Lithic Technology

ISSN: 0197-7261 (Print) 2051-6185 (Online) Journal homepage: http://www.tandfonline.com/loi/ylit20

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To cite this article: Lynch Virginia & Lynch Julieta (2018) The Study of Rock Art Engravings Through Lithic Technologies: The Villavil 2 Site (Hualfin Valley, Catamarca, Argentina), Lithic Technology, 43:2, 71-83, DOI: 10.1080/01977261.2018.1437978

To link to this article: https://doi.org/10.1080/01977261.2018.1437978

LITHIC TECHNOLOGY, 2018
VOL. 43, NO. 2, 71–83
https://doi.org/10.1080/01977261.2018.1437978

Routledge
Taylor & Francis Group

The Study of Rock Art Engravings Through Lithic Technologies: The Villavil 2 Site (Hualfin Valley, Catamarca, Argentina)

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ABSTRACT

The rock art research related to Late Regional Developments and the Inca Period in Northwest Argentina (NWA) has commonly focused on iconographic, temporal, or significance studies, and little is related to the production context and stone tools used in this process. The following paper contributes to the study of engraving techniques in the northern area of the Hualfín Valley (De Catamarca Province, Argentina), based on the analysis of the operating chains, including the associated lithic materials and their functional determination. Previous analysis identified most of the motifs as figurative zoomorphs, which are related to the Inca Period and have some association with Belén/Santamariana iconography. These images were mainly created by removing part of the rock surface by pounding, and, to a lesser extent, incisions and scraping techniques are also recorded in the production of these petroglyphs. A functional analysis of the associated lithic materials confirms the kinematics employed and their relation in the production process. The analysis carried out also identifies that the artifacts used in this process would have expeditious designs and relatively abrupt working angles.

Las investigaciones desarrolladas acerca del arte rupestre relacionado con ocupaciones de momentos tardíos en el Noroeste Argentino (NOA), han estado comúnmente focalizadas al estudio iconográfico, temporal o de significación y pocos frecuentes aquellos relacionados al contexto de producción y a la identificación de los artefactos líticos utilizados en este proceso. Es así que el siguiente trabajo intenta contribuir con el estudio de las técnicas de producción de grabados en el sector norte del Valle de Hualfín (Catamarca, Argentina) a partir del análisis de las cadenas operativas que intervinieron en este proceso, incluyendo el estudio de materiales líticos asociados y su determinación funcional. El análisis realizado permitió reconocer que en su mayoría los motivos identificados son figurativos zoomorfos y que de acuerdo a los antecedentes en el área, pantean una estrecha relación con momentos de ocupación incaica y con asociación iconográfica Belén/Santamariana. A su vez, las técnicas aplicadas fueron definidas principalmente como picado, pero a partir de los resultados obtenidos de las cinemáticas identificadas mediante el análisis funcional realizado, se cree que en los primeros momentos de su producción incluiría la técnica de horadación. Por otro lado, si bien se registraron incisiones y raspado en la producción de estos petroglifos estas técnicas fueron aplicadas en menor medida y a partir de artefactos con diseños expeditivos y ángulos de trabajo relativamente abruptos.

KEYWORDS
Late- inca period; petroglyphs; lithic artifacts; Hualfín valley; NWA

Palabras claves
Tardío-Inca; petroglifos; artefactos líticos; Valle de Hualfín; NOA

Petroglyphs and Their Manufacturing Process

Rock art is a potential source of information on the different socio-cultural aspects of a community, which includes not only ideological-symbolic patterns but also subsistence and settlement systems. The technological decisions of the rock art manufacturing process can be understood as a series of actions, gestures, tools, and agents that cause the transformation of matter into product from a series of known steps (Bednarik, 1998, 2007a, 2007b; Bleed, 2001; D'Errico & Sacchi, 1995; Gamble, 1999; Lemonnier, 1992). In this sense, petroglyphs require the use of tools that allow not only a better understanding of the production context, but also better knowledge of other social and economic spheres (Álvarez, Fiore, Favret, & Castillo Guerra, 2001; Aschero, 1988, 1999, 2000, 2006; Blanco, 2015; Blanco & Lynch, 2011; Fiore, 1996–1998). Thus, the production of petroglyphs involves a series of stages that includes obtaining resources, action on the material, maintaining the petroglyphs after production, and the integration of the artifacts used in their production within the archaeological record (Fiore, 1996–1998, 1999; Méndez Melgar, 2008). However, studies related to the stone tools used in this process, and their production, have not been

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systematically addressed and there is a lack of basic research in this area. The studies related to these topics were in most cases considered without recourse to ethnographic observations, replication experiments, or detailed examination (i.e. microscopic analysis; Bednarik, 1998, 2007a, 2007b).

In this sense, engraving techniques involve the removal of material, and it is therefore believed that the materials used for this purpose should have a suitable morphology for making marks on the selected substrate, as well as a relative hardness due to the particular features of the worked material (i.e. sandstones; Alvarez & Fiore, 1995; Álvarez et al., 2001; Bednarik, 1998; Blanco, 2015; D'Errico & Sacchi, 1995; Fiore, 1996–1998, 1999; Jackson Squella, Artigas San Carlos, & Cabello, 2002; Méndez Melgar, 2008). Thus, the integration of other archaeological evidence such as lithic study generates a better understanding of not only the technical processes of petroglyphs, but also a possible chronology by its association with different artifacts from dated archaeological contexts. In turn, artifact production is closely related to the other spheres of social production and is an essential element for expanding the human group's potential and interaction with the environment (Álvarez, 2003; Alvarez & Fiore, 1995; Fiore, 1999; Ingold, 1993).

Tools are material elements closely related to humans' intention of appropriating and generating changes in the world around them, since the tools not only modify the material on which they are applied, but also interact with humans through perception, practice, and cognition (Wobst, 2000). Each tool is the concrete materialization of the dynamics of interaction between the production and consumption spheres within the socially constructed economy (Álvarez, 2003; Alvarez & Fiore, 1995; Briz Godino, Pal, & Álvarez, 2014). It is for this reason that the ways tools are used constitute a point of reference for action, identity, and social differentiation (Briz, 2002; Briz Godino et al., 2014).

Taking into account the theoretical-methodological proposals mentioned above, this paper aims to expand our knowledge of the production processes of the petroglyphs identified in the Villavil 2 site (Hualfín valley, Catamarca, Argentina), carried out from a detailed analysis of the techniques used throughout the manufacturing process and a functional analysis of the associated stone tools. This allow us to articulate the production and the use of rock art with other aspects of culture on a spatial level, shedding light on the strategies by which social life is constructed within a community, combining objects, space, bodies, and experiences in a specific manner.

Rock Art Engravings in Northwest Argentina (NWA)

Research studies related to the rock art of the Late Regional Developments and Inca Period in Northwest Argentina (NWA) have been mainly focused on temporal assignment, iconographic identification, possible interpretations, and, to a lesser extent, the techniques applied to its production (Aschero & Martel, 2003–2005; Aschero, Martel, & López Campeny, 2003, 2009; González, 1980; Gordillo, 2009; Hernández Llosas, Podestá, Aldunate, Berenguer, & Castro, 1985; Martel, 2010; Martel & Aschero, 2007; Martel, Curletto, & Del Bel, 2012; Podestá, Raffino, Paunero, & Rolandi, 2005; among others).

Different techniques have been identified in the engraving production of this area including scraping (friction, abrasion, polishing), drilling (dimpling, rotation), inclusion, and pounding (pecking, hammering; Aschero & Martel, 2003–2005; Basile & Ratto, 2011; Martel et al., 2012; Ratto & Basile, 2009, 2012–2014). Most of these techniques were defined by Álvarez et al. (2001); they mention that the "inclusion/incision" is a cut or split made in the bedrock through the unidirectional or bi-directional movement of the tool, whose edge is moved longitudinally in relation to the working direction. The working angle is about 90 degrees. Unlike this technique, scraping consists in the abrasion of the bedrock through the bi-directional movement of the tool, whose edge is moved in a transversal way in relation to the working direction. The working angle is between 35 and 70 degrees and the contact between the material and the artifact is unifacial. Another technique is drilling, which involves the gradual insertion of an artifact into the substrate by rotational movements (Alvarez & Fiore, 1995; Blanco & Lynch, 2011). All of these techniques are defined by the type of mechanics exerted on the worked material depending on the movement and the tools necessary to perform it. In this case, these techniques are grouped within the techniques requiring pressure (Alvarez & Fiore, 1995).

Among these, surface percussion (which consists of patina removal by sustained blows) and, to a lesser extent, scraping and incision have been mostly identified in the petroglyphs related to the Late or Inca Period in Catamarca Province (Álvarez Larrain, 2012; Aschero & Martel, 2003–2005; Aschero, Martel, & López Campeny, 2009; Basile, 2012; Martel et al., 2012). Despite research developed on the different engraving techniques used and the iconographies represented, few studies have examined the petroglyph production context in NWA

(Aschero et al., 2009; Basile & Ratto, 2011, Moreno & Egea, 2016; Ratto & Basile, 2009, 2012–2014).

In the northern area of the Hualfín Valley, rock art studies associated with the Late or Inca Period are recent and have been focused on attributing a possible meaning, as well as a chronology (Lynch, 2015). Therefore, the aim of this research is to deepen our knowledge of the engraving techniques applied in the archaeological site of Villavil 2 (VV2; Catamarca Province, Argentina) and to analyze the associated lithic material. The stone tools recovered near the petroglyphs recorded at this site provide valuable information related to understanding the production context of rock art in the center of Catamarca Province.

Location and Main Features of the Site

The Villavil 2 site is located in the northern area of the Hualfín Valley, on an alluvial plateau in Northwestern Sierras Pampeanas, at an altitude of 1800 m. Based on the research carried out so far, the site underwent Late Regional Developments and Inca Period occupations (1000–1430 AD). A large amount of stratigraphic materials (lithics and pottery) and distinct late styles such as Belen and local Inca were identified (Lynch, 2015).

We recognized several different areas of the site; among them is an open area where nine rocky blocks were found, eight of which present engravings. These blocks correspond to reddish-colored sandstone presenting a black layer on the surfaces where the motifs, with iconography associated to the Late or Inca Period, are located (Lynch, 2015). In other areas of the VV2 site, rectangular and quadrangular enclosures of sandstone (delimiting major spaces) have been identified (Figure 1). The walls of the enclosures vary between 0.70 and 0.80 m in width, while the heights are in some cases not more than 0.50 m. Inside this last sector, multi-hole bedrock mortars have been recorded, some of them associated with these open spaces.

The engravings identified were divided into figurative, geometric, and undetermined motifs. In total 141 motifs were recorded. Within the figurative category, 68 zoomorphic, 18 anthropomorphic, and two therianthropomorphic motifs could be differentiated. Other motifs included 42 geometrics and nine undetermined (Lynch, 2015).

We can divide the zoomorphic figurative motifs on the one hand into animal tracks, such as feline tracks represented in Block 4, and, on the other, into "proper"

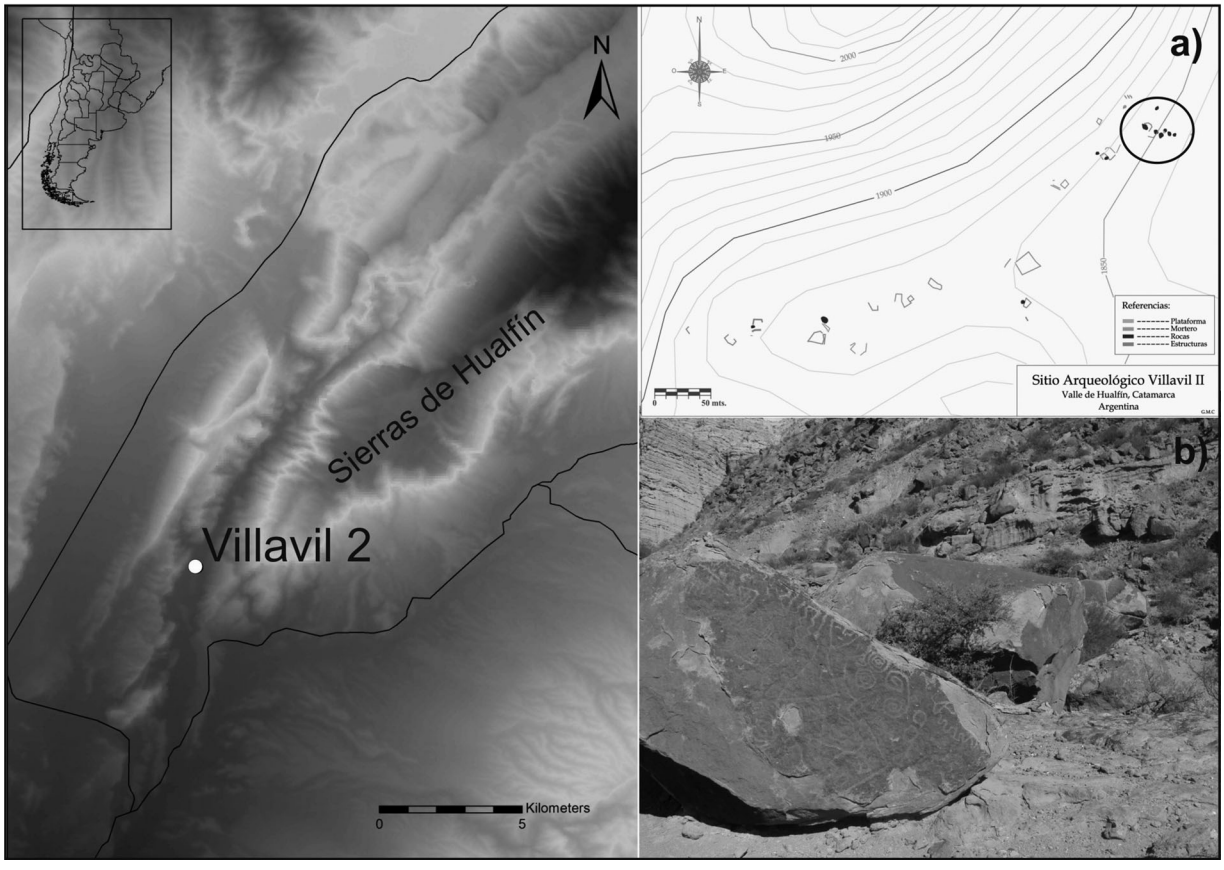

Figure 1. (a) Location of the Villavil 2 site in the northern area of Hualfín Valley (Catamarca, Argentina). (b) Engraved flat rocks recorded at the study site.

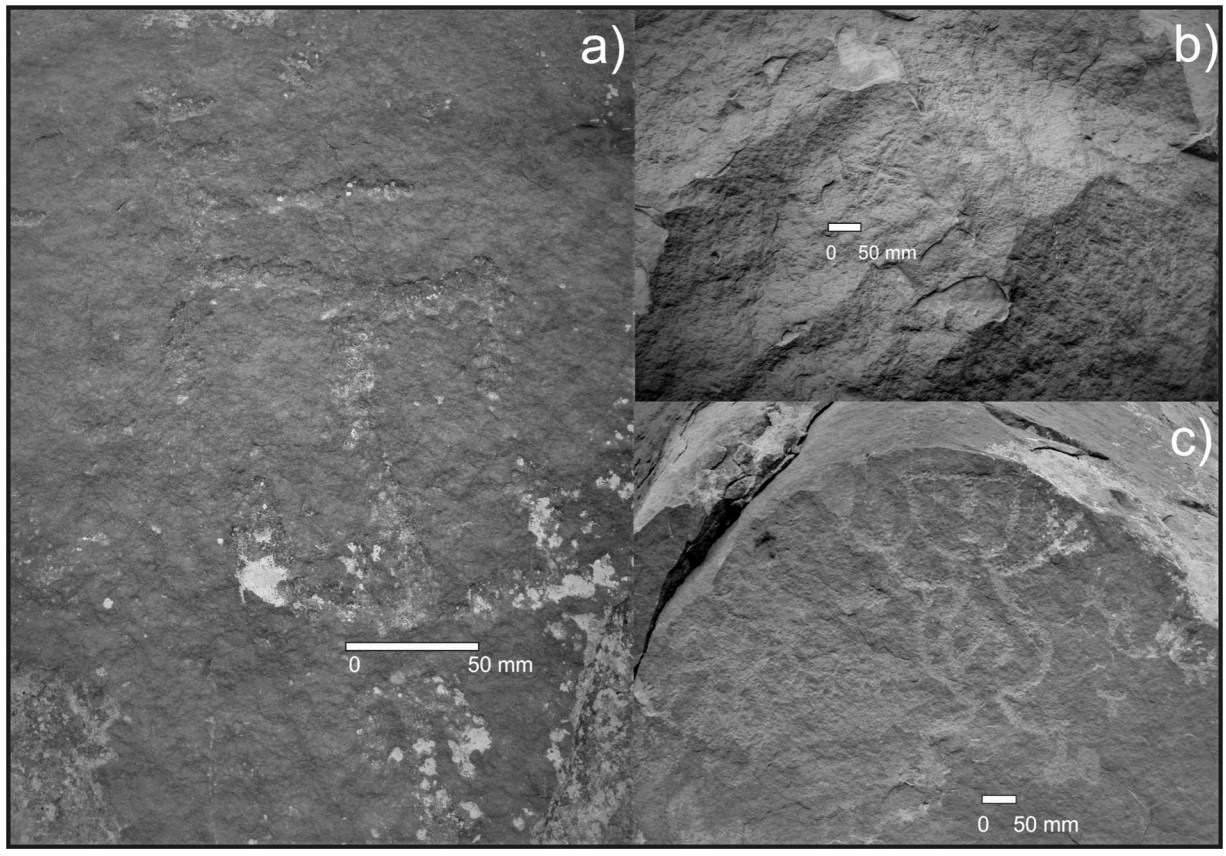

Figure 2. (a–c) Detail of anthropomorphic and geometric motifs identified in Block 1.

zoomorphic motifs that are represented by camelids, suris (a small species of *Rhea*), and reptiles, distributed across all the blocks. With respect to the anthropomorphic motifs, the characters with *unkus* or rectangular breasts and headdress stand out, some of them with an internal design of points. Anthropomorphic T has also been recorded and one of them has an arm in one of its extremities (Figures 2 and 3). The therianthropomorphic figures have forelimbs with three toes indicating the paws of the suri. They also include a bicephalous snake observed in Block 5, the main features of Belen and Santamariana iconographic style (Table 1).

Methodologies Applied

The main objective of this paper is to evaluate the rock art production process recorded at the VV2 site. For this reason, we have used a series of complementary methodologies to allow a deeper study of this process. In this sense, motif characterization was considered through a series of formal variables, techniques, and alteration processes, as well as the study of associated lithic materials. Regarding the latter, a series of excavations immediately adjacent to the petroglyphs were made in order to recover stone tools or debitage that could be related to the engravings' manufacture.

The identified petroglyphs are located in nine flat rocks, and for two of these rocks (Blocks 1 and 9), adjacent excavations were undertaken. The lithic material analyzed in this paper was recovered from these excavations. A systematic collection was carried out at the foot of these blocks and in nearby areas. These focused especially on stone tools with particular features and a potentially usable edge that allows us to hypothesize which artifacts could have been used in the engraving production.

On the other hand, we took into account a series of replicated experiments developed in a previous study (Blanco & Lynch, 2011), as well as a wider reference collection that included basalt as raw material for the identification of use-wear traces on different materials and conditions (Lynch, 2016). The purpose of these experiments was to apply diverse engraving techniques (scraping, incision, and drilling) in order to replicate different motifs and record the resulting use-wear traces on the experimental tools used. Based on the results, new inferences were made about possible engraving techniques, and also a first characterization of use-wear traces resulting from the pressure

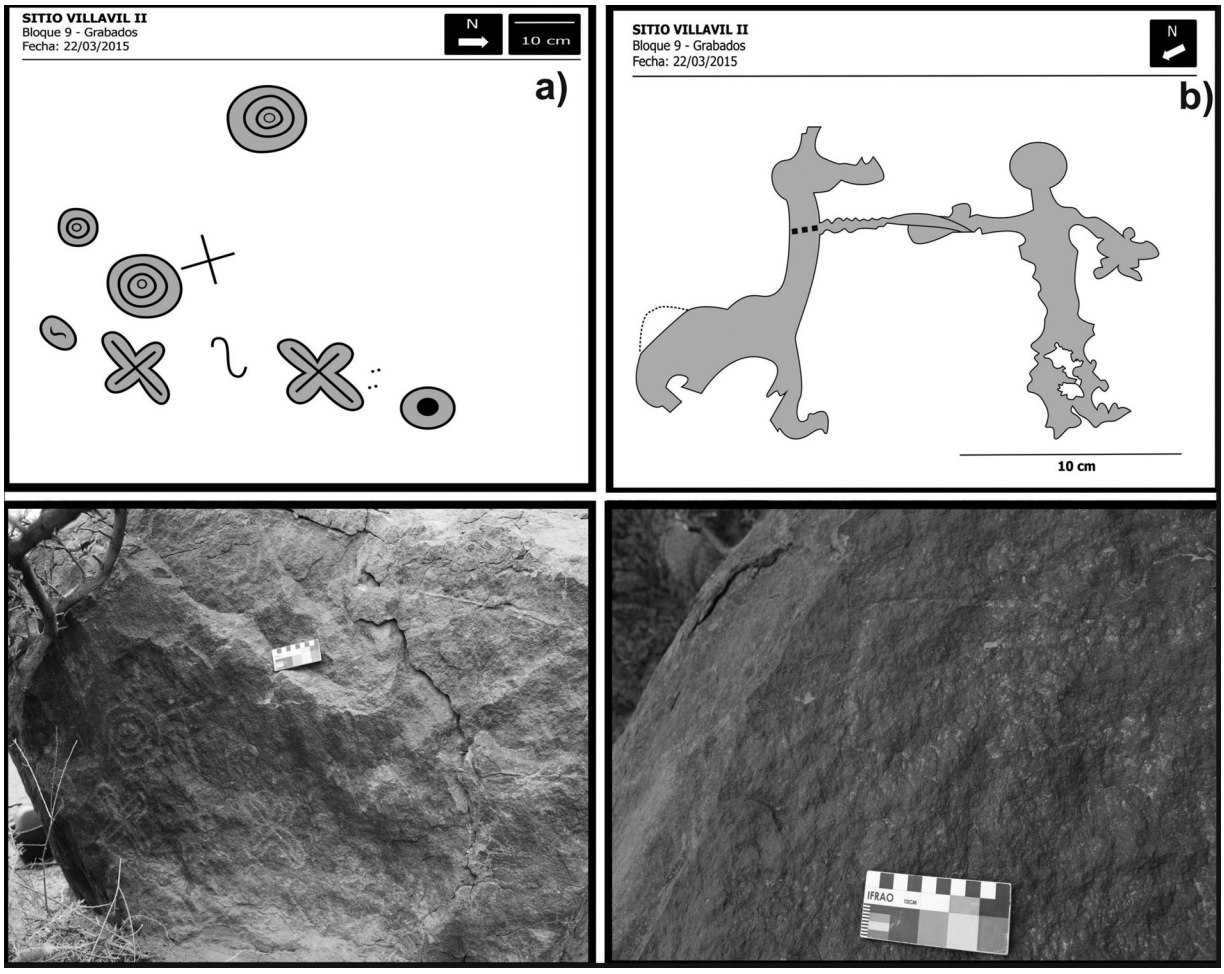

Figure 3. (a) Geometric motifs observed in Block 9. (b) Anthropomorphic and zoomorphic motifs identified in the same rock.

Table 1. Number and types of motifs identified on the flat rocks engraved at the Villavil 2 site.

Block	N panels	N motifs	Zoomorphs	Anthropomorphs[a]	Geometrics	Indeterminate
1	7	41	26	7	3	3
2	1	1	1	0	0	0
3	0	0	0	0	0	0
4	3	55	32	9	14	3
5	1	19	6	2	11	0
6	0	0	0	0	0	0
7	1	3	0	0	3	0
8	2	8	1	2	2	3
9	4	14	2	2	9	0
Total	**19**	**141**	**68**	**22**	**42**	**9**

[a]Two cases of zooanthropomorphic motifs were included in this category.

techniques. These analyses give more support to the studies proposed in this paper and were used as a basis for the analysis of engraving techniques in the VV2 site by providing more details on the lithic technology that could have been used in the production of the motifs.

Finally, laboratory analysis of the lithic materials recovered included technological, morphological, and functional analysis of the stone tools recovered and that could be linked to the manufacturing process of the petroglyphs (Aschero, 1975, 1983; Aschero & Hocsman, 2004). We also considered the raw material and metric variables of the artifacts, and identified edges and formal features and type of the edges.

The microscopy analysis was carried out taking into account the recovered material to determine a possible effective use of these tools (Álvarez, 2003; Mansur-Franchomme, 1983). The functional analysis was performed by applying two different but highly complementary approaches: the description of use-wear using low- and

high-power microscopy, with, respectively, a Nikon SMZ 800 binocular loupe (10–63× magnification) and a metallographic Nikon Epiphot 200 microscope (magnification 100–500×), each with a video-microscopy system. For this analysis, different kinds of use-wear traces were considered: gloss, micro-polish, micro-scars, breakages, striations, micro-pitting, and rounding.

We also applied different statistical tests to analyze differences between the samples. We used the non-parametric Pearson χ^2 (Chi-squared) test (Shennan, 1992).

Engraving Techniques Identified, and Associated Stone Tools

First, it is important to mention that the rocks chosen for engraving at the VV2 site have a high visibility; they are in an elevated position (at a height of 2 m) and with no obstacles blocking an observer's view. On the other hand, the motifs' degree of preservation is not optimal. Some of these motifs present exfoliations and alterations inside the grooves; however, all of these alterations are caused by natural agents. In turn, these engravings have a dark red coloration patina inside the engraved surfaces, resulting from the formation of a thin film on the surface.

The materialization of the ritual and symbolic system is found in a rich and complex iconography, where the basic figures observed in Block 1 are mainly related to the Santamariana and Belén style (Lynch, 2015). These styles are represented in almost all of the block panels of zoomorphic motifs ($n = 26$, 63, 4%), such as suris or camelids, and among some of the geometric ones ($n = 3$, 7, 3%), from crosses with curvilinear contours to concentric and spiral circles (Figures 1 and 2). On the other hand, anthropomorphic and therianthropomorphic[1] motifs (Lynch, 2015) were also identified ($n = 7$, 17, 1%), relating to the Late Period in NWA (Aschero, 2000; Basile & Ratto, 2011; Podestá et al., 2005, among others).

In relation to the engraving techniques identified on these motifs, we noticed that the pounding technique, whether continuous or discontinuous, is the technique most often used. We also noticed some motifs created through drilling or through the combination of both drilling and pounding. Other motifs were made from scraping combined with pounding. In the continuous pounding technique, the central areas of the figures are regular while they are irregular in the extremities.

Taking into account the types of techniques by motifs, we were able to identify that in the zoomorphic motifs the most used techniques were pounding, drilling, pounding/drilling, and, to a lesser extent, pounding/incision and scraping (suris). In the anthropomorphic and therianthropomorphic figures, the pounding technique was also identified, as well as pounding/drilling and pounding/scraping techniques, while in the geometric forms pounding and pounding/incision techniques (cross with curvilinear contours) were identified (Table 2). At the same time, Block 1 did not show any significant correlations between the techniques applied and the motifs created (Chi square test: pounding technique, $X_3^2 = 0.54$, $p = 0.91$; drilling technique, $X_3^2 = 0.56$, $p = 0.90$; pounding and drilling technique, $X_3^2 = 1.85$, $p = 0.60$, pounding and incision technique, $X_3^2 = 2.53$, $p = 0.47$; pounding and scraping technique, $X_3^2 = 1.56$, $p = 0.66$). In summary, pounding was the technique most often used and it was not linked to any specific type of motif; this was also observed in the rock art of other areas of NWA relating to the Late Period. This would probably indicate the absence of certain regionalization of the implemented techniques as well as in the represented motifs (Basile & Ratto, 2011; Martel et al., 2012; Troncoso & Vergara, 2013).

Table 2. Techniques identified by motifs in Blocks 1 and 9. P/D: pounding and drilling. P/I: pounding and incision. P/S: pounding and scraping.

	Techniques Used					
Motifs	Pounding	Drilling	P/D	P/I	P/S	Total
Block 1						
Zoomorphs	16	1	5	3	1	26
Anthropomorphs	4	–	2	–	1	7
Geometrics	2	–	–	1	–	3
Indeterminate	5	–	–	–	–	5
Block 9						
Zoomorphs	2	–	–	–	–	2
Anthropomorphs	3	–	–	–	–	3
Geometrics	6	–	–	2	1	9
Indeterminate	–	–	–	–	–	0

In relation to the stone tools recovered at the foot of Block 1, within the stratigraphy as well as on the surface, 11 unretouched artifacts were obtained (Figure 4). These artifacts were mostly cortical flakes and complete elements. The raw material used for their production included basalt and, to a lesser extent, granite rock, of which the source remains unknown. The use of different basalt qualities in the rest of the stone tool production at the VV2 site has been recorded. We believed that they could have been obtained from secondary sources and a local origin (Lynch & Lynch, 2016).

Regarding the unretouched flakes, these artifacts mainly correspond to external flakes, primary ($n = 4$) and secondary ($n = 5$), and one internal angular; with medium-large ($n = 4$), large ($n = 4$), and very large ($n = 3$) sizes and variable width–length modules (Aschero, 1975, 1983).

Most of these tools presented one potential cutting edge, except for one flake where two cutting edges were observed; most of these edges had a 45-mm average length and abrupt angles of 46°, a rectilinear

Table 3. Lithic materials associated with Blocks 1 and 9.

			Artifact			Edge		
Location	Raw Material	State	*Length*	*Width*	*Thickness*	*Length*	*Angle*	*Morphology*
Block 9	Basalt	Complete	24	37	12	55	37	Convex
Block 9	Basalt	Fractured	44	35	14	46	34	Rectilinear
Block 9	Andesite	Fractured	24	46	10	35	42	Convex
Block 9	Basalt	Fractured	77	56	18	45	38	Sinuous
Block 1	Quartz	Fractured	46	36	17	65	35	Sinuous
Block 1	Granite	Complete	57	69	24	51	60	Convex
Block 1	Basalt	Complete	38	11	17	45	74	Rectilinear
Block 1	Basalt	Complete	57	25	13	57	49	Convex
Block 1	Basalt	Complete	43	34	18	34	30	Sinuous
Block 1	Basalt	Fractured	33	35	8	40	35	Sinuous
Block 1	Flagstone	Complete	36	31,35	16	40	36	Rectilinear
Block 1	Basalt	Fractured	57	43	26	50	40	Rectilinear
Block 1	Basalt	Fractured	41	34	19	45	40	Rectilinear
Block 1	Basalt	Fractured	49	34	12	62	52	Rectilinear
Block 1	Basalt	Complete	43	32	12	55	46	Rectilinear
Block 1	Flagstone	Fractured	76	47	19	45	68	Sinuous

morphology, and an equally straight longitudinal section (Table 3).

In addition, it is important to mention that near Block 1, five cores of different raw materials such as basalt, dacite, and a granitic rock of grayish-green color were recovered. These cores were not exhausted, with a considerable volume, and had a minimum of three negative flakes in each case (Figure 4).

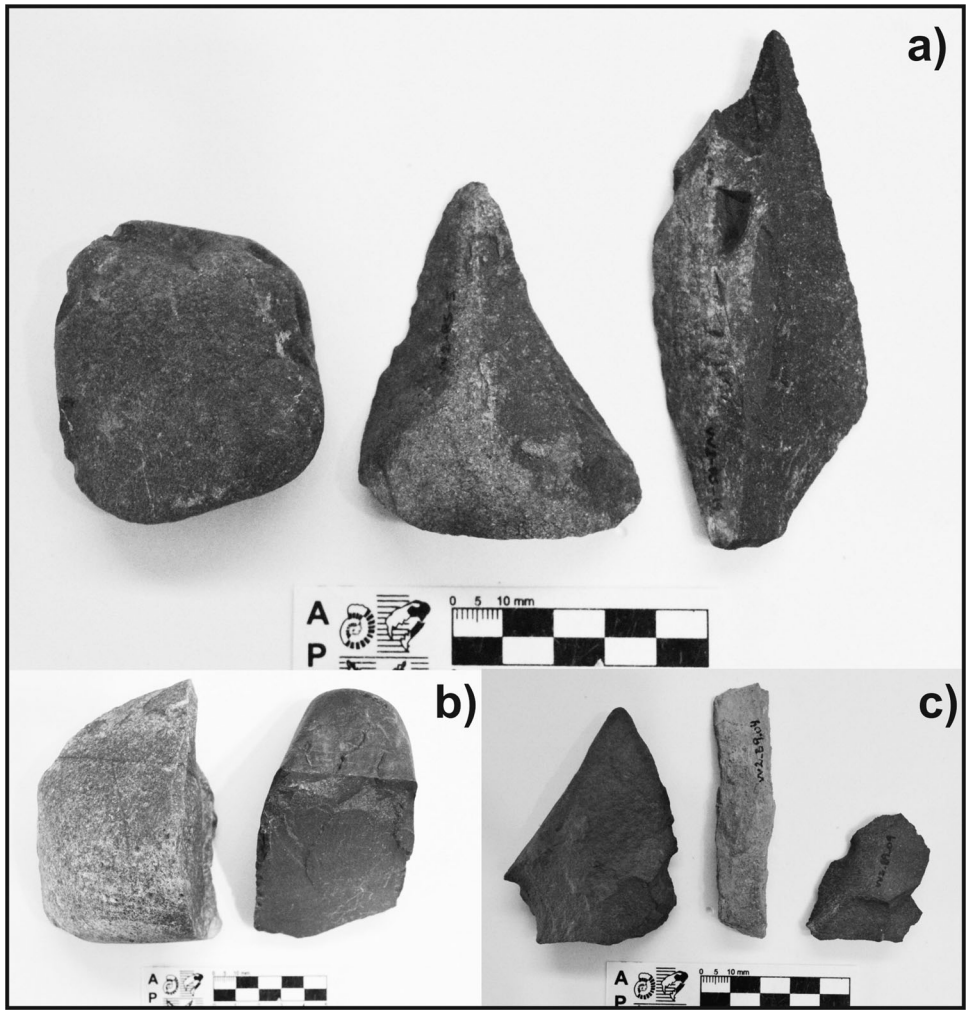

Figure 4. Lithic materials recovered at the foot of Blocks 1 and 9 within the stratigraphy of the location.

On the other hand, the recorded motifs of Block 9 are fewer in relation to those of Block 1. Among these motifs, the geometric ones ($n = 9$, 64.3%) – crosses with curvilinear contours, circles, concentric circles, sinuous lines – stand out compared to the anthropomorphic figures ($n = 3$, 21.4%) or the zoomorphic motifs ($n = 2$, 14.3%). Whereas only continuous or discontinuous pounding was identified in both the zoomorphic (camelids and suris) and the anthropomorphic motifs, a combination of incision and scraping techniques with pounding was identified in the geometric motifs (Table 2). Similarly to Block 1, Block 9 did not show a significant correlation between the techniques applied and the motifs developed (Chi square test: pounding technique, $X_2^2 = 0.24$, $p = 0.88$; pounding and incision technique, $X_2^2 = 1.04$, $p = 0.59$; pounding and scraping technique, $X_2^2 = 0.53$, $p = 0.76$).

The lithic material recovered in Block 9 consisted of five unretouched artifacts, two debitage fragments, and a red pigment sample in the stratigraphy. The unretouched artifacts mainly correspond to angular internal flakes, with the exception of one secondary flake, and are mostly fractured with or without platforms. The basalt is the raw material most used in their production and is a local high-quality knappable stone. Most of these artifacts have medium-large to very large sizes and modules of medium-normal width ($n = 3$) and short-very short width ($n = 2$). In all cases, at least one potentially usable edge was identified, with an average length of 45.2 mm and an average angle of 38°.

Micro-Wear Analysis

The functional analysis was carried out based on unretouched artifacts recovered within the stratigraphy and on those located at the foot of the engraved rocks, and included a total number of 16 elements with 20 active edges.

In the sample analyzed we registered 38 per cent of artifacts with evidence of use while we observed a slight degree of alteration of their surfaces, and only 6 per cent of these artifacts were affected by post-depositional alterations (edge rounding, polish, abrasion, striation, etc.). Sedimentary abrasion is the most frequent alteration; only one element presented bright spots and it lacked round edges. Most of the artifacts analyzed had one potentially useable edge, and in the case of double edges, these complementary edges were barely used.

In this sense, the lithic materials recovered within the stratigraphy around Block 1 were undetermined. However, the surface materials found in this block contained five edges with probable evidence of use. Regarding the identified worked materials, we observed the use of undifferentiated hard material with transverse, longitudinal, and a single case of rotational motions (Figure 5). In the

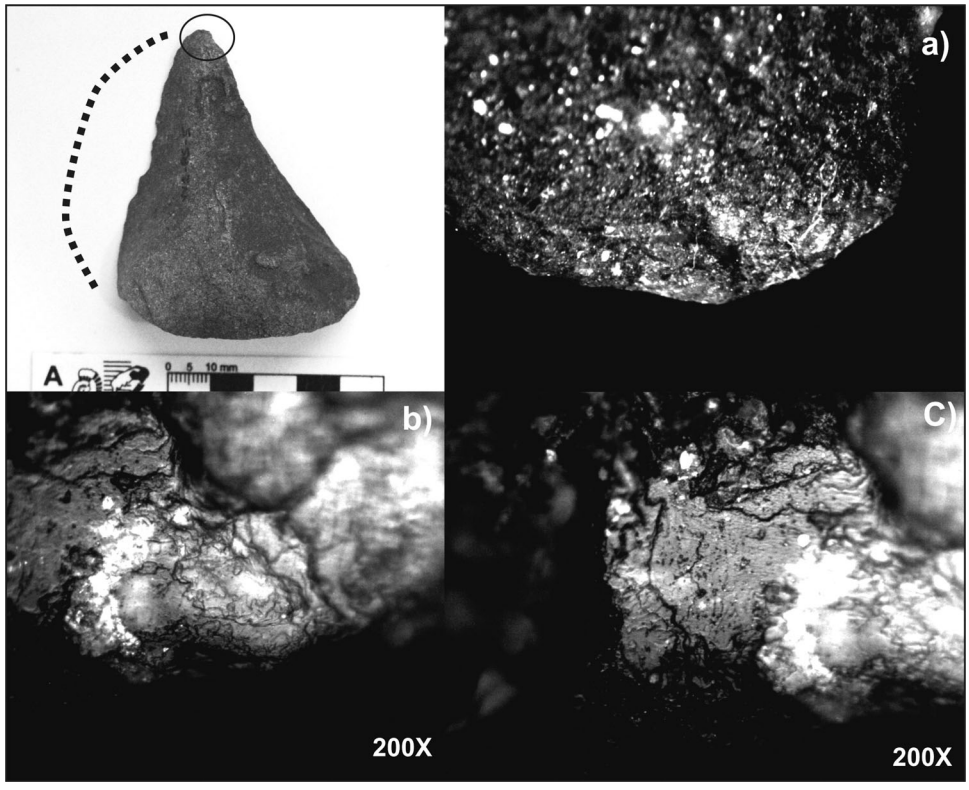

Figure 5. (a) Stone tool recovered from Block 1. (b–c) Rounding and undifferentiated hard material micropolish in rotational motions on transversal edges and distal area of the tool (magnification 200×).

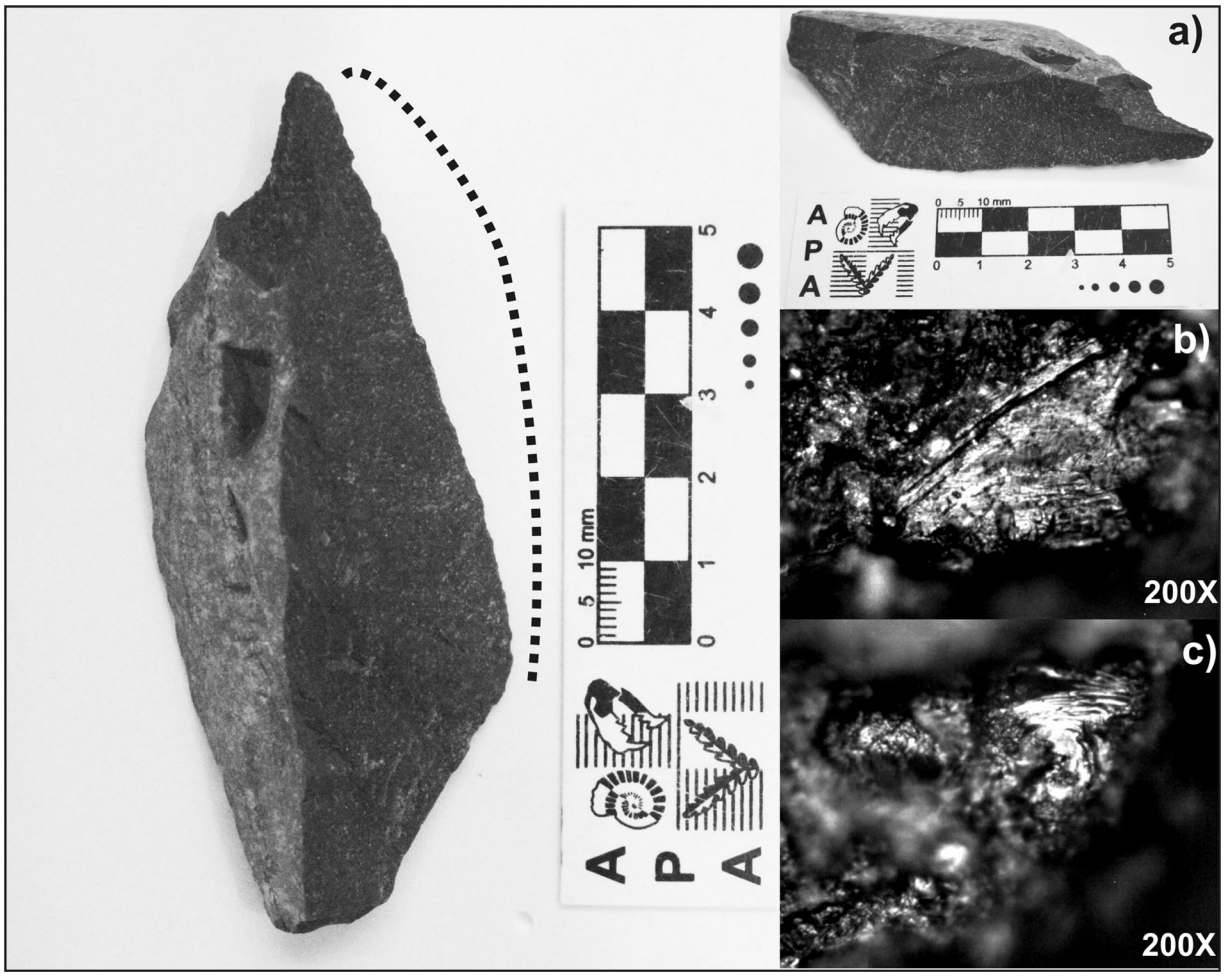

Figure 6. (a) Unretouched artifact recovered at Block 1. (b–c) Undifferentiated hard material micropolish in longitudinal and oblique motions (magnification 200×).

latter case, we identified hard material micropolish on both lateral edges and on the distal area of the tool.

Moreover, the edges worked on hard materials had mainly convex and rectilinear edges, with a length mostly greater than 50 mm and with oblique level angles (Figure 5; Aschero, 1975, 1983).

On the other hand, of the five artifacts recovered in the excavation carried out at Block 9, we recorded evidence of use in only one flake, and in this case the identified worked material corresponded to hard material undifferentiated in scraping motions. For the rest of the tools ($n = 4$), the functional analysis was undetermined (Figure 6).

Discussion and Conclusion

To begin with, we would like to mention that the results of previous studies obtained from micro-wear analysis of experimental tools used for rock engravings allowed a first characterization of diagnostic wear traces of these tools and have generated microscopic criteria for their identification. These previous experimental studies allowed us, on one hand, to generate the characterization of the traces of use on the active areas of the tools (edges or distal areas, depending on the case), and, on the other hand, to differentiate traces of use related to diverse engraving techniques (i.e. incision, scraping, and drilling; Blanco & Lynch, 2011).

From these previous experimental results, it was also observed that the stone tool morphology used for engraving would not necessarily include chisels or tips of which the natural edges would be just as effective (Alvarez & Fiore, 1995; Alvarez et al., 2001; Bednarik, 1998, 2007a, 2007b; Blanco & Lynch, 2011; Fiore, 1999; Frederick, 1999). In this sense, the materials analyzed at the Villavil 2 site are in agreement with these results since the stone tools recovered at this archaeological site have natural edges and we observed no behaviors aimed at prolonging their useful life.

Even so, certain selected edges would be used mostly with oblique angles, which would provide some robustness on the selected edges and therefore would extend

the useful life of these tools during the developed activities. Furthermore, the raw materials used (basalt of varying quality and granite rocks) would require a certain hardness as the tools would need to generate marks in the selected substrate.

Lithic materials related to engraved rocks associated to the Late Period in other sites of Northwest Argentina and in the northern area of Chile have also been recorded with similar features, informal tool designs, and few artifacts within the stratigraphy and on the surface (Méndez Melgar, 2008; Vergara, 2013). Pounding was the most frequent technique used for their production, followed by scraping, incision, and, to a lesser extent, drilling (Berenguer, Cabello, & Artigas, 2007; Martel, 2010; Troncoso, 2005; Troncoso, Armstrong, Vergara, Larach, & Urzúa, 2008; Vergara, 2009, 2013; Vergara & Troncoso, 2016).

On the other hand, the results obtained from the analysis carried out in this paper allow us to infer some connection with the engraving type and the active-edge morphology. Therefore, a study at the microscopic level was crucial to generate adequate inferences in relation to the techniques applied. In this sense, although pounding was the most commonly used technique in the petroglyphs analyzed, other techniques were also applied and the results obtained from the functional analysis allow their identification.

Block 1 presents the most diverse range of motifs (zoomorphic, anthropomorphic, and geometric) as well as a wide range of techniques (continuous or discontinuous pounding, incision, scraping, or drilling). The tools analyzed at a microscopic level have a slight degree of alteration mostly affected by sedimentary abrasion, and only one element presented bright spots and lacked round edges. The sedimentary matrix (Entisol) from which this cultural information was recovered is a fine sediment with sandy-loam texture, light in color, and with very low humus content. It is probable that these mechanical and chemical alterations were caused by different post-depositional processes such as weathering or changes in soil pH. However, these processes did not significantly affect the materials observed and allowed the functional analysis to proceed without problems.

From this analysis we recorded micropolishes generated by the work on hard material from longitudinal, transverse, and drilling motions, and these results support a possible relationship with the variety of motifs and production techniques identified in Block 1. Also, the record of hard material work is related to the mineral work and we believe that the absence of diagnostic micropolishes of this type of material in the recovered tools is due to the softness of the selected substrate (sandstone). Therefore, it is probable that during the production process, these artifacts would have been used for a short time and for this reason the absence of well-developed micropolishes would be expected on the stone tools used (Álvarez, 2003; Álvarez et al., 2001; Lynch, 2016; Mansur-Franchomme, 1999).

On the other hand, the pounding technique does not seem to have been used on the stone tools analyzed, since these artifacts do not show impact points or striations. Only a single pebble recovered on the surface showed certain impact marks that could be related to the production process of these petroglyphs (Figure 4 (a)).

With regard to the materials from the stratigraphy around Block 9, the functional determination of these tools was mostly undetermined, which implies an absence of well-developed micropolishes, because of either the short time of use or the type of worked material. However, the results obtained from the analysis carried out in this paper constitute a first approach to the study of rock art production in the northern area of the Hualfín Valley. The use of a pounding technique (continuous or discontinuous) in more than 69 per cent of the motifs recorded in the VV2 petroglyphs indicates little variability in the techniques applied as well as in the *chaîne opératoire* of production, expressed in the selected substrates and also in the related stone tools. In this way, the petroglyphs would have functioned as a communication system for the population in their social life spaces, but also probably in Inca times, when local landscape appropriation, alliance, and reciprocity relationships with local elites were very important to extend the Inca territory.

However, certain engraving techniques used in the rest of the flat rocks recorded at the VV2 site require a more detailed analysis, as do new excavations at the foot of these stones. Likewise, we believe that it is crucial to continue experiments on the possible techniques applied to the raw materials recovered at the area of study, including the pounding technique (continuous or discontinuous), as well as the evidence of functional analysis on the stone tools used in this technique. The point of view presented above aims to generate contributions based on alternative analysis for researching the rock art production sequence, generating new questions and criteria to analyze the evidence already available and to be applied to other materials in the future. Further discoveries of these and other features of the production of rock art engravings in Northwest Argentina, specifically in sites with Late or Inca Period evidence, will allow the exploration of other issues such as the reuse of these significant places. We will also be able to analyze the importance of these

petroglyphs before and after the incorporation of this territory into the bureaucratic system of the Inca State, which brought about a series of transformations to the area, such as the application of a tribute, the introduction of metals, the emergence of domesticated animals such as the llama (*Lama glama*), and cults specific to the Incas, among others.

Note

1. Therianthropomorphs were included in the "anthropomorph" motif type.

Acknowledgements

We would like to thank Emiliano Bentivenga, Milagros Rios Malan, and Laura Blanco who participated in the intensive survey in the Hualfín Valley. We are also grateful to Ophelie Lebrasseur for her comments and translation, which improved this manuscript. We thank the Consejo Nacional de Ciencia y Tecnología of Argentina (CONICET) for their financial aid. Although the research and ideas of many people are integrated into this paper, we assume full responsibility for its content.

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Disclosure Statement

No potential conflict of interest was reported by the authors.

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