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Analytical methodology for the study and diagnosis of the conservation status of archaeological objects

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In archaeology, materials characterization techniques can provide information about the origin of objects, temporal assignment, manufacturing aspects, use and deterioration processes after discarding.

In the framework of the Project for Conservation and Restoration of the Giai collection of the Museum of Patagonia (PNNH-APN), we developed a working methodology for the study of cultural assets. This was done by implementing analytical techniques for the characterization of materials with minimum impact on the objects, prioritizing non-destructive studies. Here we present, as a case study, the metallurgy of a silver earring from the colonial period belonging to the aforementioned collection (Fig. 1). The information provided led us to approximate answers to archaeological questions and to move forward in the diagnosis of the conservation status.

All the experiments that we will describe were carried out in different dependencies of the Atomic Energy Commission of the Argentine Republic (CNEA).
These experiments were approached methodologically through interdisciplinary interaction to re-elaborate the archaeological and conservation questions into chemical and morphological fingerprints. Once these were established, it was possible to select the appropriate analytical techniques to be applied.

It is possible to differentiate locally manufactured objects, objects of European origin, and objects that were manufactured with local techniques reusing European raw materials by knowing the composition of the alloy. We applied SEM/EDS technique using the FEI Inspect S50 Scanning Electron Microscope equipped with an energy-dispersive X-ray spectroscopy (EDS) detector. The identied alloy composition, was, on average 75% silver, while also identifying the presence of copper, aluminum, iron and sulfur. The latter is associated with silver degradation products, such as silver sulfide. Particle induced X-ray emission (PIXE) technique in the 1.7 MeV Tandem Accelerator will be applied to determine trace elements that could provide information about the origin of the raw material.
We performed X-ray diffraction measurements in order to identify the alloy phases and the corrosion products and to determine the preferential orientation of the crystalline grains, that is, the crystallographic texture. These measurements were carried out on a PANalytical Empyrean diffractometer with an Eulerian cradle using Cu K⍰ radiation. We observed that the earring possesses a face-centered cubic phase (FCC) with a lattice constant (a) of ~ 4.064 Å, which is close to pure silver (4.0860 Å). No other phases were detected. We found that the observed texture components aligns the {110} planes toward the ⟨112⟩ direction, this component is called "Brass". Brass components are observed in metals with FCC structure subjected to cold rolling processes (Kocks et al. 1998) (Liu et al. 1998). There is no evidence of texture components associated with annealing/recrystallization processes, giving us insight that the fabrication procedure does not involve temperatures higher than 150 ℃ (Liu et al. 1998).

Kocks, U. F., C. N. Tomé y H. R. Wenk (1998). Texture and anisotropy: preferred orientations in polycrystals and their effect on materials properties. Reino Unido: Cambridge University Press.
Liu, W. X., Y. Liu, H. Suo y H. J. Bunge (1998). Texture in silver. Materials science forum, 273:503-510. Trans Tech Publications, Ltd.

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