A genetic model that links magma, IOA and IOCG deposits

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The genesis of iron-oxide apatite (IOA) and iron-oxide copper gold deposits (IOCG) is controversial, with few observational data able to distinguish among working hypotheses that invoke meteoric fluid, magmatic-hydrothermal fluid, and immiscible melts. In this study, we use high-precision Fe and O isotope data and high-resolution trace element (e.g., Ti, V, Mn, Al) data of individual magnetite grains from the world-class Cretaceous aged Los Colorados (LC) IOA deposit in the Chilean Iron Belt to elucidate the origin of IOA and IOCG deposits. Values of δ^{56}Fe range from 0.08‰ to 0.26‰, which are within the global range of ~0.06‰ to 0.5‰ for magnetite formed at magmatic conditions. Values of δ^{18}O for magnetite and actinolite are 2.04‰ and 6.08‰, respectively, consistent with magmatic values; Δ^{18}O (actinolite-magnetite) yields minimum temperatures of ~600-670ºC. The concentrations of Ti, V, Al, and Mn are enriched in magnetite cores and decrease systematically from core to rim. Plotting [Al + Mn] vs. [Ti + V] indicates that magnetite cores are consistent with magmatic and/or magmatic-hydrothermal (i.e., porphyry) magnetites. Decreasing Al, Mn, Ti, V is consistent with a cooling trend from porphyry to Kiruna to IOCG systems. The sum of the data from LC is consistent with the following new genetic model that fully explains IOA and IOCG systems: 1) magnetite cores crystallize directly from silicate melt; 2) these magnetite crystals serve as nucleation sites for aqueous fluid that exsolves and scavenges *inter alia* Fe, P, S, Cu, Au from silicate melt; 3) the magnetite-fluid suspension is less dense that the surrounding magma, allowing ascent; 4) as this suspension ascends, magnetite grows in equilibrium with the fluid and takes on a magmatic-hydrothermal character (i.e., lower Al, Mn, Ti, V); 5) during ascent, magnetite, apatite and actinolite are deposited to form IOA deposits; 6) the further ascending fluid transports Fe, Cu and Au, as well as S, toward the surface where metal-oxides and metal-sulfides precipitate to form IOCG deposits. This model is globally applicable and explains the observed temporal and spatial relationship between magmatism and formation of IOA and IOCG deposits.