

## **Intracrystalline sulfur zonation of apatite from the El Laco iron oxide apatite deposit, Chile**

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Iron oxide - apatite ore deposits occur globally and are characterized by abundant magnetite and apatite. Apatite [commonly  $\text{Ca}_5(\text{PO}_4)_3(\text{F},\text{Cl},\text{OH})$ ] is an ubiquitous mineral in magmatic and magmatic-hydrothermal systems, and can contain up to ~1 wt.% sulfur. The sulfur content of apatite is mainly a function of the sulfur content and oxidation state of the system at the time of apatite crystallization. Thus, zonation of sulfur in apatite may record multiple generations of apatite growth and may provide valuable insight regarding the origin and evolution of iron oxide - apatite (IOA) deposits. In this study, we report new sulfur data in apatite from the El Laco IOA deposit, Chile, to test the hypothesis that the intracrystalline zonation of sulfur in apatite may serve as a proxy to temporally and spatially reconstruct ore formation processes in hydrothermal and magmatic-hydrothermal environments. Currently, there is an overall lack of literature data reporting apatite major and trace element chemistry for the El Laco deposit. Apatite that crystallized along the margins of vesicle pipes, which are interpreted to be formed during the outgassing of magmatic-hydrothermal fluids of the El Laco ore body, were qualitatively and quantitatively characterized by using (a) energy-dispersive X-ray (EDX) mapping, and (b) wavelength dispersive X-ray spectroscopy (WDS), respectively. The EDX mapping reveals chemical zonation with respect to sulfur within individual apatite grains, and was subsequently confirmed via WDS spot analyses, where the concentration of sulfur in apatite ranges from 900 to 11,000 ppm sulfur, suggesting that the system was sulfur-rich and fully oxidized with respect to sulfur (e.g., as  $\text{S}^{4+}$  and/or  $\text{S}^{6+}$ ). The cores of some apatite grains are enriched in sulfur relative to the rims, while other apatite grains exhibit the reverse trend; suggesting that (a) two or more generations of apatite exist, or (b) that some apatite grains have chemically re-equilibrated with a magmatic-hydrothermal or hydrothermal fluid. We will perform X-ray absorption near edge structures (XANES) spectroscopy analysis at the sulfur *K*-edge to measure the oxidation state of sulfur in the apatite grains to further distinguish between (a) and (b). However, the available data indicate that the sulfur-enrichment of apatite plausibly reflects equilibration with a relatively oxidized and sulfur-enriched magmatic-hydrothermal fluid phase that subsequently overprinted, relatively sulfur-depleted primary magmatic apatite.