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Hydrothermal influence on zircon from the Kiruna IOA ores - a comprehensive geochemical study of zircon crystals from the Kiruna iron apatite ore district in the Norrbotten region of northern Sweden

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The iron deposits located in the Norrbotten (Kiruna) region of northern Sweden are the type-locality of apatite iron oxide (IOA) deposits. The origin of these deposits has been debated for several decades. There are two current theories of the ore genesis of the Kiruna deposits: 1) iron oxide extracted from an immiscible silicate liquid-iron oxide melt; or 2) iron oxide transported and subsequently emplaced by hydrothermal fluids. Zircon grains were separated from the Kiirunavaara ore, adjacent hanging wall and footwall host rocks, and spatially related syenite and granite intrusions. BSE and CL images of the ore zircon reveal xenocrystic cores that are overgrown by “spongy”, inclusion-rich hydrothermal rims. Zircon crystals from the syenite intrusion contain veins and patchy zones resembling alteration and resorption textures. Zircon from the host rocks and the granite exhibit typical igneous growth zoning. Selected zircon crystals were analysed using the EPMA for Zr, Si, Hf, Ca, Fe, Y, and P, and revealed the zircon grains from the volcanic host rock and granite to be of near stoichiometric composition. Zircon crystals from the ore and syenite contained elevated Fe and P concentrations and have low analytical totals. EPMA elemental X-ray maps reveal Fe rich inclusions, veins and/or zones in zircon crystals from the ore and syenite. Similar features are not found in host rock or granite zircon. FTIR spectroscopy done on selected zircon grains from the ore and syenite revealed that they contained several weight percent of H2O. This suggests that zircon from the ore and syenite intrusion experienced post-crystallization hydrothermal fluid alteration. A high temperature (~600-700°C) magmatic fluid(s), at the magmatic-to-hydrothermal transition, possibly exsolved from the intrusions, seems the most likely heat and fluid source to have remobilised the iron, possibly locally derived, and concentrated it in the massive iron oxide deposits located at Kiirunavaara.