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Early Holocene water well in the Pampas of Argentina: Human responses to water shortage events

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Abstract

Water wells are ethnographically and archaeologically described in Australia and the plains of North America. Recently, a prehistoric water well from the early Holocene was recorded in the Pampas of Argentina. The aim of this paper is to present the main characteristics of the water well, considering its form, dimension, sediment analyses (texture and chemical parameters), and material culture content. This is the first water well recorded in the Pampas of Argentina. Consequently, a discussion about natural or cultural origins of this kind of features is provided. An evaluation of similarities and differences with well-described water wells from the United States and Australia is included in order to highlight the cultural origin of the pit. Also, the meaning of the cultural response to water availability in terms of early-Holocene hunter–gatherer adaptations as well as the implications of this strategy for understanding paleoenvironmental scenarios of the Pampas of Argentina are discussed. The well seems to have mitigated an exceptional lack of surface water in the eastern Pampas or offered an alternative for the non-drinkable quality of the available surface water. The strategy of digging water wells was available in the behavioral repertoire of the Pampean hunter–gatherer populations as early as *c.* 8700–8000 ^{14}C yr BP (*c.* 9700–8800 cal. yr BP), as these groups were fairly flexible and resilient in dealing with short-term shortages of water.

Keywords

drought, early Holocene, Pampean hunter–gatherers, water well

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Introduction

Hunter–gatherer groups responded to events of aridity and severe droughts by employing a diverse set of strategies. In arid–semiarid landscapes that experienced water shortages, changes in subsistence, mobility, and settlement were often accompanied by the development of behaviors that favored specific techniques of water acquisition, such as the digging of wells.

Water wells are ethnographically and archaeologically described (Hercus and Clarke, 1986; Meltzer, 1991, 1995; Meltzer and Collins, 1987; Rowlands and Rowlands, 1965; Wright et al., 2013). The use of water wells in Australia is well documented ethnographically (Hercus and Clarke, 1986; Rowlands and Rowlands, 1965). However, there is no preservation of these wells in the archaeological record because they were dug in sandy sediments. Concerning the Western Desert of Australia, Gould (1977) expresses that

> … the aboriginal pattern of movement is to go from one water source to the next, concentrating on smaller rockholes and soakages while they still contain water so as to forage around them thoroughly […] before moving to the larger and more permanent waterholes. (pp. 28–29)

Rowlands and Rowlands (1965) highlighted the absence of streams and watercourses and the very limited available surface water in Central and Western Australia. According to the first European explorers, aboriginal groups mainly relied on underground water for their survival based on the use of water wells. Water was never easy to find, not even using modern-day techniques. Therefore, it is evident that the knowledge gained by hunter–gatherers through millennia of inhabiting the desert played a central role in detecting this vital resource. Groundwater was not homogeneously available through the desert and wells were not easy to locate. Local landmarks such as low stony ridges, prominent patches of desert oaks or *mulga*, and large boulders besides a sand ridge were used to demarcate these important places. The presence of some wells is also related to ceremonial grounds (Hercus and Clarke, 1986).

Hercus and Clarke (1986), based on a report by D. Lindsay, described social and archaeological aspects of nine wells (*mikiri*) located at the Simpson Desert, Australia, and used by the *Wangkangurru* aborigines until the late 19th century. In this desert environment, people obtained water by digging wells in gypseous flat depressions to reach the water table. Although the *Wangkangurru* people lived in the desert on a permanent basis, evidence of its occupations is only associated with these known water wells. A variety of archaeological materials surrounding these wells,

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such as lithics, faunal remains, and human burials, attest to the importance of these places, as also indicated by the ethnography (Hercus and Clarke, 1986). Bayly (1999) provided a detailed review of how indigenous people managed to obtain water in desert regions of Australia. This author highlighted the importance of traditional knowledge, oral instruction, and mapping in defining the type of water supplies available in a particular region and in helping to locate water sources. He grouped rock-holes, soaks (native wells), dams, claypans, riverine waterholes, and mound springs as surface water resources. These resources can be highly ephemeral to often quasi-permanent native wells. Water sources such as lakes, rivers, and creeks are either dry or saline most of the time.

The archaeological evidence of water wells is well documented in the Southern High Plains of the United States in sites such as Mustang Springs (41 MT 2), Blackwater Draw Locality #1, and Rattlesnake Draw sites (Texas and New Mexico, respectively) (Evans, 1951; Green, 1962; Meltzer, 1991; Meltzer and Collins, 1987; Smith et al., 1966). The presence of these water wells indicates a period of lowered water tables and extreme aridity, related to the presence of the Altithermal during the middle Holocene (Antevs, 1955; Meltzer and Collins, 1987: 10). Late-Holocene water wells have also been identified at Gila River Indian Community, in Southern Arizona. The chronology of the wells coincides with periods of regional aridity when surface water may not have been available (Wright et al., 2013).

The digging of wells occurs in a great diversity of situations and generates patterns for understanding human behavior and the archaeological record. Gould (1991) proposed an adaptive model based on two alternative and switching strategies called 'drought evasion' and 'drought escape' for the arid lands of Australia. These strategies illustrate the ability of native *Ngatatjara* of the Western Desert of Australia to switch from one strategy to another according to the severity and duration of droughts. Gould (1991: 26) also stressed that these strategies are based on the degree of both residential mobility and social flexibility. 'Drought escape' activates under long periods of absolute drought, encouraging long-distance movements of entire families toward more favorable distant areas and the consequent abandonment of their 'home' areas, often for several years. This strategy promotes the contact with relatives in other parts of the landscape where water is an available resource. In the 'Drought evasion' strategy, groups remain within the 'home' area, depending on more stable sources and water of edible plants. In this case, groups heavily depend on more reliable water sources such as well-known native water wells (Gould, 1991: 14–15).

Meltzer (1995, see also Meltzer, 1991: 237) formulated a model for understanding human responses to the Altithermal climatic conditions, based on the archaeological record of the Southern High Plains. The author proposed four strategies, which are not mutually exclusive, and their respective archaeological implications (Table 1 in Meltzer, 1995: 356): Hardscrabblers, Collectors, Wayfarers, and Expatriates. Hardscrabblers' strategy is equivalent to 'Drought evasion' (Gould, 1991). Under this strategy, people remained in the region and heavily depended on hand-dug water wells, which underwent substantial maintenance. The Collectors abandoned the region, but its resources were still being exploited either intermittently or annually by task groups living in more favorable areas. Few wells are expected, used episodically and for short periods, with no maintenance. The Wayfarers abandoned the region, although groups crossed it and settled for very occasional and ephemeral visits. Despite these sporadic visits, water was obtained from wells which, however, were not maintained. Finally, the Expatriates' strategy, involving the abandonment of the region, is equivalent to 'Drought escape' (Gould, 1991) and with it, well-excavation activities ended.

The excavation of water wells as a strategy for dealing with water scarcity is not exclusively related to hunter–gatherer societies. A case study in southern Arizona reported the use of wells for late Archaic–early Agricultural groups (Wright et al., 2013). Evidences of wells related with prehistoric complex societies in South America were also recorded (Moseley, 1975; Quilter et al., 2012). Two wells were reported from El Brujo archaeological complex (Chicama Valley, Peru). One of them was defined as a 'Ceremonial Well' as it was placed near the Huaca Cao Viejo, probably used during the middle Moche period. After using the well, it was filled with different materials (soil, stones, pottery, plant, bone and human remains, etc.), with no spatial pattern suggesting that the filling consists in a single episode (e.g. dumping trash). Recent research suggests that the function of the well as 'ceremonial' or 'utilitarian' is still not clear (Quilter et al., 2012). Earlier, Moseley (1975: 223) has mentioned the existence of walk-in wells associated with sunken gardens and cemeteries at Chan Chan, in the Moche Valley (Peru).

Chronicles from 18th-century travelers within the Dry Pampa subregion of Argentina indicate that wells (*jagüeles*) were dug around the lagoons to reach good quality water from groundwater (de las Casas, 1969 [1779] in Tapia et al., 2017). In some Ranqueles' camps, these wells were fenced with a palisade for protecting this source of water. These structures were recorded at Las Vertientes, and Naicó 1 and 2 (Dry Pampas subregion; Tapia et al., 2017). In central–western Argentina, there were transit spaces called *travesías* which have been used since *c.* 8000 ^{14}C yr BP. These mobility circuits were strongly linked to the availability of water. The *travesías* crossed arid and sandy landscapes, where water is a critical resource. These *jagüeles* have been used for harvesting water (Heider et al., 2018). Traveler Luis de La Cruz (1969:153 in Heider et al., 2018) crossed sectors of the *travesía* in 1806 and described the existence of water wells located in the indigenous base camps and the use of a pointed stick as the technology required for digging them (Heider et al., 2018). A similar observation was made by another traveler, Santiago Avendaño (2012) in 1845 (in Heider et al., 2018).

Recently, a prehistoric water well from the early Holocene was recorded in the Pampas of Argentina. The feature was identified at Paso Otero 4 site (PO4), an open air site located in the middle basin of the Quequén Grande River (Figure 1). The aim of this paper is to present the main characteristics of the water well, considering its form, dimension, and material content. The integration of the results of radiocarbon dating, sediment analyses (texture and chemical parameters such as pH, organic carbon, and phosphorous), and the vertical distribution of cultural material provide evidence for the formal characterization of the well and also help to infer the dynamics of its excavation and further filling. Pollen, diatoms, and silicobioliths data make it possible to interpret the setting conditions and to reconstruct the local environments. This is the first prehistoric water well recorded in the Pampas of Argentina. Consequently, a discussion about what natural agents could have excavated similar features and a comparison with well-described water wells from North America and Australia, as well as with other dug features recorded in Argentina is also included in order to stress the cultural origin of the pit. Finally, this paper discusses the meaning of this cultural response to water availability in terms of early-Holocene hunter–gatherer adaptations as well as the implications of this strategy for understanding paleoenvironmental scenarios of the Pampas of Argentina.

Archaeological, geological, and paleoenvironmental background

The site PO4 is situated in the middle stream of the Quequén Grande River, in the Paso Otero archaeological locality (Figure 1). At present, this locality comprises 12 archaeological sites and natural bone accumulations that cover *c.* 10,500 ^{14}C years of

Table 1. Radiocarbon dates for Paso Otero 4.

Sample/stratigraphy	Lab. #	^{14}C yr BP	Calibrated age range (2σ) Yr BP[a]	Calibrated age median probability Yr BP	$\delta^{13}C$ (‰)	Archaeological levels	References
Puesto Berrondo Paleosoil (2.59–2.74 m)	AA-81452 (Bulk)	2281 ± 38	2156–2341	2237	–21.1	No archaeological record	Gutiérrez et al. (2011)
Stabilization surface #5 (3.31–3.39 m)	AA-82036 (Bulk)	4561 ± 41	4983–5314	5162	–22.2	Upper level	Gutiérrez et al. (2011)
Stabilization surface #6 (3.54–3.59 m)	AA-85153 (Humates)	5503 ± 43			–19.4		Gutiérrez et al. (2011)
	AA-85153 (Residues)	5559 ± 43	6213–6406	6318	–19	Upper level	Gutiérrez et al. (2011)
Stabilization surface #7 (3.68–3.78 m)	AA-87930 (Humates)	6668 ± 55			–19.2		Álvarez et al. (2013)
	AA-87930 (Residues)	6739 ± 48	7476–7661	7566	–19.2	Upper level	Álvarez et al. (2013)
Stabilization surface #8 (4.03–4.11 m)	AA-85157 (Humates)	7314 ± 73			–20.3		Gutiérrez et al. (2011)
	AA-85157 (Residues)	7729 ± 48	8394–8580	8478	–20.3	Lower level	Gutiérrez et al. (2011)
Stabilization surface #9 (4.35–4.49 m)	AA-87938 (Humates)	8305 ± 67			–20.5		Gutiérrez et al. (2011)
	AA-87938 (Residues)	8913 ± 49	9744–10,180	9999	–20.2	Lower level	Gutiérrez et al. (2011)
Puesto Callejón Viejo Paleosoil Stabilization surface #10 (4.77–4.87 m)	AA-87939 (Humates)	9912 ± 53	11,183–11,596	11,276	–17.6	No archaeological record	Gutiérrez et al. (2011)
	AA-87939 (Residues)	9283 ± 83			–20.7		Gutiérrez et al. (2011)
Water well Sample A (4.85–4.95 m)	AA-87935 (Humates)	8735 ± 48	9540–9886	9647	–19.5		Álvarez et al. (2013)
	AA-87935 (Residues)	6168 ± 43			–18.2		Álvarez et al. (2013)
Water well Sample B (5.2–5.4 m)	AA-87936 (Humates)	8075 ± 66	8642–9110	8889	–19.2		Álvarez et al. (2013)
	AA-87936 (Residues)	6395 ± 79			–18.1		Álvarez et al. (2013)
Water well Sample C (5.9 m)	AA-87934 (Charcoal)	8556 ± 65	9327–9624	9506	–26.1		Álvarez et al. (2013)
Water well Sample D (6–6.1 m)	AA-87937 (Residues)	8331 ± 65			–20.2		Álvarez et al. (2013)
	AA-87937 (Humates)	8760 ± 160	9471–10,197	9784	–21		Álvarez et al. (2013)

[a]All ^{14}C dates were calibrated using Calib Rev. 7.1 (Stuiver et al., 2018) and the southern hemisphere calibration curve (SHCal13; Hogg et al., 2013). The ages are expressed in calendar years at a two-sigma confidence level.

human occupation of the area (Gutiérrez et al., 2011; Johnson et al., 2012; Martínez and Gutiérrez, 2011).

At present, the middle Quequén Grande River is entrenched, approximately 20 m wide and possesses banks up to 10 m high (Figure 2). Incision occurs at *c.* 3000 ^{14}C yr BP, more or less coincident with regional eolian activity and with the establishment during the late Holocene of the modern Atlantic coastline which is currently about 60 km from the Paso Otero archaeological locality (Zárate et al., 2000). However, this was not always the physiognomy of the course. A small shift in the waterway seemed to have occurred during the early and middle Holocene when the channel altered its course and flowed near or through the Paso Otero locality. Broad margins of saturated ground existed rather than the deep banks that characterize the current channel of the river (Johnson et al., 2012). Moreover, it is very likely that during specific lapses within the early and middle Holocene, a channel did not exist, just a broad, marshy surface represented by interconnected longitudinal pools of flowing water (Zárate et al., 1998b, 2000). No indication of a buried channel was recorded and the settings resembled wetland or spring-fed marsh soils (Johnson et al., 2012). Eolian clastic inputs increased, and between *c.* 9000 and 5700 ^{14}C yr BP, water depths strikingly fluctuated indicating at least four brief desiccation episodes and subaerial exposure (Zárate et al., 1998b, 2000: 486).

Several lines of evidence were examined in PO4 to reconstruct paleoenvironmental conditions (e.g. geoarchaeology, pollen, silicobioliths, and diatoms). In general, these proxy data indicate water availability oscillations throughout the Holocene (Gutiérrez et al., 2011). Aridity, strong eolian activity, and environmental disturbances are recorded in the final late Pleistocene. A climatic amelioration is indicated by the development of the Puesto Callejón Viejo Paleosoil during the Pleistocene–Holocene transition (Figure 3). A dry pulse under temperate-warm conditions is recorded in the early Holocene (*c.* 9900–7700 ^{14}C yr BP; *c.* 11,200–8400 cal. yr BP). This dry pulse coincides with the stabilization surface dated at *c.* 8900 ^{14}C yr BP from which the water well described in this paper was dug (see below). Also for this period, pollen composition has no modern analogues, indicating human disturbances, and the diatom assemblages support the

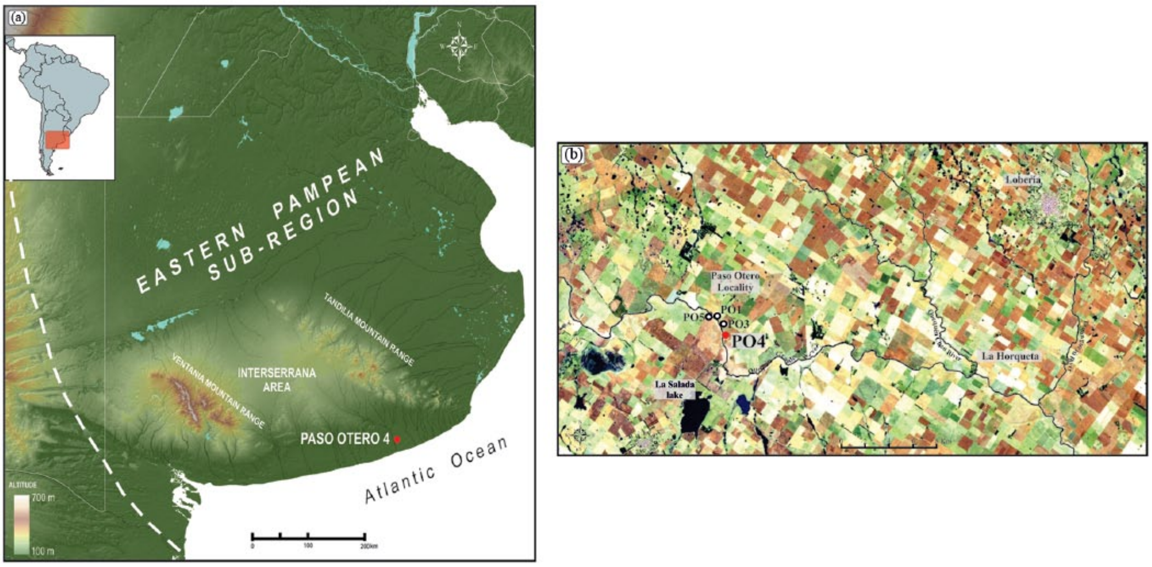

Figure 1. (a) Map of the eastern subregion of the Pampean region of Argentina showing the geographic location of Paso Otero 4 site. (b) Map of the middle stream of the Quequén Grande River showing the locations of the Paso Otero and La Horqueta archaeological localities and sites mentioned within the text.

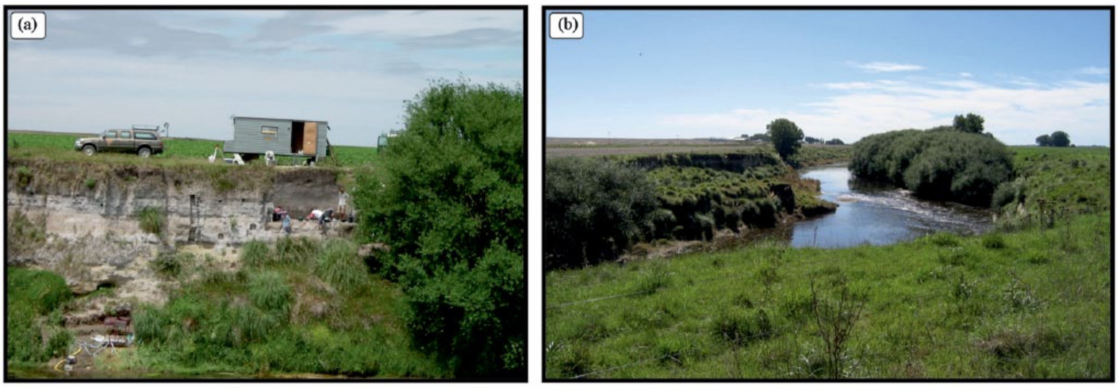

Figure 2. (a) View of the excavation from the opposite river bank. (b) View of the landscape of the middle basin of the Quequén Grande River.

proposal of a dry event. Another pulse of aridity is indicated by the pollen record in the middle Holocene (Gutiérrez et al., 2011).

At PO4, most of the stratigraphic sequence belongs to so-called Luján Formation, composed of its two members: Guerrero and Río Salado (*c.* 10,000–3000 ^{14}C yr BP; Figure 3). At the site, the former is represented by late Pleistocene loamy sands to silty sediments on which a buried soil named Puesto Callejón Viejo representing the Pleistocene–Holocene transition is recorded. An erosional unconformity separates this soil from the early–middle Holocene Río Salado Member. This member consists of fine diatomaceous sediments and was formed as part of very calm depositional processes that occurred within interconnected ponds or marshy environments throughout the landscape. In the uppermost part of this sequence, another regional soil named Puesto Berrondo Paleosoil is recognized during the late Holocene. Finally, the upper part of the sequence is composed of eolian and fluvial sediments, which indicate episodic events of flooding. Ten stabilization surfaces of the landscape ('A' buried soil horizons) were identified at PO4 (Figure 3; Álvarez et al., 2013; Gutiérrez et al., 2011).

A great variety of archaeological remains were recovered from an excavated area of 14 m^2. Archaeological materials were evenly distributed and exclusively recorded within the Río Salado Member of the Luján Formation. The chronology of the site comes from radiocarbon dating of organic matter of buried A-horizons (Table 1; Figures 3 and 4) due to poor bone collagen preservation (Johnson et al., 2012).

Early- and middle-Holocene human occupations (*c.* 8900–4600 ^{14}C yr BP; *c.* 10,000–5100 cal. yr BP) were identified at the site (Table 1). Archaeological materials were concentrated within *c.* 3.65 and 6.15 m (Figure 4). However, based on the presence of extinct fauna, the archaeological assemblage was divided into upper level (*c.* 7700–4600 ^{14}C yr BP; *c.* 8500–5100 cal. yr BP) and lower level (*c.* 8900–7700 ^{14}C yr BP; *c.* 10,000–8500 cal. yr BP).

The study of the zooarchaeological assemblages reveals a great variety of species in both levels (Álvarez et al., 2013). A total of 28,938 specimens were recovered at the site, among them large and small mammals, birds, amphibians, and reptiles. Species like *Lama guanicoe, Ozotoceros bezoarticus, Chaetophractus villosus, Zaedyus pichiy, Eutatus seguini, Lagostomus maximus, Rhea americana, Conepatus* sp., Tinamidae, Canidae, and Felidae present evidence of human exploitation (e.g. cut marks and intentional fresh fractures). Slight differences are recorded between the faunal assemblages of the lower and upper levels, the most important one being the exclusive presence of the extinct armadillo *Eutatus seguini* in the lower level. Nevertheless, Artiodactyls Index reveals that during the lower level, a diversified subsistence strategy existed, while during the upper level, the diversity of species was lower (Álvarez et al., 2013). The lithic

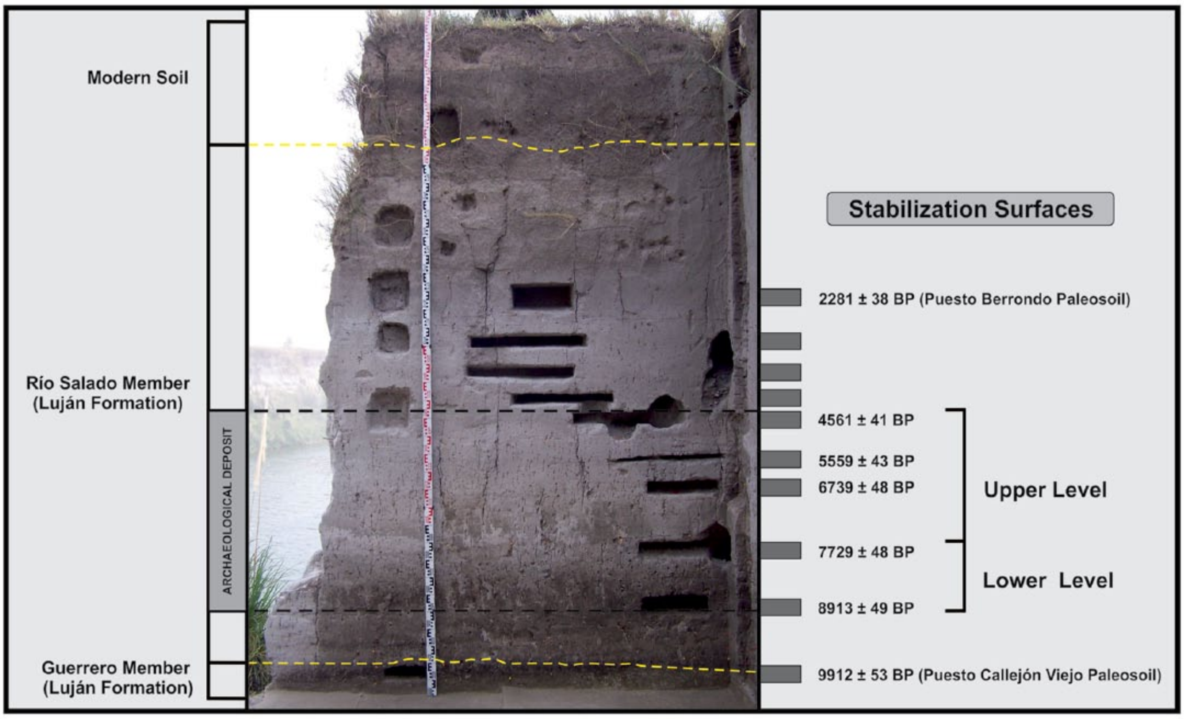

Figure 3. North wall of the main excavation area showing the stratigraphic profile, stabilization surfaces, radiocarbon dates, and archaeological deposit.

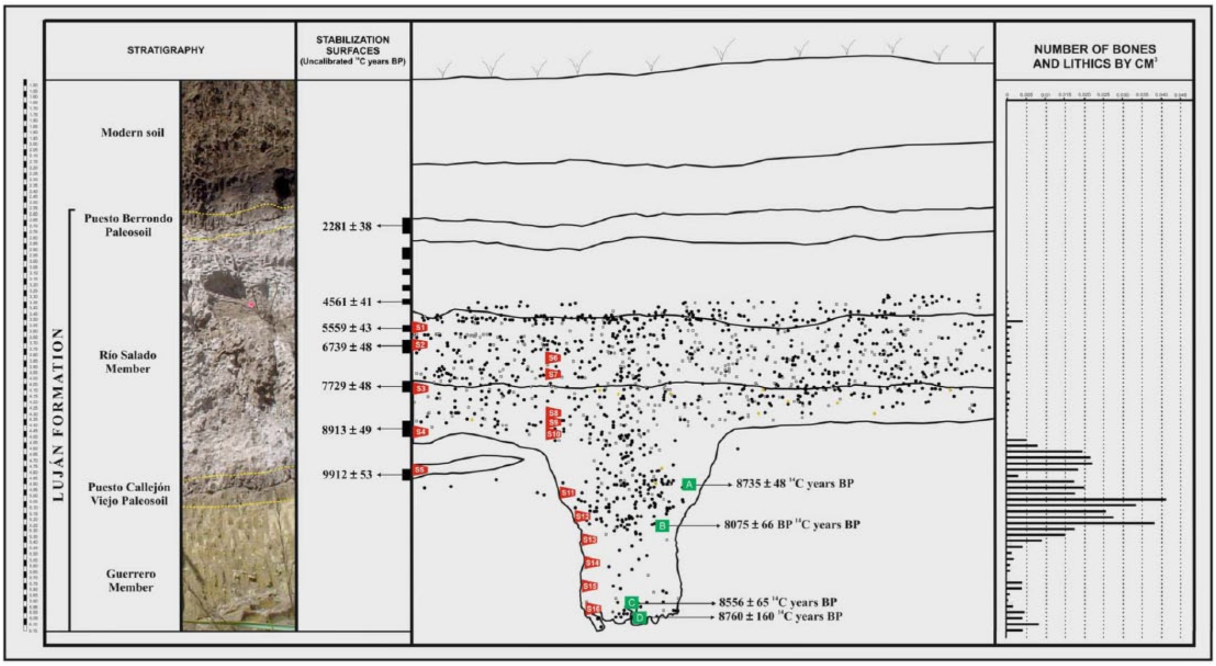

Figure 4. Cross-section of the main excavation area showing the frequency distribution of the archaeological remains in relation to the stratigraphy, radiocarbon dates, and water well location. The yellow dotted lines at the left column indicate buried soils: the lower one refers to the Puesto Callejón Viejo and the upper one to the Puesto Berrondo.

assemblage consists of 464 items, 40 of which are tools, 1 is a core, 412 are lithic debris, and 11 are ecofacts. As in most Pampean region sites, quartzite is the most frequent raw material (approximately 95%).

Geologic abrasion is the most frequent taphonomic effect registered on the bone assemblage. Weathering is presented in low frequency and dominated by stages 0 and 1 (null and very light weathering damage), 4 and 5 (severe weathering damage) being absent. Root etching significantly affected the cortical surface of a large number of bones. Carnivores, rodents, and trampling marks are scarce. Although with different intensity, the same taphonomic processes occurred throughout the entire geologic sequence (Álvarez et al., 2013).

The integration of the results from different lines of investigation supports the assumption that the site was initially occupied by humans in the early Holocene under a temperate-warm climate. The characteristics of the lithic assemblage (e.g. high tool frequency, diversity of typological groups, diversity of tool production stages, and maintenance of artifacts) along with the variability in animal resources consumed (e.g. artiodactyls, birds,

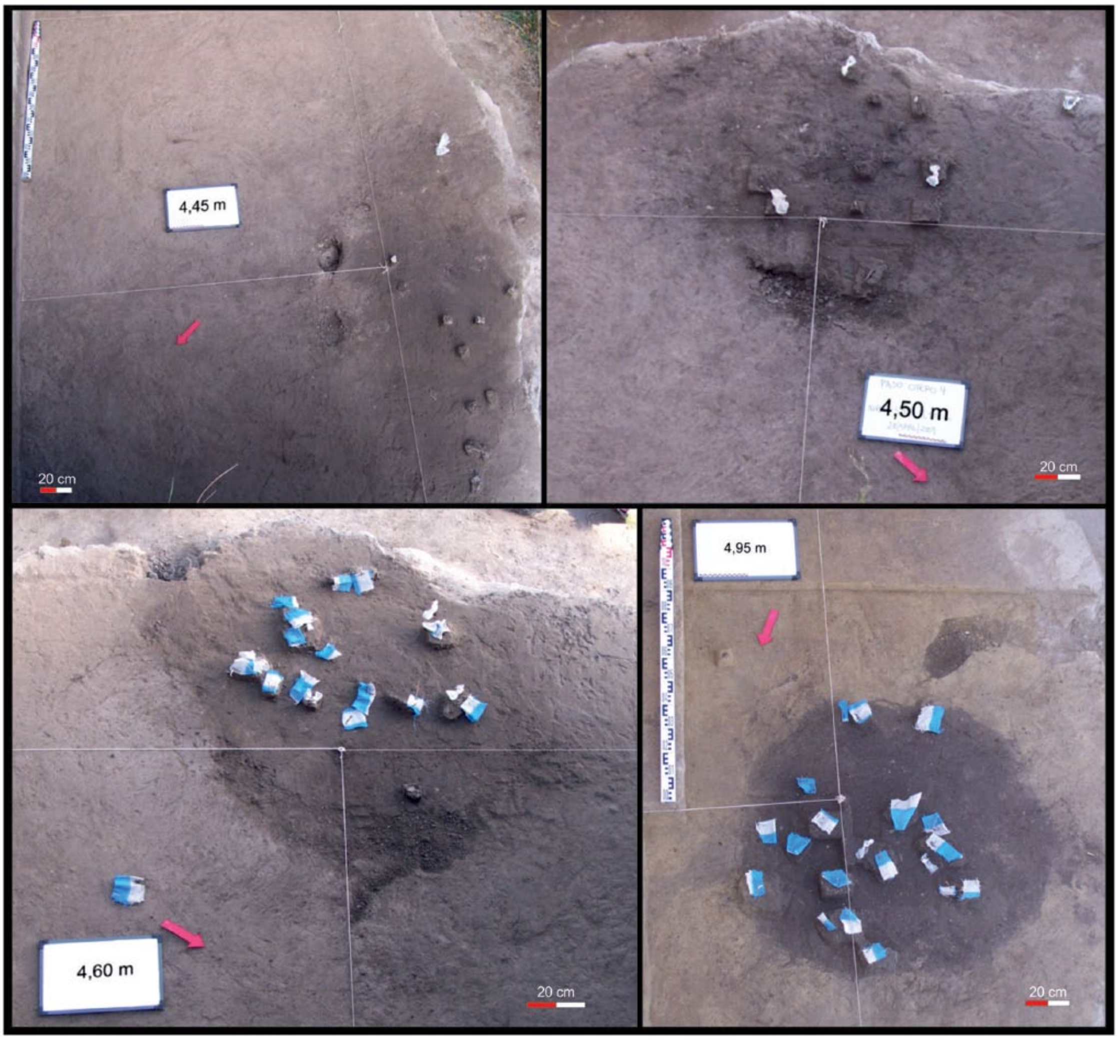

Figure 5. Views of the water well at different excavation levels. This figure shows how the limits of the feature became clearer as the excavation went deeper, to finally present a nearly circular shape.

rodents, carnivores, armadillos, extinct fauna) are consistent with residential and multi-purpose activity sites. These sorts of occupations, characterized by short-term stays, occurred repeatedly at the site during the early and middle Holocene (Barros et al., 2014).

Water well description

The water well was found in excavation unit 2 (Figure 4; Table 1). The top of this pit coincides with stabilization surface #9, dated at *c.* 8900 ^{14}C yr BP. The pit was dug into sediments of the lower portion of the Río Salado Member and upper part of the Guerrero Member. The first appearance of the feature consisted of an irregular stain of dark sediment at *c.* 4.45 m, with diffuse limits. As the excavation deepened, the limits of the feature became clearer to finally present a nearly circular shape at 4.95 m depth (Figure 5). The excavation of the feature was done by artificial levels of 5 cm and achieved in two steps. The excavation of half of the trait exposed a cross-section of the feature (Figure 6a and b). The remaining half was emptied by digging the fill (Figure 6c). After removing the sediment, the shape, dimensions, and walls were exhibited (Figure 6).

The cross-section of the pit is U-shaped with almost symmetrical lateral walls (Figure 6a). The top of it reaches 1.2 m in diameter, which narrows toward the central portion thereof to approximately 0.8 m, maintaining at its base almost the same dimension. Its depth is about 1.7 m. One remarkable feature is the presence of multiple linear marks or scratches along the side walls (Figure 6d and e). In the upper portion of the feature, these marks are scarce; they become abundant in the central and lower part of the feature. The bottom of the pit presents an irregular shape associated with scratches and holes (Figure 6d).

In order to understand the formation of the water well, parameters such as sediment composition (texture), pH, organic carbon, and phosphorus were evaluated in three different sectors of the site related to the feature. Six sediment samples came from the pit itself, five from the excavation unit where it is located (unit 2), and five from buried soils (stabilization surfaces #6–#10) of the stratigraphic column adjacent to excavation unit 2 (Figure 4). The only clayey textures appear related to samples S4 and S5 and are part of the truncated and eroded Bt soil horizon recorded at the bottom of the stratigraphic column (Table 2; Gutiérrez et al., 2011). In the remaining samples of this column, silty fractions prevail. Also in samples from unit 2, mostly silty loam, the silty fraction predominates. Comparison between sediment samples from the stratigraphic column of the main excavation and from unit 2 shows no abrupt textural changes among them (Table 2). At a glance, the fill of the pit looks homogeneous, without a clear stratification and lamination. Nevertheless, sedimentary analysis shows differences among pit samples. Sandy loam textures are only recorded in the pit and an alternating pattern of clay loam–loam–sandy loam textures is recognized (Table 2). Although the sediment textures are basically the same as those of the surrounding area, the alternating pattern indicates a different depositional

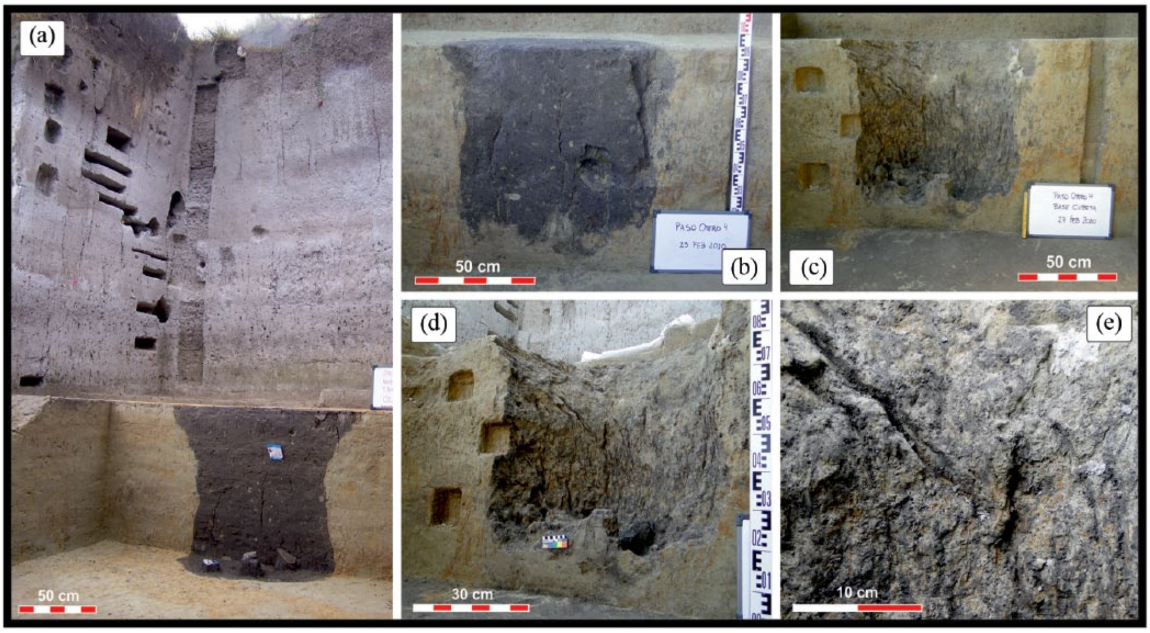

Figure 6. (a) Cross-section of the water well in relation to the site stratigraphy, (b) cross-section of the water well with the filling sediment, (c) cross-section of the empty water well, (d) lateral view of the cross-section of the water well showing the multiple linear marks or scratches along the side walls, and (e) details of the marks or scratches located on the side walls of the pit.

Table 2. Sediment textural class distribution in the stratigraphic column, the excavation of unit 2, and the water well.

Sample	Depth (m)	Clay (%)	Silt (%)	Sand (%)	Textural class
Stabilization surfaces–stratigraphic profile					
S1	3.55–3.6	8.1	55.9	36	Silty loam
S2	3.66–3.78	9.5	58.6	31.9	Silty loam
S3	4.04–4.12	12	49.3	38.7	Loam to silty loam
S4	4.37–4.5	44.5	36.4	19.1	Clayey
S5	4.77–4.87	43.9	34.5	21.6	Clayey
Excavation unit 2					
S6	3.8–3.85	9.4	61.5	29.1	Silty loam
S7	3.95–4	9.4	55.9	34.7	Silty loam
S8	4.25–4.39	11.7	47.8	40.5	Loam
S9	4.35–4.4	10	55	35	Silty loam
S10	4.45–4.5	15.5	52	32.5	Silty loam
Water well					
S11	4.95–5	30	35.8	34.2	Clay loam
S12	5.15–5.2	10.3	34.8	54.9	Sandy loam
S13	5.37–5.4	16.6	30.5	52.9	Loam
S14	5.55–5.6	29.9	27.4	42.7	Clay loam
S15	5.75–5.8	27	30.2	42.8	Loam (fine)
S16	5.95–6	7.4	36	56.6	Sandy loam

history within the feature. In this sense, based on sediment textures, four different sedimentary packages can be recognized. The first one, at the bottom of the pit (5.95–6 m; S16), was dominated by sand. In the second package (5.55–5.8 m; S15–S14), clay fractions significantly increased and subsequently decreased in the third one (5.15–5.4 m; S13–S12). Finally, the fourth package at the upper part of the pit (4.95–5 m; S11) shows a new increment of clay fractions. Except for the frequency of clay in soil samples (S4 and S5), the pit shows the highest values of this fraction (approximately 30%; Table 2).

In addition to sediment textural analysis, pH, extractable phosphorus, and organic carbon values were also obtained from the same samples (Table 3). The pH in all cases was strongly alkaline, whereas organic carbon (C) content was low. The most important differences between the samples are given by phosphorus values. Clearly, the values obtained from the pit are higher (ranging from moderate to high) than those from the unit 2 and the main stratigraphic column. One possible explanation for the high content of phosphorus is related to the alkalinity of the sediment, combined with the bounded morphology of the pit. A pH above 9 indicates a high sodium activity, brought by salt dissolution (probably sodium carbonates) and cation exchange sites (a preponderance of sodium ions produces an alkalinization of the soil). The elevated concentration of sodium produced the alteration of the soil structure by the dispersion of colloidal particles and the high mobility of the organic matter/humus (Russell and Russell, 1968). The dark color, often black, can be explained by the high concentration of humic substances, frequently observed as organic films, that were redistributed by water under alkaline conditions. Thus, in the pit, there may have been a higher concentration of incoming sodium from below or above (groundwater and surface water) that generated mobility of humates and eventually phosphorus redistribution in the soil. The higher content of soluble phosphorus linked to alkaline pH indicates a significant concentration of sodium in this sector and consequently a greater destruction of the organic matter/humus than in the rest of the profile. These processes mentioned above not only can help to explain the darkness of the filling sediment of the pit but also can help to understand the low values of organic carbon in all the analyzed samples (Table 3). Certainly, the discrete and delimited morphology of the pit has favored that these processes happened differentially to the rest of the sedimentary profile.

The sediment of the Guerrero Member, where the bottom of the feature is placed, presents evidence of intense redox reactions (Figure 6). This evidence suggests the existence of water and the fluctuation of the water table level.

The bone assemblage recovered in the pit was composed of 281 specimens, 211 of which correspond to taxa >1 kg and 70 to microvertebrates (Table 4). This assemblage was interpreted as part of the lower level due to their stratigraphic position and the presence of *Eutatus seguini* (Álvarez et al., 2013). Species representation is similar to the taxonomic categories identified in the upper and lower levels. A distinctive aspect of this pit assemblage is the high frequency of bone remains assigned to Anura (MNI = 6; approximately 18% of the total taxa, approximately 71% of

Table 3. Distribution of pH, phosphorus, and organic matter values in the stratigraphic column, the excavation unit 2, and the water well.

Sample	Depth (cm)	pH (1:2.5) in water	Phosphorus (Bray and Kurtz I) (ppm)	Organic carbon (Walkley and Black) (g kg^{-1})
Stabilization surfaces–stratigraphic profile				
S1	3.55–3.60	9.35 Strongly alkaline	4.52 Low	1.4 Low
S2	3.66–3.78	9.45 Strongly alkaline	2.00 Low	2.7 Low
S3	4.04–4.12	9.48 Strongly alkaline	2.41 Low	1.8 Low
S4	4.37–4.50	9.61 Strongly alkaline	4.13 Low	3.2 Low
S5	4.77–4.87	9.53 Strongly alkaline	12.98 Low–moderate	0.9 Low
Excavation unit 2				
S6	3.80–3.85	9.57 Strongly alkaline	14.89 Moderate	5.7 Low
S7	3.95–4.00	9.60 Strongly alkaline	6.06 Low	3.3 Low
S8	4.25–4.39	9.72 Strongly alkaline	10.66 Moderate–low	5.1 Low
S9	4.35–4.40	9.72 Strongly alkaline	7.73 Low	4.3 Low
S10	4.45–4.50	9.78 Strongly alkaline	16.53 Moderate	5.1 Low
Water well				
S11	4.95–5.00	9.65 Strongly alkaline	12.87 Moderate	5.1 Low
S12	5.15–5.20	9.48 Strongly alkaline	14.81 Moderate	3.4 Low
S13	5.37–5.40	9.44 Strongly alkaline	31.52 High	3.4 Low
S14	5.55–5.60	9.40 Strongly alkaline	24.45 High	2.6 Low
S15	5.75–5.80	9.50 Strongly alkaline	23.11 High	1.7 Low
S16	5.95–6.00	9.32 Strongly alkaline	24.81 High	2.6 Low

Table 4. Taxonomic identification of the bone assemblage recovered within the water well.

Taxa	NISP	%NISP
Vertebrata	11	3.92
Mesomammal	10	3.56
Anura	50	17.79
Ofidio	1	0.36
Artiodactyla	11	3.91
Lama guanicoe	22	7.83
Ozotoceros bezoarticus	13	4.63
Carnivora	18	6.41
Canidae	15	5.34
Felidae	4	1.42
Conepatus sp.	1	0.36
Dusicyon avus	1	0.36
Tinamidae	6	2.13
Rhea americana	6	2.13
Chaetophractus villosus	40	14.23
Eutatus seguini	2	0.71
Rodentia	12	4.27
Lagostomus maximus	51	18.15
Ctenomys sp.	2	0.71
Caviidae	1	0.36
Cricetidae	4	1.42
Total	281	100

microvertebrate assemblage; Table 4), recovered from 5 m depth (Álvarez et al., 2013).

A total of 59 lithics were also recorded within the pit, among them tools, debris, and ecofacts. Debris is the most numerous artifactual class (approximately 90%), while quartzite is the best represented raw material (*c.* 95%; Barros et al., 2014). Two large quartzite tools were found at the bottom of the pit (Figure 7a). One of them is complete (110 mm wide, 210 mm long, and 31.5 mm thick) and presents negative scars of flaking in the proximal end. The other large instrument is fragmented (71 mm wide, 140 mm long, and 32 mm thick) and has evidence of striation marks on ventral and dorsal surfaces (Figure 7b and c).

A clear pattern in the frequency and vertical distributions of lithics and bones is recorded in the water well. The bottom of the feature (between 6.15 and 5.2 m) concentrated the lower frequency of materials (22.64%), while the upper section (between 5.2 and 4.45 m) gathered the higher number of bones and lithics (77.35%) (Figure 4).

In general terms, taphonomic results were the same as those from bone assemblages of the whole site, except for an increase in the frequency of abrasion. Nevertheless, two specific types of taphonomic effects were recognized in bones of the feature. These include a porous texture on bone surface accompanied by intense abrasion and undetermined black staining (other than manganese). Both variables were exclusively found on bones located at a depth greater than 5 m and likely related to the presence of water.

As mentioned above, the top of the pit coincides with the stabilization surface #9, dated at *c.* 8900 ^{14}C yr BP. This date is consistent with the chronology obtained from samples taken within the feature, both sediment and charcoal (Table 1). In the former case, three samples obtained from the upper (approximately 4.90 m), middle (approximately 5.25 m), and lower (approximately 6.05 m) portions of the feature were radiocarbon dated (AMS), considering both sediment fractions: humates and residues (Figure 3 and Table 1). As the older of the two dates is considered closer to the true age (see discussion in Johnson et al., 2012), the accepted ages are *c.* 8700 (upper portion), *c.* 8000 (middle portion), and *c.* 8700 (lower portion) ^{14}C yr BP. A radiocarbon date of charcoal from the lower portion of the feature (*c.* 5.9 m) yielded an age of *c.* 8550 ^{14}C yr BP. Even though some reversal in ages is observed throughout the fill of the feature, a tendency in chronology that ranges *c.* 8700 to 8000 ^{14}C yr BP can be supported. Several factors can help to explain this age reversal: first, the differences in the material that was dated (sediment and charcoal); second, the complex processes that affect sediment organic matter dating; and third, the dynamic and alternating patterns of depositional episodes represented by the four packages of sediments. However, what is really consistent and shows a clear chronological pattern is the age of the stabilization surface from which the water well was dug (*c.* 8900 ^{14}C yr BP) and the ages obtained from this feature (8700–8000 ^{14}C yr BP) (Table 1).

Discussing similar features to the water well

The lack of precedents in the Pampean region of features like the water well described here deserves an exploration for discussing its origin in order to avoid equifinality when considering similar natural pits.

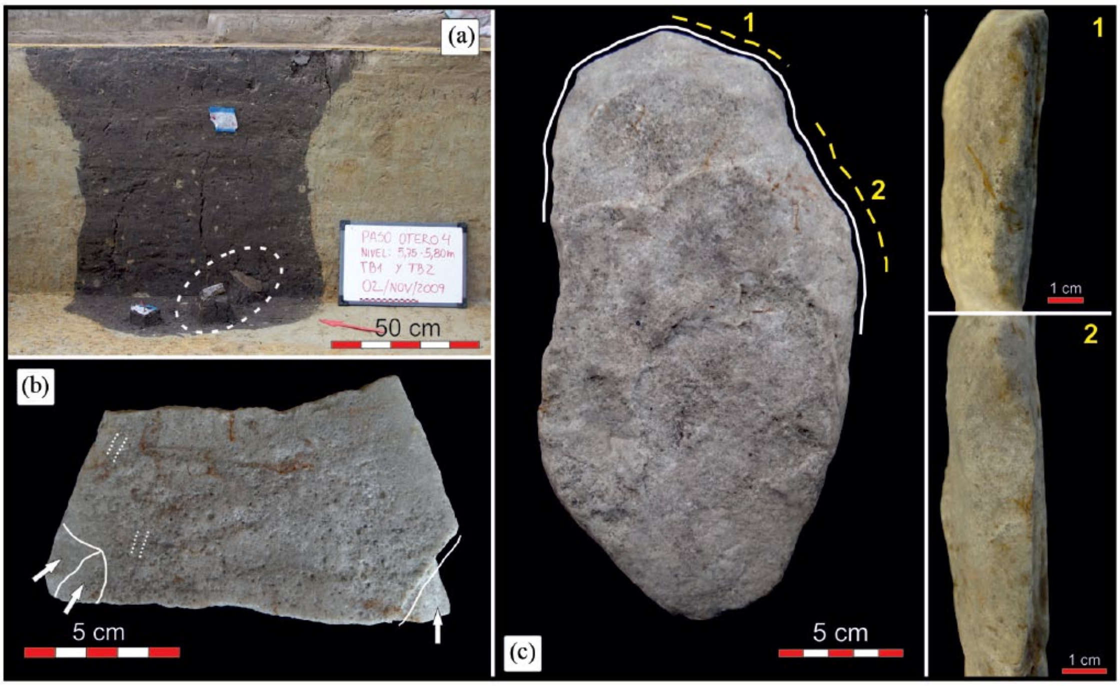

Figure 7. (a) Two large quartzite tools located at the bottom of the water well, (b) fragmented lithic tool with evidence of striation marks on ventral and dorsal surfaces, and (c) complete lithic tool with negative scars of flaking in the proximal end; (1) and (2) Details of negative scars of flaking in lateral view.

Naturally excavated features

Formal parameters such as shape and size between the PO4 pit and ancient burrows dug by extinct mammals were compared. Ancient burrows form a complex plan of underground and interconnected galleries or tunnels with elliptical or circular sections with 0.7 to 4 m in diameter and up to hundreds of meters long. It is proposed that these galleries were used as temporary or permanent dwellings by giant mammals that inhabited South America during the Tertiary and Quaternary. When these structures are then filled with sediment, they are termed crotovines (Bergqvist and Maciel, 1994). Ancient burrows and crotovines were first described in South America in coastal outcrops of Argentina, in Plio-Pleistocene sediments (Ameghino, 1908; Dondas et al., 2009; Quintana, 1992; Zárate et al., 1998a). These ichnofossils were also described in Uruguay (Ogando et al., 2010, 2011) and Brasil (Bergqvist and Maciel, 1994; Buchmann et al., 2009, 2015; Frank et al., 2013). Based on dimensions and marks found on the walls of the galleries, at least two potential builders are suggested, both of them corresponding to giant extinct mammals with fossorial habits. It is proposed that ichnofossils with a diameter between 0.7 and 1.4 m would have been dug by species of the Family Dasypodidae (i.e. *Eutatus, Pampatherium, Propraopus*) and with a diameter between 1.4 to 4 m by Family Mylodontidae (i.e. *Nothrotherium, Glossotherium*) (Buchmann et al., 2009). Ancient burrows usually have rotating chambers and the walls present carapace drag marks or claw marks (Buchmann et al., 2009, 2015; Quintana, 1992). The chronology assigned to these South American ichnofossils is estimated at between 3 million years and 400,000 years. However, as they have also been found in Pleistocene deposits, ages close to 10,000 years should not be discarded (Buchmann et al., 2009). Although the diameter of the PO4 feature may fit a crotovine of an extinct armadillo, plan (i.e. absence of galleries) and shape are the main differences. PO4 is a discrete U-shaped feature, vertically positioned from an ancient ground surface and relatively small for giant fossorial mammals to use as dwelling. In conclusion, the feature under discussion here is a pit, not a gallery or part of it. Even though bones of giant armadillo *Eutatus* were found at the site and within the feature, dwelling was not the reason for their presence in the pit. These *Eutatus* bones are evidences that this species was consumed by humans as clearcut marks were identified. Like other species with evidence of consumption, *Eutatus* was surely acquired in the surrounding area and processed and consumed at the site. Consequently, natural death of this species at PO4 can be ruled out. Currently, no other natural agent seems able to explain the origin of the feature.

Culturally excavated features

Other dug features were recorded at archaeological sites of the Pampean region. Four culturally originated pits were excavated at Calera site (Olavarría District, Pampean region of Argentina). Two of them were complete, allowing the record of form and dimensions. Both pits have a semicircular shape. Feature 1 (1.2 × 1 m) is approximately 0.8 m deep and feature 2 (1 × 0.5 m) is 0.9 m. The features were filled with a great quantity and variety of archaeological remains, in some cases separated by stone slabs. A high diversity of stone tools, decorated and non-decorated pottery sherds, shell beads, mineral pigments, marine mollusks, bone tools, deer antlers, an engraved plaque, and a phallic-shaped cylindrical statue were recovered. In addition, thousands of bone remains from mammals, birds, fish, and possibly reptiles were retrieved from the pits. This record was interpreted as part of ritual and offertory caches and also ceremonial trash formed by the performance of feasts. Radiocarbon dates indicated that these events took place between 3400 and 1700 ^{14}C yr BP (Politis et al., 2005).

Several pits have been recorded at Inca Cueva 4 site, in the Northwest of Argentina (Yacobaccio, 1985). These features have irregular circular contours with diameter ranging from 0.9 to 0.43 m, while depth varies from 0.5 to 0.38 m. The contents of these features are bone remains, vegetables, lithics, fleece, cordage, basketry, leather, beads, feathers, vegetable and bone artifacts, charcoal, hooves, and so on. The chronology of the habitation floor from which the features were excavated ranges from *c.* 9900 to 9200 ^{14}C yr BP. These pits were interpreted as food and artifact storage (Yacobaccio, 1985).

In short, given the dimensions, form, and archaeological material content of these features, it seems unlikely that the PO4 pit can be assigned to any of the cultural functions described above.

Water wells: Other case studies

At Mustang Springs, in West Texas, 63 water wells were uncovered (Meltzer, 1991; Meltzer and Collins, 1987). The wells are similar in size and morphology (circular, oval, and double lobed), but most vary greatly in depth, indicating they were dug during different visits. They are symmetrical in cross-section with almost vertical walls. Size ranges between 0.5 and 1.35 m in diameter, with a mean of 0.7 m. Depth varies between 0.1 and 1.65 m. All the wells were dug into the eroded and deflated surface by a digging stick or stone tools. This surface had originally been a spring-fed pond during the early Holocene, which began to dry *c.* 8000 ^{14}C yr BP and disappeared *c.* 6900 ^{14}C yr BP. The wells were filled with eolian sediments of the eroded surface from which they were dug. Material culture associated with the surface that contains the pits is very scarce, approximately 30 artifacts in 100 m^2, among them a single piece of red ocher and a small number of lithic artifacts, such as core remnants, flakes, and ground stone artifacts. No evidence of food remains was found (Meltzer, 1991; Meltzer and Collins, 1987). At the Blackwater Locality #1 (New Mexico), 19 prehistoric water wells were reported (Evans, 1951; Green, 1962; Hester, 1972; Meltzer and Collins, 1987; Warnica, 1966). Most of them have been dug from the same buried erosional surface. Diameter at the top varies from 0.75 to 1.5 m, while at the base it ranges from 0.3 to 1.2 m. Depth varies between 1.5 and 2 m. Unlike Mustang Springs, some wells were filled intentionally immediately after use and no backdirt piles around the wells were found. The filling of these wells seems to be the same diatomaceous sediment removed during the excavation of the pits. Other wells had a lining of red clay, possibly to plaster side walls and avoid the caving of consolidated sediments, which would suggest the reuse of these pits. No archaeological evidence was recovered from the filling sediments or from the surface of which they were excavated. The chronology of these wells was assigned between 8500 and 5000 ^{14}C yr BP (Meltzer and Collins, 1987: 18). Recently, Wright et al. (2013) described eight features interpreted as water wells within the floodplain of the present day wash channel, located on the Gila River, Arizona. The chronology of the wells is assigned to the late Holocene (*c.* 2900 ^{14}C yr BP) based on combined radiocarbon ages on charcoal from filling sediments. This chronology coincides with a period of general regional aridity and high ENSO activity in the American Southwest. The majority of the features had an insloping U-shaped morphology. Diameter at the top of the features measures approximately 1.5 m, and 0.5 m at the bottom. Depth measures roughly 2 m. The features fill is composed of laminated clay-, silt-, and sand-rich lenses. Wright et al. (2013: 53) explored the origin of the features (well vs natural fissures) by discussing five primary lines of evidence proposed originally by Meltzer (1991), namely, geomorphology, exit point, feature geometry, radiocarbon control, and sediment fill. They concluded that they were deliberately constructed features used for the purpose of water extraction. The authors proposed that these wells may correspond to an indigenous response to resource unpredictability or the development of proto-agricultural practices under climate stress.

The use of water wells in Australia is well documented ethnographically (Hercus and Clarke, 1986; Rowlands and Rowlands, 1965). However, there is no preservation of these wells in the archaeological record because they were dug in sandy sediments. Then, published information about wells in Australia is scarce. In general, the wells are *c.* 1 m diameter, roughly cylindrical with vertical to oblique shafts. The depth of a well is determined by the water table, and while some are just shallow circular basins, the depth of others varies from approximately 2 to 4 m. In some cases, the sides are plastered with mud and with a combination of mud and grasses. When the wells are not in use, they tend to fill up with silt, sand, and debris (Hercus and Clarke, 1986; Rowlands and Rowlands, 1965; Smith, personal communication, 2015).

Discussion

Based on the information discussed in former sections, the formal parameters and size of ancient burrows dug by fossorial mammals and of the storage pits and ritual and offertory caches described for the Northwest and the Pampas of Argentina do not match with the characteristics described for the PO4 pit. Besides, a storage pit would not be expected in a place related to a floodplain. Rather, the formal characteristics and dimensions of the PO4 pit are in accordance with the properties of water wells recorded in North American plains (Meltzer, 1991; Meltzer and Collins, 1987; Wright et al., 2013). Apart from the similar formal parameters of the wells described in North America, other general similarities can be noted. The wells are related to geoforms of fluvial systems that underwent changes through time, some of them triggered by fluctuations in water availability and the depth of water table. These settings favor the preservation of the wells, as opposed to those of, for example, Australia. In this case, the wells were dug in sandy sediments that collapsed with low probability of further preservation. Another similarity is the scars on the walls of the pit. These multiple linear marks or scratches are not associated with natural agents, and they are the remnants of the process of digging. Similar scars were also recorded at Mustang Springs site (Meltzer, personal communication, 2015) and defined as 'wall pockmarks' (Meltzer, 1991: 246). Either lithic artifacts or wooden sticks were used for digging. In addition, when describing ethnographic water wells in Australia, Rowlands and Rowlands (1965: 233) noted that the marks of digging sticks were also visible and few digging sticks were found surrounding these features.

Some differences were also identified between the PO4 water well and those for North American plains. While in the latter region water wells appear in large quantity (up to *c.* 60), in some cases forming 'wellfields' (Meltzer, 1991: Figure 7), a single one was found at PO4. However, there are other cases where the indigenous people only dig a single well. Both in the Simpson and the Western deserts of Australia, this situation has been testified by ethnography and archaeology. Publications by Rowlands and Rowlands (1965: Figure 1, p. 232) and Hercus and Clarke (1986: Figure 1, p. 52) show how single wells are distributed throughout important patches of landscape. These single wells were considered as 'resources nodes' where people obtained not only water but animals and plants, facilitating movements along the desert (Hercus and Clarke, 1986). Then, it is not always expected that the wells appear forming groups of several of them.

Another difference lies in the fact that many wells in North American plains were also reused and some of them even overlapped each other (Meltzer, 1991; Wright et al., 2013: Figure 6). Archaeological materials were not abundant in the wells of North America (Meltzer, 1991; Wright et al., 2013) when compared with the number and diversity of tools and faunal remains recovered in the well of PO4. The explanation for these differences could rely on the fact that while the majority of the wells in North America remained open, and were reused and filled by natural agents, the well of PO4 was partially filled intentionally, probably with the continuous occupations of the site. The two formal artifacts found at the bottom of the well (Figure 7) may represent tools used for digging, although these large rocks could also have been used as 'filters' for obtaining cleaner emerging water. In Mustang Springs, *c.* 60% of the wells exhibit 'boreholes' at their bases either for increasing well recharge rate or for going deeper to reach water table (Meltzer, 1991).

Besides similarities and differences among the well's dimensions and formal parameters, the paleoclimatic scenarios under which these wells were excavated should be taken into consideration. Water well digging and climatic disturbances are strongly connected in the case of North American plains. The presence of these water wells indicates a period of lowered water tables and extreme aridity, related to the presence of the Altithermal during the middle Holocene (Antevs, 1955; Evans, 1951; Green, 1962; Meltzer, 1991; Meltzer and Collins, 1987: 10; Smith et al., 1966). In this sense, in the North American cases, the excavation of wells was performed from erosional unconformities associated with severe droughts related to important climatic events such as the Altithermal and El Niño (Meltzer, 1991; Wright et al., 2013). Nevertheless, in PO4, the water well was excavated from a surface interpreted as a buried A-horizon of an ephemeral soil. Droughts in this case were more episodic and less severe but still intense enough to produce the lack of surface water. Also, surface water may have been available; however, due to its poor quality, the water might not have been drinkable. People could have decided to dig to obtain better water quality. As mentioned above, proxy data obtained from the site indicate water availability oscillations during the Holocene. Diatom assemblages indicate a dry pulse framed between more humid conditions under temperate-warm regimes at *c.* 9900 to 7700 ^{14}C yr BP. Pollen composition, dated *c.* 8900 ^{14}C yr BP, has no modern analogues, making it difficult to interpret when compared with a naturally developed environment. As a consequence, this pollen composition is proposed as a result of disturbances produced by human activity (see discussion in Gutiérrez et al., 2011; Martínez et al., 2013). This scenario is also reinforced by other evidence at a local scale. In PO5 site, just 1 km northwest of PO4 (Figure 1b), the silica biomorph (silicophytoliths) analysis indicates that immediately after the development of the soil Puesto Callejón Viejo (*c.* 10,000 ^{14}C yr BP), which corresponds to the stabilization surface #10 at PO4, water availability was limited and remained so until *c.* 8800 ^{14}C yr BP (Osterrieth et al., 2008). This trend also agrees with the evidence of pollen destruction in this site, which indicates the presence of wet–dry cycles during the early Holocene (Grill et al., 2007; Martínez et al., 2013). In Paso Otero 1, which is on the opposite bank of Paso Otero 5 (Figure 1b), more arid conditions after formation of the Puesto Callejón Viejo Paleosoil are proposed. The existence of an erosional contact between the latter paleosoil and the Río Salado Member of the Luján Formation as well as the isotopic composition of freshwater gastropods indicates drier conditions at *c.* 8700 ^{14}C yr BP (Bonadonna et al., 1995). Regional paleoclimatic records also indicate the existence of arid conditions during the early Holocene. These dry pulses have been proposed based on other *proxy* data such as faunal distribution and atmospheric circulation patterns (Iriondo and García, 1993; Tonni, 1992; Tonni et al., 2003). Besides 20 km downstream from Paso Otero locality, at La Horqueta locality (Figure 1b), at least four brief desiccation episodes and subaerial exposure were recorded during the early Holocene (Zárate et al., 1998b, 2000).

Conclusion

In arid environments, hunter–gatherer groups responded to events of droughts by employing a diverse set of strategies such as changes in subsistence, mobility, and settlement that were often accompanied by the development of behaviors that favored specific techniques of water acquisition, such as the digging of wells.

PO4 water well was dug at *c.* 8700 to 8000 ^{14}C yr BP. Based on local paleoenvironmental information, dry pulse events occurred, probably affecting surface water quality and availability. Under these circumstances, the water well was excavated reaching a depth where the water table was found. This is suggested by the presence of more intense redox reaction in the sediments related to the base of the pit, which may also indicate variations in the water table. Moreover, the significant increment of the frequency of anurans at the bottom of the pit indicates the presence of water. The remarkable and abrupt changes in sediment textures throughout the feature's stratigraphy, complemented with the differential distribution of the archaeological material within the pit, are among the strongest evidence for proposing an episodic filling history of the water well (Figure 4). The first episode of filling at the base of the pit contains the coarser fractions of sediments as well as the biggest artifacts which were probably used for digging and also as 'filters' for cleaning the water. This first filling event represents the abandonment of the use of the pit and the beginning of the natural sedimentation, where sand predominates. A second natural filling episode is represented where the percentages of the finest sediments increased. This portion of the pit is characterized by few and scattered archaeological items. This situation clearly changed in the upper part of the well, where the proportion of archaeological materials significantly increased. A new change toward coarser sediments occurred in this section, with a final predominance of the finest sediments at the very top of the pit. Based on these episodic events, at least a two-stage filling history is proposed: (1) a slow, probably episodic, natural filling occurred at the base of the feature, near the first 50 cm, characterized by low frequency of archaeological material. This filling episode would have taken place after the water table descended, and it is likely that at this time the site was abandoned. (2) Along with the change in sediment composition, greater quantities of archaeological materials were found in the upper portion of the pit (first 40 cm). This massive accumulation is interpreted as a cultural fill produced by people who inhabited the site after the well was no longer used.

Information on population dynamics and demography derived from radiocarbon date probability distributions indicates a continuous occupation during the early Holocene at regional (Pampas) and areal (Interserrana) scales (Martínez et al., 2015: Figures 2 and 3). Thus, regional abandonments and intermittent occupations of the area at that time cannot be supported so far. Besides, the characteristics of the well do not indicate maintenance; on the contrary, after use the pit was filled intentionally and the setting was continually occupied through time. Then, a scenario of 'drought escape' (Gould, 1991; Meltzer, 1995) cannot be defended. The case described here fits partially with a strategy of 'drought evasion'. The well seems to have mitigated an exceptional lack of surface water in the Pampas or offered an alternative for the non-potable quality of the available surface water (e.g. salty). The relevance of this case is that the strategy of digging water wells was available in the behavioral repertoire of the Pampean hunter–gatherer populations of the early Holocene. This information indicates that these groups possessed a great flexibility and resilience for dealing with short-term shortages of water.

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