GEOCHEMICAL CHARACTERISTICS AND AGE OF THE RAPAKIVI GRANITE COMPLEXES IN ESTONIA AND LATVIA

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In Estonia and Latvia, and the adjacent Baltic Sea, latest Palaeoproterozoic–Early Mesoproterozoic anorogenic magmatism is represented by the huge Riga rapakivi granite–anorthosite batholith, seven granitic plutons of various sizes and one quartz monzodioritic stock. These have been located by geophysical mapping and deep drilling that penetrated their Phanerozoic sedimentary cover.

Porphyritic felsic volcanic rocks, porphyritic basalts and shallow biotite–hornblende granites with rapakivi textures occur in the northern and central parts of the Riga batholith. Gabbro–noritic, troctolitic, anorthositic, syenitic and quartz monzonitic rocks occupy its southern, deeper part. The intrusions in Estonia consist mostly of homogeneous megacrystic microcline–biotite granites without rapakivi texture. Amongst them, the Märjamaa granitic pluton is distinctly polyphase, also including an early granodioritic intrusive phase. Glacial boulders from two large rapakivi granitic plutons in the basement of the northern Baltic Sea, indicated only geophysically, are mostly granophyric inequigranular granites.

Geochemically, the Estonian and Latvian rapakivi granites are subalkaline, metaluminous or slightly peraluminous, with high Fe/Mg ratios (4.5 to 7) and high F contents (0.05 to 0.4 wt. %). The major-element compositions overlap with those of typical Finnish rapakivi granites, although the Estonian granite intrusions contain somewhat less Al and Fe. In the ternary Rb–Ba–Sr diagram the rocks are comparable to less differentiated granite phases of the Wiborg and Laitila plutons. The biotite granites and aplitic granite dykes are slightly richer in Rb (up to 375 ppm), but concentration of this element does not reach the level of the Finnish topaz-bearing granites (550 to 990 ppm). The REE compositions also overlap with those of typical Finnish rapakivi granites showing only slightly weaker Eu anomalies. In the discriminant diagrams, the Estonian and Latvian rapakivi granites plot into fields of within-plate and A-type granites.

The mafic rocks associated with the rapakivi granites in Estonia and Latvia, have Fe-rich tholeiitic compositions and plot on the boundary between the alkaline and subalkaline fields in the TAS diagram. All are hypersthene normative and show relatively high TiO_2 (2.3–3.4 wt. %) and P_2O_5 (1.4–2.1 wt. %) contents. Low Mg numbers (40–55) correspond to low contents of Cr (10–49 ppm) and Ni (15–60 ppm). The REE contents are comparable to those reported from the mafic rocks associated with the Finnish rapakivi granites, except for the quartz monzodiorite of the Abja stock, which is more strongly enriched in light REE (La = 190 ppm). Cumulative character of the anorthosite from the Riga batholith is reflected by its low total REE contents and positive Eu anomaly.

Two of the Estonian megacrystic granites (Märjamaa and Naissaare) have U–Pb ages close to 1620–1630 Ma. Zircons from the Abja quartz monzodioritic stock yielded U–Pb ages of 1635 ± 7 Ma (mafic rocks) and 1622 ± 6 Ma (granitic veins), zircons from a leuco-gabbronorite and a biotite-hornblende granite of the Riga batholith gave U–Pb ages of 1576 ± 2 Ma and 1584 ± 7 Ma, respectively.

Whole–rock isotopic data indicate a source with chondritic Sm/Nd ratios for the mafic rocks of the Riga batholith and the Abja intrusion, and a Palaeoproterozoic (Svecofennian) protolith for the felsic rocks: the T_{DM} model ages for the felsic rocks range from 1.89 to 2.10 Ga. The Pb in the mafic and felsic rocks was derived from a source with relatively high time-integrated U/Pb ratio (single-stage μ value ca. 8.2). The Nd and Pb isotopic compositions of the felsic and mafic rocks of the Latvian and Estonian rapakivi complexes are largely similar to those of the Finnish rapakivi complexes and show that the local lower crust and subcontinental mantle were devoid of a (major) Archean component.