LAS QUEMAS ROCKSHELTER: UNDERSTANDING HUMAN OCCUPATIONS OF ANDEAN FORESTS OF CENTRAL PATAGONIA (AISÉN, CHILE), SOUTHERN SOUTH AMERICA

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Hunter-gatherer occupations of the forests of Patagonia are still not well understood compared to those of the open steppe and the coasts. The paucity of forest sites with a thorough chronological framework and the incomplete picture of climate-human dynamics in such environments pose a challenge to understanding the occupations of such habitats. This paper presents recent work at the Las Quemas rockshelter, an archaeological site located in the Andean forests of the Aisén region (44°38' S) dating between 6100 and 2400 cal B.P. We examine the context of the site, its rock art, and the technological and functional dimensions of its lithic assemblage. By comparing these records with local environmental reconstructions that report forest area fluctuations after the Post-Glacial period, this study provides novel data for a comprehensive regional-scale model of human occupations in central Patagonian forests. Following an initial mid-Holocene occupation, recurring occupational events at the site coincide with a significant contraction of forested area in the region during the late Holocene. The results are discussed in regard to regional archaeological data and current models of forest occupation in Patagonia.

Las ocupaciones de cazadores-recolectores en los bosques de Patagonia están aún escasamente entendidas en relación con las de espacios abiertos de estepa y las costas. La escasez de sitios con un acabado marco cronológico en los bosques y el incompleto entendimiento de las dinámicas humanos-clima, debilitan la comprensión cabal de las ocupaciones de tales hábitats. Este artículo presenta trabajos recientes desarrollados en el alero Las Quemas, un sitio arqueológico localizado en los bosques andinos de la región de Aisén (44°38' S) con ocupaciones entre 6100 y 2400 años calibrados A.P. Específicamente, abordamos el contexto del sitio, su arte rupestre y las dimensiones funcional y tecnológica de su conjunto lítico. Al comparar estos registros con las reconstrucciones ambientales locales disponibles que caracterizan las fluctuaciones del bosque después del post Glacial, este trabajo provee información novedosa para un modelo integral de las ocupaciones humanas de los bosques de Patagonia Central en una escala regional. Después de una ocupación inicial durante el Holoceno medio, los eventos ocupacionales redundantes en el sitio coinciden con una significativa contracción del bosque durante el Holoceno tardío. Estos resultados son discutidos en el marco de los datos arqueológicos en una escala más amplia y en relación con los modelos actuales de ocupación del bosque en Patagonia.

Our understanding of the human occupation of Patagonia is dominated by ethnographic and archaeological studies of the steppe and coastal regions (Méndez and Reyes 2008). Forest environments pose a major challenge for investigating the variability of human occupations, especially in continental Patagonia south of 42° S, because the impact of human occupation on forests is low, and limited visibility poses sampling problems. As a result, forest occupations in Patagonia and the use of forest resources are still poorly understood.

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Archaeological contexts in the temperate forests of western South America date to as early as the terminal Pleistocene (Dillehay 1997). Site reoccupation, raw material selection, particular technologies, and settlement choices, among others, have been discussed for the Araucanía region north of 42° S for distinct periods and at different spatial scales (e.g., Campbell and Quiroz 2015; Dillehay 2007; García 2009). In the same latitudinal region on the eastern slopes of the Andes, the number of radiocarbon dates from archaeological sites located in forests increases suddenly after 3500 cal B.P. (Barberena et al. 2015; Fernández et al. 2011), probably as the result of the loss of earlier datable material. Several scholars have identified characteristics of forest occupation in southwest Río Negro and west Chubut (Argentina), with a specific focus on settlement patterns, subsistence, technology, rock art, and raw material use (e.g., Fernández 2008; Fernández et al. 2011; López et al. 2009; Pérez and Smith 2007; Scheinsohn et al. 2010, 2015; Scheinsohn and Matteucci 2004). Others have investigated the possible contact between the eastern and western slopes of the Andes through mountain corridors (Bellelli et al. 2008).

This scholarly focus contrasts sharply with the amount of data published on the forests of the Aisén region (43°40' to 49° S), which comprises roughly one-third of the Patagonian forests (Figure 1). In this area where the Western Andes descend directly into the ocean, systematic archaeological explorations have been limited to the coastal fringe (Méndez and Reyes 2015:21). Although the initial dates for the coastal human occupation extend back to the mid-Holocene, radiocarbon dates mainly fall into the period after 2000 cal B.P. (Reyes et al. 2015:217). The steppe and the forest-steppe transition to the east of the Andes have higher site frequencies than the western slopes; intermittent human presence has been documented there throughout the Holocene (Mena and Stafford 2006; Méndez et al. 2011). In contrast, immense areas within the forested Andean valleys remain without survey coverage. Few sites there have been excavated, and knowledge of the spatiotemporal dimensions of human occupation is limited.

Two main scenarios have been proposed for understanding human occupations of forests in Andean Patagonia and the changes in their intensity (Scheinsohn et al. 2009). First, forests in this area are less productive (cervids are often solitary, unpredictable prey), more difficult to move through, have visibility constraints, and are much more abrupt in their topography than neighboring habitats. Therefore, occupation of the Andean forest must have complemented that of the steppe, most likely on a seasonal basis. The intensity of human occupation of forest regions is low compared to open spaces (e.g., Belardi and Campán 1999; Belardi et al. 2010; Borrero and Muñoz 1999; Reyes et al. 2009). Accordingly, western forests have been interpreted as marginally settled by populations principally located in the steppes (Borrero 2004:59). These populations may have intensified their occupation of forests during certain periods, but continued to do so in a complementary fashion (e.g., Bellelli et al. 2000; Fernández et al. 2013; Méndez and Reyes 2008; Silveira 1999).

An alternative scenario proposes that forests were permanently inhabited during specific periods, as suggested by the study of archaeofaunal assemblages (Pérez and Smith 2007), rock art designs, and biogeographical constraints. For example, in the case of Aisén, Mena (2013:187) has proposed that a microidentity developed during the late Holocene in the middle Ibáñez basin (~46°10' S).

Only few archaeological sites, however, have produced well-dated stratigraphic sequences in forest settings. The use of multiple radiocarbon dates is an appropriate method for defining occupational redundancy and for assessing the spatiotemporal dimensions of human presence and activities in specific environments. The latter requires comparison with similar data sets from neighboring areas that provide a regional context. Moreover, it is important to develop a comprehensive understanding of environmental fluctuations on a local and regional scale. In this case, the spatial extent of forests, their properties (closed or open canopies), available resources, and the role of fires in these environments provide valuable comparative paleoenvironmental data for interpreting the archaeological record. Finally, assessing the role of key resources is critical for understanding human occupations in forests. In this study, we employ use-wear analyses and a newly developed experimental program to assess

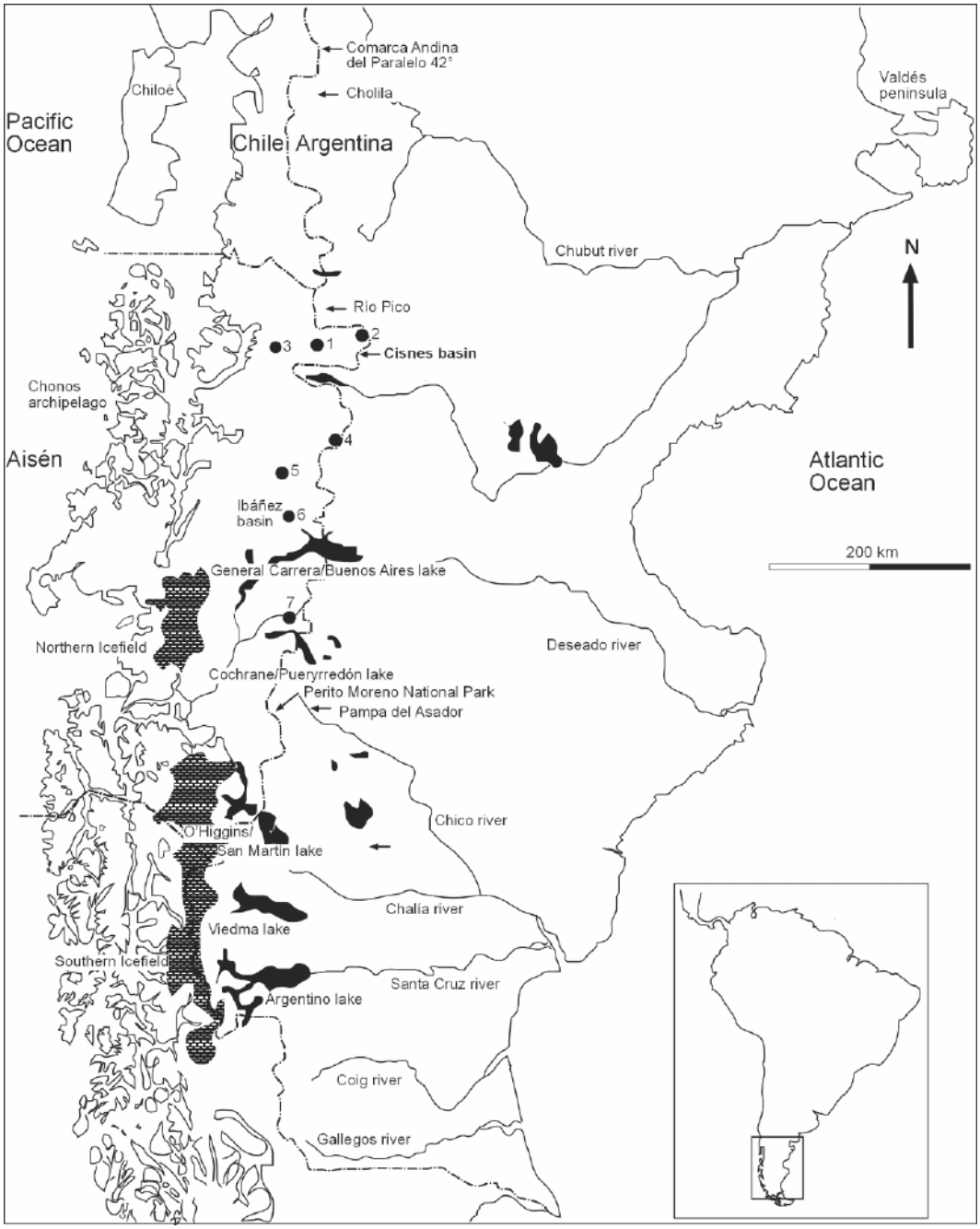


Figure 1. Map of the South Central Patagonia depicting sites and areas mentioned in the text. 1. Las Quemas rockshelter and Mallín El Embudo, 2. El Chueco 1, Lake Shaman and CIS obsidian source, 3. El Toro rockshelter, 4. Punta del Monte, 5. Coyhaique area (Lomo de Dragón, Cueva Divisadero), 6. Ibáñez basin mid-section (Fontana rockshelter, Las Guanacas cave), 7. Gianella rockshelter.

the utility of potential resources, including the procurement of wood.

Current information suggests that the Aisén steppe was first occupied at the onset of the Holocene (Méndez and Reyes 2008). Cave sites in the Cisnes (~44°30' S) and Ñirehuao (~45°15' S) basins show recurring occupations (Mena and Stafford 2006; Méndez et al. 2011), indicating

that the region was intermittently occupied at varying degrees of intensity and in connection with areas to the east (Méndez et al. 2012, 2014). The earliest forest occupations have been recorded in the Ibáñez River Basin. Las Guanacas cave and Fontana rockshelter yielded basal dates of 6450–5640 and 5620–5320 cal B.P. (Mena 1983:72, 2000:34). The evidence of occupation for this area is not continuous; it is sparse until the last millennium (Fuentes and Mena 2010; Reyes 2002).

This paper presents recent work at the Las Quemas rockshelter, which is a key location for understanding forest occupations of the Cisnes Valley of Central Western Patagonia. The Cisnes River is the only river that crosses the Aisén region east to west, covering the range of vegetation zones. As such, it is theoretically suitable for recognizing potential incursions into different types of forest environments (Méndez and Reyes 2008). The distribution of the 50 sites recorded in the Cisnes basin shows a marked drop in the number of sites moving from east to west (steppe: 26; forest-steppe transition: 17; deciduous forest: 6; evergreen forest: 1). The contemporaneous occupation of sites between 2800 and 2300 cal B.P. in the steppe (El Chueco 1) and in deciduous (Las Quemas rockshelter) and evergreen (El Toro rockshelter) forests along the Cisnes basin has been interpreted as a rise in seasonal or sporadic forest occupation. It was possibly triggered by disadvantageous environmental conditions in the steppe where groups dwelled permanently (de Porras et al. 2014; Méndez and Reyes 2008). After this rise, there are no more records of occupations in the Cisnes basin forests (Reyes et al. 2009:20). This article describes recent excavations conducted at Las Quemas, the geoarchaeological context of the site, radiocarbon dates, rock art evidence, and a complete study of lithic evidence. The results of this study are discussed in the context of local paleoenvironmental reconstructions and regional archaeological data. As a result, the Las Quemas rockshelter provides a new perspective for understanding certain aspects of the human occupation of central Patagonian forest environments.

Regional Setting and Paleoenvironment

To the west of central Patagonia, the environment of the Aisén region is primarily shaped by the prevailing westerly winds and the orographic effect produced by their interaction with the Andes mountain range (Garreaud 2009). In the western part of the region, abrupt escarpments descend directly into the ocean, whereas to the east of the Andes, the landscape consists primarily of extensive sedimentary plains. Precipitation values in excess of 3,000 mm/yr in the western archipelagos and coastal mountains, 1,500–850 mm/yr in the deciduous forests, and less than 400 mm/yr in the eastern semiarid open steppes reflect a marked west-to-east decrease in precipitation (Pliscoff 2003). In the Cisnes River Basin, this rainfall gradient takes place across less than 140 km. The main vegetation communities are dominated by Magellan's *coigüe* beech (*Nothofagus betuloides*), mistletoe (*Desfontainia*), and *quila* (*Chusquea*) in the evergreen forests; *lenga* beech (*N. pumilio*) in the deciduous forests; *ñirre* beech (*N. antarctica*) and *calafate* (*Berberis*) in the forest-steppe ecotone type transition; and *coirón* (*Festuca pallescens*) and *neneo* (*Mulinum spinosum*) in the grass steppe (Luebert and Pliscoff 2006). Potential animals of prey include the *guanaco* (*Lama guanicoe*) in the open settings. The forests are inhabited by cervids, such as the South Andean deer, or *huemul*, and the *pudú* (*Hippocamelus bisulcus* and *Pudu puda*). A wide array of smaller fauna (carnivores, dasypods), including birds (Muñoz-Pedreros and Yáñez 2009) are common to most environments.

Sedimentary records from the local Lake Shaman and Mallín El Embudo have been used to reconstruct climate variability since the Post-Glacial period in the Cisnes River Valley (de Porras et al. 2012, 2014; Figure 2). The pollen record from Mallín El Embudo, located in a forested area near the Las Quemas rockshelter (~13 km), reflects the varying overlap of the forest canopy on the horizontal plain. This indicates closed- or open-forest environment. At the beginning of the lake core sequence dating to between 13,000 and 11,200 cal B.P., grass taxa accompanied by herbs and shrubs with minor *Nothofagus* pollen suggest a local grass steppe environment (de Porras et al. 2014:1071). The presence of *Nothofagus* pollen may be explained either by scant forest patches or long-distance transport from the western coastal forests (Bennett et al. 2000). This pollen assemblage is consistent with effective moisture levels that were lower than modern levels. It is partially

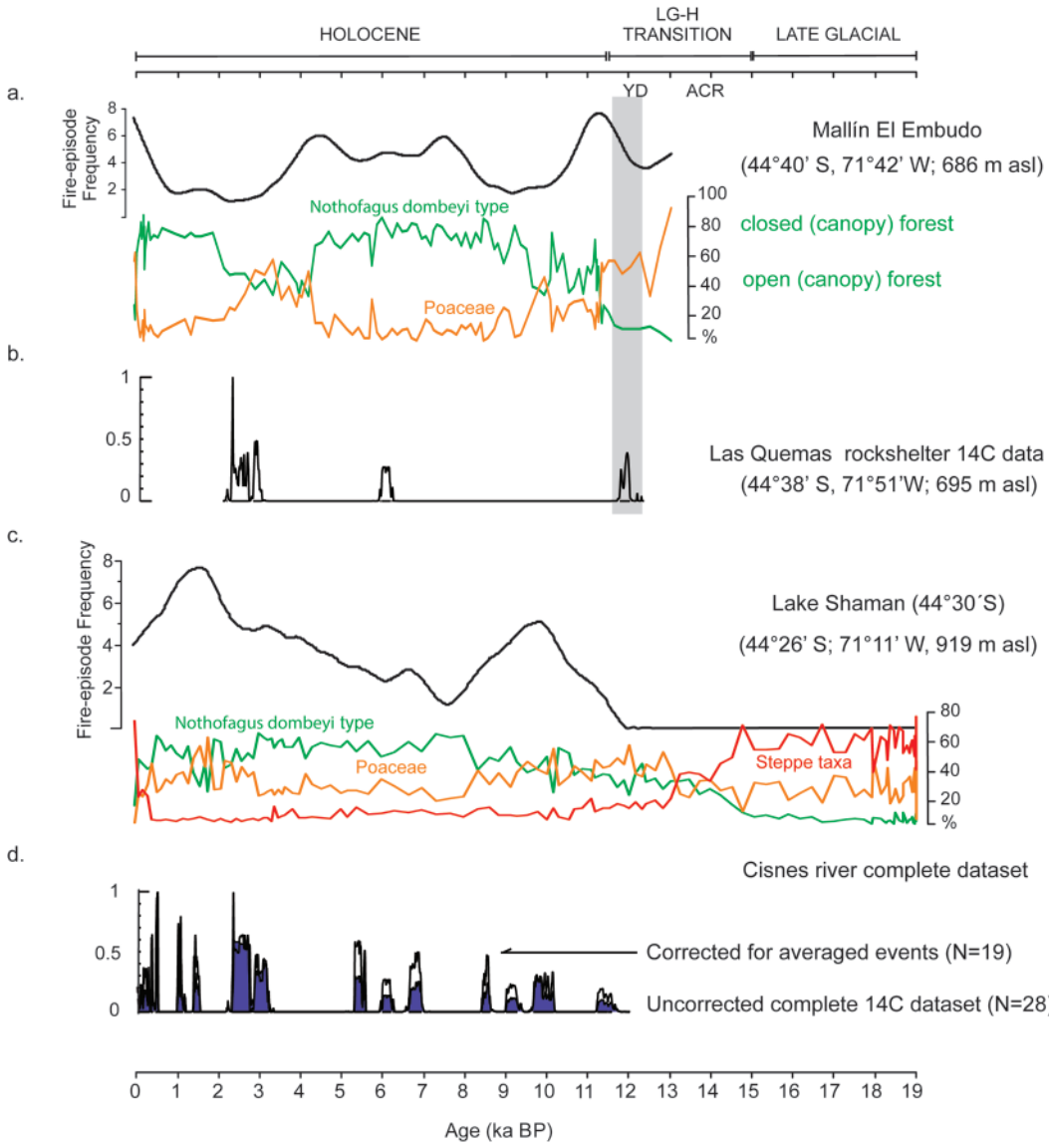


Figure 2. Pollen and charcoal from (a) Mallín El Embudo and (c) Lake Shaman (based on de Porras et al. 2014), and summed probability plots for radiocarbon data from (b) Las Quemas rockshelter and (d) all archaeological sites in Cisnes River Basin (averaged events followed the protocols described in the methods section).

explained by the initial landscape configuration following the retreat of glaciers.

A major increase of *Nothofagus* and other forest taxa indicates that an open forest developed between 11,200 and 9500 cal B.P. and that effective moisture remained at lower than modern values (de Porras et al. 2014:1071). The highest *Nothofagus* pollen percentages were recorded between 9500 and 4200 cal B.P. and reflect the development of a closed forest, which may have opened slightly after 5700 cal B.P., as suggested by minor fluctuations in the record (de Porras et al. 2014:1071). This coincides with the major expansion of forest taxa observed between 8000 and 3000 cal B.P. in the pollen profile from Lake Shaman, located 48 km northeast of Las Quemas in today's grass steppe (de Porras et al. 2012:77). From 4200 to 2000 cal B.P., the major decrease in forest taxa and a concomitant increase in understory taxa and grasses (Poaceae) indicates a

sudden vegetation change to open forest conditions in Mallín el Embudo (de Porras et al. 2014:1071). Finally, during the last 2,000 years, the frequency of *Nothofagus* increased. This increase was not as pronounced as the change that occurred during the early to mid-Holocene. Nonetheless, it is marked enough to suggest the presence of a closed forest. Modern climatic conditions characterized by dynamic shifts in vegetation were established by 400 cal B.P.

The sedimentary record at Mallín El Embudo shows a highly variable Charcoal Accumulation Rate (CHAR) with periods of low accumulation that are punctuated by high-magnitude fire episodes (de Porras et al. 2014). High fire frequencies and high magnitude episodes were characteristic for the period from 13,000 to 10,500 cal B.P., with a distinguishable maximum fire episode at ~12,000 cal B.P. High fire frequencies also occured from 8200 to 3800 cal B.P. In contrast, between 10,500 and 8000 cal B.P., and again from 3800 to 400 cal B.P., fire frequencies were generally low and the magnitudes were variable.

Methods

Archaeological fieldwork at the Las Quemas rockshelter focused on the excavation of a 12-m^2 area near a 1-m^2 test pit initially excavated by Mena (1996). The excavators used 10-cm arbitrary levels to identify distinct stratigraphic layers. Careful excavation included the tridimensional location of all artifacts larger than 3 cm and the identification of features to understand the horizontal relations between them. Excavation was restricted to 9 m^2 after a 50-cm depth. All of the sediments were sieved with a 4-mm mesh. We used ^{14}C (radiocarbon) AMS dating to establish the chronology of human occupation at the site and to understand site formation processes. Whenever several radiocarbon ages were statistically indistinguishable at $\alpha = .05$, occupational events were calculated by averaging them (Ward and Wilson 1978). The radiocarbon dates that are discussed in this paper were corrected by calibrating the ages into years before present (cal B.P.) with Calib 7.0.0 (Stuiver et al. 2013) applying the ShCal13 curve (Hogg et al. 2013); the dates are reported as 2σ.

The rock art analysis followed methods used for other sites in the region (Nuevo Delaunay et al. 2013), including image enhancing with the use of the D-Stretch program (Harman 2008). Rock art elements are defined as discrete units limited by the edges of the rock panels. These units were grouped into simple or complex motifs. The frequencies of elements and motifs should be regarded as a minimum number, given the advanced deterioration of the rock art.

Lithic material was analyzed using technological criteria that focused on assessing completeness, cortex index, tool and debitage classes, and design attributes (Andrefsky 1998). Lithic raw material identification was performed macroscopically (25 samples). The identifications were cross-checked with thin-section petrography (6 samples) and geochemical trace-element composition for selected obsidian samples using ELAN D CR ICP-MS at the University of Colorado. Trace-element compositions are considered accurate to ± 5 percent at the level of concentrations, based on repeated analysis of standard rock samples of known composition. Obsidian types were defined by comparing these data with the trace-element chemistry of obsidian samples from known sources (Stern 2004). Given the specific nature of forest resources, use-wear analyses were performed on retouched and unretouched lithics to identify particular actions and substances (Keeley 1980). These analyses included an experimental program that was designed for identifying expected uses of tools on different raw materials, targeting specifically the wear produced by woodworking (Hormazábal 2015). Microscopic observation at 200x of all lithics with edges longer than 3 cm was conducted with a digital polarized handheld Dino-Lite (model AM413ZTA) device.

Site Context, Stratigraphy, and Chronology

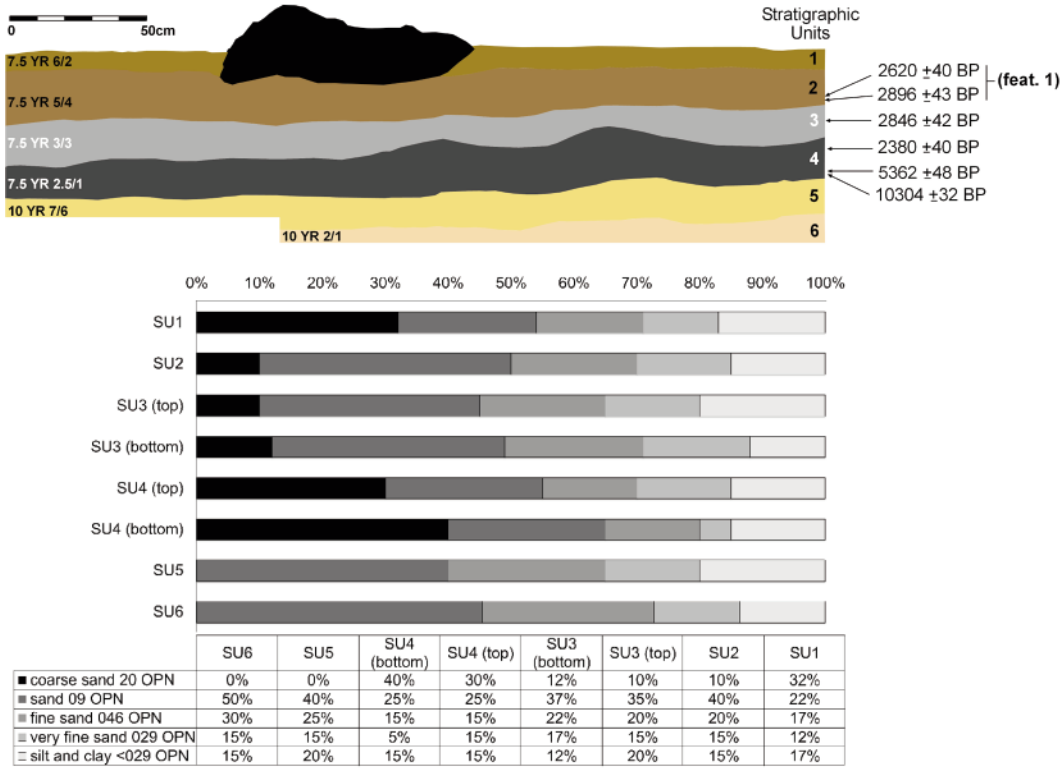
The Las Quemas rockshelter (44°37'42'' S, 71° 51'37''W, 724 m asl; Figure 3) is located at the headwaters of Las Quemas creek (Mena 1996; Méndez and Reyes 2006), which runs a length of 12.5 km. The creek first continues parallel to the Cisnes River and then drains into the mid-section of the river from northeast to southwest. This small valley is limited to the north by the Las Quemas range (> 1,600 m asl) and can be accessed only from the Cisnes juncture or along a wide terrace at the creek's headwaters. The site is fairly accessible

Figure 3. Overview of the excavations at Las Quemas rockshelter.

and visible from afar, although the view has probably been enhanced by forest clearance in the twentieth century. The shelter faces northeast, is 40 m long (E-W), and provides a protected horizontal area of ~200 m^2. The site is still used for herding.

Excavations were conducted in the center of the shelter, where occupants would have received maximum protection. The excavated section exposed six distinctive stratigraphic units (SU) that were horizontally superimposed, as shown in the southern profile (Figure 4). Roof fall particles, sometimes in excess of 125,000 cm^3, complicated the observation of layers, specifically in the western sector. As such, different SUs were occassionaly represented at the same depth or artificial level. Given the large number of volcanoes in the region, ash may be one of the main components of aeolian particles (Mena and Buratovic 1997; Vandekerkhove 2014).

SU1 was primarily composed of coarse and mid-size sand that was slightly compacted and had a minor presence of clasts. The topsoil was immature, with a 3-cm deep O-horizon and roots throughout the A-horizon. SU1 and SU2 were separated by a clear boundary. SU2 consisted of finer, slightly more compacted sand that had minor clast and was of brown color. It yielded a minor presence of charcoal speckles. The boundary between SU2 and SU3 was diffuse. SU3 was composed of fine sands that were probably more weathered than the overlaying strata because it included buried thin A- and B-horizons. Clasts were rare and charcoal particles were abundant in this dark-brown layer, which shared a diffuse boundary with the underlying SU4. The matrix of SU4 contained larger grain-size particles that included small granules in minor proportion, especially in the southern sector. In this unit, charcoal flecks were the most common and extended across the excavation area. This is likely the result of local fires that may have caused the higher organic content (black in color) of the layer as well as the abundance of roof fall particles observed at the base of SU4 and in the southern profile. The base of SU4 also yielded small (10–13 cm) pebbles; it differs sharply from the unit beneath. SU5 was composed of heavily compacted finer sands and smaller grain-size particles with a small proportion of exogenous pebbles (3–15 cm). It yielded no charcoal and was inorganic and yellow in color. The stratigraphic boundary between SU5 and SU6 was diffuse. The last layer, SU6, was also a heavily compacted layer of inorganic fine sands, which may have been deposited by normal grading in a subaquatic environment, as suggested by weak layering.



	SU6	SU5	SU4 (bottom)	SU4 (top)	SU3 (bottom)	SU3 (top)	SU2	SU1
coarse sand 20 OPN	0%	0%	40%	30%	12%	10%	10%	32%
sand 09 OPN	50%	40%	25%	25%	37%	35%	40%	22%
fine sand 046 OPN	30%	25%	15%	15%	22%	20%	20%	17%
very fine sand 029 OPN	15%	15%	5%	15%	17%	15%	15%	12%
silt and clay <029 OPN	15%	20%	15%	15%	12%	20%	15%	17%

Figure 4. Southeastern stratigraphic section of the main excavation at Las Quemas rockshelter and grain size analysis of sedimentary particles.

The archaeological materials associated with SU1 included a small number of discarded metal pieces spatially associated with a recent or historical 4-cm deep hearth (Feature 1) located in the center of the excavation. Lithics were scarce and not directly associated with the hearth. Except for a small number of sheep remains in SU1, no other bone materials were recovered from the excavated area, most probably due to poor preservation caused by the open nature of the rockshelter. The sparce lithic evidence associated with SU2 was homogeneously dispersed throughout the excavated area. At the base of the unit, roof fall boulders were exposed. These circumscribed a hearth

Table 1. Radiocarbon Dates from Las Quemas Rockshelter.

Lab. code	Stratigraphic unit	Quadrat	Material	^{14}C yr BP	δ^{13}C	2σ calibration (years B.P.)
AA102686	2 (z = 22 cm)	2D	Charcoal (Feature 1) outside	2896 ± 43	-29.1	2850–3080
BETA 227704**	2 (z = 30 cm)	1C	Charcoal (Feature 1) inside	2620 ± 40	-27	2490–2780
AA102687	3 (z = 43 cm)	2D	Charcoal (isolated)	2846 ± 42	-26.1	2780–3010
BETA 227705**	4 (z = 38 cm)	2C	Charcoal (isolated)	2380 ± 40	-25.3	2200–2490
AA102685	4 (50–60 cm)	3B	Charcoal (isolated)	5362 ± 48	-27.8	5990–6270
D-AMS 007716	UE4 (base, below roof fall particles)	1B (profile)	Charcoal (isolated)	10304 ± 32	-25.5	11,810–12,070
BETA 214640*	3–4	Test pit 1	Charcoal (isolated)	2510 ± 40	-26	2380–2720

* Méndez and Reyes (2006).
**Méndez and Reyes (2008).

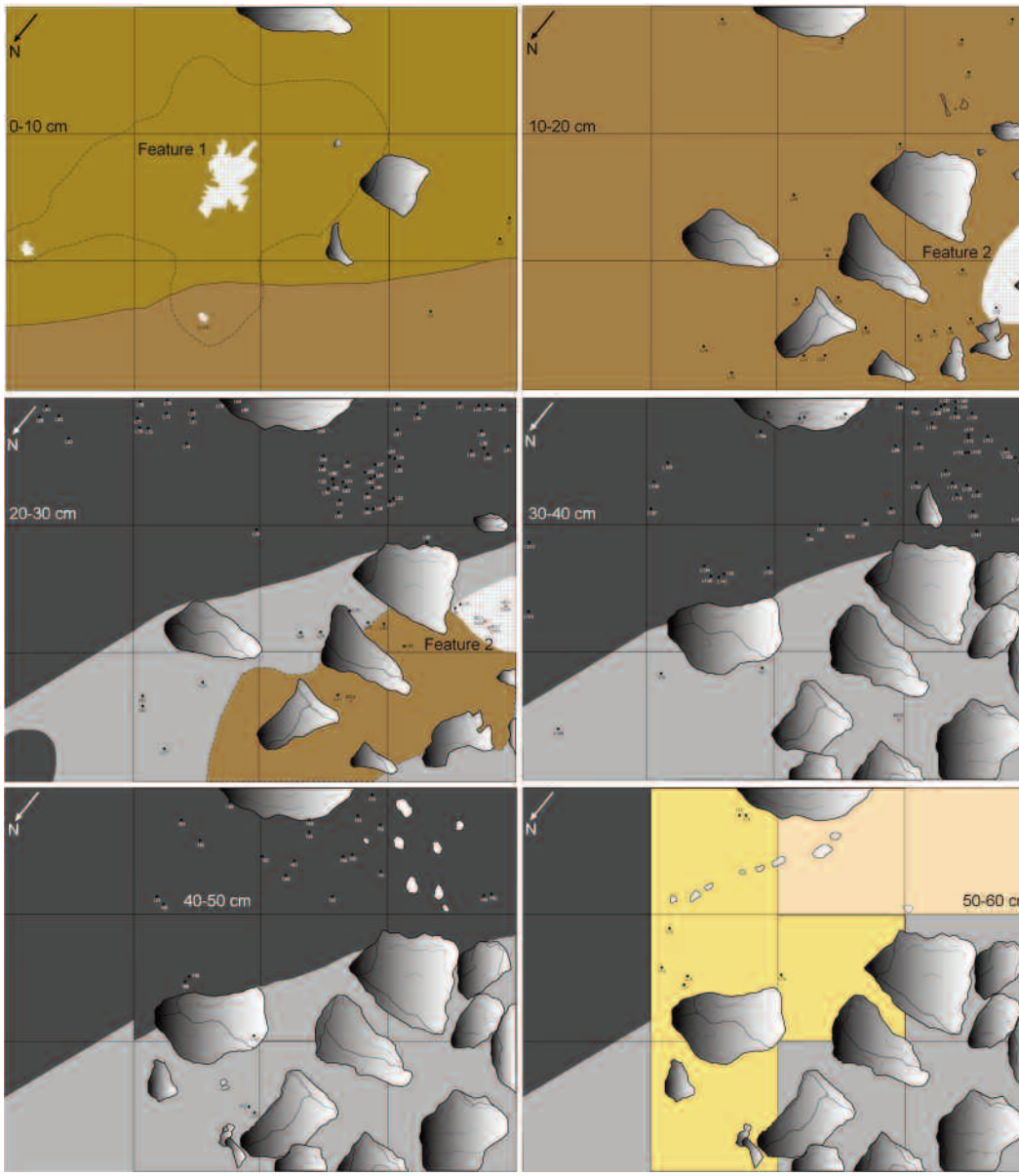


Figure 5. Ten-centimeter plans of the excavation at Las Quemas rockshelter depicting layers in horizontal manner as they were excavated, features, and piece-plotted artifacts.

(Feature 2) dated to 2490–2780 cal B.P. (Table 1; Figure 5). The hearth deposit was over 10 cm thick and extended into four excavation quadrats. SU3 yielded a significant concentration of lithic artifacts in the southern portion of the excavation area. The concentration continued through SU4 to a depth of 50 cm below surface. At this depth, the spatial extent of the lithics was reduced to only two quadrats—3B and 3C—and disappeared from the quadrats with the highest concentrations in the previous levels. All of the dated charcoal samples (N = 5) between 20 and 43 cm in depth from SU2, SU3, and SU4 yielded dates between 2200 and 3100 cal B.P. (Table 1). A single radiocarbon date obtained from a charcoal fleck at the top of SU4 reflects an inverse depositional pattern, which suggests that it was intrusive. In SU4, below 50 cm, one charcoal sample from a non-distinctive

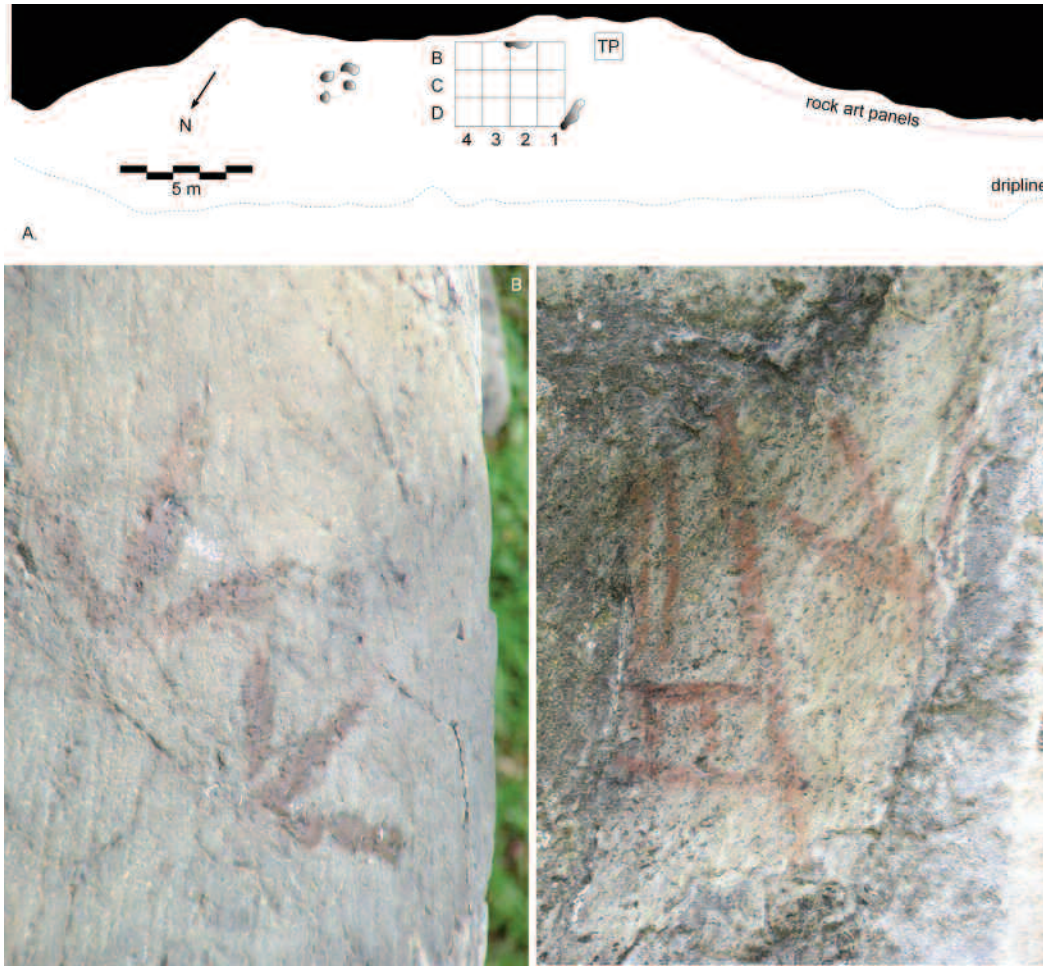


Figure 6. A. general site plan showing the location of rock art, B. group 3: two tri-digit tracks, C. group 4: two parallel lines, abstract motif, and tridigit track.

concentration of flecks associated with the lithics in quadrats 3B and 3C produced a date of 5990–6270 cal B.P. Finally, below the horizontally deposited angular platy clasts associated with the roof fall at the base of SU4, one speck yielded a date of 11,810–12,070 cal B.P. This sample was obtained from the southern profile of the 1B quadrant at a depth without associated archaeological evidence. The date coincides with the maximum magnitude fire episode that was detected at Mallín El Embudo (de Porras et al. 2014). Considering the large amount of charcoal in SU4, a major fire probably occurred in the area before humans occupied the site. No archaeological evidence was recorded in SU5 and SU6.

Given the similarity of some of the radiocarbon dates, three statistically different late Holocene occupational events were averaged and then calibrated to 2200–2490, 2490–2740, and 2850–3040 cal B.P. (2σ). In sum, the Las Quemas rockshelter was used for at least three events during the Late Holocene occupational block from ~2400 to ~2950 cal B.P. (base of SU2 to the top of SU4), and for one occupational event during the mid-Holocene around 5990–6270 cal B.P. (base of SU4 in two of the excavated quadrants).

Rock Art

Five rock art groups or panels were identified at the site (Figure 6a). Group 1 consists of four modern graffiti that depict distinct last names in thick white paint (N = 3) and engraved incisions (N = 1). Ladrón de Guevara (1996) attempted to erase

Table 2. Complete Lithic Sample Classification Ordered by Occupational Blocks and Excavated Levels.

	Complete (Fractured)						
Occupational blocks	2400–2950 cal B.P.					5990–6220 cal B.P.	
Excavated levels (cm)	0–10	10–20	20–30	30–40	40–50	50–60	Total
Retouch debitage		(1)	3	11 (4)	4 (3)	13 (8)	31 (16)
Marginal debitage	3 (3)	9 (6)	54 (34)	63 (48)	34 (38)	29 (16)	192 (145)
Bifacial thinning flake			2	5 (1)	3	9	19 (1)
Core flake	1	7 (2)	22 (15)	15 (6)	4 (1)	4 (5)	53 (29)
Clast (undetermined)		(1)	(3)				(4)
Endscraper			1 (1)	1		(1)	2 (2)
Plane scraper			1				1
Utilized flakes			1	1	1	1	4
Utilized blades		1		2 (1)			3 (1)
Grinding stone	(1)		(1)				(2)
Biface				1			1
Total	4 (4)	17 (10)	84 (54)	99 (60)	46 (42)	56 (30)	306 (200)

the graffiti following standard conservation procedures. All of the other panels had elements of red paintings with distinct levels of light, moderate, or heavy wear.

Group 2 displays motifs that consist of one set of concentric circles, two individual circles, two small parallel lines (occasionally interpreted as *guanaco* tracks), four tri-digit tracks (attributed to the flightless lesser rhea, or *Rhea pennata*), and a large, diffuse red paint stain (which may have resulted from the weathering of otherwise recognizable motifs). The aforementioned elements show the three different levels of wear. Group 3 consists of two heavily worn tri-digit tracks (Figure 6b). This is the only panel facing upward; the rest were painted on the main wall oriented north. Group 4 is composed of one large tri-digit, two parallel lines, and one complex abstract motif depicting a rectangular form with attached lines (Figure 6c). They all show light wear. Finally, Group 5 consists of several (~11) parallel lines, of which one is larger than the others. This group includes a large red stain, and the paintings show moderate wear. We do not presuppose that a distinct wear level is associated with particular motifs or panels.

Five hundred meters to the east, the research team identified Las Quemas 2 (44°37'36''S, 71°51'59''W, 724 m asl), a significantly smaller rockshelter that depicts similar rock art in one panel. The elements include parallel lines and smaller tri-digit tracks (N = 4), which are arranged in opposing directions. The characteristics of this shelter did not allow for excavation to be conducted.

The Lithic Assemblage

The excavation at Las Quemas yielded very low artifact frequencies, with fragmentation rates ranging between 35 and 50 percent per level (Table 2). Because high fragmentation increases the potential for overrepresenting data, the artifact counts presented here include only the pieces that bear striking platforms, such as flakes (Andrefsky 1998:83). Lithics were preliminarily assigned to chronological blocks that encompassed several stratigraphic units. Two hundred and fifty lithic artifacts were associated with the three stratigraphically indistinguishable events that constituted the late Holocene occupational block, whereas 56 lithics were assigned to the mid-Holocene occupation. The reduced discard of lithics therefore indicates a human occupation of low intensity.

The assemblage is largely represented by debitage classes, which are mainly flakes produced during edge modification (e.g., marginal debitage; Table 2). Core flakes are less represented, which suggests that most lithics must have entered the site as flakes instead of being locally extracted from cores. This indicates that rocks were introduced to the site at an advanced stage of processing and implies that the initial stages of reduction occurred at other locations in the area. Other debitage classes are even less frequent. Activities such as bifacial thinning and edge retouching were not conducted systematically at the site. Judging from the lithic assemblage, cores were not discarded at the site.

Only a very minor part of the assemblage displays attributes of recognizable formal or informal

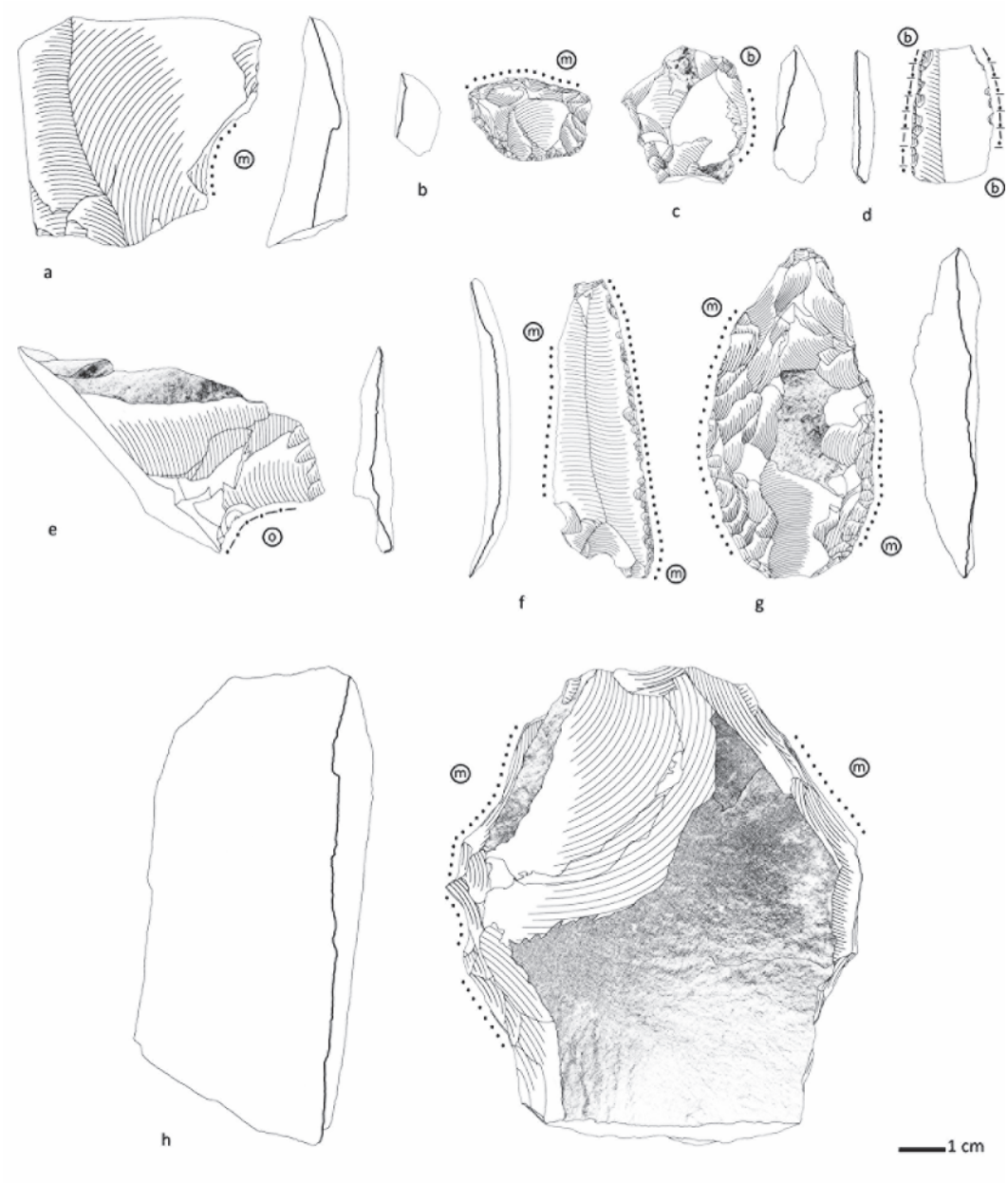
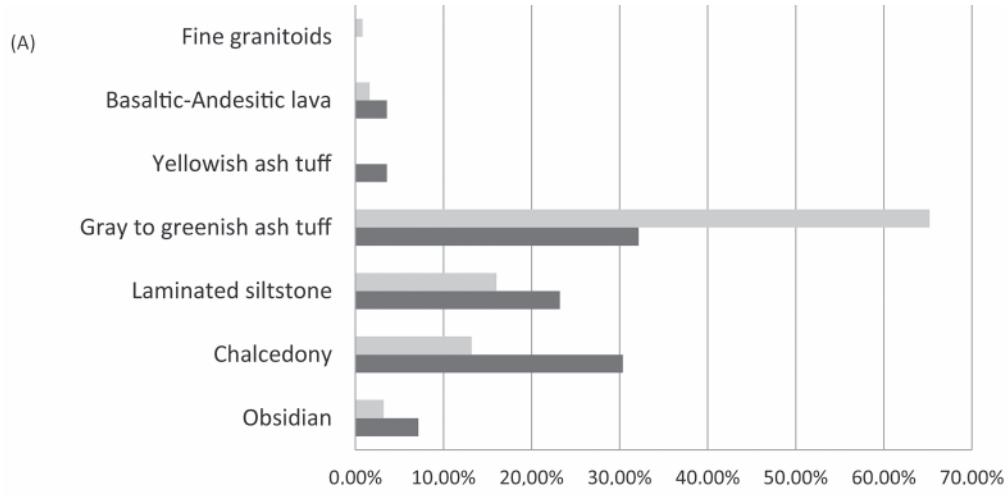


Figure 7. Lithic material classes (and functions); a. utilized flake (scrape, hard substance); b. scraper (scrape, hard substance); c. retouched flake (cut wood); d. blade mid-fragment (scrape, wood); e. utilized flake (scrape, wood); f. blade (scrape and cut, hard and semi-hard substance); g. biface (scrape, hard substance); h. plane scraper (scrape, hard substance); dots: microflaking, lines: micropolish; circled m: one shown margin; circled o: opposite margin; circled b: both margins.

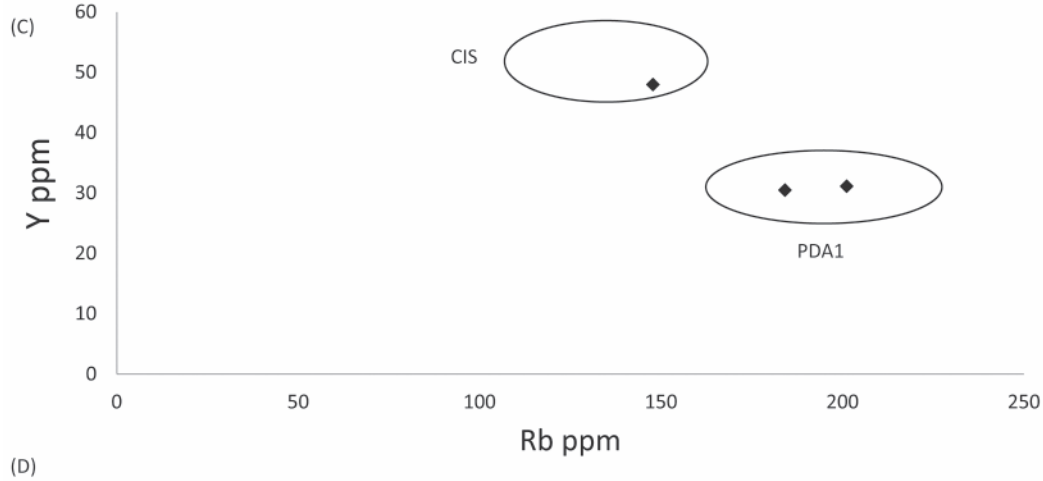
tool classes, and no one tool class dominated (Figure 7). In addition, the overall proportion between debitage and tools is constant for both occupational blocks: ~98 percent of debitage for the earlier assemblage, and ~97 percent for the later one. There were only two recorded fragments that were attributable to grinding stones. One had distinctive traces of red pigment and was probably used to process the pigment for the rock paintings.

Only seven lithologies are represented in this assemblage. The most frequent raw material group included gray to greenish ash tuffs with abundant



(B)

	Obsidian	Chalcedony	Laminated siltstone	Gray to greenish ash tuff	Yellowish ash tuff	Basaltic-Andesitic lava	Fine granitoids
2950-2400 cal BP	8	33	40	163		4	2
6220-5990 cal BP	4	17	13	18	2	2	



(D)

Sample	type	Ti	Mn	Rb	Sr	Y	Zr	Nb	Cs	Ba	Hf	Pb	Th	U
CM10	PDA1	723	283	201	35	31	132	25	9,3	231	4,8	21,5	8,2	5,0
CM11	PDA1	718	272	184	34	30	135	41	9,2	229	8,9	19,9	8,1	4,8
CM13	CIS	917	546	148	8	48	288	26	5,4	293	8,2	17,7	8,2	4,5

Figure 8. Lithic raw materials at Las Quemas rockshelter: (A) percentages express relative proportions per occupational block based on (B); (C): Plot of Rb versus Y concentrations, in parts-per-million (ppm), for obsidian artifacts based on (D). The 2-sigma confidence ellipses define fields for the chemistry of the obsidian from known sources (PDA1; CIS) (Méndez et al. 2012; Stern 2004).

quartz crystals (Figure 8), which could be procured in the dacite to rhyolitic ignimbrites that protrude from the ground in the area around the site (Divisadero Formation, de la Cruz and Cortés 2011:14). Laminated siltstones may have originated from the sedimentary Apeleg Formation, while the basaltic-andesitic lavas were most probably aquired from the Winchester Basalt Formation (de la Cruz and Cortés 2011:22). These materials could be considered locally available. The

Table 3. Worked Substances and Specific Actions Identified by Functional Analysis per Edges.

	Worked substance				Actions		
	Soft	Semi-hard	Hard	Wood	Cut	Scrape	Indeterminate
Plane scraper	-	-	1	-	-	1	-
Blade (unretouched)	-	8	6	2	3	13	4
Flake (unretouched)	3	11	12	2	11	16	3
Scraper	-	-	3	-	1	2	-
Biface	-	-	1	-	-	1	-
Total	3	19	23	4	15	33	7

technological attributes of debitage on these stone-tools and on granite are consistent with the local procurement.

Chalcedony must have been obtained from afar; the intention to curate this high quality non-local lithic material is indicated by formal attributes on the discarded tools. Three obsidian artifacts from the late Holocene occupational block were analyzed using ICP-MS. These artifacts produced signatures consistent with two cases of PDA1 type from Pampa del Asador, a high-quality source east of Perito Moreno National Park, and one case of CIS, a low-quality source in the upper Cisnes Basin (Méndez et al. 2012:370; Stern et al. 2013:245).

An assessment of the knapping quality of the different lithic resources suggests a slightly higher-quality selection of materials associated with the earlier occupational block. Here, ~60 percent of the lithics were produced using good and excellent raw materials. The assemblage of the latter occupation contained only ~33 percent of such materials and was instead dominated by mid-to-coarse grain lithic resources. The choice of raw material is consistent with the high frequency of attributes indicating hard-hammer percussion among the late occupation (~79 percent). In the earlier occupation, this technology is used only half as much (37.5 percent).

The occupational blocks also shared several technological attributes. For example, the platform typology, which consisted of simple designs, remained the same over time. To a lesser degree, there are similarities in the proportion of lithic artifacts without cortex (93 percent in the mid-Holocene, 81 percent in the late Holocene). Blade technology also remained similar, as suggested by the incidence of ridges parallel to the technological extraction axis. The slight difference in the overall size of measureable flakes across occupational assemblages indicates smaller artifacts in the mid-Holocene occupational block.

Given the small size of the assemblage—especially of edge-modified tool-types—we conducted a systematic functional analysis. An experimental program designed with raw materials of equivalent quality (obsidian, basalt, silex) allowed us to identify the used edges and patterns that resulted from specific activities (scraping, cutting). We reproduced these activities with expected local substances (woods, hide, bone, and meat) using both retouched and unretouched edges. Additional details, including direction, time, angles, state of worked substances, and kinematic motion have been discussed elsewhere (Hormazábal 2015).

Of the 338 analyzed edges, only 55 edges (16.27 percent) on 44 lithics yielded traces attributable to use-wear (edges without traces: 81.95 percent; altered edges 1.78 percent). Only four edges on three unretouched artifacts belonged to the mid-Holocene occupational block. Although specific actions were identified for all 55 edges, only 49 yielded sufficiently clear attributes for determining worked substances (Table 3). Scraping was the most frequently performed action. Use-wear traces also indicated activities on hard and semi-hard substances. Most of the clear traces were identified on unretouched blades or flakes. The unmodified edges may have aided in the identification of use-wear traces.

Because the site is located in a forest, one objective was to assess work with site-specific resources, such as wood. Identifiable traces of woodworking, specifically bright and smooth micro-polish attributable to scraping, were recorded in only four cases, and only on unretouched edges. Other identifiable traces indicative of activities on hard or semi-hard substances may also have been produced by woodworking. This

observation is tentative, because more detailed indicators require the use of higher magnifications. Lithic edges predominantly showed evidence of other actions and substances (i.e., cutting and scraping on soft, semi-hard, and hard materials) attributable to tasks expected at campsites.

Discussion

Located in a biogeographical corridor along the Cisnes River that transverses different ecological zones (Méndez and Reyes 2008), the Las Quemas rockshelter presents a useful case study for reconstructing human adaptation to forest environments in Central Western Patagonia. Research at the site elucidates the role of forest environments in the settlement choices and mobility patterns of hunter-gatherers during the Holocene. The artifact assemblage of the site reveals limited raw material diversity, predominantly close-range procurement of stonetools, low discard rates, low tool frequencies, and few utilized edges. This assemblage also represents the discarded material from at least four occupational events, highlighting the reduced nature of tasks performed at the campsite. It is also indicative of the scarcity of archaeological evidence in the Aisén forests and of the traces of human activity in the forests in Patagonia.

The main problem of the Las Quemas rockshelter is the lack of an archaeofaunal assemblage. Archaeofauna have been used to highlight the importance of forest adaptations in Patagonia (e.g., Mena 1992; Mena et al. 2004; Pérez and Smith 2007) and elsewhere (e.g., Yesner 1989). Faunal records at archaeological sites tend to represent locally procured prey instead of the overall subsistence choices of mobile peoples (Barberena and Borrero 2005:192). In an earlier paper, we addressed average regional dietary choices by analyzing stable isotope data from available human remains. We preliminarily concluded that terrestrial mammals from steppe environments were the primary source of protein (Méndez et al. 2014). This view is consistent with the low contribution of forest prey, such as *huemul*, to the overall archaeofaunal record in Patagonia (Fernández et al. 2015).

Other sites in the forests and on the forest-steppe boundary in Aisén between 45°20' and 47° S, e.g., Punta del Monte cave, the Fontana rockshelter, Las Guanacas cave, and the Gianella rockshelter, share the limited evidence for human occupation that we have described for Las Quemas (Fuentes et al. 2012; Mena 1983, 1992; Nuevo Delaunay et al. 2013). Punta del Monte yielded no archaeological material in its stratigraphic deposits (Nuevo Delaunay et al. 2013:132). Data recovered from the Gianella rockshelter revealed a density of 28.5 lithics per m^2 (Fuentes et al. 2012), which is very similar to the 25.3 lithics per m^2 recovered at Las Quemas. Despite archaeological testing, other caves in the region, such as Lomo de Dragón and El Divisadero, have yielded no archaeological remains (Méndez et al. 2013). Visibility may be one of the major factors that influence an archaeologist's ability to locate sites in this area. Even though the main population centers and the vast majority of rural communities in this region are currently located in forests, fortuitous findings of archaeological sites are not common (Méndez and Reyes 2015).

In summary, despite the availability of naturally sheltered venues, human presence in the forests in continental Patagonia south of 42° S appears to be of low intensity. This has been suggested for several other forested regions (e.g., San Martín, Tar, Viedma, and Argentino lakes, and the Gallegos headwaters) that were sampled with different methodological approaches, including the study of regional taphonomy and targeting erosional areas (e.g., Belardi and Carballo Marina 2014; Borrero and Muñoz 1999; Charlin et al. 2011). Indeed, Borrero and Borrazzo (2011) have indicated, based on historical accounts, that more recent populations in this area of Patagonia avoided the forests and its main resource, the *huemul*.

The most plausible scenario for explaining the basal age of 11,810–12,070 cal B.P. is the occurrence of a significant fire episode. This may have been the cause of the intense black charcoal associated with SU4 and would have been contemporaneous with the maximum fire episode recorded by de Porras et al. (2014:1070) in Mallín El Embudo no more than 13 km away. We cannot completely rule out human agency in producing such datable material, given that the El Chueco 1 site yielded one dated human occupational event at 11,500 cal B.P. (Méndez et al. 2011). At Las Quemas, however, no archaeological material was associated with the earliest radiocarbon date. Be-

cause the sample was located directly under roof fall particles, a non-human origin of the charcoal is quite likely.

The depositional rate at Las Quemas limits our understanding of sedimentary dynamics. Within close depth proximities, we recorded dates of ~11,940, 6110, and 2950–2400 cal B.P. This suggests either a possible interruption in sedimentation or an erosive disconformity. During the period of maximum forest expansion caused by an increase in effective moisture between ~9500 and 3000 cal B.P. (de Porras et al. 2012, 2014), the sedimentation rate appears to have stopped. The massive rock fall does not present an easily interpreted, horizontally layered context.

The first occupation at Las Quemas dating to 5990–6270 cal B.P. coincides with radiocarbon dates obtained at the base of the Fontana rockshelter and Las Guanacas cave for the initial occupations of the Ibáñez basin (Mena 1983, 1992) and, to a lesser extent, the 5590–5750 cal B.P. date at Punta del Monte (Nuevo Delaunay et al. 2013). All these occupations are significantly limited in their extent and discard rates. In each case, late Holocene reoccupations are separated by millennia-long hiatus (e.g., Las Guanacas hiatus: ~5620 years; Fontana first hiatus: ~3440 years; Fontana second hiatus ~1400 years; Lucero and Mena 2000) similar to the one recorded at Las Quemas (~3160 years). During the mid-Holocene occupations of these sites, forests reached their maximum eastward extensions, coverage, and density, as suggested by paleoenvironmental data in Cisnes and areas further south (de Porras et al. 2012, 2014; Villa-Martínez et al. 2012). Closed-canopy conditions may have constrained exploration in this environment (Borrero 1989–1990). As ethnographic studies have shown, the exploration of new territory is challenging and has low success rates due to limited environmental experience and inadequate information networks (Borrero 2015).

At least three occupational events were recorded in the occupational block that dated from 2400 to 2950 cal B.P. These are interpreted as recurring visits over a ~550-year period. Initially, it was argued that the limited carrying capacity of the steppe during that period acted as a trigger for expanding mobility ranges into the west (Méndez and Reyes 2008). This hypothesis is now supported by local paleoenvironmental reconstructions on centennial to millennial scales, which show lower effective moisture beginning around 3000 cal B.P. (de Porras et al. 2012). The paleoenvironmental data coincide with the onset of the documented human occupations in the area and provide a strong case for the collation of human and environmental records (Sandweiss and Quilter 2012). Paleoenvironmental records indicate that the forest-steppe ecotone-type boundary moved westward by that time (de Porras et al. 2012) and that forests in the central Cisnes basin had an open canopy (de Porras et al. 2014). Lower productivity and cooler winters on the steppe (~900 m asl) may have promoted seasonal livelihoods at lower elevations and along routes such as the Cisnes River. The open canopy would have facilitated resource acquisition, orientation, and information gathering and enabled repeated visits to sites like Las Quemas.

The lithic material (e.g., blades, frontal scrapers) found at Las Quemas is not distinguishable in terms of typology from assemblages of similar age recovered in the nearby steppe (e.g., El Chueco 1, Méndez et al. 2011). The obsidian found at the site was procured from sources in the eastern Cisnes Valley and from Pampa del Asador, the most exploited source in the region (Stern et al. 2013:248). Rock art is also a shared trait. The main motif at Las Quemas is the tridigit, which is interpreted as a flightless bird track. *Rhea pennata* inhabits only open steppes (Kusch and Henríquez 2011). Although animal representations do not necessarily reflect the immediate environment, it is suggestive that forest occupants in Aisén (including Las Guanacas, Fontana, and Punta del Monte) used motifs characteristic of the steppe. This case has been argued for northern Patagonia, where a cladistic analysis of rock art showed no clear distinction between rock art from the forest and the steppe (Scheinsohn et al. 2009).

Use-wear traces positively identified woodworking at Las Quemas. The low frequency of utilized edges, however, does not indicate a targeted use of wooden materials. The performance of distinct activities at the Las Quemas rockshelter, working of wood with different types of tools (blade and flake), and edge modifications (retouched and unretouched), suggest non-specific functional orientations. This differs from the coast of Aisén, where occupations show forest-specific technologies (Reyes et al. 2015).

Conclusions

There is no unique way to occupy forests (e.g., Gamble 1999). This variability may be caused by the range in population densities of hunter-gatherers living in cold forests (Kelly 1995:222). The diversity in human occupation of forest environments is undoubtedly related to carrying capacity (Steele et al. 1998). The Cisnes River Basin is an ideal corridor for accessing different ecological zones and acts as an appropriate scale for measuring the differential human uses of environments in Central Western Patagonia. Sites within this basin reveal change in human occupation over time, which can be compared to the evolution of forests regionally. The decrease in available resources caused by low effective moisture levels around 3000 cal B.P. may have triggered a series of human excursions into the forest. The lower-elevation open-canopy forests around Las Quemas likely attracted populations living on the cold, dry steppes on a seasonal basis. Overlapping dates from the Las Quemas and El Toro rockshelters (Méndez and Reyes 2008) identify an 800-year time span during which mobility ranges throughout the Cisnes basin expanded into forests.

With respect to the mid-Holocene occupation, years of archaeological research in the region show similar dates for the initial occupations of the forest and the forest margins in Aisén. Given the paleoenvironmental reconstructions of the Cisnes basin and surrounding region, the forest was dense and closed by that time. As a result, people would have faced major challenges in resource acquisition, displacement, and communication. Because all of the sites show evidence of a millennium-long hiatus after their initial human occupation, human use of this environment should also be viewed as discontinuous.

The data from the Aisén region suggests that the human occupation of forests was linked to areas farther to the east. This study has shown that seasonal occupations of forests were of low intensity and did not constitute year-round forest dwellings. Borrero (2004:60) suggests that forests were geographically marginal areas that were occupied by hunter-gatherers associated with population nuclei located in the open steppes. Marginal areas can provide information about processes that occurred at larger scales (Veth 1993); they may be more sensitive to changes in mobility and settlement patterns at local and regional scales, as shown by the archaeological records at the Las Quemas rockshelter and the Cisnes Basin.

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