Formation of Kiruna-type deposits – testing a novel model

JAAYKE L. KNIPPING[1,2,3,*], ADAM C. SIMON[2], MARTIN REICH[4], ADRIAN FIEGE[3], ARTUR P. DEDITIUS[5], JAMES D. WEBSTER[3], LAURA BILENKER[6], FERNANDO BARRA[4], FRANCOIS HOLTZ[1], MARTIN OESER-RABE[1]

[1]Institut für Mineralogie, Leibniz Universität Hannover, Germany (j.knipping@mineralogie.uni-hannover.de)
[2]Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, MI, USA
[3]Department of Earth and Planetary Sciences, American Museum of Natural History, New York, NY, USA
[4]Department of Geology and Andean Geothermal Center of Excellence (CEGA), University of Chile, Santiago, Chile
[5]School of Engineering and Information Technology, Murdoch University, Perth, Australia
[6]Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, Canada

Kiruna-type iron oxide-apatite (IOA) deposits are an important source of iron and other elements (e.g., REE, P, U, Ag and Co). However, their formation remain controversial. In this study, we focus on magnetite from the unaltered Kiruna-type Los Colorados IOA deposit (~350 Mt Fe) in Chile. LA-ICP-MS transects and high resolution X-ray elemental maps demonstrate distinct chemical zoning in magnetite grains, where cores are enriched in Ti, Mg, Mn and Al, consistent with igneous magnetite crystallized from a melt, and rims that are depleted in these elements consistent with magnetite grown from an Fe-rich magmatic-hydrothermal fluid. Based on these observations a novel model was proposed for the evolution of Kiruna-type deposits [1, 2]. It involves crystallization of magnetite microlites from a silicate melt and exsolving fluid bubbles during decompression that attach and buoyantly segregate magnetite microlites. This rising magnetite-suspension deposits massive magnetite with both, igneous and magmatic-hydrothermal signatures, in regional-scale transcurrent faults. New *in-situ* Fe isotope data obtained by LA-ICP-MS agree with this model by showing lighter Fe isotopes in the rims (δ^{56}Fe=0.10-0.23) when compared to magnetite cores (δ^{56}Fe=0.18-0.33). The reliability of the segregation model is currently tested experimentally. Results from decompression experiments, conducted similar to the approach of Matveev and Ballhaus (2002) [3] will be presented.

[1] Knipping et al. (2015) *Geology* **43** (7), 591-594 [2] Knipping et al. (2015) *Geochim. Cosmochim Acta* **171**, 15-38 [3] Matveev and Ballhaus (2002) *EPSL* **203**, 235-243.