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Paleoproterozoic felsic magmatism of the Karelian Craton: petrogeochemistry, isotope geochemistry, and genesis

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Intense rift magmatism at the Karelian craton at the Archean-Proterozoic boundary (2.5-2.4 Ga) was mainly represented by mafic rocks, which compose mafic-ultramafic layered intrusions and basaltic lava fields. Felsic rocks of this age are of limited abundance, but provide insight into the nature of magmatism in an extensional regime associated with incipient rifting.

These felsic rocks are represented by metavolcanic rocks of dacitic to rhyolitic composition, which are spatially related with mafic volcanics, their plutonic analogues, as well as fields of "remobilized granites" among the Late Archean granitoids. Their U-Pb ages vary from 2434+8 Ma and 2361 + 15 Ma, with the younger ages of the latters.

The Paleoproterozoic felsic voclanics and granitoids are ascribed to the calc-alkaline to subalkaline series with total alkalis from 4.1 to 7.3 wt % and the K predominance over Na. Their distinctive feature is elevated TiO_2 content (up to 1.19 wt%), which is not typical of siliceous rocks and expressed in the presence of numerous rutile needles in quartz. Practically all rocks have high Fe mole fraction. In terms of alumina saturation index (ASI), the volcanics show wide variations from metaluminous to highly peraluminous rocks (from 0.9 to 1.6), whereas granites are metaluminous rocks (ASI = 0.9-1.0).

The studied rocks show fractionated REE patterns with wide LREE variations ((La/Yb)N=2.09–17.08; (La/Sm)N=1.65–4.4) at weak HREE variations (Gd/Yb)N=0.66–2.09), which is typical of the rocks formed in an intracontinental setting.

In the petrotectonic diagram, the granitoids fall in the field of A-type anorogenic granites, which is consistent with rifting setting of their formation. In terms of Y-Nb-Ga relations, they correspond to the rocks derived by crustal melting.

Sm-Nd isotopic studies revealed that the volcanics are characterized by negative eNd from -3.6 to -2.4, while the granites have more radiogenic composition from -1.7 to -2.0. The model ages vary from 2770 to 3012 Ga, which is at least 300 Ma older than their formation age, thus indicating their long crustal residence time. Additional evidence for their crustal rather than mantle origin can be elevated (> 1.2) Y/Nb, as well as Nb/La ratio significantly less than 1, which manifested itself in the notable Nb minimum in the spidergrams.

Based on similar geochronological ages of the felsic rocks and associated mafic volcanics, it is reasonable to suggest that the former were derived via fractionation of basaltic melt. However, the great volumes and large areal distribution of felsic rocks, the fact that they build up the basaltic sequence, but have no direct relations with them, and their absence in some Paleoproterozoic structures indicate that these rocks do not constitute a single differentiation series. It is more likely that the felsic rocks were formed by crustal melting during underplating. Since Archean rocks (recalculated for the age of the studied rocks) have significantly less radiogenic Nd isotopic composition, the juvenile input is required to obtain the parental magmas for the Paleoproterozoic felsic rocks of Karelia.

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