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Comprehensive use of the geological resources of the Cañadón Asfalto Basin by ancient hunter-gatherers of the Middle Chubut River Valley (Patagonia, Argentina)

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ABSTRACT

This paper presents the results of an integrated study encompassing archaeological and geological fieldwork, laboratory analysis of materials, and surveys of museums and private collections. These findings demonstrate the widespread use of various geological resources from the Cañadón Asfalto Basin by the indigenous populations that inhabited the current Chubut province in the past. Central-northern Patagonia has been explored for at least 10,000 years by nomadic hunter-gatherers with marked seasonal mobility, who exploited different available environments to supply themselves with lithic raw materials, pigments, food, firewood, and shelter. The evidence obtained through our work—particularly at archaeological sites in the middle Chubut River valley—shows that colored silica, chalcedony, and opals were the raw materials most frequently used to manufacture flaked tools. Meanwhile, basalts or gabbros were selected for making boleadoras or throwing balls, and sandstones were used for grinding stone tools. Ignimbrite outcrops were recurrently chosen as temporary shelters and/or as support for rock art. Among the various colors and materials available regionally for producing paint, red hematite was the most

widely used. It is also worth noting that clays, widely available in lagoons and endorheic basins, were used for rock and/or body painting, as well as for manufacturing ceramic pieces for domestic purposes.

Keywords: Cañadón Asfalto Basin, archaeology, hunter-gatherers, Chubut River, raw materials

INTRODUCTION

Archaeology, as the science that studies the human past through material remains, requires other disciplines to deepen that understanding. Geology is one of the sciences whose support and collaboration archaeologists systematically rely on to understand the strata of an archaeological excavation, identify the types of rocks used to make tools (regional structure of lithic resources), investigate the clay materials included in ceramic pastes (petrography), and identify the mineral pigments used in rock art, as well as to understand the environment and landscape in which human populations lived in the past.

The oldest evidence of human occupation in the Chubut province has been identified on the Atlantic margin —10,210 and 10,798 cal BP (Gómez Otero et al., 2025), corresponding to the Pleistocene–Holocene transition; while for the Chubut River valley there are dates corresponding to the Middle Holocene, 5,582–6,004 cal BP and 5,299–5,909 cal BP (Bellelli and Guráieb, 2019).

The importance of the Chubut River in the way of life, development, and interaction of past human populations has been frequently mentioned in archaeological literature (see Schuster and Massaferro, 2019 and references therein), mainly because its banks provide a constant availability of fresh water, rocks, minerals, and faunal and plant resources. This wide range of resources enabled various groups of hunter-gatherers to obtain food and firewood, as well as lithic raw materials to produce different types of instruments and tools. Likewise—and in accordance with the local geology—they had access to rock walls and/or caves that offered protection against environmental hardships, as well as surfaces for creating artistic expressions.

In this particular work, we will examine the relationship—and selection—of indigenous populations with the surrounding geology and how they made use of the various types of lithic and sedimentological resources available, with special emphasis on the Cañadón Asfalto Basin (hereafter CAB). To achieve this goal, we made a review of the results obtained by the authors over 12 years of interdisciplinary work, as well as material currently under analysis from the most recent fieldwork carried out at the end of 2025 and the beginning of 2026. In addition, data obtained from the review of archaeological materials in museums and/or private collections in the region will be used.

STUDY AREA

The study area is geographically located within the CAB and encompasses both margins of the middle course of the Chubut River, between the localities of Las Plumas and Cerro Cóndor (Fig. 1a, b).

The Chubut River originates at Cerro Carreras in the Andes of Río Negro Province and flows into the Atlantic Ocean near the city of Rawson. Traditionally, the river has been divided into three sections: (a) the Upper course, extending from its headwaters to its confluence with the Gualjaina stream; (b) the Middle course, which initially follows a north–south (N–S) orientation from Piedra Parada to Paso de Indios and subsequently shifts to a west–east (W–E) direction up to the Florentino Ameghino Dam; and (c) the Lower course, also referred to as VIRCH, which continues along the same W–E orientation from the dam to the river mouth (Valladares, 2004). The middle course of the Chubut River lies within the CAB and has been the focus of interdisciplinary research conducted by our team for over a decade; accordingly, the present study is centered in this sector (Fig. 1b).

The Chubut River constitutes the only permanent fluvial system that traverses the entire province of Chubut and discharges into the Atlantic Ocean. Its geomorphological characteristics vary according to the underlying lithology: in soft substrates, the river develops a broad floodplain, whereas in volcanic formations of hard rocks—such as those of the Lonco Trapial and Marifil Groups—the valley narrows and the channel becomes confined (Fig. 1b).

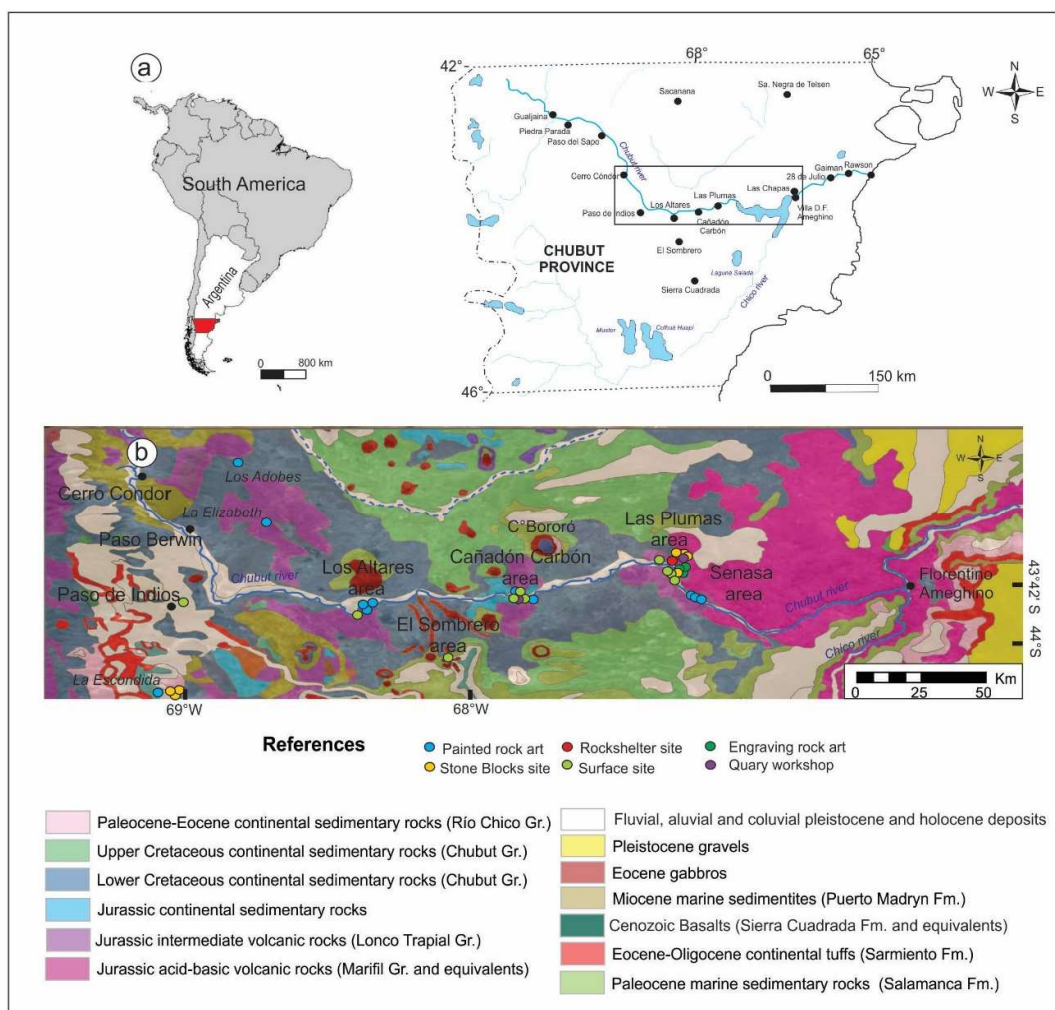


Figure 1. a) Location map; b) Geological map of Chubut Province showing the localities and archaeological sites discussed in this study, modified from SEGEMAR (1997).

According to Oyarzábal et al. (2018), the riverbanks are included within the Patagonian Phytogeographic Province, specifically within the shrub-steppe unit characterized by *Chuquiraga avellanedae* (Central District; quilembai shrub steppe). From a physiographic perspective, Beeskow et al. (1987) describe the region as comprising erosional mesa-like landforms developed on sedimentary rocks, as well as structural plains formed by lava flows. Along the N–S segment of the Chubut River, mountain ranges are present on both margins. In poorly cemented sedimentary units—such as those of the Chubut Group and the Salamanca Formation—badlands landscapes are commonly developed.

The regional climate is characterized by an arid precipitation regime, with mean annual rainfall below 200 mm. Temperatures are generally low, with a mean annual

value below 12°C (<https://www.smn.gob.ar/clima/atlasclimatico>), and prevailing westerly winds contribute to the region's low humidity. Previous studies (e.g., Labraga and Villalba, 2009) suggest that these environmental conditions have persisted for at least 3,000–4,000 years, a period during which the present-day territory of Chubut province was already inhabited by hunter-gatherer populations.

MATERIALS AND METHODOLOGY

The current archaeological study area covers a fringe of approximately 160 km along the Chubut River bank, extending several kilometers across both its right and left banks. The research project, which initially focused on the lower-middle valley of the Chubut River, has recently been expanded to encompass the entire middle course of the river (Fig. 1b).

To date, this sector has yielded open-air or surface sites, sites in rock shelters and/or caves (with and without rock art), lithic quarry-workshop sites, *parapetos* (hunting blinds), *chenque* (a type of burial), other indeterminate stone structures and concentrations of materials and/or isolated findings recorded on the surface. Furthermore, many potential lithic raw material sources have been documented, enabling the characterization of a regional structure of lithic resources (Ericson, 1984). In archaeological studies, this information is of high relevance for understanding lithic resource availability within a specific environment and how it influenced human strategies regarding the selection, procurement, and use of these resources. In this regard, this study also considers how lithic sources are positioned according to the geological and geomorphological context. These are classified as either primary—outcrops, strata, or veins found *in situ*—or secondary—rocks or deposits generated by the transport of material from its origin to near or distant locations via geomorphological agents (Nami, 1992). Additionally, following the criteria proposed by Civalero and Franco (2003), lithic sources can be categorized based on their distance from archaeological sites as: a) immediately available (within 1 km), b) local (within a 10 km radius), c) distant local (within a 40 km radius), and d) non-local (more than 40 km away). An archaeological site is defined as a quarry or quarry-workshop when a lithic source—whether primary or secondary—exhibits

evidence of core extraction and/or debitage (flakes) related to the procurement of raw materials for the manufacture of artifacts and tools.

The information presented in this paper derives from the study of archaeological materials collected from the surface during systematic and unsystematic surveys, test pits at specific archaeological sites, and the graphic recording and subsequent laboratory analysis of rock art. It should be noted, however, that the various identified archaeological sites are at different stages of study and analysis; some have been previously published, while others remain unpublished. Table 1 presents the general information for the archaeological sites considered in this study, differentiating between those already published and the ones presented here, and Figure 1b shows their spatial distribution. For practical reasons, we distinguish different kinds of uses of natural resources: rock supports, natural pigments, flaked stone tools, grinding stone tools, and ceramics.

Location	Archaeological Site	Type Sites / Rock Support	Archaeological Material Associated	Reference
Las Plumas	Piedra Calada 1	Engraving rock art/ Block	Knapped lithic, pottery	Menghin and Gradin 1972; This work
	Piedra Calada 1 - Paradero A	Surface site	Knapped lithic	This work
	Piedra Calada 1 / Transecta	Not Apply	Knapped lithic	This work
	Piedra Calada 2	Engraving rock art/ Block	Unidentified	Menghin and Gradin 1972; This work
	Piedra Calada 3	Engraving rock art/ Block	Unidentified	Menghin and Gradin 1972; This work
	Piedra Calada 4	Engraving rock art/ Block	Knapped lithic	This work
	Piedra Calada 4 - Paradero D	Surface site	Knapped lithic	This work
	Senasa 1	Painted rock art/ Rockshelter	Knapped lithic	Schuster and Massaferro 2025a
	Senasa 2	Painted rock art/ Rockshelter	Knapped lithic	Schuster and Massaferro 2025a
	Senasa 3	Painted rock art/ Rockshelter	Knapped lithic	Schuster and Massaferro 2025a
	Senasa 1/ Transecta	Not Apply	Knapped lithic	This work
	Bardas Coloradas	Rockshelter	Knapped and polished lithic	This work
	Bardas Coloradas/ Transecta	Not Apply	Knapped lithic	This work
	Bardas Coloradas/ H. Aislado	Not Apply	Knapped lithic	This work
	Cerro Colorado	Surface site	Knapped lithic	This work

	La Tapera 1	Surface site	Knapped lithic, pottery	This work
	La Tapera 2	Surface site	Knapped lithic, pottery	This work
	La Tapera 2/ Transecta	Not Apply	Knapped and polished lithic	This work
	Camping	Surface site	Knapped lithic, pottery	This work
	Parapeto 1	Hunting parapet / Stone Block	Knapped lithic, lithic raw material	This work
	Parapeto 2	Hunting parapet / Stone Block	Knapped lithic	This work
	Estructura Indeterminada 1	Indeterminate rock structure	Knapped lithic	This work
	Estructura Indeterminada 2	Indeterminate rock structure	Unidentified	This work
	Chenque	Burial structure / Stone Block	Unidentified	This work
	Cantera-Taller Jaspe PCLP	Quarry workshops / Rock outcrop	Knapped lithic, lithic raw material	This work
El Sombrero	Sombrero 1	Surface site	Knapped lithic	This work
Cañadon Carbón	Cañadón Carbón 1	Surface site	Knapped lithic	Schuster and Massaferro 2024
	Cañadon Carbón 2	Rockshelter site	Knapped lithic	Schuster and Massaferro 2024
	Cañadón Carbón 3	Rockshelter site	Knapped lithic	Schuster and Massaferro 2024
	Alero Ernesto	Painted rock art / Rockshelter	Unidentified	This work
	Alero Gonzalo	Painted rock art / Rockshelter	Knapped lithic	This work
	Cañadón Carbón / H. Aislado 1	Not Apply	Knapped lithic	Schuster and Massaferro 2024
	Cañadón Carbón / H. Aislado 2	Not Apply	Knapped lithic	Schuster and Massaferro 2024
	Cañadón Carbón / H. Aislado 3	Not Apply	Knapped lithic	Schuster and Massaferro 2024
	Cantera-Taller Jaspe CC	Quarry workshops / Rock outcrop	Knapped lithic, lithic raw material	Schuster and Massaferro 2024
Los Altares	Alero Los Altares	Painted rock art / Rockshelter	Knapped lithic	Schuster and Massaferro 2025a
	Cueva Los Altares 1	Painted rock art / Cave	Knapped lithic	Schuster and Massaferro 2025a
	Cueva Los Altares 2	Painted rock art / Cave	Unidentified	Local Information 2026
	Picadero	Surface site	Knapped lithic	This work
	Picadero / Transecta	Not Apply	Knapped lithic	This work
	Puente Colgante / Transecta	Not Apply	Knapped lithic	This work

Paso de Indios	La Escondida	Painted rock art / Rockshelter	Unidentified	Caviglia 2023; This work
	La Escondida / Transecta Tapera	Not Apply	Knapped and polished lithic	This work
	La Escondida / Transecta Sección alta	Not Apply	Knapped lithic	This work
	Muralla de Piedras	Linear structure stones and "corrales"	Unidentified	This work
	Muralla de Piedras	Surface site	Knapped lithic	This work
	Estancia Corrales	Not Apply	Knapped lithic	This work
	Los Manatales	Surface site	Knapped lithic	This work
Paso Berwin	Alero Elizabeth	Painted rock art / Rockshelter	Knapped lithic	Local Information 2026
Los Adobes	Los Adobes 1	Painted rock art	Unidentified	Caviglia 2023
Cerro Condor	Condor / Transecta	Not Apply	Knapped lithic	This work

Table 1. General characterization of archaeological sites mentioned in this work.

Finally, to further explore the methodology applied in this interdisciplinary archaeological and geological study—particularly regarding lithic raw material sources and/or mineral pigments—the following works are suggested: Schuster and Massaferro (2025a) and Schuster et al. (2023).

STRATIGRAPHIC OVERVIEW

The crystalline basement of the CAB consists of Paleozoic igneous and metamorphic rocks, including granitoids, schists, gneisses, as well as Triassic igneous rocks of both plutonic and volcanic origin (Allard et al., 2021). The most extensive outcrops are located toward the northwestern sector of the basin (Taquetrén, Jalalabat, and Calcatapul ranges), whereas in the study area they are considerably more restricted. Notable exposures include those of Sierra Mora and the La Potranca Igneous-Metamorphic Complex (south of the Chubut River between Paso de Indios and Las Plumas, Fig. 1a), which broadly comprise granites, migmatites, marbles, and schists (González and Giacosa, 2021).

The infilling of the basin began with triassic rocks represented by volcanoclastic successions, sandstones, and conglomerates corresponding to the Las Leoneras,

Puesto Lizarralde, and Los Tobianos formations, which are correlated with the El Córdoba and Osta Arena formations to the west of Los Altares (Anselmi et al., 2004; Allard et al., 2021; Foix et al., 2021).

During the Lower–Middle Jurassic, an extensive volcanic province developed which comprises the Lonco Trapial and the Marifil Groups (Fig. 1b). The Lonco Trapial Group consists of lava flows, ignimbrites, and volcanic agglomerates, with subordinate tuffs, lapilli tuffs, and breccias of intermediate to basic chemical composition (Anselmi et al., 2004), typically displaying a characteristic green to purple color. A particularly noteworthy feature is the presence, within the andesitic–basaltic lava facies, of amygdales filled with calcite, mordenite, heulandite, celadonite, and quartz, among others, formed through low-grade metamorphism associated with a post-volcanic geothermal system (Massaferro and Haller, 2004). Felsic volcanoclastic rocks of the Marifil Group are more common east of Los Altares. It includes welded tuffs, tuffs, and minor basaltic flows with sedimentites (volcanoclastic sandstones) intercalated (e.g. Villegas et al., 2026).

The Middle to Upper Jurassic is represented by the Cañadón Asfalto Formation, which crops out mainly southwest of Los Altares and along the Chubut River north of Paso de Indios (Fig. 1b). This unit comprises a variety of continental lithologies, including limestones, sandstones, tuffaceous sandstones, conglomerates, and basalts. In Silva Nieto et al. (2002), the limestones—of lacustrine origin—are described as locally silicified or containing magadiite (silica) nodules, as well as black chert stromatolites. The basalts, similarly to those of the Lonco Trapial Group, display vesicles which may be filled with calcite and celadonite. The tuffs, typically grayish-yellow to whitish in color, may also be silicified or contain siliceous nodules (Anselmi et al., 2004).

Following Allard et al. (2021), the sequence continues with the Cañadón Calcáreo Formation, which unconformably overlies the Cañadón Asfalto Formation and spans the Late Jurassic to Early Cretaceous interval (Tithonian–Valanginian). It consists of conglomerates, sandstones, and mudstones representing alluvial and deltaic environments.

During the Cretaceous, the region was characterized by extensive continental sedimentation dominated by fluvial environments with pyroclastic input, collectively known as the Chubut Group (Fig. 1b). This group includes conglomerates, sandstones, mudstones, tuffs, tuffaceous sandstones, and minor limestones, with lithological dominance varying according to the specific formation and depositional environment. The occurrence of paleosol horizons interbedded within the sedimentary sequences are also mentioned (Umazano et al., 2017, among others).

The Cenozoic record of the middle course of the Chubut River, between Paso de Indios and Las Chapas (Fig. 1a), begins with shallow marine sedimentary deposits known as Cerro Bororó or Salamanca Formation in the lower Chubut River valley and San Jorge Gulf basin, representing a predominantly Paleocene Atlantic marine transgression. Lithologies include sandstones, coquinoid sandstones, coquinas, conglomerates, and mudstones. These deposits exhibit a wide range of colors, including yellowish, gray, purple, and greenish tones, and contain abundant fossil remains such as marine invertebrates, fish teeth, and silicified trunks of angiosperms and cycadales (Anselmi et al., 2004). Claystone beds of this formation are commercially exploited in areas near the Florentino Ameghino Dam.

The Río Chico Group (Fig. 1b) is a continental assemblage of Paleocene-Eocene sedimentary (epi- and primary volcaniclastic) rocks representing fluvial systems (Foix et al., 2021).

Intense magmatic activity during the Cenozoic generated extensive lava flows and subvolcanic bodies of predominantly alkaline composition, grouped into different pulses by Haller et al. (2021), spanning from the Paleocene to the Pleistocene. The subvolcanic bodies, mainly of gabbroic composition, are gathered in the El Buitre and El Canquel Paleogene formations.

Interbedded with these basic effusions are the tuffs of the Sarmiento Group (Fig. 1b), characterized by their whitish coloration, lack of well-defined sedimentary structures, and abundant fossil content. These tuffs were formed by the deposition of volcanic ash derived from western eruptions in continental environments

(Anselmi et al., 2004). Alteration of volcanic ash in lacustrine settings led to the formation of extensive bentonite deposits (Foix et al., 2021).

Finally, Quaternary deposits are represented by sediments of highly variable grain size, formed through fluvial, eolian, lacustrine, and mass-wasting processes (Fig. 1b).

RESULTS

This section presents the unpublished results obtained from the latest fieldwork conducted between 2025 and 2026. It also presents the archaeological materials registered in museums and/or private collections during this same period.

Of the new sites with rock art reported (see Table 1), most of them were executed over acidic or andesitic ignimbrites and minor lava flows. For instance, in Alero Gonzalo and Ernesto, in the area of Cañadón Carbón (Fig. 1b), a rhyolitic ignimbrite of the Marifil Group was selected as support. In Alero Elizabeth and Los Adobes sites, the wall is also part of the Marifil Group. There is one exception to this selection of support, and it is in the La Escondida site, where the rock art was executed over basaltic rocks. These rocks have in common low porosity, fine-grained texture, and smooth surfaces.

Two thin slides were prepared on the wall rock of the Las Plumas engravings and the Senasa archaeological locality. In the first case –Piedra Calada site–, the engravings were done over blocks of a grey, coherent ignimbrite with crystalclasts of quartz and sanidine in a devitrified matrix. In the Senasa 2 site (Fig. 1b), the rock support for the paintings is represented by a purple fine-grained andesitic flow. Under the microscope, the rock shows a porphyritic texture. It is composed of plagioclase phenocrysts embedded in a pilotaxitic groundmass.

Concerning the mineral pigments, we sampled a white pigment used in the rock art of the Senasa 2 site (Fig. 1b, 2a). This is the first and only documented site with white paintings that could be analyzed due to their good preservation and thickness, characteristics that other paints at this and other sites do not have. The powder was studied by X-ray diffraction at the Universidad Nacional del Sur laboratory (Fig. 2b). The results show the presence of quartz and gypsum in the sample.

In most of the new sites, we have recovered knapped lithic tools and debitage from the surface. In the area of Las Plumas (Fig. 1a), the analysis of the raw materials employed shows a high predominance of silicified ignimbrites, jasper, and colored silicas, while in Cañadón Carbón sites (Fig. 1a) the most used raw material was red jasper and, in lesser proportion, opal, silicified ignimbrite, and colored silica. In Los Altares, it is worth mentioning the Picadero site (Fig. 1a) because of the large volume of tools recovered there, such as scrapers and side scrapers. The material used was brown, reddish-banded silica, followed by jasper. Less frequently, there are other colored silicas and xylopal. The sites near Paso de Indios (Fig. 1a) show the use of white silica and chalcedony, and in minor quantities opal and xylopal for the knapped tools. All these materials have common physical properties such as high tenacity, homogeneity, absence of fissures, and conchoidal fracture.

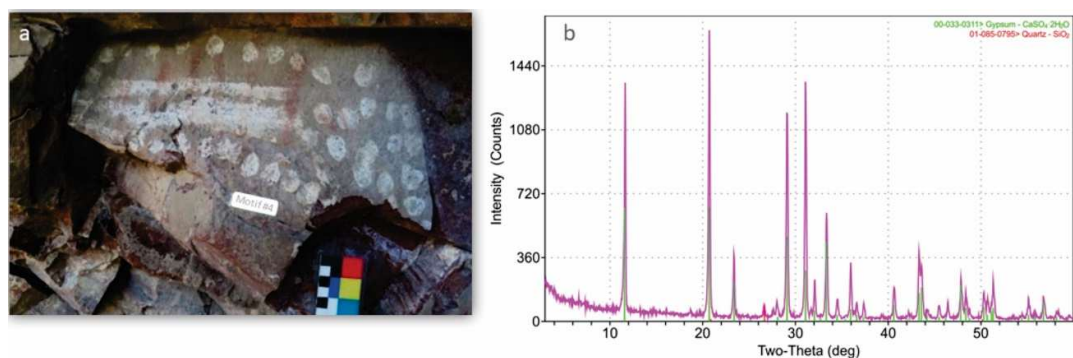


Figure 2. Senasa 2 site, Las Plumas. **a)** Detail of a panel with white paint rock art. Scale bar= 4 cm. **b)** Results of XRD studies of this painting.

The lithic assemblage also includes grinding stone artifacts produced by polished, pitted, and abraded techniques. These include *boleadoras* –or throwing balls- (Fig. 3a-d) utilized for hunting, as well as mortars or grinding stones (Fig. 3j, k, m, n) used to pulverize pigments and process edible vegetal resources, among other uses. Trends observed in the analyzed archaeological materials—primarily from private and museum collections—suggest the preferential selection of fine-grained and dense basic igneous rocks (gabbros and basalts) for manufacturing *boleadoras*. The mill found in the Bardas Coloradas site (Fig. 1a) in the Las Plumas area was the only grinding stone tool discovered *in situ* (Figure 3j, k). This mill or mortar was made with a block of a very coherent, whitish to light grey coarse-grained sandstone; the shape of the block is similar to a cube of 14 cm on each side with very rough surfaces.

Some other artifacts like this are found in private collections or museums, and many of them are crafted from sedimentary rocks.

Pottery currently represents the least common archaeological material in the study area, and its recovery is generally highly fragmented in very small pieces like in Camping site, Las Plumas.

Among other materials considered, within the archaeological record of the Las Plumas locality, specifically at the La Tapera site (Fig. 1a), isolated surface finds yielded small fragments of a very fine-grained reddish tuff carved with circular motifs (Fig. 3g). Additionally, similar carved objects were recently documented in a private collection within the same locality (Fig. 3f).



Figure 3. Archaeological materials recorded in the study area. **a), b), c)** Boleadoras or throwing balls, Museum of Lithic Art, Las Plumas; **d)** Boleadora preform, Private Collection, Paso de Indios; **e)** Colored silica scrapers recovered from archeological sites of the study area; **f-g)** Fragment of sedimentary material with incised decoration (up: own collection, down: Museum of Lithic Art, Las Plumas); **h-i)** Pottery sherds, Museum of Lithic Art, Las Plumas; **j-k)** Hand and grinding stone tool, Bardas Coloradas site, Las Plumas; **l)** Four different projectile points recovered from the archaeological sites of the study area; **m-n)** Millstone and grinding stone, Private Collection-Paso de Indios and Museum of Lithic Art-Las Plumas.

DISCUSSION

In this section we discuss all the results obtained by the authors since they began working in the area, including those described in the above section and those already published, together with data from the literature and the review of local archaeological collections.

Rock supports

Field surveys indicated that ignimbrites represent the most suitable lithologies for the development of rock shelters and caves. Consequently, these cavities exposed along the Chubut riverbank were recurrently utilized both as refuges and as substrates for rock art (Schuster and Massaferro, 2025a). Additionally, landscape features played a critical role, including panoramic visibility, freshwater availability, and shelter from the prevailing strong westerly winds. Among the alternative hypotheses explaining the formation of large, rounded caves within these lithologies, different authors propose differential weathering (Escosteguy et al., 2013) or block-fall favored by joint intersections (D´Elía and Francese, 2005).

Archaeological data show that rock art sites featuring paintings (Senasa 1, 2, and 3; Los Altares 1; Alero Los Altares; Cueva Los Altares; Alero Gonzalo; Alero Ernesto; La Escondida; Alero Elizabeth and Los Adobes) (Fig. 4a, c, d, e, f) are more frequent than those with engravings (Piedra Calada de Las Plumas 1, 2, 3 and 4) (Table 1; Fig. 1b and 4b). Nevertheless, both paintings and engravings were executed on coherent ignimbrites, or lava flows (in smaller proportions), belonging to various geological units: Marifil and Lonco Trapial Groups, and El Córdoba Formation. Conversely, south of the Paso de Indios locality (La Escondida archaeological site), rock art was executed on Cenozoic Sierra Cuadrada basalts (Fig. 1b and 4a). This latter choice is primarily attributed to the local availability of basaltic lithologies within the surveyed area, as well as their suitability for hosting rock art manifestations. The selection of these specific substrates to execute the rock art appears to be correlated with physical properties such as surface smoothness, rock compactness, and low porosity, color, and microtopography of the wall (Aschero, 1988).

Mineral Pigments

Rock paintings were manufactured from natural organic and inorganic pigments (minerals, charcoal, burnt bones, and/or colored clays). These could be mixed with vehicles or binders—such as water, vegetable oils, or animal fats—to facilitate application and enhance persistence (see Boschín et al., 2011 and references therein). Red is the dominant color observed in the regional rock art assemblage (Figure 4a, d-f), although black, white, and yellow occur in lower frequencies (Schuster and Massaferro, 2025a). According to published literature (Boschín et al., 2011; Sepúlveda, 2021 and references therein) and our own experimental data (Schuster and Massaferro, 2025a), the red hue could be sourced directly from hematite, thermally altered magnetite, or from clays containing significant amounts of these iron oxides. Black pigments were likely obtained by grinding manganese oxides or charcoal, whereas yellow hues were derived from limonite, natrojarosite, or goethite. For the white color, the archaeological literature proposes different sources, including gypsum, calcite, kaolin, or calcined bone. Conversely, green hues could be obtained from specific copper-bearing or ferrous minerals, such as malachite, celadonite, or glauconite (see Boschín et al., 2011 for a review).



Figure 4. Rock art sites in the study area. Scale Bar= 10 cm. **a)** La Escondida, south of Paso de Indios (digitally retouched image courtesy of Mr. Sergio Caviglia); **b)** Piedra Calada de Las Plumas 1, Las Plumas; **c)** Senasa 1, Las Plumas; **d)** Cueva Los Altares, Los Altares; **e)** Alero Los Altares, Los Altares; **f)** Alero Ernesto, Cañadón Carbón.

Our results indicate that the red pigment could have been sourced from clays of the Salamanca Formation, as identified at the Valeriana quarry in Piedra Grande, Las Chapas (Schuster and Massaferro, 2025a) or the hematite-pigmented levels in the Cerro Barcino Formation of the Chubut Group near the Las Plumas locality (Fig. 1a, b) (Manassero et al., 2000). Furthermore, primary potential hematite sources in natural sediments have also been reported in Los Altares (Gurin et al., 2016). Yellow pigments may have multiple provenances, such as the clay-rich horizons of the Salamanca Formation or limonite associated with manganese veins at the 28 de Julio locality in the lower Chubut River valley (Fig. 1a; Schuster et al., 2023; Schuster and Massaferro, 2025a).

For the black pigment, the analysis done on a painting of this color made by Gurin et al. (2021) in the locality of Gaiman (Fig. 1a) showed the presence of MnO as a chromogen. The few cases of rock art of this color in our study area have not yet been analyzed. The only potential regional sources of manganese oxides outcrop at the 28 de Julio and Las Plumas localities (Fig. 1a), occurring specifically as fracture-filling veins within the Marifil Formation (Malvicini and Llambías, 1974). Another potential source for black hues could be the dark fine-grained sedimentary rocks exposed at the Cerro Bororó (Fig. 1a), between Las Plumas and Los Altares (Krause, M., personal communication, 2026) that has not been tested yet.

Regarding the white color, as we mentioned above, a well-preserved sample from the Senasa 2 site (Fig. 1 and 2a) provided the first X-ray diffraction (XRD) analysis for this hue in the study area. The XRD results (Fig. 2b) revealed the presence of gypsum and quartz, minerals that are highly abundant throughout the study region, particularly within the Sarmiento Formation (Arcenio, 2023) (Fig. 1b).

Flaked Stone Tools

Lithic material constitutes the most abundant and frequent archaeological record within the study area. The raw materials selected by hunter-gatherers for knapping had to satisfy specific physical properties, such as the conchoidal fracture—resulting from rock homogeneity—a high degree of consolidation, brittleness, and the absence of internal impurities or fissures (Nami, 1992). That's why those materials lacking

crystalline structure, like opal, xylopal, obsidian, chalcedony, and colored silicas, are the most suitable for the manufacture of these kinds of tools.

Combined archaeological and geological research identified colored silica, chalcedony, and opal as the most prevalent lithologies in the archaeological sites (Fig. 5a, i). However, the raw material spectrum expands or restricts depending on the immediately available primary or secondary sources in the surroundings of the occupation sites. Consequently, in specific cases, other lithologies dominate the archaeological assemblages. Examples include silicified ignimbrites from the Marifil Group at several archaeological sites in Las Plumas (Piedra Calada, Cerro Colorado, Bardas Coloradas, Camping); jasper in Cañadón Carbón (Fig. 5j), and petrified wood (xylopal) in Sierra Cuadrada (Fig. 5d).



Figure 5. Potential or used primary/secondary lithic sources. Scale bars= 10 cm. **a)** Potential primary sources of silica, Las Plumas; **b)** Potential primary source of silicified wood (or xylopal) in Los Altares; **c)** Potential primary source of silicified wood in Paso de Indios, and the good quality for knapping is shown in detail; **d)** Primary source of silicified wood and debitage in situ in Sierra Cuadrada; **e)** Primary source of jasper, quarry/workshop site, Las Plumas; **f)** Potential primary source of silica, Los Altares; **g)** Potential primary source of celadonite, Los Altares; **h)** Secondary source in Sierra Cuadrada: nodule of silicified wood (xylopal); **i)** Potential secondary source of chalcedony, Paso de Indios; **j)** Secondary source of jasper and quarry/workshop site, Cañadón Carbón; **k)** Potential primary source of silicified ignimbrite, Cañadón Carbón.

Among the recorded archaeological sites, ancient lithic procurement sources were identified as either quarries or quarry-workshops. This is evidenced in Cañadón Carbón (Schuster and Massaferro, 2024) and Las Plumas by the jasper, and in Sierra Cuadrada by the petrified wood sources (Schuster and Massaferro, 2025b) (Fig. 1a, b). In these cases, jasper sources were found in the El Córdoba Formation and the Lonco Trapial Group, and petrified wood was linked to the Salamanca Formation.

Silicified trunks are highly abundant in the Salamanca or Cerro Bororó Formation but also in the Chubut Group, rendering them widely distributed across a vast region and acting as high-potential lithic procurement sources (Fig. 1b, 5c). Nevertheless, not all outcrops were exploited by past hunter-gatherers. Some potential petrified wood sources lacked the required mechanical properties for knapping depending on their states of opalization/silicification, as observed in certain exposures at the Florentino Ameghino Dam (Schuster et al., 2023). Anyway, the occurrence of trunks in the Chubut Group (Fig. 5b) is scarcer than in the Cerro Bororó Formation (Krause, M. personal communication, 2026), and their capacity for knapping is also variable, as we have seen in Sierra Cuadrada (Schuster and Massaferro, 2025b), Las Plumas, Los Altares, and Paso de Indios.

Ground Stone Tools

These kinds of tools should satisfy some physical properties such as the abrasive texture, high cohesion, and hardness (Babot and Larrahona, 2010). The abrasive texture is related to granular rocks such as igneous or coarse-grained sedimentary rocks. It is worth noting that these tools used to be heavy and bulky, so the proximity to raw material sources was a critical factor in procurement strategies. Regarding the provenance of the sedimentary raw materials observed in this study, further petrographic research is required to establish definitive correlations; however, suitable sandstone beds are widely available locally within the Chubut Group (see Fig. 1b).

The most frequently raw material used for making *boleadoras* (or throwing balls) was fine-grained basalt and gabbro; these denser raw materials would have better resist the various impacts when thrown. The gabbros are geologically linked to the

El Buitre Formation and equivalent units, whereas the basalts correlate with either the Cañadón Asfalto Formation or effusive units of Cenozoic magmatism (Fig. 1b).

Ceramic Technology

The scarcity in the record of these materials is primarily due to the late adoption of ceramic technology among Patagonian hunter-gatherer groups and its rapid discontinuation following European contact (Schuster, 2014). Furthermore, technical manufacturing attributes—specifically low firing temperatures (Schuster, 2014; 2020)—render these materials highly vulnerable to taphonomic degradation and weathering. Despite these preservation biases, a few ceramic pieces from local collections were documented and macroscopically analyzed (Fig. 3h, i).

Based on previous characterizations of archaeological ceramics from Las Plumas and Los Altares, clay raw materials were typically procured from immediate local surroundings. However, the archaeological record also indicates the presence of allochthonous vessels obtained through exchange networks with south-central Chile (Schuster, 2014; 2020). Petrographic thin-section and XRD analyses of local pottery samples generally reveal the utilization of clays accumulated in endorheic basins (playa lakes) or fluvial floodplains, both of which are widely distributed throughout the study area (Schuster, 2014). The abundance and quality of the regional clay deposits—particularly in the lower-middle Chubut River valley—is reflected today by the intensive industrial exploitation and artisanal use of these raw material quarries.

Other Archaeological Materials

The red tuffs carved with circular motifs likely came from the Chubut Group, whose outcrops are exposed less than 1 km from the findspot. These particular objects and those observed in the Museum of Lithic Art - Las Plumas (Fig. 3f, g) constitute a highly significant finding, as no local precedents for this type of artifact had been reported to date. In the future, the interpretation of these types of findings is expected to expand through the review of other private and/or museum collections, and fundamentally, through *in situ* recoveries of such materials within archaeological context.

CONCLUSIONS

From the studies carried out and the results presented in this work, the significant link and knowledge that ancient hunter-gatherers possessed regarding the environment and the surrounding geology becomes clear. For these populations, the geological environment represented the primary source for obtaining raw materials to manufacture hunting tools (projectile points and *boleadora* balls; Fig. 3l, a-c), artifacts for food preparation (mortars, grinding stones; Fig. 3j, k, m, n), and tools for tanning and processing animal hides used to build their *toldos* (tents used for housing, made from guanaco hides) and/or to make *quillangos* (coats made from guanaco hides), such as knives, scrapers, and leather-softeners (Fig. 3e). Likewise, from this environment, they could also extract clay sediments to manufacture fired ceramic pieces (Fig. 3h-i) and minerals to produce pigments used in rock art, mortuary contexts, and possibly for personal use as well.

In the particular case of the CAB, based on the identified archaeological record, it has been possible to recognize that the ignimbrites of the Marifil and Lonco Trapial groups were frequently used for temporary occupation due to the shelter they provided, as well as support for rock art. However, in some specific cases and according to the surrounding geology, they also took advantage of basalt outcrops, particularly those of the Sierra Cuadrada.

As previously mentioned, hunter-gatherers utilized the lithic resources available in nearby environments; nevertheless, highly prized rocks such as obsidian were transported or exchanged among hunter-gatherer groups throughout Patagonia. Although we have identified some outcrops of this raw material during our fieldwork in Las Chapas (Fig. 1a) (Schuster et al., 2023) and Cañadón Carbón (Schuster and Massaferro, 2024), none of these potential sources exhibit suitability for lithic knapping. To date, it has been determined that in localities such as Las Plumas and Los Altares (Gómez Otero and Stern, 2005) and Las Chapas (Schuster et al., 2020), obsidian circulated from the Pampa de Sacanana or Sierra Negra de Telsen, located approximately 180–200 km in a straight line from the aforementioned area (Fig. 1a). Our own ongoing studies will expand the information regarding this matter.

Another interesting aspect observed in the regional archaeological record is that the local or immediate availability of a geological resource did not necessarily mean that hunter-gatherers utilized it. An example of this is kaolin—from which white pigment can be obtained—which, despite being very frequent and abundant in the lower-middle valley of the Chubut River, has not been used in the regional rock art (Schuster et al., 2023). A similar case was observed in the Cañadón Carbón and Los Altares localities, where we recorded celadonite as part of the hydrothermal infill of vesicles in basalts of the Lonco Trapial Group and Cañadón Asfalto Formation (Fig. 1b, 5g)—along with calcite, heulandite, mordenite, and quartz. Nevertheless, the green color has not been recognized to date in the rock paintings of the middle valley area of the Chubut River (Schuster and Massaferro, 2025a), but it has been identified in the lower Chubut River valley (La Angostura site, Gurin et al., 2021) and in the upper Chubut River valley (Piedra Parada) by Wainwright et al. (2000).

As evidenced throughout the presented work, igneous rocks were widely required for tool manufacturing, whereas sedimentary rocks and/or sediments were primarily employed for making ceramic pieces, for specific artifacts—such as grinding stones or mortars—and also for paint production. Furthermore, as demonstrated by recent and highly significant findings, these raw materials could be employed as support for decorated objects whose function remains unknown.

Data obtained from rock art styles recorded in the area –Grecas Style (Menghin, 1957)- as well as the types of materials recovered from archaeological sites—such as pottery, throwing balls or *boleadoras*, and grinding stone artifacts—suggest human occupation in the area covered by this study during the Middle-to-Late Holocene. Nonetheless, certain projectile point types documented in private collections within the region, and specifically, the recovery of a Fishtail point in Sierra Cuadrada (Schuster, 2026), suggest an earlier human exploration of the territory during the Pleistocene-Holocene transition. Future work in the study area will allow us to expand the current data we have on the age and use of this river space by past hunter-gatherer groups.

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REFERENCES

- Allard, J., Paredes, J., Foix, N., Giacosa, R., Bueti, S., and Sánchez, F. (2021). Estratigrafía de la cuenca de Cañadón Asfalto. In Giacosa, R. (Ed.), *Geología y Recursos Naturales de la Provincia del Chubut*. Digital book ISBN 978-48319-0-3
- Anselmi, G., Gamba, M. T., and Panza, J. L. (2004). Hoja Geológica 4369I-V, Los Altares. Provincia del Chubut. Instituto de Geología y Recursos Minerales, Servicio Geológico Minero Argentino. *Boletín*, 313: 98. Buenos Aires.
- Arcenio, E. M. (2023). *Niveles Yesíferos de la Formación Sarmiento en el Valle Inferior del Río Chubut*. Tesis de licenciatura en Ciencias Geológicas, Universidad Nacional de Río Negro, 55 pp. Río Negro.
- Aschero, C. (1988). Pinturas rupestres, actividades y recursos naturales; un encuadre arqueológico. In H.D. Yacobaccio (Ed.), *Arqueología contemporánea argentina. Actualidad y perspectivas*. Ediciones Búsqueda, Buenos Aires: 109–145.
- Babot, P., and Larrahona, P. O. (2010). Artefactos de molienda y materias primas. Propuesta para su abordaje y estudio de casos en valles del noroeste argentino. *Relaciones*, 35: 17–39.
- Bellelli C., and Guráieb, A.G. (2019). Re-evaluación cronológica de la secuencia arqueológica del curso medio del río Chubut (área de Piedra Parada). In J. Gómez Otero, A. Svodoba and A. Banegas (Eds.), *Arqueología de la Patagonia: el pasado en las arenas*. IDEAus-CONICET, Puerto Madryn: 259–270.

- Beeskow, A., Del Valle, H., and Rostagno, M. (1987). *Los sistemas fisiográficos de la región árida y semiárida de la provincia de Chubut, Argentina*. Secretaría de Ciencia y Técnica, Delegación Regional Patagónica. Puerto Madryn, Chubut, Argentina.
- Boschin, M. T., Maier, M., and Massaferro, G. I. (2011). Une lectura pluridisciplinaire des analyses chimiques et minéralogiques de peintures rupestres de la Patagonie argentine. *L'Anthropologie*, 115 (3): 360–383. <https://doi.org/10.1016/j.anthro.2011.05.009>
- Caviglia, S. E. (2023) *Memorias en las rocas. 8 mil años de arte rupestre originario en Chubut*. Ministerio de Educación de la Provincia del Chubut, 640p. Chubut. Digital book: ISBN 978-987-47762-3-5
- Civalero, M. T., and Franco, N. V. (2003). Early human occupations in Western Santa Cruz Province, Southernmost South America. *Quaternary International*, 109-110: 77–86. [https://doi.org/10.1016/S1040-6182\(02\)00204-5](https://doi.org/10.1016/S1040-6182(02)00204-5)
- D' Elia, L., and Francese, J. (2005). Caracterización litológica y estructural de ignimbritas precuyanas en la Sierra de Chacaico, Neuquén, con énfasis en su potencial petrolero. *VI Congreso de Exploración y Desarrollo de Hidrocarburos (CONEXPLOR)*. Trabajos técnicos, Reservorios y desarrollo de reservas. Resúmenes de trabajos: 27. CD-ROM. Mar del Plata, Argentina.
- Escosteguy, L., Geuna, S., Franchi, M., and Dal Molin, C. (2013). Hoja Geológica 4172-II, San Martín de los Andes, Provincias de Río Negro y Neuquén. *Boletín* 409. SEGEMAR. Buenos Aires.
- Ericson, J. (1984). Toward the analysis of lithic reduction systems. In J. E. Ericson and B. Purdy (Eds.), *Prehistoric Quarries and Lithic Production*, Cambridge University Press, Cambridge: 11–22. <https://doi.org/10.1017/CBO9780511753244.002>
- Foix, N., Allard, J. O., and Paredes, J. M. (2021). Cuenca liásica de Pampa de Agnia. In Giacosa, R. (Ed.), *Geología y Recursos Naturales de la Provincia del Chubut*. Digital book ISBN 978-48319-0-3
- Gómez Otero, J., Svoboda, A., Millán, A. G., Banegas, A., and Marani, H. A. (2025). First archaeological evidence of Early Holocene human settlement on the Atlantic coast of South America. The Camarones burial site, Argentine Patagonia. *Journal of Archaeological Science: Reports*, 52 104234. <https://doi.org/10.1016/j.jasrep.2025.105515>
- Gómez Otero, J., and Stern, C. (2005) Circulación, intercambio y uso de obsidianas en la costa de la provincia del Chubut (Patagonia, Argentina) durante el holoceno tardío. *Intersecciones*, 6: 93–108. Buenos Aires.
- González, P. D., and Giacosa, R. E. (2021). Rocas metamórficas e ígneas del Paleozoico. In Giacosa, R. (Ed.), *Geología y Recursos Naturales de la Provincia del Chubut*. Digital book ISBN 978-48319-0-3
- Gurin, C., Mazzuca, M., Gómez Otero, J., and Maier, M. (2021). Micro-Raman spectroscopy and complementary techniques applied for the analysis of rock art paintings at the archaeological locality La Angostura, lower valley of Chubut River (Patagonia, Argentina). *Archaeological and Anthropological Sciences*, 13: 54. <https://doi.org/10.1007/s12520-021-01300-9>
- Gurin, C., Mazzuca, M., Maier, M., and Gómez Otero, J. (2016). Identificación de componentes inorgánicos y orgánicos en materiales arqueológicos pigmentados del nordeste de Chubut. *Actas XIX Congreso Nacional de Arqueología Argentina*, Río Cuarto: 2799–2806.
- Haller, M. J, Massaferro, G. I., Alric, V. I., Navarrete, C. R., and Menegatti, N. (2021). Magmatismo básico cenozoico del centro sur del Chubut. In Giacosa, R (Ed.), *Geología y Recursos Naturales de la Provincia del Chubut*. Digital book ISBN 978-48319-0-3

- Labraga, J. C., and Villalba, R. (2009). Climate in the Monte Desert: Past trends, present conditions, and future projections. *Journal of Arid Environments*, 73(2): 154–163. <https://doi.org/10.1016/j.jaridenv.2008.03.016>
- Massaferro, G., and Haller, M. (2004). Geotermometría de los basaltos de Gastre, Chubut. *VII Congreso de Mineralogía y Metalogénesis*, Río Cuarto: 333–336.
- Manassero, M., Zalba, P., Andreis, R., and Morosi, M. (2000). Petrology of continental pyroclastic and epiclastic sequences in the Chubut Group (Cretaceous): Los Altares-Las Plumas area, Chubut, Patagonia Argentina. *Andean Geology*, 27 (1): 13–26. <http://dx.doi.org/10.4067/S0716-02082000000100002>
- Menghin, O. (1957). Estilos del arte rupestre de Patagonia. *Acta Praehistorica* 1, 57–87.
- Menghin, O., and Gradin, C. (1972). La Piedra Calada de Las Plumas (provincia de Chubut). *Acta Praehistorica*, 11: 15–63.
- Nami, H. G. (1992). El subsistema tecnológico de la confección de instrumentos líticos y la explotación de los recursos del ambiente: una nueva vía de aproximación. *Shincal*, 2: 33–53. Catamarca.
- Oyarzábal, M., Clavijo, J., Oakley, L., Biganzoli, F., Tognetti, P., Barberis, I., Maturo, H. M., Aragón, R., Campanello, P. I., Prado, D., Oesterheld, M., and León, R. J. (2018). Unidades de vegetación de la Argentina. *Ecología Austral*, 28: 40–63. <https://doi.org/10.25260/EA.18.28.1.0.399>
- Schuster, V. (2026). Primer hallazgo de una punta “cola de pescado” en la meseta central de la provincia del Chubut. *Relaciones*, 51, e120. <https://doi.org/10.24215/18521479e120>
- Schuster, V. (2020). El registro cerámico de los cazadores recolectores costeros del sur de Río Negro y norte del Chubut, Patagonia Argentina. In V. Schuster and A.E. Pérez (Eds.), *Cerámica arqueológica de la Patagonia*: 35–57.
- Schuster, V. (2014). La organización tecnológica de la cerámica de cazadores-recolectores. Costa norte de la Provincia del Chubut (Patagonia Argentina). *Relaciones*, 39 (1): 203–231.
- Schuster, V., and Massaferro, G. I. (2025a). Ochre in the rock art of the lower-middle valley of the Chubut River (Chubut Province, Patagonia Argentina). Natural mineral pigments, experimentation and study cases. *Journal of Archaeological Science: Reports*, 66, 105243. <https://doi.org/10.1016/j.jasrep.2025.105243>
- Schuster, V., and Massaferro, G. I. (2025b). Xilópalo en la meseta central de la provincia del Chubut. La fuente primaria de Sierra Cuadrada (Patagonia argentina). *3° Congreso Argentino de Estudios líticos en arqueología*: 129, Puerto Madryn.
- Schuster V., and Massaferro, G. I. (2024). El jaspe de Cañadón Carbón. Fuente de materia prima lítica en el valle medio del río Chubut. *Revista del Museo de Entre Ríos*, 8 (1): 57-60.
- Schuster, V., and Massaferro, G. I. (2019). Arqueología en el valle inferior-medio del río Chubut. Resultados de los trabajos exploratorios en la localidad Las Chapas, Dto. Alsina. *Cultura, Hombre, Sociedad*, 27 (2): 201–214.
- Schuster V., Massaferro G. I., and Iglesias, C. (2023). Hacia la conformación de una base regional de recursos líticos. Disponibilidad y aprovechamiento de materias primas en la localidad Las Chapas (valle inferior medio del río Chubut). *Arqueología*, 29 (2), 11876. Buenos Aires. <https://doi.org/10.34096/arqueologia.t29.n2.11876>

- Schuster V., Massaferro, G., and Pérez, A. E. (2020). Primeros análisis químicos no destructivos de obsidiana arqueológica en el valle inferior-medio del río Chubut. Patagonia Argentina. *Revista Relaciones* 45(2): 447–453.
- SEGEMAR, (1997). *Mapa Geológico de la República Argentina*. Escala 1:2.500.000. Secretaría de Industria, Comercio y Minería, Subsecretaría de Minería, Servicio Geológico Minero Argentino, Instituto de Geología y Recursos Minerales. Buenos Aires.
- Sepúlveda, M. (2021). Making visible the invisible. A microarchaeology approach and an archaeology of color perspective for rock art paintings from the southern cone of South America. *Quaternary International*, 572: 5–23. <https://doi.org/10.1016/j.quaint.2020.05.031>.
- Silva Nieto, D. G., Cabaleri, N., Salani, F., González Díaz, E. F., Coluccia, A., Marquéz, M. J., and Lizuaín, A. (2002). *Hoja Geológica 4639-27 Cerro Cóndor*. Servicio Geológico Minero Argentino. Instituto de Geología y Recursos Minerales. Buenos Aires.
- Umazano, A. M., Krause, J. M., Bellosi, E. S., Perez, M., Visconti, G., and Melchor, R. N. (2017). Changing fluvial styles in volcanoclastic successions: a cretaceous example from the Cerro Barcino Formation, Patagonia. *Journal of South American Earth Sciences*, 77: 185–205. <https://doi.org/10.1016/j.jsames.2017.05.005>
- Valladares, A. (2004). Cuenca del Río Chubut. Subsecretaría de Recursos de Nación, Argentina. <https://www.argentina.gob.ar/sites/default/files/65.pdf>
- Villegas, P. M., Bernardi, M. I., and Umazano, A. M. (2026). New U-Pb zircon age and volcano-sedimentary evolution of the Jurassic Marifil complex, Las Plumas area, Chubut province, Patagonia. *Journal of South American Earth Science* 180, 106138. <https://doi.org/10.1016/j.jsames.2026.106138>
- Wainwright, I. N., Helwig, M. K., Podestá, M. M., and Bellelli, C. (2000). Analysis of pigments from rock painting sites in Rio Negro and Chubut Provinces, Argentina. In: *Podestá M. and M. De Hoyos (Eds.), Arte en las Rocas*. Sociedad Argentina de Antropología, Buenos Aires, pp. 203–206.