Experimental knapping with sandstones and prospection of lithic raw material sources from Cabra Corral area, Salta, Argentina

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Abstract:

Within the framework of the project named *Technological Variability and Social Interaction Networks in Northwest Argentina through the study of lithic technology strategies throughout the Formative period* we collected samples of lithic raw materials in different portions of Las Conchas-Guachipas river area (Lerma Valley, Salta, Argentina) in order to create a reference collection. The main goal of the conformation of the assemblage was to have material for comparison with the archaeological at raw material level on one side and to allow us to carry on other studies such as the one we present here.

With part of this material we performed experimental lithic knapping with the aim to observe fractures and other characteristics that allow determining knapping quality so that we can understand and give a first reading to the selection of raw materials for making artifacts using local rocks.

We present the results of these experiments conducted on sandstone, as it was the predominant raw material in the archaeological record. First results allow us to affirm that sandstone, given the availability and quality for knapping tasks constitutes an optimal raw material for the production of artifacts. We also note that the obtained edges are suitable for cutting work and the notches recorded in the artifacts are due probably to the characteristics of rock fracture.

Keywords: sandstone; archaeological survey; experimentation; lithic material; Valle de Lerma; Salta

1. Introduction

The ecological frame within which human populations travel is not something static, it is dynamic due to both, people interactions and geology involved in various processes. Even if we consider that in human populations, environmental aspects are not those that set the rules, they may determine the nature of the interaction with external elements. Within the frame of lithic record variability analysis, it is remarkably important to study the regional lithic resource base. This implies its structure and identification and characterization of provenance sources (Escola 2000). In such manner, acquiring knowledge and understanding the ecology of the study area constitutes a main step to be able to make interpretations on the archaeological material.

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In general terms, we refer to technologies almost as a synonymous of artifact, this is, any object or material modified by humans. Technology encomprises every process, from collecting of raw materials to manufacture the artifact, to its final discard, going through stages of resharpening, lateral cycling, maintenance and recycling (Schiffer 1972). So in our case, from a wide analytical frame, we are interested in the artifacts' 'biography' (e.g. Gosden & Marshall 1999) and we consider that such sequential proposal (Bleed 2001; Ericson 1982; Leroi-Gourhan 1964; Schiffer 1976) may be compatible and complementary with a typological analysis of the artifacts. In this first approach to lithic assemblages' characteristics we intend to explore the first stages of artifact shaping. Therefore, within the framework of the project named Technological Variability and Social Interaction Networks in Northwest Argentina through the study of lithic technology strategies throughout the Formative period (Mercuri 2012), we carry on a survey to research raw material availability and we pursue an experimental analysis on the collected sample to test the knapping quality of rocks. It will later be compared with the archaeological sample of SsalLav 1 [8] as a mean to understand the archaeological record.

The study area is located in the south-central section of Salta province, at 80 km, approximately, south from the capital city of the province, in the frontier of La Viña and Guachipas departments, in Valle de Lerma (Figures 1 and 2). In general terms, it presents a mountainous relief characterized by submerid mountain chains. Towards the western section there is a wide elongated depression in north- south direction which closes towards Alemanía latitude and constitutes the southern section of Valle de Lerma (Rodríguez 1996).

All of this area has influence of the three ecoregions which characterize the south of Salta province: Yungas, Dry Chaco woodlands and Mount of plains and pockets, therefore xerophyte plants and hard grass predominate, conforming a wide spread of plains which alternate with patches of bushes. Towards more shallow areas there is a predomination of epiphytes, some trees such as black carob tree (*Prosopis nigra*), yuchán (*Chorisia insignis),* horco quebracho (*Schinopsis haenckeana*) and tala (*Celtis iguanaea)* and bushes such as palán (*Nicotiana glauca)* and jarilla (*Larrea sp*.). Towards the mountains summit there are thorny bushes (Freytes 1965).

Guachipas is the main river in the study area. It flows into Embalse General Belgrano (locally known as Cabra Corral) at approximately 7 km from the site. Likewise, it is the nearest to archaeological sites. Hydrologically the confluence of Guachipas (south) and Arias or Arenales (north) rivers give origin to the Juramento or Pasaje river that branches minor courses which irrigates the area (Rodríguez 1996) (Figure 1). From Cuchiyaco creek water course goes in direction NE with the name Las Conchas river. Some courses that flow directly into the perimeter of the reservoir, which are also important because of its watering potential, are: Chuñapampa, Ampascachi and La Viña rivers. Ampascachi river has a hydric exploitation based on infrastructures of catchment, regulation and conduction, developed by private enterprises, meanwhile watering areas of La Viña and Guachipas represent ancient public systems nowadays operated by irrigation consortia. These river systems settle the Las Conchas- Guachipas Sub-basin (Paoli *et al*. 2011) and are nowadays affected by Cabra Corral dam's level rise, and therefore they tend to sediment with sands in the river mouth area. In this sense, archaeological sites environments could have been more alike to that observed upper stream: more rocky and less sandy.

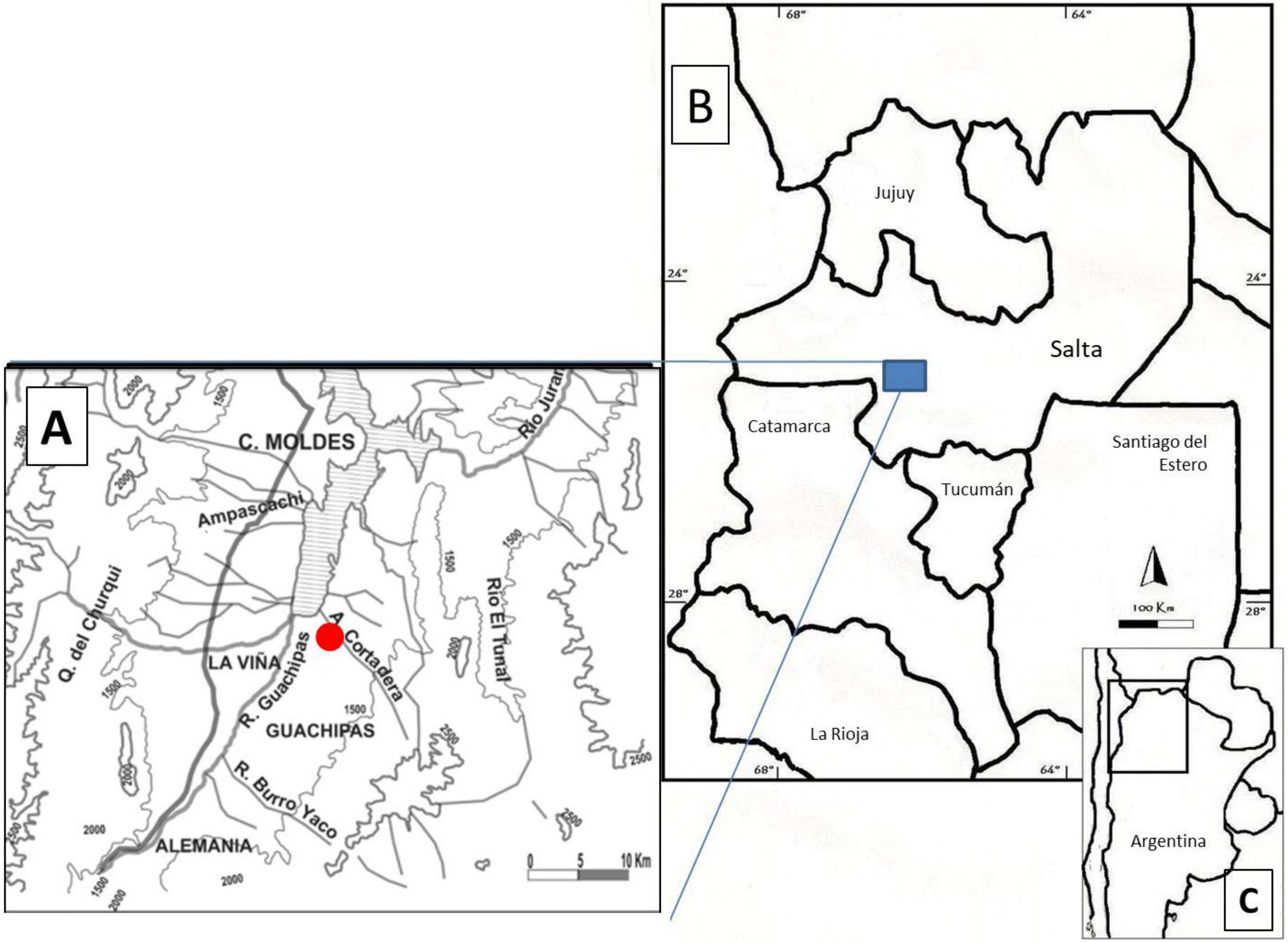

Figure 1. Location map. Red indicates the archaeological sites under study.

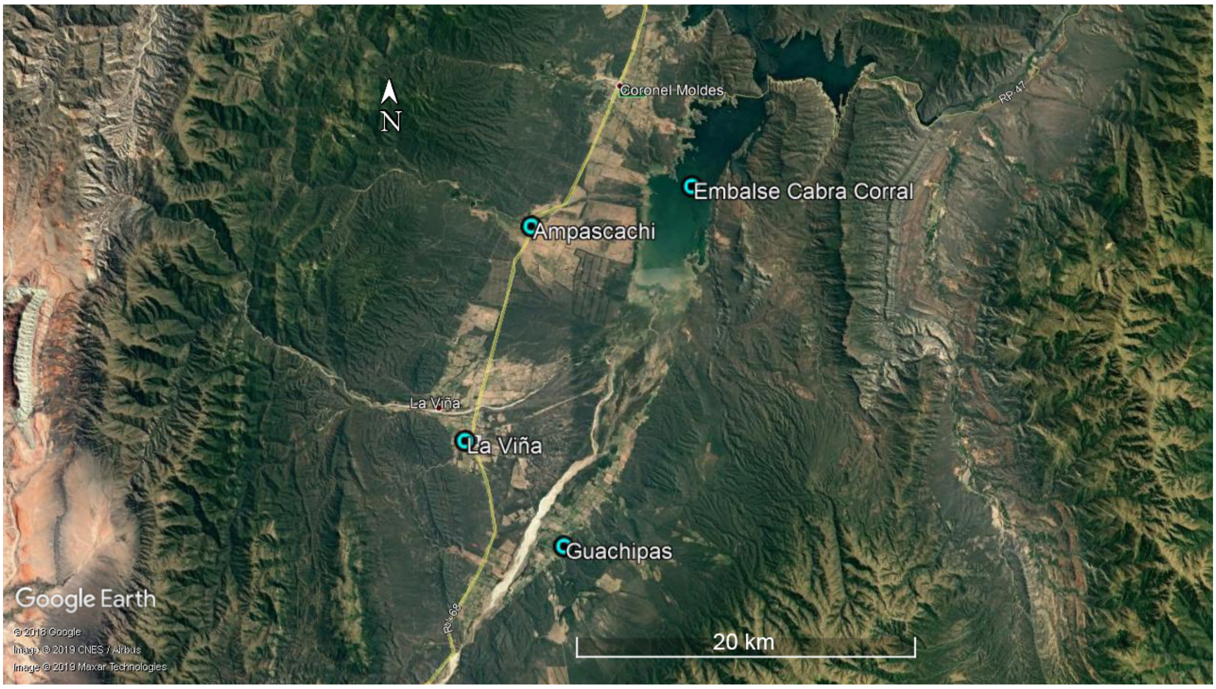

Figure 2. Map with towns from which the samples were collected. Image taken from Google Earth. (See the KMZ supplementary file for details.)

Archaeological sites under study are located specifically in La Viña department and border with Guachipas town. Even though this town lacks a meteorological station and information is from Talapampa and Ampascachi (south and north respectively) it may be asserted that the weather corresponds to tropical serrano with dry season. Even though precipitation average is about 450-500 mm a year, in the summer these can be torrential, focusing between November and March, being intense and short with very variable precipitation values in time span (Moya Ruiz 1989). Prevailing winds come from E and NNE (Alonso *et al.* 2000; Gelli 1990, among others). Between April and September weather is cold to mild and warm to mild weather the rest of the year, and the average temperature per year is 19.2ºC, with a maximum of 41.8ºC and a minimum of -4.5ºC (Moya Ruiz 1989).

Most important geomorphological traits in the area are accumulation forms and fluvial erosion conditioned by the structure and composition of rocks outcrops, outlining the river valley of Guachipas (Figure 2). This river is influenced by regional structure, dripping in a syncline of submerid course (Moya Ruiz 1989). It presents a predominant draining direction from S-N and it exhibits a channel of dryness of approximately 20 metres wide, a channel of flood that may reach an average of 600 metres wide in some sectors. Water is cloudy due to the great amount of sediments that carries in suspension. Towards East a series of creeks drain to the Guachipas river, though most of them are not permanent (Moya Ruiz 1989). From Guachipas (S25º30,664’ W065º31,395’), La Viña (S25º27,051’ W065º33,659’) and Ampascachi (S25º20,946’ W065º31,610’) riversides we took the rock samples that are the case study in this paper (see Table 1 as example).

Table 1. Table used for recording data regarding collection of rocks.

Sample source	GPS	Colour	Grain size	Objective piece
Guachipas	(S25º30,664’ W065º31,395’)	red	coarse	nodular flake
Guachipas	(S25º30,664’ W065º31,395’)	gray	coarse	nodular flake
Guachipas	(S25º30,664’ W065º31,395’)	gray	fine	nodular flake
Guachipas	(S25º30,664’ W065º31,395’)	green	fine	pebble
Guachipas	(S25º30,664’ W065º31,395’)	green	medium	nodular flake
Guachipas	(S25º30,664’ W065º31,395’)	gray	medium	nodular flake
Guachipas	(S25º30,664’ W065º31,395’)	gray	medium	pebble
Guachipas	(S25º30,664’ W065º31,395’)	pink	medium	pebble
Guachipas	(S25º30,664’ W065º31,395’)	gray	coarse	nodular flake
Guachipas	(S25º30,664’ W065º31,395’)	gray	medium	nodular flake
Guachipas	(S25º30,664’ W065º31,395’)	gray	medium	pebble
La Viña	(S25º27,051’ W065º33,659’)	green	fine	tablet
La Viña	(S25º27,051’ W065º33,659’)	gray	fine	nodular flake
La Viña	(S25º27,051’ W065º33,659’)	gray	fine	nodular flake
La Viña	(S25º27,051’ W065º33,659’)	green	medium	pebble
La Viña	(S25º27,051’ W065º33,659’)	green	fine	pebble
Ampascachi	(S25º20,946’ W065º31,610’)	yellow	fine	tablet
Ampascachi	(S25º20,946’ W065º31,610’)	oranged red	medium	nodular flake
Ampascachi	(S25º20,946’ W065º31,610’)	gray	fine	nodular flake
Ampascachi	(S25º20,946’ W065º31,610’)	gray	medium	pebble
Ampascachi	(S25º20,946’ W065º31,610’)	gray	fine	nodular flake
Ampascachi	(S25º20,946’ W065º31,610’)	gray	fine	tablet
Ampascachi	(S25º20,946’ W065º31,610’)	gray	medium	tablet
Ampascachi	(S25º20,946’ W065º31,610’)	gray	medium	nodular flake

1.1. Some previous archaeological research

The area of Guachipas has scarcely been investigated from an archaeological perspective. Nevertheless~~,~~ studying some elements found throughout the building of General Belgrano dam, Ercilia Navamuel sets that there are many peopling flows: from north, through the Andes, by Subandina region and from West by the Andes (Alonso *et al.* 2000: 94). In general terms their findings include big and rudimentary lithic artifacts similar to those known as Ampajango.

Towards 1974, Maidana, Ashur, Chafatinos, Nadir and Márquez published a paper in which they synthesize their research in Osma and proposed a chronology based in this archaeological site. This chronology could hypothetically be extended to all Valle de Lerma. They identify material that goes from archaic moments to Inka times. For Early Agro-pottery Period (time span of the current research) between 200 and 800 aC, they describe: ‘*The settlement site of these population in Osma was recorded in western piedmont (…) We had observed the slabs put in such manner as sockets and from the fireplaces of those housing vestiges we exhumed a smooth grey pottery and (…) from Complejo Cerámico Candelaria (smooth Candelaria) and other polychrome type of undeniable Condorhuasi influence*’ (Maidana *et al.* 1974: 14). For Medium and Late Agropottery Periods (from 700 aC) they indicate an expansion of housing space, ~~of~~ agricultural intensification and the presence of domesticated animal species (Maidana *et al.* 1974). Recently, Eleonora Mulvany finds in a likely lithic work place in Saladillo (in the vicinity of the one studied by Maidana and colleagues), a high frequency of backed flakes (*lascas de dorso*) (Mulvany personal communication).

In the decade of the 1980s, Cremonte, Flegenheimer and De Santis (1987), carried a field work that included survey and excavation in Las Garzas estate, to the south of Salta city. They recorded abundance of ceramic and lithic material in surface, most of it is not in its original position due to removal produced by plowing. Dating suitable material was obtained from 2 excavation pits, which put the site in a chronological span 'towards 200 BCE' (Cremonte *et al*. 1987: 26). The material evidence indicates a single occupation, where the economy would be diversified including small animal capture, fishing, hunting and collecting of carob tree and corn crops.

Regarding lithic materials, they recovered projectile points (corner notched elongated triangular with differentiated stem, medium- small and very thick, made by extended retouch), burin instruments and notches and obsidian flakes. Even though there is not detail of the provenance it highlighted that this late raw material are not local.

Considering this, 99% of artifacts are made in local rocks. Mostly pebbles (pyroclastic rocks, rocks that combine clastic and pyroclastic materials determined as chonites and tufonites based on thin cuts) and in less quantity quartzites and limestones. Authors propose that these rocks may come from nearby Arias river, which stands at approximately '500 metres from site' (Cremonte *et al*. 1987: 24). Made on these local rocks they found polyhedral cores, some of which present abrading or chopped marks in the edges. They also recovered some instruments on cores (1 biface and 1 expedient tool). They emphasize on the remarkable proportion of cortex in flakes (75% cortical platforms).

Towards the 1990s, there is a rise in the frequency of researches in the area. Escobar (1996), determines that the lithic assemblage of Silisque- Tilián site is characterized by a predominance of local raw materials (andesites, quartzites, quartz, some metamorphic, and sandstones), spalls mostly naturals (nodules and pebbles) and flakes of different sizes and nature of the objective piece (possibly limited by a high anisotropy of these rocks resulting in a high fragmentation index) (Escobar 1996). Artifacts shaping was made mostly by knapping and marginal retouch. It also stands the use of natural edges and rocks modified by use.

In the mid-1990s, Alejandra Kornstanje analyses Vaquerías style ceramic material both from collections and recovered in archaeological excavations (Kornstanje 1995; 1997). Even though the papers aim to discuss this ceramic style, she takes into account the abundance of rocks and lithic artifacts in an area nearby our study case.

1.2. Case study: Cabra Corral 1 [8] (Ssallav 1 [8])

In southeast part of Cabra Corral dam, La Viña Department, there are located a series of archaeological sites. What makes them outstanding is that the only painted decorated pottery in surface is the one known as Vaquerías style (Pantorrilla Rivas 2007). The sites are characterized as surface concentrations, of variable sizes, of ceramics, lithics and animal bones. They are in general terms greatly perturbed both by the action of local people and river action. We highlight that given that the sites are located near the riversides they constantly undergo dam water level variations. On one side this issue could benefit the conservation of the archaeological record because their underwater permanence may result in less exposure to human depredation. But on the other side it is more complicated to carry on the archaeological work for its excavation depends on the level of dam.

Vaquerías pottery style has a wide dispersion in Northwestern Argentina and exceptionally reaches north of Chile and Tarija in south of Bolivia. Most of these ceramic recoveries consist on fragments and some complete pieces from surface collections and private collections without any contextual data (Pantorrilla Rivas 2009a). Excavations where

Vaquerías style pottery was found in context alongside other materials are scarce (Cigliano *et al*. 1972; Heredia *et al*. 1974; Berberian & Massida 1975; Raffino 1975, 1977; González & Baldini 1989; Castro *et al*. 1994; Korstanje 1995, 1997; Ortiz 2007, among others). Excavations on Cabra Corral 1 [8] site (SSALlav 1 [8]) allow to put into context for the first time Vaquerías materials (Pantorrilla Rivas 2009 a; 2009 b). A radiocarbon dating on camelid bone from the deepest levels of Cabra Corral 1 [8] site (SSALlav 1 [8]) provided a date of 1868±63 BP (AA88373), cal. BP: 1806±70, 68% range cal. BP: 1735- 1876 (CalPal 2007).

Besides the ceramic materials that were described, other pottery was recovered: coarse pottery, polished grey, burnished black and red-orange with no decoration alongside lithic materials and an abundance of fragments of animal bones and charcoal (Pantorrilla Rivas 2009 a; 2009 b).

Lithic artifacts recovered in the excavations carried on in Cabra Corral 1 [8] (SSALlav 1 [8]), are still under analyses (Mercuri 2015) and we only have preliminary information. Lithic material in the sites is abundant both in surface and subsurface. They are mostly big to medium size pieces of local sandstone, including cores, flakes and instruments manufactured by knapping and polishing and abrading (Mercuri *et al*. 2011).

A standing characteristic is related with certain patterns observed in spalls, being predominantly wide long- wide module (50% of the analysed sample till the moment this was written) and medium sized. Even if mostly they are angular flakes is also high the frequency of backed flakes (20%). Another pattern is related with percussion bulbs, which are in a 16.6% doubles and 11.11% are fractured, with steps caused by the knapping, or both fractured and with steps caused by the knapping. A 33.3% of the bulbs (both simples and doubles) are prominent and a 17.6% diffuse.

Regarding manufactured artifacts it may be state that in general terms are expediently (informal tools) and many have notches. Side scrapers and knifes could be recognized, all of them medium and medium- large sized cutting edges artifacts.

2. Methods

2.1. Reference collection and lithic resources regional base

As stated above, we consider that technology encomprises every process in the life of an artifact (Gosden & Marshall 1999; Schiffer 1972). The first stage of artifact production consists in the acquisition of lithic raw materials. This step implies having rocks at disposition, and, more importantly to know them. In this sense we decided on one side to survey the availability of lithic resources in the study area, and on the other side to develop an experimental analysis on the collected sample, which was later compared with the archaeological sample of SsalLav 1 [8].

Given the low frequency of non-local lithic artifacts recovered in the archaeological record (some few obsidian flakes) we decided to carry out a survey to register the availability and main characteristics of local lithic raw materials.

Following Escola (2000), a proper evaluation of the base of lithic resources of a particular region begins with a deep research on geological bibliography in a way of acquiring a preliminary panorama of the spatial distribution of potential resources.

The study area is located in the geological province of Cordillera Oriental (Turner & Mon 1979), which corresponds with the southern end of the long Andean strip that encomprises Peru’s Cordillera Oriental and Bolivia’s Eastern and Central Cordillera. This province limits to the East with Subandean Sierras by a series of faults (Tacónico- Odóyico front) (Gelli 1990). A geomorphological feature that stands out, is the deposit that fill the structural depression (graben) located East of Guachipas between Cebilar sierras and Guachipas slopes. These deposits constitute an attenuated piedmont in its Southern section and could be individualized in different alluvial cones in Nothern section. All of the draining proceeding from Cebilar sierras infiltrates in these sediments (Moya Ruiz 1989). Rocks belong to the last fase of Mesozoic and Cenozoic eras (including Tertiary and Quaternary) (Alonso *et al.* 2000). Stratigraphic column may be synthetized: Puncoviscana Formation (green quartzite sandstones), Grupo Salta (Pirgua subgroup, Balbuena subgroup, Santa Bárbara subgroup) (powerful sedimentary complex continentally originated in its upper and lower parts and shallow water marine in its middle section), Grupo Orán (continentally originated sedimentites) (Moya Ruiz 1989). It is observed a great variety of colours, red, yellow and green rocks that mostly correspond to Grupo Salta (Mesozoic) (Alonso *et al.* 2000). Some of the rocks found in the area are quartzites, a diversity of quartz, orthose, schistos, metamorphic rocks, sandstones, arcilite and limestone (Kihien Collado 1973).

Now, what is acknowledged as *potential lithic resources* is generally related to physic and mechanic properties of rocks that turn these materials susceptible of being transformed into tools. Nevertheless, we must to take into account that the motives for a particular rock to appear in an archaeological site are diverse and not always related with its intrinsic characteristics (Mercuri 2011). Given that in general terms beyond its physical- mechanic characteristics a rock may be chosen because is the only available option, or for its aesthetic appearance, or due to symbolic aspects related both to the place of collection and to certain characteristics of the rock such as colour or texture (see Flegenheimer & Bayón 1999). At the moment of recording rock availability we may choose to register presence, abundance, frequency, accessibility and distribution of each rock, or we may choose to record those observed in the archaeological site under study. This means to look for a particular type of rock present in the archaeological record. In our case, due to characteristics of sites and the ecology of the area (see supra about visibility related to seasonally water level), we decided to perform this last protocol.

Fieldwork was carried out during March, when rains tend to diminish and the visibility and accessibility are optimal. Two people with a distance between them of 5 meters, pursued transects along the river sides Prospecting areas were selected according with hydrological and geological data and where potential rocks were located. Three transects were carried on covering an area of 0.30 km in Guachipas riversides and 0.15 km in both La Viña and Ampascachi. Logistics implied recollection of portable samples of rocks that had previously been detected in the archaeological excavation of the sites, but also of material that priori presented a certain quality for knapping. We collected materials from Guachipas, La Viña and Ampascachi riversides.

Recovered material was analysed in an early stage by geologist Pablo Borttoloti from Universidad Nacional de Tucumán and later by Fernando Hongh of IBIGEO (Bio and Geosciences of NWA Institute, for its initials in Spanish). Even if collected rocks present a relatively variety regarding grain size and colour it was determined that the collection was mainly composed by sandstones. Sandstones are detritic sedimentary rocks conformed predominantly by mineral particles of sand size (though they may be sorted according to grain as fine, medium or coarse using Udden-Wentworth scale). Quartz is usually one of its main components. Lithification with silica or calcium hardens this rock (Strahler 1992). In our study case we recovered sandstones of different colours: grey, green and pink, though the first varieties are the most common. Regarding the grain, they are mostly medium- fine, though we also detected some very fine and some others of coarse grain.

2.2. Experimentation

Experimentation took place at Universidad Nacional de Tucumán. We situated in a place with good natural illumination and we condition it clearing and cleaning the area to allow us a better control and detail recording of the results regarding size and shape of pieces, distribution and dispersion.

Following Hugo Nami (1992), experimental archaeology is a term used to address experiments conducted to simulate o reproduce archaeological artifacts in laboratory. Within these we can find those that aim to obtain results providing *useful information applicable to any archaeological assemblage of similar characteristics* (Nami 1992: 35). In our study case the main goal is to observe fractures and to register characteristic traces patterns that allow us to determine knapping quality of the rocks. In this sense the final goal is to understand and give a first interpretation to raw material selection to manufacture instruments in local rocks.

As we have already mentioned, the sample comes from Guachipas, La Viña and Ampascachi riversides. In this case we perform the experimentation with the diversity that the sandstone subgroup presented (see above).

Knappers equipment may consist in a variety of items (different kinds of billets and pressure flakers, abraders, intermediaries to indirect percussion). In our study case, one person carried on the task. The knapper was sitting at the moment of the primary removal of flakes and standing when he was spalling the pieces. He used a piece of leather to protect the hand with which he held the rock being knapped. He performed direct percussion with two varieties of billets (see infra). We consider fundamental to highlight that the knapper had experience in accomplishing such task. This is relevant due that the patterns generated by an apprentice are consistently different from those of an experienced artisan (Sacchi 2014, among others) and as the goal here is to observe fractures, we considered substantial that the knapper had the necessary technical expertise to perform sandstone nodule reduction.

To perform the testing, we chose those nodules and nodular flakes that range in between 25 and 12 cm size (very big, *sensu* Aschero 1975). Due to the rock samples we had presented cortex (nodules), they were sorted by and tested according colour observed at naked eye. So, there were tested dark grey nodules (mostly from Guachipas riverside) and a variety of green ones (from La Viña and Ampascachi). Rocks were not conditioned in any way before testing them.

The set of billets used in the experimentation was sorted according hardness. As hard hammer, pebbles and rolling stones of diverse raw materials, (such as quartz and quartzite) of different sizes were used (range between 6 by 10 and 8 by 3 cm). As soft hammer, a quina wood (*Myrpxylon perulferum*) billet was used. This wood has a density of 1190 kg/m^3 (green)- 970 kg/m^3 (dry) (Atencia 2003), which is very similar to that of the black carob tree (*Prosopis nigra*, 1170- 900 kg/m^3) as we mentioned above a local tree. We also prepared a bone billet of cow femur.

Products of testing were analysed and registered in an attribute table (see Supplemental File 2). Variables that we took into account are based on Aschero’s analytical proposal: objective piece, distal end of flakes, bulbs, platforms and usewear traits (Aschero 1975) (Supplemental File 2). Resulting material was analysed and put into tagged bags.

3. Results

3.1. Results on sources survey

Within the frame of lithic record variability analysis we have to take into account the regional base of lithic resources and the identification and characterization of provenance sources (Escola 2000) because this constitutes a fundamental part at the moment of defining some parameters both to develop study strategies and to analyse the archaeological material (Mercuri 2011).

Guachipas (Figure 3). This potential source of lithic raw material presents itself basically in the shape of a large plain of red lime with accumulations of river pebbles of different sizes

6 to 20 cm. These are mostly dark grey sandstones but other colours such as red and green are present. There was also a recognizable abundance of quartz (some pebbles are about 15 cm) and other sedimentary rocks and conglomerates with or without metamorphism.

La Viña (Figure 4). This place is nowadays dredged and therefore the pulled material is located in the form of mounds in the riverside. In this case, we recorded a major presence of green sandstones and sedimentary rocks. It is relatively low the frequency of grey sandstones and extremely scarce the quartz which appears in the shape of veins in other rocks.

Ampascachi (Figure 5). This river presents a narrow runway (recently intervened after the summer rains). Rocks, even if they have been placed at the sides of the river forming uniform mounds are sorted by size, bigger ones at the base. We recorded a variety of green sandstones, some with a very high degree of metamorphism. In lower frequency, grey ones. We recognize a diversity of sedimentary rocks and conglomerates. Many of these rocks are tabular prisms.

3.2. Results on experimentation

Regarding distribution and dispersion of knapping material we can state that it mostly took the shape of a crescent moon towards the front of the knapper. Dispersion of artifacts had a 3-meter range though most of the material concentrated in the meter nearer to the artisan. General size of debitage distributed in a relatively uniform manner, the smaller items being those that reach the greater dispersion.

In general terms raw materials turn out to be extremely hard, being primary reduction a very hard work. Hard hammers (quartz and quartzite pebbles) were used to perform the primary reduction and flakes removal, whilst quina billet was used to the secondary reduction. This item was subject to considerable wearing (Figure 6). Bone hammer was not of use as it broke almost immediately.

In general terms, results show that tested sandstones present internal variations and therefore resulting flakes may be of different grains (fine or medium).

Even if both tested rocks (grey sandstone from Guachipas and green ones from La Viña and Ampascachi) present a common pattern (see below), there are particularities for each. Guachipas grey sandstone exhibits an extreme hardness that produces chippings and steps when knapped. Therefore ventral sides are not smooth, presenting many steps and eraillure flakes product of the strength that has to be put in the task. Resulting flakes are not as sharp as those of finer grain. Green sandstones from La Viña and Ampascachi, even if they are relatively less hard that those grey from Guachipas and present a lower tendency to stepping nodules are smaller and resulting flakes more homogeneous in size. As well they tend to chip less though they turn to be more brittle and very sharp.

Objective pieces used, in our case nodules, seem to put limits to the production, that is the results show a high frequency of backed flakes of wide o very wide modules of length width (Aschero 1983) (Figure 7). In every case, distal end of flakes are very irregular. Considering that they are very thin all of the irregularities do not affect the edges (Figure 7).

Due to its hardness, to knap these rocks require lots of strength to generate a flake. This factor originates double and triple bulbs (Figure 8).

Usewear traits in the edges such as chipping and nicks (Aschero 1975) are originated in the preparation of platforms at the moment of reduction. In several cases we detected notches (Figure 9) that are related with the memory of previous knapping and internal irregularities of the rock itself.

Summing up, in general terms experimental products are very similar to archaeological ones. In both assemblages we may observe high frequency of wide backed flakes with irregular edges, double bulbs and notches (Figures 7, 8 and 9).

Figure 3. View of Guachipas river and rock availability. The scale bar is 10 cm wide (in two 5 cm segments).

Figure 4. View of La Viña river and detail of available rocks. The scale bar is 20 cm wide (in two 10 cm segments).

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Figure 5. View of dry runway of Ampascachi river and detail of available rocks. The scale bar is 20 cm wide (in two 10 cm segments).

Figure 6. Quina billet after being used. Notice the wearing. The scale bar is 25 cm long (in 5 cm segments).

Figure 7. To the left archaeological material, to the right experimental products. Notice similarities regarding objective pieces and distal end of flakes. The scale bar is 10 cm wide (in ten 1 cm segments).

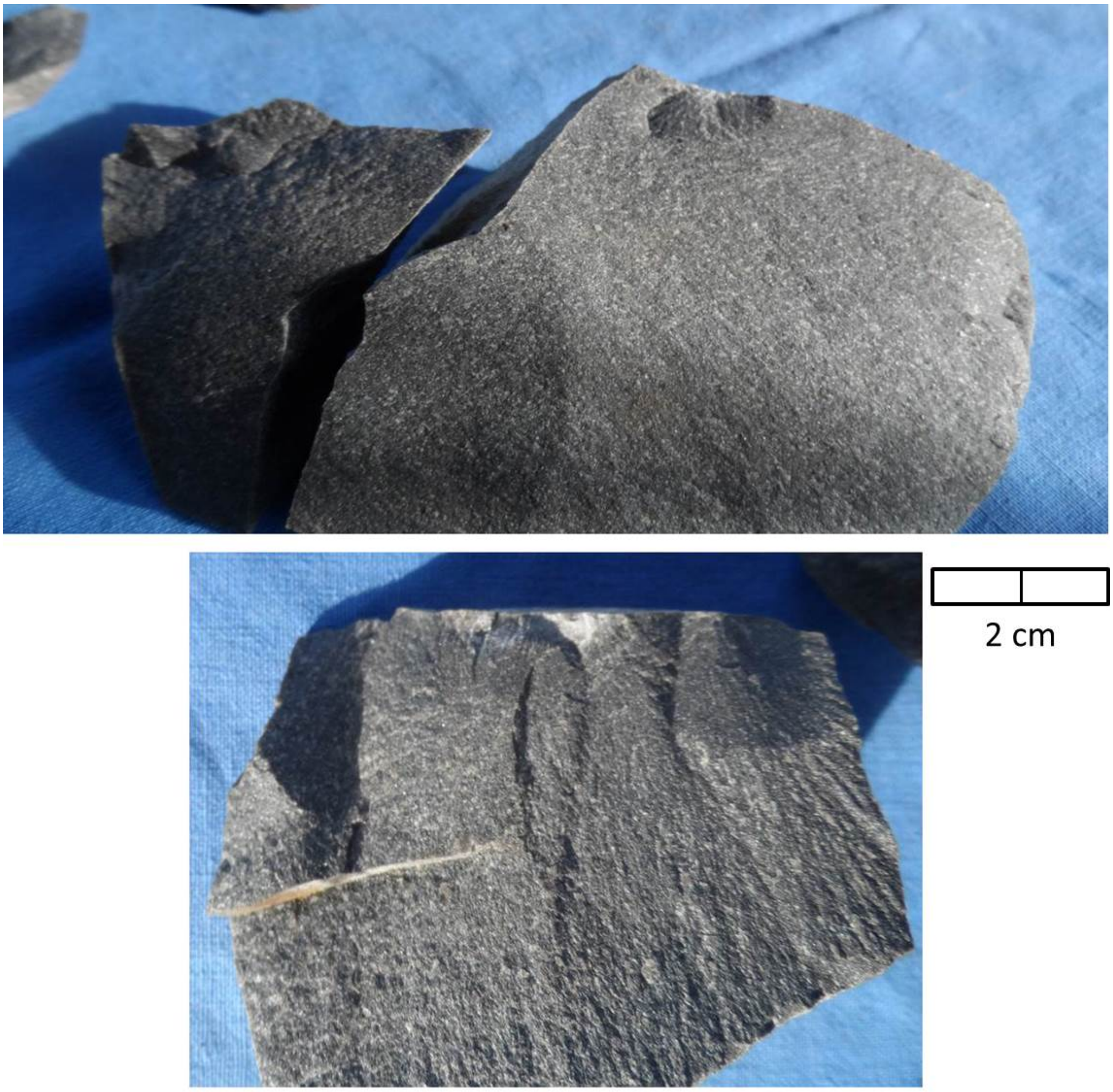

Figure 8. Double and triple bulbs in experimental material. The scale bar is 2 cm wide (in two 1 cm segments).

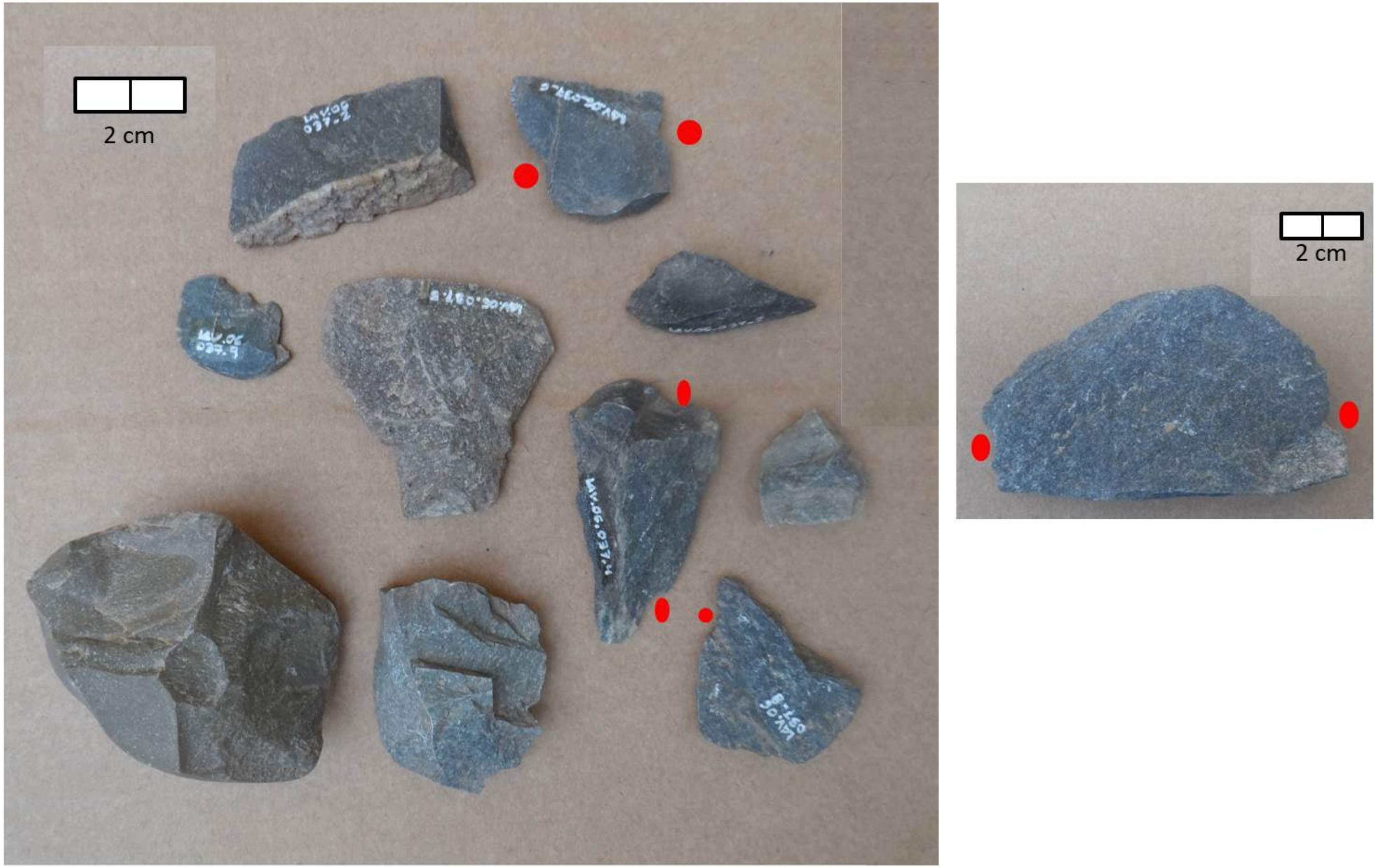

Figure 9. To the left archaeological material, to the right experimental products. Dots indicate notches. The scale bars are 2 cm wide (in two 1 cm segments).

4. Discussion and conclusions

First results allow us to state that sandstones, due its availability, knapping quality and hardness constitutes an optimal lithic raw material to elaborate instruments.

Even if its distribution, its morphology and size are diverse, at first this rock is found (in more or less quantity) in all of three riversides that we surveyed). Most important, all of them (even considering those season rivers of sub- basin Las Conchas- Guachipas) are relatively near the archaeological site under study. In Guachipas river, the one with major runway at the moment of our research registers an abundance of great hardness sandstones. These are in a wide variety and frequency by which its selection (if the knapper has experience in this task) does not present major difficulties. On the other hand, in La Viña and Ampascachi rivers the availability of rocks is slightly minor and nodules smaller. Nevertheless, some of the green sandstones of these riverside are more fined grained homogeneous and easy to knap.

In spite of the difficulties that imply the work on such hard rocks we consider that they present a good knapping quality. Once primary removal of flakes is done, and appropriate spalls are acquired, these may be shaped and its edges sharpened in an effective way. The products acquire present many irregularities and imperfections but that is also the pattern observed in the archaeological record though it may be possible to achieve bifacial products with the finer grained ones.

The extreme hardness registered in sandstones of the area (most of all those grey ones from Guachipas) may result a useful characteristic for the manufacture of certain artifacts. If we add the resistance that in general present such rocks as sandstones we may hypothesise that these are optimal choices of raw materials. Mostly when we consider that the artifacts are big and rudimentary. The hardness and resistance of the rocks could have been necessary in tools destined to hard works such as wood cutting as they are mostly used in retouch tools and in some specimens we could detect curation in resharpened edges.

This experience allows us to confirm the possibility that the lithic materials found at Cabra Corral SSALlav 1 [8] site is of local manufacture. Experimental knapping generated artifacts very similar to those recovered in the archaeological context. We observed that the obtain edges are good for cutting tasks and the regularization of these is possible with hard wood billets.

Even though the raw material presents internal irregularities which if we add to its hardness generate traits such as notches and steps, we consider that they also present advantages as hardness itself and resistance by which along with the easy availability of these resources constitutes a good choice to the shaping of a diversity of artifacts intended to cutting tasks.

To know the rocks and their fractures has been effective to compare with the archaeological record and differentiate natural traits ~~of~~ from those anthropic or intentionally generated. Nevertheless, this does not imply that in the decision of the selection of raw materials had not being an intention of acquire certain characteristics such as notches or other irregularities generated in edges. When analysing both archaeological and experimental artifacts we get closer to patterns that may be escaping to the norm, to anomalies, and they push us to evaluate other possibilities and make a progress in our investigations.

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Supplementary Files

Supplementary File 1
Table. Table used for recording data regarding collection of rocks.

Supplementary File 2
Table. Attributes took into account in the recording of the collection.

Supplementary File 3
KML file. Map with towns from which the samples were collected.

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