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Source: *Current Anthropology*, Vol. 52, No. 3 (June 2011), pp. 463-475
Published by: The University of Chicago Press on behalf of Wenner-Gren Foundation for Anthropological Research
Stable URL: http://www.jstor.org/stable/10.1086/659426
Accessed: 06/06/2011 05:54

Early Evidence (ca. 12,000 BP) for Iron Oxide Mining on the Pacific Coast of South America

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Iron oxides have been used extensively in the Americas from the Paleoindian period up to the ethnographic present. But, because archaeological mining sites are extremely rare in this continent, we still know very little about how indigenous groups exploited and processed these minerals. Here we report finds from the San Ramón 15 site, located on the arid coast of northern Chile, where our research revealed a prehistoric mine with associated tailings and mining debris that was exploited by hunter-gatherer-fisher groups. The mine was first exploited during the Pleistocene-Holocene transition (ca. 12,000–10,500 calibrated years before present [cal yr BP]) and then again during the Late Archaic (ca. 4300 cal yr BP), representing the earliest known mining activity in the Americas. This discovery has important implications, including (1) the record of undisputed mining activity in the continent is extended by several millennia, showing the first insights into Early Archaic mining techniques and technologies; (2) the earliest inhabitants of the Pacific Coast of South America had a well-developed mining knowledge, that is, they were hunter-gatherer-fisher-miner communities; and (3) mobility patterns of early nomadic maritime adaptations in northern Chile were influenced by repeated access to iron oxide pigments used mainly for symbolic purposes.

Iron oxide use has been dated in Africa to more than 200 kyr ago (Barham 2002) and has been associated with diet and habitat expansion by *Homo sapiens* as early as 160 kyr ago (Marean et al. 2007). It is therefore not surprising that in the Americas the use of iron oxides is well documented from the very first human occupations of the continent (ca. 13,000 calibrated years before present [cal yr BP]), during the Paleoindian period (Lahren and Bonnischen 1974; Scalise and Di Prado 2006; Stafford et al. 2003; Tankerley et al. 1995), and up to the ethnographic present. The use of these minerals is therefore one of the most ubiquitous and long-lasting activities of *H. sapiens* in general and of American prehistory in particular.

Furthermore, the appearance of iron oxides in the archaeological record has been considered direct evidence of symbolic activities by early groups, especially during the Upper Paleolithic (Hovers et al. 2003). Notwithstanding the well-attested use of these pigments and their importance in human evolution, we know virtually nothing about how they were procured, exploited, and processed throughout most of history. In the Americas, little archaeological research has been done on this topic, so it is unclear whether during prehistoric times iron oxides were exploited through planned mining techniques and technologies or as an opportunistic collection of surface outcrops, or both. As a matter of fact, it has been generally assumed that hunter-gatherer mineral procurement strategies were low-cost activities that were embedded in mobility patterns driven by subsistence requirements (Bamforth 2006).

Existing work in the field may present misleading assumptions regarding the antiquity of iron oxide mining in the Americas. There are records of a Paleoindian "mine" in central North America (Stafford et al. 2003); however, no dates are known for the site, and the published material shows an absence of prehistoric mining tools and little evidence of a prehistoric mining context. It seems to us that the only published references of secure prehistoric iron oxide mines in America come from coastal southern Peru and have been dated to the beginning of our era (ca. 2000 BP; Eerkens, Vaughn, and Linares 2009; Vaughn et al. 2007). In North America, the earliest mines reported so far correspond to Late Archaic hunter-gatherers (ca. 4500–2500 BP) exploiting native copper (Martin 1999). Therefore, there are no secure data on mineral exploitation and extraction during the first 8,000 years of American prehistory, and no attempt to understand the transformations of mining techniques and technologies is yet possible.

This paper complements our lack of knowledge on early mining by contributing undisputed evidence of systematic iron oxide mining during the Early Holocene in the Americas. Our evidence comes from the San Ramón 15 site (SR-15), a prehistoric mine located on the arid coast of northern Chile (fig. 1), 2 km from today's shore and 170 m above mean sea level. Here, a prehistoric mining trench was exploited for almost 2,000 years during the Pleistocene-Holocene transition (ca. 12,000–10,500 cal yr BP) and then again during the Late Archaic (ca. 4300 cal yr BP).

Because it is the most intensive of the two occupations of the site, and due to the significant theoretical implications

 0011-3204/2011/5203-0012$10.00 DOI: 10.1086/659426

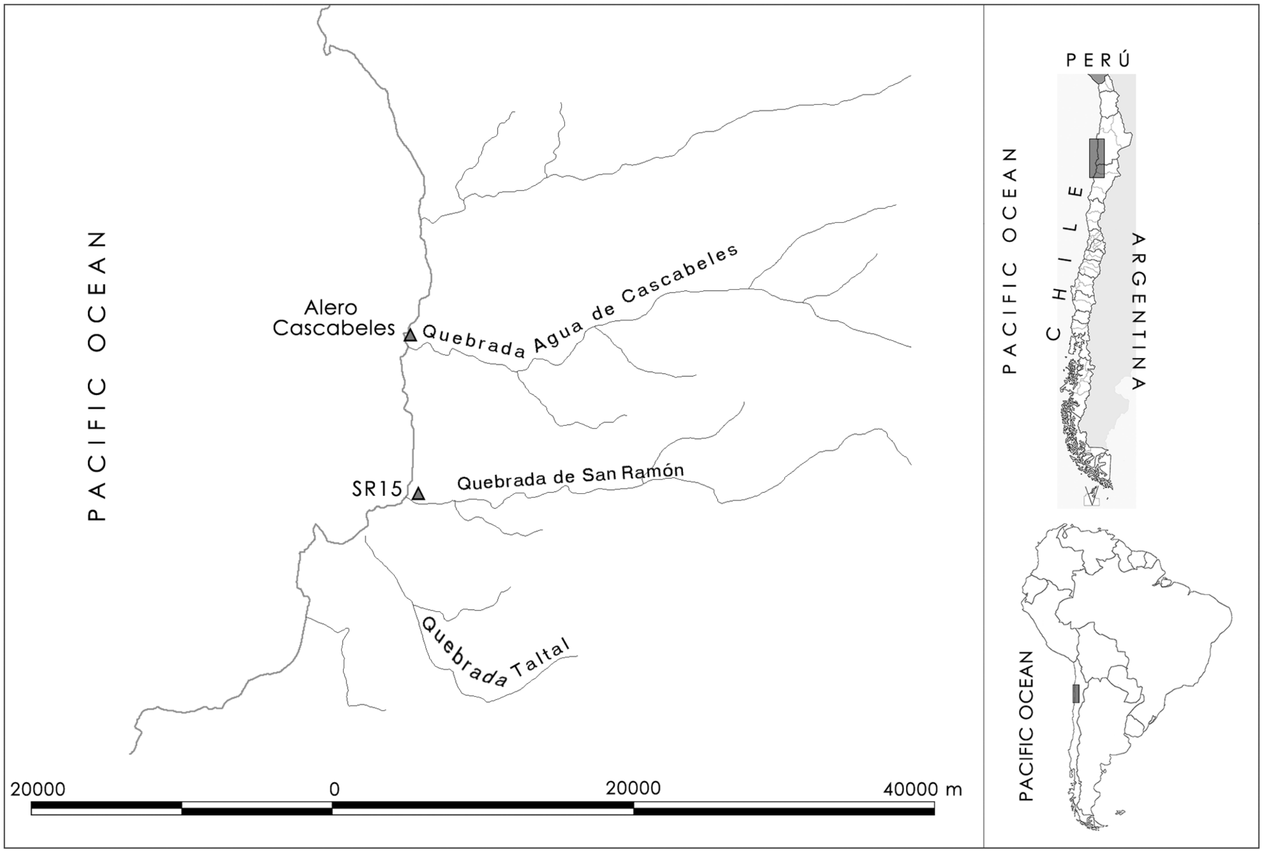

Figure 1. Location map of Taltal area and the Early Holocene sites of the Huentelauquen Complex, including San Ramón 15 (SR-15).

that can be derived therefrom, our discussion will be focused on the Early Holocene exploitation. SR-15 demonstrates that mining was not an opportunistic, low-cost activity for the early settlers of the Pacific Coast of South America but, on the contrary, was an integral part in mobility systems. Furthermore, it shows that it was a labor-intensive activity demanding specific technical skills and some level of social cooperation transmitted through generations. This suggests the existence of mining knowledge and a mining tradition in the first settlers of the Pacific Coast of northern Chile, who were part of an early maritime adaptation known locally as the Huentelauquen Cultural Complex. Our research thus offers an opportunity to further our knowledge on early mining in the Americas and also to complement our understanding of the settlement systems of the first maritime adaptations of the Pacific Coast of the south-central Andes.

The San Ramón 15 Site

SR-15 is located in the western margin of the Coastal Cordillera in northern Chile. Topographically, the area is characterized by a marked climb up to 2,000 m above sea level and a thin (and in some cases absent) coastal shelf (fig. 1). Presently, in spite of its hyperarid weather and with drinkable water available only in small and dispersed springs, the coast has a rich ecosystem as a consequence of the Humboldt Current influence (Bittmann 1986; Llagostera 1979). Paleoenvironmental records for the highlands of northern Chile and the southern coast of Peru suggest more humid conditions in those areas during the Late Pleistocene and Early Holocene periods (Betancourt et al. 2000; Grosjean 1994; Mächtle et al. 2010; Moreno, Santoro, and Latorre 2009).

The mining trench in SR-15 followed the N70°E orientation of an iron vein hosted in Lower Cretaceous plutonic rocks from the Coastal Cordillera (fig. 2). The iron vein shows a filling pattern parallel to the walls, gangue minerals dominated by quartz, and fine and coarse calcite crystals, with iron oxide as cement of irregular breccia bodies and veinlets. Iron oxides are also present as red and yellow ochre filling small veinlets and as fine precipitation on the altered granodiorite. These ochre ores can be interpreted as secondary enrichment by remobilization and oxidation. X-ray diffraction analyses performed on powdered (1–3-μm particle size) specimens of ochre pigments sampled from the prehistoric mine identified them as hematite and goethite.

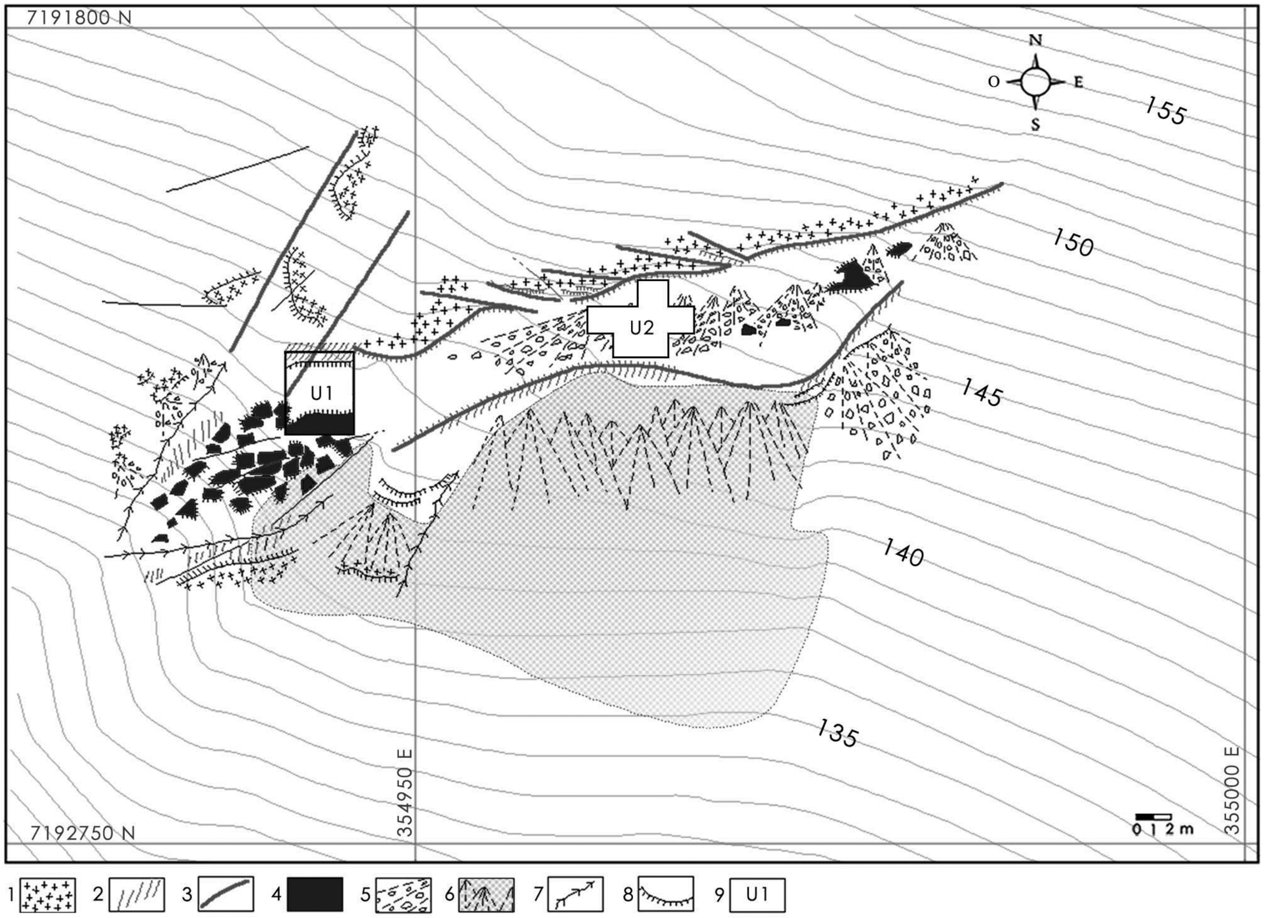

Figure 2. Site plan of San Ramón 15. *1*, Granodiorite host rock. *2*, Altered granodiorite. *3*, Faults or joints with secondary iron veinlets. *4*, Iron rocks of the main iron vein. *5*, Yellow colluviums of gravel, sand, and silt. *6*, Mining waste dumps of dark gray color located on the exterior part of the mined trench. *7*, Small ravines. *8*, Small escarpments. *9*, Archaeological excavations (units 1 [*U1*] and 2 [*U2*]).

The mining trench exploited during the Archaic Period is nearly 40 m long and 5–6 m wide. Excavations have determined that the depth of the original operation was around 2.5 m on the western end and more than 6 m on the central part of the trench (fig. 3). Ancient miners were following the higher-grade veinlets of hematite and goethite pigments in the altered softer rocks within the main iron vein. However, in order to follow these relatively narrow veinlets (20–30 cm wide), harder calcite and iron oxide breccias within the main iron vein were removed as well. The final result of the prehistoric exploitation was the formation of a subrectangular-shaped trench.

Today the trench is completely filled with sediments (figs. 3, 4). Two archaeological units were excavated inside the mining trench following natural as well as artificial layers (10 cm) within each natural stratum. Natural layers were distinguished according to sedimentological criteria and cultural material, while stratigraphic interpretations were based on macrostratigraphic observations and micromorphology. Both excavations showed two different types of infill covering the prehistoric trench: the most superficial one (between 10 and 100 cm) is naturally deposited sediment as a result of colluvial processes or transportation by water. Under this sediment, excavations showed 240–500 cm of deposit of a dark sediment rich in iron that is a result of direct mining activities (tailings and waste heaps). Our interpretation of the latter is that after extraction and selection of the higher-grade pigments made inside the trench, the gangue dumps filled the earlier cavities of the mine and/or were pushed back toward the already exploited and abandoned areas of the trench. Thus, the exploited trench was gradually filled with tailings.

The chronology of the site is supported by the stratigraphic analysis of the two archaeological units excavated at the mine and by 10 radiocarbon dates (AMS) obtained from charcoal

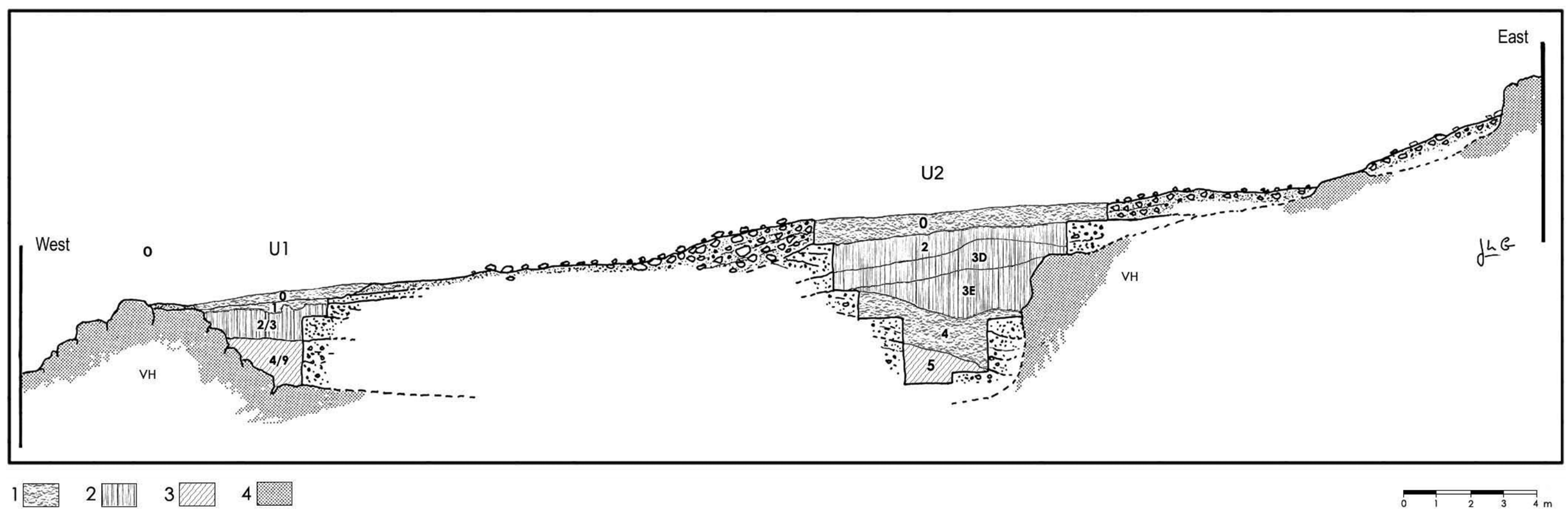

Figure 3. Schematic profile of the prehistoric trench showing the different types of infill deposit. *1*, Naturally deposited layers. *2*, Late Archaic layers. *3*, Early Archaic layers. *4*, Iron vein. *U1*, unit 1; *U2*, unit 2; *VH*, iron vein.

Figure 4. Prehistoric mine in unit 1. Note the granodiorite host rock on the right, the unexcavated iron vein on the left, the cultural infill of the trench on the central top, and some shafts and galleries at the bottom of the mine. A color version of this figure is available in the online edition of *Current Anthropology.*

and shell samples in a well-controlled depositational context (figs. 5, 6; table 1). Radiocarbon dating shows that the central part of the mine was the first area to be exploited (12,543–12,095 cal yr BP) and that the operation then moved westward, reaching the western end of the trench nearly 2,000 years later (ca. 10,500 cal yr BP). A second period of exploitation occurred during the Late Archaic (ca. 4000–4800 cal yr BP) that focused mainly on a lateral and less intensive exploitation of the earlier mine. After this second period, the mine was abandoned and natural sediments covered the trench completely.

In the western part of the trench (unit 1), Late Archaic miners excavated part of the Early Holocene deposits in order to reach the deeper mine walls and/or recuperate high-grade pigment fragments within the earlier dumps. This fact is well attested by the presence of an almost horizontal contact between Early and Late Archaic layers and a stratigraphic inversion indicated by an Early Archaic date within Late Archaic layers (fig. 5). This alteration of earlier contexts seems less probable on the central part of the trench, where Early and Late Archaic exploitations are separated by 130–180 cm of naturally deposited colluvial sediments (fig. 6). It is worth noting that there is an absence of Middle Holocene contexts at SR-15.

The Archaeological Context of the Early Holocene Mine

The archaeological context corresponding to the Early Holocene exploitation was recovered from the lower layers of both archaeological units, within dark gray sediments with a high presence of magnetite and iron oxides as a consequence of excavating into the iron vein in order to extract the pigments. Artifacts found in these layers include lithic hammerstones of various types and sizes, flakes and broken hammerstones, gangue material, and big rocks extracted from the iron vein. Some of these rocks show evidence of battering with stone implements. Small cavities and shafts through which the miners followed the richer veinlets have been recorded in the bottom of the mine and, to a lesser degree, in some of the mine walls (fig. 4). Taken together, these elements define a clear prehistoric mining context located in the lower levels of the trench and associated with five stratigraphically coherent Early Holocene dates (table 1). Food refuse found

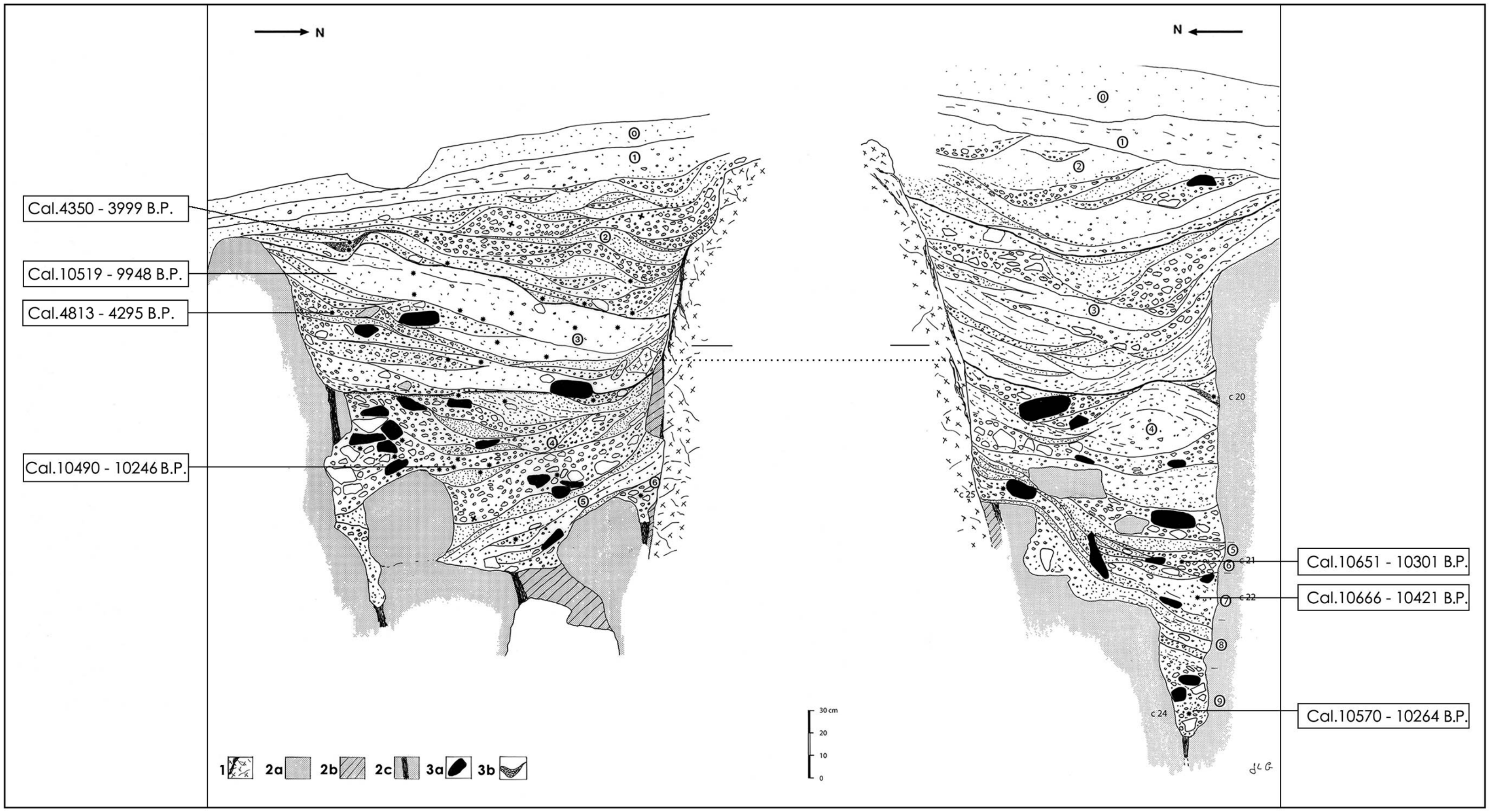

Figure 5. East and west profiles of unit 1, showing the stratigraphic location of the dated radiocarbon samples. *1*, Altered granodiorite with thin iron oxide veinlets. *2*, Main iron vein: *a*, massive iron facies with silica; *b*, calcite facies; *c*, iron oxide veinlets within the main iron vein. *3a*, Hammerstones; *3b*, primary combustion feature.

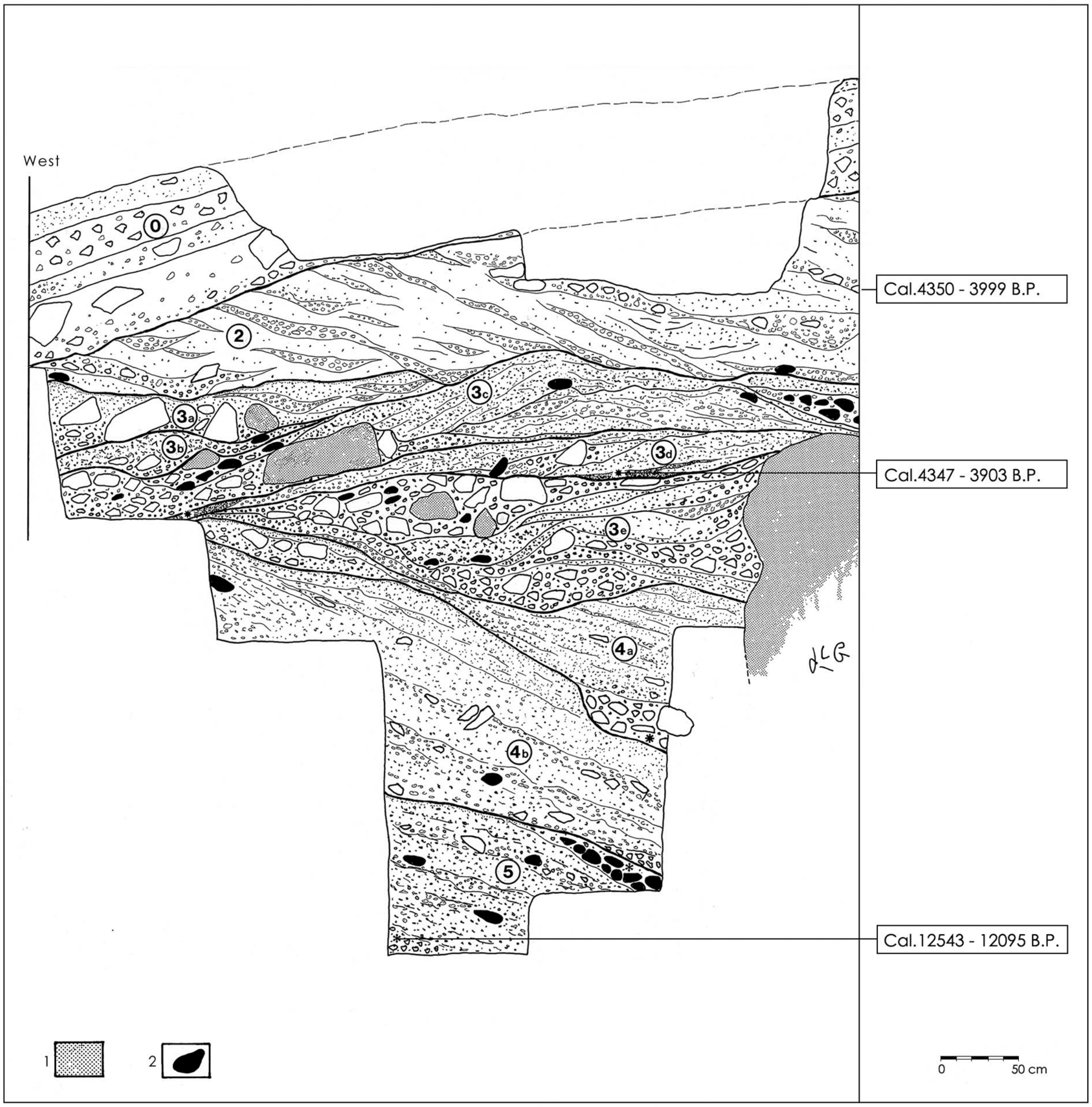

Figure 6. North profile of unit 2 showing the stratigraphic location of the dated radiocarbon samples. *1*, Iron vein and rocks extracted from the iron vein. *2*, Hammerstones.

during excavation of these early layers consists mainly of mollusks, mammals, and fish (table 2). A few flakes of siliceous raw material and some shell artifacts complete the early Holocene context of SR-15.

The most ubiquitous archaeological finds are the lithic mining tools. From the Early Holocene layers alone we have excavated 491 hammerstones (total weight, 500.684 kg), as well as 24.567 kg of flakes (table 3; fig. 7). We designed a methodology for the analysis of the hammerstones aimed at the recognition of the physical properties that enable them to fit the diverse percussion functions required at different stages of a mining operation (Salazar and Salinas 2008; Salinas et al. 2010). The analysis of three main variables was considered especially relevant: (1) physical dimensions, (2) raw material, and (3) the quantity and morphology of the active functional edges of the hammers. The values of the physical dimensions of the Early Holocene hammerstones are presented in table 3. A factorial analysis (principal component analysis) showed that the highest variance of the ensemble can be explained by the contribution of weight, volume, and density, with the first two being highly correlated. This indicates that these were the main criteria for the selection of the cobbles to be used

Table 1. Radiocarbon dates from San Ramón 15

Stratigraphical context	^{14}C yr BP	Cal yr BP	Cal BC	Material	Lab no.
Unit 1:					
Layer 2	3850 ± 30	4350–3999	2401–2050	Charcoal	UGAMS 5439
Layer 2–3	9160 ± 80	10,519–9948	8570–7999	Charcoal	Beta-255687
Layer 3	4080 ± 60	4813–4295	2869–4346	Shell	Beta-257858
Layer 4	9250 ± 30	10,490–10,246	8541–8297	Charcoal	UGAMS 5440
Layer 6	9360 ± 30	10,651–10,301	8702–8352	Charcoal	UGAMS 5441
Layer 7	9390 ± 30	10,666–10,421	8717–8472	Charcoal	UGAMS 5442
Layer 9	9310 ± 50	10,570–10,264	8621–8315	Charcoal	POZ-32943
Unit 2:					
Layer 2	3800 ± 60	4350–3999	2401–2050	Charcoal	Beta-261668
Layer 3	3850 ± 30	4347–3903	2398–1954	Charcoal	UGAMS 5443
Layer 5	10,430 ± 60	12,543–12,095	10,494–10,146	Shell	Beta-280992

Note. All dates are shown in calibrated years before present (cal yr BP) and calendar years before Christ (cal BC) and have been calibrated with OxCal 4.01 (Bronk Ramsey 2009). The ShCal04 curve has been used for radiocarbonic dates <10,000 BP, and the IntCal09 curve has been used for radiocarbonic dates >10,000 BP. All dates correspond to 2σ (confidence interval of 94.5%). The results of the shell samples have been corrected for local reservoir effect applying a ΔR of 175 ± 34 (http://calib.qub.ac.uk/marine).

as hammerstones. We suspect that different sizes and volumes were selected by ancient miners in order to improve the performance of the lithic instruments in the diverse stages of mining extraction and sorting, with their particular demands of strength and force. Differences were also identified in the size and shape of the extreme functional edges of the artifacts, which seem to have had functional significance as well.

Raw material in the hammerstone ensemble was identified according to standard petrographic analysis on thin sections (30-μm thickness) of selected specimens studied under a polarizing microscope. Results indicate the predominant use of seven local rocks belonging to the Coastal Cordillera Batholith (granitoid rocks) and the La Negra Formation (andesites and basaltic andesites), the main lithological units of the Coastal Cordillera in northern Chile. Most of these rocks came from the Pacific shoreline, which is located today some 2 km from the site, and also from the alluviums of the nearby quebradas. These data indicate a local "supplying mode" for the macrolithic mining instruments used at SR-15. There is little evidence for hafting. Only a few specimens found in the stratigraphic deposits corresponding to the Early Holocene ($n = 5$) show the presence of intentional modifications in the center of the artifact; that is, it is indicative of the use and location of the haft (fig. 7, plates 1 and 2). The majority of the hammerstones were thus hand used (fig. 7, plate 3). Overall, the hammerstone complex is consistent with an opportunistic use in the unmodified, hand-used hammerstones and an expedient technological strategy in the modified (hafted) artifacts (sensu Nelson 1991). Large amounts of hammerstones and little preparation of the artifacts suggests on-site discarding after a short life-use. This is consistent with the varied local availability of cobbles that could be used as hammerstones.

It is interesting to consider at this point that there seems to be a technological continuity between the Early and Late Archaic periods. Hammerstones in both periods are mainly handheld instruments (unhafted). They have similar mean dimensions (table 3), and the same raw materials were used throughout the exploitation of the mine. This continuity in the lithic assemblage from both periods might be explained by the fact that Late Archaic miners excavated and redeposited Early Archaic contexts, thus incorporating early artifacts in the later deposits, and/or by the physical and geological constraints encountered by early miners (Martin 1999). However, this might also be an indication of a mining tradition among hunter-gatherer societies in America, which were well established several millennia before the first copper exploitations in the continent. Similar technologies and technical strategies between SR-15 and Mina Primavera in southern Peru (Vaughn et al. 2007) suggest that this tradition may have been transferred to agropastoralist societies as late as the Nazca. In fact, given the antiquity of this mining tradition in SR-15, it may well be the case that it is a continuation of a mining know-how first developed in the Old World. Similarities in technology and extraction techniques between SR-15 and hunter-gatherer iron ochre mines from the Old World such as Bad Salsburg (Goldenberg et al. 2003) in Germany may support this interpretation. Thus, we may be dealing with an activity that might constitute one of the most long-lasting and conservative activities among hunter-gatherers, and one that

Table 2. Numbers of identified specimens (NISPs) for archaeofaunistic remains recovered from the Early Holocene levels at San Ramón 15

Animals	NISP
Mollusks	221
Fish	29
Mammals	10
Echinoderm	1
Birds	1
Site total	41

Table 3. Descriptive statistics of the Early Holocene hammerstone ensemble at San Ramón 15

	Mean (SD)
Weight (g)	1,017.13 (1,142.89)
Length (cm)	14.35 (7.04)
Width (cm)	8.80 (2.82)
Height (cm)	5.24 (1.68)
Volume (mL)	366.81 (378.15)

Note. $N = 491$.

may relate Old and New World populations (Tankersley et al. 1995).

On the other hand, it is important to note that this was not a monolithic tradition. In fact, there are a few albeit significant differences in the technology and technical strategies between Early and Late Archaic miners at SR-15. On the one hand, while Early Archaic miners excavated most of the trench as it is seen today, Late Archaic miners did not dig deeper but instead concentrated on a lateral extraction, including veinlets in the granodiorite host rock as well as the smaller veinlets in the main iron vein not previously mined. It is possible that in unit 1, Late Archaic miners excavated the earlier tailings in order to recuperate discarded ore. The technical differences between both periods are not evidenced significantly in the mining instruments recovered, as has already been stated. However, despite the fact that the same local raw materials are in use in both periods, granite-granodiorites are predominant in the Early Archaic, while during the Late Archaic andesites are most common. These differences are statistically significant (χ^2 log ratio, $gl = 4$, $P = .00464$). Moreover, in the Early Archaic, big granodiorite boulders coming from the shoreline are significantly more widespread, while there is no evidence of hafting in the Late Archaic. As such, there is clearer evidence of some functional specialization in the lithic ensemble of the Early Archaic, surely as a result of more intensive mining during this period.

During the Early Archaic context, lithic artifacts in SR-15 were also complemented by the use of shell artifacts, though in low frequencies. Again this is indicative of functional specialization that is not so evident in Late Archaic contexts. Different mollusk species corresponding to the early phase of exploitation (*Argopecten purpuratus*, *Choromytilus chorus*, and *Concholepas concholepas*) show evidence of rounded edges with perpendicular grooves, while some also show rounded and pointed edges with use-wear marks. Pigment remains in the interior of *C. concholepas* specimens indicate that the shells of these organisms were also used as containers. Given such findings, it is evident that we are dealing with a mining tradition that was flexible enough to adapt to different scales and intensities of exploitation.

There is no evidence of domestic activities at the site in the Early or the Late Archaic occupations. However, we unearthed within the mining dumps a variety of seashells and the bones of some fish and mammals that had been consumed by the ancient miners during their working activities. The minimum number of individuals (MNI) for seashells corresponding to the Early Holocene layers alone is 221, classified into 19 species of mollusks that include 10 gastropods, six poliplacofors, and three bivalves plus one species of echinoderm. Some fish and mammal body parts were transported in order to be consumed at the site. Of these, a total of 40 bone fragments were registered and classified as five species of fish (*Citharichthys gilberti*, *Hydrolagus macropthalmus*, *Synodontis violacea*, *Trachurus symmetricus*, and *P. microps*), penguin (*Spheniscus* sp.), and unidentified mammals and fish. For the taxonomic identification of mollusks and bones, only diagnostic elements were considered and compared with reference material and published descriptions and keys.

Discussion

Our modern estimates, considering the geometry of the mine and the weight of the rocks that make up the iron vein, indicate that nearly 700 m^3 and 2,000 tons of rock were extracted from SR-15 during the Early Holocene operation alone. This was a task-specific site, with very few indicators of functional activities other than mining itself and marginal food consumption, presumably by the miners. The dimensions of the exploitation required planning and also a regular and constant return to the locality in order to organize pigment production. The time span shown by the radiocarbon dates—more than 1,500 years within the Early Holocene—seem to corroborate both the planning and the regularity of the exploration, since they demonstrate a long-term productive activity. Thus, the site must have been part of regular mobility patterns that included repeated residences in the vicinity of SR-15.

It is not yet clear why the mine was not exploited during the Middle Archaic (ca. 8000–5000 BP), especially given the presence of habitational sites on the coast of Taltal during this period, which have evidence of use of ochres in the archaeological context (Durán 1985; Silva and Bahamondes 1969). One possible explanation is that the Early Archaic exploitation may have extracted all of the higher-grade ores that were accessible with lithic hand-used technology. In fact, stratigraphical and contextual data in SR-15 indicate that when the mine was exploited again during the Late Archaic, miners concentrated on lateral and lower-grade veinlets such as those present in the altered granodiorite that serves as the host rock of the main iron vein. The amounts of pigments seen in Late Archaic domestic and funerary contexts in the coastal area necessarily suggest that SR-15 was not the only source of iron oxide during this later period. Thus, it is likely that Middle Archaic mining for iron oxides was also performed in another, yet unidentified locus. Future research is needed to determine whether there were other mines exploited in Taltal after the Early Archaic period.

Because of its contemporary time spans within the Early Archaic period, the first exploitation of SR-15 can be con-

Figure 7. Lithic artifacts from San Ramón 15. *1*, *2*, Hafted hammerstones. *3*, Nonhafted hammerstone. *4*, Disc-shaped stone diagnostic of Huentelauquen Cultura Complex, found in a stratigraphic context.

sidered part of the settlement system of the Huentelauquen cultural complex, the earliest group that inhabited the coast of northern Chile (Jackson and Méndez 2006; Llagostera 1979; Llagostera et al. 2000; Sandweiss 2008). This is further attested by the discovery of a disc-shaped stone at the site (fig. 7), which is considered diagnostic of the Huentelauquen complex (Llagostera 1979). Alero Cascabeles (ca. 12,000 cal yr BP), located 10 km north of SR-15, remains the only known Huentelauquen site in the vicinity of SR-15 (Castelleti et al. 2010). Other sites corresponding to this cultural complex have been identified both to the north and to the south of Taltal. The significant distance between some of these indicate long-distance coastal mobility patterns for these early groups, and inland procurement of raw materials has also been demonstrated (Jackson and Méndez 2006; Llagostera et al. 2000).

In many of these early sites, iron oxides have been reported as selected minerals, grinding stones with pigment residues, and/or painted artifacts. Even though it remains unclear whether these pigments where exploited at SR-15 and/or elsewhere, the data from SR-15 do demonstrate for the first time that the procurement of iron oxides within the early maritime adaptations of the Pacific Coast was not an opportunistic activity but rather the outcome of consolidated mining knowledge that enabled early hunter-gatherer-fishers to superficially identify the ores, follow the higher-grade veins through hard calcite and iron breccias, reach significant depth without safety hindrances, and sort the higher-grade ores. Moreover, the fact that iron oxides are readily available on the coast of Taltal, while ancient extractive activities were concentrated at SR-15 site coupled with the labor investment observed at the site, its preliminary functional specialization and the selectivity and variability of its technical ensemble all indicate an appropriate way of dealing with the contingencies and the mechanical requirements of a mining operation. Evidence of mining know-how are seen in later contexts, such as the iron oxide Mina Primavera site (Vaughn et al. 2007), the Andean copper mines (Núñez 1999; Salazar and Salinas 2008; Shimada 1994), and maybe even the Lake Superior native copper mining (Martin 1999), but their presence in early hunter-gatherer societies had not been identified previously in America.

It seems clear that the iron oxides of SR-15 were a valuable resource for the early maritime adaptations of the coast of northern Chile, influencing the organization of mobility patterns and settlement systems. Therefore, while supporting earlier claims that suggested that the distribution of stone quarries directly affected mobility patterns of hunter-gatherers (Bamforth 2006; Smith 1990), SR-15 at the same time expands these claims by demonstrating that not only raw materials with direct relation to subsistence and technology, like stone quarries, were important in mobility systems. On the contrary, the data presented in this article indicate that settlement patterns were organized to some important extent in order to access iron oxides that were destined mainly for the social reproduction and symbolic manifestations of nomadic maritime groups. Painted disc-shaped stones and bone instruments found at the La Chimba 13 site support the symbolic use of these pigments among early Huentelauquen groups (Carevic 1978; Llagostera 1977; Llagostera et al. 2000). This site is considered to be a ceremonial gathering location, and it is the only one where pigments have been found on painted artifacts (Llagostera et al. 2000). On the other hand, disc-shaped stones have been related to symbolic behavior among this early maritime society (Llagostera 1979) as well as Paleoindian groups in Patagonia (Jackson and Mendez 2006). Given the dimensions of the extraction activities at SR-15 and the yet-limited evidences of its use, it is likely that iron oxides were also exchanged during the Early Holocene and/or used in perishable materials such as clothing or body painting, as has been documented in many indigenous societies in South America and other parts of the world.

Taken together, the mining evidences from SR-15 and other early sites on the Pacific Coast of South America show a complex and consistent settlement system for the first maritime adaptations. While both residential and logistical campsites have been recorded on the southern coast of Perú (DeFrance and Umire 2004; Keefer et al. 1998; Lavallée et al. 1999; Sandweiss 2008; Sandweiss et al. 1989, 1998), on the coast of northern Chile, besides this type of camp, funerary sites have been identified, as well as other locations with more limited activities (Castelleti et al. 2010; Jackson and Méndez 2006; Jackson et al. 1999; Llagostera 1979; Llagostera et al. 2000). SR-15 complements these data, showing a diversified settlement system by the earliest maritime adaptations of the Southern Pacific Coast organized around some of the key resources required for both biological and social reproduction of these societies.

We wish to emphasize that this study demonstrates that at least part of the mining production at SR-15 is contemporary with the oldest human occupations of northern Chile and the Pacific Coast of South America (Keefer et al. 1998; Lavallée et al. 1999; Stothert, Piperno, and Andres 2003; Sandweiss et al. 1998), thus extending by several millennia the mining sites yet recorded in the Americas. The regular exploitation of SR-15 for more than a millennium during the Early Holocene indicates that knowledge about the location of the mine, the properties of its iron oxides, and the techniques required to exploit and process these minerals were transmitted over generations within the Huentelauquén Cultural Complex, thereby consolidating the first mining tradition yet known in America.

This tradition is related to other iron oxide mines in both the Old and the New World, but it is different from later copper mines in the Americas and elsewhere. In the case of later copper mines, there is certainly evidence of systematic mining knowledge similar to that in SR-15, but the abundance of hafted hammerstones indicates a different technology and probably a different technological organization from the early hunter-gatherer mining reported in this paper.

Acknowledgments

We would like to thank the Fondo Nacional de Investigación Científica (Chile), the Comisión Nacional de Investigación Científica (Chile), and the Centre National de la Recherche Scientifique (France) for funding this research through projects FONDECYT 1080666, ACT-96, and CNRS/CONICYT 22956, respectively. We also thank A. Troncoso, F. Falabella, I. Cartajena, N. Salazar, and L. O. de Castro for comments on this article, as well as C. Méndez for the calibration of the dates.

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