BASALT UTILIZATION IN THE ARCHAIC PERIOD OF BOLIVIA GEOLOGICAL AND ARCHAEOLOGICAL BACKGROUND•

BAZALT FELHASZNÁLÁS BOLÍVIÁBAN AZ ARCHAIKUS PERIÓDUSBAN GEOLÓGIAI ÉS RÉGÉSZETI HÁTTÉR

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"In theory, there is no difference between theory and practice, while in practice there is."

Benjamin Brewster (1860-1941)

Abstract

The motivation of this paper was given by some basalt artefacts found at Pueblo Sajama (Department of Oruro, Bolivia). This small assemblage consists mainly of flakes and does not contain culture-specific artefacts at all. In the absence of the latter, it is unreasoning to focus on the possible cultural affiliation of the assemblage. However, there are some typological characteristics, which suggest rather an elder origin of the artefacts. The detailed review of the lithic assemblage is in progress. Since, according to the available archaeological information on the study area, the environment of the Nevado Sajama is little-known, this attempt of the authors should be regarded as a sort of awareness-raising. Apart from the utilization of various types of obsidians, very little is known about the basalt utilization in the Archaic Period of this territory. This fact is especially surprising as there seems to be numerous evidence of the use of basalt as a lithic raw material. In this summary, the authors try to gather the available facts on the basalt utilization concerning this period. The authors would like to emphasize the fact that this paper does not contain any new results either in a geological or an archaeological point of view. It reflects only the results of the performed data collection.

Kivonat

Ennek a tanulmánynak az indíttatását néhány Pueblo Sajama-ban (Oruro, Bolívia) talált bazalt lelet adta. Ez a kis leletegyüttes főleg szilánkokból áll, és egyáltalán nem tartalmaz kultúra-specifikus leleteket. Ez utóbbiak hiányában indokolatlan, hogy a leletegyüttes lehetséges kulturális kapcsolataira összpontosítsunk. Vannak azonban olyan tipológiai jellemzők, amelyek a leletek idősebb származását sugallják. A leletegyüttes részletes feldolgozása folyamatban van. Mivel a tanulmányozott területről rendelkezésre álló információk alapján a Nevado Sajama környezete régészeti szempontból kevéssé ismert, a szerzőknek ezt a kísérletét egyfajta figyelemfelkeltésnek kell tekinteni. A különböző típusú obszidiánok felhasználása mellett nagyon keveset tudunk a bazaltnak és általában a vulkanikus kőzeteknek, mint kőeszköz-nyersanyagoknak a használatáról a vizsgált terület archaikus időszakában. Ez a tény különösen meglepő, mivel úgy tűnik, hogy számos bizonyíték áll rendelkezésre a bazalt nyersanyagként való felhasználására. Ebben a rövid összefoglalóban a szerzők megpróbálják összegyűjteni a bazaltfelhasználásról rendelkezésre álló tényeket ezen időszakra vonatkozóan. A szerzők hangsúlyozni szeretnék, hogy jelen írás sem geológiai, sem régészeti szempontból nem tartalmaz új eredményeket. Csupán az elvégzett adatgyűjtés eredményeit tükrözi.

KEYWORDS: BOLIVIAN ALTIPLANO, ARCHAIC PERIOD, RAW MATERIAL PROCUREMENT, BASALT

KULCSSZAVAK: BOLÍVIAI-MAGASFÖLD, ARCHAIKUS PERIÓDUS, NYERSANYAGBESZERZÉS, BAZALT

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Introduction

Several chronologies in the archaeology of the Americas include an Archaic Period. Following Aldenderfer's (2009, Fig. 5.1) chronological scheme for the South Central Andes, the term "Archaic Period" refers to human occupations chronologically situated between, approximately, 10,950 and 3,900 cal BP. Geologically, this period ranges from the Late Pleistocene to the beginning of the Late Holocene. The end of the Archaic Period is associated with the consolidation of agricultural, pastoral, and ceramic technologies, sedentary ways of life, and the emergence of socio-political complexity. Aldenderfer's (2009) general sequence divides the Archaic Period into four sub-chronological periods: Early Archaic (9,500-8,000 BP or 10,950-8,950 cal BP), Middle Archaic (8,000-6,000 BP or 8,950-6,950 cal BP), Late Archaic (6,000-4,500 BP or 6,950-5,250 cal BP), and Terminal Archaic (4,500-3,600 BP or 5,250-3,950 cal BP).

Lately, José M. Capriles and Juan Albarracín-Jordan (2013) attempted to assess the current state and to summarize the available data of archaeological research regarding the earliest human occupations in Bolivia. Their paper provided an overarching synthesis of the history of archaeology, different interpretation frameworks, and results of recent investigations on early human occupations. It also provided information on available radiocarbon dates associated with early human settlements and discussed their archaeological context and implications.

For the time being, on the area of present-day Bolivia, there have been already a large number of archaeological sites which can be related to the Archaic Period. Among them, there are seven sites dated by radiocarbon measurements. For all of the archaeological sites, the original name has been taken, disregarding the fact of the recent revisions in the official spelling for place-names originating from Aymara and the Quechuan languages. A typical change is to replace the digraph (hu or gu), characteristic for the Hispanicized spelling, with the single letter (w) (see e.g. the site Wakolli=Huacolli). In **Fig. 1.** 58 Archaic Period archaeological sites sorted in alphabetical order and the two PAM (Proyecto Arqueológico Mauri) site complexes near Charaña; furthermore the known basalt quarries are represented. In the first part of the paper, only the archaeological sites with reported basalt utilization will be described. During the description, in general, we will follow the north-south direction. The sites were sorted ascending after their latitude coordinate and were numbered from B1-B22. The two PAM (Proyecto Arqueológico Mauri) Complexes got the identification of B23 and B24 respectively.

Fig. 1.: Known Bolivian Archaic Period archaeological sites and basalt quarries.

Archaeological sites in alphabetical order

1=Abrigo Clemente, 2=Aguallamaya, 3=Betanzos, 4=Cala Cala, 5=Callapa, 6=Cerro Cobre, 7= Chuñu Chuñuni, 8=Cinti, 9=Corque, 10=Cueva Bautista, 11=Eucaliptus, 12=Huari, 13=Huerta Mayo, 14= Iroco KCH20, 15=Irohito, 16=Iscayachi, 17=Isla del Sol, 18=Jaihuayco, 19=Jiske Molle Pukara, 20=Kayarani, 21=Laguna Colorada, 22=Laguna Hedionda, 23=Laguna Verde, 24=Lagunas de Taxara. 25=Maira Pampa, 26=Maragua, 27=Mecoya, 28=Nuapua, 29=Paja Colorada, 30=Palacio Tambo, 31=Potosi, 32=Pumiri, 33=Quebrada Honda, 34=Quetena, 35=Quetena Chico, 36=Quila Quila, 37=Rejara, 38=Sacaba, 39=Salar de Coipasa, 40=Sama (Tarija), 41=San Agustín, 42= San Bartolomé, 43= San Cristóbal SC-1, 44= San Cristóbal SC-2, 45= San Cristóbal SC-3, 46=San Lucas, 47=San Luís, 48=San Pablo, 49= Santiago de Huata, 50=Soniquera, 51=Taxara, 52=Tomarapi, 53=Viacha, 54=Vila Vila, 55=Viscachani, 56=Wakolli, 57=Wiskachcalca, 58=Yunchará, 59=PAM (Proyecto Arqueológico Mauri) Complex-1, 60= PAM (Proyecto Arqueológico Mauri) Complex-2

Basalt quarries

Q1= Chiñimayu, Q2= Montaña Santa Bárbara, Q3=Palacio Tambo, Q4=Querimita, Q5=San Juan Mallku, Q6=Carapari

1. ábra: Az Archaikus Periódus ismert régészeti lelőhelyei és bazalt bányák Bolíviában

The complete list of the sites is the following: B1=Irohito, B2=Aguallamaya, B3=Viscachani, B4=Abrigo Clemente, B5=Iroco KCH20, B6=Wakolli, B7=Tomarapi, B8=Jiska Molle Pukara, B9=San Lucas, B10=Palacio Tambo, B11=Cueva Bautista, B12=San Cristóbal SC-03, B13=San Cristóbal SC-02, B14=San Cristóbal SC-01, B15=San Agustín, B16=Alota, B17=Laguna Hedionda, B18=San Pablo, B19=Soniquera, B20=Quetena Chico, B21=Laguna Colorada, B22=Quetena.

In **Fig. 2.,** the above-mentioned Bolivian (B1-B22) archaeological sites, and the two PAM Complexes (B23-B24) belonging to the Archaic Period, and the identified Bolivian basalt quarries (Q1-Q5) can be seen. For the classification of the raw materials from the provenance point of view, a simplified system has been used, which is based mainly on the radius of the raw material procurement areas, disregarding the geographical situation and the availability of the raw material sources. Each raw material type that can be collected from a distance of not greater than 25 km as the crow flies should be considered as local. The medium distance or regional group is formed by raw materials which can be collected from a distance of 25-80 km. The raw material types stemming from a distance greater than 80 kilometres make up the long-distance group.

In the second part of the paper, a summary will be given on the basalt as a lithic raw material and the possible geological sources of the various igneous rocks.

Environment and topography of the area of focus

In Bolivia's mountainous western region, the Andes reach their greatest breadth and complexity. The system in Bolivia is dominated by two great parallel ranges. To the west along the border with Chile is the Cordillera Occidental, which contains numerous active volcanoes. To the east is the Cordillera Oriental, whose spectacular northern section near La Paz is called Cordillera Real ("Royal Range"). An impressive line of high peaks, some exceeding 6,100 metres, characterize this northern section, which maintains an average elevation of more than 5,500 metres for more than 320 km. Between these ranges lies the Bolivian Altiplano, the main focus area for this paper. The Altiplano, English High Plateau, also called Puna, is occupying parts of Southern Peru, Northern Chile, and Western Bolivia. Its northwestern edge is situated at Lake Titicaca in Southern Peru and it extends about 965 km southeast to the southwestern corner of Bolivia. It consists of a series of intermountain basins, wide valleys between mountain ranges which are partly filled with alluvium, lying at about 3,650-4,000 metres above sea level. Lake Titicaca occupies the northernmost basin, to the south there are the Lake Poopó and the Coipasa and Uyuni salt flats. The basins are separated by spurs reaching eastward from the Cordillera Occidental of the Andes Mountains. On the eastern side of the Altiplano, however, there is a continuous passageway of gentle gradient extending southward across Bolivia.

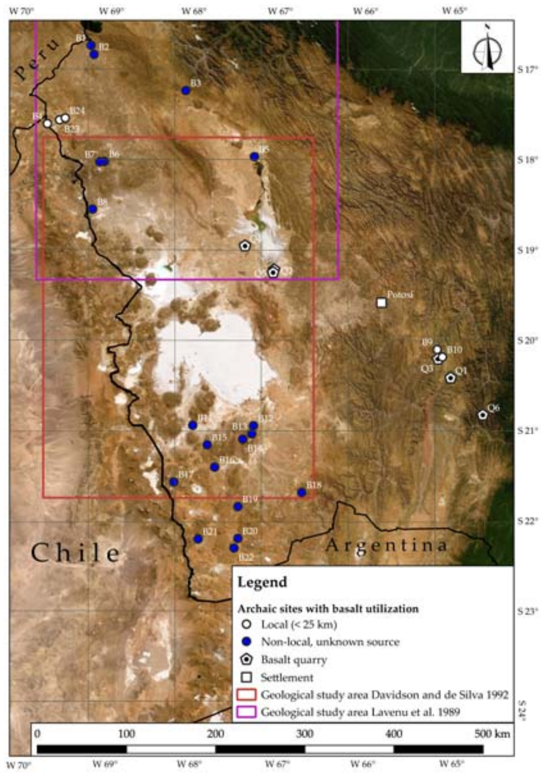

Fig. 2.: Bolivian Archaic Period archaeological sites with basalt utilization and basalt quarries

The complete list of the sites is the following: B1=Irohito, B2=Aguallamaya, B3=Viscachani, B4=Abrigo Clemente, B5=Iroco KCH20, B6=Wakolli, B7=Tomarapi, B8=Jiska Molle Pukara, B9=San Lucas, B10=Palacio Tambo, B11=Cueva Bautista, B12= San Cristóbal SC-03, B13= San Cristóbal SC-02, B14= San Cristóbal SC-01, B15=San Agustín, B16=Alota, B17=Laguna Hedionda, B18=San Pablo, B19=Soniquera, B20=Quetena Chico, B21=Laguna Colorada, B22=Quetena, B23= PAM (Proyecto Arqueológico Mauri) Complex-1, B24= PAM (Proyecto Arqueológico Mauri) Complex-2

Bolivian basalt quarries

Q1= Chiñimayu, Q2= Montaña Santa Bárbara, Q3=Palacio Tambo, Q4=Querimita, Q5=San Juan Mallku

2. ábra: Bazalt felhasználás az Archaikus Periódus ismert régészeti lelőhelyein és bazalt bányák Bolíviában

The Cordillera Oriental of the Andes forms the eastern boundary of the Altiplano. The Altiplano Basin, a sedimentary basin, is located on the Altiplano plateau between the Cordillera Occidental and the Cordillera Oriental. The basin has evolved through time in a context of horizontal shortening of Earth's crust. The great thickness of the sediments accumulated in the basin is mostly the result of the erosion of Cordillera Oriental (Arnade & McFarren 2019).

The highest peak of the Western Cordillera is the Nevado Sajama, reaching an elevation of 6,542 metres on the eastern side of the cordillera. It is an extinct composite volcano consisting of an andesitic stratovolcano overlying several andesitic-to-rhyodacitic lava domes. The volcano has erupted rocks ranging from andesite to rhyodacite. The mountain has a conical shape and is capped by a summit crater; at lower elevations the whole volcano features glacially deepened valleys. The ground moraines are the most prominent moraines on Nevado Sajama and have varying colours depending on the source of their component rocks.

The water resources of the Nevado Sajama region are made up of the lakes Huaña Kkota, Isla, Chiar Kkota, Inca Ingenio, along with others of lesser size and the rivers Mauri, Sajama, Sabaya, Tomarapi, Copasa, Esquillani and many others of smaller volume which disappear in the dry season. Starting in the lake Laguna Huaña Kkota on the northwestern foot of Nevado Sajama, the Tomarapi River flows firstly eastward, then east, south and southeast around the northern and eastern flanks of the volcano; the Sicuyani River which originates on Nevado Sajama joins it there. The Sajama River originates on the western side of the volcano and flows to the south, increasingly turns southeast before joining the Lauca River. Other rivers draining Nevado Sajama and its ice cap also eventually join the Lauca River and end in the Salar de Coipasa (MISS 2016).

Basalt utilization in the Bolivian Highlands

1. The southern part of the Lake Titicaca basin (Fig. 2., B1-B2)

The paper of Adolfo E. Pérez (2006) reviewed the results of a typological analysis made on projectile points obtained from the southern part of the Lake Titicaca basin, from the Archaic Period archaeological sites of Aguallamaya, Chuñu Chuñuni and Irohito and the comparison with those of the South Central Andes region.

The site Aguallamaya (Fig. 2., B2) is located in the Ingavi Province of the Department of La Paz on the banks of the Jacha Jahuira River, a tributary of the Desaguadero River. The site with lithic material is twelve kilometres to the southeast of Irohito and approximately two kilometres from the eastern bank of the Desaguadero River on a natural hill eight to ten metres above the level of the river. The lithic material from the surface collection is composed of several fragmented and entire projectile points together with flakes and knapping waste product mainly of black basalt, and to a lesser extent, siliceous rocks and obsidian. It is presumed that it is a lithic workshop (Álvarez 1999, 12). In the photographs and scaled drawings, it is observed that the fragments of the projectile points belong all to the proximal part of the said instruments, so it is possible that in this site have been carried out tasks of their production and maintenance. Among the artefacts, there is a projectile point of grey basalt related to the unstemmed forms with rounded shoulders of Series 2 (Pérez 2006, 22, Fig. 8, A-01). The pentagonal shape with wide straight or slightly convex base resembles the Type 2C of Klink and Aldenderfer. This type of projectile points is considered as diagnostic of the Middle Archaic between the years 8,000 and 6,000 BP. (Klink & Aldenderfer 2005, 34). The other grey basalt projectile point of triangular shape with pointed stem and little marginal retouching (Pérez 2006, 22, Fig. 8, A-02). It has no relation to any of the types proposed by Klink and Aldenderfer (2005). This type of projectile point can be considered as a local variant of the Middle Archaic (8,000 – 6,000 BC).

Irohito (Fig. 2., B1) is located in the Ingavi Province of the Department of La Paz at a height of 3,810 m.a.s.l. on the eastern shore of the Desaguadero River. No research has been conducted on the site focused particularly on the Archaic Period. However, during the excavation and renewed surface collection, lithic material could be registered, and specifically, some projectile points (Pérez 2005). In the southern sector of the site, at a distance of 50 metres from the shore, there is a small hill approximately six metres high correlate with the river level. Several artefacts and some projectile points were collected in an area of approximately 5 m^2. A black basalt projectile point was found in stratum IV-2 in the east sector of the site (Pérez 2006, 21, Fig. 7, H-02). It does not have a direct relationship with the typology of Klink and Aldenderfer (Klink & Aldenderfer 2005). It could only be compared with the unstemmed form of Series 4 of these authors, but the comparable type (4F) differs in several important aspects (Klink & Aldenderfer 2005, 42). According to Pérez, it is likely that this type can be considered as a local variant within the Archaic Terminal (4,400 – 3,600 BC) (Klink and Aldenderfer 2005, 47).

2. Viscachani (Figs. 2-3., B3)

The site of Viscachani is located in the northern part of the Altiplano, along the road between La Paz and Oruro, near the settlement of Huancarani at 3,820 metres above sea level. Around the village of Viscachani an area of about six to seven hectares covered by stone artefacts. The main concentration is in the eastern part, with an extension of at least 400 m^2. There appear several cores, modified flakes, bifaces and monofaces, as well as scrapers and projectile points of different shapes. The raw material is first of all dark red quartzite and green quartzite. Eastwards from the site, the Viscachani River meanders through the valley, cutting a plain extended to a level lower than the site and interpreted as the rest of an old lake. Surface collections carried out between 1954 and 1960 produced over 9,000 artefacts. Excavations conducted at the site firstly included five test pits, shortly after the preliminary report of the site, and

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30 additional test pits conducted in 1960 in collaboration with German scholars. No substantive stratigraphy was documented from the excavations, due to a combination of agricultural ploughing and soil erosion (Capriles & Albarracín-Jordan 2013).

Within the framework of the doctoral thesis of Yara Lizarraga-Mehringer (2004), supervised by Prof. Dr G. Bosinski, two field investigations were carried out in 1995 and 1996, to find the exact location of the different archaeological sites and registering the existence of raw material deposits. As a result of these field works, it was possible to locate a small hill in Viscachani with deposits of sandstone and green quartzite in the form of fragments and slabs. In the nearby river, there is quartzite of different colours and other raw materials in the form of boulders. After a second, more detailed field investigation, systematic and restricted excavation of a square metre trench was carried out in Viscachani.

The total surface collection consists of an approximate number of 13,000 specimens. The archaeological artefacts of Viscachani were made of different raw materials. There are metamorphic, sedimentary and magmatic rocks, as well as microcrystalline siliceous rocks among the lithic artefacts. The classification of the raw materials was made by the geologist Ramiro Suárez S., Jorge Mitchell and Rolando Mocobono of the petrographic laboratory of YPFB (Yacimientos Petroliferos Fiscales Bolivianos). A large part of the Viscachani lithic artefacts (73.21 %) was made of local quartzite. The second largest group consists of magmatic rocks (14 %) and siliceous rocks (9.54 %). Among the magmatic rocks, dark grey or black basalt stands out with 89.83 %. Its texture is fine and is provided with small crystals. The reddish, pink and lilac trachyte covers 9.21 % of all igneous rocks present. This raw material has a porphyritic structure with small crystals. Lizarraga-Mehringer emphasized the fact, that the exact origin of basalt, trachyte and obsidian, used in Viscachani, is unknown. She suggested that presumably these raw materials were brought to the site from the western mountain range. This area is located at a distance of approximately 150 kilometres from Viscachani and available via the safe natural path formed by the Desaguadero and Mauri rivers. Also the origin of the fine-grained rocks, like silex, chert, flint and microcrystalline quartz varieties like agate, opal and other subforms of the chalcedony, from which finely worked artefacts were made, could not be determined with precision. Lizarraga-Mehringer summarized the statistical data on the raw materials of the surface collection at Viscachani. Observing the spectrum of the raw material used in other archaeological sites of the leaf-point tradition, that is, of the „Ayampitín" inventory of the highlands of the Andes, such as that of the rock shelter Telarmachay in the district of San Pedro de Cajas, Junin, Peru (Julien et al. 1987) and comparing it with that of Viscachani, it is obvious that these are the same raw materials, even when they are present in different quantities.

The 466 lithic artefacts from the 1997 excavation were also made of very different raw materials. Like in the case of the surface artefacts, the metamorphic and sedimentary rocks are here also the most represented with 76.61 % (357 pcs.). Unlike the surface findings, the igneous rock artefacts from the excavation (6.65 %: 31 pcs.), are less represented than those made in microcrystalline siliceous rocks (7.08 %: 33 pcs.). Among the metamorphic and sedimentary rocks, fine and coarse-grained quartzite of different colours are also present. The black basalt stands out from the magmatic rocks (77.42 %), trachyte, on the other hand, are less represented.

Patterson and Heizer (1965) carried out a technological and stylistic analysis on a selected sample set consisting of 63 artefacts of Viscachani stone tools. The sample was predominated by projectile points. It was found that 58 of the 63 artefacts are made of quartzite of different colours. Concerning the other artefacts, it is a pink chalcedony side-scraper, two small lanceolate projectile points of red jasper and two pedunculated points of a specific type of andesite (hornblende andesite). On the basis of the analysis, the bulk of the assemblage was similar to the earliest („Ayampitín") level of Intihuasi Cave (8,060±100 BP (P-345); Prates et al. 2013), in Northwestern Argentina, and the Luz (ca. 5,500 BC) and Canario (ca. 4,950 BC) complexes of the Peruvian coast. Exceptions included small stemmed points, characteristic of Laguna Hedionda and the Pichalo Preceramic II of Northern Chile, dated to approximately 2,000-3,000 BC. As regards the projectile points, according to Lizarraga-Mehringer, the Viscachani findings can be compared, more appropriately, with those of the Camarones 14 and Hakenasa sites in Northern Chile, because in these sites similar elongated triangular tips are found along with simple foliaceous projectile points. As a consequence, Viscachani was interpreted as a "typical" Archaic Period settlement associated with an adaptation to highland hunting and gathering, an interpretation still employed by many researchers (Lizarraga-Mehringer 2004, 245; Capriles & Albarracín-Jordan 2013). On the whole, it can be stated, that both from typological and raw material utilization point of view, the lithic assemblage of Viscachani suggests distant cultural connections.

3. Mauri and Pampa de Charaña (Figs. 2-4., B4, B23-B24)

Abrigo Clemente (**Figs. 2-4.**, B4)

A very important site identified by Arrellano and Kuljis is the rock shelter Abrigo Clemente Coat. This cave has evidence of continuous occupations that left remains of projectile points, bifacial knives, bifacial preforms, flakes, cores and knapping waste products (Arellano and Kuljis 1986, Michel 2000). The projectile points have various forms, there are lanceolate, stemmed, notched and small triangular and rhomboid points as well. The knives are lanceolate and asymmetrical, of varying sizes, the preforms of projectile points are of lanceolate shape with base. The raw material includes basalt, high-silica rhyolite and obsidian.

Markenasa Valley, PAM (Proyecto Arqueológico Mauri) Complexes (**Figs. 2-4.**, B23-B24)

Along the banks of the Mauri River, numerous lithic workshops and shelters had been identified by Arrellano and Kuljis (1986) in rocky eaves located on the old terraces of the Mauri and in the Pampa de Charaña. The lithic assemblages included secondary flakes, fragmented bifaces, end-scrapers and side-scrapers which were classified within the preceramic period. However, since the artefacts are always found with remains from the Late Intermediate Period, there are some doubts about this classification. The raw materials are varied (quartz, opal, dacite, basalt, etc). The identified artefacts at the sites of Pando and General Campero had wide typological diversity and forms, which would imply that the place was successively occupied. A detailed typology describes the lanceolate and triangular forms of this complex made of varied raw materials of basalt, dacite, opal, rhyolite and other materials possibly brought from the south. More recently, field surveys were made in the Markenasa Valley, near Charaña by Vanessa Jiménez (2013). Eighteen open-air sites and seven rock shelters were documented. At two of the rock shelters (PAM-5 and PAM-06) test excavations were carried out, which yielded stratigraphic and projectile point sequences, comparable to the nearby site of Cueva Hakenasa in Northern Chile (Osorio et al. 2011). Regarding the raw material utilization, different types of volcanites of likely local origin, such as basalt, black basalt, olivine basalt, dacite, hornblende dacite, rhyolite, trachyte, trachyandesite dominate in all lithic assemblages.

4. Iroco KCH20 (Fig. 2., B5)

Iroco is located at the northern margin of Lake Uru-Uru west to Oruro. Here, fieldwork has been carried out since 2003. During systematic high-intensity, full-coverage surveys of a large area of about 38 km^2, 35 Archaic Period settlements were documented. In 2005, systematic collections and excavations were conducted at one of these sites, at KCH20. On the whole, 4,439 lithic artefacts were collected from the surface, mainly consisting of flakes and debitage products (91 %). The most frequent raw material was black basalt (62 %), followed by two types of chert (23 %), and other less frequent raw materials, including obsidian. Black basalt probably originated from Querimita, from the formerly mentioned quarry located at the southwestern shore of Lake Poopó (Capriles et al., 2011; Capriles & Albarracín-Jordan 2013; Capriles et al. 2017).

Excavation Unit 6 contained 146 lithic artefacts. The majority of the assemblage was manufactured from non-local black basalt; other non-local raw materials included chalcedony and various kinds of large dark-coloured chert cobbles. In the environs, there are small nodules of a variety of cherts, which seemed to have been occasionally used. Most sources of good quality cherts are situated between 40 and 120 km towards the eastern Cordillera. The best source of igneous extrusive, high-quality basalt is Querimita, situated approximately 110 km to the south of Iroco (Giesso, 2003). Some of the outcrops are dispersed mainly to the south of Querimita (Montaña Santa Bárbara and San Juan Mallku), but still substantially far from Iroco. In the case of black basalt flakes, no cortex was observed. It is thus very likely that primary preparation occurred at the quarry and black basalt was entering the site in the form of prepared cores, blanks, preforms or finished tools. All three projectile points were made on black basalt. The evidence, that most stone tools were manufactured with non-local raw materials, suggests the hypothesis that highland foragers engaged in relatively high and possibly seasoning mobility. The two shouldered and stemmed „Patapatane" style projectile points indirectly suggesting an Early Archaic Period age of the site. The two samples of bone recovered from the trash pit feature were AMS dated 9,304-9,033 cal BP (AA91568) and 9,115-8,774 cal BP (AA91569). Both dates produce the range estimate of 9,396-8,985 cal BP for the feature.

5. The Sajama region and surrounding areas (B6-B8)

Before the Inca period, the Lordship of Carangas was one of the last developed cultural entities in the Altiplano of Bolivia. It had its roots among the hunter-gatherers who inhabited the vast plain of Oruro and its foundation in the rich formative tradition of the Wankarani Cultural Complex. The study of Marcos Michel (2000) intended to be an introduction to the complex problem of the regional cultural developments of the Bolivian highlands, being one of the first attempts in archaeology to try to understand the phenomenon of the formation of the so-called "Señoríos", "Pre-Columbian Reynos" and also "Señoríos post Tiwanaku". The study was based on archaeological field survey carried out in 1993 when 16 archaeological sites were documented on the margins of Lake Poopó. The area of this work included the basin of Lake Poopó, the Huayllamarca mountain ranges to the northwest and the Pampa Aullagas region to the southwest. Later on, the roads to the Sajama region were taken as a sample reference for the evaluation, considering that these roads are crossing the region in different directions thus forming transects. A stratified sampling work carried out in the vicinity of these roads allowed the identification of 43 archaeological sites.

Among the localized sites, there were some with lithic archaeological assemblages which correspond to the first hunter-gatherers of the Altiplano, although the chronological interpretation of the sites has encountered many problems. The archaeological material is generally mixed on the surface without any sediment present or stratigraphic position that would provide the sequence of artefacts with a proper excavation. On the other hand, the comparisons of the lithic materials, to make comparative-typological dates, were always made concerning distant regions.

Wakolli (**Figs. 2-5.**, B6)

The site of Wakolli (Estancia Huacolli) is located at the small settlement with the same name, which can be accessed by a road from Tomarapi. The site covers approximately one hectare and is located next to an area with an abandoned church, one kilometre to the west of the bed of the Tomarapi River. Although the majority of the material from this place is dated to the colonial period, projectile points from the Archaic period were also collected. The shapes of the collected projectile points are varied, but the majority is oval and elongated forms worked with bifacial retouching made by percussion technique, the triangular forms with a semicircular base, or with a rectangular tongue and the large oviforms with double wings and a central notch. There are many large and small knives obtained by retouching and micro-retouching at the edge of the flakes. This material has characteristics similar to the projectile points of the Archaic Period of northern Chile. Although some of the above-mentioned projectile point forms are similar to those found along the Mauri River, the types of raw materials (black basalt) and the existence of greater variability of artefacts in this region suggest that the Carangas sites correspond to some form of archaic regional development.

Cueva de Tomarapi (**Figs. 2., 5.**, B7)

This site is located in the Sajama region, north of the Tomarapi bridge. It consists of two caves, a large one and a small one; both were used as habitat sites and also served for the execution of mural paintings. A lithic workshop for the production of hoes, knives, arrowheads and other tools made of black basalt was located concerning the larger cave. The ceramics and lithic artefacts found within a radius of 50 m which represent local characteristics of continuous occupation, from a hunter's epoch to the times of Carangas and of Inca occupation.

Jiska Molle Pukara (**Figs. 2-3.**, B8)

It is a lithic workshop located at the foothills of the hill with the same name south of Nevado Sajama, which extends to a plain near the Macaya lagoon. The site presents abundant remains of lithic material worked in black basalt: knives, side-scrapers, hoes, arrowheads and remains of slabs and manufacturing waste: cores, flakes, debitage products, covering an area of about 1 hectare. According to the characteristics of the lithic and ceramic material, it can be said that the site was occupied from the Archaic Period until the Carangas times.

6. Pueblo Sajama

In his doctoral thesis, Adam Birge (2016) dealt with the issue of the so-called Sajama lines in western Bolivia. These are a network of ritual trails that cover an estimated area of 22,000 km^2 and connect forts (pucara), ancient Aymara funerary towers (chullpa), villages and chapels. During his field surveys in the environment of Pueblo Sajama, mainly in the valley of the Tomarapi River, Birge documented 13 lithic artefacts as well. Out of these, he recorded five modified flakes, four ground stones, three preforms, and one core. The most common type of raw material was basalt, but two examples of obsidian and two white chert preforms are also reported. The lithic artefacts distributed across different types of sites. According to Birge, the lithics may be from prehistoric contexts, but cannot be discarded the possibility that they originate from later archaeological contexts. In connection with the site of “Chapel N1”, Birge mentioned, that: “*The site was also the only place where we found possible lithic projectile points*.” (2017, 7).

7. Southwestern Bolivia (Figs. 2., 5., B11-B22)

Cueva Bautista (**Figs. 2., 5.**, B11)

Field survey and excavations were conducted in the Sora River Valley in southwestern Bolivia in 2008 and 2010. It is a small watershed, which is located between San Agustín and Alota, along the southern edge of the Lípez Desert. As a result of the surveys, 17 Archaic Period settlements were documented, of which 11 proved to be caves and rock shelters. Some of these sites include evidence of occupation earlier than 9,500 BP or 10,950 cal BP. In 2008, a 1 m^2 test pit was excavated in Cueva Bautista, situated at 3,932 metres above sea level. The unit was located at the centre of the cave and produced a 1.8 m deep stratigraphic sequence. A charcoal sample from this occupation surface was AMS dated to 10,917±69 BP or 12,684-12,878 cal BP

(AA84158). Lithic artefacts recovered from the Late Pleistocene stratum at Cueva Bautista included five light brown chert flakes, one red jasper flake, one chalcedony flake, five obsidian flakes (one with retouch), and one black basalt flake. Most of the identified lithic raw materials are locally and regionally available, but the closest known obsidian source is Laguna Blanca/Zapaleri, near the Bolivian-Chilean-Argentinean border, and roughly 150 km south of the site (Nielsen 2004; Yacobaccio et al. 2004; Seelenfreund et al. 2010). The research in Cueva Bautista involved excavations of 20 contiguous one-metre units, the first of which was initially excavated as a test pit. The complete recovered lithic assemblage consists of 439 artefacts, some formal tools and debitage products. The majority of the artefacts (384 pcs.) correspond to the Late Pleistocene occupation. Among them, there are three black basalt flakes. Obsidian is the most common raw material, followed by an extremely fine homogenous chert. XRF (X-Ray Fluorescence) analyses were carried out on an obsidian sample. The source of the analysed obsidian is a previously unknown outcrop of Cerro Kaskio (Cerro Kasquiu), located 15 km southwest from Cueva Bautista (Albarracin-Jordan & Capriles 2011; Capriles & Albarracín-Jordan 2013; Capriles et al. 2016; Capriles et al. 2018). The possible provenance of the black basalt was not discussed at all.

South Lípez Province (**Figs. 2., 5.,** B12-B22)

In 1958, an expedition of the University of Cambridge explored the salt lakes of Atacama Desert, in Northern Chile. Besides, field surveys were taken in the environment of the adjacent highland lakes of the Lípez Desert, in Southwestern Bolivia. As a result of these surveys, several preceramic sites were reported mainly from Laguna Colorada (**Figs. 2., 5.,** B21) and Laguna Hedionda (**Figs. 2., 5.,** B17). Among the lithic artefacts collected from the sites, several projectile points were described by Lawrence Barfield (1961). In Barfield's interpretation, the typological similarity, observed between the „Puripica" (Northern Chile; contemporary with „Ayampitín" of the Inti Huasi Cave in Northwestern Argentina) and the assemblage of „Colorada" "give an indication of a long tradition of hunting in the area, but at present can only be tentatively fitted into a cultural or chronological scheme" (Barfield 1961, 96).

Around the shores of the Laguna Hedionda (**Figs. 2., 5.,** B17), five sites were localized, one of them, the earliest one, Site V was a one-period encampment, where numerous flakes and broken „Puripica" type projectile points made on black basalt, scattered near the water's edge, were collected. At the cave site, Site IV, a little excavation was carried out. The lowest deposit of the cave, Layer 12 contained tiny flakes of basalt, refuse from the secondary flaking of stone implements. In the layer above, in Layer 11b, the basalt flakes were accompanied with basalt tools and chips of obsidian and quartz.

Le Paige (1964) carried out explorations in the Atacama Desert of Northern Chile and made some explorations in the Bolivian part of southern Altiplano. He documented sites in the southwestern part of the Province of Potosí. Several artefacts had been collected from the sites of San Agustín (**Figs. 2., 5.,** B15), Laguna Hedionda (**Figs. 2., 5.,** B17), San Pablo de Lípez (**Figs. 2., 5.,** B18), Soniquera (**Figs. 2., 5.,** B19), Quetena Chico (**Figs. 2., 5.,** B20), Laguna Colorada (Figs. 2, 5, B21), Quetena (**Figs. 2., 5.,** B22), and described them as mostly manufactured from black basalt and some local raw materials. According to Le Paige, the occupations in Southwestern Bolivia correspond well with the chronological phases he identified in the different environments of the Atacama Desert.

Jorge Arellano López (1984; 1987) was working in Lípez and reported Archaic settlements near Alota (**Figs. 2., 5.,** B16), San Pablo de Sud Lípez (**Figs. 2., 5.,** B18), Soniquera (**Figs. 2., 5.,** B19), and Quetena (**Figs. 2., 5.,** B22). Without any absolute dates and chronology, he gave a functional interpretation and described three types of located sites: lithic workshops, temporary camps (paraderos) and hunting camps. In general, the lithic workshops were located on top of terraces of rivers. At such lithic workshops, he found that principally two classes of raw material were used for the artefacts: basalt of black colour and devitrified obsidian of olive green colour. Along the rivers of Lípez and Quetena, four further sites were localized. Each of the sites has a close relationship with each other in terms of typology of artefacts (especially projectile points) and of raw material (black basalt, devitrified greenish obsidian, opal and milky quartz). Arellano López interpreted the site of Ichu Pampa as a hunting station. The lithic artefacts range from projectile points of various types to side scrapers, end-scrapers, borers and retouched flakes. However, in the close vicinity of the site, there is no similar raw material source to manufacture these instruments (Arellano López 1987; Capriles & Albarracín-Jordan 2013).

8. Nor Cinti Province in Chuquisaca (Fig. 2., B9-B10)

The region of San Lucas is located in the Nor Cinti Province of the Department of Chuquisaca, which physiographically corresponds to the sub-Andean valleys or torn puna. Within the study region, different formations and geological units are present, consisting mainly of sedimentary rocks such as sandstones, shales, limonites, marls, limestones and claystones. Also, quartz and various types of quartzite are common. Claudia Rivera

Casanovas and Sergio Calla Maldonado (2011) have recently carried out systematic field surveys in the region. In the San Lucas region, a total of 33 sites belonging to the Archaic Period were recorded (8,000-2,000 / 1,500 BC), 14 of them are in the San Lucas valley (**Fig. 2.,** B9) and 19 in the Palacio Tambo (**Fig. 2.,** B10). Among the reported sites, about 58 % were located in the high sierra and 42 % in lower quebradas. In the frame of their work in the valley, they cleaned up a naturally occurring profile in a river cut. For the site of SL79, an AMS date of an unearthed hearth produced the date of 7,041±60 BP (OZK-824) or 7,745-7,925 cal BP. They provided a typology of projectile points and other stone tools that suggests people in the valleys and the highlands shared a similar technological tradition.

The raw materials used in the lithic assemblages were not locally available in the San Lucas valley, while in Palacio Tambo (**Fig. 2.,** Q3) they were immediately accessible. Preferably, the regional raw material was favoured, followed by local ones, basalt and quartzite, respectively, present in geological formations of the region at close and relatively short distances. Other varieties of materials that occur in a lesser proportion in the analyzed sets are flint, chalcedony and milky quartz. Interestingly, despite its immediate availability, quartzite had a smaller impact on the archaeological record of the region, especially in the valley of San Lucas where there is an immense quarry. The reduced exploitation of quartzite contrasts with the high use of basalt in the lithic assemblages. In the case of basalt, the mobility circle for obtaining this raw material pose wider contact dynamics, since obtaining them involves relatively larger distances to travel, especially for the groups of the San Lucas valley. The sources of basalt identified in the region are at distances of 15–20 km within the study area and 40 to 100 km away from it.

The main procurement areas are to the south and the east of the region and can be divided into four sectors. The closest source is in the Palacio Tambo area, where the basalt appears in the bed of the rivers in the form of boulders. The human groups of the San Lucas valley had to travel between 15 and 20 km to access this raw material, while those of Palacio Tambo had it close.

The second area is in the Chiñimayu region (**Fig. 2.,** Q1), where there are sources of basalt from the Cretaceous period. This is 39 km away from the sites located in the northern sector of the San Lucas Valley and 14-17 km away from the sites located in Palacio Tambo. Other far basalt quarries are located in the Caraparí area in the Corral Blanco (**Fig. 2.,** Q6) and Algodonal mountains to the southeast. The distance from Cerro Algodonal to the valley sites is approximately 110 km and 95 km to the sites located in the Palacio Tambo area. The distance from the Corral Blanco hill to the valley is approximately 100 km and up to the sites located in Palacio Tambo is 75 km. X-ray diffraction analysis of the samples has not yet been carried out to obtain the most accurate location of the basalt sources used in the past.

This feature contrasts with data from other sites in this period in which local supply mechanisms were chosen. There is a preference for basalt for the construction of projectile points, perhaps due to certain technical characteristics or a sense of social differentiation between groups and/or individuals. Access to the basalt sources located to the southeast of the region would have been realized by following the courses of major rivers that lead to the Pilcomayo River and the Chaco regions. These routes could also have greater implications on the regional interaction with groups from the foothills of the Chaco region in Argentina.

Basalt as a lithic raw material

In the archaeological literature, the use of names of various types of igneous or volcanic rocks is frequently wrong or inconsequent from a petrological point of view. That is why we should clarify some essential terms in the first place. By the short characterization of basalt, and in general the igneous rocks, we leaned on mainly on the classification scheme of the British Geological Survey (Gillespie & Styles 1999) and the study edited by Le Maitre, R. W. and colleagues (Le Maitre et al. 2005).

According to chemical parameters, igneous rocks can be classified by the Total Alkali-Silica (TAS) classification. The system contain 17 root names, common types of igneous rocks (basalt, basaltic andesite, andesite, dacite, rhyolite, trachybasalt, basaltic trachyandesite, trachyandesite, trachyte, trachydacite, picrobasalt, basanite, tephrite, phonotephrite, tephriphonolite, phonolite and foidite), based upon the relationships between the combined alkali content and the silica content (Le Bas et al. 1986; Le Maitre et al. 2005, 35, Fig. 2.14). The felsitic volcanic rocks contain high silica content, greater than 63 % SiO_2 (for example trachyte and rhyolite), intermediate volcanic rocks are between 52–63 % SiO_2 content (examples are andesite and dacite), and mafic volcanic rocks have low silica (45–52 %) and typically high iron–magnesium content (for example basalt). Certain igneous rocks will be called aphanitic if the rocks are so fine-grained that their rock-forming mineral crystals are not detectable by the naked eye. The geological texture may have been the result of rapid cooling in igneous or shallow subsurface environments. Several common igneous rocks can be aphanitic (examples are andesite, basalt, dacite, rhyolite).

As per the definition of the International Union of Geological Sciences (IUGS) classification scheme, basalt is an aphanatic volcanic rock, with generally 45–53 % silica (SiO_2) (Le Bas & Streckeisen 1991). Basalt commonly features a very fine-grained or glassy matrix interspersed with visible mineral grains. Basalt is usually grey to black, but rapidly weathers to brown or rust-red due to oxidation of its mafic (iron-rich) minerals into hematite and other iron oxides and hydroxides. Basaltic rocks exhibit a wide range of shading because of regional geochemical processes. Due to weathering or high concentrations of plagioclase, some basalt variants can be quite light-coloured, superficially resembling andesite. Basalt has its fine-grained mineral texture due to the molten rock cooling too quickly for large mineral crystals to grow.

As regards the flaking quality of various volcanic rocks, it can be stated that the raw materials for flaked stone tools must fracture conchoidally. Furthermore, they should be elastic, but brittle, and homogeneous both in crystalline structure (amorphous or cryptocrystalline) and in lacking cracks, inclusions or other flaws. The crystalline structure is the most important factor in how easily a given raw material works. The toughest and least amorphous raw materials like basalt and other volcanic rocks are hard to work, and the fracture surfaces are usually rough, with a grainy or sugary texture. The slower the volcanic rocks cooled, the more different minerals sorted out into crystalline formations. For this reason, the flaking qualities are variable, ranging from fairly homogeneous, to coarsely grained, to completely unflakeable. Some basalt variants, in particular, are often porous or vesicular, that is, being pitted with many cavities at its surface and inside. (Whittaker 1994, 66, 69)

Basalt occurrences of the Bolivian Altiplano

The names and terminology applied to different kinds of igneous rocks can be quite confusing for archaeologists. Various terms may refer to rock texture, mineral constituents, or chemical composition. Many names with vague or poorly defined meanings have been applied over the years to the great variety of rocks formed by cooling from magma or lava. That is why, in the literature, concerning the igneous rocks (volcanites) based mainly on classifications made by naked eye view, sometimes incorrect terms can be found. If it is possible, we try to review the known geological availability of several volcanite types, other than basalt.

The Central Volcanic Zone (CVZ) of the Andes is located between latitudes 14° and 29° S of the Andean Cordillera. It is an elevated region, much of it over 4,000 m in altitude (constituting the Altiplano of Bolivia and Puna of northern Chile and Argentina) and forms the western boundary of the Altiplano plateau (de Silva et al 1993; Stern 2004). In CVZ the volumetrically weighted average composition of erupted material is predominantly andesitic in composition, and instances of true basalts (< 52 % SiO_2), are rare. Small volcanic centres containing a wide range of igneous rocks (basalt to dacite types) are distributed sparsely over the Bolivian Altiplano, behind the Andean volcanic front. There are three main areas in which the centres are located (Davidson & da Silva 1992; 1995, 388, Fig. 1b). (1) immediately behind the arc in the region of Nevado Sajama, (2) immediately behind the arc in the region of the volcano Ollagüe, a massive stratovolcano on the border between Bolivia and Chile, and (3) farther to the east in the Altiplano.

(1) The centres near Nevado Sajama are trachybasalts from small cinder cones. It has a composition between trachyte and basalt, or basalt with high alkali content.

(2) The region to the east of the volcano Ollagüe covers a wide area and includes both silicic andesite and dacite flow complexes and trachybasalt cinder cones. The most evolved centres are located in the Pampa Luxsar region just to the north and northwest of Cerro Luxsar, a Pliocene to Pleistocene composite cone.

(3) The minor centres further to the east on the Altiplano define two broad lineaments subparallel to the line of the arc.

The central Altiplano group comprises basaltic trachyandesites to dacite flows that form isolated plugs or mesa-like flows. The age relations of these again suggest Pliocene to Pleistocene time range. Two small maars (broad, low-relief volcanic craters), between Salar de Coipasa and Salar de Uyuni, Jayu Kkota and Nekhe Kkota are much younger and are probably dated to the Holocene. Chiar Kkollu is a small isolated hill formed by an alkali basalt sill. The lava of this tabular sheet intrusion is fine- to medium-grained olivine-porphyritic basalt. Further to the east, a second lineament occurs along the southwestern edge of Lake Poopó. Rocks here vary from basalts to andesites, which are microporphyritic and contaminated (Davidson & da Silva 1992; 1995).

The quarry of Querimita is located on the southwestern shore of Lake Poopó. This is the only major basalt quarry in the Bolivian Altiplano that has been identified. Basalt cores were pre-formed, worked later in sites, mainly for the manufacturing of different basalt implements. Large amounts of debris accumulated outside the quarried areas and still litter the surface of the basalt outcrop. It is a clear indication of intensive exploitation during several periods of Bolivian prehistory. Martín Giesso from the Illinois University in the USA

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employed NAA (neutron activation analysis) on the excavated basalt lithic artefacts at Tiwanaku heartland sites. For the majority of the samples, the analysis proved their provenance from Querimita quarry. However, several samples were not from Querimita, implying that one or two other basalt quarries were in use (Giesso 2011, 142).

Besides the main basalt quarry of Querimita, south to the Lake Poopó, at San Juan Mallku and Santa Bárbara in Quillacas, there are additionally basalt outcrops. Michel López (2008) suggests that Querimita, at a lower degree, San Juan Mallku and Santa Bárbara and the Formative Period site of Casca Kollu were part of a network of extraction quarries and basalt distribution on the south side of Lake Poopó that was also sustained by the main basalt formation.

The following basalt occurrences are very closely linked to the region of Nevado Sajama. In connection with the Neogene magmatism (20.0 to 1.6 Ma) in the Bolivian Andes, Lavenu and colleagues (1989) collected several samples from pyroclastic lava flows. According to the authors in the so-called Mauri Formation, in the Berenguela–Charaña region of the Northwestern Altiplano, basalts and basaltic andesites are common in the lower part, whereas dacitic tuffs and dacitic pumice clasts are dominant in the middle and upper parts. The Abaroa Formation crops out in the same area as the Mauri Formation and consists mainly of dacitic flows. Jiménez and colleagues (1993) mentioned the presence of basalts and andesites, which have SiO_2 content ranging between 46 to 56 %.

In **Fig. 3.**. a location map of Central Bolivia can be seen after Lavenu and colleagues (1989, 36, Fig. 1). A single dot pattern area shows the Oligocene-Miocene sediments, the Mauri and Abaroa Formations. Numbered stars indicate the location of analyzed samples taken from pyroclastic lava flows (1=BO-3, 2=LA80-2, 3=PH43, 4=LA80-6, 5=LA80-4, 6=LA80-5, 7=BO4, 8=LA81-4, 9=PH48, 10=PH75, 11=LA82-2, 12=BO7, 13=LA82-1, 14=PH53a, 15=MB158, 16=MB161, 17=MB159, 18=MB160, 20=MB154, 21=MB153, 22=PHM1, 23=PHM2). Based on the petrographic description, the analyzed samples came from andesite lava flows (4, 6, 7), from basalt lava flow (1), from dacitic lava or ash flows (3, 5, 9, 11, 13, 22), rhyolitic lava or ash flows (8, 10, 14). The central and northwestern Bolivian archaeological sites with basalt utilization are marked as well.

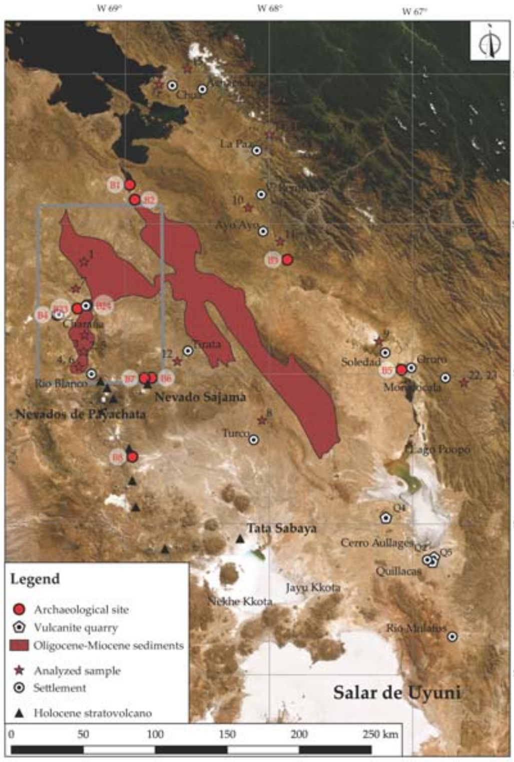

Fig. 3.: Analyzed volcanic samples by Lavenu and colleagues (1989) of Central Bolivia and Archaeological sites with basalt utilization

Analyzed volcanic samples

1=E. Kusima, 2=E. Abaroa, 3=Co. Canasita, 4=E. Kolkhe Uma,5=C. Lupijcala, 6=E. Kolkhe Uma, 7=E. Sacacani, 8=Azurita Mine, 9=Soledad,10=V. Remedios, 11=Ayo Ayo, 12=E. Tirata, 13=Chua, 14=Chuquiaguillo, 15=Achacachi, 16=Cota Cota, 17=La Paz, 18=La Paz, 19=La Paz, 20=Rio Kaluyo, 21=Rio Kaluyo, 22= C. Tankha Tankha, 23= C. Tankha Tankha

Bolivian Archaic Period Archaeological sites with basalt utilization

B1=Irohito, B2=Aguallamaya, B3=Viscachani, B4=Abrigo Clemente, B5=Iroco KCH20, B6=Wakolli, B7=Tomarapi, B8=Jiska Molle Pukara, B23= PAM (Proyecto Arqueológico Mauri) Complex-1, B24= PAM (Proyecto Arqueológico Mauri) Complex-2

3. ábra: A. Lavenu és kollegái (1989) által vizsgált vulkanikus minták Középső-Bolívia területén, és bazalt felhasználás régészeti lelőhelyeken

Irohito (**Fig. 2.,** B1), Aguallamaya (**Fig. 2.,** B2), Viscachani (**Figs. 2-3.,** B3), Abrigo Clemente (**Figs. 2-4.,** B4), Iroco KCH20 (**Fig. 2.,** B5), Wakolli (**Figs. 2., 5.,** B6), Tomarapi (**Figs. 2., 5.,** B7), Jiska Molle Pukara (**Figs. 2., 5.,** B8), PAM (Proyecto Arqueológico Mauri) Complex-1 and Complex-2 (**Figs. 2-4.,** B23-B24).

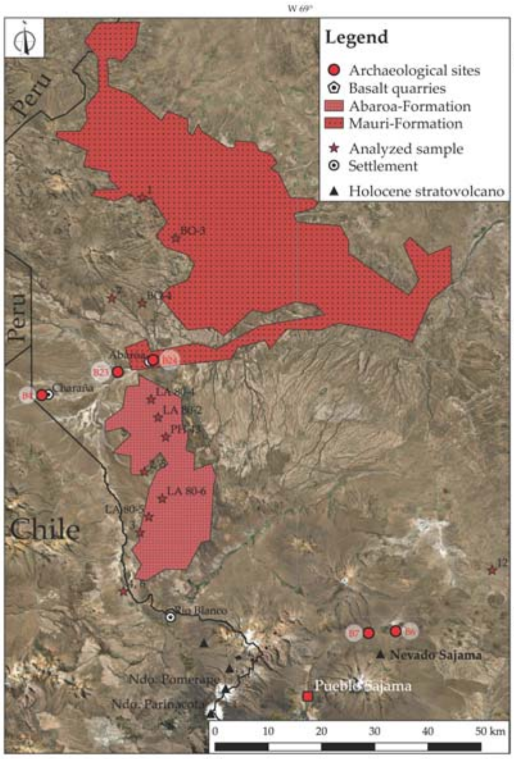

Fig. 4.: Analyzed volcanic samples by Lavenu and colleagues (1989) of the Western Cordillera and its Piedmonts near Charaña and archaeological sites with basalt utilization

Analyzed volcanic samples

BO-3=E. Kusima, BO-4=E. Sacacani , LA-80-2=E. Abaroa, LA-80-4=C. Lupijcala, LA-80-5=E. Kolkhe Uma, LA-80-6=E. Kolkhe Uma, PH43=Co. Canasita

Bolivian Archaic Period Archaeological sites with basalt utilization

B4=Abrigo Clemente, B6=Wakolli, B7=Tomarapi, B23= PAM (Proyecto Arqueológico Mauri) Complex-1, B24= PAM (Proyecto Arqueológico Mauri) Complex-2

4. ábra: Lavenu és kollegái (1989) által vizsgált vulkanikus minták a Nyugati-Kordillerák és azok Charaña közeli hegylábi területén, és bazalt felhasználás régészeti lelőhelyeken

In **Fig. 4.**, a simplified geological map of the Western Cordillera and its foothills near Charaña can be seen (Box 1 in the grey frame, see **Fig. 3**.) after Lavenu and colleagues (1989, 36, Fig. 2). Dot patterns show the Oligocene-Miocene sediments, the Mauri and Abaroa Formations separated. The samples taken by Lavenu and colleagues (1989) and the nearby archaeological sites are represented too. The samples from top to bottom are as follows BO-3 (basalt lava flow), BO-4 (andesite lava flow), LA 80-4 (dacite lava flow), LA 80-2 (basalt dike), PH 43 (amphibolitic dacite lava flow), LA 80-6 (andesite lava flow), LA 80-5 (andesite lava flow).

According to Vanessa Jiménez (2013), at the two PAM (Proyecto Arqueológico Mauri) Complexes (**Figs. 2-4.**, B23-B24) a large variety of igneous rocks can be found, among them andesite, silicified hornblende andesite, basalt, olivine basalt, dacite, silicified dacite, rhyolite, trachyte, trachyandesite. As mentioned above, in the raw material utilization these volcanites are dominant.

Fig. 5. shows the physiographic-geologic map of the Nevados de Payachata volcanic group and the surrounding area after the paper, of Wörner and colleagues (1988). In this paper, the authors had dealt with the subduction-related volcanism in the Nevados de Payachata region of the Central Andes. This region comprises two temporally and geochemically distinct phases. An older period of magmatism is represented by glaciated stratocones and ignimbrite sheets of Late Miocene age. The Pleistocene to recent phase (≤ 0.3 Ma) includes the twin stratovolcanoes Volcan Pomerape and Volcan Parinacota (the Nevados de Payachata volcanic group) and two small centres to the west (i.e. Caquena). The two Nevados de Payachata stratovolcanoes display continuous major- and trace-element trends from high-K_2O basaltic andesites to rhyolites (53-76 % SiO_2) that are well defined and distinct from those of the older volcanic centres.

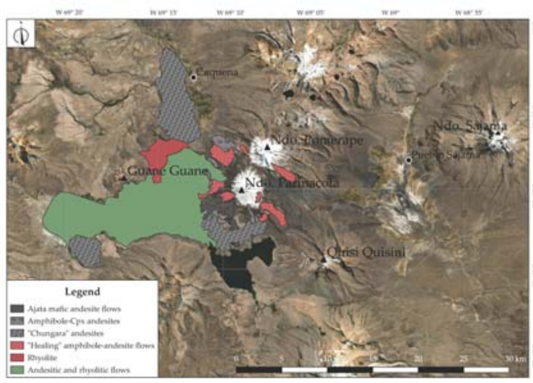

Fig. 5.: Physiographic-geologic map of the Nevados de Payachata volcanic group and the surrounding area after G. Wörner and colleagues (1988, 291, Fig. 4.). The older Ajata flows are plagioclase-porphyritic, mafic, andesite flows, and the youngest flows are distinctly olivine-rich clinopyroxene-bearing basaltic andesites. West to the Nevado Pomerape, there are amphibole-clinopyroxene andesite flows. The „Chungara" andesites are monotonous hornblende andesites. The „Healing" flows are amphibole-andesite flows. The different andesitic and rhyolitic flows contain the following debris flow: amphibole andesite, basaltic andesite, clinopyroxene andesite, microporphyritic andesite, plagioclase andesite, rhyolite.

5. ábra: A Nevados de Payachata vulkanikus csoport és környékének fizikai-földrajzi−geológiai térképe Wörner és kollegái (1988, 291, Fig. 4) nyomán.

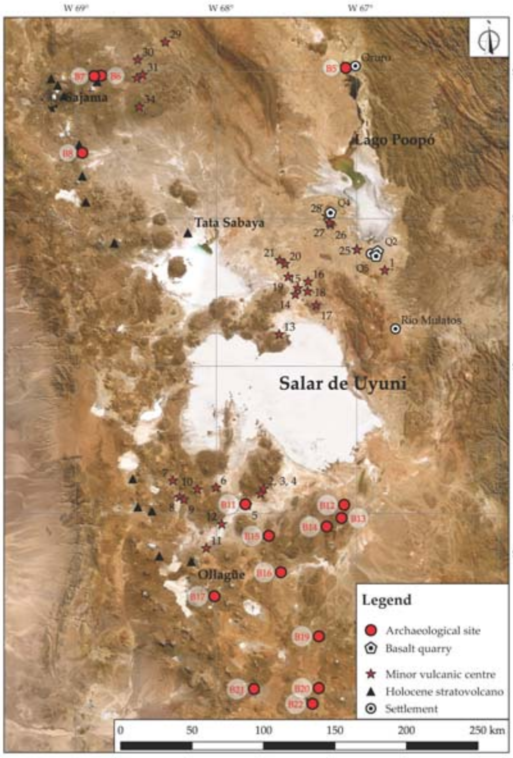

Fig. 6.: Holocene stratovolcanoes and minor volcanic centres after Davidson & de Silva (1995) and archaeological sites with basalt utilization.

Minor volcanic centres

Southern Bolivian Altiplano: 2=Lomas Uchimilles, 3-12; Central Bolivian Altiplano: 13=Cerro Jata, 14=Nekhe Kkota, 15=Jayu Kkota, 16=Chiar Kkollu, 17-20, 21=Cerro San Martín/Cerro Vili Vili); Eastern Bolivian Altiplano: 1=Cerro Gordo, 22-24=Quillacas, 25=Cerro Aullagas, 26-28).

Bolivian Archaic Period Archaeological sites with basalt utilization

B5=Iroco KCH20, B6=Wakolli, B7=Tomarapi, B8=Jiska Molle Pukara, B11=Cueva Bautista, B12=San Cristóbal SC-03, B13=San Cristóbal SC-02, B14= San Cristóbal SC-01, B15=San Agustín, B16=Alota, B17=Laguna Hedionda, B19=Soniquera

6. ábra: Holocén sztratovulkánok és kisebb vulkanikus központok Davidson és de Silva (1995) nyomán, és bazalt felhasználás régészeti lelőhelyeken

In **Fig. 6.,** some Bolivian archaeological sites with basalt utilization and the Holocene stratovolcanoes and minor basalt centres can be seen (after Davidson & de Silva 1992; 1995, 388, Fig. 1b). Sample numbers match analyses in Tables but have the prefix BC90- omitted. The three groups of centres from the Altiplano are subdivided into a southern (samples 2 to 12), central (samples 13 to 21) and eastern (samples 1 and 22 to 28) group. The most typical volcanic rock occurrences are the following: andesite (1=Cerro Gordo, 2-4=Lomas Uchimilles, 6, 21=Cerro San Martín/Cerro Vili Vili, 25=Cerro Aulalgas), basalt (5, 16=Chiar Kkollu, 21=Cerro San Martín/Cerro Vili Vili). Basaltic trachyandesite to dacite rocks are present at Nekhe Kkota (14) and Jayu Kkota (15).

It is obvious that at some southwestern Bolivian sites (e.g. Alota (**Figs. 2., 5.,** B16), Cueva Bautista (Figs. 2, 5, B11), Laguna Hedionda (Figs. 2, 5, B17), San Agustín (Figs. 2, 5, B15)) and at the three San Cristóbal sites (**Figs. 2., 5.,** B12-14) the raw material named basalt can be regarded as local or at the most regional raw material.

Discussion

In the following, we will summarize the gathered information on basalt utilization in the study area. Our remarks can only be based on a geographic comparison of geological maps with archaeological sites. Without making such comparison, we cannot understand the raw material procurement strategy of the Archaic Period hunter-gatherers. The vicinity, the easy availability or the remoteness of the raw material sources have great significance in lithic analysis. The distinction between curated and expedient technologies was developed by R. L. Binford (1979, 1980). The curation is a strategy of caring for tools and toolkits that can include advanced manufacture, transport, reshaping, and caching or storage. On the other hand, expediency refers to the minimized technological effort under conditions where time and place of use are highly predictable. Nora Franco (2012, 85) stated simply that curated tools were those made in one place, used in another, and discarded in yet another place. On the contrary, expedient tools were those made quickly, used, and discarded in one place. Curation anticipates the need for materials and tools at "use locations", expediency anticipates the presence of sufficient materials and time (Nelson 1991, 62-64). In addition to the concepts described by Binford, Nelson (1991, 62) added the opportunistic behaviour. However, she contrasted this opportunistic, unplanned technological behaviour with expediency. The opportunistic behaviour is a response to immediate, unanticipated conditions. It is very likely that in the case of locally available raw materials of relatively low flaking quality, such as quartzite and the most volcanic rocks as well, an opportunistic behaviour can be assumed. Only a detailed lithic analysis made on a complete lithic assemblage, containing not only manufactured tools but debitage products as well, can imply the nature of the used technological behaviour.

Concerning the Bolivian archaeological sites, except for the sites B10 (Palacio Tambo), B17 (San Lucas) in the San Lucas Valley and the PAM Complexes (B23-B24), we have only macroscopic evidence, the geological source of the basalt raw material is mostly unknown.

At the site of Aguallamaya (**Fig. 2.,** B2) in the southern part of the Lake Titicaca basin, a projectile point of grey basalt was reported (Pérez 2006, 22, Fig. 8, A-01). A particular kind of volcanic rock, the olivine basalt, exotic to the southern Titicaca Basin, comes from geological outcroppings near Incatunahuari, just north of the town of Chucuito, south of Puno (southeastern Peru). This olivine basalt is a fine-textured, homogeneous grey rock including frequent yellow or white olivine phenocrysts. Overall, it presents a very distinctive appearance. It differs from the more common andesite, which has a very similar colour but contains frequent plagioclase feldspar inclusions as well as biotite and is generally more porous and coarse-grained. Feldspar is not present in the olivine basalt. M. S. Bandy made the assumption (2001, 142) that the "grey andesite" reported by Seddon, which makes up upwards of 90 % of the lithic sample at the Formative site of Tumatumani (southern Peru) (Stanish et al. 1994, 70), is possibly olivine basalt. Despite the distance of about 150 kilometres between the source of the olivine basalt and the site of Aguallamaya, it is very likely that there at the site the same raw material is present.

In connection with the largest and richest site of Viscachani (**Figs. 2-3.,** B3) Lizarraga-Mehringer (2004) emphasizes the fact, that the exact origin of most raw materials, among them the igneous rocks, such as basalt and trachyte is unknown. As for the basalt, it is surprising that the Querimita basalt quarry as a possible source was not mentioned, although the existence of this basalt quarry had been noticed formerly by Ponce and Mogrovejo (1970). Both from typological and raw material utilization point of view, the lithic assemblage of Viscachani suggest distant cultural connections. Owing to this fact, it cannot be excluded the possibility that despite the significant distance from the site (ca. 205-210 km), the basalt quarry of Querimita is the geological source of the utilized basalt. Lizarraga-Mehringer (2004, 77) mentioned also the present of grey basalt. The distance between the site and the above-mentioned geological source of olivine basalt at Incatunahuari is about 260 kilometres.

At the site of Iroco KCH20 (**Fig. 2.,** B5), the evidence, that most stone tools were manufactured on non-local raw materials (chalcedony and various kinds of chert), suggests high seasonal mobility. Regarding basalt, as a supposed source, the quarry of Querimita was given.

For all the remaining sites, both in Northwestern Bolivia, in the surroundings of Nevado Sajama, and Southwestern Bolivia (except for the site of Cueva Bautista (**Figs. 2., 5.,** B11)), no suggestion had been made in the available literature concerning the provenance of the utilized raw materials, among others the basalt.

In the case of the sites of Iroco KCH20 (**Fig. 2.,** B5) and Viscachani (**Figs. 2-3.,** B3), the paper of Lavenu and colleagues (1989) yielded supplementary information about the possible provenance of the basalt. Besides an assumed origin from the Querimita quarry at Lake Poopó, the possibility of incidental local origin should be taken into consideration. The site of Iroco KCH20 (**Fig. 2.,** B5) is situated between the Soledad area and the Morococala volcanic field. The former is a complex volcanic structure which is surrounded by lacustrine detrital deposits of supposed Pliocene-Pleistocene age. The Soledad crater has erupted dacitic material (Redwood 1987; Monrroy et al. 1994). The latter is a volcanic field, which is formed by ignimbrites and associated volcanic features. The rocks of Morococala are dominantly dacite and rhyodacite (Ericksen et al. 1987; Morgan et al. 1998). Next to the site of Viscachani (**Figs. 2-3.,** B3), in the Ayo Ayo and Villa Remedios area, dacitic ash flows are known (Hoffstetter et al. 1971; Lavenu et al. 1989, 40, 42).

Conclusion

In this short paper, based on the available literature, we gathered the facts about the occurrence of basalt and volcanic rocks and their use in several archaeological sites during the Archaic Period of the Bolivian Altiplano. The present paper can be considered as a sketchy summary, instead of being an archaeological evaluation of the sites. However, we would like to make some closing remarks about the use of lithic raw materials at the sites and the typological characteristics of the lithic assemblages that highlight the regional issues of the Archaic Period.

Concerning the use of raw materials, it is important to emphasize the fact that in some of the lithic assemblages of archaeologically significant sites (e.g. Viscachani, Iroco KCH20, Cueva Bautista), raw materials from 100 to 200 km are often used.

Among the typological features, it is necessary to mention the presence of the so-called Patapatane type leaf-points which can be found at Iroco KCH20 and Wiscachcalca sites. Wiscachcalca is a wetland (bofedal) located northwest of Patokho, a small settlement located on the slopes of the Nevado Sajama volcano (Marcos Michel 2000). The landscape of Wiscachcalca has several rocky outcrops in the form of small hills, and one of them represented an important find. A projectile point was located at the lower part of a hill, which was discarded during elaboration. It has a triangular form, stemmed with shoulders, made of volcanic quartz, and being similar to those ones associated to the „Patapatane" (Osorio et al. 2017a; 2017b) and „Tojo Tojone" (Dauelsberg 1983; Osorio 2013; Osorio et al. 2016) phases in Northern Chile, which are dated by radiocarbon method ranging from 9,500 to 6,000 BP.

Around 9,500 BP hunter-gatherers began to employ more regularized settlement patterns, connected mainly to high altitude environments, at the same time they abandoned the earlier pattern of high environmental mobility. These events have been separated as a late phase within the Early Archaic Period, which we have called "Patapatane", placed chronologically between 9,500 and 8,000 BP. During the initial episodes of this phase, the manufacturing of triangular-shaped projectile points continued, at the same time the classic lanceolate form that later became popular appeared. The Patapatane projectile point is a strong indicator of a highly specialized bifacial and curator technology (Santoro & Núñez 1987; Santoro 1989, 40-46; Klink & Aldenderfer 2005, 32-33). It should seem that this particular type of projectile point persisted for most of the early Holocene, suggesting some form of stability over time. „Retaining a similar design of projectile points might relate to information transmission within a common cultural background, and consequently serve as an identity marker that the earliest hunter-gatherer groups shared throughout most of the south-central Andes during the late Pleistocene to early Holocene" (Osorio et al. 2017a, 9).

According to Santoro (1989, 52, 64-65), the style of particular artefacts can serve as archaeological evidence for an assumed existence of social identity over wide areas. For instance, the rhomboidal points at Toquepala, Caru and Patapatane (all three sites are situated in pre-cordilleran valleys of Northern Chile) seem to be a specific form in the Early Archaic Period. At the same time, the rhomboidal points, some with side barbs from Tiliviche in Northern Chile (Nuñez 1980, Lámina 4-6.), which resembles those at Caru and Patapatane may indicate some kind of interaction between highland and lowland groups. The use of long-distance lithic raw materials, indicating distinct cultural connections and the obvious resemblance of projectile points gives a larger dimension to the sharing of technological know-how, subsistence strategy, settlement organization, and other cultural patterns of these early highland hunter-gatherer groups.

References

ALBARRACIN-JORDAN, J., CAPRILES, J.M. (2011): The Paleoamerican occupation of Cueva Bautista: Late Pleistocene human evidence from the Bolivian Highlands. *Current Research in the Pleistocene* **28** 95–98.

ALDENDERFER, M.S. (2009): Key Research themes in the South-Central Andean Archaic. In: MARCUS, J., WILLIAMS, P.R. eds., *Andean Civilization: a Tribute to Michael E. Moseley*. Cotsen Institute of Archaeology, University of California, Los Angeles, 75–88.

ARELLANO LÓPEZ, J. (1984): Comunicación preliminar sobre asentamientos precerámicos en el sur de Bolivia. *Estudios Atacameños* **57** 85–92.

ARELLANO LÓPEZ, J. (1987): Primeras Evidencias sobre el Paleoindio en Bolivia. *Estudios Atacameños* **8** 186–197.

ARELLANO LÓPEZ, J., KULJIS MERUVIA, D. (1986): Antecedentes preliminares de las investigaciones arqueológicas en la zona Circumtitikaka de Bolivia, sector (occidental sur). En: *Prehistóricas*. **Vol. 1.** Universidad de San Andrés. La Paz, 9–28.

ARNADE, Ch. W., McFARREN, P. J. (2019): Bolivia. Encyclopædia Britannica. https://www.britannica.com/place/Bolivia

BANDY, M. S. (2001): *Population and History in the Ancient Titicaca Basin*. PhD dissertation, Department of Anthropology, University of California Berkeley. pp. 1–374.

BARFIELD, L. (1961): Recent discoveries in the Atacama Desert and the Bolivian Altiplano. American. *Antiquity* **27/1** 93–100.

BINFORD, R. L. (1979): Organization and formation processes: Looking at curated technologies. *Journal of Anthropological Research* **35** 255–273.

BINFORD, R. L. (1980): Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity* **45** 4–20.

BIRGE, A. (2016): *Ritualized Memory and Landscape at Pueblo Sajama, Bolivia: A Study of a Sacred Landscape and Colonial Encounter* (MA Thesis). The University of Texas at San Antonio. pp. 1–149.

BIRGE, A. (2017): Mapping Lines and Lives at the Sajama Lines, Bolivia: A Model for Ritualized Landscapes. *Paper presented at the 82nd Annual Meeting of the SAA in Vancouver, BC,* March 29th-April 2nd.

CAPRILES, J. M., CALLA MALDONADO, S., ALBARRACIN-JORDAN, J. (2011): Tecnología Lítica y Estrategias de Subsistencia durante los Períodos Arcaico y Formativo en el Altiplano Central, Bolivia. Chungara, *Revista de Antropología Chilena* **43** 455–468.

CAPRILES, J. M., ALBARRACIN-JORDAN, J. (2013): The earliest human occupations in Bolivia: A review of the archaeological evidence. *Quaternary International* **301** 46–59.

CAPRILES, J.M., ALBARRACIN-JORDAN, J., LOMBARDO, U., OSORIO, D., HERRERA, K.

A., MALEY, B., GOLDSTEIN, S. T., DOMIC, A. I., GLASCOCK, M. D., VEIT, H., SANTORO, C. M. (2016): High-altitude adaptation and late Pleistocene foraging in the Bolivian Andes. *Journal of Archaeological Science: Reports* **6** 463–474.

CAPRILES, J. M., ALBARRACIN-JORDAN, J., BIRD, D. W., GOLDSTEIN, S. T., JARPA, G. M., CALLA MALDONADO, S., SANTORO, C. M. (2017): Mobility, subsistence, and technological strategies of early Holocene hunter-gatherers in the Bolivian Altiplano. *Quaternary International* xxx 1–16. (Article in press.)

CAPRILES, J. M., TRIPCEVICH, N., NIELSEN, A. E., GLASCOCK, M. D., ALBARRACÍN-JORDAN, J., SANTORO, C. (2018): Late Pleistocene Lithic Procurement and Geochemical Characterization of the Cerro Kaskio Obsidian Source in South–western Bolivia. *Archaeometry* **59** 815–833.

DAUELSBERG, P. (1983): Tojo-Tojone: un paradero de cazadores arcaicos (características y secuencias). Chungara, *Revista de Antropología Chilena* **11** 11–30.

DAVIDSON, J. P., De SILVA, S. L. (1992): Volcanic rocks from the Bolivian Altiplano: Insights into crustal structure, contamination, and magma genesis in the central Andes, *Geology* **20** 1127–1130.

DAVIDSON, J. P., De SILVA, S. L. (1995): Late Cenozoic magmatism of the Bolivian Altiplano. *Contributions to Mineralogy and Petrology* **119** 387–408.

De SILVA, S. L., DAVIDSON, J. P., CROUDACE, I. W., ESCOBAR, A. (1993): Volcanological and petrological evolution of Volcan Tata Sabaya, SW Bolivia. *Journal of Volcanology and Geothermal Research* **55** 305–335.

ERICKSEN G. E., SMITH R. L., LUEDKE R. G., FLORES M., ESPINOSA A., URQUIDI B. F., SARAVIA F. (1985): Preliminary geochemical study of ash-flow tuffs in the Morococala and Los Frailes volcanic fields, central Bolivian tin belt. Department of the Interior U.S. Geological Survey. Open-File Report 85–258, 1–8.

FRANCO, N. V. (2012): Binford and ethnoarchaeology, a view from the south. Reflections on his contributions to hunter-gatherer archaeology and lithic analysis. *Ethnoarchaeology. Journal of Archaeological, Ethnographic, and Experimental Studies* **4/1** 79–99.

GIESSO, M. (2003): Stone tool production in the Tiwanaku heartland. In: KOLATA, A.L. (ed.), *Tiwanaku and its Hinterland: Archaeology and Paleoecology of an Andean Civilization* **Vol. 2** Urban and Rural Archaeology. Smithsonian Institution Press, Washington, D.C, 363–383.

GIESSO, M. (2011): La producción de instrumental lítico en Tiwanaku (Stone tool production in the Tiwanaku) El impacto del surgimiento y expansión del estado en las unidades domésticas locales (The impact of state emergence and expansion on local households). *BAR International Series* **2244** pp. 1–274.

GILLESPIE, M. R., STYLES, M. T. (1999): BGS Rock Classification Scheme. Volume 1: *Classification of Igneous Rocks. British Geological Survey Research Report,* (2nd edition) RR99-06, British Geological Survey Keyworth, Nottingham, UK, pp. 1–52.

HOFFSTETTER R., MARTINEZ, C., MUNOZ-REYES J., TOMASI, P. (1971): Le gisement d'Ayo Ayo (Bolivie), une succession stratigraphique Pliocène-Pléistocène datée par des mammifères. *Comptes Rendus de l'Académie des Sciences. Série D: Sciences Naturelles* **273/25** 2472–2475.

JIMÉNEZ, V. (2013): *La Movilidad de los Cazadores-Recolectores en el Valle de Markanasa durante el Período Arcaico (7700-3200 AP).* Licenciatura thesis, Universidad Mayor de San Andrés, La Paz. pp. 1–315.

JIMÉNEZ, N., BARRERA, L., FLORES, O., LIZECA, J. L., MURILLO, S., SANJINÉS, O., HARDYMAN, R. F., TOSDAL, R. M., WALLACE, A. R. (1993): Magmatic evolution of the Berengüela-Charaña region, northwestern Altiplano, Bolivia, In *2nd International Symposium on Andean Geodynamics,* Paris, Extended abstract, 377–380.

JULIEN M., PATRICK, V., LAVALLÉE, D. (1987): Armes et outils emmanchés? Telarmachay. Présomptions et indices. In: La Main et l'Outil. Manches et emmanchements préhistoriques. Table Ronde C.N.R.S. tenue â Lyon du 26 au 29 novembre 1984, sous la direction de D. Stordeur. Lyon: maison de l'Orient et de la Méditerranée Jean Pouillox, 1987. *Travaux de la Maison de l'Orient* **15** 287–295.

KLINK, C., ALDENDERFER, M. S. (2005): A Projectile Point Chronology for the South Central Andean Highlands. In: C. STANISH, A. E. COHEN AND M. S. ALDENDERFER, eds., *Advances in Titicaca Basin Archaeology*, Los Angeles California: Costen Institute of Archaeology 25–54.

LAVENU, A., BONHOMME, M. G., VATIN-PERIGNON, N., DE PACHTERE, P. (1989): Neogene magmatism in the Bolivian Andes between 16°S and 18°S: Stratigraphy and K/Ar geochronology. *Journal of South American Earth Sciences* **2** 35–47.

Le BAS, M. J., LE MAITRE, R. W., STRECKEISEN, A., ZANETTIN, B. (1986): A chemical classification of volcanic rocks based on the total alkali–silica diagram. *Journal of Petrology* **27** 745–750.

Le BAS, M. J., STRECKEISEN, A. L. (1991): The IUGS systematics of igneous rocks, *Journal of the Geological Society* **148** 825–833.

Le MAITRE, R. W., STRECKEISEN, A., ZANETTIN, B., LE BAS, M. J., BONIN, B., BATEMAN, P. (2005): *Igneous Rocks: A Classification and Glossary of Terms.* Recommendations of the International Union of Geological Sciences Subcommission on the Systematics of Igneous Rocks, 2nd Edition, Cambridge University Press, UK. pp. 1–256.

LE PAIGE, G. (1964): El Precerámico en la Cordillera Atacameña y los Cementerios del Período Agroalfarero de San Pedro de Atacama. *Anales de la Universidad del Norte* **3** 1–93.

LIZARRAGA-MEHRINGER, Y. (2004): *Viscachani y el Precerámico de Bolivia.* Ph.D. Dissertation, University of Cologne, Cologne. Tomo 1 (Texto), pp. 1–493; Tomo 2 (Illustraciones), pp. 1–130.

MICHEL, M. (2000): *El Señorio prehispánico de Carangas.* Diplomado Superior en derechos de los Pueblos Indígenas, Universidad de la Cordillera. pp. 1–95.

MICHEL LÓPEZ, M.R. (2008): *Patrones de Asentamiento Precolombino del Altiplano Boliviano. Lugares Centrales en la Región de Quillacas,* Departamento de Oruro, Bolivia. Ph.D. Dissertation, Uppsala University, Uppsala. pp. 1–225.

MISS (2016): “Manejo integral de la sub-cuenca Sajama”. Gobierno Autónomo del Departamento de Oruro. 1–259.

MONRROY I., GORINOVA E., ALARCON H., FORNARI M., SOLER, P. (1994). Geologia y petrografia de la zona de Esquentaque-La Joya. In: *Memorias del 11 congreso geologico de Bolivia.* Santa Cruz (BOL), 1994/10/6-9. La Paz, SGB 330–339.

MORGAN, G. B., LONDON, D., LUEDKE, R. G. (1998): Petrochemistry of Late Miocene Peraluminous Silicic Volcanic Rocks from the Morococala Feld, Bolivia. *Journal of Petrology* **39** 601–632.

NELSON, M. C. (1991): The study of technological organization. *Archaeological Method and Theory* **3** 57–100.

NIELSEN, A. E. (2004): Aproximación a la Arqueología de la Frontera Tripartita Bolivia-Chile-Argentina. Chungara, *Revista de Antropología Chilena* **36/2** 861–878.

NUÑEZ, L. (1980): Cazadores tempranos en los Anbdes Meridionales. Evaluación cronológica de las industrias líticas del norte de Chile. *Boletín de Antropología Americana* **2** 87–120.

OSORIO, D. (2013): *Reevaluación del Arcaico Temprano de la Puna Seca: (~12.000 años cal. AP-9.000 años cal. AP).* Implicancias para el Poblamiento Inicial del Altiplano del Norte Grande de Chile. Universidad de Chile, pp. 1–235.

OSORIO, D., JACKSON, D., UGALDE, P.C., LATORRE, C., DE POL-HOLZ, R., SANTORO, C.M. (2011): Hakenasa Cave and its relevance for the peopling of the southern Andean Altiplano. *Antiquity* **85** 1194–1208.

OSORIO, D., SEPÚLVEDA, M., CASTILLO, C., CORVALÁN, M. (2016): Análisis lítico y funcionalidad de sitios de los aleros de la Precordillera de Arica (Centro-Sur Andino) durante el período Arcaico (ca. 10.000-3700 años a.p.). *Intersecciones en Antropología* **17** 77–90..

OSORIO, D., CAPRILES, J. M., UGALDE, P. C., HERRERA, K. A., SEPÚLVEDA, M., GAYO, E. M. LATORRE, C., JACKSON, D., DE POL-HOLZ, R., SANTORO, C. M. (2017a): Hunter-Gatherer Mobility Strategies in the High Andes of NorthernChile during the Late Pleistocene-Early Holocene Transition (ca. 11,500–9500 cal b.p.), *Journal of Field Archaeology* **42** 228-240 http://dx.doi.org/10.1080/00934690.2017.1322874

OSORIO, D., STEELE, J., SEPÚLVEDA, M., GAYO, E. M., CAPRILES, J. M., HERRERA, K. A., UGALDE, P. C., DE POL-HOLZ, R., LATORRE, C., SANTORO, C. M. (2017b): The Dry Puna as an ecological megapatch and the peopling of South America: Technology, mobility, and the development of a late Pleistocene/early Holocene Andean hunter-gatherer tradition in northern Chile. *Quaternary International* **461** 41–53.

PATTERSON, T.C., HEIZER, R.F. (1965): A preceramic stone tool collection from Viscachani, Bolivia. *Ñawpa Pacha* **3** 107–115.

PÉNTEK, A., SÁGI, T., SZAKMÁNY, Gy., FARAGÓ, N.: A lithic assemblage from Pueblo Sajama (Oruro Department, Bolivia). (Manuscript in preparation)

PÉREZ, A. E. (2005): *Autonomía y Dinámica Social en los Andes: Proceso y Desarrollo en Irohito, Bolivia*. Tesis de Licenciatura inédita. Carrera de Arqueología, Universidad Mayor de San Andrés, La Paz. pp. 1–228.

PÉREZ, A. E. (2006): Desarrollo e interacción en el Periodo Arcaico: Una comparación tipológica en la

Cuenca del Río Desaguadero y el Altiplano Sur. Memorias del primer simposio sobre tecnología lítica en el area Centro Sur Andina. Universidad Mayor de San Andres, Producciones CIMA. pp. 1–38.

PONCE SANGINÉS, C., MOGROVEJO T. G. (1970): *Acerca de la Procedencia del Material Lítico de los Monumentos de Tiwanaku. Examen Arqueológico.* Tomo II. La Paz: Academia Nacional de Ciencias de Bolivia, Publ. no. **21**. 11–188.

PRATES, L., POLITIS, G., STEELE, J. (2013): Radiocarbon chronology of the early human occupations of Argentina. *Quaternary International* **301** 104–122.

REDWOOD, S. D. (1987): The Soledad caldera, Bolivia: a Miocene caldera with associated epithermal Au-Ag-Cu-Pb-Zn mineralization. *Geological Society of America Bulletin* **99** 395–404.

RIVERA CASANOVAS, C., CALLA MALDONADO, S. (2011): Cazadores recolectores del periodo Arcaico en los valles y serranías de la región de San Lucas, Chuquisaca, Bolivia – Hunter Gatherers of the Archaic Period in the Valleys and Mountains of San Lucas, Chuquisaca, Bolivia. Chungara, *Revista de Antropología Chilena*, **43/1** 433–454.

SANTORO, C. M. (1989): Antiguos Cazadores de la Puna (9000–6000 A.C.). In: J. HIDALGO, V. SCHIAPPACASSE, H. NIEMEYER, C. ALDUNATE, AND I. SOLIMANO eds., *Culturas de Chile. Prehistoria, Desde sus Orígenes Hasta los Albores de la Conquista*, Santiago: Editorial Andrés Bello 33–55.

SANTORO, C. M., NÚÑEZ, L. (1987): Hunters of the Dry Puna and Salt Puna in Northern Chile. *Andean Past* **1** 57–110.

SEELENFREUND, A., PINO, M., GLASCOCK, M.D., SINCLAIRE, C., MIRANDA, P., PASTEN, D., CANCINO, S., DINATOR, M.I., MORALES, J.R. (2010): Morphological and geochemical analysis of the Laguna Blanca/Zapaleri Obsidian source in the Atacama Puna. *Geoarchaeology* **25** 245–263.

STANISH, C., STEADMAN, L., SEDDON, M. T. (1994): Archaeological Research at Tumatumani, Juli, Peru. C. Stanish and L. Steadman, eds., *Fieldiana Anthropology* New Series **23**, Chicago: Field Museum of Natural History. 1–111.

STERN, Ch. R. (2004): Active Andean volcanism: its geologic and tectonic setting. *Revista Geológica de Chile* **31/2** 161–206.

WHITTAKER, J. (1994): *Flintknapping: Making and Understanding Stone Tools*. University of Texas Press, Austin. pp. 1–341.

WÖRNER, G., DAVIDSON, J., MOORBATH, S., TURNER, T.L., MCMILLAN, N., NYE, C., LÓPEZ-ESCOBAR, L., MORENO, H. (1988): The Nevados de Payachata Volcanic Region 18°S/69°W, Northern Chile. I. Geological, geochemical and isotopic observations. *Bulletin of Volcanology* **30** 287–303.

YACOBACCIO, H. D., ESCOLA, P. S., PEREYRA, F. X., LAZZARI, M., M. D. GLASCOCK (2004): Quest for Ancient Routes: Obsidian Sourcing Research in Northwestern Argentina. *Journal of Archaeological Science* **31/2** 193–204.