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The coexistence of Fe-rich and Si-rich silicate melts in the Mesoproterozoic ferrobasalt flows and sill in the Ladoga Graben, Karelia

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The mechanism of accumulation of Fe-rich melts has been widely discussed for massifs of AMCG associations. The probability of immiscibility for melts associated with anorthosite has been shown experimentally; however, in natural objects of this association, evidence of its direct evidence is rare [1]. Mesoproterozoic ferrobasalt and gabbromonzonite Valaam sill of the Ladoga Graben in the Baltic Shield belonging to AMCG-type contain a natural convincing example of immiscibility between two Fe-rich and Si-rich silicate melts.

Microstructural evidence for the coexistence of two silicate melts was observed in interstices filled with unaltered glass, mainly between plagioclase and apatite crystals in ferrobasalts. There are tiny (1-2 μm) and large (15–20 μm) globules in Si-rich melts. Large globules usually occur in the volume of individual interstices as single globules. As a rule, they are partially crystallised; the inner part of the globule is most likely partially crystallised Fe-rich glass. The outer part of the globules consists of pyrrhotite (mss) or an aggregate of 1–2 μm crystals of magnetite and orthopyroxene or magnetite and pyrrhotite. Sulphide segregations of the chalcopyrite composition (iss) are often located in the center of such globules. The large globules are surrounded by a Fe-depleted and K and Mg enriched zone.

In the Valaam Sill, gabbro and gabbromonzonite contain abundant ilmenite-rich intergrowths with mica and amphibole. This Fe-Ti oxide microstructure is typical of liquid immiscibility in layered intrusives such as Skaergaard [2]. The ilmenite-rich intergrowths are associated with interstitial granophyre or apatite. Magnetite surrounded and associated with ilmenite. Segregations of Cu enriched sulphides (iss) can be found in the centre of the Fe-Ti-oxide intergrowths. Detailed petrographic and geochemical studies of ferrobasalts and gabbro-granite sills have provided evidence for the immiscibility of Fe-rich and Si-rich silicate melts in magmatism of the AMCG type.

[1] Honour et al. (2019), *Contrib. to Mineral. Petrol.* 174, 1–24.

[2] Holness et al., (2011), *Elements* 7(4), 247-252.