Magnetite chemistry and Fe-O isotopes help unravel origin and affinities of the Malmberget iron oxide-apatite deposit, northern Sweden

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Abstract

European iron ore production is primarily sourced from iron oxide-apatite deposits in the northern Norrbotten ore province in northernmost Sweden. The Malmberget iron oxide-apatite deposit is the largest underground iron ore resource in Europe and is an amphibolite grade analogue of the world-famous Kiirunavaara iron oxide-apatite deposit. The Malmberget rock association is characterised by multiple phases of deformation, metamorphism and alteration that resulted in a genetically ambiguous and geometrically complex deposit. Primary ore textures and emplacement structures of the Malmberget iron oxide-apatite deposit have largely been recrystallised during metamorphic overprint and now comprises dominantly medium- to coarse-grained, granoblastic magnetite. In this contribution, we combine magnetite trace element chemistry and stable Fe-O isotopes to characterise the magnetite of the Fabian-Kapten and ViRi ore bodies and unravel the primary origin of the Malmberget iron oxide-apatite deposit. Trace element and Fe-O isotope data from massive magnetite samples from the Fabian-Kapten and the ViRi ore bodies indicate a high-temperature magmatic to magmatic-hydrothermal origin of the Malmberget iron oxide-apatite ore deposit, regardless of subsequent metamorphic modifications. Magnetite trace element contents and Fe-O isotope equilibrium calculations reveal a temperature discrepancy between the Fabian-Kapten ore body and the ViRi ore body, where the ViRi ore body has a more pronounced magmatic character than the Fabian-Kapten ore body. We explain this difference by the respective ore body's stratigraphic position in the ore-forming, magmatic system.