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The Las Herrerias Deposit: Replacive IOCG Systems in the Ossa Morena Zone (SW Iberia)

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The iron oxide-copper-gold (IOCG) mineral system encompasses a range of hydrothermal ore deposits characterized by abundant iron oxides, copper sulfides, and gold. These deposits can form through various geological processes, including the replacement of volcanic rocks and ironstones, brecciated fault zones, and the alteration of felsic igneous rocks.

The Ossa Morena Zone (SW Iberia) contains several ore deposits sharing features with the IOCG mineral system that are near enigmatic Fe-B-REE deposits. The Las Herrerías deposit is one of the best IOCG-like examples. The mineralization is hosted by an Early-Middle Cambrian rift-related sequence that includes limestone and bimodal volcanic rocks capped by shale and sandstone. These late siliciclastic rocks host a stratabound ironstone that is interpreted as being exhalative in an oxic third-order basin. During the Variscan deformation, the ironstone and host rocks were affected by major N-S shearing and formation of NW-SE extensional faults. These late faults controlled a second event of mineralization dated at 332 to 330 Ma that includes the widespread hydrothermal replacement of the ironstone by semi-massive chalcopyrite and bornite with magnetite-hematite, quartz, and carbonates. Host rocks have been affected by a pervasive phyllic alteration.

High $^{87}Sr/^{86}Sr_i$ and eNd_i ratios suggest that fluids forming the Cu-rich mineralization are significantly different from those related to the ironstone. They are of crustal derivation and probably were distal to coeval peraluminous granitoids. Numerical modelling indicates that the brittle ironstone is a preferential site for epigenetic copper-rich mineralization. Reaction of the hydrothermal fluids produces major changes in the fO_2 and pH, destabilizing the Cu aqueous complexes. However, the critical issue is the input of external reduced sulfur. In this case, it was derived from the abiogenic reduction of the barite in the ironstone.