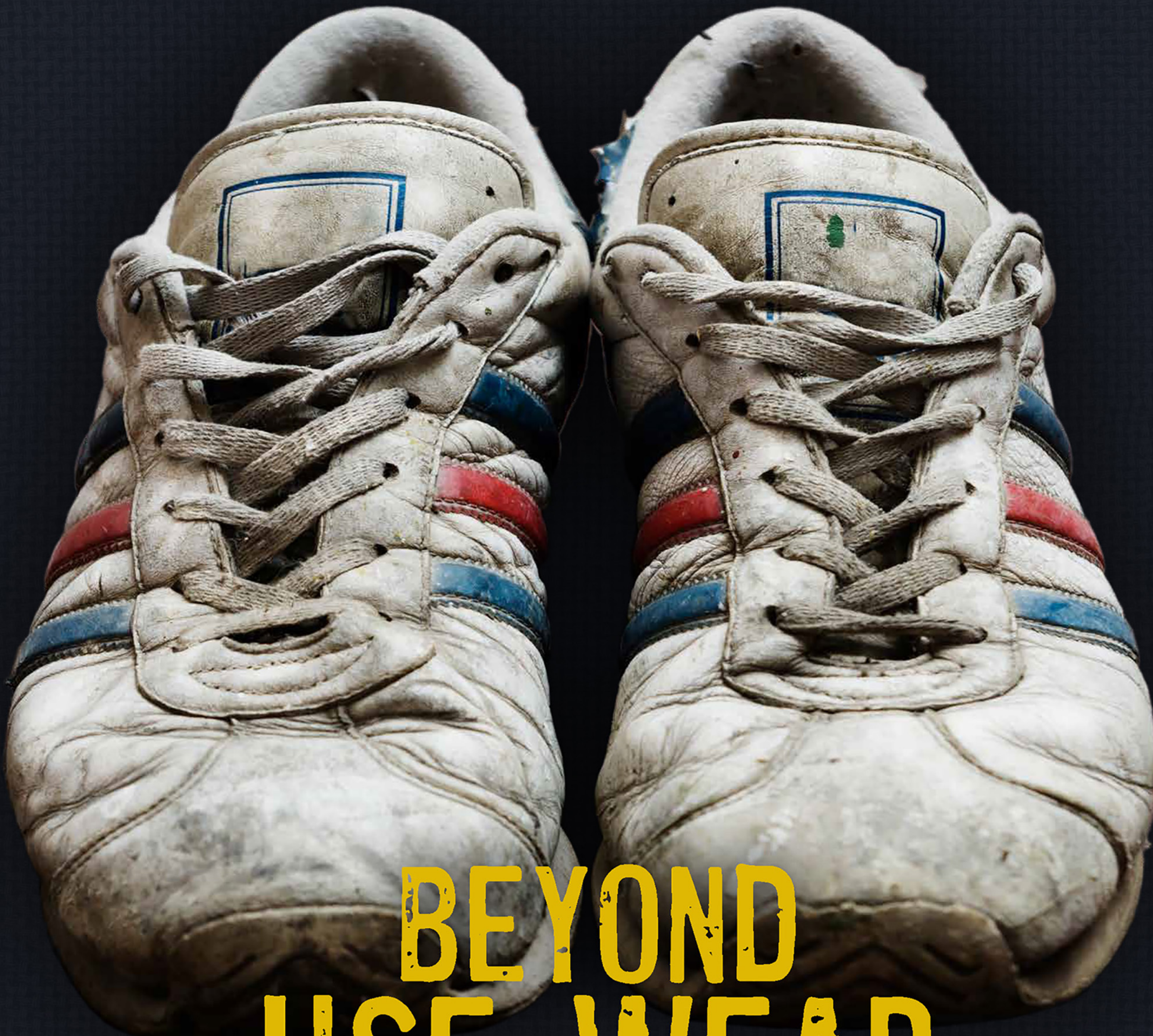

BEYOND USE-WEAR TRACES

GOING FROM TOOLS TO PEOPLE BY MEANS OF ARCHAEOLOGICAL WEAR AND RESIDUE ANALYSES

SYLVIE BEYRIES, CAROLINE HAMON & YOLAINE MAIGROT (EDS)

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PART 2 - TOWARD TECHNICAL BEHAVIOR

Lithic artefacts and the production of metallic goods

A case of study in north-western Argentina

Erico G. Gaál and Hernán De Angelis

Abstract

The objective of our research is start to understand the processes of knapping and the use of lithic artefacts involved in the production of metallic goods in the Rincon Chico 15 metallurgical workshop, located in the Andean region of north-western Argentina, during the Late Period (ca. 900-1500 AD). The approach combines the complementary perspective of experimental work with native copper and the use-wear analysis of lithic artefacts. Such an approach has never been carried out in technological studies of Argentine archaeology and the available information on the subject for the southern region of the Andes is very limited. The results obtained so far have allowed us to begin to recognize the diversity of traces present in lithic artefacts that could indicate their use at different stages of the production of metal goods in the workshop. We consider as an initial hypothesis that some of the recorded microscopic traces occurred during deformation, rolling or polishing work in native copper and tin bronze. Trace analysis also allowed us to observe the presence of impregnations unknown so far in other artefacts from metallurgical contexts in local archaeology.

Keywords: Lithic tools, metal production, experiments, Argentina

Introduction

According to several researchers, the pre-Hispanic metallurgy of the Andean world was not oriented towards the production of weapons or tools, but mainly to obtain ornamental pieces that symbolically reflected different aspects of the mythical universe. The transformation of raw materials into artefacts produced by humans implied a “recreation” of matter, which meant that metallurgists possessed a hidden knowledge

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Figure 1: Satellite image of the south of the Yocavil valley, Catamarca province, north-west Argentina. The red dot indicates the location of the archaeological settlement of Rincon Chico.

and the power to manipulate the vital forces of nature. This privileged knowledge of the metallurgists was put at the service of the political-religious structures organized by Andean societies from the beginning of the Early Horizon (ca. 900-200 BC) in the Central Andes (Lechtman 1980). The metallurgical tradition of north-west Argentina reached its greatest development during the Late Period (ca. 900-1500 AD). The increase in the production of bronze articles was manifested in the quantity and variety of pieces manufactured, as well as in the volume of material invested in each piece. This type of production was maintained later during the Inca domination.

While archaeometallurgy in the southern Andes has been concerned mainly with the extraction, sourcing and smelting of minerals, much less effort has been devoted to the final stages of metal production (González 2004). The processes of rolling, forging, polishing, decorating and sharpening metal objects, among others, were often carried out with specialized lithic artefacts. For that reason, our research began with an experimental program of replication of copper and tin bronze goods using only experimental lithic artefacts similar to those excavated in the Rincon Chico 15 metallurgical workshop, located within the archaeological settlement of Rincon Chico, in the Catamarca province, north-west Argentina, in the Southern Andes.

The archaeological settlement of Rincon Chico extends over an area of 50 km^2 and is located on the western strip of the Yocavil Valley, Catamarca province. The settlement is made up of about 37 sets of structures that worked like a

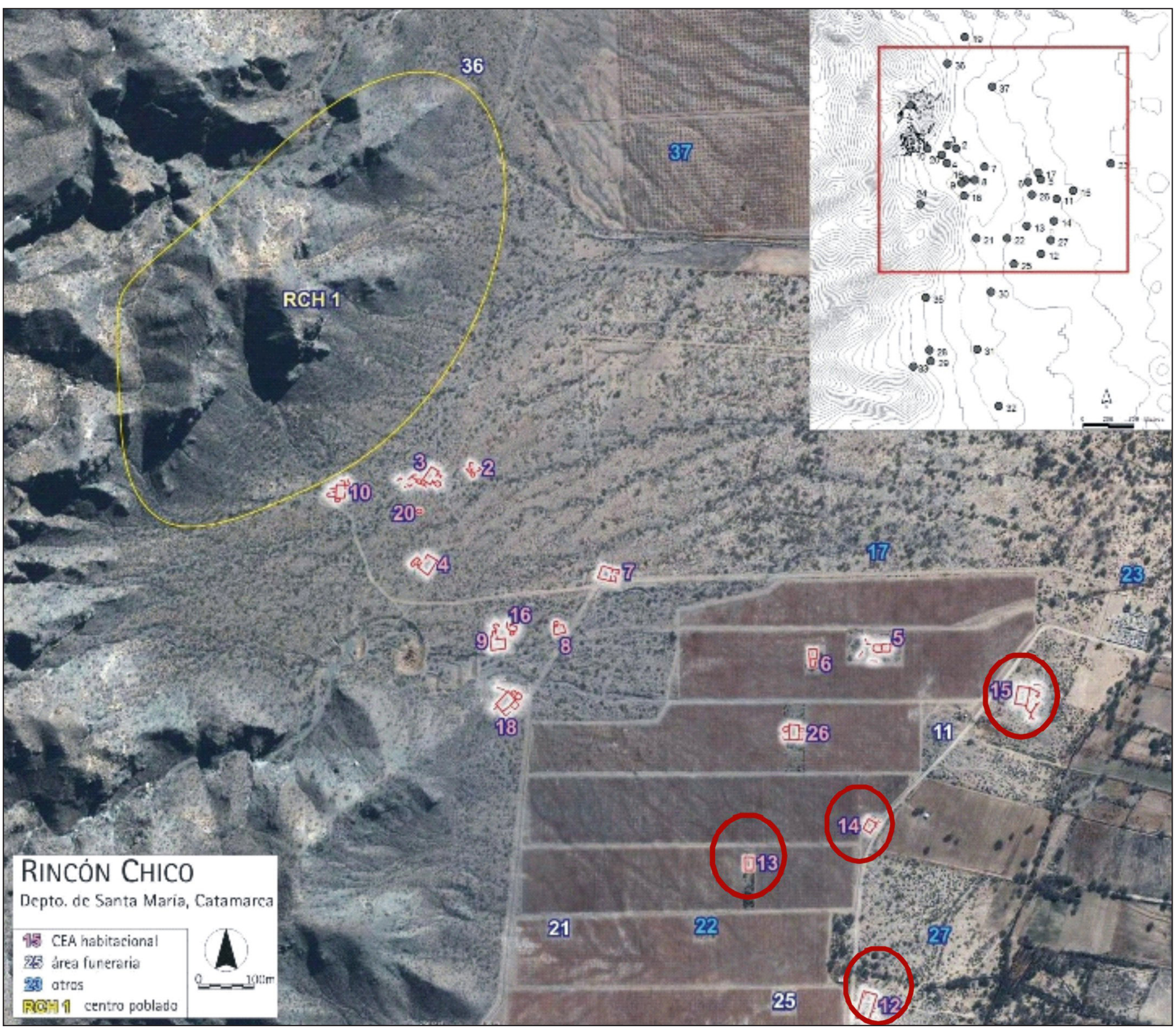

Figure 2: Archaeological settlement of Rincon Chico. The numbered figures indicate the archaeological sites that are part of the settlement. Red circles indicate archaeological sites with archaeometallurgical evidence, including workshop number 15.

leading regional centre during the Late Period, and has 36 radiocarbon dates that support an occupation that began in the 10th century of the era and lasted until the arrival of the Spanish (Tarragó 1998) (fig. 1). The settlement pattern is of a tripartite type that covers the sectors of the hill, intermediate areas and the sloping surface of the alluvial cones that extend from the Sierra del Cajón and reach the alluvial plain of the Santa María river. In the lower area of the archaeological settlement are located sets of structures and work spaces characterized by a quadrangle formation with associated structures on its periphery. Four of these archaeological sites are linked to metallurgical activities, one of which we will discuss here (fig. 2). Rincon Chico 15 is composed of a simple construction unit with an intramural surface of approximately 1500 m^2. Taking into account the dispersion of material remains and cultural features, its surface amounts to at least 5500 m^2. The architectural structure is made up of two units delimited

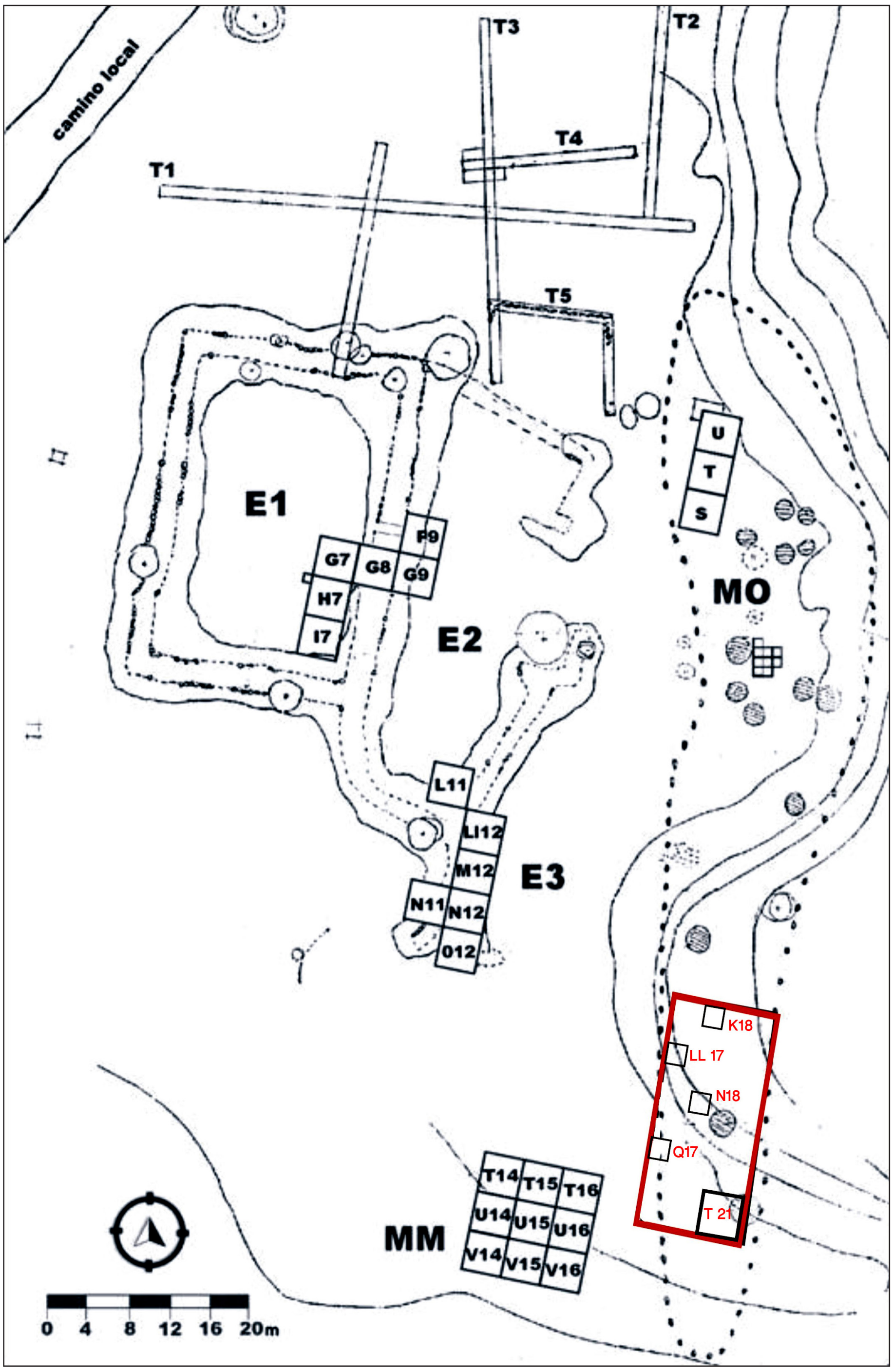

Figure 3: Plan view of Rincon Chico 15. The numbered images indicate the excavation units of 16 m^2. The red rectangle indicates the location of the last excavations performed.

by four walls (E1 and E2) and a semi-open space (E3). Two mounds are associated with these structures and an area without evidence of surface structures complete the characterization of the site (Tarragó 2007). The so-called Southern Mound (MM) has an area of approximately 70 m^2, while the Eastern Mound (MO) is approximately 400 m^2. Sixteen radiocarbons dates on samples of charcoal corresponding to different contexts of the site indicate their occupation from the ninth to the seventeenth century (fig. 3) (González 2001; 2004).

Research carried out over more than twenty years at Rincon Chico 15 has produced a significant amount of information related to the smelting of metallic ores, the casting of tin bronze artefacts, the use of ceramic moulds and crucibles, the registration of combustion structures, metallurgical slag, remains of copper ore, metal discards and hundreds of lithic artefacts (Tarragó 1998; 2007; González 2001; 2004). Site Rincon Chico 15 is one of the few bronze production sites to have been excavated intensively in Argentina and it is especially significant because archaeological evidence indicates that both the smelting of metallic ores and the casting of bronze artefacts took place there for hundreds of years (González 2001; Lechtman 2014). The metallurgical workshop was built on the second terrace of the Santa María River, an area that had hardwood forests in pre-Hispanic times, a fundamental raw material for large-scale smelting activities. The archaeological evidence of the workshop indicates that prolonged and intense metallurgical activities were re-executed periodically and with greater intensity. These activities involved, among many others, sourcing of raw materials, ore refining, dosing of alloys, smelting of chisels, axes, discs and bronze bells with tin in refractory ceramic moulds. The majority of cast objects required between a half and one kilo of metal, but large pieces that required more than two kilograms of metal were not uncommon. The volume of metal used was oriented to the production of ornamental pieces whose consumption must have exceeded the domestic consumption (González 2001; 2004)

The role played by lithic artefacts in the production of pre-Hispanic tin bronze objects at the site is still unknown. We believe that the activities of polishing, forging, rolling

Figure 4: Artefacts from the excavation of the T21 unit located south of the Eastern Mound. The wide variety of shapes, sizes and thicknesses, as well as the absence of knapping, makes it difficult to identify macroscopically.

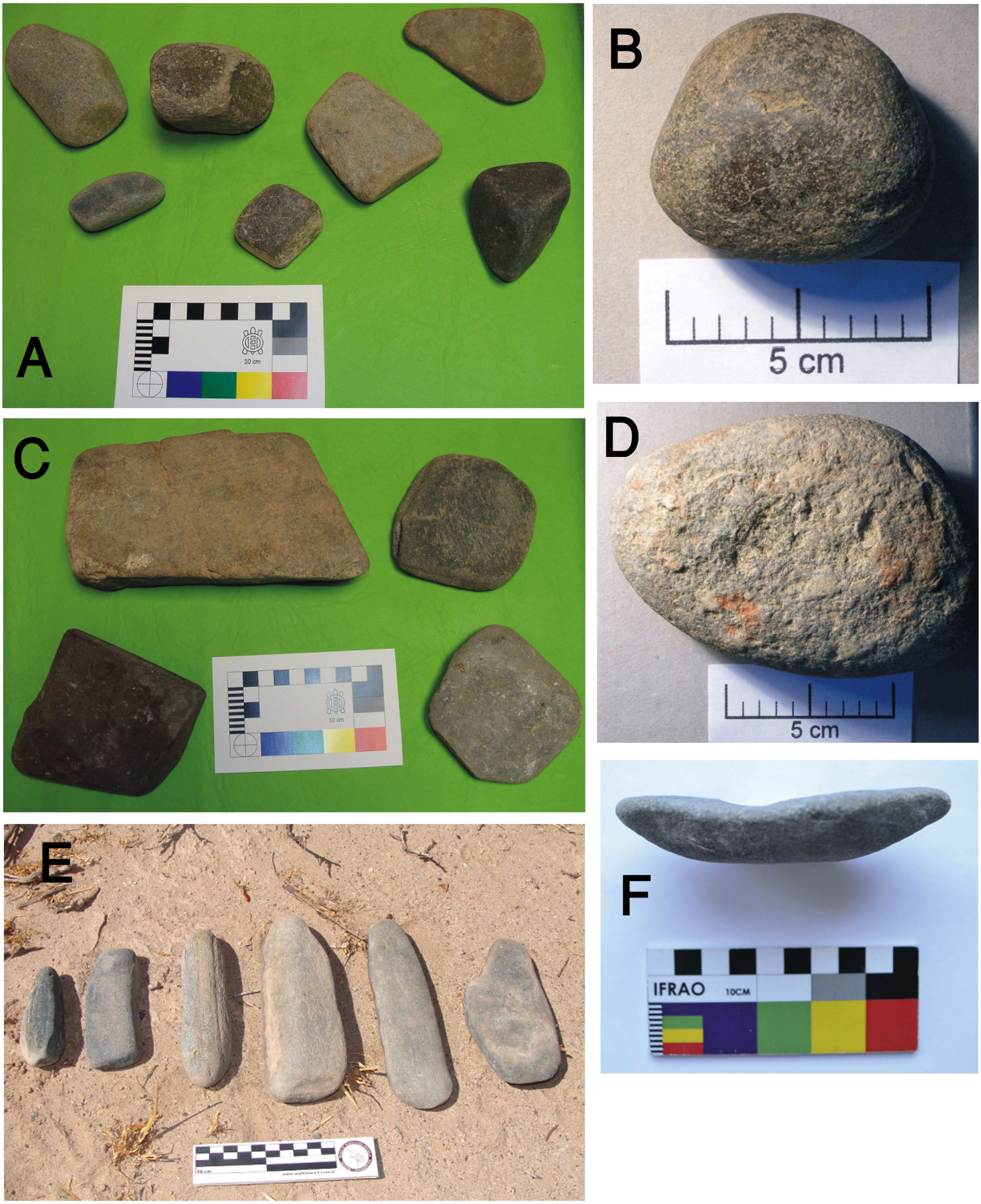

Figure 5: The variety of anvils (A, C, D), polishers (B) and instruments with a function not yet identified (E, F) recovered from the excavations of structure E1 and the Eastern Mound. All artefacts were produced from natural forms on slate and andesite.

and sharpening of metals could have been done with different types of lithic artefacts. However, the information available on this subject for the Southern Andes and north-west Argentina is very small or practically does not exist. The aim of our research is to begin to identify some features and traces in lithic tools related to metal working through use-wear analysis and experimental work.

Characterization of lithic artefacts

In the archaeology of the Southern Andes there are some references regarding lithic artefacts in mining extraction contexts and the first stages of mineral grinding (Nuñez 1999; González 2004; López *et al.* 2018). However, references to lithic artefacts related to the manufacture of metal products are very scarce, which is why we turn to the literature available for Central Andes (Lothrop 1950; Grossman, 1978; Shimada 1978; Carcedo de Mufarech 1992). In the archaeology of north-western Argentina in particular, the study of lithic artefacts specifically in contexts of metallurgical production does not exist, so we consider that the analysis of artefacts from the excavations of the metallurgical workshop of Rincon Chico 15 constitutes an excellent opportunity to investigate this subject. More than twenty years of excavations in the different sectors of the metallurgical workshop have allowed hundreds of lithic artefacts to be recovered, many of which could have been used for hammering, rolling or polishing tasks (González 2001). However, such characterization proved to be very general and never allowed us to determine the great variety of forms in the artefacts and assign them possible functions in the metallurgical context. For these reasons we are undertaking the first microscopic analyses to be performed on the materials in order to characterize the identified traces and impregnations, necessary steps in order to develop a protocol of analysis and a general identification of this particular type of lithic artefact.

So far, we have analysed around one hundred lithic artefacts from different excavation contexts of the metallurgical workshop. Most of them have a rounded or sub quadrangular morphology with flat faces, or elongated forms of rounded edges, and their lengths can vary from 5 cm to approximately 20 cm. The thicknesses can also be very variable. Anvils of different sizes could also be recognized, some very small and specific for detail work in goldsmithing. Most artefacts have general forms similar to those of natural pebbles, and few possess evidence of knapping with conchoidal fracture. All artefacts were almost entirely of metamorphic rocks such as gneiss and slate, as well as quartz and andesite, locally available raw materials. However, the metallurgical contexts where they come from, their similarity with artefacts from other metallurgical contexts in the Central Andes and the presence of microscopic traces and impregnations, has allowed us to begin to differentiate those that are clearly lithic artefacts from others that could be unused preforms. We believe that the diversity of shapes and sizes is an expected feature of these types of artefacts and that it agrees with the available data from the metallurgical contexts of the Central Andes (fig. 4, 5 and 6) (Lothrop 1950; Grossman 1978; Shimada 1978; Carcedo de Mufarech 1992; González 2001; 2004). Like modern-day goldsmiths and craftsmen of wood, they have a set of tools of the most diverse shapes and sizes, some of formal design or perhaps transformed by use and recycling, but they also have many others of more informal type and whose designs are a product of the craftsman's comfort. However, unlike the current tools used by goldsmiths, it is not known precisely what is the diversity of shapes and sizes of the lithic tools used by pre-Hispanic metallurgists in the Southern Andes, and even less their possible functions. That constitutes the real challenge we initially addressed here.

Of the hundred artefacts analysed so far, about 40 have clear evidence of having intervened at some time in the process of manufacturing metal goods or in the grinding of minerals, mainly iron oxide. This mineral was very commonly used to make reddish pigments that were later used to decorate ceramic and metal artefacts in north-western Argentina. Only the evidence of microscopic traces allowed us to separate natural pebbles from other small non-diagnostic pieces, such as examples of small hammers and anvils, as well as some instruments whose function is still unknown. In those cases, only the evidence of striations, micropolish and impregnations allowed us to separate them from pebbles with natural forms (fig. 6C, D and F).

In addition, the energy dispersive X-ray spectroscopy (SEM-EDS) analysis was performed on sediment extractions detected in some artefacts. The results obtained, in some cases, were the presence of Fe_2O_3 and minimal amounts of Cu, results that do not coincide with the analysis of the sediments in the excavation contexts. Since they were associated with thermo-altered sediments and refractory ceramic fragments, we believe that the results obtained are indicators that these artefacts were possibly part of the process of producing bronze or copper products, as well as the grinding of minerals for pigment preparation. It remains to be determined what activities were carried out with them, how they participated in the production of metal artefacts, how intensive was their use and whether their function could be replaced or not by another morphology.

Use-wear analysis of a sample of archaeological stone tools

The hammering and rolling techniques reached a very high technical level in the indigenous cultures of the Central Andes. The rolling involved not only extraordinary handling of hammers, anvils and other tools but also a

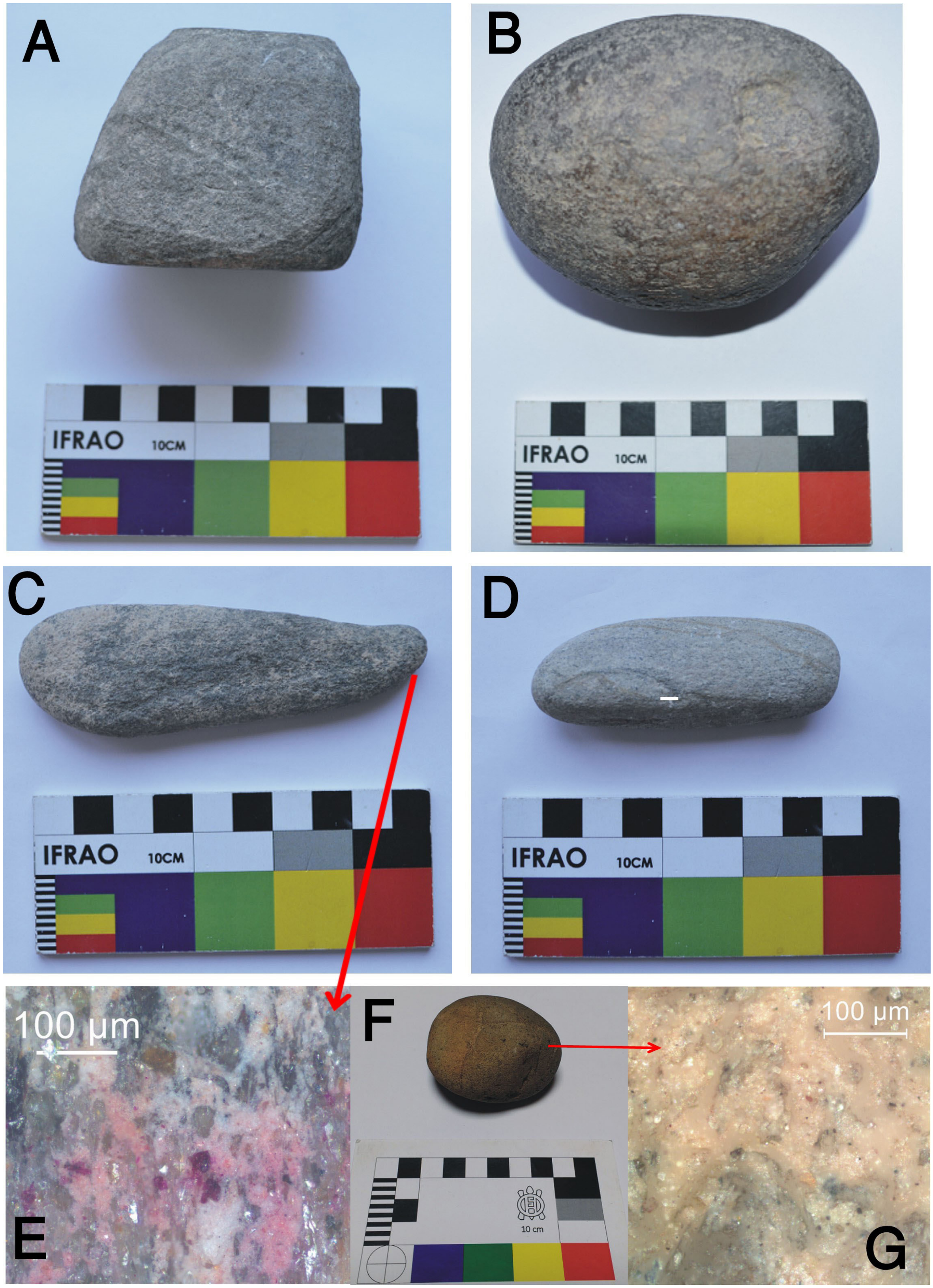

Figure 6: Possible slate polisher (A), andesite grinding handstone (B), small slate goldsmith hammers (C, D) and an andesite instrument with unknown function and evidence of fire exposure.

deep knowledge of the technical characteristics of the alloy. The weight, shape and size of the hammers were directly related to the volume, type of alloy, weight and size of the mass to be beaten (Carcedo de Mufarech 1992; Lechtman and Macfarlane 2005).

As mentioned earlier, most of the lithic instruments of the metallurgical workshop were obtained from natural forms of pebbles without modification, so that their macroscopic recognition was initially difficult. To solve this, it was decided to perform a microscopic techno-functional analysis in order to be able to differentiate the used artefacts from the selected and unused natural forms (Mansur-Franchomme 1987; Mansur 1999). The lithic artefacts were examined under a stereoscope at low magnifications (x10-x40) and then under a metallographic microscope at x50, x100, and x200 magnifications.

So far, there is no clear association between the morphological characteristics of the materials and their origin in the excavation units. That is, the data obtained does not allow us to think or recreate specific work areas with particular lithic tools to do certain tasks, since the evidence is distributed more or less evenly throughout the entire site. On the other hand, nor was it possible to recognize in all cases a clear relationship between the morphology of the active surfaces and the presence of the traces, beyond knowing that they are of anthropic origin and do not correspond to natural formation processes. An exception is the case of anvils, a typical artefact in metallurgical contexts that can be recognized by the accumulation of impacts on a flat face. Even this type of artefact was not always easy to recognize, since pieces with a potential anvil morphology were analysed and did not register the presence of macro or microscopic impact traces. At the same time, other morphologies of the metallurgical workshop were identified as small goldsmiths' anvils, which are very rare in the excavations of north-western Argentina. The small anvil of gneiss, very similar to those found in pre-Inca metallurgical contexts

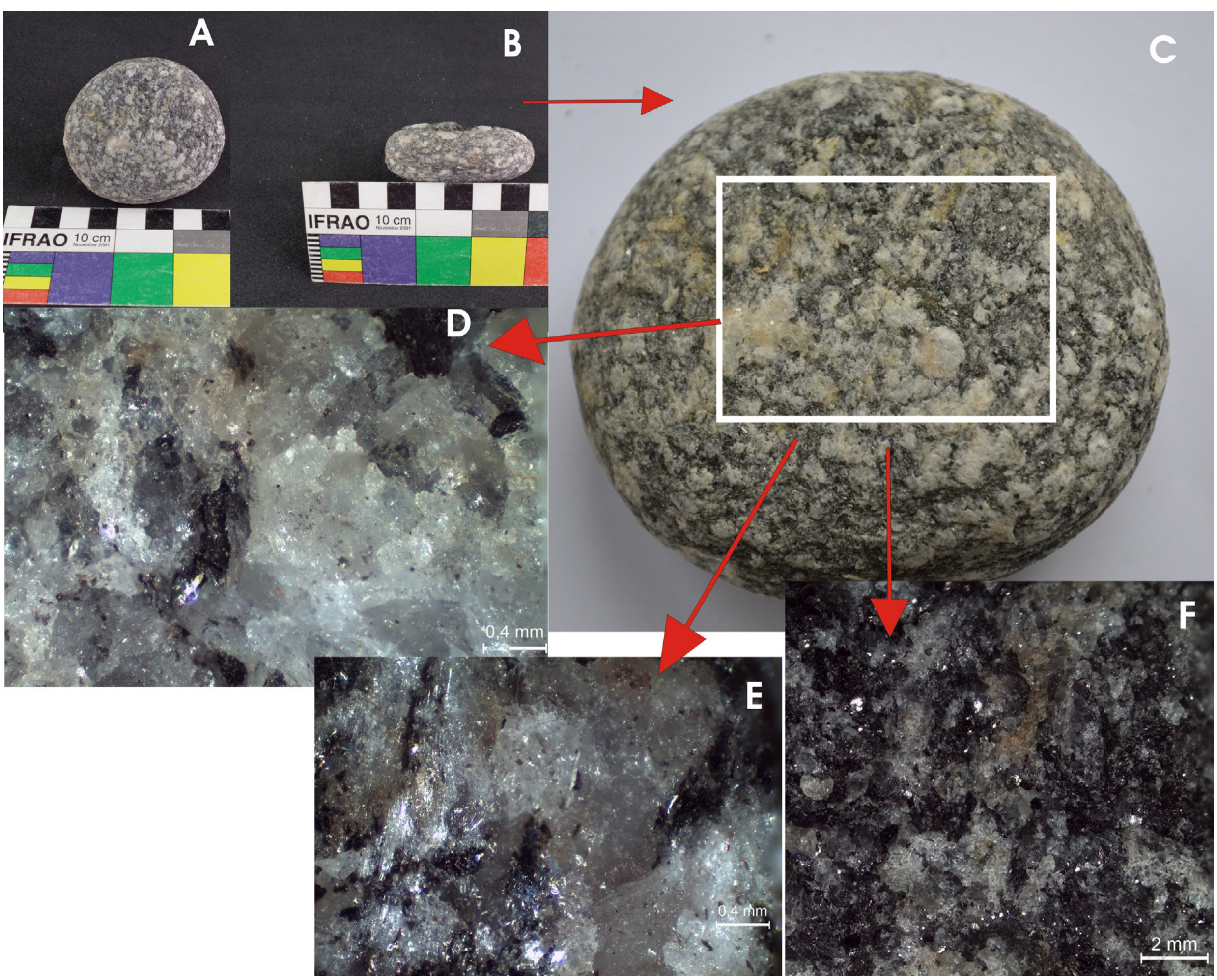

Figure 7: Small goldsmith's anvil of gneiss from the excavations of unit T21, south of the Eastern Mound. We consider that this type of device is perfectly suited for deformation or rolling work on very small metal parts.

of the Central Andes, has evidence of multiple impacts on only one of its flat surfaces. Such accumulation of small impacts on the same surface does not correspond to those generated by post-depositional processes at the site (fig. 7).

The rest of the materials have a variety of rounded, cylindrical, irregular or quadrangular morphology with rounded edges or tabular shapes. The vast majority of them have a smooth surface, a characteristic that was microscopically corroborated with the detection of micro polish in different degrees of development. One of the most diagnostic pieces recovered is an andesite grinding artefact, identified as a "mano", that has numerous traces and impregnations along all its edges and active surfaces (fig. 8A and 9A). Some of these reddish impregnations were chemically identified as iron oxide residues, which could be generated during the grinding of minerals for pigment preparation (fig. 8B). In addition, potential traces of metal were also recorded, which were subjected to X-ray fluorescence analysis and energy dispersive X-ray spectroscopy (SEM-EDS), but we have not yet been able to identify them chemically (fig. 8C, D). In many cases they are small metal "points" arranged throughout the piece without a clear organization. However, metal traces associated with other marks, particularly those that are arranged obliquely in relation to striations, are of special interest because they could have been generated during some type of activity that involved friction work on a metal surface (fig. 8B). Striations are usually rough in their upper sectors and smooth in the deeper sectors, narrow, long and variable depth. Sometimes they are associated with metallic residues arranged in the same direction. The mano, originally used as a food grinding artefact, was reused as a mineral grinding instrument and possibly as a metal-working tool, although we still don't know what function it could have performed. We believe that both the reddish impregnations and the micropolish (fig. 9B, C) could have been generated by milling iron and copper ore, minerals that were present at the site. This would support

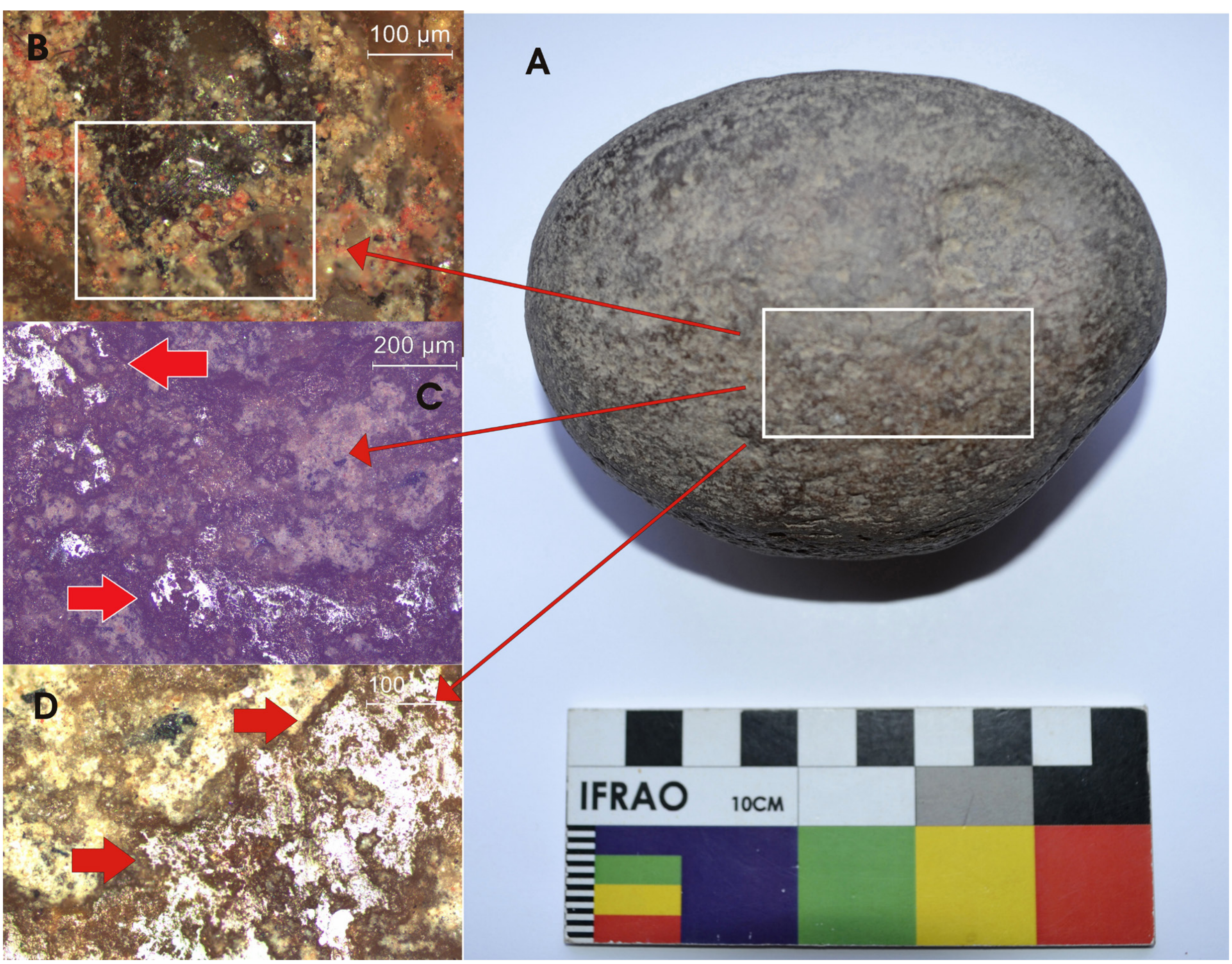

Figure 8: Andesite grinding handstone that was used to crush minerals with a high composition of iron oxides (B) and possibly metal impregnations (C). The variety of traces detected seems to indicate a multi-purpose device that was carefully preserved.

that at least part of the ore grinding work was done within the metallurgical workshop. In the case of metal impregnations, we still do not have a clear answer, since the device seems too large and heavy to have served as a percussion instrument for laminating or as a polishing device (González 2001; 2004). However, the mano has multiple striations in one or two predominant directions in different sectors of the curved edges (fig. 9D, E), which do not correspond to naturally formed patterns. Such striations were not recorded in lithic artefacts from other non-metallurgical contexts within the archaeological settlement of Rincon Chico. We believe that they have a pattern similar to those striations formed by metal polishing activity obtained by experimentation, as we will see in the next section.

Small artefacts of elongated morphology and rounded ends were also recorded. At the ends, iron oxide was identified, and other impregnations of calcium, iron, magnesium and potassium, that is, a composition very similar to that of bone tissue (fig. 6E, G). These results are relevant because in the metallurgical workshops of north-western Argentina an interior coating was used for refractory ceramics and moulds, made from a chemical compound of calcium. The calcium came from the grinding of bone, clays and other elements. We believe that some of the larger and heavier artefacts may have been used for a first instance of bone grinding (fig. 8), while smaller ones with sharp edges could have been used to pulverize it.

The recording of the modification of the micro-topography in potentially active sectors of the artefacts also allows us to think that they were used for some abrasive activity, expected in contexts of production of copper and bronze objects that require polishing after the extraction of the mould, as well as burr trimming. Finally, the detection of multiple small impacts accumulated in the edge and flat sectors of elongated pieces allowed us to differentiate small goldsmith hammers that, otherwise, would have been very difficult to identify as artefacts (fig. 10A, B, C).

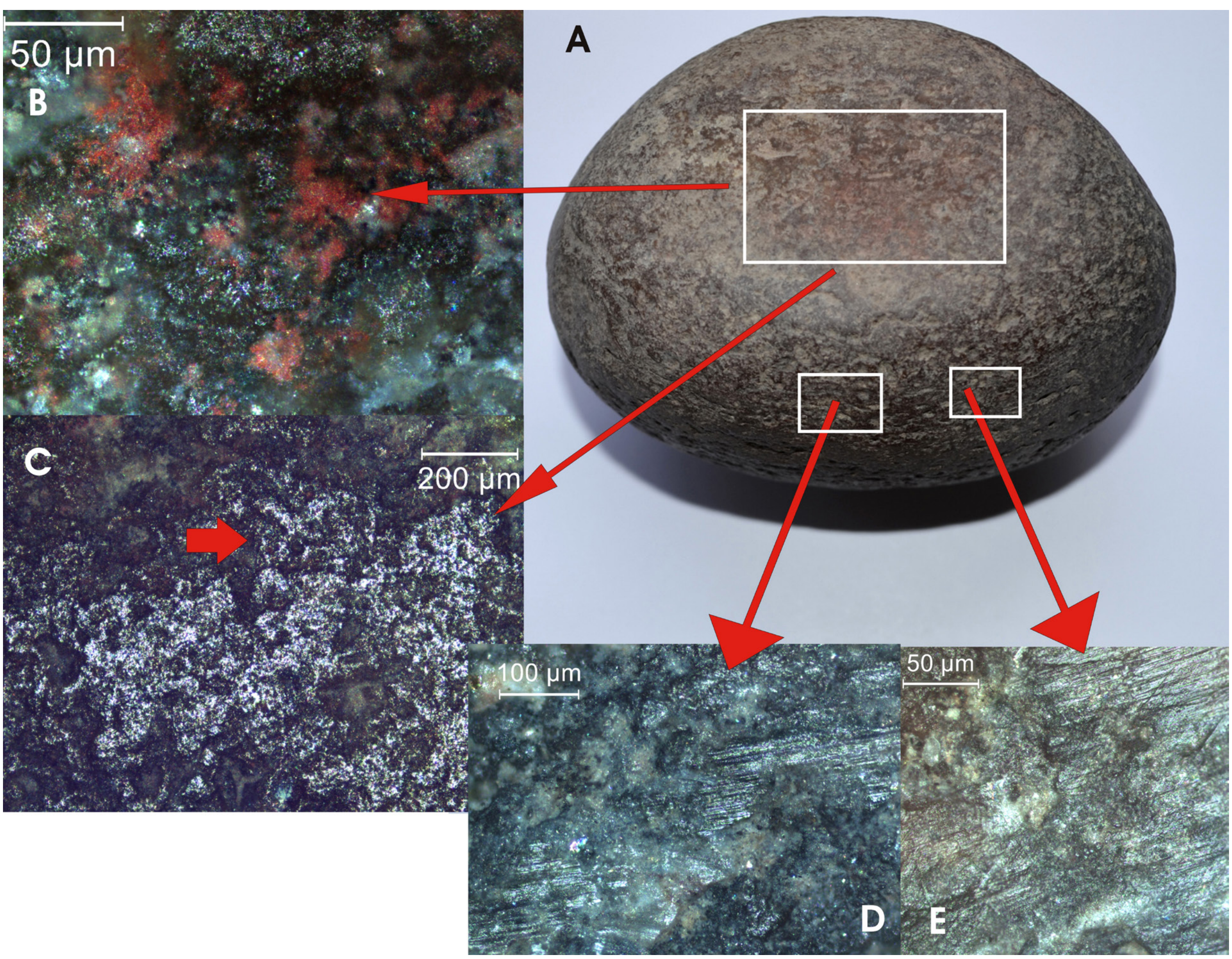

Figure 9: Iron oxide impregnations (B) and development of micro polish (C) in andesite grinding handstone. The device has numerous different traces on all its faces, which indicates an intense use of the artefact for one or more activities in the context of metallurgical production.

The longitudinal zones of this type of artefact, on the other hand, do not show any impact marks and keep their initial crystalline structure (fig. 10D, E). We believe that this type of small hammer could have served to laminate small pieces of copper or gold, metals that were present in the workshop of Rincon Chico 15 (González 2001; 2004).

Finally, microscopic analysis allowed us to register in some cases flat and very bright micropolish surfaces, such as those recorded in experimental copper-polishing work (fig. 11).

Experimental research in metals and microscopic trace analysis

At the same time, we begin to perform the first exploratory experiments of deforming a small ingot and a sheet of copper using hammers and stone anvils, to observe the degree of trace development in both lithic artefacts during controlled work intervals. Five-minute work intervals were defined, due to the time required to observe changes in the surface of the metal parts. We were interested in being able to answer the most general questions related to copper deformation work using lithic artefacts. Therefore, we use natural rhyolite and quartz stones that could be used as hammers and anvils. The artefacts were used without hooks and almost without previous knapping, following bibliographical references. Flat and curved faces were used in the artefacts for the deformation work, since that is the morphology of the active faces of the hammers recovered in archaeological contexts. We worked with ingots and copper sheets to explore how much the original shape of the mineral could affect the degree of deformation that was achievable (fig. 12). In the first case, a quartz pebble was used as a hammer and a rhyolite anvil (fig. 12D, I). In the second case, rhyolite was used as a hammer with a wooden anvil (fig. 12B, C). The active parts of the hammers were carefully chosen, differentiating those impact surfaces with rounded or curved morphologies, from other flat ones. The active and passive surfaces of the experimental artefacts, as well as the metallic material worked, were recorded with

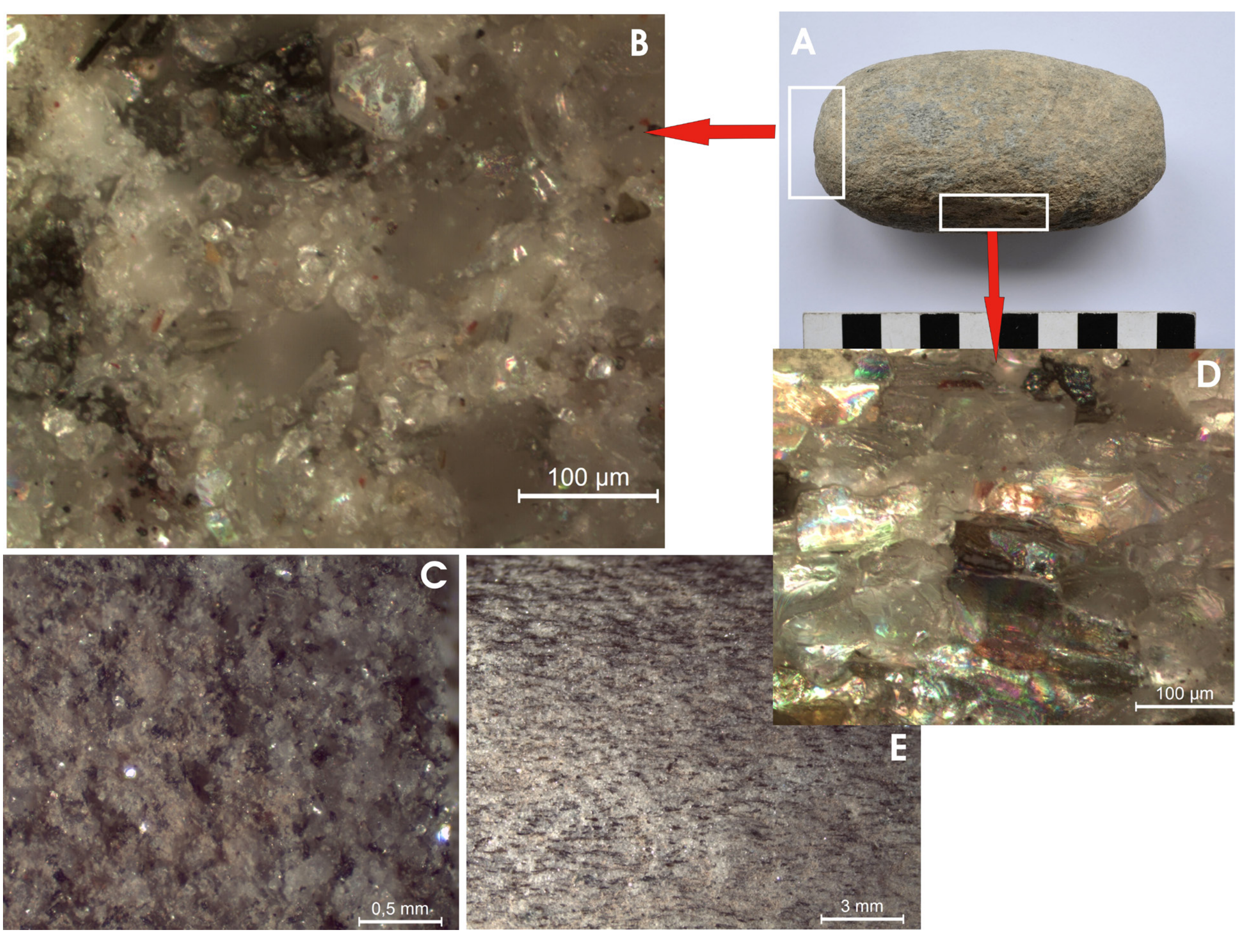

Figure 10: Small gneiss goldsmith's hammer. It has clear marks of multiple impacts at one of its visible ends at different scales (B and C). The crushing of the crystals and the irregularity of the general microrelief can be seen. In the longitudinal area of the artefact no impact marks were found and the crystals have very good integrity (D and E).

photomicrographs at different magnifications (x50, x100, x200, x500) before, during and after the experimentation.

The results obtained, although preliminary, were highly productive and allowed us to begin testing general notions about the association between certain morphologies of the instruments, active work surfaces and the behaviour of raw materials in different modalities of use, as well as to recognize the possibilities of working with cold copper. Thus, the formation of copper traces in lithic artefacts could quickly be verified. Their degree of development was much faster and more massive in the instrument that worked actively, while the anvil had a considerably slower development of copper traces. Finally, this exploratory experimentation also allowed us to verify the importance of knowing the technical properties of metals and gave us experience of how to handle them successfully.

Subsequently, work began on a second experiment that involved the gradual work of deformation, lamination and polishing of a copper ingot, with the aim of reproducing a plate similar in shape and size to the archaeological ones referred to in the bibliography (Carcedo de Mufarech 1998; González 2004; Tarragó *et al.* 2010, among others). We consider, as a predictive hypothesis, that the massive artefacts and volcanic raw materials present in Rincon Chico 15 could have been used for deformation and rolling works, while metamorphic rocks with a laminar morphology and friable matrix would be better suited to metal-polishing tasks.

The initial hammering and rolling work were carried out using a hammer with two opposite active faces and a lithic anvil, both of local andesite from the vicinity of the Rincon Chico 15 workshop. The hammer had a weight of 430 grams and measured 105 mm long, 60 mm wide on its widest active face and 15 mm wide on the opposite side, and approximately 50 mm thick. The larger active face had a flatter surface, better suited to generating a greater

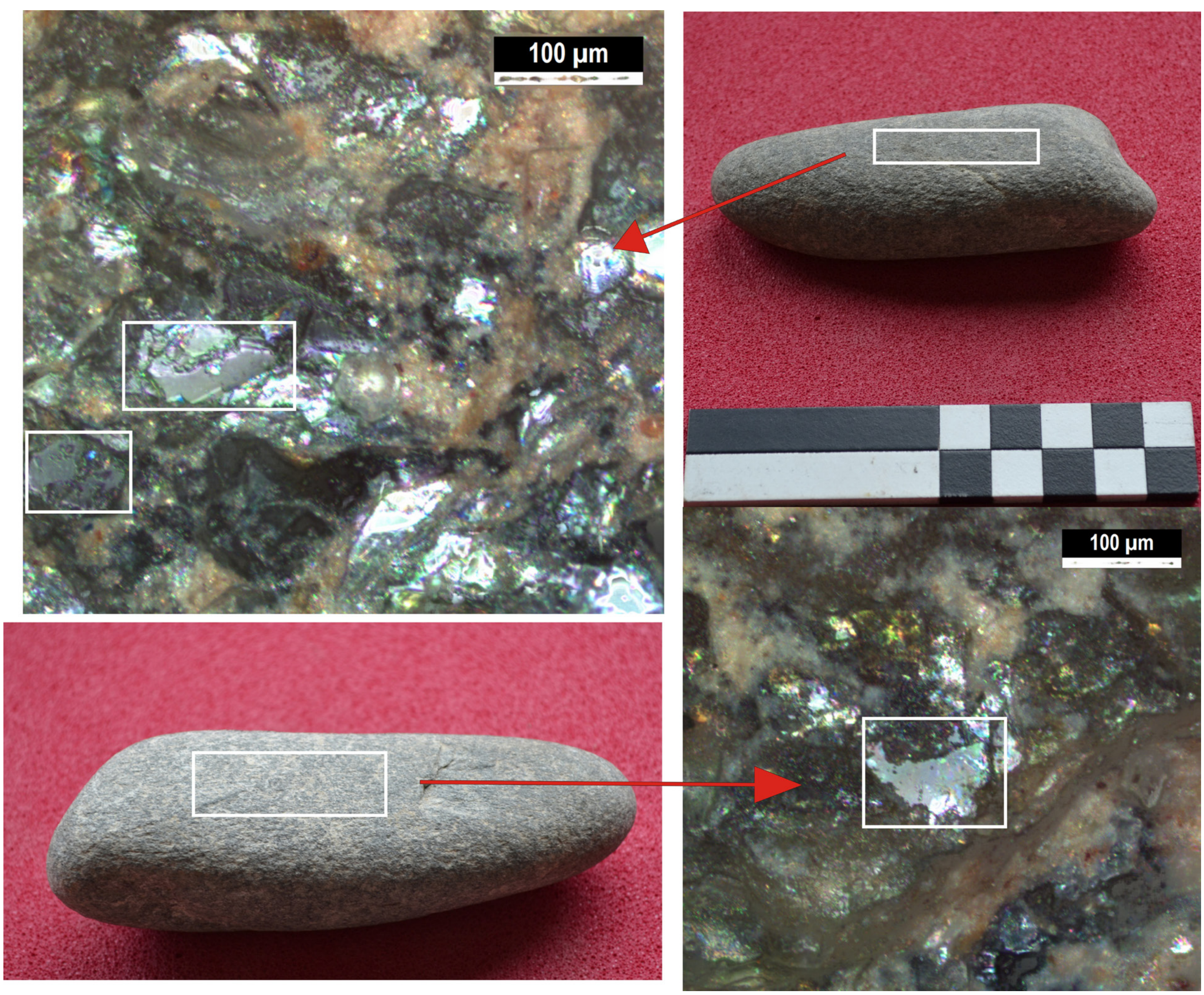

Figure 11: Small slate artefact possibly used for polishing activities. The size, weight and friable matrix of the device is adequate to have been used as a polisher. The detection of small micropolish in its flat sector reinforces this possibility.

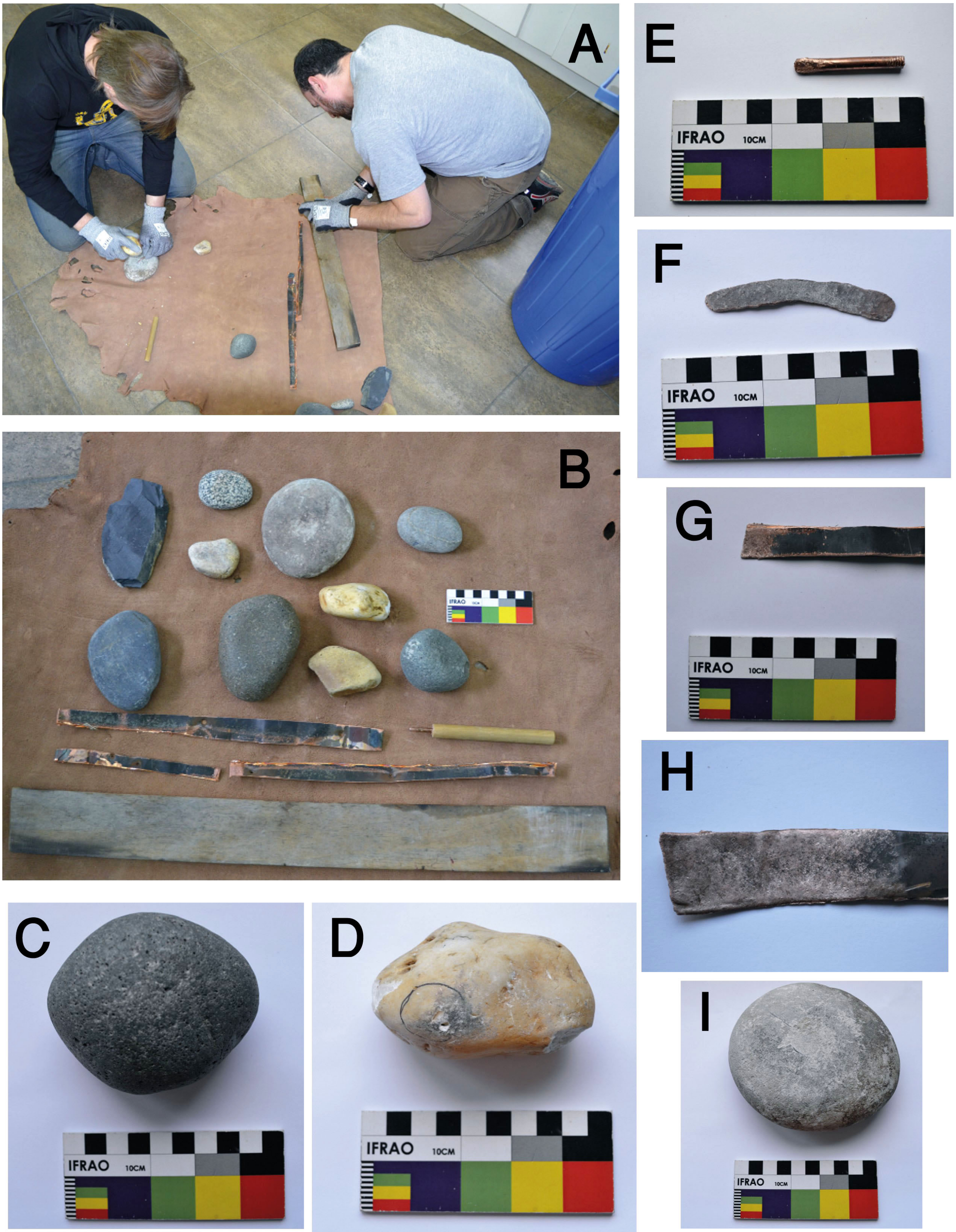

Figure 12: Initial experimental work that allowed us to test the usefulness of lithic artefacts for the deformation of copper ores and the technical knowledge necessary to be able to do it successfully.

impact force on a larger surface. The second active face of the hammer was smaller and had a slightly more convex surface, better suited to gradual rolling jabs that required a greater number of impacts, but of lesser force each (Carcedo de Mufarech 1998). The anvil, used as a direct support element, was 110 mm long, 70 mm wide and 65 mm thick (fig. 13 and 14). The copper ingot was obtained by smelting and had initial measures 35 mm long, 28 mm wide and 4.5 mm thick.

Thus, in the initial stage of the work, the largest active face of the andesite hammer was used, which allowed the user to generate a greater impact force and a greater degree of deformation. The entire work process was performed using an andesite anvil as a support element. The impacts were executed alternately on both opposing flat faces of the ingot. The work periods consisted of intervals of 5 minutes, since this proved to be sufficient to generate a minimum deformation that could be measured with a gauge. The working interval was maintained until the end of the experiment, as a constant unit of time that allowed the degree of deformation to be compared throughout the entire rolling process. After each working interval, changes in the length, width and thickness of the metal mass were measured. These points indicated the differential degrees of deformation and thinning of the piece throughout the entire process.

After 80 minutes of hammering, and having reached a thickness of 1 mm, a width of 19 mm and a length of 42.5 mm, only the smallest active face of the hammer was used, in order to perform the task of lamination. In contrast to the first stage consisting in performing a greater deformation based on impacts with greater pressure, the second stage of rolling required an increase in the number of executions, but with a smaller force each. The objective was to obtain a reduction in thickness and an increase in length and width, but generating a surface as regular as possible and avoiding cracking or fractures. This second stage of lamination was continued a further 100 minutes using the same interval of 5 minutes as for the previous work, which added to the 80 minutes of the first stage resulted in a total of 180 minutes of plastic deformation. The product obtained was a copper plate whose thickness varied between 0.35 mm and 0.15 mm, that is, thicknesses similar to those measured in gold and copper pieces in pre-Hispanic ornamental goods (González 2001; 2004; Tarragó *et al.* 2010). The length reached was 65.5 mm and the width

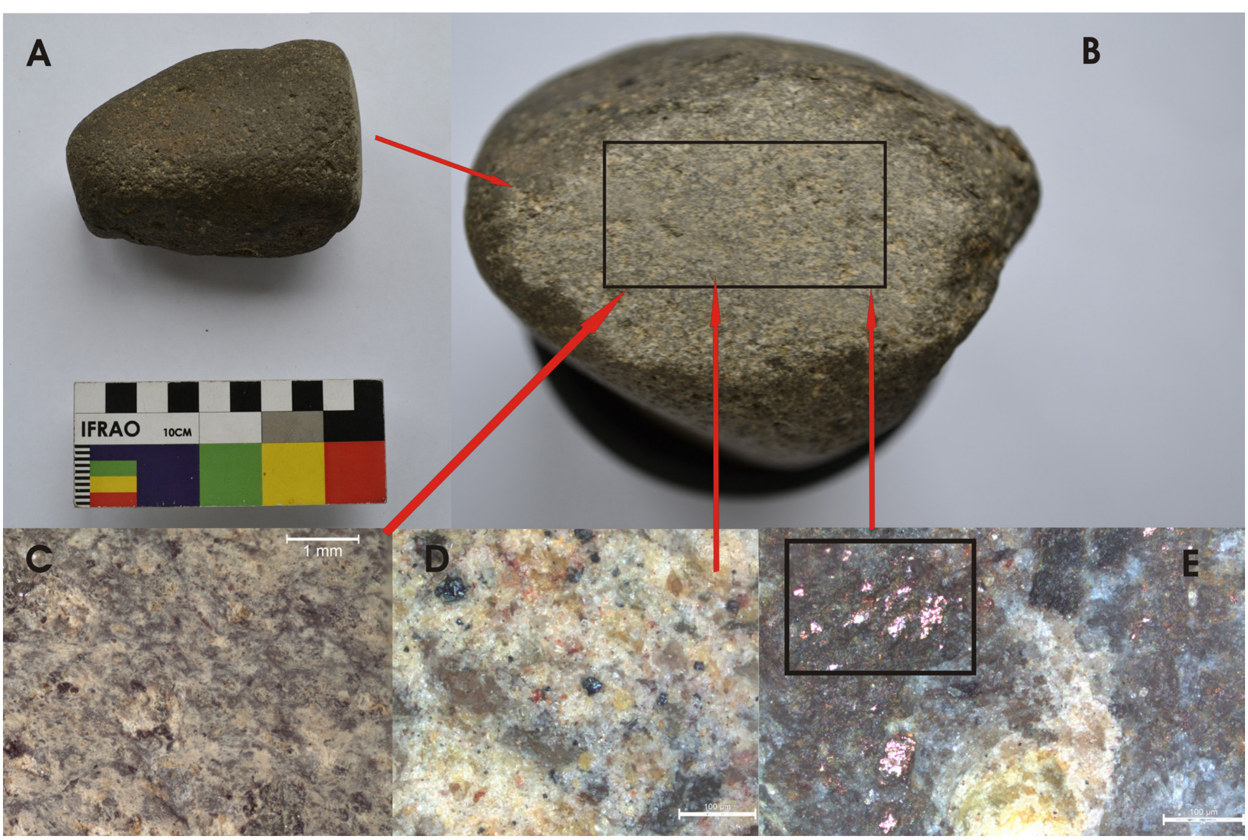

Figure 13: Andesite experimental hammer. In images C and D, the accumulation of impact marks can be observed. In image E the traces of copper that remain after a few minutes of rolling work are observed.

was 35.5 mm, which implies an increase in length of 150%, a significant increase in width and a reduction in thickness by more than 90% (fig. 15).

Once these dimensions were reached, we began to polish the surface on one of the faces of the sheet. For this, small slate slabs from the vicinity of the site were used, trying to select the same forms and raw materials recorded at Rincon Chico 15 (fig. 1). The interval used for the polishing stages was 20 minutes, the minimum time needed to observe macroscopically some change on the surface. The length and width measurements of the sheet remained virtually unchanged after the accumulation of all polishing intervals, while the thickness was modified between 1 and 4 hundredths of a millimetre per working interval. After reaching 100 minutes of polishing, that is to say the sum of 5 intervals, a metallic lustre and a uniform surface were obtained, such as those observed on metallurgical pieces in collections, after which the work was repeated on the opposite side for another 100 minutes.

After observing the experimental slate slabs under a microscope, we could observe that the micro polishes were arranged in strips (fig. 16D) and spots (fig. 16B), all associated with copper impregnations. In general, the topography of micro polishes is flat and the brightness of metal impregnations is very intense, as in the case of the archaeological traces recorded.

Preliminary conclusions

Although the functional analysis research and the experimental work on copper are still in a preliminary stage, we can say that the results obtained have been of considerable importance. In the first place, we have begun to delineate a record of the microscopic wear present in the Rincon Chico 15 lithic artefact assemblages. Such

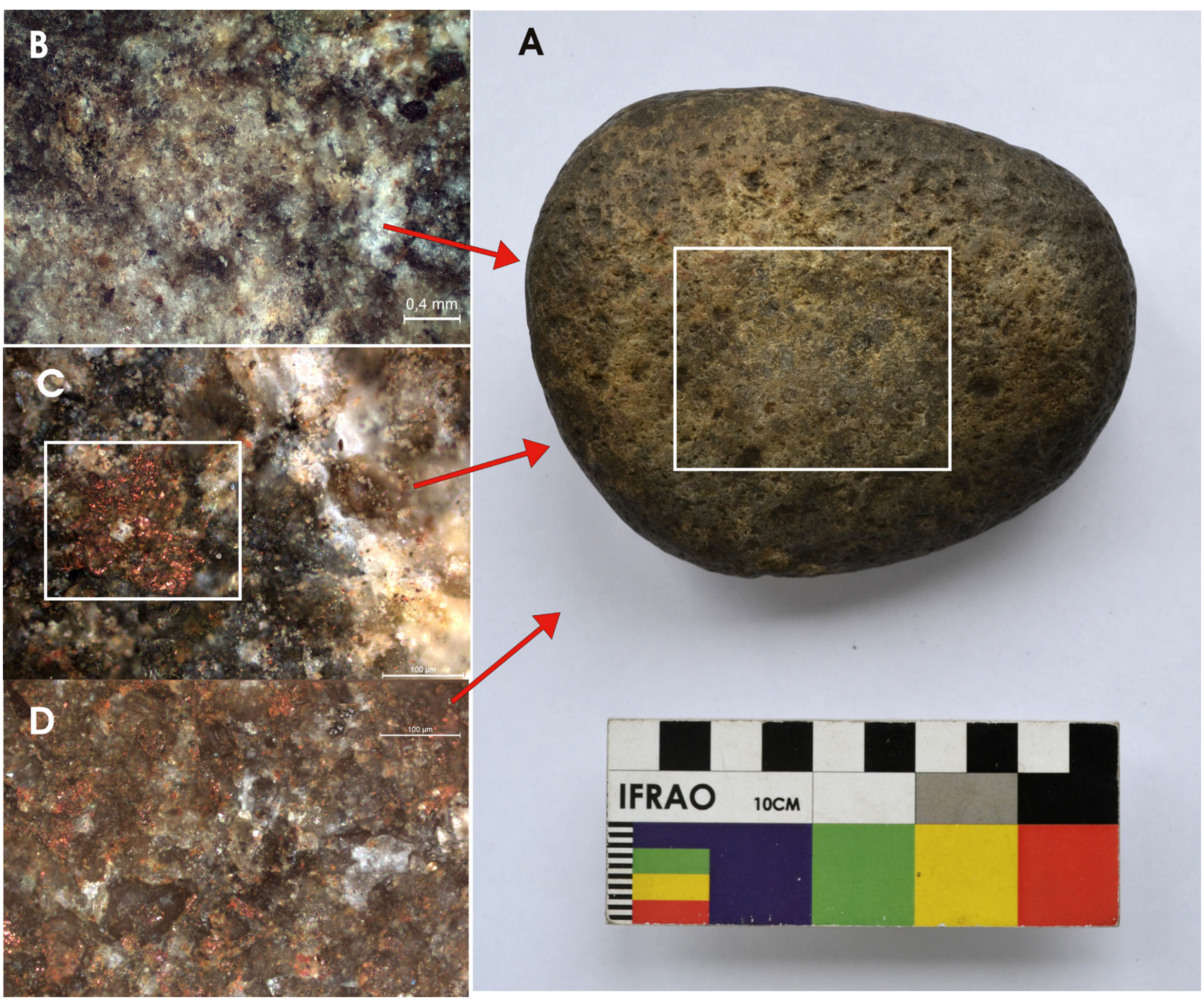

Figure 14: Andesite experimental anvil. In images B, C and D the accumulation of impacts on the surface and the formation of copper impregnations can be observed.

an approach has never been made in the metallurgical workshop or in any other similar context in the Andean archaeology of north-western Argentina. The description of lithic materials in archaeometallurgical studies always lacked importance in local archaeology and was only mentioned briefly. We are now fully aware that these particular types of lithic artefacts possess much more evidence of their use and use-life than has been suspected so far in local archaeology. Moreover, we now have a somewhat more precise idea about the great morphological variation they possess, some of their general characteristics and their dangerous similarity to natural pebbles without macroscopic signs of use. It is important to note that the general morphologies of most of the lithic artefacts recovered in the metallurgical context of the workshop are not found in any of the other archaeological sites that are part of the extensive and complex archaeological settlement of Rincon Chico. The presence of these morphologies, which could complicate their macroscopic recognition as artefacts, are entirely expected in metallurgical contexts and are consistent with evidence of other metallurgical sites in the Andean region.

Secondly, we now know that they can possess not only traces of use but also impregnations of the substances in whose development they participated. In the case of Rincon Chico 15, the chemical identification studies through SEM-EDS allowed us to record the first evidence of copper on the surface of a few artefacts, as well as iron oxides that were processed for pigment production. This type of data has never been recorded in lithic artefacts from metallurgical contexts in local archaeology.

Finally, the experimental research has served to begin to explore the potential uses of the artefacts not from their techno-morphological descriptions, but from their direct use in the development of metal goods that have circulated throughout the Andean world for millennia. Some of the traces generated during the tasks of lamination by impact and polishing by abrasion certainly have some similarities with those recorded archaeologically. For example, striations are usually smooth in the deeper sectors and rough in the upper, narrow, long and variable in depth. Such characteristics were recorded in archaeological (fig. 9D, E) and experimental artefacts during copper polishing work (fig. 16D). In some archaeological artefacts,

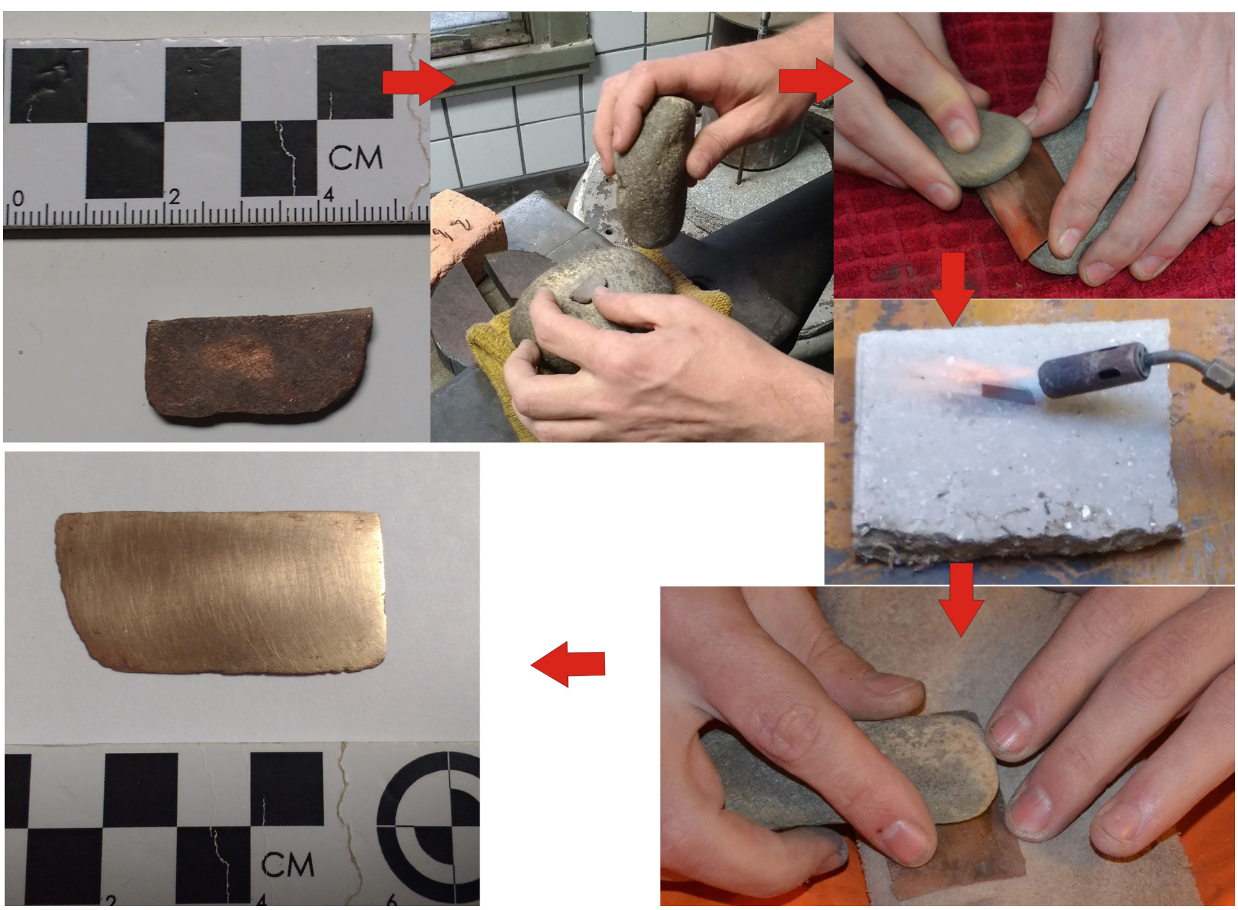

Figure 15: Deformation, rolling and polishing work on the experimental copper sheet.

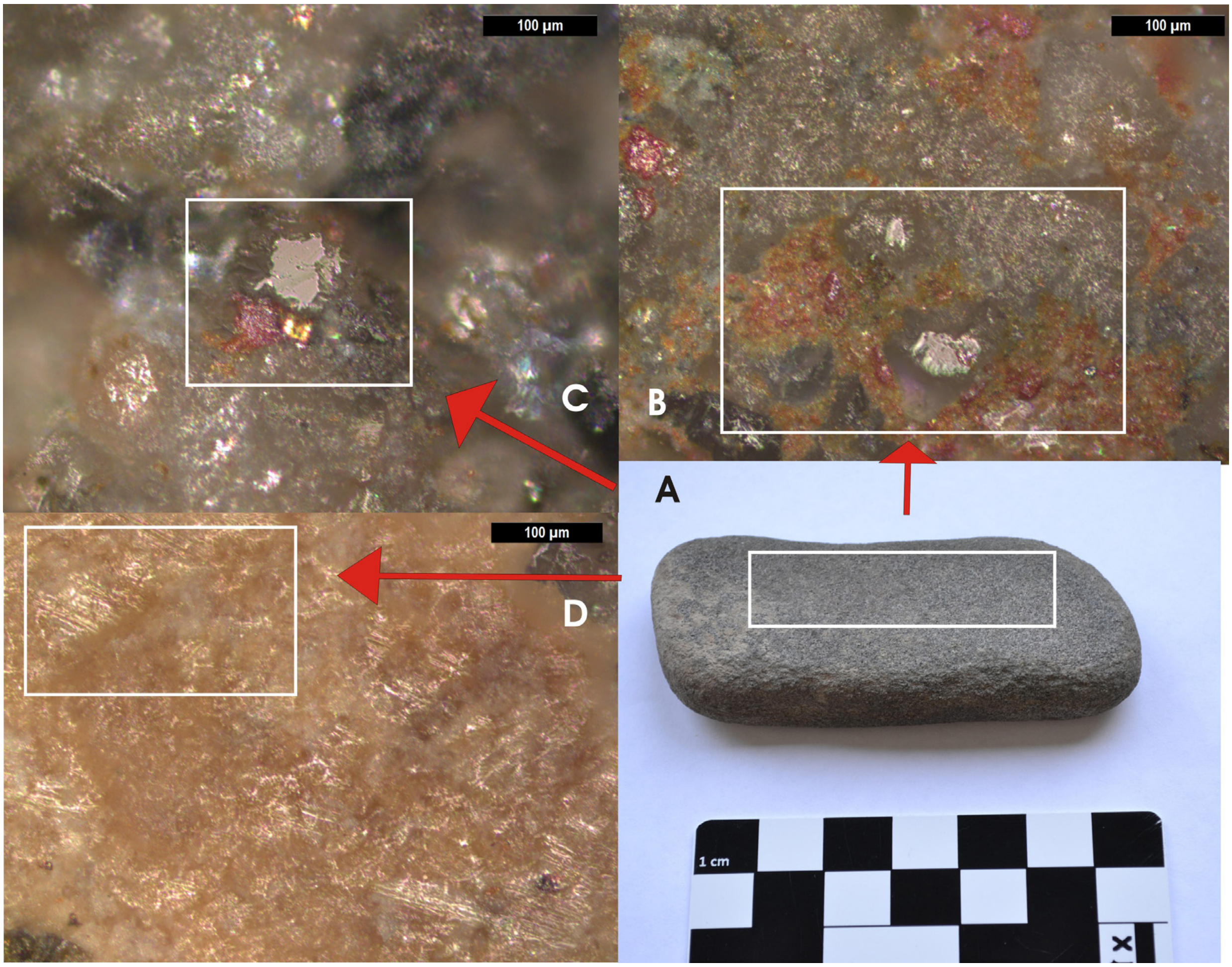

Figure 16: Experimental slate slab used to polish the copper plate. In the images, the formation of impregnations can be observed soon after use (C), polishing of some sectors of the microtopography (B) and the formation of striations (D).

metal or iron oxide impregnations share the same zones as striations (fig. 8B, C, D). The detection of micropolishes on the high points of the topography and with a flat and bright appearance, were recorded in both archaeological and experimental cases (fig. 11 and 16). Finally, traces of accumulation of small impacts by percussion work were recorded in both archaeological and experimental cases (fig. 7, 10, 13 and 14).

It is clear that we have to continue working and not to think that the problems raised here are the conclusion. On the contrary, they are just a beginning to be approached with a little deeper knowledge.

The results obtained are promising since there is practically no information available for the Andean region of north-western Argentina. Moreover, the general morphologies of lithic artefacts from metallurgical contexts, as well as their possible uses and the identification of microscopic traces, are almost completely unknown in local archaeology. The articulation of multiple research pathways such as experimental work, microscopic studies and chemical identifications will allow us to generate an approach based on complementary and coordinated analyses.

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References

Carcedo De Mufarech, P. 1998. Instrumentos líticos y de metal utilizados en la manufactura de piezas metálicas conservadas en los museos. *Boletín del Museo del Oro* 44/45, 241-270.

González, L.R. 2001. Tecnología y dinámica social. La producción metalúrgica prehispánica en el noroeste argentino. Tesis Doctoral inédita, Facultad de Filosofía y Letras de la Universidad de Buenos Aires.

González, L.R. 2004. *Bronces sin nombre*. Buenos Aires: Ediciones Fundación CEPPA.

Grossman, J. 1978. Un antiguo orfebre en los andes, in: Ravines (ed) *Tecnología Andina*, Instituto de Estudios Peruanos. Lima, 521-527.

Lechtman, H. 1980. The Central Andes: Metallurgy without iron, in: Wertime, T. and Muhly, J. (eds.). *The Coming of the Age of Iron*, New Haven: Yale University Press, 267-334.

Lechtman, H. 2014. Andean Metallurgy in Prehistory, in: Roberts, B. W. and Thornton, C. P. (eds.). *Archaeometallurgy in Global Perspective*. *Methods and Synthesis*. New York: Springer, 361-422.

Lechtman, H. and Macfarlane, A. 2005. La metalurgia del bronce en los Andes Sur Centrales: Tiwanaku y San Pedro de Atacama. *Estudios Atacameños* 30, 7-27.

López, G., Coloca, F., Rosenbusch, M., and Sola, P. 2018. Mining, macro-regional interaction and ritual practices in the South-central Andes: The first evidence for turquoise exploitation from the Late Prehispanic and Inca periods in North-western Argentina (Cueva Inca Viejo, Puna de Salta). *Journal of Archaeological Science*: *Reports* 17, 81-92.

Lothrop, S. 1950. Metalworking tools from the central coast of Perú. *American Antiquity* 16/2, 160-164.

Mansur, M. E. 1999. Análisis funcional de instrumental lítico: problemas de formación y deformación de rastros de uso, in: *Actas y Trabajos, XII Congreso Nacional de Arqueología Argentina*, La Plata, 355-366.

Mansur-Franchomme, M.E. 1987. *El análisis funcional de artefactos líticos.* Cuadernos. Serie Técnica 1. Buenos Aires: Instituto Nacional de Antropología.

Nuñez, L. 1999. Valoración minero-metalúrgica circumpuneña: menas y mineros para el Inka rey. *Estudios Atacameños* 18, 177-221.

Shimada, I. 1978. Economy of a prehistoric urban context: commodity and labor flow at Moche V Pampa Grande, Peru. *American Antiquity* 43/4, 569-592.

Tarragó, M.N. 1998. El patrimonio del valle de Santa María en peligro, in: 50 años de aportes al desarrollo y consolidación de la antropología argentina. *Homenaje a Alberto Rex González*. Facultad de Filosofía y Letras de la Universidad de Buenos Aires. Buenos Aires: Fundación Argentina de Antropología, 215-253.

Tarragó, M.N. 2007. Ámbitos domésticos y de producción artesanal en el Noroeste argentino prehispánico. *Intersecciones de antropología* 8, 87-100.

Tarragó, M.N., González, L., Ávalos, G. and Lamami, M. 2010. Oro de los señores. La tumba 11 de la Isla de Tilcara (Jujuy, Noroeste argentino). Estudios arqueometalúrgicos y comparaciones regionales. *Boletín del Museo Chileno de Arte Precolombino* 15/2, 47-63.

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