found articulated, several anatomical correspondences have been observed: in the NW sector of the excavated area there was a concentration of bones from the right and left forelimbs (Fig. 13) and in the central part of the excavation most of the axial skeleton was present (Fig. 2), and (e) the *Megatherium* bones have the same taphonomic characteristics suggesting a similar taphonomic history for all of them. The most interesting example is the cracking of the bones, which is always in the lower section of the bone cortical surface and is related to chemical weathering. This means that the lower part of the bones were in contact with an environment saturated with water and the bones did not suffer any significant modification in their position.

All of this evidence suggests that the *M. americanum* bones correspond to a single individual and therefore, the possibility of an attritional cluster should be rejected. Accepting this, the chronological span of the  $^{14}\text{C}$  dates can

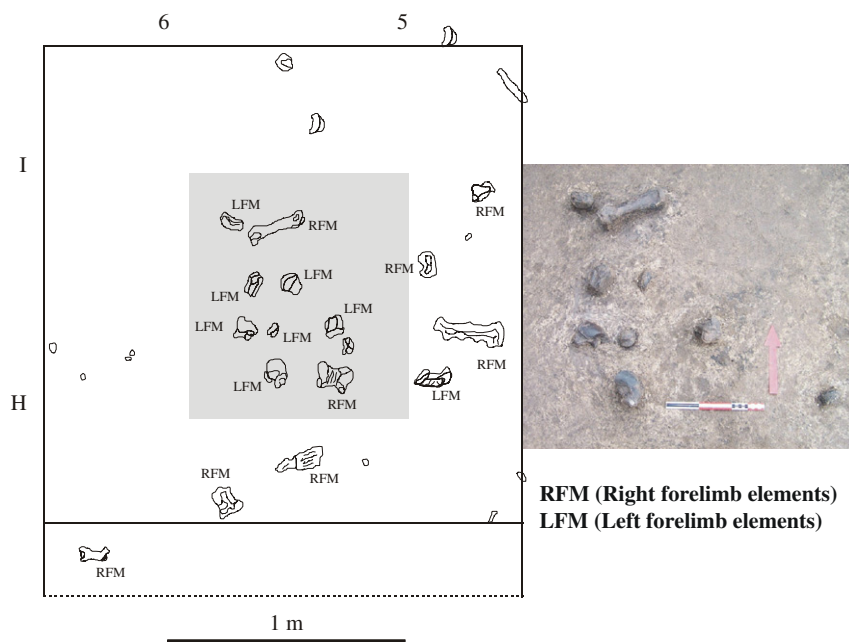


Fig. 13. Anatomical correspondences between *Megatherium americanum* bones.

be interpreted as the result of the low collagen content of the various bones. Combining the different sources of dating, the age of the *Megatherium* could be tentatively placed in the Early Holocene sometime between ca. 7500 and 9000 BP.

### 3. Discussion

The information presented above is germane to the discussion on survival of some species of megafauna into the Early Holocene, extinctions of Pleistocene megafauna, and human strategies for faunal exploitation during the Late Pleistocene and Early Holocene in the Pampas. Other sites in the Pampean grassland, dated between ca. 12 000 and 7500 BP also provide relevant data to approach these issues from a regional perspective. Evidence from the Campo Laborde site as well as data from other sites suggest that the Pampean grasslands were one of the environments where the Pleistocene megafauna survived into the Holocene.

The survival of Pleistocene megafauna in the Pampas into the Holocene has been proposed previously based on the information generated from the archaeological sites of La Moderna and Arroyo Seco 2 (Politis and Beukens, 1991; Politis et al., 1995; Politis and Gutiérrez, 1998), both located in the Interserrana Area in the eastern Pampas (see Gutiérrez and Martínez, 2007, Fig. 1). A date of 4300 BP for a caparace of glyptodon (*Glyptodon clavipes*) reported by Rossello et al. (1999) was considered unsupported (Cione et al., 2001).

La Moderna, an open-air site located on the banks of the Azul Creek, was the first archaeological site from the Pampean region where a stratigraphic association between lithic artifacts and extinct faunal remains was confirmed (Palanca et al., 1972, 1973; Palanca and Politis, 1979). The lower component of this site was also located in a paleoswamp which is a transition between the Guerrero and the Río Salado Members (Zetti et al., 1972). La Moderna is also interpreted as a procurement site, where during a single event, a *Doedicurus clavicaudatus* (Glyptodontidae) was butchered at the edge of an ancient swamp (Palanca et al., 1972, 1973; Politis, 1984; Politis and Gutiérrez, 1998; Politis et al., 2003). In order to carry out this activity, expedient tools of crystalline quartz (a raw material that is located a few kilometres away from the site) and some curated tools of quartzite and chert (Fig. 1) were used for butchering (Politis and Olmo, 1986; Politis and Gutiérrez, 1998). A few bones from other glyptodonts such as *Neosclerocalytus* sp. (formerly named *Sclerocalytus*) and *Glyptodon* sp., were also recovered in the same sediments but no traces of human exploitation were observed on these bones.

The chronology of this event has always been problematic and controversial. For these reasons, multiple samples have been run on *Doedicurus* bone collagen and organic sediment samples. The first dating result was a standard age processed by Beta Analytic and yielded an

age considered to be too young:  $6550 \pm 160$  BP (Politis, 1984). A second age of  $12\,350 \pm 370$  BP was obtained by AMS from the ISOTRACE Lab. However, two additional samples from the same bone sample from the same laboratory with a more appropriate pre-treatment, yielded ages of  $7010 \pm 100$  and  $7510 \pm 370$  BP (Beukens, 1992). Finally, a radiocarbon sample from another bone fragment gave a result close to these ages ( $7460 \pm 80$  BP). More recently, two organic samples were taken from the lithostratigraphic unit (a') where the Lower component is located. Sample C-MQ8-1 came from sediments with a high content of organic matter (a buried A-horizon) that was located directly above the archaeological unit and yielded an age of  $8356 \pm 65$  BP. Sample C-MQ8-2 came from sediments associated with the archaeological material and yielded an age of  $7448 \pm 109$  BP (Politis et al., 2003). These results correspond with the estimated age for the deposit based on radiocarbon ages (considering the 12 350 BP age as an outlier). As a consequence, this series of ages proposed a chronology for the lower component of La Moderna to be established between 7000 and 7500 BP, and supports the survival of Pleistocene megafauna into the Early Holocene (Politis et al., 1995; Politis and Gutiérrez, 1998; Politis et al., 2003).

Arroyo Seco 2 presents the most exceptional evidence related to the study of the extinct megafauna (Fidalgo et al., 1986; Politis et al., 1995; Gutiérrez, 2004). This multi-component, open-air site is located between a low ridge of loess and a small stream, Arroyo Seco. Arroyo Seco 2 has an early component containing a lithic assemblage composed of unifacial, marginally retouched tools associated with bone remains of guanaco (camelid), Pampean deer, and nine extinct megafauna: *Paleolama*, *Equus*, *Hippidion*, *Toxodon*, *Megatherium*, *Eutatus*, *Glossotherium*, *Macrauchenia*, and *Glyptodon* (Politis, 1984; Fidalgo et al., 1986; Gutiérrez, 2004). The preponderance of guanaco bones within this assemblage indicates that it was exploited as a main resource. Additionally, three extinct species found in the early component show evidence of human exploitation: *Equus*, *Hippidion*, and *M. americanum* (see Discussion in Gutiérrez, 2004). The lower component of Arroyo Seco 2 is interpreted to be the result of several human occupations at the end of the Pleistocene without a clear vertical resolution. The span of  $^{14}\text{C}$  ages on megafauna bones is interpreted to be the result of two main factors: site reoccupation and differential bone contamination due to diagenetic processes. Two additional factors, possibly of secondary nature, might also be involved: non-cultural mixing of bones due to biological and geomorphological processes and discrepancies between labs in the pretreatment of the dating samples.

In the late 1980s and early 1990s, three radiocarbon ages from bone collagen of extinct horse (*Equus [Amerhippus] neogeus*) and giant ground sloth (*M. americanum*) yielded Early Holocene ages:  $8890 \pm 90$  BP (TO-1504),  $8470 \pm 240$  BP (LP-53), and  $7320 \pm 50$  BP (TO-1506) (Politis and Beukens, 1991; Politis et al., 1995). However, 11 new AMS

ages on megafauna bones from Arroyo Seco 2 run at different radiocarbon laboratories yielded an age range between  $10\,500 \pm 90$  and  $12\,240 \pm 110$  BP (Gutiérrez et al., 2000; Politis and Gutiérrez 2007; Steele and Politis). Among these, three new results were particularly significant as they were obtained on the same *M. americanum* bone sample previously dated to  $7320 \pm 50$  BP. These new results do not confirm the Early Holocene age of the sample, placing it at the end of the Pleistocene:  $12\,200 \pm 170$  BP (CAMS-58182),  $12\,155 \pm 70$  BP (Oxa-10387), and  $11\,770 \pm 120$  BP (AA-62514) (Steele and Politis). Therefore, the 7320 BP age should now be rejected and the age of 8470 BP previously obtained on a separate specimen of *Megatherium* of the site must now be considered suspect. The age of 8890 BP from *Equus* was not replicated either. Three ages, from separate bone samples of this species also gave Late Pleistocene ages:  $11\,320 \pm 110$  BP (AA-39365),  $11\,250 \pm 105$  BP (AA-7965), and  $11\,000 \pm 100$  BP (OxA-4590). The revision of all megafauna bone dates from Arroyo Seco 2 led to the conclusion that the dated assemblages contains at least four extinct species and at least three different events: one involving *Megatherium* at ca. 12 100 BP, a second with *Toxodon* at ca. 11 750 BP, and a third involving *Equus* at ca. 11 200 BP (Steele and Politis). As a consequence, the new group of radiocarbon ages from Arroyo Seco 2 does not appear to support a Holocene fauna survival in the site as was proposed previously.

In spite of the rejection of Arroyo Seco 2 as a strong evidence of the extinct megafauna survival in the Pampean region, the information obtained from Campo Laborde and La Moderna indicate that both sites represent the use of swamps during the Early Holocene for hunting/scavenging and butchering of at least two extinct genera: giant ground sloth (*M. americanum*) and glyptodon (*D. clavicaudatus*). This conclusion led to the discussion about the causes of the extinctions as well as the survival of some species.

The evidence from Campo Laborde and La Moderna can be used to test some of the models related to Pleistocene extinctions. Based on information summarized in this paper and in many other reviewed papers (see Politis et al., 1995; Miotti and Salemme, 1999; Politis and Madrid, 2001; Martínez and Gutiérrez, 2004; Martínez et al., 2004; Politis et al., 2004; Gutiérrez and Martínez, 2007) it has been shown that the “last appearance dates” (LADs, see Steadman et al., 2005) of Pleistocene megafauna is significantly younger than the early date of human arrival in the region. In the Pampas, there is evidence of human activity at Arroyo Seco 2 as early as ca. 12 200 BP and evidence at various other sites dates between 11 000 and 10 000 BP (Martínez and Gutiérrez, 2004; Politis et al., 2004; Gutiérrez and Martínez, 2007). This means that there is a chronological overlap of 3000–4000 years, when humans and several megafauna species coexisted in the Pampas. This observation rejects the “overkill hypothesis” and confirms (contra Steadman et al., 2005) that giant ground sloth survived several millennia in the Pampas after

humans arrived (see other evidence in the Americas in Hubbe et al., 2007).

The survival of some Pleistocene species in the Early Holocene in the Pampas would be the result of different factors. First, a broad spectrum of resources were exploited by humans in the Pampean region and in the context of a generalized regional economy, it focused on terrestrial mammals (Martínez and Gutiérrez, 2004; Gutiérrez and Martínez, 2007). Some extinct species like giant ground sloth and glyptodon were exploited resources in this generalized subsistence pattern (Politis et al., 2004). This implies that there would not be significant hunting pressure on these megafauna population, as has been proposed in North America with mammoth. Other factors that would have facilitated the survival of some megafauna were the low density of human population as the archaeological studies suggest (Politis and Madrid, 2001). Third, some species, such as the glyptodonts, would not have been a “first choice” due to the intrinsic difficulties they present for butchering (the rigid and thick carapace). *Neosclerocalyptus* has been found in the Early Holocene deposits in both sites (La Moderna and Campo Laborde) indicating that this genus was inhabiting this environment, although no traces of human exploitation have been yet recorded in any early site in the Pampas (see Politis et al., 2003). Finally, the particular environmental characteristics of the region, which is an extensive plain with abundant grasses capable of supporting a great density of large herbivorous animals even in the Late Glacial, would transform the Pampas into a “resource pocket” where megafauna found better conditions for living during the Late Pleistocene through the Early Holocene. However, eight values of  $\delta^{13}\text{C}$  (collagen) obtained from megamammal bones from Arroyo Seco 2 and Campo Laborde sites, suggest that some important changes might have occurred in the plant preference of the giant ground sloth and/or in the grassland composition. Arroyo Seco 2's values for giant ground sloth, ground sloth and American horse (*M. americanum*, *Glossotherium robustum* and *Equus (Amerhippus)* sp.) ( $N = 3$ ; range from  $-20.1\text{‰}$  to  $-23.5\text{‰}$ ; mean =  $-21.3\text{‰}$ ) indicate a diet based on C3 plant species consumption. Five results of  $\delta^{13}\text{C}$  (range from  $-18.7\text{‰}$  to  $-19\text{‰}$ ; mean =  $-18.9\text{‰}$ ) from Campo Laborde site indicate that giant ground sloth (*M. americanum*) also consumed C3 plants, but these  $\delta^{13}\text{C}$  values are enriched when compared to Late Pleistocene samples from Arroyo Seco 2, suggesting temporal variations in plant availability (Politis et al., 2006). This topic is currently being studied.

To sum up, the ages generated in these investigations point out that the extinction process in the Pampean region cannot be explained with the Blitzkrieg Model proposed by Martin (1984) and supported by Alroy (2001), and Haynes (2006), because of a long overlap between human presence and megafauna survival as indicated by the Campo Laborde and La Moderna evidence. It does not support either a process of overkill, meaning that human precipitated extinction by causing death rate to exceed birth

rate with the process taking 1500 years or more (Barnosky et al., 2004, p. 1). The Late Pleistocene megafauna (36 species distributed in 18 genera) and the large fauna (46 species distributed in 30 genera) extinction must be associated with the pronounced climatic changes during the Late Pleistocene and with new ecological relationships between fauna and humans during this period and the Early Holocene (Cione et al., 2003; Barnosky et al., 2004; Koch and Barnosky, 2006). It seems that most of the species, which became extinct in South America in the Late Pleistocene were not affected by human hunting pressure or by alterations induced by human presence (see Discussion in Politis et al., 1995). In addition, in the Pampas many of the 36 extinct Late Pleistocene species distributed in 28 genera of mega and large mammals probably were already extinct when humans arrived. A similar situation has been proposed for Patagonia (Borrero, 1997). However, as the Pampean data show some of these genera (basically *Megatherium*, *Equus*, *Doedicurus*, and *Eutatus*) were exploited by people, probably with a low level of predation, over several millennia. More high-resolution information is needed to evaluate the role of humans in this process and to identify which genera were more greatly affected. The Pampean region seems to be an optimal place to test the extant models.

#### 4. Conclusions

1. The Campo Laborde site is the consequence of one event of the hunting/scavenging of a giant ground sloth, which occurred in a paleoswamp in the Early Holocene, sometimes between ca. 9000 and 7.500 years BP.
2. The Campo Laborde site is similar to the La Moderna site, only 40 km apart, a site, which was interpreted as a glyptodont (*D. clavicaudatus*) procurement site. Both sites occurred in Early Holocene paleoswamps and shared several traits, which would indicate a common pattern in the strategies for exploiting megafauna.
3. The previously published evidence for the Holocene survival of *Megatherium* and *Equus* from the Arroyo Seco 2 site (Politis and Beukens, 1991; Politis et al., 1995) were not confirmed with new analysis and therefore should be now rejected (Steele and Politis).
4. Based on the La Moderna and Campo Laborde faunal assemblages, stratigraphic position and chronology, one can conclude that at least three Pleistocene megamammals genera survived in the Pampas until Early Holocene times: *Megatherium*, *Doedicurus*, and *Neosclerocalyptus*. While the first two species were exploited by humans, no evidence of hunting or scavenging has been yet recorded for *Neosclerocalyptus*.
5. The Holocene survivals of at least three genera of megafauna do not support the blitzkrieg or the overkill models. On the contrary, the information provided by the Pampean grasslands sites hold up the co-existence of humans and extinct megafauna for several millennia and generate a picture where hunters were oriented toward a

broad range economy. The “LAD” of at least three megafauna do not coincide with the first evidence of human presence which in the Pampas is ca. 12 200 BP, producing a minimum overlap of 4000 years. This supports the models which see the South American Pleistocene extinctions as a result of a combination of climatic/environmental changes and anthropogenic causes, with strong regional variations (among many others Politis et al., 1995, 2004; Borrero, 1997; Cione et al., 2003; Barnosky et al., 2004; Koch and Barnosky, 2006).

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