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Supergene Copper Alteration at Miguel Vacas Mine, Ossa-Morena Zone, Portugal

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Miguel Vacas Mine is an hydrothermal copper ore deposit located in the Ossa-Morena Zone (OMZ), between Vila Viçosa and Alandroal, near the NE Flank of the Estremoz Anticline. Albeit a number of exploration campaigns and its exploitation from the beginnings of the 20th century up to 2007, there isn't, in the literature, a detailed mineralogical characterization of the deposit, being difficult an understanding of the ore-forming processes. Aiming to fill this gap we have characterized the primary and supergene ore mineralogy and its implications for a better understanding the metalogenesis of this deposit.

Miguel Vacas deposit corresponds to a sub-vertical vein system, filled with quartz and carbonates and sub-concordant with the regional structure. Generally displayed in a NNW-SSE lode, it extends over more than 2 km with a variable thickness (10 to 20 m). The deposit is emplaced in metasedimentary formations, composed mainly of black and grey shales, with interbbeded lyddites.

Based on petrography, mineralogy, and chemistry it is possible do distinguish an hypogene primary ore and a supergene ore, with a typical weathering profile comprising four different zones: leached zone, oxidized and reduced supergene zones, and primary ore zone. It was also possible to highlight the episodic character of the primary mineralization with characteristic metal remobilization and sulfide re-precipitation.

Each zone has a characteristic mineral assemblage. The leached zone is mainly composed by hematite and goethite with remnants of primary sulphides (chalcopyrite and pyrite) and secondary copper carbonates/phosphates (malachite/pseudomalachite). The supergene oxidized zone is dominated by copper carbonates (malachite ± azurite), phosphates (pseudomalachite ± libethenite), sulphates (brochantite), and oxides (cuprite and copper oxide – XRD File: 01-080-1916), with minor native copper. The Cu-S phases (chalcocite, digenite, anilite, djurleite, and covellite) prevail over bornite and chalcopyrite at the reduced supergene zone. The primary ore zone consists of hypogenic chalcopyrite, pyrite ± arsenopyrite ± gersdorffite. It's still possible to observe bismuth minerals (wittichenite, cuprobismutite, emplectite, bismuthinite, and native bismuth) that can be later within the hypogenic mineralization.

The mineralogical variability that is observed attests for the complexity of the ore-forming processes and variation of the physical-chemistry parameters with time and space. Changes in pH, ρCO_2, aPO_4^{3-} are critical to understand the complex mineralogy of the oxidized zone. The presence of chalcocite in this zone reflects water table level fluctuations. The hypogenic Ni, Cu, Bi, Co, Au signature can be associated with the influx of mineralizing fluids along deep regional structures.