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LATE PLEISTOCENE GEOARCHAEOLOGY OF THE SOUTHERN PAMPAS, BUENOS AIRES PROVINCE, ARGENTINA

ABSTRACT: The southern Pampas of Buenos Aires comprises three main environmental units: the Tandilia and the Ventania ranges and the Pampa Interserrana. Several late Pleistocene sites are located either in quartzite rockshelters or nearby to rock outcrops in the Tandilia range whereas few sites were found in fluvial settings of the Pampa Interserrana and none have been reported in the Ventania range so far. These early human groups occupied the region during the late Glacial; most of the radiocarbon ages are comprised between the 11,000 and 10,000 ^{14}C yr interval BP. Paleogeographically, the region extended eastward because the sea-level was about 100–120 m below the present one. The variable reliability of the radiocarbon dates along with the low stratigraphic resolution of the archaeological records, do not permit a precise reconstruction of the environmental and climatic conditions of that time interval. Pedogenesis and the biota substantially modified the records and played major roles as site formation processes. To date, the strategy of prospecting the late Pleistocene sites can be oriented by the landscape reconstruction of the southern Pampas.

KEY WORDS: Geoarcheology – Late Pleistocene – Early Holocene – Southern Pampas – Argentina – Paleoclimates – Paleosols

INTRODUCTION

In Argentina, the collaboration between Earth scientists and archaeologists has got a long tradition of almost a century. For many decades, geological information was used either as a complementary description of archaeological sites or it provided a general framework to discuss the chronology of human occupation. In the early 80s the application of the ecological systemic paradigm (Politis 1988) contributed to intensify the interaction between archaeologists, paleontologists and geologists resulting in numerous interdisciplinary projects (Zárate, Prieto 1996). The archaeological interest was then addressed to issues barely explored before; in this way, site formation processes, technological properties and source areas of raw materials along with the chronology of cultural episodes, past climates and environmental reconstruction, became major goals of the archaeological research. Consequently, several papers have appeared in the last 15 years dealing with these topics that require the use of geological methods in archaeology.

At present, the evolution of the archaeology – geology interaction is in transit between an advanced stage of multidisciplinary approach and interdisciplinary approach represented by geoarchaeology, a discipline still in an early phase of development (Zárate, Prieto 1996). However, geoarchaeology has now been going through a remarkable expansion as it is illustrated by a growing number of contributions. Very recently, several papers dealing with geoarchaeology have been presented at the XIIth Argentine

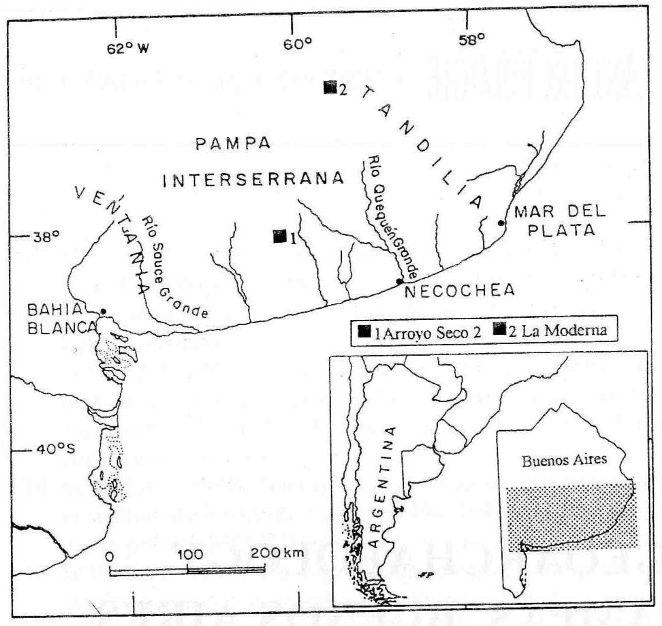

FIGURE 1. Location map of the region under analysis.

Archaeological Congress, mainly by young researchers, a promising indication of the expansion (Blasi, Zárate, in print).

Nevertheless, in spite of this outstanding growth, geoarchaeological research still faces several methodological problems. In the first place, archaeological interpretation of recovered geological information has not been fully elaborated, in part because the archaeological goals of numerous studies under progress are not always clearly defined. Second, the lack of academic training in interdisciplinary projects, makes the discussion among team members of a research program rather confusing. Technical terms, either archaeological or geological, are not known or they are barely understood, which results misinterpretations and deficient consensus on specific debates. Third, the detailed scale of work needed in archaeology, "the archaeological scale", is not used by Earth scientists. Geologists, in particular, are usually trained in regional or continental scale investigations and geological intervals of thousands to millions of years, but rarely in episodes and changes ranging from hundreds of years to several years which are mere instants in terms of geological time.

Last but not least, Quaternary history of an enormous extension of Argentina remains barely studied, particularly with the detailed reconstruction and chronology needed for the time span of human occupation that covers the Late Glacial and the Holocene. This is by far the most common drawback for many archaeological investigations which have been conducted in areas where the Quaternary record was not studied at all. Among other difficulties presented, the use of a hierarchical scale approach to correlate the site stratigraphy with the local and regional stratigraphies is impeded. Thus, the Earth scientist involved in these studies cannot always place the human episodes into a temporal and spatial context.

This situation is very common in the extra-andean Patagonia along with the central-western and the northern regions of Argentina. The southern Pampas of Buenos Aires province shows an important difference (*Figure 1*). Here, the late Quaternary history has been studied by paleontologists, palynologists, geologists and pedologists who have also focused their attention on some archaeological sites. Hence, a great deal of background information was generated that is indispensable for the understanding of the human history.

Because of this particular circumstance, I will analyse, as a case study, the geoarchaeology of the southern Pampas of Buenos Aires province. The main goal is to discuss the site formation processes, the landscape variability and the chronology of the early human occupation in order to understand the resolution of the archaeological record. Subsequently, I will consider the exploration in search of late Pleistocene sites by means of stratigraphy and the landscape reconstruction of the southern Pampas.

THE SOUTHERN PAMPAS CASE STUDY

General characteristics

The region comprises two low mountain systems (Tandilia and Ventania) and a gently rolling plain in between known as Pampa Interserrana or Llanura Interserrana (*Figure 1*). The climate is temperate and humid-subhumid grading to drier conditions southward and westernward. The original vegetation consists of a grassland now deeply modified by intensive agriculture.

The Tandilia range, where several late Pleistocene sites have been found, is composed of groups of buttes, mesas and bornhardts disconnected by fluvial erosion along fracture lines which stand at altitudes between 50 to almost 300 meters above the surrounding plain. This low mountain system consists of an igneous-metamorphic Precambrian complex overlain by a sedimentary cover of late Precambrian sedimentary rocks (quartzites, limestones) and mainly Early Paleozoic quartzites. The ranges offer not only easily accessible natural shelters but good quality raw material (fine grained quartzites, chalcedony) for lithic manufacturing (Flegenheimer *et al.* 1996) and abundant natural resources. The late Pleistocene sites so far discovered are either located in rockshelters formed in the Paleozoic quartzites or they are open air sites either overlying these rock outcrops or very close to them.

The Ventania range is composed of folded sedimentary rocks, mainly quartzites of Paleozoic age; the mountain system is a continuous chain about 150 km long with some peaks over 1000 m asl.; mean elevations range from 200 to 600 m above the surrounding plain. Although natural resources are very abundant, no late Pleistocene sites have been reported so far.

The Pampa Interserrana is a gently undulating plain with some small and scattered rock outcrops. The area is dissected by fluvial systems that mostly drain the Tandilia

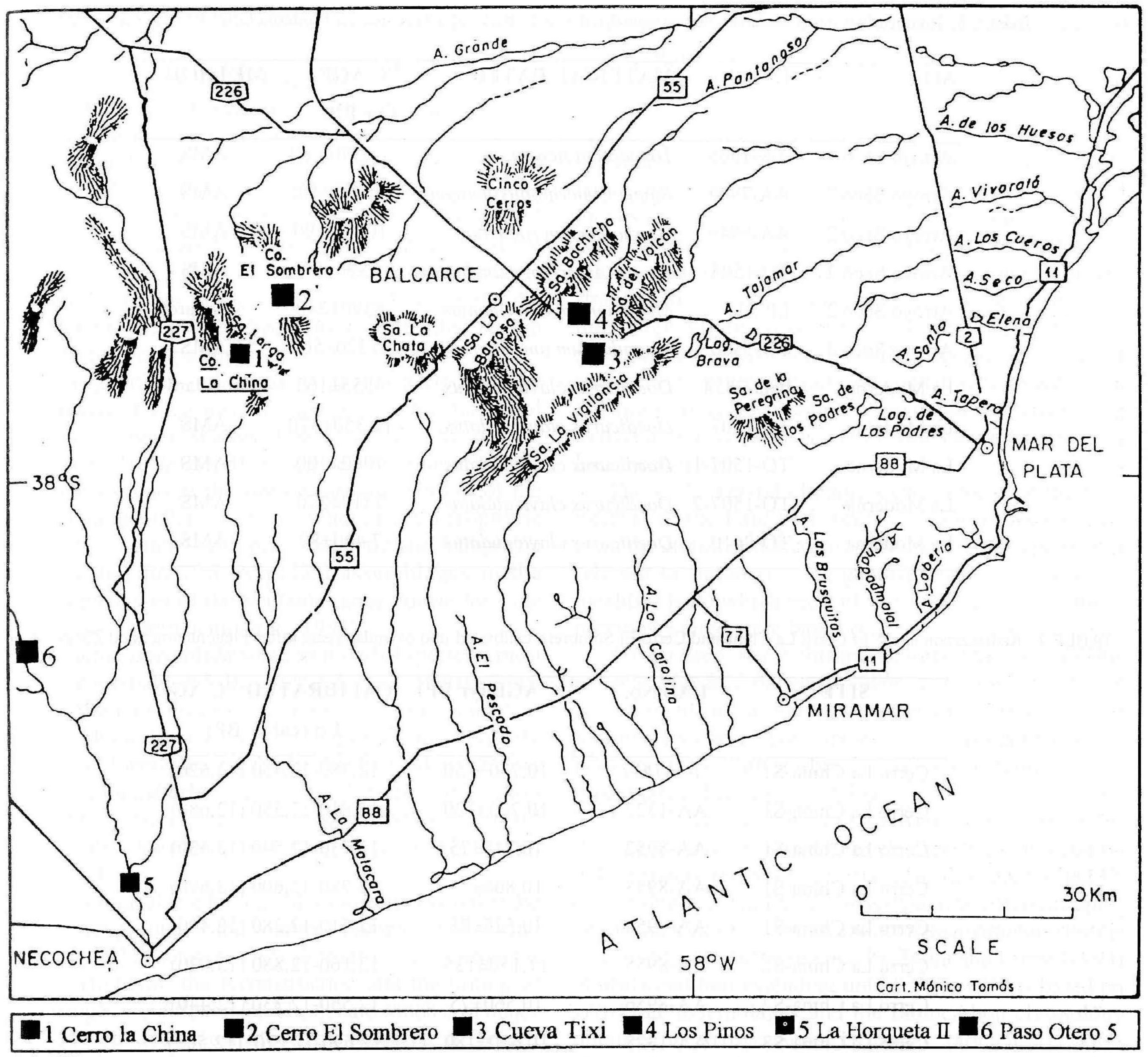

FIGURE 2. Location map of archaeological sites and localities cited in the text.

and the Ventania ranges and flow to the Atlantic ocean. An eolian apron of Late Pleistocene-early Holocene age with an average thickness of about 2 meters covers the landscape; the topmost section of these eolian materials has been modified by the Holocene pedogenesis whereas the uppermost 30 cm of the topsoil has been disturbed by plowing and tillage. In this area, the two Late Pleistocene-early Holocene archaeological sites reported are located in fluvial environments.

Environmental scenario during the Late Pleistocene human occupation

During the Full Glacial and the Late Glacial, prior to the arrival of the first human groups, the stratigraphic record testifies the occurrence of several eolian episodes interval that covered the area with a blanket of fine sands, loessial sands and sandy loess (Zárate, Blasi 1993) while alluvial aggradation mainly consisted of these eolian materials redeposited by the streams in the floodplains (Zárate 1997). Hence, it is inferred that water availability was very reduced and only concentrated in the major collectors of the fluvial system.

Paleogeographically, during the interval under analysis, the southern Pampas covered a much bigger area since the Atlantic shoreline was located 160 to 200 km eastward from its present position when sea-level was about 120–100 meters below the present sea-level.

Unpublished results indicate that the lowest sections of the alluvial sequences which may have been deposited prior to and partly during the Full Glacial, show coarser grain sizes corresponding to sandy facies and sedimentary structures revealing deposition by fluvial agents. Coarser

TABLE 1. Radiocarbon dates made on megamammal remains from Arroyo Seco and La Moderna (after Politis *et al.* 1995).

SITE	LAB. No	MATERIAL DATED	^{14}C AGE (yr BP)	METHOD
Arroyo Seco 2	AA-7965	*Toxodon platensis*	11,590± 90	AMS
Arroyo Seco 2	AA-7964	*Equus (Amerhippus)neogeus*	11,250±105	AMS
Arroyo Seco 2	AA-9049	*Glossotherium robustum*	10,500±90	AMS
Arroyo Seco 2	TO-1504	*Equus (Amerhippus)neogeus*	8890±90	AMS
Arroyo Seco 2	LP-53	*Megatherium americanum*	8390±240	standard
Arroyo Seco 2	TO-1506	*Megatherium americanum*	7320±50	AMS
La Moderna	beta-7824	*Doedicurus clavicaudatus*	6555±160	standard
La Moderna	TO-1507	*Doedicurus clavicaudatus*	12,350±370	AMS
La Moderna	TO-1507-1	*Doedicurus clavicaudatus*	7010±100	AMS
La Moderna	TO-1507-2	*Doedicurus clavicaudatus*	7510±370	AMS
La Moderna	TO-2610	*Doedicurus clavicaudatus*	7,460±80	AMS

TABLE 2 . Radiocarbon ages* of Cerro La China and Cerro El Sombrero calibrated into calendar years (after Flegenheimer and Zárate, in print).

SITE	LAB No.	^{14}C AGE (yr BP)	CALIBRATED ^{14}C AGE 1 σ (cal yr BP)
Cerro La China-S1	I-12741	10,730±150	12,780-12,450 (12,620)
Cerro La China-S1	AA-1327	10,790±120	12,810-12,550 (12,680)
Cerro La China-S1	AA-8952	10,745±75	12,730-12,540 (12,630)
Cerro La China-S1	AA-8953	10,804±75	12,780-12,600 (12,690)
Cerro La China-S1	AA-8954	10,525±75	12,510-12,280 (12,400)
Cerro La China-S2	AA-8955	11,150±135	13,160-12,880 (13,020)
Cerro La China-S2	AA-8956	10,560±75	12,550-12,330 (12,440)
Cerro La China-S3	AA-1328	10,610±180	12,690-12,270 (12,500)
Co El Sombrero-A1	AA-4765	10,725±90	12,720-12,500 (12,620)
Co El Sombrero-A1	AA-4766	10,270±85	12,210-11,765 (12,025)
Co El Sombrero-A1	AA-4767	10,675±110	12,690-12,430 (12,560)
Co El Sombrero-A1	AA-5220	10,480±70	12,460-12,220 (12,349)
Co El Sombrero-A1	AA-5221	8060±140	9140-8580 (8950)

* radiocarbon ages made on charcoal particles

grain sizes are also reported from the lowermost sections of the eolian blanket (Zárate, Blasi 1991). Vertebrate assemblages recovered from the lower alluvial sandy facies suggests more humid conditions while those of the upper alluvial sandy facies indicate drier and cooler conditions (Prado *et al.* 1987). No pollen analysis has been performed at these levels.

The environmental change from the Full Glacial to the Late Glacial conditions remains speculative due to the poor chronological control and insufficient sedimentological analysis. Stratigraphically, the uppermost sections of the alluvial and eolian sequences which are composed of finer deposits (increasing amount of coarse silt) are tentatively assigned to the Late Glacial.

The peopling of the southern Pampas started when the sandy silt eolian deposition was under progress. Most of these sites yielded ages ranging from 11,000 to 10,000 ^{14}C yr BP (*Tables 1, 2*). During this time interval, the eolian sedimentation rate notoriously decreased and landscape stability conditions started in the region (Zárate1996a). The late Pleistocene shoreline was still at around 100 meters below present sea-level (Schnack *et al.* in prep.); consequently, in terms of the paleogeography, there seem to be no remarkable changes in relation to the Full Glacial. Potentially, the Late Pleistocene groups had a much extended region available for occupation.

The vegetation and fauna from this period can be reconstructed in their general aspects from palynological and paleontological studies. The pollen records indicate that prior to 10,500 yr BP, a herbaceous psammophytic vegetation existed at the northwestern piedmont of the Tandilia range (Prieto 1996) whereas, a xerophytic woodland associated with psammophytic and halophytic steppe is documented by pollen assemblages in the southern piedmont of the Ventania range during the Late Pleistocene (Quattrocchio *et al.* 1993).

The faunal assemblage was composed of species typical of the Patagonian and the central district of Argentina. Besides, the Late Pleistocene/ Early Holocene transition is marked by a decrease in the frequency and diversity of grazing forms, particularly the Cervidae, and an increase of megaherbivore grazers of more than one ton of weight. These changes are interpreted as the result of a climatic deterioration (Prado *et al.* 1987, Tonni, Cione 1994).

The geological and biological indicators reveal that the early human groups of the southern Pampas lived during an interval characterized by dramatic environmental changes. However, the reconstruction and the timing of these changes is controversial. The debate which is of major relevance in archaeology, involves two different interpretations.

First, at Cerro La China locality, rather more humid conditions are interpreted after 10,600 ^{14}C BP when the early occupation occurred (Zárate, Flegenheimer 1991). This environmental change is supported by pollen analysis. Prior to 10,500 ^{14}C BP, a subhumid-dry climate is interpreted whereas a vegetation shift, characteristic of pond, swamps and floodplains or towards environments with locally more effective moisture, occurred *ca* 10,500 yr BP, suggesting a subhumid-humid climate (Prieto 1996).

On the other hand, based on vertebrate paleontological evidence, Tonni and Cione (1994) considered that the arid conditions existed until 8,500 ^{14}C yr BP, extending the terminal Pleistocene extinction until this age.

Very likely, the main source of disagreement is not based on the indicators themselves but rather on the radiocarbon chronology and scale resolution of the stratigraphic sections used in each case as it is discussed below.

Assessment of radiocarbon chronology and temporal stratigraphic resolution

The deficient calibration control and the spatial and temporal scale approaches used to interpret the environmental changes are by far the most remarkable drawbacks experienced when the late Glacial and the early Holocene are analyzed. Also important is to point out that factors such as the geomorphological settings of the studied sites, the diversity of environmental conditions within the region, the nature of the ^{14}C dates obtained, and the stratigraphic resolution of the sedimentary sequences, were not often taken into consideration in the general reconstructions. Instead, and partly because of the lack of sufficient studies, the results obtained in settings with local conditions have been regionally extrapolated, conducting to oversimplified models within which the interpretations have been framed.

The controversial climatic explanations for the time interval of the Late Pleistocene – Early Holocene arise from the aforementioned circumstances. At this point, it is relevant to summarize the general characteristics of the localities from which most of the climatic interpretations previously cited were based on.

Arroyo Seco, site 2: this multicomponent open-air site, under study since the early 1980p, is located in a fluvial environment of the Pampa Interserrana (*Figure 1*). The sedimentary context is composed of aeolian material where pedogenic calcium carbonate of two different cycles precipitated (Figini *et al.* 1984).

The earliest component of Arroyo Seco includes Pleistocene and modern mammals in physical association with artifacts and several burial episodes represented by eleven single and multiple burials found at different depths below the levels containing extinct megamammals (Politis *et al.* 1995).The interpretation by Tonni and Cione (1994) of arid condition extending until 8,500 yr BP is based on vertebrate assemblages and the radiocarbon chronology obtained at Arroyo Seco. However, radiocarbon dates obtained later which were made on extinct megammal bones from the early component of Arroyo Seco yielded ages ranging from 11,590 to 7320 yr BP (*Table 1*), (Politis *et al.* 1995). As a result of the wide range of ages obtained, these authors pointed out that new radiocarbon samples were in process in order to check the validity of the Early Holocene dates.

Cerro La China locality: this locality, situated in the Tandilia range (*Figure 2*), comprises a quartzite rockshelter and its surrounding area and two other open air sites close to the quartzite outcrops. The Late Pleistocene lower component, consisting of lithic artifacts, small charcoal particles and some bone fragments, is stratigraphically located in a Bt horizon of a truncated soil profile. The soil formation which started after the human occupation ca 10,600 yr BP, suggests a landscape stability interval and a rather humid regime which may have existed at the time of the Holocene marine transgression. No evidence of an Early Holocene arid phase has been recorded at this site until ca 4500 yr BP (Zárate, Flegenheimer 1991).

Later studies at other nearby localities both in the Tandilia range and Pampa Interserrana also support the Cerro La China interpretation.

At *Abrigo 1 Cerro El Sombrero,* a quartzite rockshelter located 15 km away from Cerro La China locality (*Figure 2*), environmental conditions during the Late Pleistocene human occupation has been interpreted as relatively humid based upon the presence of several slabs produced by chemical weathering (Flegenheimer *et al.* ms).

At *La Horqueta II locality,* situated in the valley of the Rio Quequén Grande in the Pampa Interserrana, the floodplain environment was already stabilized prior to or ca 10,000 ^{14}C yr BP. This is indicated by the development of a soil profile on top of the Late Pleistocene sandy silt faces. No radiocarbon ages have been obtained to calibrate the initiation of this soil forming interval which is tentatively placed between 11,000 and 10,000 ^{14}C yr BP. An apparently sudden change towards much more humid conditions or higher water availability is recorded around 9,000 ^{14}C yr BP when small lakes and ponds were formed in the floodplains (Zárate *et al.* 1995, Zárate *et al.* in print). A comparable radiocarbon date made on organic matter was reported from a swampy deposit situated at the same stratigraphic position of this buried soil at the locality of Salto de Piedra in Arroyo Tapalqué (Bonadonna *et al.* 1995).

Reliability of the ^{14}C dates

A potential difficulty not fully evaluated so far is the reliability of radiocarbon dates in each environment. Lately, a reservoir effect of nearly 1,100±300 yr has been mentioned for freshwater mollusk shells recovered from an alluvial sequence at the northern piedmont of the Tandilia range causing older ages (Figini *et al.* 1995). The headwaters of the fluvial systems, draining the northwestern area of the range, flow over a Precambrian bedrock composed of calcareous rocks. The discharge of these streams comes from groundwaters circulating through the calcareous rocks. Hence, as a working hypothesis, it is possible to consider that the reservoir effect and the abundant calcium carbonate found in the Holocene alluvial sequences of these fluvial systems have their sources in the Precambrian calcareous bedrock. This may also explain the predominantly slight alkaline conditions of several floodplain environments, as la Horqueta, which favour the preservation of bones and shells. At La Moderna (*Figure 1*), a Glyptodon kill site in a fluvial setting, the radiocarbon dates of an extinct megamammal yielded ages between 12,350 and 6555 yr BP (*Table 1*). In this case, the younger date may have been rejuvenated by the freshwater table which could have introduced some contaminants (Politis *et al.*1995).

Many of the sites are in relatively shallow settings within the range of the present pedogenesis, so the archaeological organic materials may also be affected by rejuvenation due to the rainwater infiltration, it has been as also pointed out by Figini *et al.* (1984) at Arroyo Seco 2. Bones seem to be particularly vulnerable to these potential source of rejuvenation yielding a wide age range, as it has been reported by Politis *et al.* (1995).

No sources of contamination have been reported for the charcoal particles dated at Cerro El Sombrero and Cerro La China. Although rejuvenation may be possible due to the humic acids and the present roots, this has not been proven yet.

In summary, the radiocarbon ages made on different materials (e.g. bones, charcoal, shells) are not strictly comparable. Hence, the ages should be cautiously evaluated for each case.

The calibration into calendar years

The calibration into calendar years has implications not only for the time of the southern Pampas peopling but also when the climatic conditions that existed during the human occupations are considered in detail. To illustrate the different perspective obtained, the time span of human occupation is extended from 1000 to more than 2000 yrs when the radiocarbon dates of Cerro La China and Cerro El Sombrero, mostly ranging from 11,000 to 10,000 ^{14}C yr BP, are calibrated (*Table 2*), (Flegenheimer, Zárate, in print).

In addition, the estimated rate of climatic change based on the calibrated chronology was not as fast and perhaps not as simple as it has previously been thought. What seemed to be a simple reconstruction of environmental conditions suggesting more humid conditions at the end of the Pleistocene, may actually represent an average situation that masks different conditions and does not permit to chronologically discriminate minor climatic episodes.

The stratigraphic resolution of most of the Late Pleistocene archaeological sites is markedly weakened by pedogenesis and particularly bioturbation which masked and reorganized the original characteristics of the sedimentary units. If short events had taken place, they may either have been not strong enough to generate a recognizable record in the studied sequences, or they may have been obliterated by postdepositional modifications.

As previously discussed, current environmental interpretations differ in *ca* 2000–3000 ^{14}C yr in relation to the transition from the Late Glacial to the Holocene conditions, encompassing specifically the time of the Late Pleistocene human occupations. Then, when exactly did the beginning of the more humid conditions occur. In general terms, we have been able to reconstruct major climatic trends by independent indicators, but not with the precision needed for archaeological purposes.

Site formation processes

The stratigraphic levels where Late Pleistocene remains are found have been usually modified by soil formation, considered to be one of the most important postdepositional

processes that generates transformation in the archaeological record (Flegenheimer, Zárate 1993). Archaeological remains are within pedological horizons where clay illuviation, leaching or precipitation of calcium carbonate and alternating oxidation and reduction conditions take place. Thus, the preservation potential of cultural remains is mainly governed by soil forming processes.

In relation to the regional environmental setting, oxidation dominates in the surficial environment; only seasonally, waterlogging may affect the archaeological records of some localities due to the rise of the freshwater table or perched watertables.

Under these general conditions, the preservation of macrobotanical remains is not facilitated and no records are reported from Late Pleistocene sites. The survival of pollen grains in the Pampean soils and sediments are not well understood; generally, under dominant alkaline conditions, pollen is normally absent or very poorly preserved; however, at some stratigraphic levels under the same conditions, pollen may be well preserved and abundant (Prieto 1997) another frequent plant remains are phytolithes, sometimes abundant where pollen is absent, but they have not been studied.

Faunal remains are much more common in numerous archaeological sites probably due to the dominance of alkaline conditions which favour their preservation. At Cerro La China, the absence of well preserved bone remains was attributed to the alternation of oxidization and reduction conditions (Zárate, Flegenheimer 1991).

In relation to the pattern showed by archaeological remains, generally not found to form living floors but layers 10 cm thick or more, it was interpreted as either the result of multiple occupation events or of postdepositional transformations (Flegenheimer, Zárate 1993), with the latter supported by sites in actively evolving soil profiles. The biota as a soil forming factor, plays a key function in the disturbance of the archaeological record. Recent observations in present soil surfaces permit to evaluate the prominent role played by the soil invertebrate bioturbation in postburial disturbance (Zárate *et al.* 1997) along with the fossorial vertebrate fauna (Politis, Madrid 1988). Plant roots are also inferred to take part in the archaeological record disturbance but their specific role and the way they modify the contexts have not been investigated.

Another important site formation process rarely identified in archaeological sites is erosion (Flegenheimer, Zárate 1993). It is part by because the field identification of erosion surfaces, buried A horizons and truncated soil profiles rises controversies among geologists whose criteria of field description and interpretation differ. The stratigraphic intervals including the topmost section of a paleosol are either described as transitional limits between stratigraphic units or truncated profiles if a sharp boundary is observed. Generally, erosion is normally assumed to have acted wherever a sharp boundary separates two different lithological layers. This creates not only confusion but unreliable stratigraphic contexts interpreting the archaeological records.

Prospecting Late Pleistocene archaeological sites

As few Late Pleistocene sites have been discovered so far, an important future step is to intensify the exploration and survey of the area. The search of the sites reported did not follow particular geological indicators except for very general clues. To date, the much refined and better comprehension attained of the regional and local stratigraphic contexts, is now potentially fruitful in the search of Late Pleistocene sites. In this way, the strategy of prospecting can be guided by the landscape reconstruction of southern Pampas.

On the stable interfluvial environments of the Pampa Interserrana, where pedogenesis has been the dominant process since the end of the Pleistocene, Late Pleistocene sites, if present, could be stratigraphically located in the middle or lower sections of the present soil profiles (Bt horizons, upper C horizons). A strong biased archaeological record is expected in this surface setting, since pedogenesis must have destroyed the Late Pleistocene organic cultural remains. Moreover, the preservation potential of organic remains at the present pampean soils is very poor, and very much unlikely for organic material older than the Late Holocene (Zárate *et al.* 1997). Only lithic artifacts could have been recovered. From a chronological viewpoint, radiocarbon dates should be interpreted as minimum ages since these are sedimentary contexts of age rejuvenation. In other words, the recognition of cultural features of Late Pleistocene sites would be extremely problematic unless very diagnostic artifacts were found.

The fluvial settings of the Pampa Interserrana shows a better potential for finding buried archaeological sites because in these environments the alluvial sedimentation rates were higher during the Holocene; also, stratigraphic resolution is greater than in the eolian sequences of the interfluves. Here, the search for Late Pleistocene sites can be oriented by the buried soil profile developed on top of the Late Pleistocene sandy silt facies. This paleosol is a stratigraphic marker that can be traced along the floodplains of many fluvial pampean valleys and would indicate the transition from the Late Glacial to the Early Holocene conditions. An early site (Paso Otero 5 locality) was very recently reported at the alluvial sequence of the Rio Quequén Grande (*Figure 2*). In this site, extinct megamammal remains have been recovered along with lithic artifacts from a "transitional layer"(the buried soil profile?) between the *Lujanense* (Late Pleistocene sandy silt facies) and the *Platense* (Holocene) deposits (Martínez 1997).

For prospecting purposes, it is also noteworthy to mention the occurrence of a paleotopography in the fluvial valley of Rio Quequén Grande. This is revealed by the lateral changes of altitude and morphology of the buried paleosol, suggesting a gently undulating Late Pleistocene landscape with a relative relief of about 2 meters. Laterally the paleosol grades into a surface soil overlain by recent alluvial deposits. If archaeological remains were found in this latter context, a biased record more similar to what has been deduced for the interfluvial surfaces should be expected. This paleotopography does not seem to be an exclusive feature of the Quequén Grande fluvial valley. Previous studies (Quattrocchio *et al.* 1988) and unpublished results (Zárate 1996b) seem to indicate their occurrence in some other southern pampean valleys.

In the Tandilia range, although each rockshelter shows particular characteristics resulting in unique local facies, a general stratigraphic sequence has been recognized in which early archaeological assemblages have been found. The presence of a truncated paleosol represented by a strong developed Bt horizon of Late Pleistocene age prior to the Late Glacial Maximum (Zárate *et al.* 1993) is the stratigraphic marker below which no archaeological remains are found. Archaeological remains are located within eolian sediments modified by pedogenesis either in Bt horizons (Cerro La China) or A horizons as in Cerro El Sombrero-cima (at the summit of the hill) where the archaeological remains are mainly within the first 20 cm of a very shallow soil on top of quartzite outcrops.

Some other Late Pleistocene sites (Cueva Tixi, Abrigo Los Pinos) have been reported at about 25 km south-east of Cerro El Sombrero (*Figure 2*) (Mazzanti 1994, 1997). Cueva Tixi is a small quartzite cave where the first human occupation was radiocarbon dated to 10,375 ± 90 and 10,045 ± 95 yr BP. At Abrigo Los Pinos, a quartzite rockshelter situated 5 km away from Cueva Tixi, the lower component presents a Fell's Cave point in association with numerous artifacts and 6 hearths from which charcoal was radiocarbon dated to 9,570 yr ± 120 BP (Mazzanti 1997).

In the Ventania range, the absence of Late Pleistocene sites can be attributed to the rather exiguous exploration performed in the area, because no evidences suggest the occurrence of environmental conditions which precluded human occupation of the ranges during the Late Glacial. On the contrary, the ranges are source of abundant natural resources. Besides, the stratigraphic sequence of the eolian and colluvial deposits and the fluvial settings is comparable to Tandilia, so the stratigraphic markers may also guide the searching for Late Pleistocene sites in that area.

CONCLUSIONS

In the southern Pampas of Buenos Aires, archaeology has remarkably contributed to our present understanding of the last 14,000 years. The interaction between geologists and archaeologists has resulted in the development of geoarchaeology which has an enormous potential of expansion. Argentina future research should be focused on the reliability of ^{14}C dates, a problem that severely hinders our comprehension of the Late Pleistocene chronology, and the record of short-term climatic fluctuations, not detected in the sequences due to the low stratigraphic resolution.

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