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Mantle sources and origin of the Middle Paleoproterozoic Jatulian Large Igneous Province of the Fennoscandian shield: evidence from isotope geochemical data on the Kuetsjarvi volcanics, Kola Craton

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Paleoproterozoic is one of the most important stages in the Earth's evolution as marking a cardinal change in a style of tectonomagmatic processes at 2.2-2.0 Ga, which corresponds to the formation of the Jatulian Large Igneous Province at the Fennoscandian Shield. The fragment of this province is represented by the volcanics of the Kuetsjarvi Group in the Kola Craton. These rocks differ in the extremely wide rock diversity and prominent role of alkaline rocks, the extremely rare rocks in the Precambrian. The rocks of the group are subdivided into the alkaline and tholeiitic basaltic series.

The tholeiites are highly fractionated (mg# 38) high-Ti rocks enriched in HFSE. The alkaline series show wider mg# variations (32-52), which is inconsistent with a single fractionation sequence of these series. All rocks have high HFSE, at extremely wide LILE variations. Tholeiites show moderate LREE fractionation pattern at practically flat HREE: La/YbN = 3.6-4.5; La/SmN = 2.2-2.4, Gd/YbN = 1.5-1.7 and slight Eu anomaly (Eu/Eu* = 0.80-0.85). The alkaline rocks display much more fractionated LREE and fractionated HREE (La/YbN = 43.9-5.8; La/SmN = 2.2-2.4, Gd/YbN = 2.04-3.92) patterns at Eu anomaly varying from 0.53 to 1. The spidergrams of both series reveal negative Nb and Sr anomalies at sign-variable Ti anomaly. The alkaline rocks are enriched relative to tholeiites in U, Th, and Nb. Examination of behavior of incompatible trace elements offers an opportunity to compare the conditions of generation of parental mantle magmas of the studied series. In particular, the tholeiitic basalts have higher Zr/Nb ratios than the alkaline rocks, which in combination with their lower La/Yb ratios indicates their formation under the higher melting degree of mantle source as compared to the alkaline rocks. Simultaneous increase in Ce/Y ratio in the alkaline rocks may indicate their formation at greater depths. Tholeiitic basalts have lower Nb/U ratio, which testifies some crustal contamination of the melts. In addition, they have low Ti/Y (323-449) ratios and high Lu/Hf (0.11-0.16), which is typical of the rocks formed by melting of spinel peridotites. The alkaline basalts were derived from a deeper garnet-bearing mantle source (Ti/Y = 640-1140, Lu/Hf = 0.03-0.05). Isotope-geochemical study showed that these rocks have very similar Nd isotope composition ((eNd (2200) = +1.5 in the alkaline basalt and +1.9 in the tholeiites). It was found that the studied alkaline rocks are similar in composition to the OIB-type Tristan da Kunha basalts, while tholeiites are closer to the high-Ti rocks of the Parana plateau, which experienced significant lithospheric contribution. Obtained data confirm the within-plate setting at the Jatulian stage of the Fennoscandian Shield. The Kutesjarvi Group consists of two rock types: OIB-type alkaline and E-MORB-type tholeiitic, which is typical of most Phanerozoic large igneous provinces. However, unlike the latters, the rocks of this area were too much tectonized and eroded to compile a systematic sequence. But, the Kuetsjarvi Group may be considered as the fragment of the oldest large igneous province.