Magmatic-hydrothermal fluids transport more than dissolved solutes

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The ability for magmatic-hydrothermal fluids to scavenge and transport elements from silicate melt to form ore deposits is well accepted. Less well understood is the capacity for magmatic-hydrothermal fluids to sweep up and transport microlites that serve as nucleation sites for exsolving bubbles in silicate magma. Magnetite from the Los Colorados Kiruna-type iron oxide - apatite (IOA) deposit in the Chilean Iron Belt preserves evidence for the transport of igneous magnetite microlites by magmatic-hydrothermal fluid. IOA deposits are spatially and temporally associated with magmatic activity in arc environments. However, existing genetic models cannot successfully explain the geochemical signature of Kiruna-type IOA deposits, or their spatial association with magmatic activity. Here, we use trace element concentrations, and Fe, O and H stable isotope abundances in magnetite from Los Colorados to develop a new genetic model that explains IOA deposits as a combination of igneous and magmatic-hydrothermal processes. The novel genetic model invokes 1) near-liquidus crystallization of magnetite microlites from an intermediate silicate melt; 2) nucleation of gas bubbles on crystal faces of magnetite microlites; 3) coalescence of the volatile phase and encapsulation of magnetite microlites to form a magnetite-fluid suspension; 4) scavenging of Fe and other metals from the melt; 5) buoyant ascent of the suspension along structurally enhanced dilatant zones during regional extension; 6) growth of originally igneous magnetite microlites that source Fe from the decompressing magmatic-hydrothermal fluid; and 7) deposition of magnetite. The model explains the origin of Kiruna-type IOA deposits, and the globally observed temporal and spatial relationship between magmatism and IOA deposits, and provides a valuable conceptual framework to define exploration strategies.

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