AGRICULTURAL STONE IMPLEMENTS FROM THE PARIA BASIN (ORURO DEPARTMENT, BOLIVIA)•

MEZŐGAZDASÁGI KŐESZKÖZÖK A PARIA MEDENCE TERÜLETÉRŐL (BOLÍVIA, ORURO MEGYE)

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"We can expect many such tool-design parallels, that is tools of very different design being used for identical tasks; but this is not to say that they are functionally isomorphic since they are clearly designed for very different intended roles within the technology"
(Binford, L. R. 1979. Organization and formation processes: Looking at curated technologies).

Abstract

During the field research initiated by the Paria Archaeological Project (PAP) in 2004 in the area of the Paria Basin (Oruro Dept., Bolivia), and then during the excavation in the municipality of Paria, several agricultural stone tools were discovered. Their raw material is partly volcanic rock and partly sandstone. The stone tools have not yet been described in more detail. In the present article, from the whole set of artefacts 22 stone tools classified into different archaeological periods will be presented. As the area of the Paria Basin itself is less researched and there are relatively few publications on the topic, the amount of information gathered during the processing of the finds will also be outlined. The review also includes a brief discussion of the potential geological sources of raw materials for stone tools.

Kivonat

A Paria Régészeti Projekt keretében 2004-ben a Paria medence (Bolívia, Oruro megye) területén kezdeményezett terepkutatások során, majd a Paria településen lefolytatott ásatáson számos mezőgazdasági kőeszköz került elő. Ezek nyersanyaga részben vulkáni kőzet, részben homokkő. A kőeszközök részletesebb ismertetése még nem történt meg. Jelen cikkben a teljes leletegyüttesből, különböző régészeti korszakokba sorolható, 22 darab kőeszköz kerül bemutatásra. Miután maga a terület kevésbé kutatott és a témáról viszonylag kevés a rendelkezésre álló publikáció, ezért a leletek feldolgozása során gyűjtött információmennyiség is vázlatos ismertetésre kerül. Ugyancsak vázlatosan ismertetjük a kőeszközök nyersanyagainak potenciális geológiai forrását is.

KEYWORDS: BOLIVIA, AGRICULTURAL STONE IMPLEMENTS, VOLCANIC ROCK, SANDSTONE

KULCSSZAVAK: BOLÍVIA, MEZŐGAZDASÁGI KŐESZKÖZÖK, VULKÁNI KŐZET, HOMOKKŐ

The Paria Basin and its archaeological background

The Paria Archaeological Project (PAP) started in 2004 with the primary goal to identify every archaeological site with surface remains to better understand the pre-Hispanic settlement patterns and diachronic changes of the Paria Basin. Another equally important objective of the research was the secure identification of Paria, the one-time Inca provincial centre and to learn more about the role of Paria in the region's life and its connection with the Cochabamba Valley as well as about the other similar provincial centres and their

• How to cite this paper: PÉNTEK, A.; GYARMATI, J., (2022): Agricultural stone implements from the Paria Basin (Oruro Department, Bolivia), *Archeometriai Műhely* **XIX/3** 233–266.
doi: 10.55023/issn.1786-271X.2022-017

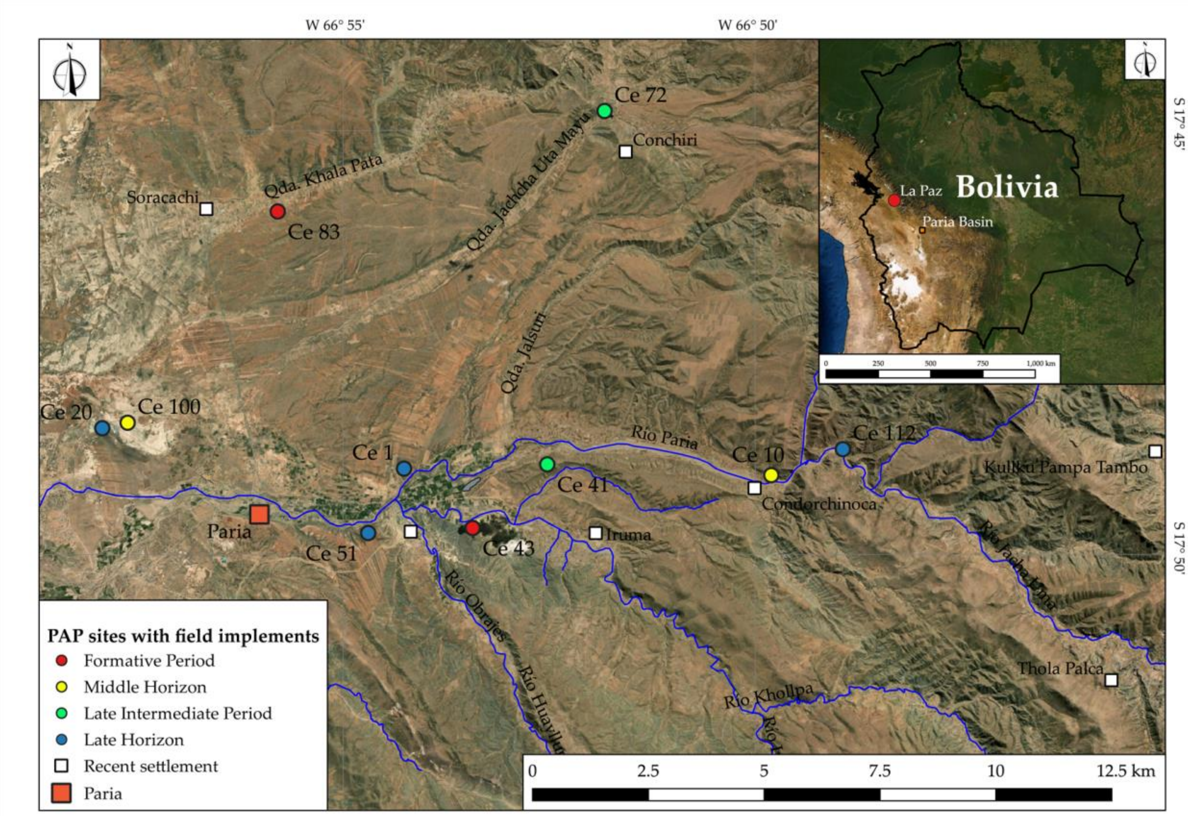

Fig. 1.: Archaeological sites with agricultural stone implements.
1. ábra: Régészeti lelőhelyek kőeszközökkel

role in the administration and economy of the Inca Empire. To achieve these goals a roughly 95.5 km^2 large area was systematically surveyed, which incorporated three different ecological zones of the basin: the piedmonts up to 4050 m asl, the plain of the Altiplano lying west of the piedmonts, and river valleys traversing these two zones. In the course of the field survey conducted in 2004 109 archaeological sites were discovered completing the earlier published five sites (**Fig. 1.**). In 2005 and 2006 a series of excavations were conducted in the Inca provincial centre and on a few other sites revealing two great and several lesser structures and abundant ceramic, lithic, osteological and metal material (Gyarmati & Condarco 2014).

The research area named Paria Basin lies 200 km southeast of La Paz, in the Cercado Province of the Department of Oruro, and forms a part of the Poopó–Desaguadero (Navarro & Maldonado 2002, 454) or Caracollo–Oruro–Vinto (Montes de Oca 1989, 232) region which is the eastern–southeastern sub-basin of the northerly part of the 3600–4000 metres high Altiplano. In terms of its topography, the investigated section of the Paria Basin can be divided into two main areas: the piedmont region lying at an altitude of 3800–4100 metres, which graduates into the over 4,500 metres high Cordillera de Azanaques lying beyond the study region, and the plateau part of the Altiplano, lying at 3700–3800 metres to its west. The basin's current landscape is determined by the Quebrada Khala Pata (or Soracachi) and the rivers Jachcha Uma (also written as Jacha Uma, Jach'a Uma), Iruma (or Kachi Kachi), and Obrajes (or Huaylluma) flowing to the plateau from the Andes and the seasonal gullies incised into the piedmont. The latter three rivers have their confluence at Balneario Obrajes, near the former provincial centre of Paria, and flow on as the Paria River.

The motivation of this paper was given by altogether 22 agricultural stone implements found in the Paria Basin (Department of Oruro, Bolivia). Nineteen artefacts were found at archaeological sites localized by PAP, and three artefacts were found as stray finds without archaeological context during the field survey. Although a relatively large number of agricultural stone implements are known from Bolivia, they are practically unprocessed. The only processing known to the authors is the use-wear analysis of some implements from the Jachakala site (Aoyama 1995). In their monograph on Paria La Viexa (Gyarmati & Condarco 2014),

Table 1.: Metric data (measured and derived) and macroscopic petrographic determination of the 22 studied artefacts

1. táblázat: A vizsgált 22 kőeszköz (mért és számított) méretei és makroszkópos kőzetbesorolása

No	Site Id.	Length	Width	PW (proximal width at 0.2×L)	MW (mid-width at 0.5×L)	DW (distal width at 0.8×L)	PL (proximal length)	Thickness	L/W	L/PW	L/MW	L/DW	L/PL	Weight (g)	Raw Material	Figure	Period
1	Ce 1	51.00	72.00					9.00						34	black-basalt	Fig. 9, 2A-2B	LH
2	Ce 10	95.00	67.00	56.50	66.00	54.50	45.00	13.35	1.42	1.68	1.44	1.74	2.11	116	basaltic-andesite	Fig. 12, 1A-1B	MH
3	Ce 20	89.80	47.00	23.50	39.30	44.50	64.00	11.50	1.91	3.82	2.28	2.02	1.40	46	amygdaloidal basalt	Fig. 7, 1A-1B	FP, LH
4	Ce 20	95.40	52.00	31.00	43.50	43.00	63.00	10.00	1.83	3.08	2.19	2.22	1.51	66	amygdaloidal basalt	Fig. 6, 1A-1B	FP, LH
5	Ce 20	106.70	53.50	36.50	52.00	49.50	55.80	11.00	1.99	2.92	2.05	2.16	1.91	72	amygdaloidal basalt	Fig. 6, 2A-2B	FP, LH
6	Ce 20	126.80	64.50	53.00	64.50	58.70	63.40	18.00	1.97	2.39	1.97	2.16	2.00	177	fine-grained sandstone	Fig. 5, 1A-1B	FP, LH
7	Ce 41	205.10	130.00	85.00	116.00	129.00	135.70	18.75	1.58	2.41	1.77	1.59	1.51		fine-grained sandstone	Fig. 13	LIP
8	Ce 43	84.90	66.50	39.50	58.50	53.50	49.50	5.00	1.28	2.15	1.45	1.59	1.72	39	fine-grained sandstone	Fig. 10, 1A-1B	FP, LH
9	Ce 43	87.00	51.00					11.00	1.71					62	black-basalt	Fig. 9, 1A-1B	FP, LH
10	Ce 43	80.50	44.00					9.00	1.83					34	black-basalt	Fig. 7, 2A-2B	FP, LH
11	Ce 43	88.50	75.00					10.50	1.18					86	black-basalt	Fig. 8, 2A-2B	FP, LH
12	Ce 43	105.15	66.50	37.50	59.50	63.00	74.15	12.00	1.58	2.80	1.77	1.67	1.42	90	amygdaloidal basalt	Fig. 10, 2A-2B	FP, LH
13	Ce 51	(79.00)	(96.50)					(15.00)						182	fine-grained sandstone	Fig. 14, 1A-1B	LIP, LH
14	Ce 72	94.80	70.00	32.00	49.50	70.00	75.84	13.50	1.35	2.96	1.92	1.35	1.25		black-basalt	Fig. 14, 2A-2B	LIP
15	Ce 83	150.30	89.00					13.70	1.69						black-basalt	Fig. 11, 1A-1B	FP
16	Ce 83	125.00	84.00					12.60	1.49						black-basalt	Fig. 11, 2A-2B	FP
17	Ce 100	134.00	82.00	56.00	81.00	72.00	80.50	20.00	1.63	2.39	1.65	1.86	1.66	182	basaltic-andesite	Fig. 15, 2A-2B	MH
18	Ce 100	(48.00)	(40.00)					(5.00)							basaltic-andesite	Fig. 12, 3A-3B	MH
19	Ce 112	(48.00)	(51.50)					(9.00)						31	sandstone	Fig. 12, 2A-2B	LH
20	stray find	91.50	62.00					11.50	1.48					65	amygdaloidal basalt	Fig. 8, 1A-1B	
21	stray find	78.50	46.50	30.50	42.50	44.00	54.50	11.50	1.69	2.57	1.85	1.78	1.44	55	amygdaloidal basalt	Fig. 15, 1A-1B	
22	stray find	112.20	54.50	38.50	52.00	50.00	70.00	9.50	2.16	2.91	2.16	2.24	1.60	88	fine-grained sandstone	Fig. 5, 2A-2B	

the authors described the found agricultural stone implements in a very general way, without a more detailed discussion of the used raw materials, the manufacturing process and the possible function of the tools. Despite the relatively small assemblage, available for study, this paper aims to provide a general picture of the agricultural stone tools found in the Paria Basin. By studying the artefacts, we may have obtained a more accurate picture of the cultural aspects of the area. Compared to the neighbouring countries, especially Argentina, where there is already significant literature on these agricultural stone tools, such an investigation definitely fills a research gap in Bolivia. As regards the possible cultural connections of the Paria Basin, it is worth mentioning a recently published article in Spanish language on the arrowheads found by PAP (Péntek et al. 2021).

General characterization of agricultural stone implements

Orientation and illustration

We follow largely the methodology elaborated by Susana Pérez (2007). During taking the photos, the orientation of the tools considers the morphological axis. The active edge was placed in the distal position (the upper part of the photos). It should be kept in mind that the initial base form of the tool generally is a slab, a laminar/tabular raw material piece. In the case of implements manufactured by flaking all its perimeter, the more convex face was considered Face A (usually the upper face of the implement). Thus, Face A was defined by convexity and not by other characteristics, for example, the manufacturing technique or the possession of traces of use.

Measurement method

We applied a linear measurement method developed on bifacial manufactured hand-axes (Roe 1964; 1968; Brande & Saragusti 1996; McPherron 2000; 2003; Archer & Braun 2010). The following basic measurements were made on the implements: length (maximum length (L), the distance from the proximal to the distal end), the vertical location along the length (height) (proximal length (PL)) where the largest width occurred and the width at three specific locations: at 20% (proximal width (PW)) and 80% (distal width (DW) of the height from the proximal to the distal end and the largest width (W). François Bordes (1961) measured an additional width at half (50%) of the length (mid-width (MW)). To the basic measurement data, some ratios, for example, L/W, and L/PW were computed. Fourteen implements, regarded as whole ones, from the Paria Basin were measured in grams. All measured and derived data of the 22 discussed field implements from the Paria Basin can be seen in **Table 1.**

Technological characteristics

Julio C. Ávalos (1998) carried out a detailed analysis of field implements from archaeological sites in two regions of the Province of Jujuy (Northwestern Argentina). He identified two manufacturing techniques for the production of those stone artefacts: 1) percussion technique and, 2) "sharpening" technique, carried out in two steps. Firstly, the distal part of the implements was regularized with finer adjustments, generating straight edges, and secondly, they were sharpened by abrasion on flat surfaces, making the debitage negatives disappear (Ávalos 1998, 295). The artefact assemblage of the Doncellas Collection (Department of Cochinoca, Province of Jujuy, Northern Argentina) presents variability in the manufacturing techniques. Some tools formatted in its entire perimeter with flaking and marginal retouching were manufactured by direct percussion. In the case of other implements, the formatting was done by polishing (Pérez 2010b, 12, Fig. 5) on and around the active working edge (apical segment) and by the technique of flaking and bifacial marginal retouching in the rest of the perimeter (lateral segments of the body, inflection body/peduncle and peduncle), being manufactured by direct percussion.

In general, little work has been done on basalt (or related igneous rock) tool making and many studies (see, for example, McAnany 1989) of bifacial manufacturing technologies treat the bifacial tools as end products. The bifacial reduction sequence, in which bifacial tools are the end products, was described in the study of William J. Parry (1987, 46, Fig. 14). Christine Beaule tried to reconstruct the bifacial hoe production sequence for the Jachakala lithic assemblage (Beaule 2002, 58-66). The black basalt raw material from which almost all of the stone tools were manufactured was imported in the form of tool blanks, rather as raw nodules, and therefore initial manufacturing debris was absent. Nodules were lacking at the site, a visible cortex was present only in limited amounts (Aoyama 1995). At Jachakala, broken bifaces fragments became cores and were further used and refurbished to make smaller tools. According to the model of lithic production and consumption at Jachakala (Beaule 2002, 64, Fig. 15), bifacial hoes were produced from pre-worked (roughly shaped) tool macroflakes or tool blanks, hence the primary-stage reduction debris and large cores are absent. Broken tools were later recycled into smaller tools such as scrapers and projectile points, producing later-stage reduction debitage. This second stage of chipped stone working produced both sub-angular debris as well as complete flakes. The residual cores that are left have multidirectional flake scars, suggesting that flake tools were manufactured on an expedient basis.

Apart from some necessary extensions, the method of Julio C. Ávalos (1998) was followed during the use-wear analysis. The term wear is considered in a general way; as the progressive loss of substance from the surfaces of the implements when coming into contact with other surfaces (of other artefacts or material). On the studied tools, only macroscopic traces such as striations, scratches, detachments of material, polish(ing), smoothing and lustre were analyzed. That is, those registered with the naked eye or by the use of low magnifying hand glasses and/or stereomicroscope. The wear patterns that are the results of human activities have been divided into two categories: (1) those that have their origin in the process of reduction by knapping and fit to a handle /haft (manufacturing traces), and (2) those that have been formed on the edge and adjacent areas during the use of the instrument (traces of use).

Manufacturing traces

The manufacture of the implements under analysis included two steps: the knapping process of the piece of stone and the adjustment of this to a haft.

In the manufacturing process, the adjustment of the tool to a haft does not leave direct marks. These marks will be developed progressively with the use of the instrument, appearing exclusively on the stem. The following traces can be identified:

1) Smoothing on one of the faces of the stem. It is observable usually in the centre of the stem and affects the entire length of it. This imprint (trace) is generated by rubbing and/or friction of the haft with the surface of the stem since the rigid material of the haft develops localized wear.

2) Jagged surfaces in the central part of the proximal edge of the stem. The presence of these marks, together with the above-mentioned friction traces, allows inferring the shape of the end of the haft.

3) Light polishes. Those are located on the surface of the stem opposite to that one bearing smoothing, and on its edges. They can also be observed on and within the concavities of the marginal flaking negatives of the stem. Based on experimental studies, it is inferred that these traces were generated by friction with the leather thongs that served as mooring.

Traces of use

Traces of use were recorded on both sides of the instruments and are circumscribed mainly along the edge and adjacent areas.

1) Smoothing. Those occur in the edges and adjacent areas, taking the form of smooth surfaces. The area covered by smoothing can be similar on both sides. These smoothed areas disappear towards the interior of the tool where only the protruding irregularities of the surface are affected. On the edges that suffered a more intense use, smoothing has affected the hollows of manufacturing flaking, making them disappear completely. The presence of smoothing with similar extensions on edges and adjacent areas on both sides can indicate that the implement was in contact with the sediment in a direction perpendicular to its surface, as a consequence of an action that led to both sides suffering the same mechanical impact. This action could be possible if the edge was in a single line with the handle, which is parallel to the axis.

2) Striations, scratch marks. Those are the most common traces that can be observed with the naked eye. Those are very thin striations that are found more profusely along the surface of the edge and extend into the interior of the blade. The area covered by the striations exceeds the area of the smoothing. It can be seen that the grooves start parallel from and perpendicular to the edge, presenting the base wider than its end.

3) Material detachments. On the edges, detachments of variable sizes can be observed generated by the impact of the tool on the sediment. Its distribution is random on the edges, which allows differentiating from those produced in the manufacturing process.

4) Edge angles. The angles of the edges of the face where the stem is smoothed are much sharper than those of the opposite face. This is attributable to the greater wear received by one of the faces of the instrument, which implies that the edge surface with a sharper angle received greater wear than the surface of the opposite edge. In cross-section, the borders of the edges, in the process of wear, acquire a rounded shape.

Geological background

In the Paria Basin and its surrounding, there are Palaeo-Mesozoic siliciclastic sedimentary rocks (Ordovician-Devonian shales-siltstones-sandstones, Jurassic-Cretaceous sandstones) as products of flysch formation. Subsequently, there are Paleogene-Neogene clastic sedimentary and volcanic rocks (volcanites-pyroclastics connecting to subduction-related Miocene effusive volcanic activity) and finally Quaternary sediments (fluvial and lacustrine clay-silt-sand-gravel) were formed (GEOBOL, 1992; 1994; see, also, Szilágyi et al. 2012). From the point of view of our investigation, the most important formations for possible raw materials of the agricultural stone implements are the Silurian shales-siltstones-sandstones and the Miocene volcanites.

In a proper sense, sediments of the Paria Basin have their direct source only from the Silurian siliciclastic sedimentary sequence since this is the only material which can be eroded within 5 km from the main archaeological site on the edges of the alluvial basin. The relatively monotonous sequence of the Silurian grey shales-siltstones-sandstones was subjected to low-grade metamorphism (GEOBOL, 1992; 1994). In the field, the Silurian rocks form eroded ridges built of stratified (weakly folded) structures. The thick, cyclical sequence (alternating finer and coarser-grained layers) forms a relatively homogeneous source for the alteration products (Szilágyi et al. 2012, 3, 4, **Fig. 2.**). According to Ivan Monrroy and colleagues (1994, 330), the oldest rocks existing in the area are Paleozoic sedimentary rocks of Silurian age (Catavi Formation), which emerge in a restricted area between the western sector of the massif of Esquentaque and the east flank of Cerro La Joya. These rocks consist of well-stratified greenish-grey micaceous (mica-rich) sandstones in banks with thicknesses between approximately 20 and 70 cm, locally affected by small gravitational faults.

Fig. 2. is a location map showing the Bolivian tin belt and the Morococala and Los Frailes volcanic fields after George E. Ericksen and colleagues (1987, Figs. 1-2). The Morococala Volcanic Field is part of the so-called Bolivian Tin Belt and situated in the Cordillera Occidental, approximately 20 km to the east from Oruro. It lies 15 km to the southeast from Paria and is in connection with the Paria Basin area through the Jachcha Uma River. Morococala was formed during the late Miocene-early Pliocene (8.4–6.4 Ma ago) (Morgan et al. 1998, 604). The volcanic events formed rhyolithic and rhyodacitic tuffs (ignimbrite) forming an extremely eroded high plateau (Lavenu et al. 1989).

The Los Frailes Plateau is situated somewhat further to the south at a distance of about 120 km to the southeast from Oruro. The rocks of the Plateau, as the Morococala volcanic fields and a few small satellite fields, consist predominantly of a sequence of silicic nonwelded to welded ash-flow tuff sheets.

Keller (2010, 10-11) highlighted that due to the close geographical location and similar peraluminous composition (see, for example, Ericksen et al 1990), some similarities may be expected between the Frailes and Morococala ignimbrites. Other nearby units include outcrops of shoshonites and basaltic andesites to the west (Keller 2010, Figs. 2 and 3), which Hoke & Lamb (2007) model as originating from a partial melt of an enriched mid-ocean ridge basalt (MORB) source.

Because of its importance, in **Fig. 2.**, the major sources of the fine-grained vitreous black basalt, the Querimita quarry, and the surroundings of San Juan Mallku and Montaña Santa Barbara are also indicated. These sources are located on the southwestern and southern shores of Lake Poopó in Oruro Department (Ponce & Mogrovejo 1970; see, also, Péntek & Faragó 2019) some 200 km from the Paria Basin, are also indicated. For the time being, these are the only known sources in the Bolivian Altiplano. Unfortunately, although the archaeological utilization of this raw material is significant, its geological characteristics are not yet known.

Fig. 3. and **Fig. 4.** show the Soledad caldera and the La Joya stock cluster after Stewart D. Redwood (1987). The Soledad caldera is on the plain of the Altiplano, 20 km to the northwest from Oruro, between the Desaguadero River and the small town of Caracollo. It lies 30 km to the west from the archaeological site of Paria. The Soledad caldera is somewhat elongated with dimensions of 14 by 22 km (8.7 mi × 13.7 mi). It contains an ephemeral lake, Lago Soledad. The Soledad dacitic tuffs are exposed in particular on the eastern margin of the caldera. On the southern side, a group of lava flows forms the Esquentaque complex.

The La Joya stock cluster of seven small dacitic stocks intrude northwest-trending Silurian Catavi Formation sediments around the village of La Joya, at a distance of about 50 km northwest of Oruro. These stocks are considered to be the roots of domes, rather than subvolcanic stocks. The group is dominated by the Cerro La Joya, located 6 km west of the caldera margin. All of the La Joya group of stocks are porphyritic quartz-biotite-plagioclase-sanidine-dacites. Redwood mentioned also that “A tiny vesicular, basaltic andesite or andesite lava crops out 9 km northwest of La Joya (Cerro Pujno), but its relationship to the caldera is unknown.” (Redwood 1987, 397-400; Monrroy et al. 1994).

Field implement use from the formative period in the Bolivian Altiplano and the Titicaca Basin

According to Jason R. Fox (2007, 159-160), the abundant large bifaces found in Formative Period Wankarani (approximately 1500 BC to 400 AD) lithic assemblages were regarded in general as the remains of stone hoes. These implements were presumably hafted on wooden or bone shafts. The bifaces were usually recovered in broken condition, with breaks occurring transverse to the long axis of the tool. This breakage pattern is consistent with what would be expected in the case of hafted hoes (see, for example, Haber & Gastaldi 2006, 294, Fig. 5; Pérez 2010a, 411, Figs. 4-5; Ávalos 2010, 1647). For these reasons, large bifaces have been used as an index of agricultural intensity in Wankarani studies (Bermann & Estevez 1995; Bermann 1997, 102; McAndrews 1998). Even without microscopic use-wear studies, it seems likely that these Wankarani bifacial tools were used for several functions related to agricultural

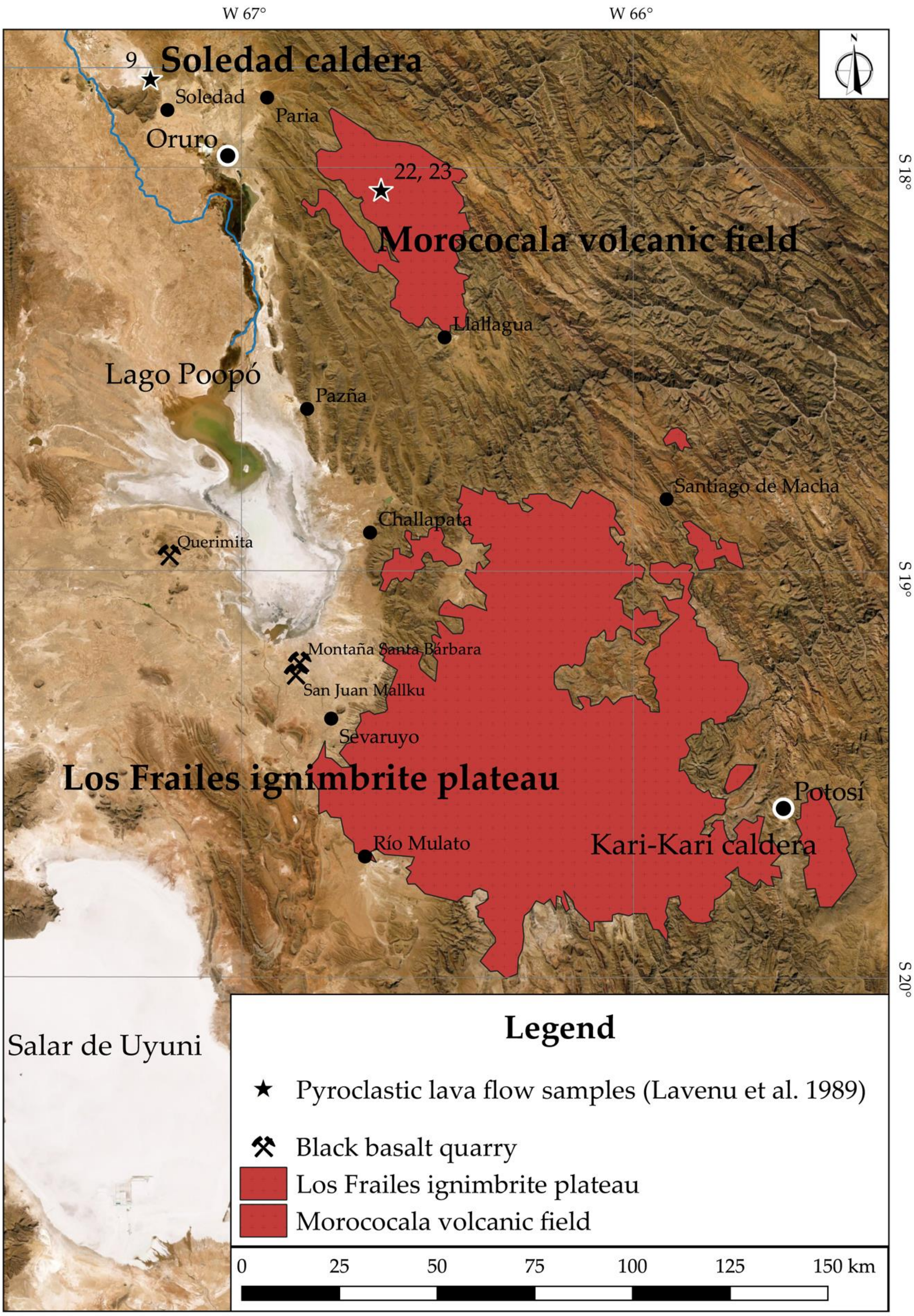

Fig. 2.: The Bolivian tin belt and the Morococala and Los Frailes volcanic fields according to George E. Ericksen and colleagues (1987, Figs. 1-2)

2. ábra: A bolíviai ónöv és a Morococala és Los Frailes vulkáni mezők George E. Ericksen és munkatársai (1987, 1-2. ábra) alapján

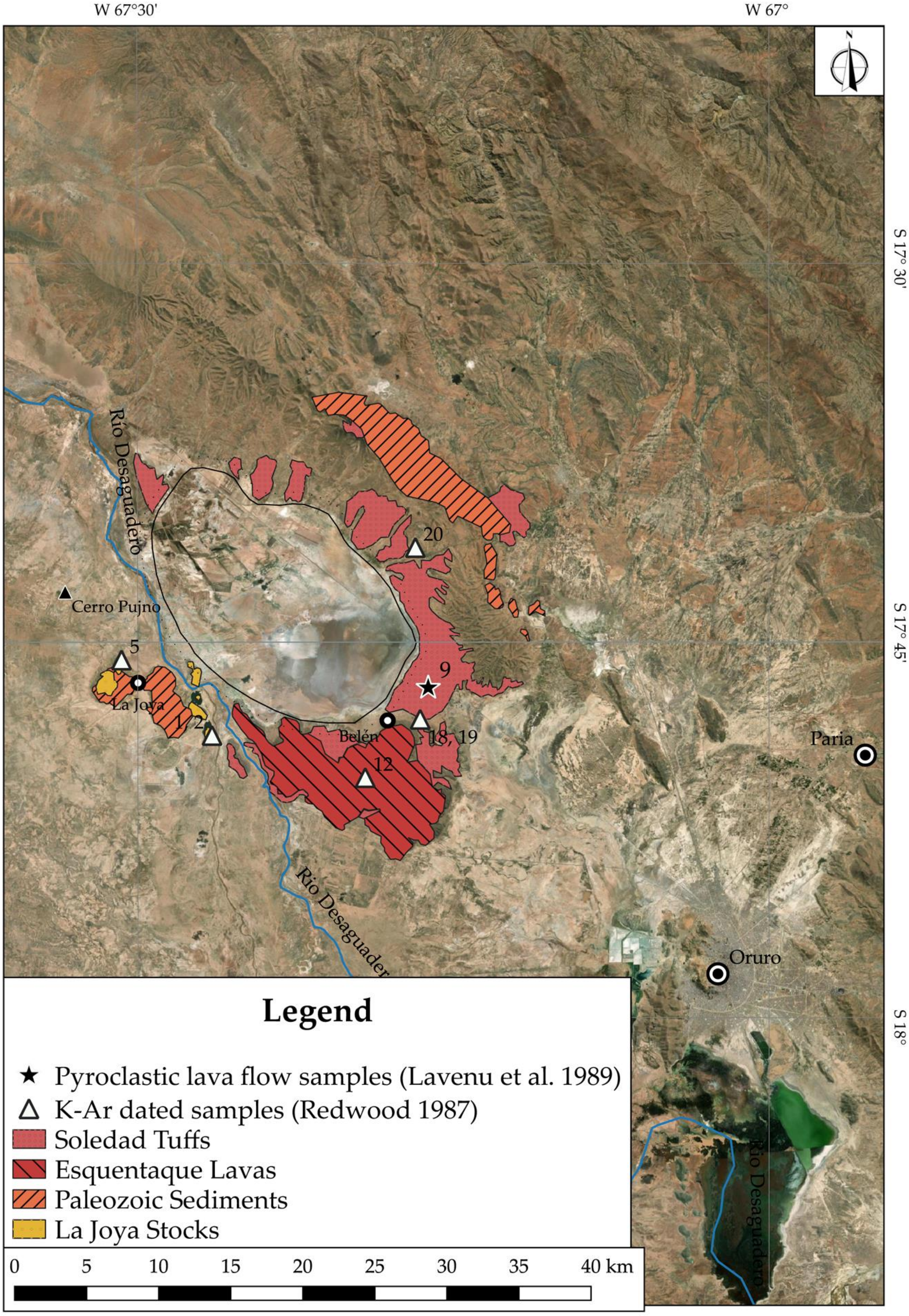

Fig. 3.: Caldera Soledad and the group of small Stocks called “La Joya Stocks” according to Stewart D. Redwood (1987, Fig. 2)

3. ábra: A Soledad vulkanikus kráter és a “La Joya” vulkanikus kőzetcsoportok Stewart D. Redwood (1987, 2. ábra) alapján

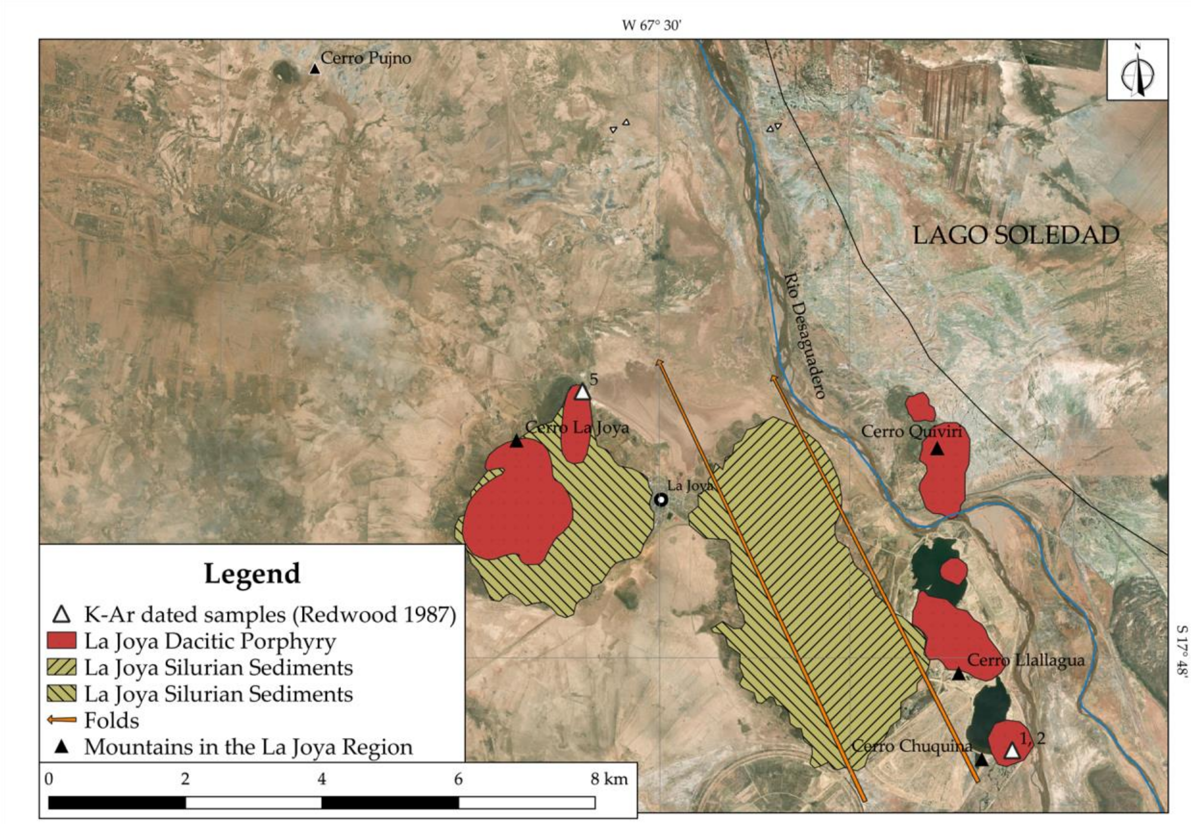

Fig. 4.: Caldera Soledad and the group of small Stocks called "La Joya Stocks" according to Stewart D. Redwood (1987, Fig. 4)

4. ábra: A Soledad vulkanikus kráter és a "La Joya" vulkanikus kőzetcsoportok Stewart D. Redwood (1987, 4. ábra) alapján

practices, including tilling, planting, and other cultivating activities. The most important bifacial tools were presumably the hoes. The tools were used in activities carried out in the residential base, cleaning of garbage dumps and habitation places, digging wells for storage of various products, and they were also used in activities related to fodder practices, such as pasture cutting (Fox 2007). At the Wankarani sites, bifaces were principally produced either from local sedimentary stone that was available near the communities, or from local igneous rocks that were available within a few kilometres of the communities, and finally, from vitreous black basalt that was imported from considerable distances (Fox 2007). All of these materials were reduced at least partially before being brought to the site in the form of large, lightly worked cores or macroflakes. The abundance of stone artefacts among the surface finds at Wankarani sites indicates that the population had equal and unlimited access to the essential raw materials needed for the production of various tools and implements (McAndrews 2005, 31, 115). However, the abundant occurrence of these implements on almost every site does not necessarily mean that each settlement was involved in their manufacture to the same extent.

The importance of black basalt in the La Joya area appears to have been particularly marked during the Late Intermediate Period (Fox 2007, 163). The site of Jachakala (Department of Oruro, Bolivia), which is situated in the central Bolivian highlands, was occupied from ca. 170–1200 AD, including the Late Formative Period (ca. 150–800 AD) and Late Intermediate Period (ca. 800–1200 AD). Large, chipped hoes manufactured from black basalt were among the most common tools produced throughout the site's history. A selection of black basalt bifacial lithic artefacts from the site was analyzed to reconstruct their production and consumption systems and processes. The use-wear analysis indicated that these tools were multifunctional. Among 29 artefacts, which were selected for use-wear analysis, 27 artefacts had soil polish on the distal end of the bifaces (Aoyama 1995, 4 cited in Hein 2004, 7). Some of the bifaces had hide polish on all edges of them indicating that they may have also been used for hide scraping (Beaule 2002, 58).

According to Marc Bermann (1997, 101-102), biface hoes were common agricultural implements particularly in the Tiwanaku Heartland in the Formative Period and post-Tiwanaku contexts. Hoes of this type may have been more important in dryland farming than in raised-field agriculture. The central issue of the detailed study of Martín Giesso (2010) was to explain changing patterns in the organization of stone tool production among different social groups that occurred with the emergence and expansion of the Tiwanaku state. The focus of the research was to determine the characteristics of stone production and consumption in different social contexts during the Tiwanaku IV and V periods (ca. 400–1100 AD). Giesso stated that most lithic analysis focused on Early and Middle Holocene sites belonging to the Archaic Period, in preference to later Formative sites. Therefore, the change in long-term sequences of stone tool production in Andean complex societies has rarely been analyzed in any detail. No use-wear analysis had been carried out on the lithic assemblages of the period in focus. Large bifaces are present in many areas of Tiwanaku, and the other major urban centre of Lukurmata (Bermann 1997; Giesso 2010). In Tiwanaku, the largest raw material group is black basalt, while in Lukurmata this group is slate, a fine-grained, foliated, homogeneous metamorphic rock. Andesite, quartzite and some unidentified finer-grained metamorphic rocks were also used to manufacture large bifaces (hoes). The increase throughout time in the production and use of bifaces found in the Tiwanaku heartland may be correlated with climatic amelioration and the expansion of agriculture after 300 AD. These bifaces were most likely used as agricultural tools. These tools are similar to those found in other Formative Period sites of the Altiplano such as San Andrés (Oruro) (Bermann & Estevez 1995). At the Tiwanaku site of Iwavi, the hoes are thin and have an almost rectangular shape, most exhibit a smooth and glossy polish at the distal end and a handle at the proximal end. Most of these tools were made of basalt. Although basalt hoes comprise 3.6% of lithic tool types, less than 2% of lithic knapping wastes (waste products) consist of basalt, suggesting that these tools were produced elsewhere and brought to the site as finished tools. Basalt is not a typical raw material in the area, so it was not readily available (Bencic 2000, 100-101).

In the Middle Formative Period, there is evidence for exchange within the Titicaca Basin itself and probably also of trade with immediately adjacent regions. The evidence is the large quantities of olivine basalt a rock type which is exotic to the southern Titicaca Basin. This raw material comes from outcrops near Incatunahuari, just north of the town of Chucuito, south of Puno, approximately 150 km northwest of the Taraco Peninsula. This raw material was imported in the form of finished agricultural implements (Bandy 2001, 141-142, 147; 2005, 96, Fig. 6.4). 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 coarser-grained. Feldspar is not present in the olivine basalt. Other types of basalt are present at Chiripa, including a black, vitreous variety possibly from the Queremita quarry near Lake Poopó. The trade of olivine basalt hoes seems to have drastically decreased during the Late Formative, though a few such hoes are known from Khonkho Wankane and possibly Karwanpata (Bandy 2001, 144; Callisaya Medina 2010, 225; Giesso 2006, 205).

Besides basalt as volcanic rock, the use of andesites as raw materials for the production of bifacial hoes is documented throughout the south-central Andes, particularly in the Titicaca Basin (Bandy 2001; 2005; Bermann & Estevez 1995; Giesso 2010; Steadman 1995).

Other Late Formative hoes were made from different raw materials, often grey slate. In the Katari Valley, quartzite and grey slate hoes were common at Qeya Kuntu, Urikatu, and Kirawi. At the site of Kirawi, a hoe production area was localized (Janusek & Kolata 2003, 141-142, 145). At Khonkho Wankane, hoes were found on the surface, and during the excavation of most of the site's sectors (Giesso 2006, 205; Marsh 2006, 150, Figure 10). John W. Janusek and Alan L. Kolata (2003, 138, Fig. 6.9) published Middle Formative quartzite hoes from Qeya Kuntu. Most of the illustrated tools have almost parallel-sided or convex-sided oval forms, followed by sub-rectangular and egg-shaped forms. In Fig. 6.20 in Janusek and Kolata (2003, 145), there are several examples of stone hoes recovered from Late Formative contexts in the Katari Basin. Besides two or three oval hoes, most of the undamaged tools have a sub-rectangular form. Slate hoes were usually thinner in profile and more rectangular in plane section than quartzite hoes.

Martti Pärssinen (1999) presents a formerly unknown Late Formative archaeological complex of Pajcha Pata at Caquiaviri (0–375 AD), in the Bolivian province of Pacajes. The settlement is situated in the Altiplano, between the area of the Tiwanaku and Wankarani cultures. Most of the hoes (agricultural tool blades) present types similar to those of Wankarani (Bermann & Estévez 1995, Fig. l0), and similar forms are also known in Tumatumani, Juli in Peru (Stanish et al. 1994, 104, Figs. 166-167). They are made of slate or basalt, percussed on their edges in an oblong (elongated trapezoid) or conical shape, with the body expanding towards the edge. Some of them are almost triangular, and others are almost rectangular (Pärssinen 1999, 190-191, Figs. 12-13). Among the represented implements, stemmed artefacts are not present.

The twin mound complex at Tumatumani, in the southwestern Titicaca Basin, was occupied from at least 500 BC (Stanish et al. 1994, 2). In the lithic collection of Tumatumani, there were few complete examples of field implements, the vast majority were fragments of broken implements. Morphometric analysis was carried out on the fragments by Matthew T. Seddon (Seddon 1994), length, width, and thickness of the fragments were measured to classify them as hoe fragments or adze fragments. On the fragments no use-wear analysis was made, however, Seddon stated that the fragments generally possessed polish, striations and/or worn surfaces indicating that they are from hoes or adzes. The majority of the tools were composed of grey andesite, with a small number manufactured from dark black basalt (Stanish et al. 1994, 67). Matthew S. Bandy assumed (2001, 142) that the "grey andesite" reported by Seddon, which makes up upwards of 90% of the lithic sample at the Early and Late Sillumocco and Tiwanaku site of Tumatumani (Stanish et al. 1994, 70), is possibly olivine basalt.

In the "Early Qaluyu I" phase of Camata in the north basin of Lake Titicaca Lee Steadman (1995, 7) found hoes made of grey andesite; and similar pieces were recovered also in Huatta (Zapata Benites 2016, 47 after Erickson 1996, 253). From the Quilcamayo-Tintiri Valley (Department of Puno, Peru) Henry Tantaleán (2010) mentioned several hoes of grey andesite. At the site Sillumocco-Huaquina, located on the southwestern margin of Lake Titicaca, several hoes or fragments made of andesite, basalt and quartzite were found (de la Vega 2005a).

On the site of Taraco (Zapata Benites 2016, 47 after de la Vega 2005b) these tools, usually made of andesite, are quite common. There are hoes made with olivine basalt, which would come from the Ichu-Incatunuhuiri quarry and, above all, its greater use in the northern Titicaca basin belongs rather to the Pukara era (Bandy 2001). These artefacts have an oval shape tending to triangularity (Zapata Benites 2016, 47, Fig. 24 after Steadman 1995, Figs. 18-19). In Pukara settlements quite frequent artefacts are hoes, made of olivine basalt, such as those found by Clark L. Erickson in Huatta (Erickson 1988, 12); Hoes have also been identified at the Taraco-Puno site (Chávez Justo 2007, 11-12), some made from grey and green andesite (de la Vega 2005b, 16-17). The use of these field implements seems to be more widespread in the Pukara era. In the case of Huatacoa, only hoes associated with Pukara are registered and not for Qaluyu and in Taraco-Puno there is an increase of these for Pukara (cited in Zapata Benites 2016, 46, 53 after de la Vega 2005b, 16-17 and Cohen 2010, 224). During the excavations at the site of Chaupisawakasi, hoes made of olivine basalt, associated both with the Qaluyu and Pukara layers were also registered (Zapata Benites 2016, 270, Fig. 225 above).

The field implements from archaeological sites of the Paria Basin

Out of the 109 archaeological sites identified by the PAP, agricultural stone implements were found only at 10 sites. The selected 19 finds derived from known archaeological contexts. In the following, in the ascending chronological order of the archaeological sites, a short description of these tools will be given. Under the term of the dimension of a given artefact, the length, width, and thickness should be understood. Measured data in brackets indicate broken implements.

Formative period (1500 BC–400 AD)

Ce 20 (Anocariri Pampa) (Castellón & Gyarmati 2009, 77; Gyarmati & Condarco 2014, 32)

There is a drop-shaped implement from the site (**Fig. 5.** 1A-1B; see also Gyarmati & Condarco 2014, Plate XV, e) made from layered fine-grained sandstone. The edge all around is roughly, bifacially worked. The proximal end is somewhat accurately thinned on both faces, for an effective hafting of the tool. There are no traces of use visible with the naked eye. The dimensions are 126.8 × 64.5 × 18.0 mm.

In **Fig. 6.** 1A-1B, the drop-shaped instrument was made of basaltic andesite. The lateral edges are bifacially worked with wide, flat detachments. The asymmetrical distal end and the distal part of the lateral edges are unworked but intensively rounded due to use. The protruding parts of both faces are smoothed and covered with fine striations and scratch marks. The dimensions are 95.4 × 52.0 × 10.0 mm.

In **Fig. 6.** 2A-2B, another drop-shaped instrument was also made of basaltic andesite. The entire surface of Face B is covered with a weathering layer. The lateral edges are roughly worked from both faces with irregular detachments. The distal end and the distal part of the lateral edges are intensively rounded due to use. The longitudinal profile of the distal end is asymmetric wedge-like, it obliquely slopes towards Face B. The distal part on both faces is smoothed and covered with fine striations, and scratch marks. The dimensions are 106.7 × 53.5 × 11.0 mm.

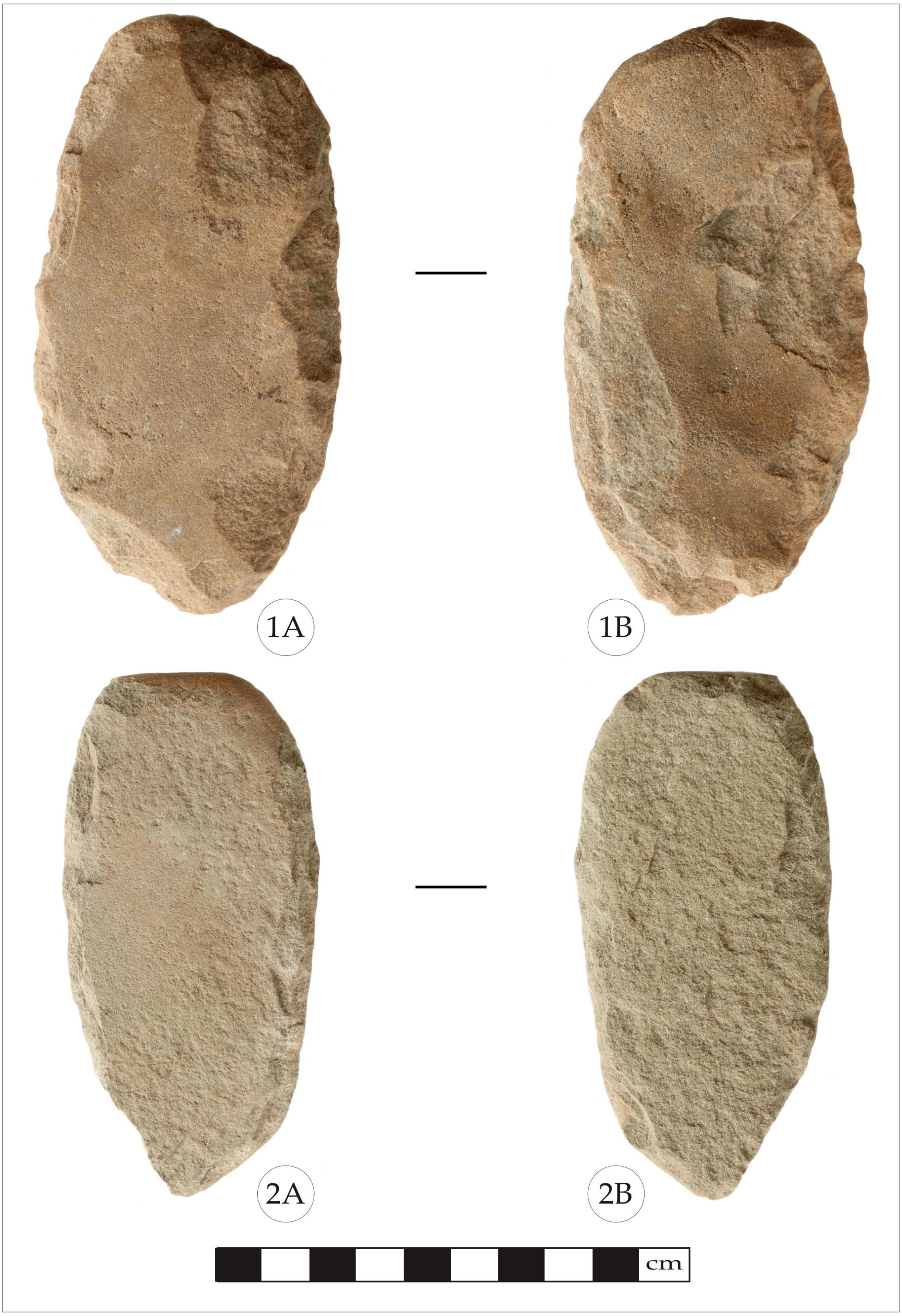

Fig. 5.: Selected artefacts (1A-1B=*Ce 20* site, 2A-2B=stray find)
5. ábra: Válogatott eszközök (1A-1B=*Ce 20* lelőhely, 2A-2B=szórványlelet)

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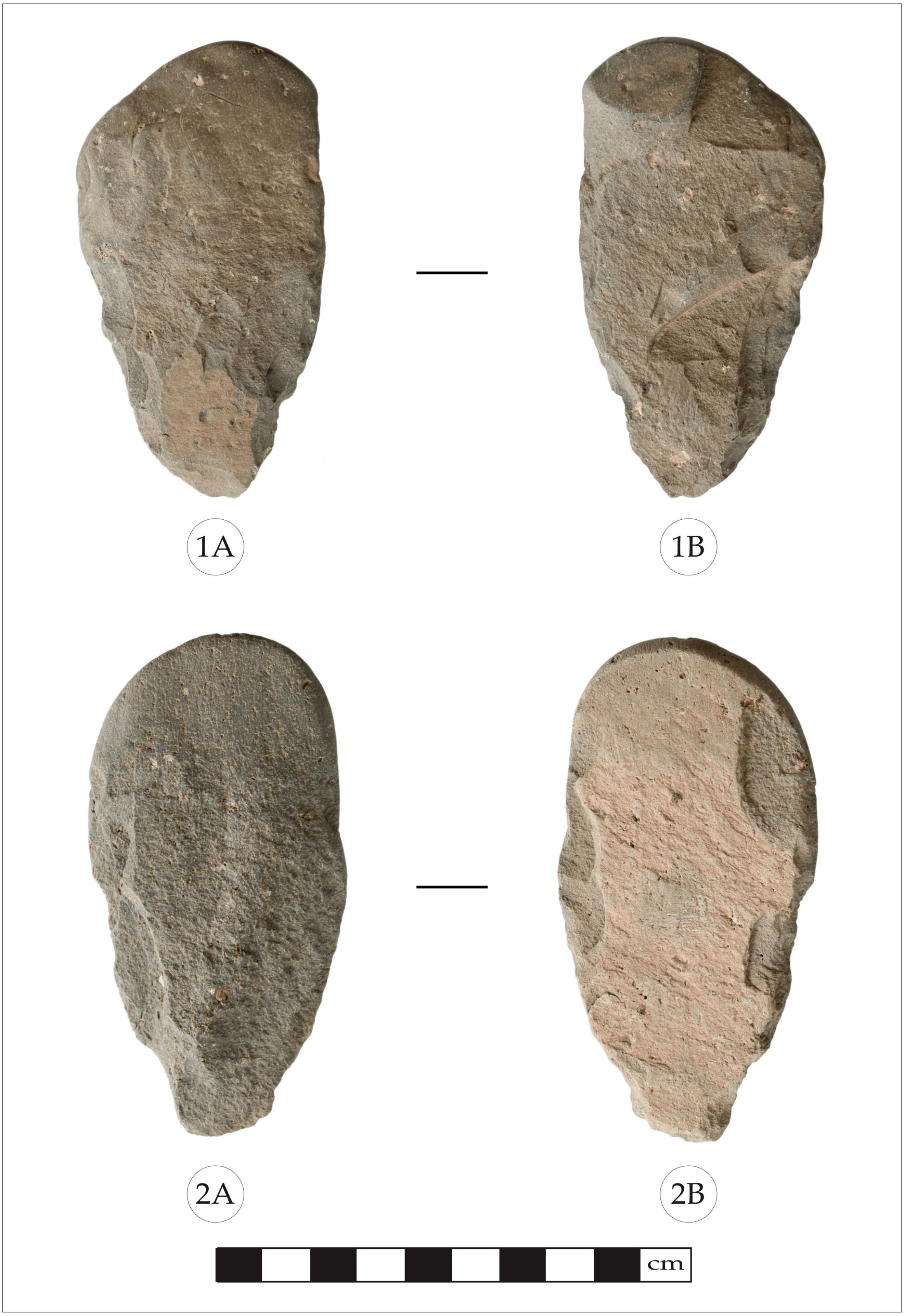

Fig. 6.: Selected artefacts from the *Ce 20* site
6. ábra: Válogatott eszközök a *Ce 20* lelőhelyről

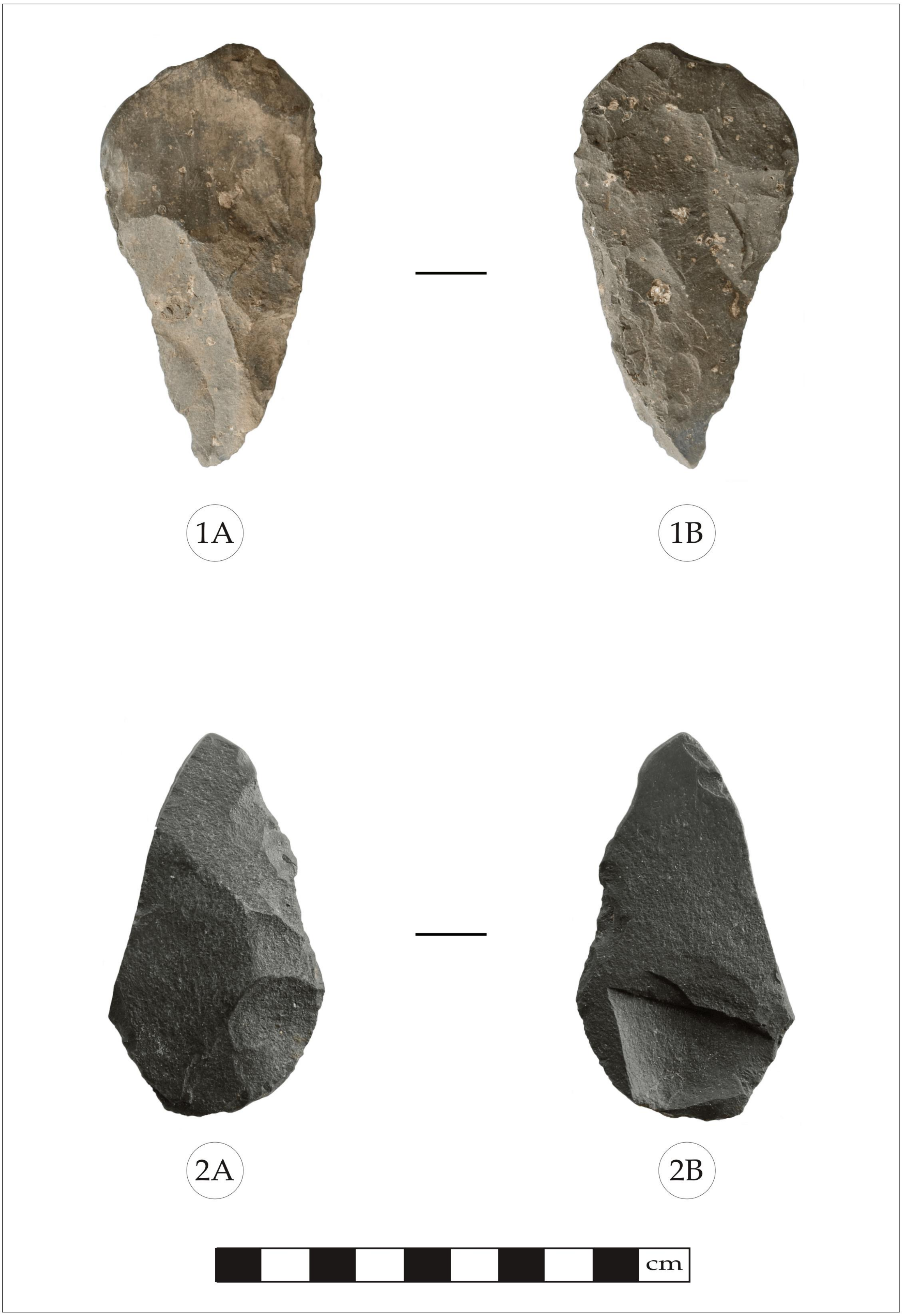

Fig. 7.: Selected artefacts (1A-1B=*Ce 20* site, 2A-2B=*Ce 43* site)
7. ábra: Válogatott eszközök (1A-1B=*Ce 20* lelőhely, 2A-2B=*Ce 43* lelőhely)

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The fourth implement from the site (**Fig. 7.** 1A-1B) has a rather elongated drop-shaped form. The raw material is also basaltic andesite. The lateral edges show traces of only necessary modifications by variable-sized detachments. The almost pointed distal end is asymmetric, and the distal edge is rounded intensively. On Face A (**Fig. 7.** 1A), the distal part is intensively polished, having dense scratch marks. These marks have a somewhat irregular, confusing pattern since there are several transversal or oblique marks as well. On Face B, only the very end of the implement is smoothed due to use. However, on the proximal part, especially on standout areas, there is smooth as a possible result of the hafting. The dimensions are 89.8 × 47.0 × 11.5 mm.

Ce 43 (Uspa Uspa)

This Formative site was excavated by Carola Condarco in 2000 (Condarco et al. 2002).

A stemmed field implement (**Fig. 8.** 2A-2B; see also Gyarmati & Condarco 2014, Plate XV, b) was made of black basalt. The implement has an irregular quadrangular/rectangular body and a chunky stem. The lateral edges of the stem are slightly curved and broadening towards the body. The shoulders are rough-and-ready made and have different lengths. The convergent-sided, pointed stem is bifacially worked. The sides of the stem have different lengths; both shoulders are roughly shaped through a suitable notch-like detachment. Except for the stem, all edges are intensively polished and rounded. Originally, the implements would have had a semi-circular silhouette. Viewing from Face A, the distal edge and the left lateral edge have several splinterings. The polished distal part of the right edge is a possible result of the manufacturing of the implement. The middle part of the stem is smoothed likely due to the hafting. The entire distal area on Face B is heavily polished and covered by scratching marks. The length of the implement is 88.5 mm, the width is 75.0 mm, and the thickness is 10.5 mm. The width of the stem at the shoulders is 42.0 mm.

In **Fig 9.** 1A-1B, there is a small taclla point (probably a spade) made of black basalt. The relative rarity of this highly valued long-distance raw material likely explains the deterioration of the implement. Its form is asymmetric to the longitudinal axis, the base is oblique, and the wings of the arrow-like blade have different shapes. The traces of several adjustments and necessary renewals of the implement are overall to be seen. The form due to these activities is irregular, asymmetric to the longitudinal axis, the base is oblique, the wings of the arrow-like blade have different shapes, and the contracting stem is somewhat atypical. The V-shaped distal edge is rounded having some splinterings. The standout left distal part on Face A is intensively polished and scratched. On the left distal part of Face B, there is only a small, smoothed area. The traces of hafting are not visible. The approximate dimensions are: length is 87.0 mm, width is 51.0 mm, and thickness is 11.0 mm.

In **Fig. 7.** 2A-2B, there is another small taclla point (probably a spade) made from a black basalt flake. Viewing from Face A, the left lateral edge had a straight-lined fracture, the right edge is bifacially worked. On Face B, the bulb of the flake was eliminated through a wide oblique detachment, causing a deep flaking scar on the base. The distal part of both edges and the tip is rounded. Intensive smoothness can be seen only on the very end of Face B, near the tip. The dimensions are 80.5 × 44.0 × 9.0 mm.

This implement has an egg-shaped form and was made from a thin fine-grained sandstone slab (**Fig. 10.** 1A-1B). The lateral edges are finely worked by bifacial detachments. The distal edge is somewhat damaged (due to splintering) and rounded. On both surfaces, slight traces of use can be seen. The dimensions are 84.9 × 66.5 × 5.0 mm.

The artefact in **Fig. 10.** 2A-2B (see also Gyarmati & Condarco 2014, Plate XV, c) has a drop-shaped form. This field implement was also made of amygdaloidal basalt. Except for the distal edge, both curved lateral edges are bifacially worked by irregular detachments. The partially damaged distal edge on Face B shows some detachments. The distal part of Face A is smoothed and covered by mostly longitudinal scratches. On the proximal part of Face B, there are rather vague hafting traces. The dimensions are 105.15 × 66.5 × 12.0 mm.

There is a small piece of black basalt (**Fig. 9.** 3), without having the characteristics of being a flake (no butt, no bulb is visible), which may be a fragment of a broken implement. Along the edges, there are sporadic fine detachments, making the tool similar to an end-scraper. The dimensions are (48.5) × (38.0) × (8.5) mm.

Ce 83 (Condarco & Gyarmati 2009, 77; Gyarmati & Condarco 2014, 30-31)

Two field implements made of black basalt from the *Ce 83* site is discussed shortly. Based on the surface scatter of finds, several sites can be classified as nucleated settlements. The site, or at least its core, was a tell-like mound, conforming to most Formative Period settlements whose occupation spanned several centuries.

The artefact in **Fig. 11.** 1A-1B (see also Gyarmati & Condarco 2014, 31, Fig. III.2 above) is a chaqui taclla point (probably a spade). As regards the manufacturing technique, it is similar to that has been observed by Pérez on some implements at the Río Doncellas site (Puna of Jujuy, Northwestern

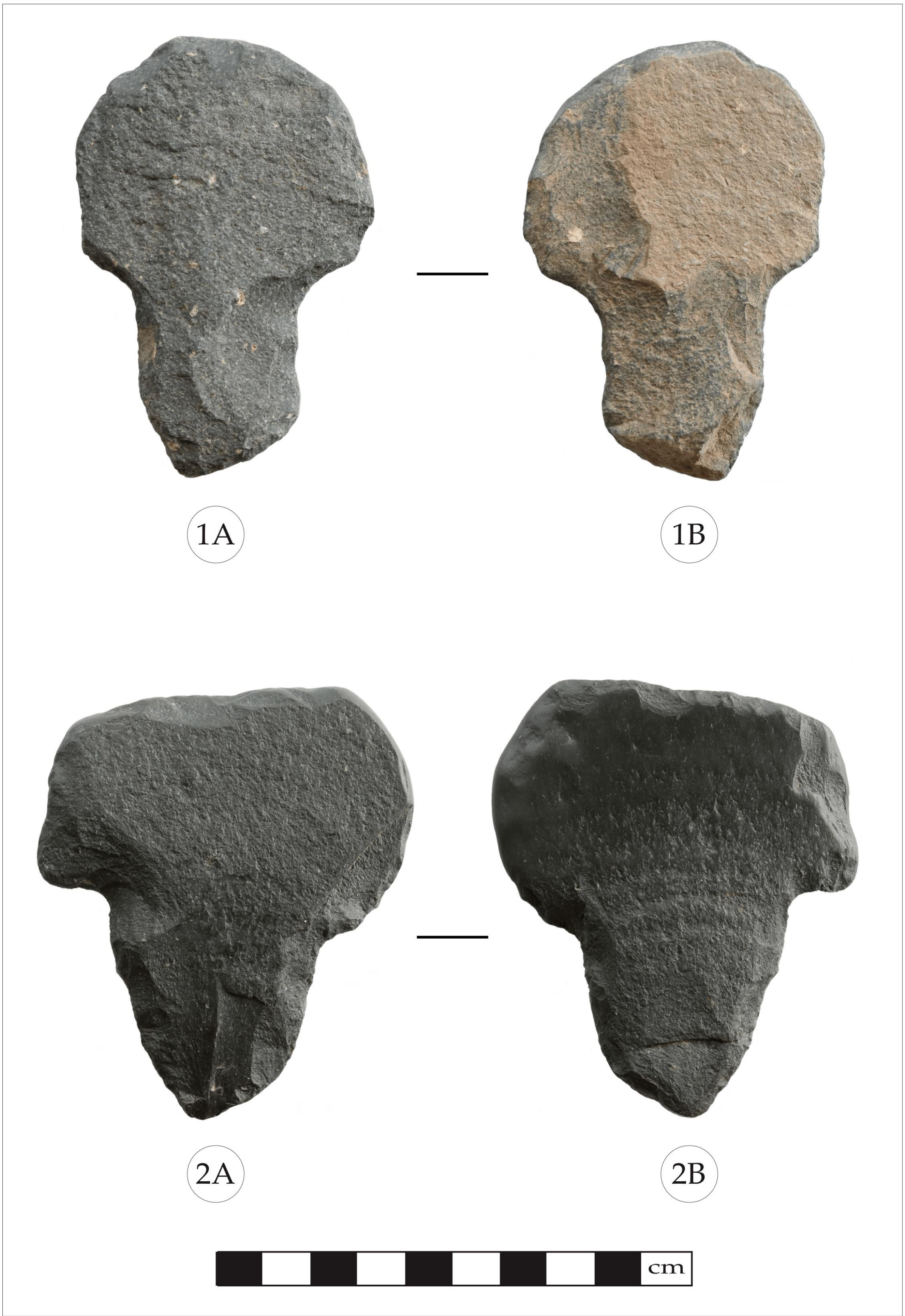

Fig. 8.: Selected artefacts (1A-1B= stray find, 2A-2B=*Ce 43* site)
8. ábra: Válogatott eszközök (1A-1B=szórványlelet, 2A-2B=*Ce 43* lelőhely)

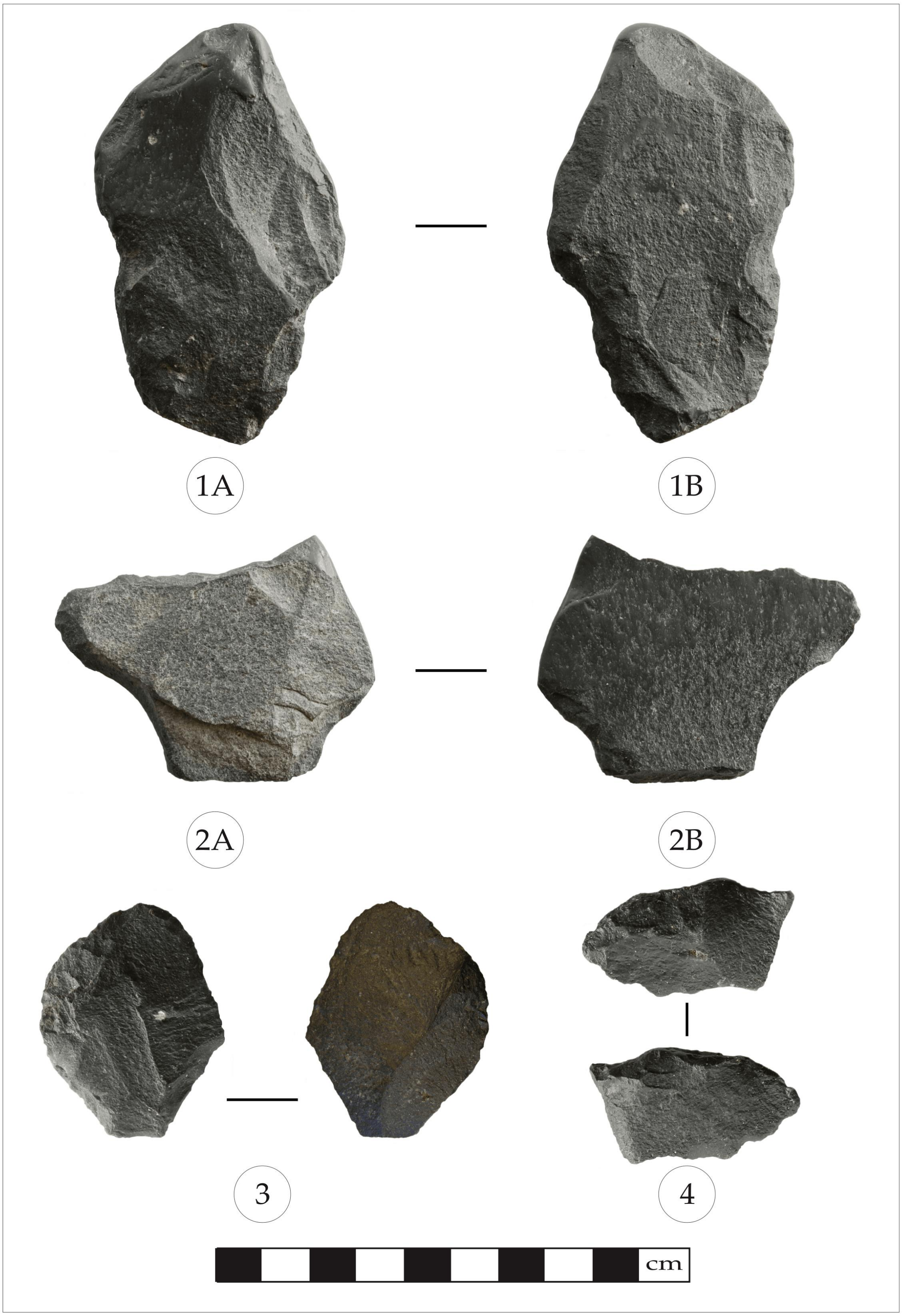

Fig. 9.: Selected implements (1A-1B=*Ce 43* site, 2A-2B=*Ce 1* site) and fragments (3=*Ce 43* site, 4=*Ce 100* site)
9. ábra: Válogatott eszközök (1A-1B=*Ce 43* lelőhely, 2A-2B=*Ce 1* lelőhely) és töredékek (3= *Ce 43* lelőhely, 4=*Ce 100* lelőhely)

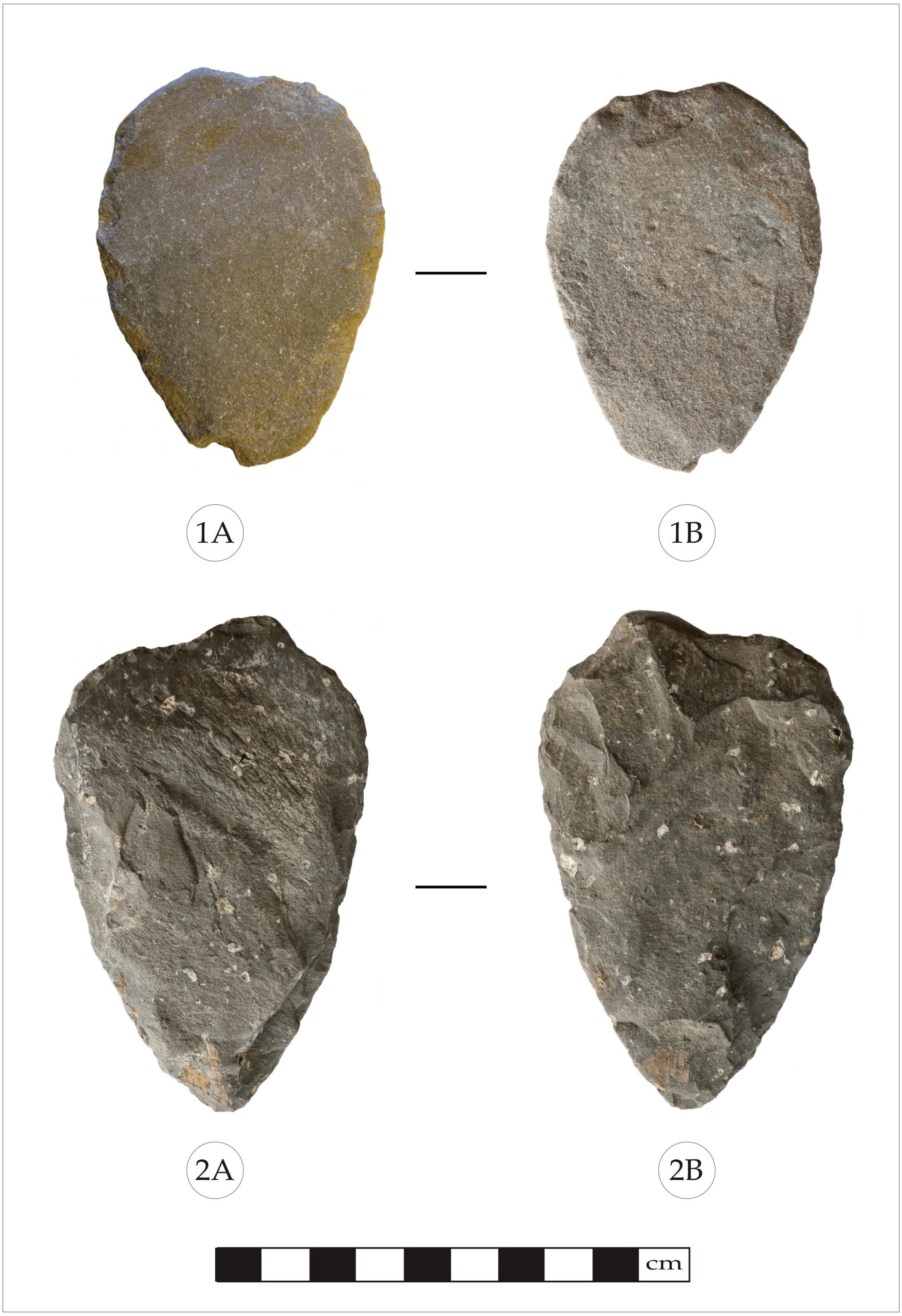

Fig. 10.: Selected artefacts from the *Ce 43* site
10. ábra: Válogatott eszközök a *Ce 43* lelőhelyről

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Argentina). The formatting was done by polishing (Pérez 2010b, 12, Fig. 5) in the part corresponding to the active working edge and by the technique of flaking and bifacial marginal retouching in the rest of the perimeter (lateral segments of the body, inflection body/peduncle and peduncle), being manufactured by direct percussion. The implement from the *Ce 83* site has a somewhat unusual form, namely its stem is wide, and the join between body and stem is not pronounced at all. The roughly straight-lined, convergent lateral edges of the stem are bifacially manufactured. On the photo on the right side of the figure, the polishing is recognizable along the edges. The dimensions are 150.3 × 89.0 × 13.7 mm.

In **Fig. 11.** 2A-2B, the implement (see also Gyarmati & Condarco 2014, 31, Figure III.2 below) is a hoe. It was made on a flake of considerable size. In the figure, on the left side, the lower (ventral) face of the flake can be seen, characterized by a diffuse bulb and bulb scar. On the right side, the upper (dorsal) face of the flake, there is a flaking scar, the trace of the previous detachment. The edge, along its entire perimeter, is bifacially retouched. The implement has an unusual ovaloid form, which is a transition between an unstemmed and stemmed implement. In this case, the stem is not pronounced, but the proximal part (the base) of the implement (at the top of the illustration) is markedly narrowed. The distal edge show traces of splintering and the distal part of the lower face is intensively polished due to wear. The dimensions are 125.0 × 84.0× 12.6 mm.

It is worthy to mention that, though tool manufacturing waste was found on several sites in the Paria Basin, lithic debris was represented in high proportion only at site *Ce 83*, which is the largest Formative Period settlement in the survey area. This can suggest that the site had functioned as a major production centre and that there had perhaps been some sort of division of labour among the Formative Period settlements of the Paria Basin. In general, judging by the relative scarcity of knapping waste products at the sites in the Paria Basin, it is possible that at least the majority of the instruments were made off-site. The marked difference between fragments and recovered waste products might indicate that the reduction process was carried out outside the settlements, either in quarries or workshops.

Middle horizon (Tiwanaku Period; between 400–1000 AD).

Ce 10 (Jachcha Uma River) (Condarco & Gyarmati 2009, 78; Gyarmati & Condarco 2014, 34).

There is a single implement found at this site (**Fig. 12.** 1A-1B). Its broken base is about straight-lined. Comparing to the entire surface of the implement, the breakage surface is not so worn. But in any case, the implement seems to be broken a long time ago. Its original form may have been oval. After the breakage which happened likely during the usage, the implement was used further. On Face A, there are light-coloured sporadic strains of the embedding sediment. The proximal part of both lateral edges is bifacially worked through short, wide detachments. The distal end is 11 mm thick, this part and the distal part of the lateral edges are rounded and polished. The smoothing has almost the same extension and intensity on both faces. On the area covered by smoothing, thin longitudinal striations can be seen. On Face A, next to the base, there is a little smoothed spot. On Face B, also next to the base, there is a greater, elongated smoothed area. These areas can be related to the hafting of the implement. The raw material is basaltic andesite. The implement's dimensions are 95.0 × 67.0 × 13.35 mm.

Ce 100 (Condarco & Gyarmati 2009, 78).

In **Fig. 13**, 2A-2B, there is a large, intact field implement made of basaltic andesite. On both faces, especially on Face A, there are light brown colored sporadic strains of the embedding sediment. Except for the proximal part, the edge is bifacially worked through rough, irregular detachments. With the naked eye, no trace of use can be seen at all. The dimensions are 134.0 × 82.0 × 20.0 mm.

In **Fig. 12.** 3A-3B, the broken distal end of a small taclla point (probably a spade) made of basaltic andesite can be seen. The upper surface, Face A (**Fig. 12.** 3A) is moderately smoothed. The lower surface, Face B (**Fig. 12.** 3B) is a cleavage surface. The fracture could have happened accidentally on an unknown score, despite the non-tabular nature of the raw material. The edge is worked through fine, tiny detachments. The recent measures are (48.0) × (40.0) × (5.0) mm.

Besides these implements, there is a small, fragmented piece made of black basalt ((49) × (23) × (7) mm). One surface of the fragment (**Fig. 9.** 4 above) is intensively smoothed. Another small, fragmented piece is also made of black basalt ((25.0) × (32.0) × (5.0) mm). Its undamaged surface is intensively smoothed, and its edge is rounded. The flat piece may have been splintered off the curved distal end of a small-sized field implement as the implement hit a hard object. During the Tiwanaku Period, the utilization of black basalt is well reported. In general, broken fragments of field implements were likely brought to the site to reuse them as small domestic tools, such as end-scrapers or retouched flakes.

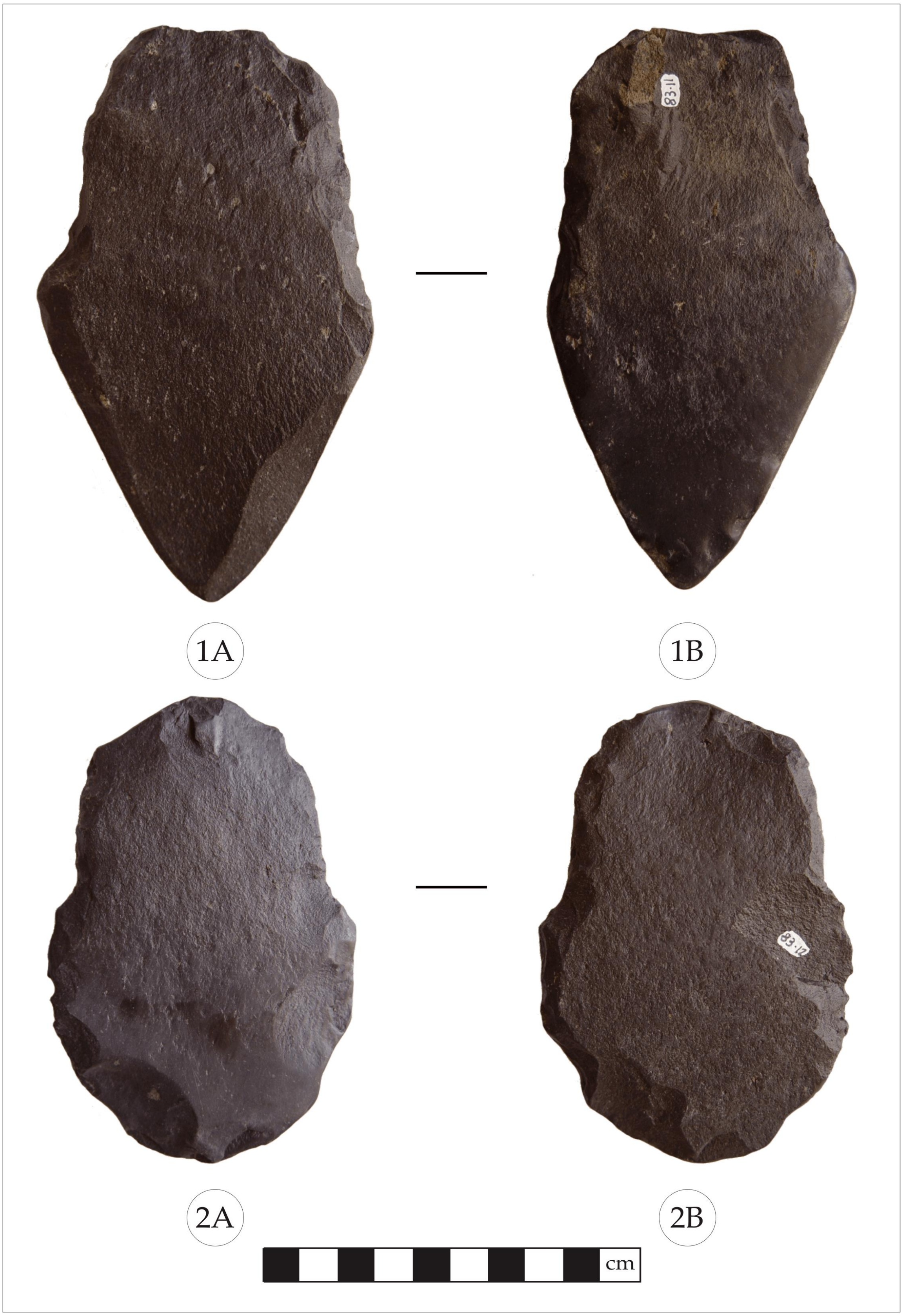

Fig. 11.: Selected artefacts from the *Ce 83* site
11. ábra: Válogatott eszközök a *Ce 83* lelőhelyről

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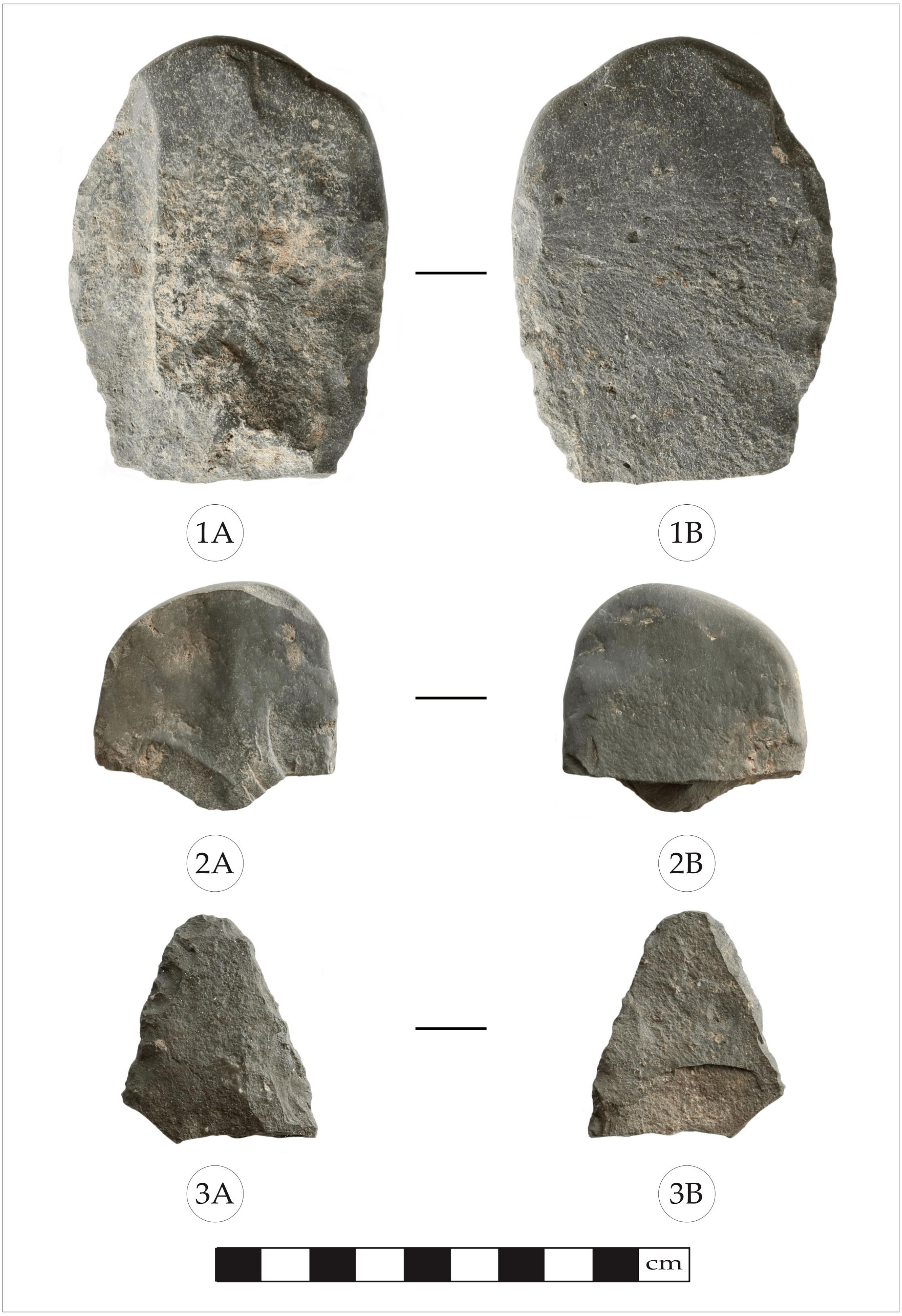

Fig. 12.: Selected artefacts (1A-1B=*Ce 10* site, 2A-2B=*Ce 112* site, 3A-3B=*Ce 100* site)
12. ábra: Válogatott eszközök (1A-1B=*Ce 10* lelőhely, 2A-2B=*Ce 112* lelőhely, 3A-3B= *Ce 100* lelőhely)

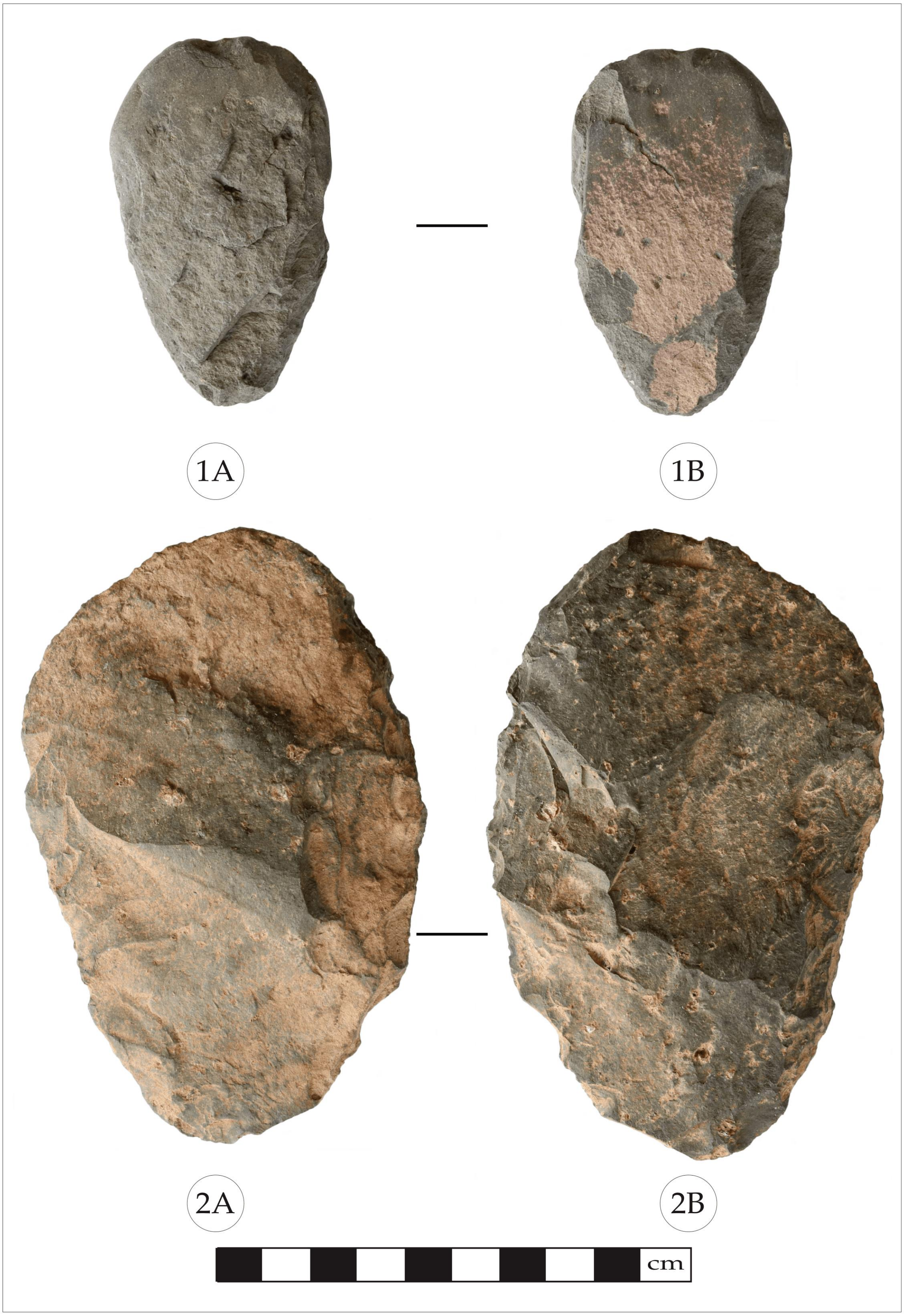

Fig. 13.: Selected artefacts (1A-1B= stray find, 2A-2B=*Ce 100* site).
13. ábra: Válogatott eszközök (1A-1B=szórványlelet, 2A-2B=*Ce 100* lelőhely)

Late intermediate period (between 1000–1400/1450 AD)

Ce 41 (Condarco & Gyarmati 2009, 79; Gyarmati & Condarco 2014, 32).

There is an asymmetric oval implement of enormous size (**Fig. 14.**; see also Gyarmati & Condarco 2014, Plate XV, h), made of fine-grained sandstone from this site. Along the edges, there are no traces of fine elaboration. The edges, even the straight-lined broken part of the left edge, are rounded. The distal end of the upper face (Face A) is damaged. This damage and the rounded edges may be the result of intensive working activity. The implement has dimensions of 205.1 × 130.0 × 18.75 mm.

Ce 51 (Condarco & Gyarmati 2009, 80).

There is an implement from the site (**Fig. 15.** 1A-1B) made of fine-grained sandstone. The artefact has an approximately straight-lined transversal fracture, which is perpendicular to the longitudinal axis. The breakage surface is uneven. The orientation of the implement cannot unambiguously be determined. Hereinafter this broken part will be referred to as the proximal part. The U-shaped edge is roughly elaborated by bifacial detachments. The edge bears no traces of any usage. At the same time, on the left side of Face A, there is an elongated indentation. Its recent length is 49 mm, the width is 39 mm, and the depth is about 1 mm. The surface of the bottom of the indentation shows evidence of some sort of grinding or rubbing activity. The possible biography of the implement should be the following. Firstly, the implement was used as a field implement (hoe). After breakage, the rest of the implement may have served as a grinding stone for smaller objects (for example bones or fragments of it). Lastly, probably during usage, the implement broke again and was discarded. The recent measures are (79.0) × (96.5) × (15.0) mm.

Ce 72 (Conchiri) (Gyarmati & Condarco 2014, 32)

In **Fig. 15.** 2A-2B (see also Gyarmati & Condarco 2014, Plate XV, d), there is an intact, drop-shaped implement made of black basalt. The implement is rough-and-ready shaped. On the edge, there are no traces of further working. On the distal end (on the working edge) on Face A, there are pittings. A small standout spot is polished moderately, no other traces of use are observable. The dimensions are 94.8 × 70.0 × 13.5 mm.

Late Horizon (Inca Period; between 1400/1450–1535 AD)

Ce 1 (Khota Chullpa; Iruma River) (Condarco & Gyarmati 2009, 77, 80-81; Gyarmati & Condarco 2014, 29)

In **Fig. 9.** 2A-2B, there is a mesial fragment of a likely implement made of black basalt. Considering the scratch marks on Face B, the orientation of the fragment is correct. Viewing from Face A, the right edge is polished and rounded intensively. Almost the entire surface of Face B is heavily smoothed. The recent dimensions are (51.0) × (72.0) × (9.0) mm. There are five small fragments of black basalt; two of the fragments have a polished, smoothed surface indicating that they derive from broken field implements and were brought to the site likely to reuse them.

Ce 112 (Tambo de Condorchinoca) (Condarco & Gyarmati 2009, 81-82).

The sole implement from the site (**Fig. 12.** 2A-2B) is made from very fine-grained silty sandstone. The artefact has an approximately straight-lined transversal fracture en languette, which is perpendicular to the longitudinal axis. The fracture could have happened during the use of the implement. According to Vidale and colleagues (2013, 123), similar fractures are due to inflection efforts, in which pressure is exerted along the whole length of the blade; and in such cases, the fracture does not necessarily fall near the point of contact with the modified material. The breakage surface is uneven. The U-shaped edge is polished due to the manufacturing and rounded due to the use. Both faces are smoothed with the same

Fig. 14.: An artefact from the *Ce 41* site

14. ábra: Egy eszköz a *Ce 41* lelőhelyről

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Fig. 15.: Selected artefacts (1A-1B=*Ce 51* site, 2A-2B=*Ce 72* site)
15. ábra: Válogatott eszközök (1A-1B=*Ce 51* lelőhely, 2A-2B=*Ce 72* lelőhely)

intensity. Especially, on Face B, on the smoothed area, thin longitudinal striations can be seen. The recent measures are (48.0) × (51.5) × (9.0) mm.

Description of the agricultural stone implements found as stray finds in the Paria Basin

During the field surveys carried out by the Paria Archaeological Project, three implements were found, that cannot be connected to any of the archaeological sites, they can be considered stray finds.

In **Fig. 13.** 1A-1B, there is a small-sized oval field implement made of amygdaloidal basalt. The lateral edges are bifacially worked. The U-shaped distal edge is partly damaged (splintering) but intensively rounded. The distal part of both faces is smoothed. On Face B the remains of the weathering layer can be seen. The dimensions are 78.5 × 46.5 × 11.5 mm.

In **Fig. 8.** 1A-1B (see also Gyarmati & Condarco 2014, Plate XV, g), there is a small-sized stemmed field implement made of amygdaloidal basalt. The implement has a pronounced curved distal end, the oblique stem is chunky. The shoulders and the contact points between the body and stem are finely curved. On the whole, the body has a semicircular shape. The stem is somewhat twisted, the base is oblique. On the edges, there are only the most necessary adjustments were done. The semi-circular edge is rounded. On both faces, next to the edge some smoothing is observable. The left distal area of Face B is covered by a patina layer. On the stem, there are no hafting traces to be seen. The dimensions are 91.5 × 62.0 × 11.5 mm.

The oval field implement in **Fig. 5.** 2A-2B was made on a tabular (laminar) fine-grained sandstone piece. The edges are roughly, bifacially worked. The straight-lined distal edge is rounded. The distal part of Face A is partially scratched. Viewing from Face A, on the left part of the surface, there is a lengthy deepening, making the impression that this area might have been served for grinding or rubbing function as well. The dimensions are 112.2 × 54.5 × 9.5 mm.

Discussion

Raw material utilization of the agricultural stone implements

The lithic raw materials of the analyzed agricultural stone implements were categorized macroscopically according to several characteristics, such as colour, texture, inclusions, hardness and magnetic susceptibility. This analysis has been carried out with the help of the geologists Sándor Józsa, Tamás Sági, and György Szakmány of the Department of Petrology and Geochemistry, Eötvös Lóránd University in Budapest. It should be emphasized that there is only indirect evidence that the volcanic raw materials originate from the relatively close geological areas discussed above in the context of geological backgrounds.

Since the majority of the analysed artefacts originate from archaeological sites belonging to the Formative Period, in some places, comparative remarks regarding the use of raw materials in the nearby La Joya region will be made.

A) The most common lithic raw material at Paria Basin sites is comprised of intrusive igneous rocks.

1) The first type is some variably medium-dark grey to black volcanic rock, called amygdaloidal basalt of likely regional origin. Gas bubbles entrapped in the magma during the generation and create macroscopic spherical cavities in the solidified rock. After some time, groundwater or hot solutions connected with the volcanic activity pass through the porous lava and deposit crystals in the open cavities, which gradually fill up with quartz, calcite or zeolites. Filled cavities in lavas are called amygdales, which have usually white. The rock containing amygdales will be called amygdaloidal. The use of amygdaloidal basalt is documented at the *Ce 20* site (**Fig. 5.** 1A-1B, 2A-2B; **Fig. 10.** 1A-1B), and there are also three stray finds (**Fig. 13.** 1A-1B; **Fig. 10.** 2A-2B; **Fig. 8.** 1A-1B).

2) The second type is not so characteristic in its appearance, so it can be generally called basaltic andesite. This type of rock is dark grey. The fracture is rough and irregular. The structure of the rock is granulated fine and compact, characteristics that give rigidity greater resistance to wear. This raw material is present at two sites (*Ce 10* (**Fig. 12.** 1A-1B) and *Ce 100* (**Fig. 12.** 3A-3B; **Fig. 13.** 2A-2B)).

As regards the nearby La Joya area, according to Fox (2007, 162), without any petrological or geochemical analysis, the most commonly used raw materials for the production of bifacial hoes can be characterized as andesite or dacite, being of medium-fine to medium texture, with few crypto-crystalline inclusions. Andesites and dacites are locally available in the La Joya area.

3) The third type of volcanites is vitreous black basalt, which is categorized as a long-distance raw material. The major source of black basalt in the Bolivian highland was the Querimita mine (Péntek & Faragó 2019). It is located on the southwestern shores of Lake Poopó in Oruro (Ponce & Mogrovejo 1970) some 200 km from La Joya and the Paria Basin. Large amounts of basalt debris still litter the surface of the Querimita outcrop. Basalt mining is documented to begin in the Formative

HU ISSN 1786-271X; urn: nbn: hu-4106

Period since Wankarani ceramics have been identified at Querimita (Kolata 1996, 369).

According to McAndrews (1998, 184), the Wankarani also participated in the long-distance exchange of basalt. The black basalt has a highly vitreous texture, a very homogeneous structure and produces sharp flaked surfaces, suggesting that it would have been a valuable commodity to consumers. Given the great distance to the Querimita mine, the black basalt raw material was likely imported to La Joya and the Paria Basin in a "semi-reduced" state, that is, in the form of cleaned tool blanks and macroflakes without cortical waste (Aoyama 1995; Fox 2007; Beaule 2002).

In the Paria Basin, black basalt is present at three sites (*Ce 1* (Paria; **Fig. 9.** 2A-2B), *Ce 43* (Uspa Uspa, **Fig. 7.** 2A-2B; **Fig. 8.** 2A-2B; **Fig. 9.** 3; **Fig. 13.** 1A-1B), and *Ce 100* (**Fig. 9.** 4)), in the form of very intensively used field implements, but there are several little fragments and shatters. These pieces, however, are not manufacturing waste products, some of them showing use traces, implicating that the fragments are parts of broken field implements. It is very likely, that even the smallest fragments may have been re-used as expedient tools.

B) The second most important raw material category is that of sedimentary rocks, containing mostly sandstone. Sandstone is composed of sand-size grains of mineral, rock, or organic material. It also contains a cementing material that binds the sand grains together and may contain a matrix of silt- or clay-size particles. Mineral grains in sandstones are usually quartz (sometimes up to 90% or more).

According to Fox (2007, 162), the above-mentioned locally available sedimentary rocks were the most commonly used sedimentary rocks in the La Joya area. During the Formative Period, these were primarily used to produce flakes and expedient tools, though these were also sometimes applied for bifacial field implements.

In the Paria Basin, the use of fine-grained sandstone seems to be very common in all archaeological periods. In the Formative Period, there are specimens at the sites of *Ce 20* (Anocariri Pampa; **Fig. 5.** 1A-1B; see also Gyarmati & Condarco 2014, Plate XV, e), and *Ce 43* (Uspa Uspa; Fig. 10, 1A-1B). In the Late Intermediate Period, sandstone is present at the sites of *Ce 41* (**Fig. 14.** see also Gyarmati & Condarco 2014, Plate XV, h) and *Ce 51* (**Fig. 15.** 1A-1B). In the Late Horizon (Inca Period), there is also an example at the site of *Ce 112* (Tambo de Condorchinoca; **Fig. 12.** 2A-2B). There is also a stray find, an oval field implement, which was made on a tabular (laminar) fine-grained sandstone piece (**Fig. 5.** 2A-2B).

Morphological categories

Among the field implements from the Paria Basin, regardless of any possible morphological transformation through maintenance and repair activities, two main morphological categories were defined.

1) Unstemmed implements

As regards the almost intact measurable instruments, the first main morphological category is where the instrument has no stem (tang, peduncle).

On the grounds of the above-described ratios, among the 11 unstemmed implements from the Paria Basin, three forms were classified.

Form 1) Two implements are somewhat stubby egg-shaped. The L/W and L/PW ratios are relatively low, with mean values of 1.43 and 2.28 respectively. Both implements were made of fine-grained sandstone (**Fig. 10.** 1A-1B; **Fig. 14.**).

Form 2) Four implements have elongated ovaloid shapes. The length varies between 78.5–134 mm; the mean value is 112.88 mm with a rather high standard deviation of 24.65. The width varies between 46.5–82 mm, the average is 61.88 mm, and the standard deviation is 15.3. The L/W and L/PW ratios are a little bit higher than for the previous form, the mean values are 1.86 and 2.57 respectively. Two implements were made of fine-grained sandstone (**Fig. 5**. 1A-1B, 2A-2B), and the other two implements of igneous rock (amygdaloidal basalt (**Fig. 7.** 1A-1B) and basaltic andesite (**Fig. 13.** 2A-2B).

Form 3) Five implements have elongated drop-shaped, sub-triangular forms. The length and width are variable, but they range in relatively narrow intervals, between 89.8–106.7 mm, and 47–66.5 mm respectively. The standard deviations are moderate, 7.25 and 9.92 mm. The L/W ratio is about the same as for Form 2, the mean value is 1.74. The L/PW ratio is significantly higher with a mean value of 3.12. There is an outlier, an extremely elongated implement with an L/PW ratio of 3.82 (**Fig. 7.** 1A-1B).

The substantial difference between Form 2 and Form 3 is that the latter has a narrower convergent proximal part. Both forms seem to be manufactured in a standardized manner. For all forms, the narrower end proved to be the proximal part to haft the implement. According to the hypotheses formulated by Pérez (2008, 207), the morphological differences (both within the same morphological standard and between Early Formative vs. Late Formative) of the lithic shovels and/or hoes would be associated with different modes of action. The lithic spades/shovels and/or hoes used with different modes of action will present differential wear traces, such for example striations (scratching marks) with different orientations and extensions in the active edge, which allow isolating functional indicators. Without detailed use-wear analysis, it is hard to decide the assumed agricultural functions carried out by the instruments. The above-mentioned three different shapes may indicate different functionalities but may also indicate different stages in the biography of a given tool, for some reason or other the proximal end, to sit up for hafting, was gradually restricted, and narrowed down. Based on the available literature, during the Formative Period in Bolivia the egg-shaped and oval forms seem to be very common (Bermann & Estévez 1995, Fig. l0; Bermann 1997, 100, Fig. 5c; Pärssinen 1999, 190-191, Figs. 12-13; Beaule 2002, 57; 295). The available morphometric data on unstemmed implements are rather scarce. Marc Bermann and José Estévez Castillo (1995) presented investigations at the “Wankarani complex” site of San Andrés. The excavations revealed among other artefacts chipped stone bifaces (hoes) in domestic contexts. The bifaces were made of black basalt from the Querimita quarry at Lake Poopó. The whole bifaces were measuring between 70–150 mm long.In Figure 10 (Bermann-Estévez 1995, 396), a sample of bifaces found in a cache context was represented. Most implements have oval, elongated egg-shaped or drop-shaped forms. The dimensions of the largest implement are 122 × 75 × 16 mm.

In Fig. 10, in Christine Beaule (2002, 57), there is a sample of black basalt bifacial hoe or handaxe from Jachakala. The two undamaged examples on the left have approximately oval forms, their reproduced measures are 105 × 65 mm and 95 × 63 mm respectively. There is an egg-shaped bifacial hoe or handaxe example from Jachakala in Fig. 71 (Beaule 2002, 295). The unpolished and highly polished (used) part of the surface is indicated. The reconstructed measures are 98 × 66 × 15 mm. In Fig. 16 and Fig. 17 (Giesso 2010, 229), there are large bifaces from the Formative Period pre-Tiwanaku occupation of Lukurmata, from the site of TMV-79. That one in Fig. 16 (Giesso 2010, 229) has a somewhat asymmetric drop-shaped form. It is rather small-sized having measures of 68 × 48 × 13 mm. The other tool, in Fig. 17 (Giesso 2010, 229) has an elongated trapezoid form. Its measures are 98 × 50 × 20 mm. As regards the raw material of the illustrated large bifaces in Figs. 16-17, those are likely made of quartzite. The „chipped-stone hoe” from Lukurmata, illustrated in Bermann (1997, 100, Fig. 5c), has an egg-shaped form. The estimated measures are 75 × 35 mm. In the Upper Desaguadero Valley (Bolivia), in Sector 2 of the site Cerro Chijcha, there is an extraordinarily large oval andesite hoe (Smith et al. 2014, 110, Fig. 4c). The implement has a length of 354 mm, and a width of 155 mm. During the prospecting stage of the Pumiri Archaeological Project, on the agriculturally cultivated terraces of “Pumiri Loma”, unstemmed hoes of different shapes and forms were also found from the Inca period (Méncias Bedoya 2007, 91, Fotografía 10.). Among the discernible forms of the relative whole implements, the oval or ovaloid form dominates. There is an implement with a pronounced elongated oval form. Based on the scale below the photo, the length of the rather small implements varies between 60–110 mm. From the Qaluyu site of Callacoyo in the Quilcamayo-Tintiri Valley, located in the northern part of the Titicaca Basin, Henry Tantaleán represented a wide oval hoe made of grey andesite (2010, Fig. 303). The base of the implements is straight-lined but oblique. The edge is in its entire perimeter bifacially manufactured. The dimensions of the implements are 138 × 100 × 15 mm.

At the Formative Period (broadly defined as the period between 1500 BC–500 AD) site of Chiquero in the Colca Valley, located in the southwestern Peruvian highlands, the large sample of recovered hoes may reflect, in part, opportunistic exploitation of the abundant basalt reefs (outcrops) found on the surface. However, the site was not just a lithic workshop, since the evidence of wear, polishing and use striations at their distal ends indicate that the implements were used and not only elaborated locally. The hoes represented by Wernke (2011, 211, Fig. 7), are large-sized and have an elongated oval form. The base of the implement in Fig. 7A is possibly broken and has a length of 240 mm, and a width of 110 mm. There are oval examples from the Early and Late Sillumocco (900 BC–200 AD and 200–400 AD) and Tiwanaku site of Tumatumani, which is located in the southwestern Titicaca Basin of southern Peru. The complete hoe, represented in Stanish and colleagues (1994, 104, Fig. 166) has an oval form with a straight-lined base. Its dimensions are 263 × 135 × 25 mm. For the few recovered examples of hoes, Stanish and colleagues (1994, 66) gave rather variable size ranges, the length varies between 110 and 255 mm, and the width between 115 and 140 mm. The thickness is between 19 and 21.5 mm. In any case, these implements from Tumatumani are, at least partly, significantly larger than the Bolivian ones. The somewhat damaged, almost parallel-sided artefact represented by Zapata Benites (2016, 47, Fig. 24 on the right; after Steadman 1995, Figs. 18-19; see also Tantaleán 2010, 107, Figs. 35-36) from the Qaluyu era of Camata has an oval form. The dimensions are 220 × 120 × 24 mm, with an L/W ratio of 1.83, which is similar to those of the Bolivian specimens.

The multicomponent site of Taukamayo (Colca Canyon, Southern Peru) was tested in the course of the 2003 survey and two partial test units that produced dates ca. 650–870 cal AD (Tiwanaku period; Tripcevich 2007, 623). The site contained an exceptional collection of 16 large, broken andesite hoes, which varied considerably in size, and it is difficult to assess the original, unbroken size of the implements. The approximate dimensions of the parallel-sized implement (Tripcevich 2007, 631 Fig. 6-66, left) are 305 × 135 mm. The asymmetric, oval implement (Tripcevich 2007, 631 Fig. 6-66, right) is 305 mm long, but significantly wider (170 mm), and the lateral edges are convergent. The hoes ranged in weight from 112 g to one as large as 1189 g (shown in Tripcevich 2007, 631 Fig. 6-66, right), with a high variance. The mean weight was 512 g, but with a standard deviation of 483.7. The initial shaping of the hoes was made through percussion flaking, the working was manufactured by bifacial flaking.

The drop-shaped form seems to be rather rare. Some examples are represented in the Titicaca Basin, from Pajcha Pata de Caquiaviri (Pärssinen 1999, 190-191, Figs. 12-13) and Lukurmata (Giesso 2010, 229, Fig. 16). From the Wankarani site of San Andrés, among the represented "cached" implements, there are some relatively small specimens (100–120 mm long) having a drop-shaped form (Bermann & Estévez 1995, 396, Fig. 10). The dimensions of the largest drop-shaped implement are 113 × 54 × 12 mm, with an L/W ratio of 2.09. The large artefact represented by Zapata Benites (2016, 47, Fig. 24 on the left; after Steadman 1995, Figs. 18-19) from the Qaluyu era of Camata has an extraordinarily elongated oval or drop-shaped form. The dimensions are 413 × 160 × 32 mm. The maximal width is equal to the proximal width since it was measured at 20% of the length from the proximal to the distal end. The L/W or L/PW ratio is 2.58, which is rather characteristical for the oval forms.

From the radiocarbon-dated site of Ojo de Agua (680± 70 BP (LP-1520); Albeck 2019, 151, Table 1) in the area of Casabindo (Puna de Jujuy, Northwestern Argentina), Julio C. Ávalos represents a "lanceolate" field implement from a surface collection (Ávalos, 1998, 294, Fig. 3, 2A-2B). It is a rather large instrument, the length is 202.5 mm, and the width is 97 mm. Its dimensions significantly exceed those of the known Bolivian implements. However, its morphometric indices, the L/W and L/PW ratios are almost the same as those of them.

2) Stemmed implements

The second main morphological category is where the implement has a stem (tang, peduncle) for hafting purposes. Among the stemmed implements, the chaqui taclla was considered generally the most important technological invention, which has a very long tradition everywhere in the Andes (Donkin 1970, 514-519; Gade & Rios 1972; Bourliaud et al. 1986; 1988; Morlon 2007). There is no explicit information about the size of a taclla, which might have been variable, according to the assigned functionality. As Melissa A. Goodman-Elgar noted (2003, 51), chaqui tacllas vary in form and use which may be connected to different soil qualities. The various forms are suited to different agricultural activities such as a wide blade for turning over the sod and a pointed blade for planting. Overall, it can be assumed, that the chaqui taclla may have had a length of between 40 and 50 cm (see, for example, Bourliaud et al. 1988, 20, Fig. 2, after Rivero Luque 1987; 24, Fig. 4). In the study of Armenio F. Galindez, several types of chaqui taclla with 30-40 cm long metal blade are represented (1981, 39-40, Figs. 7-8). After Rivero Luque (1987, 12-13), Stanish and colleagues (1994, 66) mentioned the smaller makitaqlla, which was a hand-held implement used for digging individual tubers, much like a gardener's trowel.

Though the occurrence of the stemmed implements in the Formative Period is not reported, it should not necessarily mean that there were none. It can be the result of certain research hiatus or lack of information about the existing but not analyzed assemblages. Site *Ce 43* (Uspa Uspa) in Paria Basin was classified as Formative. The presence of the stemmed implement (**Fig. 8.** 2A-2B; see also Gyarmati & Condarco 2014, Plate XV, b) and the two small taclla points (**Fig. 7.** 2A-2B; **Fig 9.** 1A-1B) seems to be contradictory with earlier considerations. However, these implements may belong to the Inca period. It cannot be excluded that the small taclla point from the Paria Basin was also a hand-held implement. There are only five intact stemmed implements investigated from the Paria Basin. In **Fig. 9.** 2A-2B, the fragmented piece of black basalt may have originally been the stem of a hoe. In **Fig 9.** 1A-1B, the small taclla point was made from black basalt. The two other stemmed instruments are made from amygdaloidal basalt (**Fig. 8.** 1A-1B) and black basalt (**Fig. 8.** 2A-2B). According to a generalized classification, these implements can be named hoes. In **Fig. 11.** 1A-1B, the small taclla point and in **Fig. 11**. 2A-2B, the hoe were made from black basalt.

Conclusion

Based on the small number of agricultural stone implements, it is not possible to judge the connection of the Paria Basin to the wider archaeological context, the ceramic material is much more suitable for this purpose. It is problematic to evaluate the relatively small assemblage, mostly containing stone implements from scattered sites, or even stray finds.

Concerning the raw material utilization in the Paria Basin for manufacturing the bifacial implements, only a general statement can be made. As at the

Wankarani sites, bifaces were produced probably either from local sedimentary stone or from igneous rocks that might be available within a few kilometres of communities, and from vitreous black basalt that was imported from considerable distances. Based on **Table 1.**, however, it is distinct that no clear tendency in the archaeological period and the used raw material can be formulated. As no recognizable change in raw material utilization exists, so the manufacturing technique seems to be also constant for a long period. For obvious reasons, the more fine-grained the used raw material, the more precise the elaboration of the tools.

As a lesson learned from the performed analyses, some general remarks about Central Andes agricultural stone implements need to be made.

The question may arise whether the morphological, morphometric features, size and weight differences of the implements can be interpreted as a kind of chronological marker. Or perhaps due to cultural traditions, differences in the agricultural cultivation processes and technologies (soil structure, nature of cultivated plants, etc.) justify them.

In connection with the above briefly described implements, it seems that stemmed forms are not known either in the Titicaca Basin or in Southern Peru but are found for example in the Wanka culture in Central Peru (Russell 1988, 140, Fig. 4.1; 238, Fig. 6.2). At the same time, in Northwestern Argentina, most field implements are stemmed forms; the "lanceolate" form represented by Julio C. Ávalos (Ávalos, 1998, 294, Fig. 3, 2A-2B) is exceptional.

Regardless of the raw material, and the differences in form, the field implements from Southern Peru and Northwestern Argentina are generally larger-sized than the Bolivian ones. It can be assumed that these field implements significantly differing in dimensions either should have had different agricultural functions (if any) or should have been used under different conditions. In the course of the research project in the Upper Mantaro Valley (Junin region of the central Peruvian highlands), Glenn S. Russell (1988) made a comprehensive analysis of a variety of artefacts recovered from excavations of Wanka residence units from the Wanka II phase (1350–1460 AD) immediately before Inca conquest and the Wanka III phase (1460–1532 AD) under Inca domination. The most important agricultural tool made from stone is the stemmed hoe of a semi-circular form (Russell, 1988, 140, Fig. 4.1; 238, Fig. 6.2) commonly found in habitation sites from the Early Intermediate Period. These hoes vary in size and shape; the lengths range from approximately 10 cm to 20 cm and widths range from approximately 8 cm to 15 cm. According to Russell, given the relatively small size of the hoe blade, and the relatively brittle nature of the stone used to make hoes (coarse-crystalline intrusive or fine-crystalline volcanic rocks, phyllite (metamorphosed shale)), it is not likely that hoes were used to break ground or other heavy earth moving agricultural practices. It is more likely that this tool served as a cultivating tool, used in planting, mounding, furrowing, weeding, and harvesting.

Based on **Table 1.**, the agricultural stone implements from the Paria Basin seem to be rather lightweight. This fact raises understandably the question, what possible working activities could have been executed with them.

Hopefully, the above short description of the field implements from the Paria Basin has shown the necessity of processing and publishing some comparatively larger and morphologically more varied other lithic assemblages to gain further information about possible cultural connections of affected archaeological periods.

Acknowledgements

The fieldwork of the Paria Archaeological Project (PAP) was carried out by the grants of the Hungarian Scientific Research Fund (OTKA Grants T 047048), the Curtiss T. Brennan & Mary G. Brennan Foundation and the Heinz Latin American Archaeology Program (University of Pittsburgh) with the permission of the Bolivian Dirección Nacional de Arqueología (DINAR AUT. No. 27/04, 030/05, COM. EXT. 228/06).

The authors would like to express their special thanks of gratitude to the geologists Sándor Józsa, Tamás Sági, and György Szakmány at the Department of Petrology and Geochemistry of the Eötvös Lóránd University for their indispensable assistance in the macroscopic identification of raw materials.

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HU ISSN 1786-271X; urn: nbn: hu-4106 © by the author(s)