# AN EXPLORATION OF HISTORIC METALS IN SOUTH AMERICA

## A study of metal artifacts from the Mendoza region of Argentina reveals the influences of native migration and European conquest.

*Patricia Silvana Carrizo,* Mendoza Regional Faculty, National Technological University, Argentina*

The Mendoza province in Argentina is endowed with a great variety and richness in metal mineral deposits. Archaeometallurgical study of metal artifacts provides examples of precapitalist metalworking technologies, including the Mapuches in South America who through their jewelry sought a link with the universe. Although Mapuche jewelry is best known for silver work (Mapuche Silverware), this was not the only material on which they would have worked, and various studies indicate that they began to work with copper (Vergel Culture). Although they went through various stages of development and improvement of their silver work, they never abandoned copper.

Copper, which they called "anta," was used instead of iron to make weapons of war, knives, carpenter's tools, pins to hold women's cloaks, or hoes to dig the earth. The native Andean miner was intimately linked with the land, "Pachamama," and the mineral was treated as one more living element of nature, which was reproduced, manipulated, and "harvested" as a crop. The native metallurgists, more than mere artisans, were intermediaries between humans and deities, owners of both technical and esoteric knowledge.

## CHANGING POPULATIONS

The south of the province of Mendoza was part of a southern border between territories controlled by the original peoples, and the colonial government, which later became the Argentine Republic. This made the region a place of convergence for different types of societies with very different economic, productive, and social systems. The conquest of this territory by the Spanish began with the first exploration by Francisco de Villagra around 1551 and the subsequent foundation of the city of Mendoza around 1561[1].

Roughly around the same time, the migration of the Mapuche-speaking peoples from Chile, known as "araucanización" began, bringing instability to the southern border of the Viceroyalty of the Río de la Plata, which allowed the border to move south with the native peoples. With this exchange and circulation of people, networks, and goods, it is likely that knowledge about the manufacture of metals was also dispersed, including information about its significance and use.

## STUDYING ARCHAEOMETALLURGY IN MENDOZA

Archaeometallurgy uses metallographic and chemical techniques, and historical and bibliographic review to answer various archaeological questions. In this case, archaeometallurgy was used to study the relationship with metallurgy and metals by native peoples.

The effective use of metals in Argentine territory dates back well before the 1500s, although territorially it is restricted to the northwestern region of Argentina[2]. In southern Mendoza, known use of metals corresponds to post-colonial times. However, recent evidence shows that use of metals may have been practiced in the centuries prior to the arrival of Europeans to the region[3]. Metallic elements corresponding to both time periods were found at sites such as the Mapuche Cemetery of Cerro Mesa, Malargüe, Mendoza.

As the Mapuches were divided by the Los Andes range, those who occupied the Argentine pampas were called Puwelches, particularly those found south of the Rio Salado. Those who lived in Chile were called Guluches, and they occupied the region from the Bíobio River to the south in the Araucanía area, maintaining a great exchange on both sides of the Andes mountain range, an ideal mechanism to expand families and strengthen the transfer of goods through the region.

Through the study of historical pieces of Mapuche origin, it is possible to find connections of great importance from before the expansion of the Inca Empire. It is already known that a tradition of metalworking (Vergel Culture) would have existed in the southern regions of Chile and Argentina. In the same way, the arrival of the Spanish to these latitudes left a mark regarding the use of other techniques for metalworking and the mode of supply of raw materials.

In the different areas of the vast Andean territory, the path that metallurgy followed acquired its own peculiarities. The production and technical innovations of metals in the Andes was driven primarily by their use for social status and in the religious sphere where metals served as elements of connection with supernatural powers[4]. As Heather Lechtman[5] pointed out, Andean metallurgy was, above all, a way to communicate with the gods.

*Member of ASM International

## HOOP RING IN THE EL VERGEL TRADITION

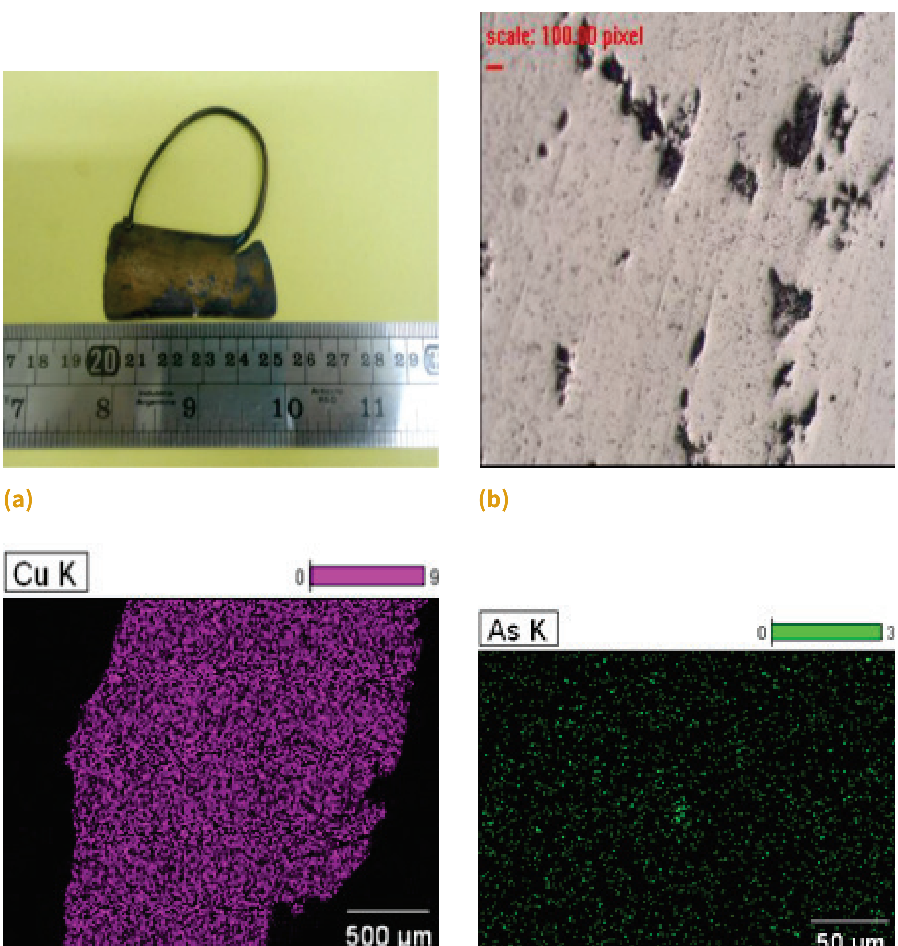
The El Vergel metalworking tradition (1000 to 1500 A.D.), includes objects such as square notched hoops shown in Fig. 1, flat circular hoops, simple circular hoops, bracelets, and rings. These pieces are characterized by being small in size, not very thick, made up of a single piece, without moving or articulated parts, and without engraved or cut-out and/or relief decorations. All these pieces are made of copper.

The type of notched quadrangular ring belonging to the El Vergel metallurgical tradition surely ceased to be manufactured at some point before the 18th century, but may have continued in use as it passed from generation to generation.

The quadrangular notched ring (also called "Chawai Chapel") presents, macroscopically, a good state of conservation and only a gentle cleaning was necessary to begin studies. The chemical composition shows it is composed of copper (94.83%) and arsenic (4.32%), and the rest are trace elements. The data on the copper-arsenic alloy is very interesting and allows this piece to be located on the timeline, because this alloy tends to be the dominant alloy before the 1500s.

According to metallographic studies, the simultaneous concurrence of an approximately constant composition and an adequate proportion of arsenic (<8%) results in the typical structure: a solid copper-arsenic solution made up of a single phase[6]. Then, arsenic would have been added with intention or considered a fortuitous event according to the characteristics of the minerals in the region: enargite ($CuAsS_4$) and tennantite ($Cu_3AsS_3$), and it would also be considered valid. In other words, although they could not know that they "technically" manufactured a copper-arsenic alloy, they could take into account that when processing the enargite they had a metal with better qualities and a more red color than that resulting from the processing of malachite [$Cu_2CO_3(OH)_2$].

The microhardness test shows that the manufacturing process was by successive reduction of thickness by forging and reheating of the original stem to stretch it both longitudinally and transversely. The average value of microhardness in the longitudinal direction is 154 HV and in the transverse direction it is 150 HV. The microhardness value of a current Cu-As alloy is: 151 HV. The Cu-As alloy improves properties such as resistance, hardness, malleability, and ease of fusion, which indicates the degree of technological development of the Mapuche to achieve a resistant material.



(a) (b) (c) (d)

**Fig. 1 —** (a) A quadrangular hoop with notch as found in Mendoza, (b) the microstructure, and (c) and (d) chemical composition.

## BRASS ALLOY CONES

A study of brass alloy cones illustrates the change of raw materials used in the region around 1800 A.D., and is attributable to the processes of social and political transformation strongly fueled by the arrival of Europeans and the creation of the border. Both indigenous and Spanish-Creole metal artisans (criollos) would participate in this process, adapting to the aesthetics of both worlds, leading to changes in the universe of the manufactured pieces[7]. The cones (Fig. 2) indicate a process of recycling of materials, their chemical compositions are very uniform and the interesting fact is that brass was introduced in the Southern hemisphere by the conquerors. It is possible that these cones were integrated into pectoral pendants called 'Sikil' but made of copper. The 'Sikil' made of silver seem to arise after the 19th century, approximately in 1860 A.D.[8].

From the microhardness measurement it is possible to suggest the manufacturing process of the receptacle. It could be that the original ingot had a greater plastic deformation at one of its ends to form a thin sheet, which was laminated in a certain way using, for

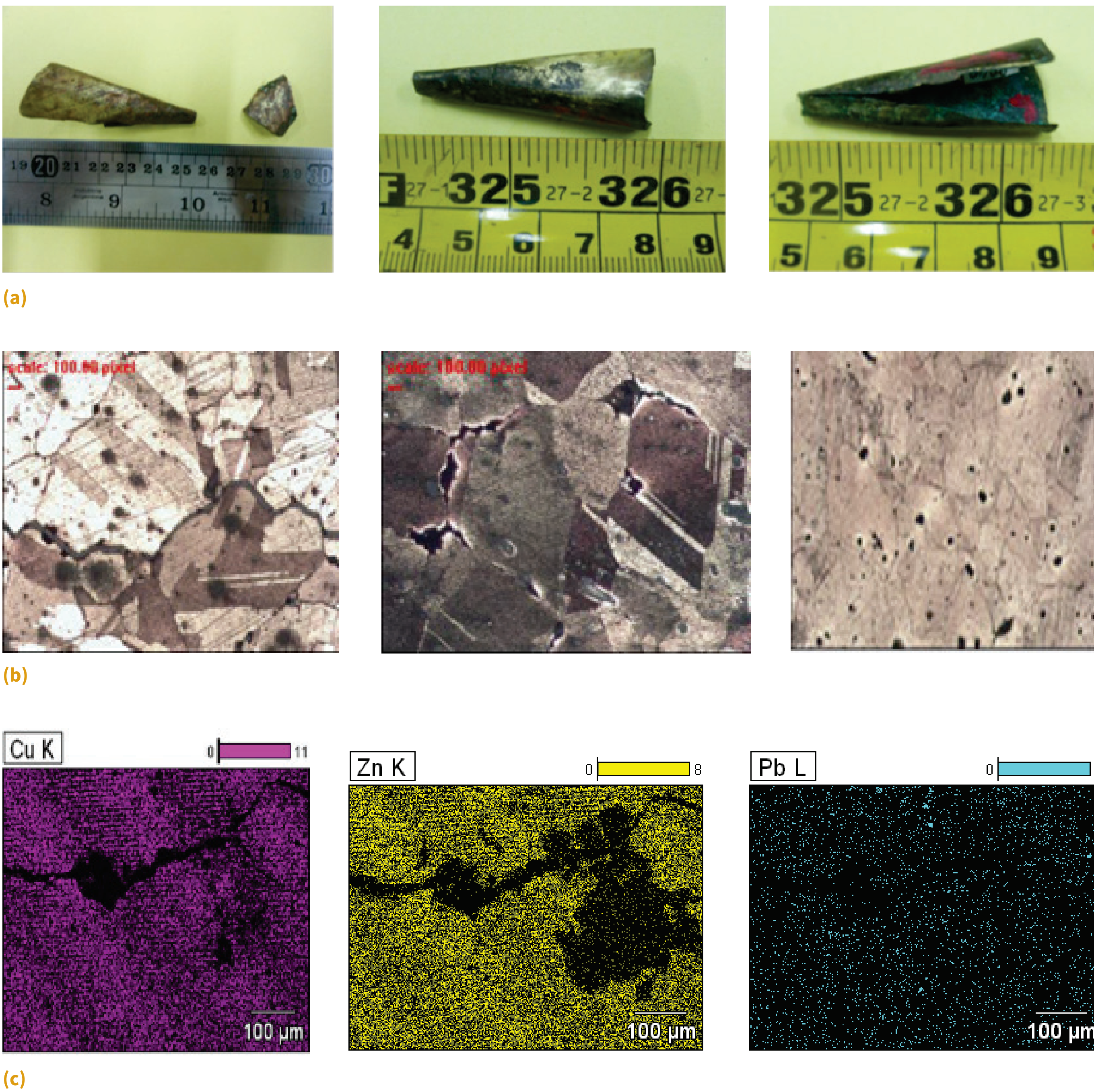



**Fig. 2 —** (a) Brass cones from the post-1600s era, (b) their corresponding microstructures, and (c) chemical compositions.

example, a piece of wood as a guide in its interior. The average microhardness data for Cone 1 is 121 HV, Cone 2 is 109 HV, and Cone 3 is 144 HV.

Observing the three cones macroscopically, their morphology is very similar (Fig. 2a). From the metallographic study (Fig. 2b), the images show structures consistent with α-brass and leaded brass (Cu-Zn-Pb). The metallographic structure is very similar to brass alloy (Cu-Zn) and lead appears as small dark particles at the grain boundaries. The images show equiaxed grains, polygonal grains, annealed twins, slip lines, and void segregation.

The chemical composition values as shown in Fig. 2 are: for Cone 1: Cu is 71.1% and Zn is 24.4%; for Cone 2: Cu is 66.7% and Zn is 27.9%; for Cone 3: Cu is 66.6% and Zn is 26.2%. The chemical analysis of the three cones corresponds to the current alloys for forged brass α, that is, brass type α with lead (Cu-Zn-Pb), precisely it is cartridge brass 70% C36000 for Cone 2 and Cone 3. In the case of Cone 1, the alloy is equivalent to that of cartridge brass 70% C26000[10].

## CONCLUSIONS

The work done to study these artifacts from the era before the arrival of the Spanish reiterates the role metallurgists played in their communities. They didn't consider metalworking an industrial process, more as a way of interpreting the universe and creating offerings to their gods. Archaeometallurgical study shows the influence of migration and European settlement in the area. **~AM&P**

**Acknowledgments**

The author wants to especially thank the staff of the Natural Museum of San Rafael, Mendoza, Argentina for allowing the study of these historical-heritage assets. This research study is part of the Border Archaeometallurgy Project (MATUNME code 004308) developed at the Metallurgy Laboratory, National Technological University, Faculty Mendoza Regional.

**For more information:** Patricia S. Carrizo, chemical engineering and archaeometallurgy specialist, National Technological University, Argentina, patricia.carrizo@frm.utn.edu.ar.

**References**

1. N.E. Sosa Morales, Historia de un Pueblo La Villa Vieja [History of a Town Village The Old], Serie Libros N°1, Museo de Historia Natural, Dirección Municipal de Cultura, San Rafael, Pro-vincia de Mendoza, Argentina, 1979.

2. H. Lagiglia, Hacha insignia ceremonial de bronce Santamariana hallada en Mendoza [Santamariana bronze ceremonial insignia axe found in Mendoza], *Actas Jornadas de Arqueología del Noroeste,* Buenos Aires, Universidad del Salvador, p 74-84, 1979.

3. R. Campbell, Entre el Vergel y la Platería Mapuche: El Trabajo de los Metales en la Araucanía Post Contacto (1550-1850 D.C.) [Between the Vergel and the Mapuche Silverware: Metalworking in Post-contact Araucanía (1550-1850 A.D.)], 2004.

4. J. Antinao, Sociedad y Cosmovisión en la Platería Mapuche [Society and Cosmovision in Mapuche Silverware]. Universidad Católica de Temuco, Temuco, Chile, 2010.

5. H. Lechtman, Reflexiones Sobre la Metalurgia de América. En Metalurgia de la América Precolombina [Reflections on the Metallurgy of America. In Metallurgy of Pre-Columbian America], p. 301-306. Memorias 45° Congreso Internacional de Americanistas. Banco Popular, Bogotá, Colombia, 1988.

6. M. Hansen, Constitution of Binary Alloys, Metallurgy and Metallurgical Series. Mac Graw-Hill Book. Segunda Edición, 1958.

7. L. González, Bronce Bajo el sol. Metalurgia Prehispánica en el Noroeste Argentino [Bronze under the Sun. Pre-Hispanic Metallurgy in the Argentine Northwest], pp. 97-131. En: Masked Histories. Editores. Stenberg, P. y Muñoz, A., Etnologiska Studier 43, Gotemburgo, 1999.

8. Antinao, J.: op. cit., 2010*ASM Handbook,* Volume 9: *Metallography and Microstructures*, ASM International, 2004.

9. *ASM Handbook,* Volume 2: *Properties and Selection: Nonferrous Alloys and Special-purpose Materials,* ASM International, 1990.

## GET ENGAGED, GET INVOLVED, GET CONNECTED

Join the conversation about historic metals. The archaeometallurgy community on ASM Connect is very active and welcomes new participants. Recent discussions include metallurgy during the Iron Age, pigment analysis, misconceptions in archaeometallurgy, and a call for papers to present at IMAT 2021. Visit the ASM Connect home page at connect.asminternational.org, search for the Archaeometallurgy Committee, and get into the conversation!

Patricia Silvana Carrizo prompted the formation of the Archaeometallurgy Community and has been leading its efforts.