Geochemical and chronological relationships between magnetite-apatite (MtAp) and iron oxide-copper-gold (IOCG) mineralization

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Summary

Iron oxide-copper-gold (IOCG) deposits are a controversial group of ore deposits that share common characteristics, such as the abundance of iron oxides, and the associated sodic or sodic-calcic alteration. The IOCG (*sensu stricto*) deposits contain Cu and Au minerals and iron oxides. The mineralogy consists of low-Ti magnetite or/and hematite, actinolite and/or pyroxene, and chalcopyrite, with subordinate bornite, pyrite, and pyrrhotite, and they are known from the Archean (Carajàs, Brazil) to the Mesozoic (Peru and Chilean iron belts). The other type of deposit in this group, magnetite-apatite (MtAp) or Kiruna-type deposits, contain low-Ti magnetite with apatite and actinolite and/or pyroxene. They are principally associated with calc-alkaline to alkaline volcanic or plutonic rocks, and are present from the Proterozoic (e.g. Kiruna, Sweden) to the Pliocene (El Laco, Chile; Abovian, Armenia). Despite a history of variable genetic interpretations of MtAp and IOCG deposits, their shared characteristics and temporal and spatial relationships have led several authors to propose that they are end-members on a continuous spectrum, with both types of deposits being formed from the same melt/fluid source, and recording mineralization from evolving fluids. To clarify the possible relationship between these two types of deposits, and to understand the behaviour of the actinolite in these deposits, several analyses have been made in deposits from Chile and Perú that comprise a MtAp mineralization event overprinted by an IOCG event: Marcona MtAp deposit, and Mina Justa and Monterrosas IOCG deposits in Peru, and Montecristo IOCG deposit, and Los Colorados and Pleito-Melón MtAp deposits in Chile, among others. The study principally focuses on the characterization of the actinolite from MtAp and IOCG deposits, using the EPMA for chemical analyses and x-ray maps, the LA-ICPMS for trace elements analyses, and ^{40}Ar-^{39}Ar geochronology for age determinations in actinolite associated with the alteration halo in the deposits. The characterization of the actinolite in these types of deposits is a novel study that will lead to a better understanding of the deposit formation and the possible relationship between both deposits, along with the magnetite and apatite. Other analyses in this research include Re-Os dating in molybdenite, δ^{34}S isotopes in sulphides, and U-Pb dating in zircons from the host rock in the Montecristo deposit for a clearer knowledge about the timing of the mineralization events and the formation conditions.