

# Geology and geochronology of the Estonian Precambrian basement

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The Estonian Paleoproterozoic to Mesoproterozoic metamorphic and igneous rock basement can be considered a southern continuation of the Fennoscandian Shield within the East European Craton. The Estonian basement comprises two major units: amphibolite facies rocks in northern Estonia and mostly granulite facies rocks in southern Estonia, separated by the Paldiski-Pskov tectonic (shear) zone. These rock complexes are similar to the rocks found in southern Finland. Due to a sedimentary cover of 100–780 meters, geological information is primarily derived from drill core studies and geophysical investigations. Geophysical, petrological, and geochemical studies have delineated the Estonian basement six structural-petrological zones: Tallinn, Alutaguse, Jõhvi, West-Estonian, Tapa, and South-Estonian zones, each varying in rock composition, genesis, geophysical properties, and metamorphic degree.

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Until the early 1980s, it was assumed that the granulite facies rocks in southern Estonia might be of Archaean origin. However, pioneering Sm-Nd analyses and U-Pb zircon age determinations in the early 1990s suggested a Palaeoproterozoic age for the granulites. The U-Pb zircon dating of metavolcanic rocks in northern Estonia reveals ages from 1889 Ma to 1844 Ma, while granulitic metavolcanics from the South-Estonian Zone show U-Pb zircon ages between 1840 Ma and 1802 Ma. Additionally, U-Pb monazite dating of orthopyroxene-garnet gneiss from the South-Estonian Zone yields an age of  $1778 \pm 2$  Ma. Partial melting of granulitic rocks in the South-Estonian and Tapa zones indicates crystallization ages for tonalites and charnockites clustering around 1822–1833 Ma and 1761–1788 Ma, respectively. Zircons from the Jõhvi Zone in iron-rich gneisses show three distinct age groups: 1874 Ma, 1826 Ma, and 1789 Ma. Post-orogenic magmatism in Estonia is represented by small monzonite-type mafic to felsic plutons with shoshonitic geochemical affinity, originating from the enriched lithospheric mantle and emplaced within the Estonian crust between 1800 Ma and 1610 Ma.

Estonia, situated in the central part of the Fennoscandian Rapakivi province, hosts granitoids temporally similar to both Rapakivi subprovinces. The Neeme rapakivi yields a U-Pb zircon age of 1634 Ma, Taebla rocks date to 1648 Ma, and Ereda rocks exhibit two age groups at 1642 Ma and 1627 Ma (unpublished data by A. Soesoo). The Märjamaa rapakivi provides a U-Pb zircon age of 1626–1630 Ma. Notably, the Calymmian granitoids in Estonia are known only from the Riga batholith, with ages ranging from 1576 Ma to 1584 Ma.

Currently, the Geological Survey of Estonia is revising the crystalline basement map. Future goals include extending geological knowledge to marine areas, linking the Estonian parts of the Fennoscandian Shield to rock units of similar age in South Finland and Sweden, and integrating new information from deep boreholes and geophysical investigations to update the map.

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