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Trace element geochemistry of iron oxides from the Per Geijer apatite iron ores in the Kiruna district, northern Sweden: Implications for ore genesis

Patrick Krolop[1], Kari Niiranen[2], Sabine Gilbricht[1], Bernhard Schulz[1], Marcus Oelze[3], and Thomas Seifert[1]

[1]TU Bergakademie Freiberg, Mineralogy, Economic Geology and Petrology, Freiberg, Germany (patrick.krolop@mineral.tu-freiberg.de)

[2]Luossavaara-Kiirunavaara AB (publ.), Kiirunavaaravägen 1, 98186 Kiruna, Sweden

[3]GFZ German Research Center for Geosciences, Telegrafenberg, 14473 Potsdam, Germany

Iron oxide-apatite (IOA) deposits are an important source of iron ore based on the modal abundance of magnetite > 90 vol.%. Further interest is generated due to the high variability of apatite and hematite in some of these ores. The origin of the so-called Kiruna-type deposits has been subject to controversy for more than a century. Models range from a purely magmatic origin to ore-forming processes that involve variable stages of hydrothermal fluid involvement to a not widely accepted sedimentary-exhalative origin. In contribution of understanding ore-forming processes of this deposit type, we performed mineral chemistry and trace element analyses on samples from the Per Geijer deposits. They account for the lesser studied deposits in the Kiruna district of northern Sweden. A comprehensive mineral-chemical dataset of magnetite and hematite obtained by electron microprobe analysis (EPMA) and LA-ICP-MS from representative drill core samples is presented. Magnetite and four different types of hematite constitute the massive orebodies: Primary and pristine magnetite with moderate to high concentrations of Ti (□61–2180 ppm), Ni (□11–480 ppm), Co (□5–300 ppm) and V (□553–1831 ppm) indicate a magmatic origin for magnetite. Hematite type I appears as a replacement of magnetite with high Ti (□15,700–42,300 ppm), relatively constant V (□1460–2160 ppm) and moderate Sn (□29–105 ppm) concentrations. Moderate and variable Ti (□369–12,490 ppm) and low Sn (□1.4–19 ppm) concentrations are representative for hematite type II. Hematite type III has lowest Ti (□99–1250 ppm) concentrations. Significantly high Ti concentrations (□12,100–78,700 ppm), low V (□132–381 ppm) and high Sn (□129–456 ppm) concentrations account for type IV. The presence of fluorapatite and disseminated pyrite with high Co:Ni ratios (> 1–10) in massive magnetite ores are consistent with a high temperature (□ 800°C) genesis for the deposit. The different and abundant types of hematite state subsequent hydrothermal events.