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## Genesis of Palaeoproterozoic iron skarns in the Misi region, northern Finland

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**Abstract** Sodic alteration is widespread in Palaeoproterozoic greenstone and schist belts of the northern Fennoscandian shield. In the Misi region that forms the easternmost part of the Peräpohja schist belt, several small magnetite deposits show intimate spatial relationships with intensely albitised gabbros, raising the possibility that regional acid alteration released iron, which was subsequently accumulated into deposits. Two of these magnetite deposits, Raajärvi and Puro display a typical paragenesis as follows (from oldest to youngest): (1) diopside, (2) actinolite/tremolite-magnetite ± chlorite, biotite, and (3) serpentine ± hematite, chlorite. Mass balance calculations suggest that significant amounts of Fe, Ca, Mg, K, Cu, V, and Ba were lost, and Na and Si gained during the albitisation of the gabbro, at near-constant Al, Ga, Ti, and Zr. Significant amounts of Si, Ca, Fe, and Na were enriched in the formation of skarn related to magnetite deposits. Fe and V leached from country rocks deposited during the skarn-alteration and formed the vanadium rich iron deposits while

Cu passed through the system without significant precipitation due to low sulphur fugacity. Variations in Na, Ca, Mg, K, and Ba contents reflect the composition of the infiltrating fluid during alteration. Conventional heating-freezing measurements and proton-induced X-ray emission (PIXE) analyses of the fluid inclusions related to actinolite/tremolite-magnetite stage alteration indicate that the fluids that caused the alteration and the Fe-mineralisation were complex, oxidised, highly saline  $H_2O \pm CO_2$  fluids that contained high amounts of Na, Ca, K, Fe, and Ba as well as elevated concentrations of Cu, Zn, and Pb. The oxygen isotope thermometry suggest that temperature during the Fe-mineralisation stage was between 390 and 490°C. Calculated  $\delta^{18}O_{fluid}$  values of 6.1–9.8‰ SMOW and  $\delta^{13}C$  values of calcites in the ores and skarns were between –7.7 and 10.9‰ PDB and most likely reflect admixture of  $^{13}C$  depleted, possibly magmatic fluids with the marble wall rocks that show  $\delta^{13}C_{calcite}$  values of 13‰ PDB. The SIMS U–Pb data on the zircons in the albitised gabbro next to the Raajärvi and Puro deposits suggest that intrusion of the gabbro took place at  $2123 \pm 7$  Ma and was accompanied by the formation of diopside skarn. The TIMS data on the metasomatic titanites related to sodic alteration yielded ages of  $2062 \pm 3$  and  $2017 \pm 3$  Ma. Iron was probably stripped from the mafic country rocks by sodic alteration between 2123 and 2017 Ma, driven by repeated brine influxes. Subsequently, the metal-rich brine was focused by a fault system and the iron was precipitated from this fluid by a combination of wall rock reaction, fluid mixing, and a drop in the temperature.

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### Introduction

Albitised and scapolitised rocks are common in Palaeoproterozoic greenstone and schist belts of northern