Magnetite geochemistry from Andean Kiruna-type deposits

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The origin of magnetite-apatite "Kiruna-type" or iron oxide-apatite (IOA) deposits is still a matter of debate with models that range from a purely magmatic origin by liquid immiscibility to replacement of host rocks by hydrothermal fluids. More recently, a magnetite "flotation model" has been proposed to explain the genesis of Andean IOAs. In this model, fluids exsolved from the magma nucleate on the surface of primary magmatic magnetite. Due to its lower density this magnetite suspension migrates upward and accumulates forming the iron ore.

Magnetite is a ubiquitous mineral phase in different geological environments and the specific forming conditions are reflected in its trace element geochemistry. Several trace elements can be incorporated within the magnetite structure. Hence, the presence and concentration of these elements can be used to construct discrimination diagrams and to explain the chemical variation of magnetite for any particular deposit. Here we discuss the trace element signatures of magnetite grains from three large IOAs in the Chilean Iron Belt: Los Colorados, El Romeral and Cerro Negro Norte.

EPMA and LA-ICP-MS data coupled with micro-textural observations demonstrate that the magnetite ore formed by several stages, with an early magmatic event characterized by magnetite grains usually enriched in Ti, Mg, Al, Mn, V and Ga, followed by a high-temperature hydrothermal event with magnetite precipitated over the primary magnetite grains. In some cases, late hydrothermal magnetite veinlets form by dissolution-reprecipitation processes. The results present here show that the incorporation and concentration of trace elements in magnetite is a temperature-dependant process and that certain elements can be remobilized by superimposed hydrothermal events. Overall, the data obtained from these deposits are consistent with the "flotation model" proposed to explain the origin of Andean IOA deposits.