First technological and provenance analysis on obsidian artifacts from Tafí Valley (Tucumán Province, Argentine Republic)

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Abstract:

Regional provenance analyses of obsidian have enabled to identify so far twelve sources in Northwest of Argentina and defined two main and stable areas of distribution along the pre-Hispanic period. The aim of this paper is to report the first analyses carried out on obsidian artifacts recovered from two archaeological sites of the Tafí valley (Tucumán, Argentina), dating to the first and second millennium CE. The study addresses the sourcing and use of this raw material in their contexts, as well as the inclusion of the study area within the obsidian distribution circuits in the Northwest of Argentina. The methodology included techno-morphological and morphological-functional analyses as well as chemical provenance studies using x-ray fluorescence (ED-XRF). The results enabled us to detect, so far, the use of the Ona-Las Cuevas source, located approximately 240 km far from Tafí valley in the southern puna of Argentina (Catamarca province); and to suggest the implementation of indirect procurement practices within complex distribution circuits. We have also established that the obsidian artifacts would have been used intensively in daily activities which were part of household organization, such as long-distance relationships, hunting and processing food. Based on this information, we discuss the practical uses of obsidian, as well as other possible roles of this raw material in pre-Hispanic contexts which contribute to broaden knowledge about the cultural developments of Tafí valley.

Keywords: obsidian; Tafí Valley; circulation; daily practices; pre-Hispanic contexts

1. Introduction

The aim of this paper is to present and comment the first analyses carried out on obsidian artifacts recovered in two archaeological sites of the Tafí valley, northwest Tucumán province, Argentine Republic (Figure 1). This type of research is scarce in the study area, so

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that the results contribute to broaden knowledge about the cultural developments of this valley.

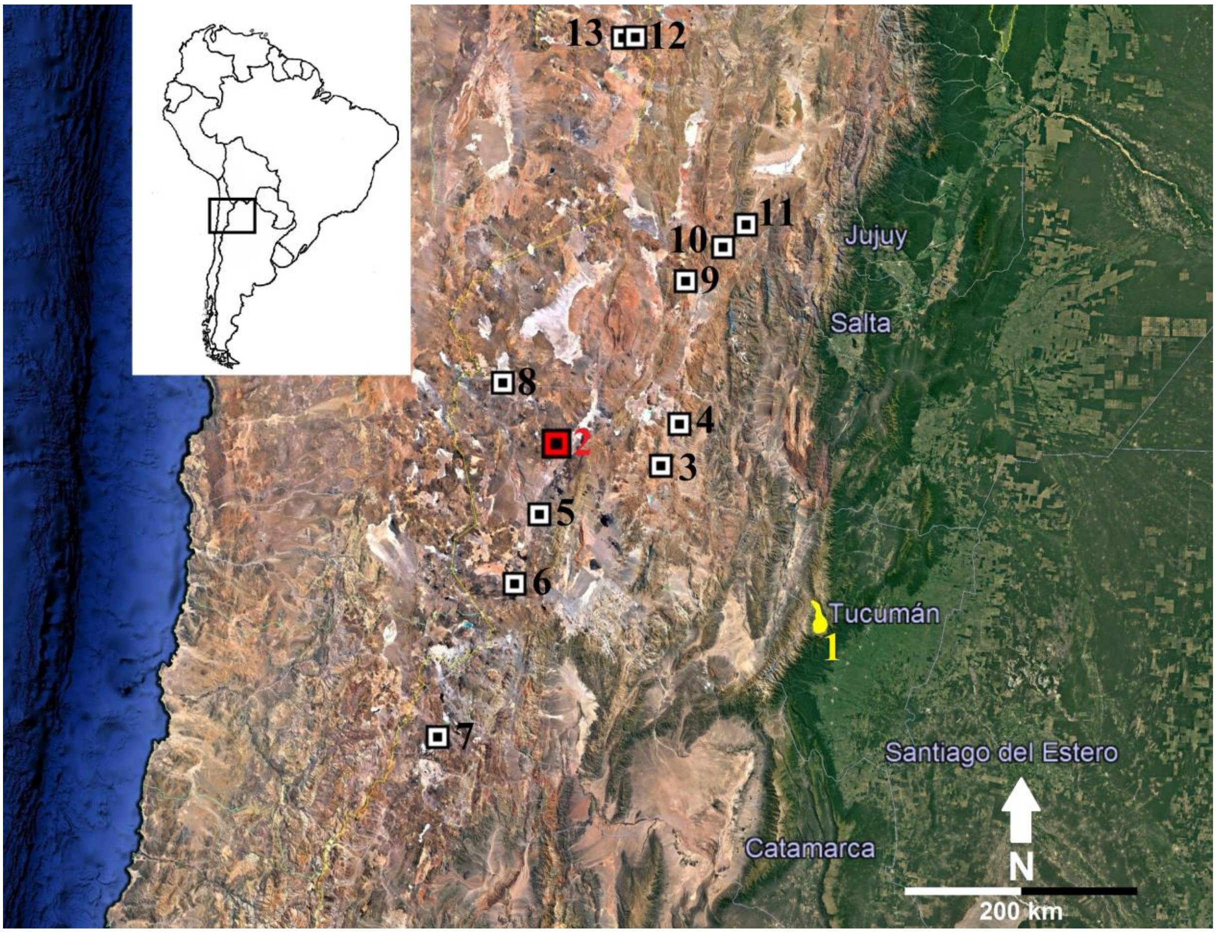

Figure 1. Location of the study area (1. Tafí Valley) and obsidian sources in Northwest Argentina (2. Ona-Las Cuevas; 3. Laguna Cavi; 4. Salar del Hombre Muerto; 5. Cueros de Purulla; 6. Chascón; 7. Valle Ancho; 8. Archibarca; 9. Quirón; 10. Alto Tocomar; 11. Ramadas; 12. Caldera Vilama 1 and 2; 13. Laguna Blanca and Zapaleri).

The study is aimed at determining the origin of obsidian artifacts recovered in stratigraphic excavations and understanding the practices of use of these materials in their archaeological contexts. Thus, an initial approach to the role of this raw material in the social reproduction of the pre-Hispanic groups in the study area and its role in the relationships with other populations of Northwest Argentina was performed.

Regional provenance analyses of obsidian have enabled to identify so far twelve sources in Northwest of Argentina (Figure 1) and defined two main and stable areas of distribution along the pre-Hispanic period from 2200 to 400 BP (Escola 2007; Yacobaccio *et al.* 2002; 2004). Here we highlight a source located in the southern area of the region, called Ona-Las Cuevas. It is a primary deposit which is situated in Southern Puna of Argentina, at 3700 m.a.s.l., more specifically, on the west bank of the Salar de Antofalla, in the department of Antofagasta de la Sierra, province of Catamarca (Escola 2004) (Figure 1). Obsidian from this source is a black translucent rock with variations ranging from black and gray black, changing from light gray to reddish brown (Escola & Hocsman 2007). In the pre-Hispanic period mentioned above its range of circulation covered approximately 340 km, being present in archaeological sites of the puna, valleys and the eastern piedmont (Escola 2007).

Several authors highlighted the almost exclusive use of obsidian for the manufacture of small stemmed and unstemmed triangular projectile points during the early and late agro-pastoralist periods (Carbonelli 2014; Chaparro 2009; Escola 2000; 2007; De Feo & Alvarez Soncini 2010; Gaál 2014; Hocsman 2006; Mercuri 2007; 2008; Montegú 2018; Moreno 2005; Palma & Olivera 1992-1993; Salazar 2006; 2010; Somonte 2009; Wynveldt & Flores 2014). At the same time, the social and symbolic role of circulation and use of this raw material has been proposed for the Northwest of Argentina and Patagonia (Escola 2007; Hermo 2008; Moreno 2005). Both the relationship between raw material and projectile points and the social role of obsidian will be discussed in this paper.

1.1. Archaeological sites

Lithic materials were collected from La Bolsa 1 (LB1) and La Bolsa 2 (LB2) (Figure 2), two archaeological sites with similar material remains. They are located in the north of Tafí valley, Northwestern Argentina, between the orographic systems of Sierras de Aconquija and Cumbres Calchaquíes, at 2500-3000 m.a.s.l. (Figure 2). Both sites include house compounds, agricultural fields, food storage features, craft production areas, and material features emphasizing kinship relations. LB1 presents chronological dating associated to the first millennium CE while LB2 presents a dating during the first half of the second millennium CE. During the first millennium CE, the earliest village settlements in the valley started to grow based in sedentary settlements systems, agropastoral economies and technology developments (*e.g.*, pottery) (Salazar 2010). In the first half of the second millennium A.D. the political and environmental conjuncture changed the social constitution of the valley as the agrarian landscape was segregated from household areas and a new spatial logic was recognized in the archaeological record (Franco Salvi & Molar 2018).

Lithic assemblages analyzed were recovered from two dwellings and a temporary use enclosure. The two dwellings - Unit 10 (U10) and Unit 14 (U14) - are located in LB1 while the temporary use enclosure -Shelter- is located in LB2 (Figures 3 and 4).

In case of dwellings (Figure 3) they include a circular open courtyard, about 10-20 m wide, surrounded by circular rooms ranging from 2 to 8 m wide, both built with large stone masonry (Berberián & Nielsen 1988; Franco Salvi 2012; Salazar 2010) and inhabited during the 3rd to 8th centuries CE. These clusters vary in size and number of structures attached to the central patio courtyard (from 3 to 15, with 5 in average), but in all cases with the same spatial organization around circular rooms connected to a large "*patio*". Excavations indicate that the burial cists were often located in the center of these patios. Domestic groups with extensive and highly competitive segmental identities were responsible for building these large houses (Salazar 2010; Salazar *et al*. 2007).

The temporary use enclosure is attached to a rectangular enclosure (Figure 4) corresponding to the second millennium of the CE (Franco Salvi & Molar 2018). The recovered materiality (*i.e.*, black on white Santamaria pottery sherds, and architecture typology) and the archaeobotanical analysis (micro remains of maize) suggests that the structure was a crop field with a seasonal position control of agricultural activities. Obsidian artifacts come from a layer with remains that, according to the absolute and relative dates, correspond to the 13th century CE, a particular period in the Northwest of Argentina due to the prevailing drought and potential conflicts (Nielsen 2006a).

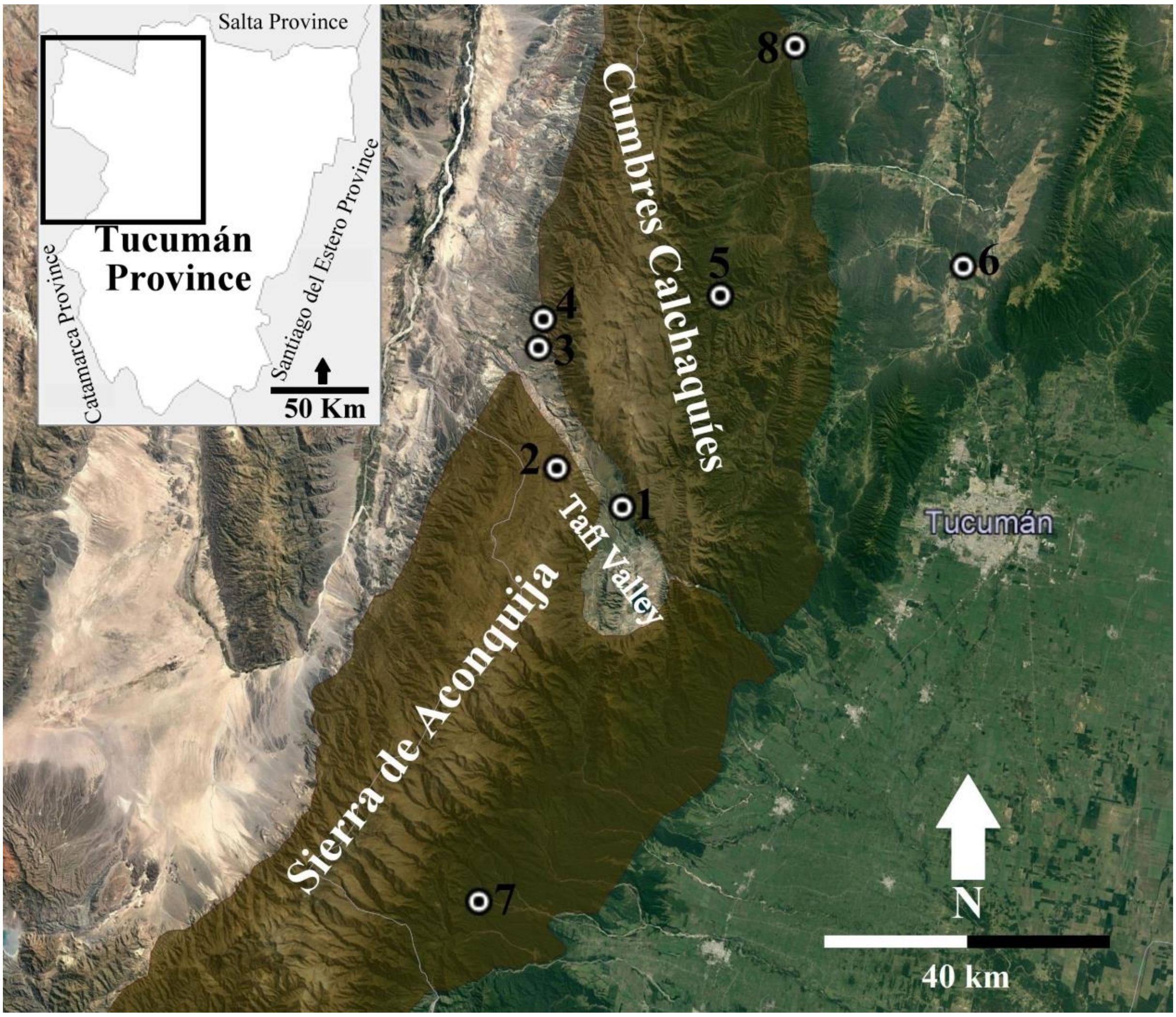

Figure 2. Location of the Tafí Valley (northwest of the Tucumán province) and archaeological sites mentioned in the text (1. La Bolsa 1 and 2; 2. Puesto Viejo 1; 3. El Observatorio; 4. El Divisadero; 5. Terraza; 6. Ticucho 1; 7. Santa Rosa; 8. Tambo).

2. Methods

Obsidian artifacts were subjected to two types of studies. On the one hand, techno-morphological and morphological-functional analyses according to Aschero (1975; 1983) and Sullivan and Rosen (1985) proposals adapted to the case study were applied. Thus, the percentage ratio between obsidian and other lithic resources was considered and compared to quantify the consumption of this raw material. Then, the obsidian set was divided and analyzed into typological categories of debitage, cores and instruments. Origin of the extraction, type of platform and the relative size of the chips were recorded. In the cores, morphological designation and the presence or absence of cortex was important. Finally, in the typological groups of instruments, technical series and the stage of the flaking sequence were characterized. These data were analyzed to determine the use of the lithic resource.

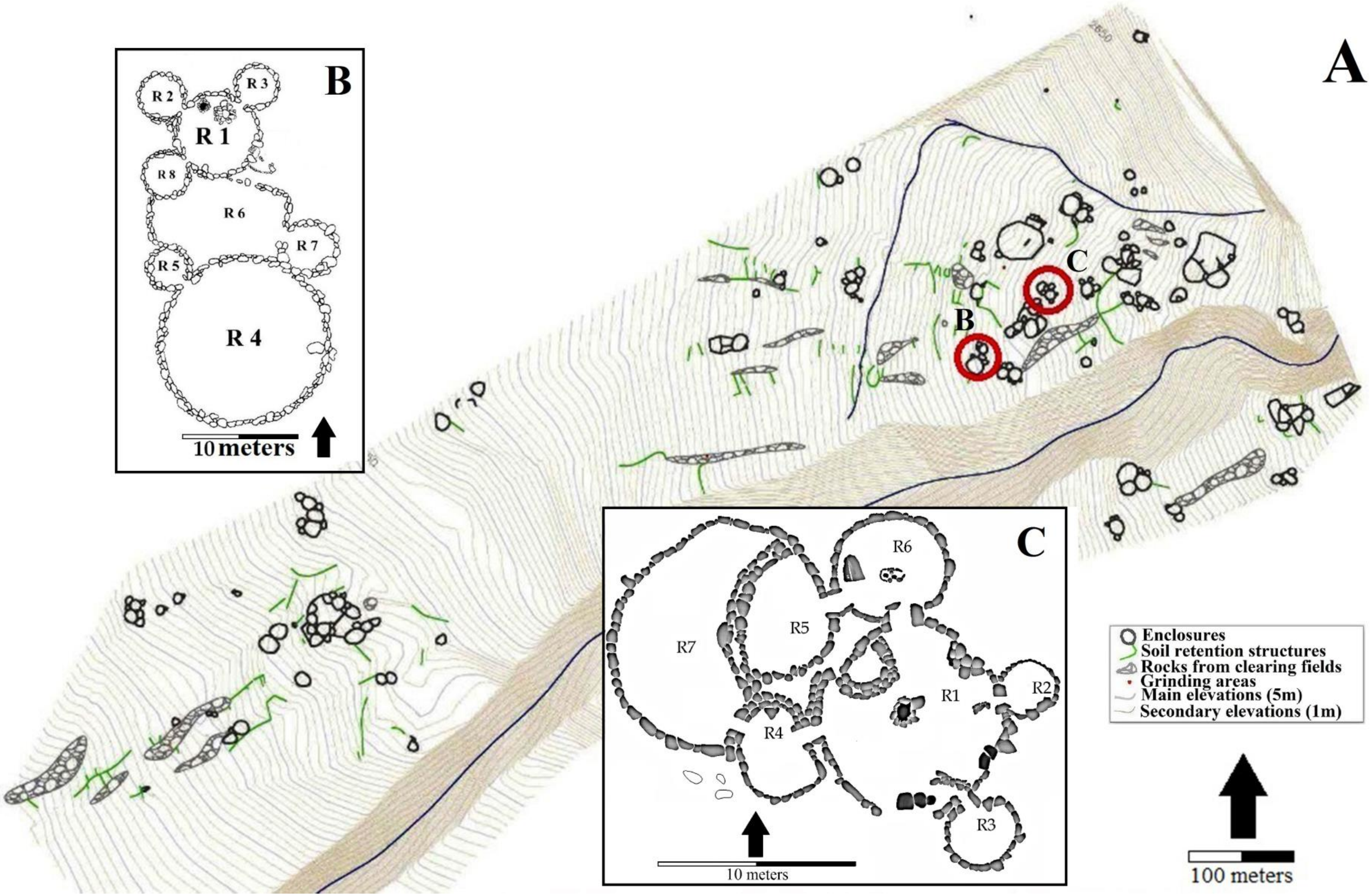

Figure 3. Archaeological site of La Bolsa 1 (A) and structures from which the lithic groups came (B. Unit U10; C. Unit U14).

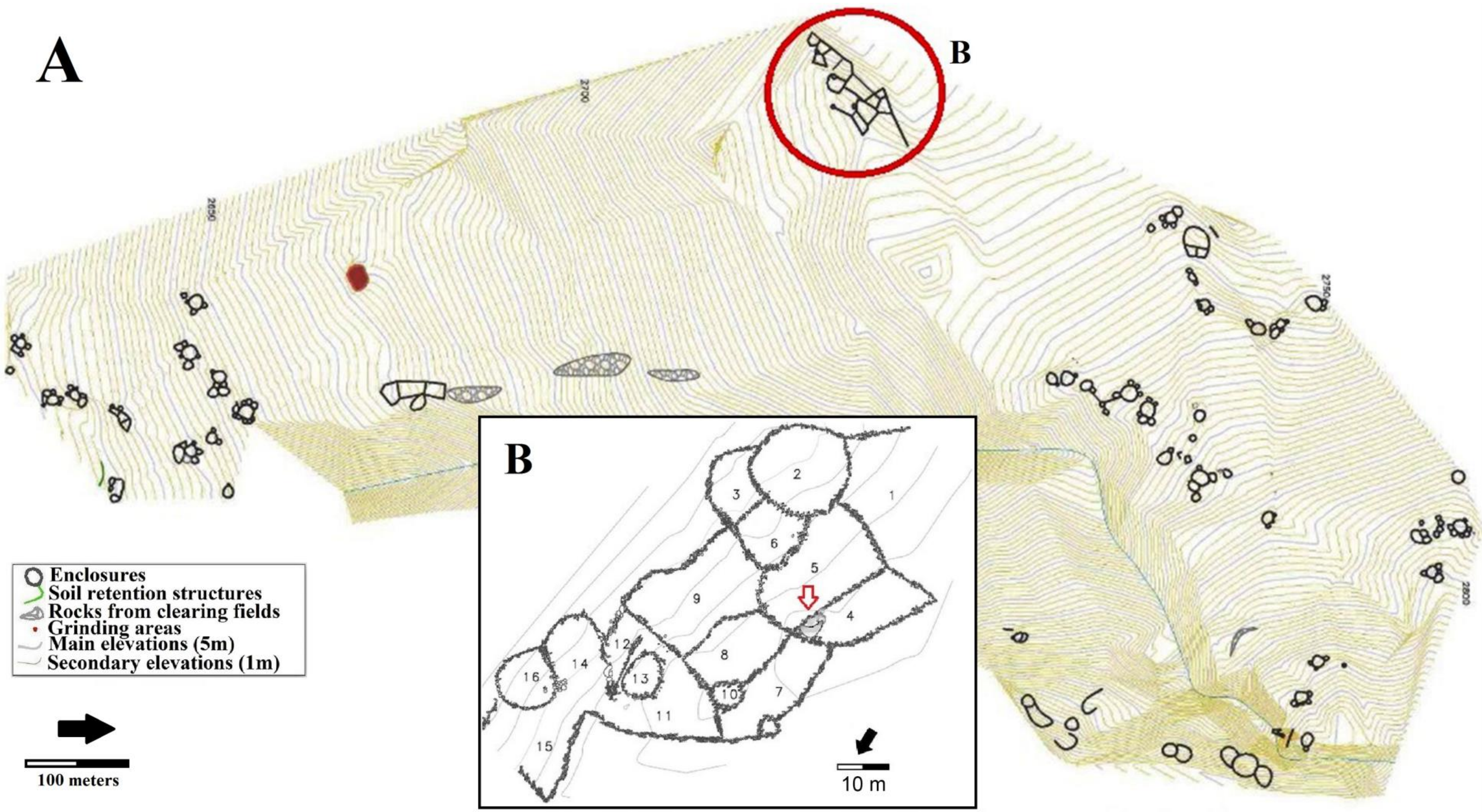

Figure 4. Archaeological site of La Bolsa 2 (A) and structure from which the lithic groups came (B. rectangular enclosure attached to a shelter).

On the other hand, a sample was selected for geochemical analysis using x-ray fluorescence (ED-XRF). Samples were sent to the Archaeometry Laboratory of the Research Reactor Center at the University of Missouri (MURR) and compared to Northwest Argentina obsidian for facilitating identification. The samples were selected based on stratigraphic layers (when appropriate) and macroscopic characteristics, such as color, brightness, transparency, inclusions, *etc*. These selection parameters were applied in order to distinguish multiple uses according to historical processes and possible sources of supply. It should be noted that the obsidian assemblages have highly uniform macroscopic characteristics, so those which had some particular external characteristic were selected. All XRF measurements were performed using a ThermoScientific ARL QuantX energy-dispersive XRF spectrometer. The instrument has a rhodium-based x-ray tube and thermoelectrically-cooled silicon-drift detector (SDD). The tube was operated at 35 kV, with a 3.5 mm collimator, and the current was automatically adjusted to create a deadtime of approximately 25%. The samples were counted for two minutes each allowing measurement of nine elements: Mn, Fe, Zn, Rb, Sr, Y, Zr, Nb, and Th.

3. Data results

Techno-morphological and morphological-functional studies of the flaked obsidian corresponding to the two archaeological sites showed, firstly, that obsidian is a very rare resource, not exceeding in any case 2% of the lithic assemblage (Table 1). On the other hand, the predominant typological classes correspond to debitage and instruments (Table 1), with only a small core in LB1-U14 that shows signs of reduction by bipolar technique and absence of cortex (Figure 5).

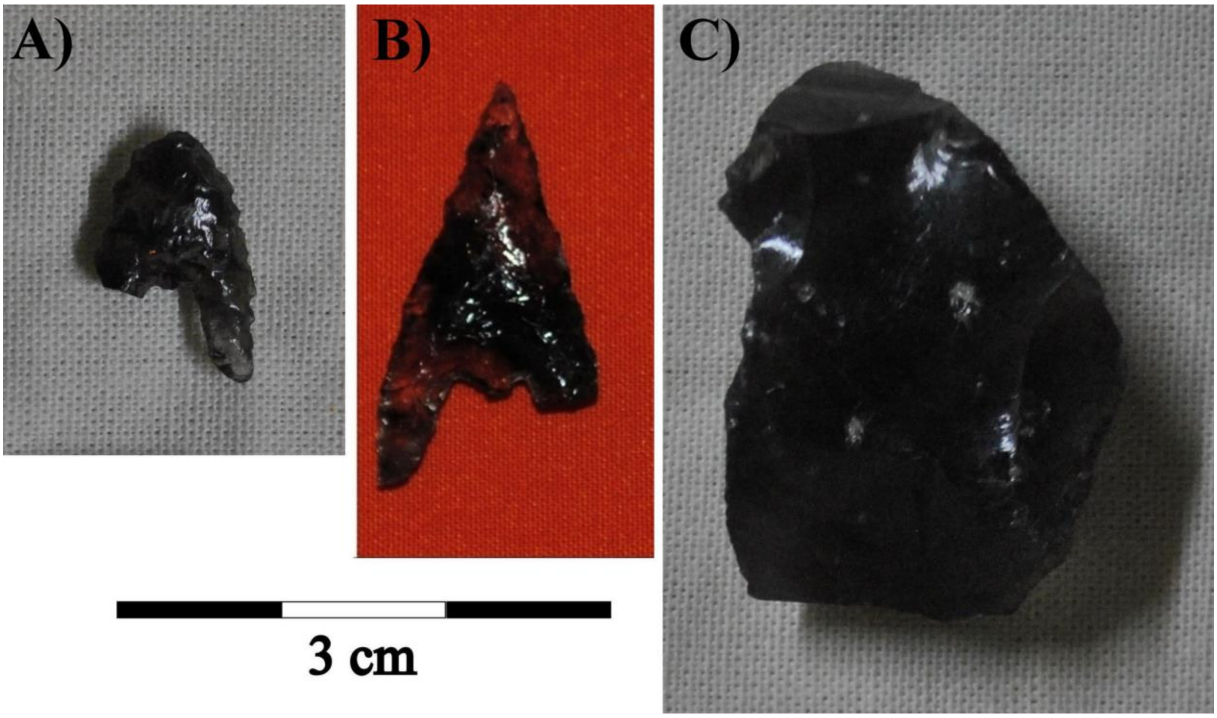

Figure 5. Obsidian artifacts from the analyzed sets. A and B. small stemmed triangular projectile point with bifacial flaking; C. small core with signs of bipolar technique and absence of cortex.

Table 1. Typological categories of artifacts and composition lithic assemblages according raw materials and contexts.

		Debitage		Cores		Instruments		Total	
Context	**Raw Material**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
LB1-U14	quartz	868	97.9%	7	0.8%	12	1.4%	887	67.5%
	andesite	179	97.3%			5	2.7%	184	14%
	quartzite	124	100%					124	9.4%
	obsidian	11	73.3%	1	6.7%	3	20%	15	1.1%
	chalcedony	3	100%					3	0.2%
	slate	37	94.9%			2	5.1%	39	3%
	metamorphic	30	100%					30	2.3%
	undetermined	32	100%					32	2.4%
	Total	**1284**	**97.7%**	**8**	**0.6%**	**22**	**1.7%**	**1314**	**100%**
LB1-U10	quartz	300	94.3%	10	3.1%	8	2.5%	318	49.7%
	andesite	225	98.3%			4	1.7%	229	35.8%
	quartzite	10	76.9%			3	23.1%	13	2%
	obsidian	2	50%			2	50%	4	0.6%
	chalcedony	1	100%					1	0.2%
	undetermined	74	98.7%			1	1.3%	75	11.7%
	Total	**612**	**95.6%**	**10**	**1.6%**	**18**	**2.8%**	**640**	**100%**
LB2-Shelter	quartz	221	98.7%			3	1.3%	224	97.8%
	andesite	2	100%					2	0.9%
	quartzite	1	100%					1	0.4%
	obsidian	1	50%			1	50%	2	0.9%
	Total	**225**	**98.3%**	**0**		**4**	**1.7%**	**229**	**100%**

As for the typological groups of the instruments, three small or very small stemmed and unstemmed triangular projectile points were recorded (Table 2 and Figure 5). All of them have bifacial flaking and, in some cases, traces of reactivation. A burin point and two flaking edges were also recorded (Table 2). These last three instruments, recovered in dwellings, had been related to food processing (Franco Salvi *et al.* 2016; Salazar *et al.* 2007).

Finally, debitage is dominated by flakes generated in advanced production tasks (*i.e.*, internal, formatization flakes), with prepared platforms (mainly punctiform), whose sizes are small (Table 3).

XRF analyses were conducted on four obsidian samples: one sample comes from U10, while the other two samples from U14 and the last one from the shelter. Table 4 and Figure 6 shows the trace elements analyzed by ED-XRF and their values as well as the macroscopic characteristics of the samples.

In Figure 7 and 8 bivariate graphs used to establish the relationship with the sources recorded in the MURR show that all the samples in question came from the Ona-Las Cuevas source, located at a linear distance by approximately 240 km from the sites (Figure 1).

It should be noted that the other obsidian artifacts analyzed so far have the same macroscopic characteristics as the samples chemically analyzed, therefore it is understood that they come from the same identified source.

Table 2. Typological groups of instruments according raw material and contexts. References: Qz - quartz; And - andesite; Ob - obsidian; Sl - slate; Qzite - quartzite; Undet - undetermined; NECF - Natural edge with complementary features; SFA - Simple flaking artifact; UFFA - Undifferentiated fragment of flaking artifact.

Context	**LB1-U14**				**LB1-U10**					**LB2-Shelter**		
Raw Material	**Qz**	**And**	**Ob**	**Sl**	**Qz**	**And**	**Qzite**	**Ob**	**Undet**	**Qz**	**Ob**	**Total**
Projectile point	4		2		1		1			1	1	10
Burin point		1	1									2
Notch + flaking edge	1											1
Notch		1			2					1		4
Scraper	1				1							2
Raedera						1						1
NECF	1									1		2
Flaking edge		1		1	2	3	1	2				10
Hammerstone	2											2
SFA	1	1			2		1		1			6
UFFA	2	1		1								4
Total	**12**	**5**	**3**	**2**	**8**	**4**	**3**	**2**	**1**	**3**	**1**	**44**

Table 3. Debitage data. References: IF - internal flake; EF - external flake; FF - formatization flake; C - cortical; Sm - smooth; D - dihedral; F - faceted; P - punctiform; VS - very small; S - small; MS - medium small; ML - medium large; L - large; VL - very large.

Context		**LB1-U14**			**LB1-U10**			**LB2-Shelter**		
Raw material		**Other**	**Obsidian**	**Total**	**Other**	**Obsidian**	**Total**	**Other**	**Obsidian**	**Total**
Origin of extraction	IF	582	10	592	240	2	242	82		82
	EF	153		153	63		63	14	1	15
	FF	29	1	30	12		12	6		6
Platform	C	36		36	15		15	9		9
	Sm	172	2	174	71		71	48		48
	D	12	1	13	6		6		1	1
	F	20	1	21	9	1	10			0
	P	15	7	22	4	1	5	5		5
Size	VS	16	1	17	11	2	13	9		9
	S	32	10	42	14		14	27	1	28
	MS	10		10	4		4			0
	ML	15		15	1		1			0
	L	3		3	1		1			0
	VL	1		1			0			0

Table 4. Concentrations of elements in parts per million measured in obsidian artifacts from Tafí Valley by ED-XRF.

Site	**Context**	**ID Sample**	**Description**	**Mn**	**Fe**	**Zn**	**Rb**	**Sr**	**Y**	**Zr**	**Nb**	**Th**
LB1	Unit 10	JM001	Light grey, translucent	454	5269	27	233	137	15	81	20	25
LB1	Unit 14	JM002	Light grey, translucent	460	5258	27	238	140	16	89	18	27
LB1	Unit 14	JM003	Dark grey, translucent	456	5104	27	237	138	17	79	19	26
LB2	Shelter	JM004	Light grey, translucent	454	5547	32	232	139	16	82	19	26

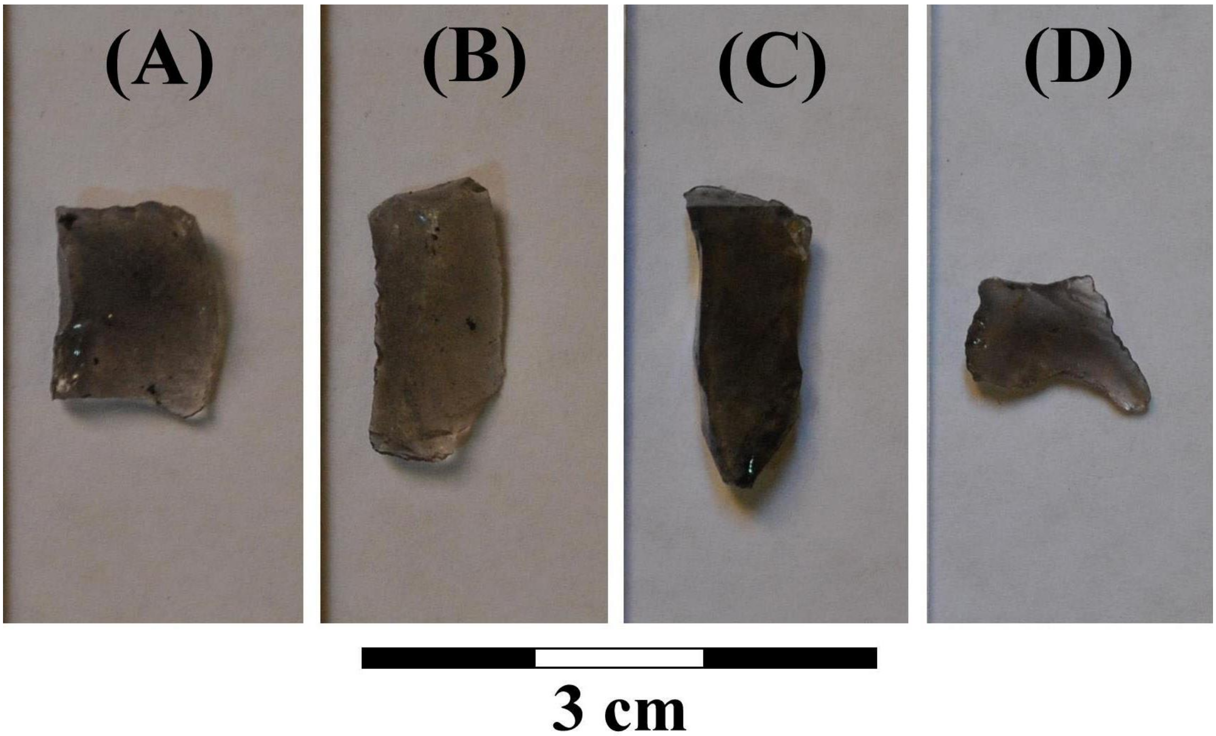

Figure 6. Obsidian samples from Tafí Valley analyzed by ED-XRF. A. JM001 flake from LB1-U10; B and C. JM002 and JM003 flakes from LB1-U14; D. JM004 base of projectile point fractured from LB2-Shelter.

4. Data interpretation

The presence of obsidian, as a foreign resource whose source is located at a great distance (240 km), shows that the pre-Hispanic inhabitants of Tafí valley turned to special practices for the procurement of this raw material. This evidence suggests long distance relationships with people living in Puna highlands or their intermediaries, through practices that could include exchange, alliances, cooperation, or caravan systems.

The use of the same source from around 200 BCE to 1400 CE shows stability in the Ona-Las Cuevas long distance network of obsidian circulation (Escola 2007). That is to say, those relationships were maintained despite social, political and economic changes in this long period. In a micro-regional scale, provenance studies carried out in neighboring areas showed the same pattern. Caria *et al.* (2009) characterized obsidian sources from a large sample taken from archaeological sites dated to the First and Second Millennium of CE in the eastern (Terraza, Tambo, and Ticucho 1) and western (El Divisadero, El Observatorio, and Puesto Viejo 1) slopes of the Cumbres Calchaquíes ranges (Figure 2). The obsidian came mainly from Ona-Las Cuevas, and in an insignificant proportion from Laguna Cavi and Cueros de Purulla. Míguez *et al.* (2015) identified also *Ona-Las Cuevas* obsidian in the first millennium CE archaeological site of Santa Rosa, in the eastern slopes of Sierras del Aconquija (Figure 2). Therefore, Tafi valley was involved in the circulation sphere of this source whose range of action was broader than other sources' spheres in the southern Puna.

In relation to the presence of a single source, other sources of obsidian have been recorded that provided materials to different archaeological sites (Caria *et al.* 2009; Escola 2007). In turn, some sources are located closer to Tafi Valley, such as Laguna Cavi and Cueros de Purulla located 160 and 170 km away respectively. Although it is possible that these sources were used, it is noteworthy that they did not present a geographical dispersion or a temporary stability in their use, as in the case of Ona-Las Cuevas (Escola 2007; Yacobaccio *et al.* 2004). On the other hand, these sources do not have the same aesthetic characteristics as Ona-Las Cuevas. Laguna Cavi obsidian for example is dark gray not fully translucent (Escola *et al.* 2007). Finally, the presence of important human settlements during the pre-Hispanic period around Ona-Las Cuevas - *i.e.*, Antofagasta de Sierra (Escola 2000), Salar de Antofalla (Moreno 2005) - could have allowed the establishment of long-distance relationships. Therefore, a specific combination of natural, aesthetic and social factors could have influenced the use of Ona-Las Cuevas over other sources.

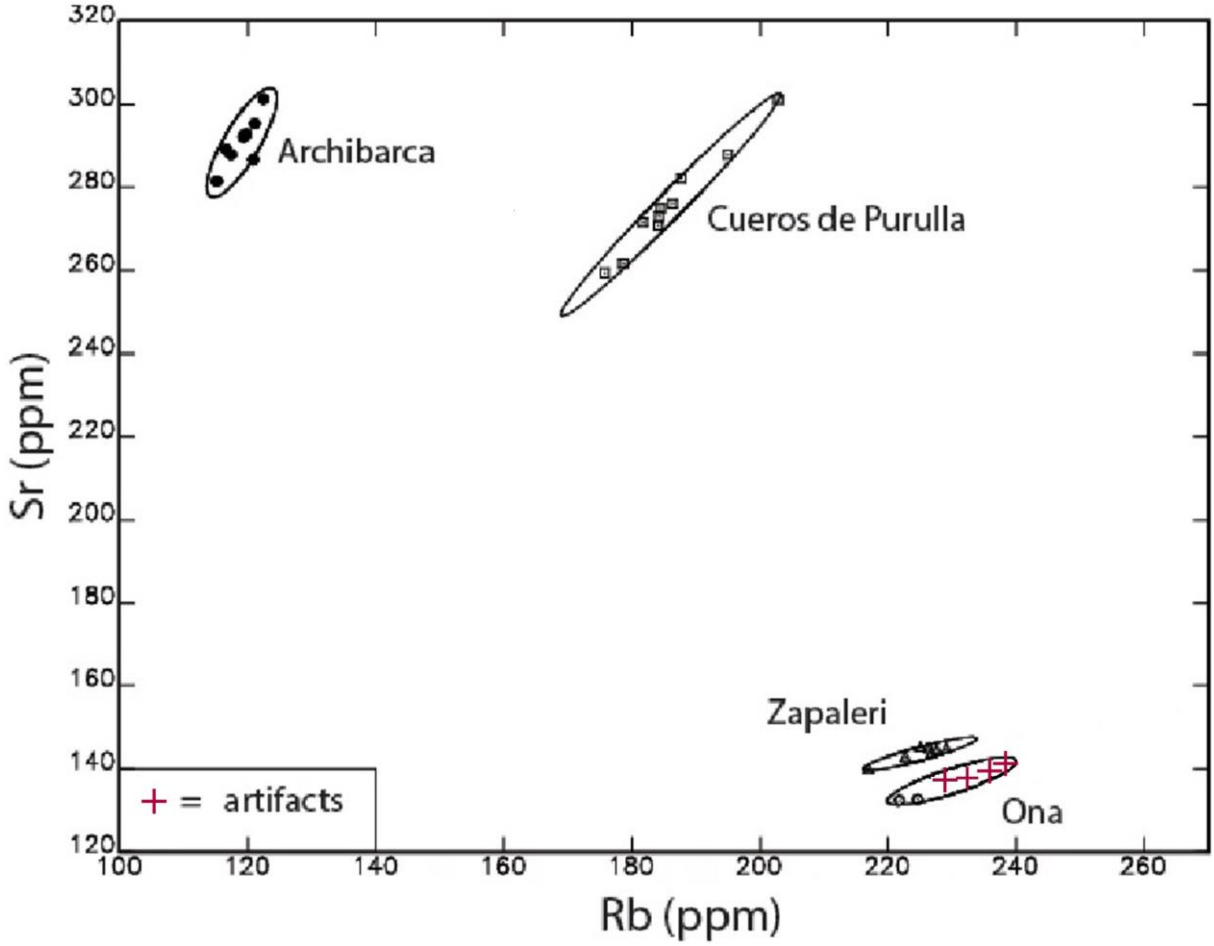

Figure 7. Scatterplot of Rubidium versus Strontium measured by ED-XRF. Artifacts (+) have been projected against 90% confidence ellipses.

Regarding the use of obsidian in the study area, the scarce presence of cores and the appearance of knapping debitage coming either from final formatization, or recycling tasks, would state that most of this raw material entered to the sites either as almost-prepared base forms for their final manufacture, or as final products. It is possible that the material was obtained through the exchange of transportable size obsidian pieces and or by direct access (Meltzer 1989) to the source. It should be noticed that archaeological research carried out by Escola (2000) in the Ona-Las Cuevas source evidenced core selection, testing and crust extraction activities, as well as flake extraction for carrying, and use in far locations. Therefore, this lithic resource played a key role, together with other resources, in an intense traffic network that lasted at least from 2200 to 400 BP (Lazzari 1997; Nielsen 2006b).

On a smaller scale, the presence of obsidian tools in household settings or in contexts of embedded activities (Binford 1979) of Tafí Valley shows that procurement, use, and disposal of this “exotic” good was managed by and within daily, and possibly kinship relationships. Furthermore, the use of this raw material for projectile points, edges and point tool evidences that obsidian would have been directly related to subsistence and feeding practices, such as hunting and food processing. Due to the fact that so far no evidences of conflict situations were found -as it happens in neighboring sectors for the second millennium of the CE (Carbonelli 2014; Martínez *et al.* 2010)-, it is not possible to determine if projectile points were used in social conflicts within Tafi Valley.

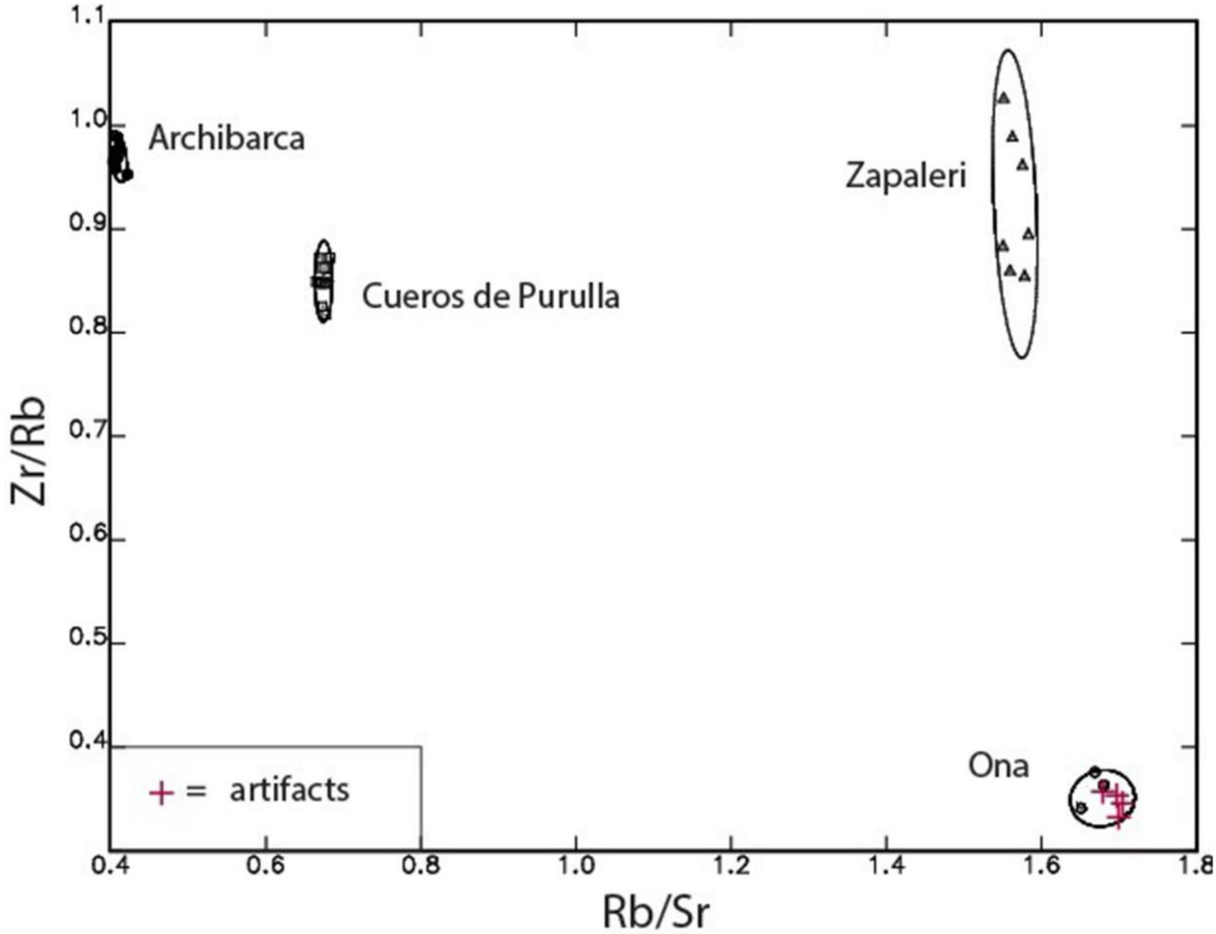

Figure 8. Scatterplot of ratios of Rubidium and Strontium versus Zirconium and Strontium measured by ED-XRF. Artifacts (+) have been projected against 90% confidence ellipses.

It is worth noting that in the study area and surroundings, such as Quebrada de los Corrales and Amaicha, there is a good availability of knapping materials (*i.e.*, andesite, quartz) and in fact projectile points in these materials were recorded (Franco Salvi *et al.* 2016; Mercuri & Mauri 2015; Salazar 2006; Somonte 2009). Therefore, the use of obsidian in confrontation to this scene is striking. It is possible, as mentioned by Escola (2007), that beyond the physical-mechanical properties that make obsidian ideal for the knapping of projectile points, social factors had to influence this relationship between raw material and instrumental typology. This author emphasizes the central role of the obsidian within interaction networks as a potential container of coded information that was transmitted from group to group, within which the manufacturing of projectile points must have connoted a very specific knowledge (Escola 2007). In turn, for Moreno (2005), the aesthetic aspects of obsidian (*i.e.*, brightness, transparency) should have been significant properties in its collection and use, while its ductile knapping properties made it a relevant resource in the transmission of knowledge through learning practices in the production of points, which would have occurred from generation to generation and from masters to trainees.

The presence of a resource that requires effort to obtain it and that is strongly related to the macroregional circulation and with specific instruments forms may be marking a particular role of obsidian over other raw materials more abundant in lithic assemblages. In our cases, for example, quartz represents 50% or more of the assemblages and it has brightness natural qualities. However, quartz is not mediated by distance and interaction with other groups because it is an immediate local resource (Franco Salvi *et al.* 2016; Salazar *et al.* 2007).

These proposals require further study, but they open up the possibility to go beyond the utilitarian value of obsidian, obtaining new hypotheses about its circulation and consumption in order to progress in the study of the relationships between people and objects.

5. Conclusions

The analyses and discussion of this study allowed to identify the source of the obsidian artifacts recovered and to learn about the way in which obsidian was consumed in the study area. Evidence suggests that obsidian was a resource primarily involved in long-distance relationships and subsistence practices which were vital to the social and biological reproduction of pre-Hispanic people. Relations with other social groups to obtain information and or resources, as well as obtaining and processing food would have been practices developed routinely by household groups. The use of obsidian within these areas could have granted to this raw material an outstanding role in the daily life of the pre-Hispanic inhabitants of the Tafi Valley during the first and second millennium of the CE.

On the other hand, it was possible to start thinking about other types of roles -*e.g.*, information carrier, information transmitter, long-distance linkage mechanism- that obsidian possibly played in Northwest Argentina.

It should be noted that in the area of study and at a regional level, the provenance and technological studies on this type of resource should be expanded in order to further analyze the ideas expressed in this project work.

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