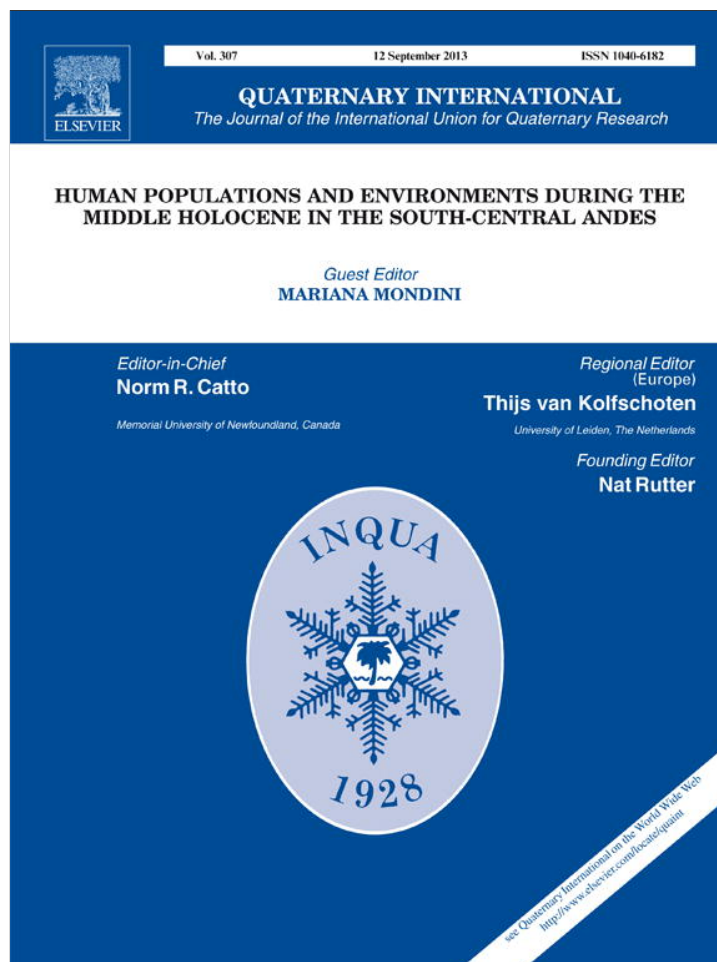


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Environmental instability in western Tinogasta (Catamarca) during the Mid-Holocene and its relation to the regional cultural development

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ABSTRACT

The survey of natural profiles comprising thin interspersed volcanic and peat banks along different ecological zones and altitudinal levels in western Tinogasta (Catamarca Province, Argentina) provides an insight into the natural environmental conditions for the past human activities in these areas. The geological analysis integrated to the archaeological data allows the proposal of climatic fluctuations, explosive volcanism and, probably recurrent, seismic activity influencing the low and null occupation intensity of the highlands and lowlands, respectively, during the Mid-Holocene (8000–4000 BP). These conditions generated unstable environments that prevented the continuous and sustained occupation of the ecological zone of the Chaschuil Valley highlands (3500–4000 m asl), and hindered the occupation of the lowlands in the mesothermal valleys of the Fiambalá region (1400–2400 m asl). The products of explosive volcanism caused changes in topography which, along with other factors, had different impacts on the productive populations occupying the region since the first century AD.

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1. Introduction

The Chaschuil-Abaucán Archaeological Project (PACH-A) took up the challenge of understanding how human behavior was reflected in material culture and its distribution by integrating several lines of research, intertwining archaeology, history, physicochemical and natural sciences (Ratto, 2007). The Archaeological Project Chaschuil-Abaucán (PACH-A) is a generic name given to several projects that, over the past years, have been funded by academic and scientific institutions (Universidad Nacional de Catamarca, Universidad de Buenos Aires, Agencia Nacional de Promoción Científica y Tecnológica, among others), directed by Dr. Norma Ratto.

The investigations were focused on more than one period of time, because social dynamics can only be grasped through a theoretical and methodological approach accounting for the processes of change and the acting mechanisms in order to know which practices were maintained and which ones transformed or lost.

A landscape approach is suitable to understand 10,000 years of regional history of hunting and productive societies. This approach enables the expression of the past of pre-Hispanic populations and the evaluation of their dynamic and interdependent relations with the physical, social and cultural dimensions of the environment through time and space.

From this perspective, landscape has a particular dynamic where each community and generation imposes its own cognitive map of an anthropogenic world linked by morphology, planning and coherent meaning (Criado Boado, 1999; Ingold, 2000; among others). In this sense, socio-historical contexts followed one another and were transformed through time creating a multiplicity of landscapes where competition, negotiation and agreement mechanisms were activated to favour interests, impose symbolic systems and/or enhance social cohesion. However, all these practices were developed within a physical environment that must not be ignored but integrated into the process of construction of a dynamic landscape, articulated with the different space dimensions (physical, social and symbolic).

In this context, the low density of occupation in the highlands of western Tinogasta (Catamarca) in the Archaic (*ca.* 10,000–3000 BP) stands out. Contemporaneously, the same happened in the lowlands of the mesothermal valley of Fiambalá or Bolsón de Fiambalá (1400–2400 m asl). This situation is ascribed to climate

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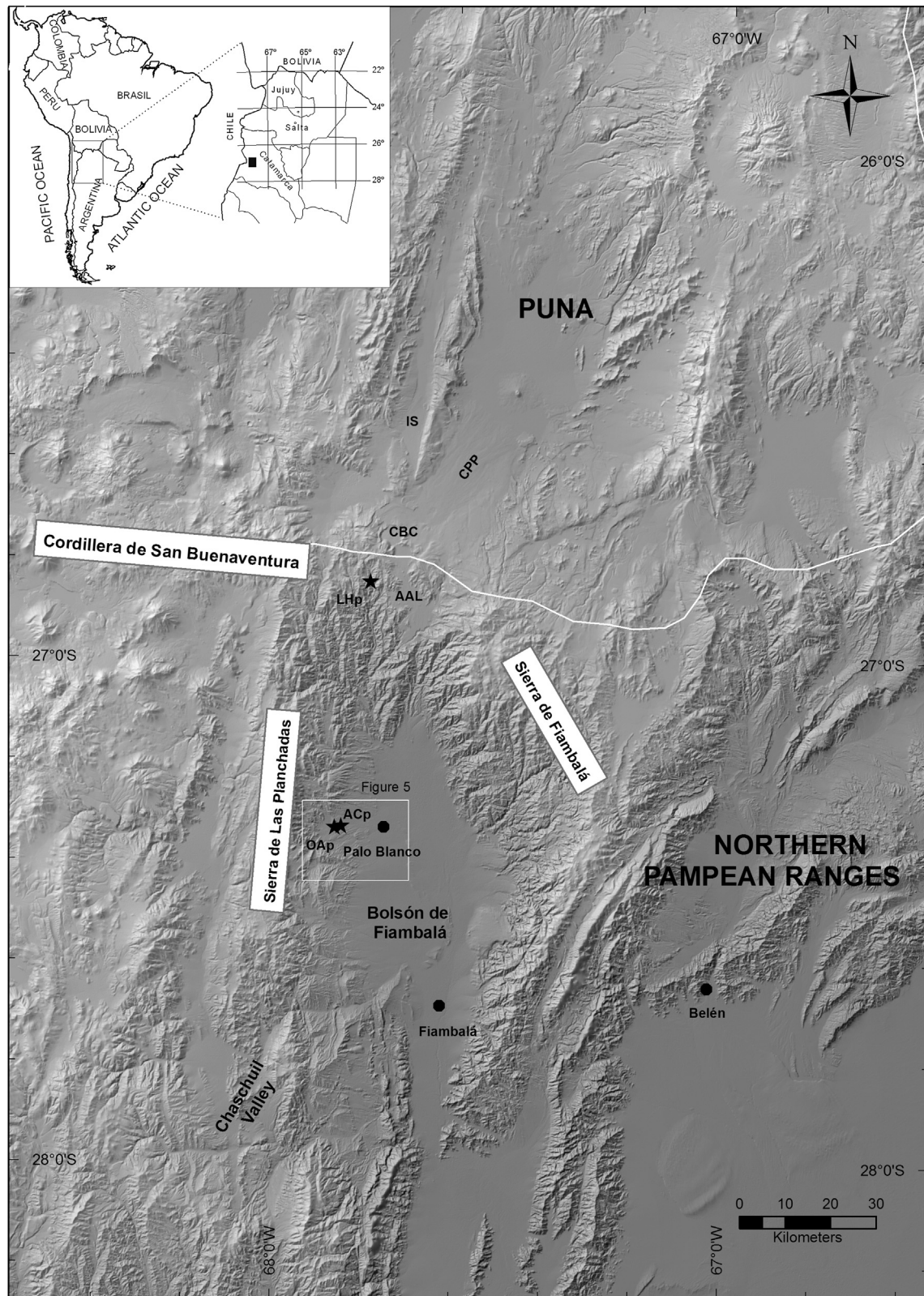


Fig. 1. SRM 90 m image of the Puna region, the Bolsón de Fiambalá and the Chaschuil Valley, forming the study area. The location of the calderas of Cerro Blanco (southern Puna) and the mapped profiles are shown. AAL: Aguada Alumbreira Lake; ACp: Agua de la Cañada profile; CBC: Cerro Blanco calderas; CPP: Campo de la Piedra Pómez; IS: Incahuasi Salar; LHp: La Hoyada profile; OAp: Ojo de Agua profile; PL: Purulla Lake.

changes and a catastrophic explosive event of the Cerro Blanco Volcanic Complex (Cordillera de San Buenaventura, Southern Puna) (Fig. 1), probably combined with seismic movements. The volcanic event had a regional extent and occurred after 5500 BP, although volcanic activity was regular since 12,000 BP (see further description in Section 4.1).

Therefore, the objective is to present and discuss: (i) how this explosive volcanic event modified the physical landscape in the Mid-Holocene, creating an unstable environment for the hunter-gatherer populations of the Archaic; and (ii) the way the volcanic explosive products, along with other agents, influenced later landscape modifications that impacted on other regional histories, particularly of those productive populations occupying these spaces from the first century.

Different records are presented of natural profiles rich in both organic (peat) and volcanic material, interbedded in thin layers or banks, covering diverse ecological zones and altitude levels. The ages of the dated organic matter from the Southern Puna (Cordillera de San Buenaventura, 3800–4000 m asl) and the Bolsón de Fiambalá (Northern Pampean Ranges, 1400–2400 m asl) environments (Fig. 1) range between 8000 and 4100 BP. Moreover, discussion considers how this volcanic event impacts on the regional fluvial dynamics and, consequently, on the water sources for human activities.

2. The archaic in the highlands and lowlands of western Tinogasta (ca. 8000–4000 BP)

The image of an empty space is the best description for the cultural development of hunting societies that occupied the highlands of the Chaschuil Valley and the mesothermal valleys of Fiambalá region in western Tinogasta (Fig. 1) between 8000 and 4000 BP. Both regions are longitudinal valleys oriented north-south, separated by Sierra de Narváez and Sierra de Las Planchadas mountain ranges, bordered to the north by the east–west Cordillera de San Buenaventura.

The previously stated facts have some particularities for each ecozone during the Mid-Holocene. In this sense, occupation was punctual (instead of non-existent), spatially restricted and lacking the feedback mechanisms related to protracted actions in the highlands. In the lowlands, however, there is no record of hunter-gatherer occupation for this time. This statement is based on the intense field work done in both areas.

The characteristics of the archaeological record in the Chaschuil Valley highlands, together with the absence of rock art (Ratto, 2000, 2003, 2006), show that the social representation of the space is different from that one found in the neighboring area of Antofagasta de la Sierra. The lack of stratified records is notable, with the lithic point sets ascribed to the Mid–Late Holocene by means of comparing the designs against those finely dated in the region of Antofagasta de la Sierra (Aschero et al., 1991, 1993–1994; Aschero and Martínez, 2001; among others) and trans-Andean areas (Núñez, 1980, 1983; Santoro and Núñez, 1987; among others).

These particularities allow the visualization of the Chaschuil Valley highlands as a space shared by extractive societies with a wide range of mobility, whose center was located in other extra-regional areas, such as Antofagasta de la Sierra and/or trans-Andean regions. It is likely that the wide mountain bogs (*vegas*) of a height of 4000 m asl, e.g. San Francisco, may have functioned as buffer areas for climate change during the Holocene, retaining relative humidity even when the characteristic Mid-Holocene dry periods took place (Garleff et al., 1992; Grosjean et al., 1997; Valero Garcés et al., 1999; Olivera et al., 2006; Tchilinguirian, 2008; among others).

Moreover, the area occupied by these mountain bogs is connected by natural routes to Antofagasta de la Sierra and the trans-Andean region, nowadays Chilean territory, through the Cordillera de San Buenaventura and San Francisco international crossing, respectively. Considering the absence of rock art in the region and the similarity of the projectile points designs to those of Antofagasta and/or trans-Andean Holocene contexts, this space constituted an extended hunting region for times of environmental stress affecting extra-regional spaces. This is linked to the hypothesis of the existence of ecological refuges (*sensu* Núñez et al., 1999). Within this context, the occupation of the highlands of western Tinogasta between 8000 and 4000 BP was mainly focused on the development of camelid hunting by hunter-gatherers.

This was a low intensity occupation, discontinuous in time, due to climate changes, explosive volcanism, to a great degree, and seismic activity, in lesser degree: the last two activities recurrent within the time frame under consideration. The conditions stated here created unstable environments preventing an uninterrupted and long-term settlement in the highlands, while interfering with the settlement in the lowlands of the Bolsón de Fiambalá.

3. Methods

3.1. Identification and mapping of natural profiles

Three natural profiles showing alternating levels rich in organic matter (peat) and volcanic products (pumice and ignimbrite levels) were surveyed. Two of the profiles are located in the Bolsón de Fiambalá (1400–2400 m asl) and the other one in the Southern Puna (3800–4000 m asl). From a purely geological approach, the Bolsón de Fiambalá is a transitional region between the Southern Puna and the Northern Pampean Ranges. These studies were done in the frame of geological and archaeological projects, merging the generated data into interdisciplinary work. Deposits with deformation signals were mapped, and fault escarpments were registered relying on satellite image observation and interpretation.

3.2. Geochronology

The surveyed profiles intercalate several levels rich in organic matter. Samples for dating came from those peat levels showing higher concentrations of organic matter. The dating method used was radiocarbon. Most of the collected samples in this work were analyzed by conventional radiocarbon dating (^{14}C), while one of them was analyzed by AMS (Accelerator Mass Spectrometry). The analytical results are shown in Table 1. Although the samples have been dated in different laboratories, the obtained ages are coherent among them and with the stratigraphic position in the studied profiles.

Table 1

Results of the ^{14}C ages for the levels rich in organic compounds in La Hoyada, Ojo de Agua and Agua de la Cañada profiles (see Fig. 1). *Beta Analytic Radiocarbon Dating Laboratory; **NSF-Arizona AMS Laboratory; ***Laboratorio de Tritio y Radiocarbono (LATYR, UNLP-CONICET).

Level	Sample	Profile	Method	Age (BP)
A	N1	La Hoyada	* ^{14}C Radiometric	8830 ± 60
	N2	La Hoyada	* ^{14}C Radiometric	8410 ± 50
B	N4	La Hoyada	* ^{14}C AMS	8230 ± 60
C	N5	La Hoyada	* ^{14}C Radiometric	5480 ± 40
D	OAB02	Ojo de Agua	** ^{14}C Radiometric	5960 ± 100
E	AA60922	Ojo de Agua	** ^{14}C Radiometric	5387 ± 45
F	OAB022	Ojo de Agua	** ^{14}C Radiometric	5040 ± 110
G	Acp (LCñ-67)	Agua de la Cañada	*** ^{14}C Radiometric	4040 ± 80
H	Acp (LCñ-71)	Agua de la Cañada	*** ^{14}C Radiometric	3810 ± 80

4. Results

4.1. Natural profiles in the region of Fiambalá and Southern Puna

The natural profiles located in different sectors of the broad region of the Bolsón de Fiambalá and the southernmost sector of the Puna show the occurrence of repeated volcanic events during the Holocene. The volcanic material present in the stratigraphic profiles (pumice of various sizes) was released to the surface by the calderas of Cerro Blanco Volcanic Complex (Seggiaro et al., 2006), located in the northeast edge of Cordillera de San Buenaventura, Southern Puna (Fig. 1).

The large volume of pyroclastic flow deposits has been spread in several directions to the northern area of the calderas (Carachipampa, Incahuasi-Purulla and Campo de la Piedra Pómez areas) as well as to the south (Laguna Aguada Alumbreira area), nowadays covered by eolian deposits (Fig. 1). Relying on geochronological dating, geochemical analyses and the study of deposits, it is possible to separate the rocks of this complex into two volcanic cycles. The first one occurred between 0.55 Ma and 0.44 Ma, and the second between 12,000 years (Arnosio et al., 2008) and an undetermined Holocene time, the last event occurring after 5500 BP (Montero López et al., 2010). The deposits assigned to the youngest cycle are ignimbrite, unconsolidated ash-fall deposits, lava domes and block-and-ash flows.

The mapped profiles (La Hoyada in the Southern Puna, Ojo de Agua and Agua de la Cañada in the northern area of the Bolsón de Fiambalá) (Fig. 1) display levels rich in volcanic material (ashes and pumice) of diverse thickness interspersed with peat banks. In La

Hoyada profile, primary pyroclastic flow (ignimbrite) covers all the pumice and peat banks.

4.1.1. La Hoyada profile

La Hoyada profile ($26^{\circ}50'54''\text{S}$ – $67^{\circ}47'18''\text{W}$, 3646 m asl) is located 7 km south-west from the calderas of Cerro Blanco, in the southern sector of Puna (Fig. 1) and comprises alternating levels rich in pumice and organic matter. It is fully covered by an ignimbrite deposit from the second volcanic event registered for Cerro Blanco Volcanic Complex (Montero López et al., 2009, 2010) (Figs. 1 and 2a, Table 1). Based on dates obtained from the organic levels, a maximum age of 5500 years was assigned to the overlying ignimbrite deposit, indicating the occurrence of explosive volcanic events in Mid to Late Holocene (Montero López et al., 2010).

4.1.2. Ojo de Agua profile

Ojo de Agua profile is located in the northern sector of the Bolsón de Fiambalá, on the northern margin of Quebrada Ojo de Agua ($27^{\circ}20'09''\text{S}$ – $67^{\circ}51'51''\text{W}$, 2400 m asl) about 14 km west from Palo Blanco village. It is a 7 m-thick profile with similar characteristics to La Hoyada one; being the distance between them about 55 km. Sand and silt strata interspersed with organic-rich layers and pyroclastic material banks from Holocene eruptions of Cerro Blanco Volcanic Complex (Montero López et al., 2009) form this profile (Figs. 1 and 2b). Banks rich in volcanic material have high pumice content (up to 90%), immersed in a matrix of coarse ash. No primary structures or other evidence of primary volcanic origin were found. Nevertheless, some of these deposits may have originated as ash-fall deposits, later trapped in

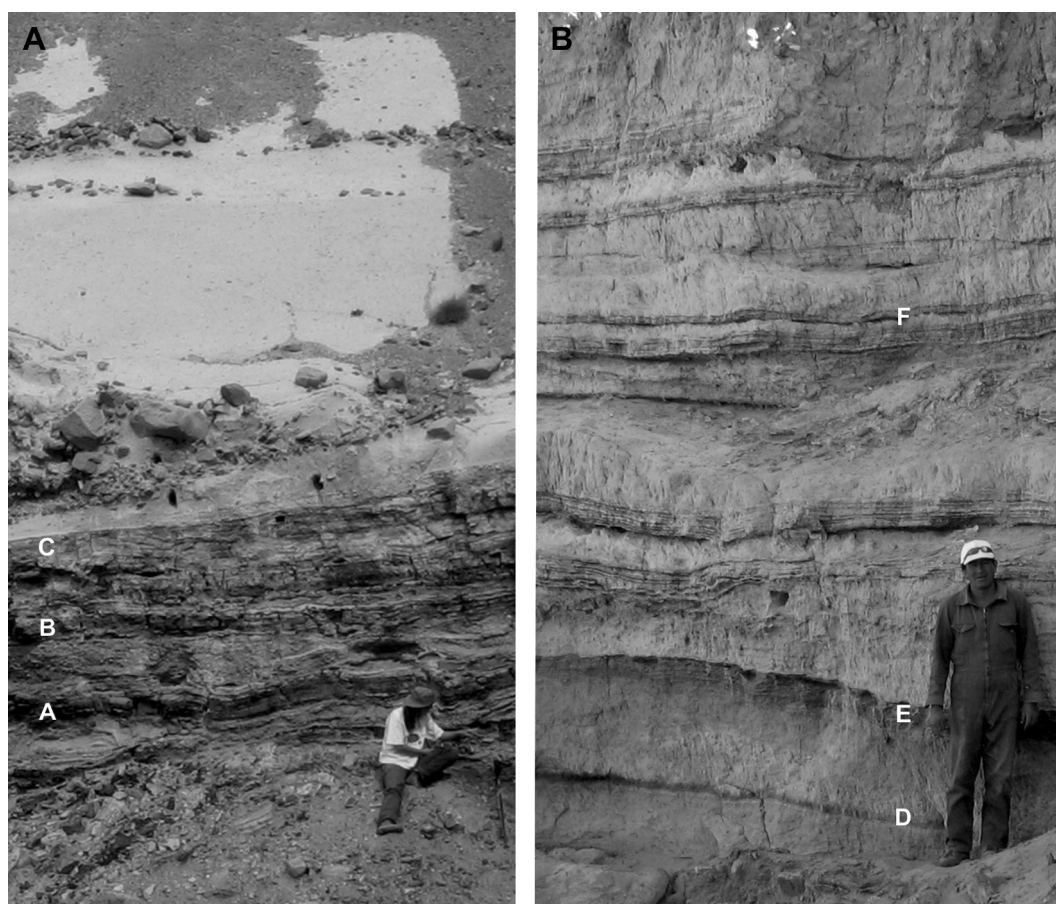


Fig. 2. Detail of the profiles. A – La Hoyada; B – Ojo de Agua, indicating the peat levels that were dated (See Table 1).

the layers rich in organic matter. These layers formed in mountain bogs with high water content during the ash-fall time, enabling the entrapment of pumice and ashes. The interbedded peats yielded ages between 6000 and 5000 BP (Montero López et al., 2009) (Table 1). The base of the profile is a sandy bank of 2.5–3 m thick with bioturbation structures. The top the profile is covered by weakly consolidated sand and gravel banks, supporting the current soil.

4.1.3. Agua de la Cañada profile

This profile is also located in the northern sector of the Bolsón de Fiambalá. Subcropping levels with high contents of ancient organic matter are located 20 m from the escarpment of the left margin of the inactive stream Agua de la Cañada (27°19' 57.7"S–67°50'57"W, 2370 m asl). A trench of 0.60 m long and 0.75 m deep was dug in this site, at 14 m above the current river base level. The trench wall shows interbedded layers of peat and pumice that are gently dipping (Fig. 3). Radiocarbon dating of the upper and basal levels of peat yielded ages of 4040 ± 80 and 3810 ± 80 BP (Table 1).

4.2. Evidence of deformation

On the left margin of Quebrada Ojo de Agua, a few meters from Ojo de Agua profile, a sedimentary Holocene level with clear deformation evidence was detected (Fig. 4). The deformed bank is approximately 3 m thick, comprising organic matter and pumice levels, overlying bioturbated medium-grain sands. Covering the deformed deposit, there are fine-grain sand to mud layers that become coarse up to the top, where the soil cover is developed (Fig. 4). The sequence of pumice and peat banks shows convolutions and faults at outcrop scale. The contact with the lower undeformed bank is distinct, which might have acted as a detachment level at the

moment of deformation. The deformation does not affect the sediments overlying the pumice-peat levels. One of the possible causes triggering the deformation of these levels is the occurrence of earthquakes of $M_w \geq 5.5$.

Although the available information is not enough to characterize these beds as seismites (Montenat et al., 2007), there are other features supporting the hypothesis of their association to seismic movements:

- Quaternary faults affecting the alluvial modern levels. Well-defined fault escarpments are identified on Google Earth satellite images analysis along the western sector of the Bolsón de Fiambalá (Fig. 5a, b, c and d). One of these fault escarpments is next to Ojo de Agua profile where the deformed strata were detected. Moreover, the gently dipping strata of La Cañada profile would be the result of this neotectonic activity.
- The existence of two well-defined Quaternary bajada levels. The oldest one shows a clear uplift in relation to the current level and its surface records the deep incision made by the temporary water courses running along the current base level (Fig. 5a). Sudden altitude variations between neighboring profiles containing the interlayered volcanic and peat levels also argue for the occurrence of vertical displacements related to faults. Ojo de Agua is illustrative due to the fact that this surveyed profile is at the level of the present water course and the deformed banks located nearly 100 m eastwards crop out on the top of the erosive wall of the same water course.
- Seismicity of the region. Although there is no record of historic seismicity in this sector of the Bolsón de Fiambalá, there are records of others occurring in the last 50 years in the vicinity (Fig. 6), whose magnitudes range from 2.5 to 5.1 on the Richter scale, with depths less than 55 km (sources: www.inpres.gov.ar and www.usgs.gov). The historical earthquake that was registered took place in the city of Belén, 57 km from Fiambalá, to the east of Sierra de Fiambalá, with an intensity of VII on the Mercalli scale and a magnitude of 5 on the Richter scale (source: www.inpres.gov.ar). This information on the occurrence of earthquakes in the Bolsón de Fiambalá area indicates that this region may be considered seismically active, and that other earthquakes of considerable magnitude may have occurred in the last 5000 years. This is indicated in the observed fault-escarpments, which contributed to the generation of an unstable environment for archaic populations.

5. Discussion

The interbedded peats, representing ancient mountain bogs, and pumice with diverse degrees of reworking, which in some cases have primary ash-fall features, indicate that explosive volcanic activity linked to the calderas of Cerro Blanco Volcanic Complex has been recurrent since at least 12,000 BP; with an explosive event occurring sometime later than 5500 BP (Montero López et al., 2009, 2010).

Volcanic and seismic events occurring during the Mid-Holocene have influenced the different components of the environment both social and physically (i.e. air, water, soil, fauna) since they have generated an ecosystem unsuitable for the sustainable occupancy over time. In summary, the dominant environmental conditions altered the relationship between water-sources, vegetation and the herbivores and hunters populations, as well as being a potential topographic modifier.

Volcanic deposits, comprising mostly unconsolidated pyroclastic material, have been affected by secondary fluvial processes causing their erosion and reworking, which meant changes to the



Fig. 3. Photograph of Agua de la Cañada profile with the ages of the dated levels.

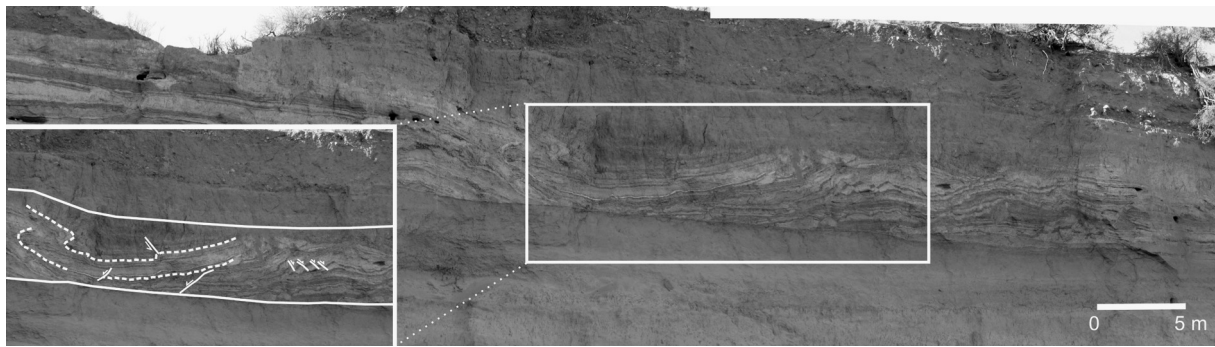


Fig. 4. View of the deposit with deformation evidence and a detail of the sector where convolutions and faults are developed.

valley bottom topography and possibly, also, in the dynamics of the mountain bogs. The analyzed profiles show clear evidence of volcanic material, mainly ash and pumice, episodically covering the mountain bogs. This volcanic cover surely modified the conditions of water supply. Furthermore, the potential seismic activity in the region, suggested by several features that may be associated to deformation occurring later than 5500 BP, may have contributed to environmental instability and an unfavorable physical scenario for the settlement of human populations with hunting economies.

Thus, the synergy of the processes was one of the causes of the changes in the fluvial regional dynamics. Nowadays, rivers run entrapped between high escarpments where the strata have been

uplifted 6–15 m above the modern basin level. This suggests one or several rising and/or eroding events with a direct impact on the regional base level. Accordingly, streams are constantly incising to reach their equilibrium condition in response to tectonic movements and/or climate change, causing a high sedimentation rate in the Bolsón de Fiambalá area.

The large amount of pyroclastic material erupted by the calderas of Cerro Blanco must have also had an impact on the surrounding regions, depending on the terrain, the topography and the predominant winds. This environmental scenario of high instability is consistent with the absence of a Mid-Holocene population record in the Fiambalá region and low occupation density in the highlands of the Chaschuil Valley for the same period.

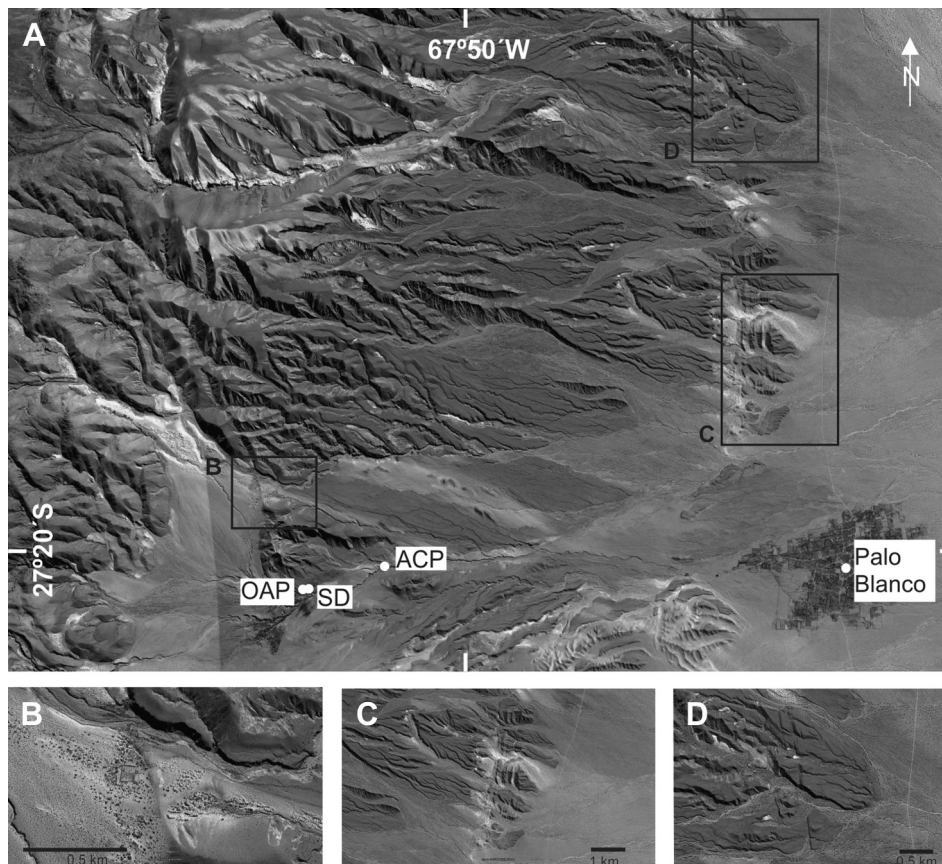


Fig. 5. A – Satellite image showing the profile location in the Bolsón de Fiambalá; B, C and D – View of the escarpment faults in the surroundings. OAP: Ojo de Agua profile; ACP: Agua de la Cañada profile; SD: strata deformed.

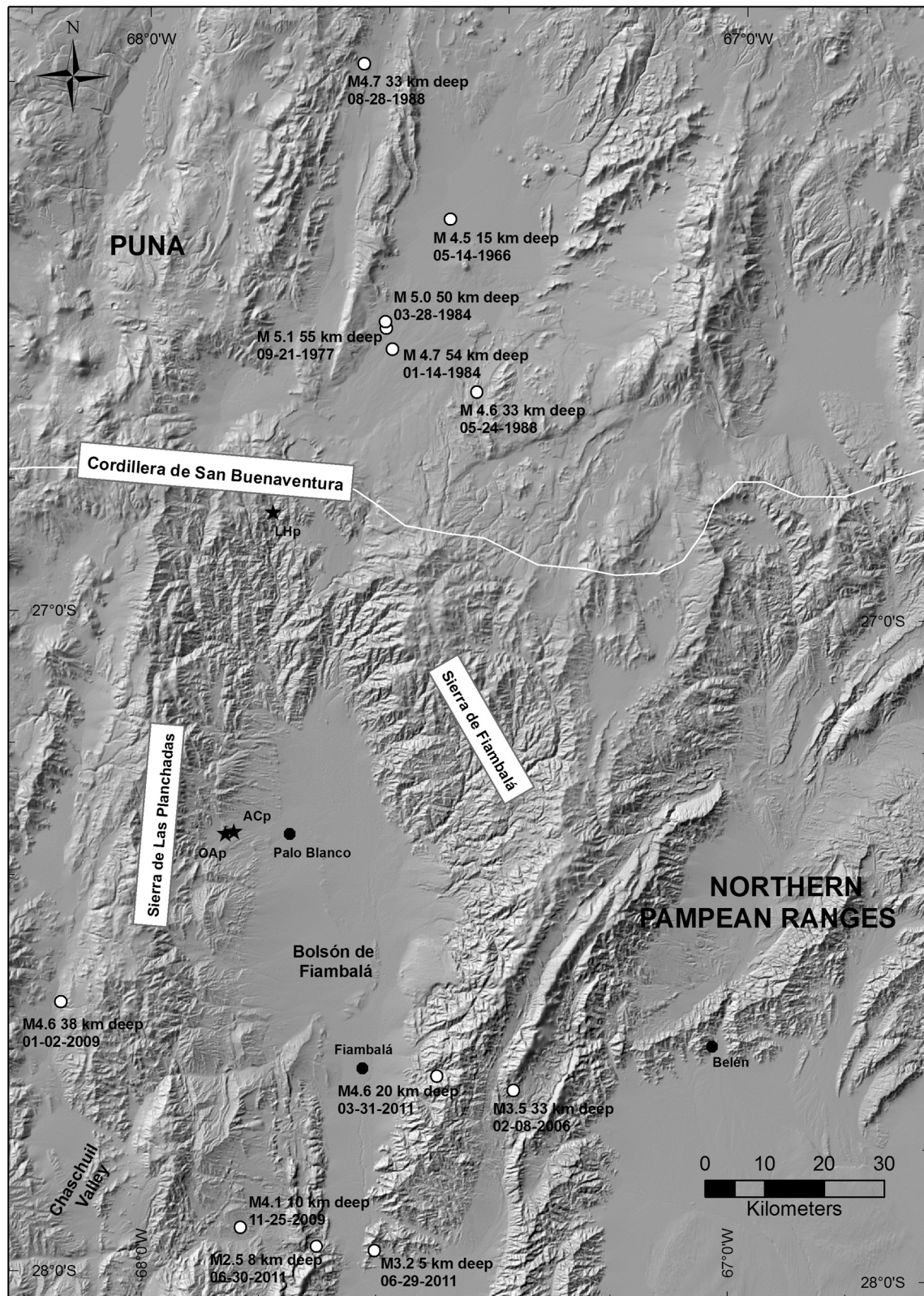


Fig. 6. General view of the Bolsón de Fiambalá and the southern Puna areas showing the location, date, magnitude and depth values of the earthquakes occurring during the last fifty years (sources: www.inpres.gov.ar and www.usgs.gov). OAP: Ojo de Agua profile; ACP: Agua de la Cañada profile.

In summary, these catastrophic events that occurred thousands of years ago had an indirect impact on the productive societies that settled in the valley bottoms since the first century AD. This was indicated by the presence of large volumes of sediment

accumulated in the low relief area of the Bolsón de Fiambalá. In some cases, they formed huge dunes towards the eastern edge of the valley due to the intense activity of the wind. The sedimentary fill of the valley was previously affected by mud flows and/or

pumice material haulage, impacting on the agro-pastoral societies settled in the valley bottom between AD 500 and 900 (Montero López et al., 2009; Ratto and Basile, 2010).

6. Conclusion

Cultural objects are social products, the study of which enables the characterization of the production and reproduction of social practices through time. Nevertheless, even if human groups cherish, use and modify nature, the conditions, restrictions and/or contingencies of the environment are always present. To this respect, this paper contributes to show how necessary the articulation of the different dimensions of space (physical, social and symbolic) actually is, in order to gain knowledge on the use of the territory by past societies, in this particular case, by Mid-Holocene hunter-gatherer populations.

Western Tinogasta has not had a strong archaeological presence in the development and consolidation of the Argentinian northwest archaeology, mainly because of the lack of continuity in the occupation of the space through time, as opposed to neighboring areas such as Antofagasta de la Sierra. Paleoenvironmental studies provide valuable information that allow definition of long environmentally unstable periods caused by volcanic episodes generating deposits of pumice material, changes in the fluvial dynamics and probable seismic activity, preventing continuous occupation in western Tinogasta during the Holocene. This affected, mainly, the valley bottom due to the synergic action of various agents.

The history revealed by La Hoyada, Ojo de Agua and Agua de la Cañada profiles accounts for the conditions of the physical environment that interacted with these populations, key to understand the characteristics of the use of the space by Mid-Holocene hunter-gatherers. The low density and discontinuous occupation of the highlands of the Chaschuil Valley, as well as the lack of record of extractive societies in the lowlands of the Bolsón de Fiambalá, is reinforced by the recognition of the dominant environmental conditions interacting with these societies. The responses given by social agents are neither unique nor mechanic, but surely the adverse dominant environmental conditions led to an alternating and/or discontinuous use of this space within the considered time, consistent with the characteristics of the regional archaeological profile.

Acknowledgments

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References

- Arnosio, M., Becchio, R., Viramonte, J.G., de Silva, S., Viramonte, J.M., 2008. Geocronología e isotopía del Complejo Volcánico Cerro Blanco: un sistema de calderas cuaternario (73–12 ka) en los Andes Centrales del sur. *Actas 17° Congreso Geológico Argentino*. Jujuy, T° 1, pp. 177–178.
- Aschero, C., Martínez, J., 2001. Técnicas de caza en Antofagasta de la Sierra, Puna meridional, Argentina. *Relaciones de la Sociedad Argentina de Antropología* 26, 215–241.
- Aschero, C., Elkin, D., Pintar, E., 1991. Aprovechamiento de recursos faunísticos y producción lítica en el precerámico tardío. Un caso de estudio: Quebrada Seca (Puna Meridional Argentina). *Actas 11° Congreso de Arqueología Chilena*. Universidad de Chile, Santiago, pp. 101–114.
- Aschero, C., Manzi, L., Gómez, A., 1993–1994. Producción lítica y uso del espacio en el nivel 2b4 de Quebrada Seca 3. *Relaciones de la Sociedad Argentina de Antropología* 19, 191–214.
- Criado Boado, F., 1999. Del Terreno al Espacio: Planteamientos y perspectivas para la arqueología del paisaje. Criterios y convenciones en arqueología del paisaje. In: *Capa*, vol. 6, pp. 1–55.
- Garleff, K., Stingl, H., Veit, H., 1992. New dates on the Late Quaternary history of landscape and climate in the Bolsón de Fiambalá (NW Argentina). *Zentralblatt für Geologie und Paläontologie Teil 1*, 333–341.
- Grosjean, M., Valero Garcés, B., Geyh, M.A., Messerli, B., Schreier, H., Kelts, K., 1997. Mid and Late Holocene limnogeology of Laguna Negro Francisco, northern Chile and its paleoclimatic implications. *The Holocene* 7 (2), 151–159.
- Ingold, T., 2000. *The Perception of the Environment: Essays on Livelihood, Dwelling and Skill*. Routledge, London, 465 pp.
- Montenat, C., Barrier, P., Ott d'Estevou, P., Hibsich, C., 2007. Seismites: an attempt at critical analysis and classification. *Sedimentary Geology* 196, 5–30.
- Montero López, M.C., Hongn, F., Seggiaro, R., Marrett, R., Ratto, N., 2009. Relación entre el volcanismo y los registros arqueológicos en el bolsón de Fiambalá (Departamento Tinogasta, Catamarca). In: *Entrelazando Ciencias: Sociedad y ambiente antes de la conquista española* (comp. N. Ratto). EUDEBA, Buenos Aires, pp. 131–158.
- Montero López, M.C., Hongn, F., Brod, J.A., Seggiaro, R., Marrett, R., Sudo, M., 2010. Magmatismo Ácido del Mioceno Superior-Cuaternario en el área de Cerro Blanco-La Hoyada, Puna Sur. *Revista de la Asociación Geológica Argentina* 67 (2), 327–346.
- Núñez, L., Grosjean, M., Cartagena, E.I., 1999. Un ecorefugio oportunístico en la puna de Atacama durante eventos áridos del Holoceno Medio. *Estudios Atacameños* 17, 125–174.
- Núñez, L., 1980. Cazadores tempranos en Andes meridionales. *Boletín de Antropología Americana* 2, 88–120.
- Núñez, L., 1983. Paleoindio y Arcaico en Chile: diversidad, secuencia y procesos. In: *Serie Monográfica 3*. Editorial Cuicuilco, México.
- Olivera, D., Tchilinguirian, P., De Aguirre, M.J., 2006. Cultural and Environmental Evolution in the Meridional Sector of the Puna de Atacama During the Holocene. *International Prehistoric Congress. Change in the Andes: Origins of Social Complexity Pastoralism and Agriculture*. 14° UISPP Congress. University of Liege, Belgium, pp. 1–7.
- Ratto, N., Basile, M., 2010. La localidad arqueológica de Palo Blanco: nuevas evidencias. *Actas 17° Congreso Nacional de Arqueología Argentina*. Universidad Nacional de Cuyo, Mendoza, T° IV, pp. 1707–1712.
- Ratto, N., 2000. La estructura del registro arqueológico en la cuenca superior del Valle de Chaschuil (Dpto. Tinogasta, Catamarca). *Arqueología* 10, 39–78.
- Ratto, N., 2003. Estrategias de caza y propiedades del registro arqueológico en la Puna de Chaschuil (Departamento Tinogasta, Catamarca). PhD thesis. Universidad de Buenos Aires –Área Arqueología. <http://cambiocultural.homestead.com/Ratto.html>.
- Ratto, N., 2006. El Arcaico y el Formativo en la Puna de Chaschuil a través del diseño de las puntas líticas (Departamento Tinogasta, Catamarca). *Cazadores Recolectores Del Cono Sur*. *Revista De Arqueología* 1, 93–110.
- Ratto, N., 2007. Paisajes Arqueológicos en el Tiempo: La interrelación de ciencias sociales, físico-químicas y paleoambientales (Dpto. Tinogasta, Catamarca, Argentina). In: Nielsen, A., Rivolta, M.C., Seldes, V., Vázquez, M., Mercolli, P. (Eds.), *Producción y Circulación Prehispánicas De Bienes en el Sur Andino*. Colección Historia Social Precolombina Tomo 2, Editorial Brujas, Córdoba, pp. 35–54.
- Santoro, C., Núñez, L., 1987. Hunters of the dry Puna and the Salt Puna in Northern Chile. *Andean Past* 1, 57–109.
- Seggiaro, R., Hongn, F., Folguera, A., Clavero, J., 2006. Hoja Geológica 2769-II. Paso de San Francisco. *Boletín* 294. SEGEMAR, Buenos Aires, 52 pp.
- Tchilinguirian, P., 2008. *Paleoambientes Holocenos en la Puna austral, provincia de Catamarca (27°S): Implicancias geoarqueológicas*. PhD thesis. Facultad de Ciencias Exactas y Naturales de la Universidad de Buenos Aires.
- Valero Garcés, B., Grosjean, M., Schwalb, H., Geyh, M., Kelts, K., Messerli, B., 1999. Holocene lacustrine deposition in the Atacama Altiplano: facies models, climate and tectonic forcing. *Palaeogeography, Palaeoclimatology, Palaeoecology* 123, 107–119.