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A microtextural record of silicate-liquid immiscibility in the 1800 Ma monzonitic Raftsund intrusion, Vesterålen-Lofoten archipelago, Northern Norway

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The 1800 Ma Raftsund intrusion covering area of 75x35 km is the largest intrusion in the Vesterålen-Lofoten AMCG suite in Northern Norway. It consists of monzonite to syenite containing scattered Fe-Ti-P mineralizations which vary from mm-size Fe-rich mineral clusters and apatite +/- zircon, to up to 200 m x 50 m-large lenses. Although the Raftsund has suffered from medium to high-pressure metamorphism subsequent to crystallization of the intrusion, primary igneous minerals and textures are generally well preserved.
A prominent feature in undeformed monzonites and syenites, is the common texture of stringer-like clusters of mafic minerals (inverted pigeonite or Fe-rich olivine, iron-rich augite, Fe-Ti oxides and minute grains of apatite and zircon) around larger areas of alkali feldspar and smaller amounts of plagioclase and small random mafic minerals. According to Philpotts (1981) such mafic clustering is best explained by crystallization from droplet of immiscible Fe-rich melt trapped in Si-rich melt. We suggest that these Fe-rich melts have coalesced and pooled to form the mineralized bodies, since bulk-rock geochemistry and trace element analyses of clinopyroxene, as well as field evidence, is consistent with formation of the mineralizations by liquid immiscibility and cannot be explained by simple accumulation or fractionation processes.
In addition to the predominant texture, several different microstructures related to late-stage reaction between liquid and primocrysts has locally been identified. These include fish-hook pyroxene consisting of a symplectite of plagioclase and clinopyroxene, found at the contact between inverted pigeonite and alkali feldspar, indicating that inverted pigeonite was resorbed at the expanse of alkali feldspar. Serrated grain boundaries between pyroxene and alkali feldspar are also common and result from similar process. Thin films of interstitial plagioclase occur locally, between Fe-rich minerals in mafic clusters, but also at the border between larger Fe-Ti-P lenses and the host syenite. The occurrence of plagioclase instead of alkali feldspar, which predominate in the syenite and the monzonite, indicate that the melt from which the Fe-rich minerals cluster crystallized was less alkaline than the one from which the monzonite and syenite originated. These reactive microstructures require a chemically open system and reaction between primocrysts and Fe-rich immiscible melt (Holness et al. 2011).
This study shows evidence of a complex system governed by liquid immiscibility occurring at various scales and immiscible liquids that are not always in equilibrium with one another. We speculate that silicate-immiscibility is relative widespread in AMCG complexes since the textural evidence reported here is not unique to the Raftsund intrusion.

Holness et al. 2011. Silicate liquid immiscibility within the crystal mush: Late-stage magmatic microstructures in the Skaergaard intrusion, East Greenland. J. Petrol. 52, 175-222.

Philpotts, A.R. 1981. A model for the generation of massif-type anorthosites. Can. Mineral. 19, 233-253.