

## **Magmatic-hydrothermal evolution of the El Laco iron deposit revealed by trace element geochemistry and high-resolution chemical mapping of ore and gangue minerals**

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The Plio-Pleistocene El Laco massive magnetite deposit in the Central Andes of Chile represents an unusual variety of iron oxide-apatite (IOA) deposit, with surface structures remarkably similar to basaltic lava flows. The long-standing debate regarding its origin has endured, in part, due to intense hydrothermal overprinting, which has obscured primary textures. Here, we present a geochemical and micro-textural data set of ore and gangue minerals from the magnetite orebodies and andesite host units at El Laco. Our aim is to deconvolve the magmatic processes that took place in the magma reservoir, and link them to the formation of the overlying magmatic-hydrothermal system. We integrated in situ EPMA and LA-ICP-MS data of magnetite and clinopyroxene with high-resolution chemical maps obtained by EMPA-WDS and synchrotron micro-XRF mapping. Our observations lead to the following findings: (1) Magnetite compositions reveal systematic trends of progressive depletion in most major, minor and trace elements (e.g., Ti, V, Ni, Mn, Cr, Ga and Co). These, extend from trace element-rich magnetite in the andesite to trace element-poor magnetite in the outcropping orebodies. Similar trends were also observed in chemical composition of clinopyroxenes, and are interpreted along with magnetite data as record of different conditions of mineral growth ranging from purely magmatic conditions evolving to a cooling magmatic-hydrothermal environment. (2) Magnetite and clinopyroxene record a wide variety of complex micro-textures that reflect highly dynamic crystallization conditions. Clinopyroxene from host andesites account for multiple episodes of mafic magma recharge into the El Laco magma chamber. Whereas textural observations in clinopyroxene-bearing iron ores point to an evolving system fed by repeated pulses of mineralizing fluids under fluctuating physico-chemical conditions, possibly controlled by boiling stages. The results present here reveal key evidence on the chemical evolution of the ore-forming magmatic-hydrothermal system, providing new constraints on the genesis of this enigmatic deposit and other similar shallow IOA systems elsewhere.