Defining the Syn-Kinematic, Amphibolite-Facies Sequeirinho-Style IOCGs, Carajás Mineral Province

Charlys V. S. Neves[1], Roberto F. Weinberg, Leandro D. Campos, Andrew G. Tomkins, Carlos E. Ganade, Ivan Belousov, Jeffrey Oalmann
[1]Monash University, Melbourne, Australia

Most of the classification schemes for Iron Oxide Copper-Gold (IOCG) deposits are too broad, encompassing multiple deposit styles, obscuring possible genetic differences. The Carajás Mineral Province hosts two distinct IOCG types: the Salobo and Sequeirinho styles. We investigate the Sequeirinho-style and its Ni-Co-rich analogs, to define its style and to propose a model for its formation.

The ore bodies are sigmoidal, brecciated lenses enveloped by steeply dipping mylonitic rocks where mineralization occurs either following the mylonitic foliation or as massive breccias, also often deformed. Microstructural and mineralogic evidence indicates mineralization was syn-kinematic and syn-peak metamorphism at mid-amphibolite-facies.

The development of deposit-scale alteration haloes depends on the ore body size, with the transition from preserved protoliths (e.g., granitoids, basalts, metapelites) to mineralization occurring from mm-scale on smaller bodies to m-scale on world-class deposits. The mineralized rocks define a paragenetic sequence comprising an early stage that can be of two kinds: both kinds display F-Cl-apatite, magnetite, and allanite, but the dominant silicate can be either actinolite (±K-Cl-hastingsite) or biotite/chlorite. This is followed by a transitional sulfide stage with pyrite, (Ni-Co)pyrrhotite, and REE-epidote, more marked in the Ni-Co-rich deposits; and by the proper Cu-Au mineralization, with chalcopyrite, epidote, chlorite, F-apatite, Fe-actinolite, and gold. The mineral chemistry evidences an evolution from reduced and chlorine-rich fluid to oxidized and Cl-poor and likely F-rich fluid.

The chalcopyrite-rich Sequeirinho-style IOCGs constrast with many IOCGs worldwide, including the Salobo-style counterpart in Carajas, which is represented by ‘blue breccias’ (bornite-chalcocite-covellite-magnetite) and garnet-biotite-grunerite alteration haloes. Sequeirinho-style deposits are likely associated with saline fluids released during amphibolite-facies metamorphism. Reverse shear zones acted as fluid pathways, promoting interaction with several lithologies, including mafic-ultramafic rocks (resulting in Ni-Co-rich deposits). In this scenario, fluid overpressure pulses triggered brecciation and mineralization. This model reconciles structural control with alteration paragenesis, offering new exploration vectors.