ISOTOPIC AND GEOCHEMICAL COMPOSITION OF THE KOMATITIDES SOURCES: IMPLICATIONS FOR ARCHAEOAN MANTLE PLUME EVOLUTION OF THE BALTIC SHIELD

A. B. VREVISKY

Institute of Precambrian Geology & Geochronology, Makarova emb., 2, 199034, St.-Petersburg, Russia

Many aspects of crust formation and evolution of the crust-mantle system of the Baltic Shield through Archaean and Proterozoic times are relatively well known (Huchma, 1986; Timmerman & Dely, 1995; Gaal & Gorbatschev, 1987; Lobatch-Zshuchenco, 1993; Dely et al., 1993). At the same time many problems of composition and evolution of the mantle remain a subject of discussion. In fact our knowledge of the Archaean and Proterozoic mantle is in many ways no better than is our knowledge of Venus and Mars.

In order to understand the geochemical and isotopic evolution of the Archaean upper mantle of the Baltic Shield, geochemistry of incompatible and rare earth elements, oxygen isotopic composition, Sm–Nd and Rb–Sr systematics of komatiites (PK) from 11 greenstone belts of the Kola peninsula, Karelia and E Finland have been studied. From our data we conclude that:

1. Based on the U–Pb zircon and Sm–Nd isochron whole-rock age, the greenstone belts could be subdivided into three groups: i) 3.05–2.9 Ga; ii) 2.9–2.8 Ga; iii) 2.8–2.7 Ga;
2. PK with εNd(T) from +3.7 to +2.6 represent the greenstone belts of the assumed age group 2.8–2.9 Ga; their mantle source has overall REE content (particularly HREE) 0.4–2.0 x chondrite; the fact that 7 data points form a good linear array with MSWD = 3.6 favours the hypothesis that PK from the Kola peninsula (Polmos–Poros and Ura–Guba belts), North (Hizovaara belt) and West Karelia (Kostomuksha belt) originated in a time span of 2.79 ± 0.31 Ga and that the isotopic characteristics of their respective mantle sources were similar (εNd = +3.4); the TDM model age of 2.79 ± 0.31 Ga is equal within errors to the Sm–Nd whole-rock isochron age of 3.15 ± 0.15 Ga of PK + TH from the Ura–Guba belt and 2.81 ± 0.6 Ga from the Kostomuksha belt and U–Pb isochron zircon ages, which are thought to represent the time of volcanism in this greenstone belt; it must be noted that these samples are depleted in LREE to different degrees, but have similar (flat) HREE distribution patterns; if such LREE heterogeneity is not reflected by εNd values of the rocks, it could mean that LREE depletion occurred not long before the magma generation;
3. Two samples from Hautavaara and Palaj–Lamba belts have considerably lower εNd values (+1.7 and +1.3, respectively); in the light of Zr, Ti and Y concentrations it can be assumed that mantle reservoir with which this PK reequilibrated, was "enriched";
4. The most depleted εNd values (+4.2 to +4.9) were observed in PK from the Kamennoozero (E. Karelia) and Sovdzerozero (C. Karelia) belts; such high εNd value might be explained by depletion of the mantle source by removal of significant masses of the continental crust, represented by adjacent gneisses of Vodlozero region with U–Pb zircon age of 3.14 ± 0.03 Ga and Sm–Nd model age > 3.3 Ga (εNd = -2 to +1) and gneisses from conglomerate pebbles of Oster belt with TDM model age > 3.2 Ga; in this case, it might be expected that in the other parts of the Baltic Shield a smaller volume of continental material had been extracted from the mantle before 2.9 Ga.

We assume that all these features could be best explained in the context of mantle plume evolution.

**Early stage (3.05–2.90 Ga)** — the melting of a mixture of heated surroundings (moderate DM) and cooled source material (undepleted) in the head of the mantle plume produced the PK of Eastern and Central Karelia, characterized by high Al2O3 = 6–10 %, moderately low FeO = 6–13 %, low TiO2/Zr and Y/Zr ratios, slightly depleted (Ce/Sm)N = 0.66–0.73, “normal” overall HREE = 2.0–3.0 x chond.; and with high εNd +4.2.

**Middle stage (2.9–2.8 Ga)** — the melting of a heated high DM surroundings in a tilted plume head produced the PK of Kola and N Karelia with high MgO = 36–28 %, FeO = 10–20 %, chondritic Y/Zr ratios, flat REE patterns (Ce/Sm)N = 0.92–1.09, “chondritic” overall HREE content (0.3–2.1 x chondrite), moderate high εNd = +2.6 to +3.7, and moderate to low 87Sr/86Sr = 0.704–0.701. These PK were probably derived from the nearly chondritic source in the hot axial zone.

**Late stage (2.8–2.7 Ga)** — the melting of a heated high DM surroundings in a tilted plume head produced the PK of E Finland (Ce/Sm)N = 0.27–0.57; overall HREE = 3.3–5.0 x chondrite; low TiO2/Zr and Y/Zr ratios.