From biomorphs to euhedral galena, evidences of diagenetic processes in the Las Cruces deposit.

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INTRODUCTION

Las Cruces is a volcanogenic massive sulphide deposit located in the easternmost Iberian Pyrite Belt. The deposit is situated in the Guadalquivir Basin, beneath Miocene sediments, within a zone of major block compartmentalization controlled by large ENE-WSW Alpine faults. The deposit is composed of a large lens of massive sulphides, dominated by pyrite, with smaller amounts of sphalerite, galena, chalcopyrite and tetrahedrite-tennantite (Blake, 2008; Knight, 2000).

The deposit was isolated from the surface by a layer of sedimentary breccia and sandstone (up to 20 m thick) and overlain by c.a. 150 m of Messinian marl. This changed the conditions of what was a standard VMS deposit. The interaction between water circulating through the aquifers and the gossan cap led to the formation of a set of unusual rocks: the red rock dominated by siderite with traces of anglesite-cerussite and jarosite, and the black rock composed of iron sulphides, galena and calcite with abundant accessory phases including silver, mercury and lead sulphides as well as sulphosalts, cinnabar and gold (Blake 2008; Menor-Salván, 2011; Yesares et al. 2014; Tornos et al. 2017).
There are also several evidences of alteration processes, like the intense argillic alteration beneath the gossan, or the pervasive silicification in the red and black rocks. While the argillic alteration has been dated in 10-11 Ma and is interpreted as related to the supergene alteration, the silification processes are controlled by Alpine faults and therefore have affected the secondary minerals (Tornos et al. 2017).

Maybe the most interesting feature of the deposit is the presence of biomorphs in the black rock (Tornos et al. 2014) along with microbial communities still alive nowadays (Tornos et al., 2019), and related with the secondary minerals.

In this work, a study of these biomorphs is presented with special attention to textures and fabric.

METHODS

Samples were taken from the Black rock outcropping in the open pit at the Las Cruces mine. A rock hammer was used to extract them. Polished sections were prepared to look for the presence of biomorphs and, once located, SEM probes were prepared from those same rocks.

XRD analysis was performed in a BRUKER D8 Advance with a SOL-X detector. Data was preprocessed with DIFFRACplus software and processed with Spectragryph software.

Scanning Electron Microscopy (SEM) was carried out by means of a JEOL JSM-820 electron microscope at the CAI of Geological Techniques (Complutense University of Madrid) equipped with an energy dispersive spectrometer (EDS) system for determination of chemical composition during SEM observations.

RESULTS AND DISCUSSION

Biomorphs analysed are rod-shaped forms, of 0.5 µm to 1 µm wide and 2 µm to 8 µm long, with an outer crust of Pb sulfide. They are always found coating oxides (hematite or goethite) or siderite-calcite as several piling layers of continuous mats.

In several zones, it has been observed a tendency of the rods to organize, changing towards an idiomorphic euhedral crystal shape (Fig.1). This is likely the consequence of the interaction of the biomorphs to diagenetic alterations. The process should have partially recrystallized the Pb sulfides allowing them to change into more cubic shapes. Indeed, evidence of recrystallization is limited to some samples, and in those samples there is a tendency from parts full of unbounded rods towards almost perfectly reticular structures, something that could be related to an sparse diagenetic process driven by the waters controlled by Alpine faults, similar to those described by (Tornos et al. 2017).

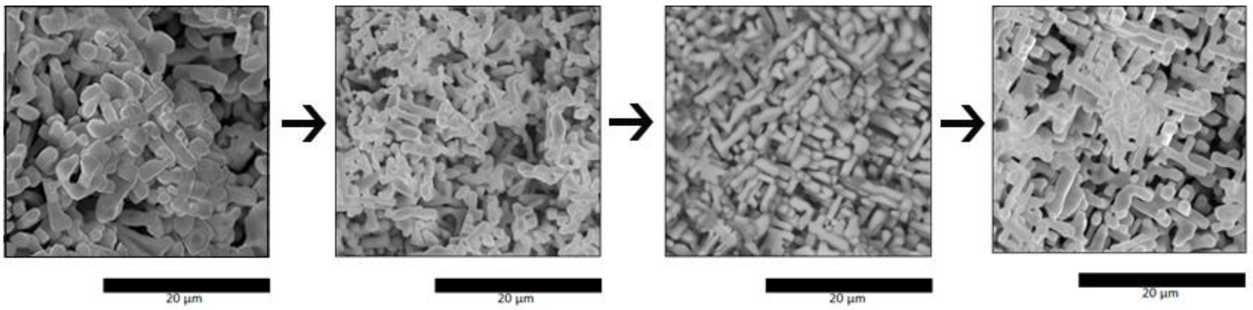

***Fig 1**. SEM images of the evolution of the rod-biomorphs towards euhedral crystals of galena. From left (initial stage) to right (final stage).*

REFERENCIAS

Blake C (2008): The mineralogical characterization and interpretation of a precious metal-bearing fossil gossan, Las Cruces, Spain. Ph D Thesis, Cardiff University.

Knight, F.C. (2000): The mineralogy, geochemistry and genesis of the secondary sulphide mineralisation of the Las Cruces deposit, Spain. Ph D Thesis, University of Wales.

Menor-Salván, C. (2011): Minerales de plata de la mina "Las Cruces", Gerena (Sevilla, España). Revista digital de Mineralogía Topográfica Ibérica, **59-69.** ISSN 2171-7788

Tornos, F., Velasco, F., Menor-Salván, C., Delgado, A., Slack, J.F., Escobar, J.M. (2014): Formation of recent Pb-Ag-Au mineralization by potential sub-surface microbial activity. Nature Communications, **5(1)**, 4600.

Tornos, F., Velasco, F., Slack, J.F., Delgado, A., Gomez-Miguelez, N., Escobar, J. M., Gomez, C. (2017): The high-grade Las Cruces copper deposit, Spain: a product of secondary enrichment in an evolving basin. Mineralium Deposita, **52**, 1-34.

Tornos, F., Oggerin, M., de los Ríos, A., Rodriguez, N., Amils, R., Sanz, J. L., ... Slack, J.F. (2019): Do microbes control the formation of giant copper deposits?. Geology, **47(2)**, 143-146.

Yesares, L., Sáez, R., Nieto, J.M., de Almodóvar, G.R., Cooper, S. (2014): Supergene enrichment of precious metals by natural amalgamation in the Las Cruces weathering profile (Iberian Pyrite Belt, SW Spain). Ore Geology Reviews, **58**, 14-26.