Using bulk-rock and mineral chemistry to unravel the origin of Fe-Ti-P mineralizations in the 1.8 Ga Raftsund monzosyenite, Lofoten, Northern Norway

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The Raftsund batholith, which belongs to the Vesterålen-Lofoten AMCG complex in Northern Norway, was emplaced at 1.80 Ga. The central equigranular unit grades from a pigeonite-cpx (Wo_{41-46} $En_{26.2-29}$ Fs_{25-29}) monzosyenite ($Mg\#_{35-26}$), to a fayalite (Fo_{2-8})-cpx (Wo_{32-45} En_{9-19} Fs_{36-56}) +/-opx monzonite ($Mg\#_{24-7}$). Fe-Ti-P mineralizations ($Mg\#_{19-25}$), scattered in the pigeonite-cpx monzosyenite, occur as lensoid bodies up to 200 m x 50 m but also as small cm-scale diffuse clusters. They are composed of cpx (Wo_{34-45} En_{20-46} Fs_{23-44}), Fe-rich olivine (Fo_{22-29}), apatite and Fe-Ti oxides, occuring in variable proportions along with late hornblende and biotite.

Bulk-rock analyses show that the mineralizations are enriched in Fe, Ti, P, Mg, Ca, Sc, Co, Zn, Cu, V and REE but depleted Si, Al, alkalies and LILE, compared to their monzosyenite host. The presence of Fe-rich olivine (Fo_{22-29}) in the mineralizations and the chemistry of the cpx, which show an enrichement in Al and Ti, suggest that the lensoid bodies do not result from simple accumulation of the mafic minerals from the monzosyenite but rather that they crystallized from a melt, enriched in Fe,Ti, P and depleted in Si. Furthermore, high Ca/Al ratios of the bulk-rock Fe-Ti-P bodies indicates a decoupling between the 2 elements. These observations are consistent with liquid immiscibility, where Ca, P, F, Ti concentrate in a Fe-rich melt, whereas Al, K and Na remain in the Si-rich melt.

Preliminary LA ICP-MS analyses of cpx and apatite from the Fe-Ti-P mineralizations show they contain more Zr and Hf than cpx and apatites in the other 1.8 Ga monzonite and qz monzonite of the region. Furthermore, cpx from the mineralizations is enriched in Sc and to a lesser extent in Ti, Zn and depleted in V, Co, Sr, Y, Nb, LREE and Al, which is consistent with coprecipitation of apatite and magnetite and the formation of such a melt by liquid immiscibility.