New U-Pb and Nd data for the Kiruna iron oxide apatite ores and their host rocks in the Norrbotten region of northern Sweden

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About 40 iron deposits near Kiruna in the Norrbotten region of northern Sweden are of the iron oxide-apatite (IOA) type, also referred to as Kiruna-type deposits. They are commonly considered a subgroup or end-member of iron oxide-copper-gold (IOCG) deposits, containing no economic grades of copper or gold. Both IOCG and IOA deposits are characterized by abundant low-Ti Fe oxides, enrichment in rare-earth elements (REE), and intense sodium and potassium wall-rock alteration adjacent to the ores. Deposits of these types are of a great economic importance, not only for iron, but also for other elements such as REE or uranium.

Kiruna, the type locality of the IOA type of mineral deposits, is the focus of this study, including the giant underground mine Kiirunavaara. Despite a century-long mining history and 2500 Mt of iron ore produced in the region to date (with grades of 30 to 70 wt % Fe), the genesis of these deposits is poorly understood: theories of a magmatic vs. a hydrothermal or metasomatic origin have been proposed, and the iron mineralization in the Norbotten region has never been directly dated. The results anticipated from this study will provide a better understanding of the nature of the IOA type of mineral deposits and their relation to IOCG deposits such as Olympic Dam in Australia. An array of geochemical methods is used in order to gain insights into the emplacement history of the host rocks, their subsequent alteration, and the ore genesis of these deposits. This includes in-situ U-Pb geochronology of zircon, monazite, and titanite to constrain the timing between host-rock emplacement, alteration and mineralization. The combination of U-Th-Pb ages, tracer isotopes and trace element abundances at mineral scale (e.g., Lu-Hf in zircon, and Sm-Nd in monazite, apatite, titanite), along with the O-isotopic composition of zircon, will be used to decipher whether the Kiruna iron ore deposits are of metasomatic or igneous origin.

First Sm-Nd isotopic data point to distinct source differences between host rocks (εNd ~ -6), ore and heavenly altered (εNd ~ -3 to -4) samples. Preliminary in situ U-Pb dating of zircon from both host rock and ore samples confirms a previously documented event around 1880 - 1900 Ma in the Norrbotten region. However, U-Pb in monazite from an ore sample suggests a further event at ca. 1624 Ma, a period of known activity in Fennoscandia.

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Further investigation and more U-Pb data are needed to confirm those dates and how the iron mineralization is related to those two events. Overall, the study also intends to develop a predictive model for exploration of similar iron oxide-apatite deposits worldwide.