The Kiruna apatite iron oxide deposits, Sweden – new ages and isotopic constraints

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The apatite iron oxide (IOA) deposits in the vicinity of Kiruna in northern Sweden have been mined and studied for over a century; however, their genesis remains poorly understood. One hypothesis is that these deposits are the result of immiscible liquid iron oxide melts. Alternatively, they have been interpreted as the result of hydrothermal fluids mobilizing the Fe and and then concentrating it in these massive iron oxide deposits. Advocates of the latter suggest similarities of IOA deposits with the iron oxide copper gold (IOCG) class of deposits. This study is the first to combine detailed *in situ* U-Pb dating on accessory minerals with tracer isotope geochemistry on the whole rock and mineral scale to explore the different hypotheses.

U-Pb dates of zircon from host rocks confirm previously reported dates of ~1880 to ~1900 Ma, however, our dating of the metavolcanic host rocks of the main ore body at Kiiurnavaara more accurately at c. 1887 Ma and c. 1882 Ma. Syenitic and granitic intrusions in close proximity of the ore body have also been dated for the first time, at c. 1880 and c. 1875 Ma. Zircon found within the ore body Kiirunavaara itself shows a very distinct appearance from the magmatic host rock zircon grains: ore zircons consist of an oscillatory zoned core (c. 1878 Ma) that is overgrown by an inclusion-rich rim with highly discordant U-Pb dates. Monazite from the ore samples has been dated to c. 1628 Ma. The oxygen isotopic composition has further been determined on dated zircon grains. This confirms a significant difference between zircon grains from metavolcanic host rocks and intrusions ($\delta^{18}O$ ~3‰) and zircon grains from the ore samples ($\delta^{18}O$ ~7‰). Whole rock Sm-Nd data shows a similar picture with an εNd of ~ -6 for host rocks and εNd ~ -3 for the ore.

The combination of the isotopic differences between ore and host rocks with the young monazite age suggests a secondary event influencing the ore, but not the host rocks. The nature of this event and its relation to the ore formation is still under investigation.