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Nd-Sr Isotopic and Trace Element Systematic of the Devonian Kimberlites from the Northern Margin of the Russian Platform: Implications for the Mantle Source Heterogeneity

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The Devonian occurrences (pipes, sills, dykes) of kimberlites, melilitites, and basalts are known at the northern margin of the Russian Platform. They are clustered mainly within the following three areas: (a) Terskii Coast and Kandalaksha, southern part of the Kola Peninsula, (b) Arkhangel'sk Province (100km northeast of Arkhangel'sk), and (c) Middle Timan (figure). They are related to Devonian continental rifting and form a W-E trending chain about 1300km long. The trace-element and isotope features of kimberlites of the former two areas have been previously discussed on the basis of a plume-lithosphere or plume-protoarc interaction models (Beard et al., 1998; Bogatikov et al., 1999; Makhotkin et al., 1995; Parsadanyan et al., 1996). New ICP-MS trace-element data for kimberlites of Middle Timan as well as for some new Arkhangel'sk diamondiferous pipes (named by Vladimir Grib etc.) allow more comprehensive comparison of the kimberlite mantle sources and mantle heterogeneity. Our database includes 35 analyses for 30 elements of the unaltered [Contamination Index (C.I.) < 1.5 (Taylor et al., 1994)] hypabyssal kimberlites from these three areas: 30 an. from 11 pipes of the Arkhangel'sk Province; 2 an. from 1 pipe of Middle Timan; and 3 an. from the Kola Peninsula (after Beard et al., 1998). A comparison of these data lead us to the conclusions on compositional heterogeneity of the kimberlite and their mantle sources in the northern margin of the Russian Platform.

- The geochemical systematics of the studied kimberlites in terms of commonly accepted kimberlite groups (Smith et al., 1985).

The discriminant analysis based on contents of major oxides (Taylor et al., 1994) and incompatible trace elements and their ratios indicate that: (a) Kandalaksha monticellite kimberlite and one of two kimberlite analyses from the Terskii Coast are close to calcite kimberlites, while the second Terskii Coast sample is similar to the South African Group IA kimberlites; (b) the Arkhangel'sk and Middle Timan kimberlites are compositionally variable. They are comparable with the South African Group I (nonmicaceous) and Group II kimberlites (micaceous). It can be noted that the Aries geochemical signatures that have been recognized in kimberlites and related rocks from various Gondwanaland cratonic regions was not detected in the studied occurrences.

- The mantle plume signature and its lateral variations.

Initial $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ ratios of the studied nonmicaceous kimberlites plot close to CHUR and indicate their origin within asthenospheric (convective) mantle. However, the level and style of the trace elements enrichment vary in the samples from different areas studied. The highest LILE and LREE enrichment is typical of the Kola occurrences (about 80 primitive mantle concentrations for the Terskii kimberlites), while it is much lower in the Arkhangel'sk and Middle Timan kimberlites (about 50 PM values). The Nb, Sr, Th and some other element concentrations are also lower in the Arkhangel'sk and Middle Timan nonmicaceous kimberlites.

- The contribution of the lithosphere material into the mantle plume magma.

Arkhangel'sk micaceous kimberlites are similar in major-element chemistry to the South African Group II kimberlites. However, they have specific geochemical features: unlike the African Group II kimberlites, which have EM II mantle isotope characteristics, the Arkhangel'sk micaceous kimberlites exhibit EM I mantle isotope signatures (ε_{Sr} varies from -2 to +2 and ε_{Nd} varies from -2 to -4); the latter also have low Nb, Zr, Th, and U contents and Ce/Y (4), Ce/Sr (0.20) ratios as well as high P_2O_5/Ce (both in ppm) (> 60), Nb/U (> 40) ratios. The positive LILE- and negative HFSE-anomalies in the normalized trace-element patterns remind the geochemical features of the island-arc volcanics. Apparently, the EM I sources were generated in this area by the ancient (PR_1) metasomatism of subcratonic lithosphere blocks. These processes are believed to be associated with subduction of the Belomorian paleo-oceanic plate beneath the Kola craton. The EM I signatures of the Arkhangel'sk micaceous kimberlites was probably resulted from a plume-lithosphere interaction, when the asthenospheric kimberlite magmas could be contaminated by magmas derived from the old lithospheric domains.

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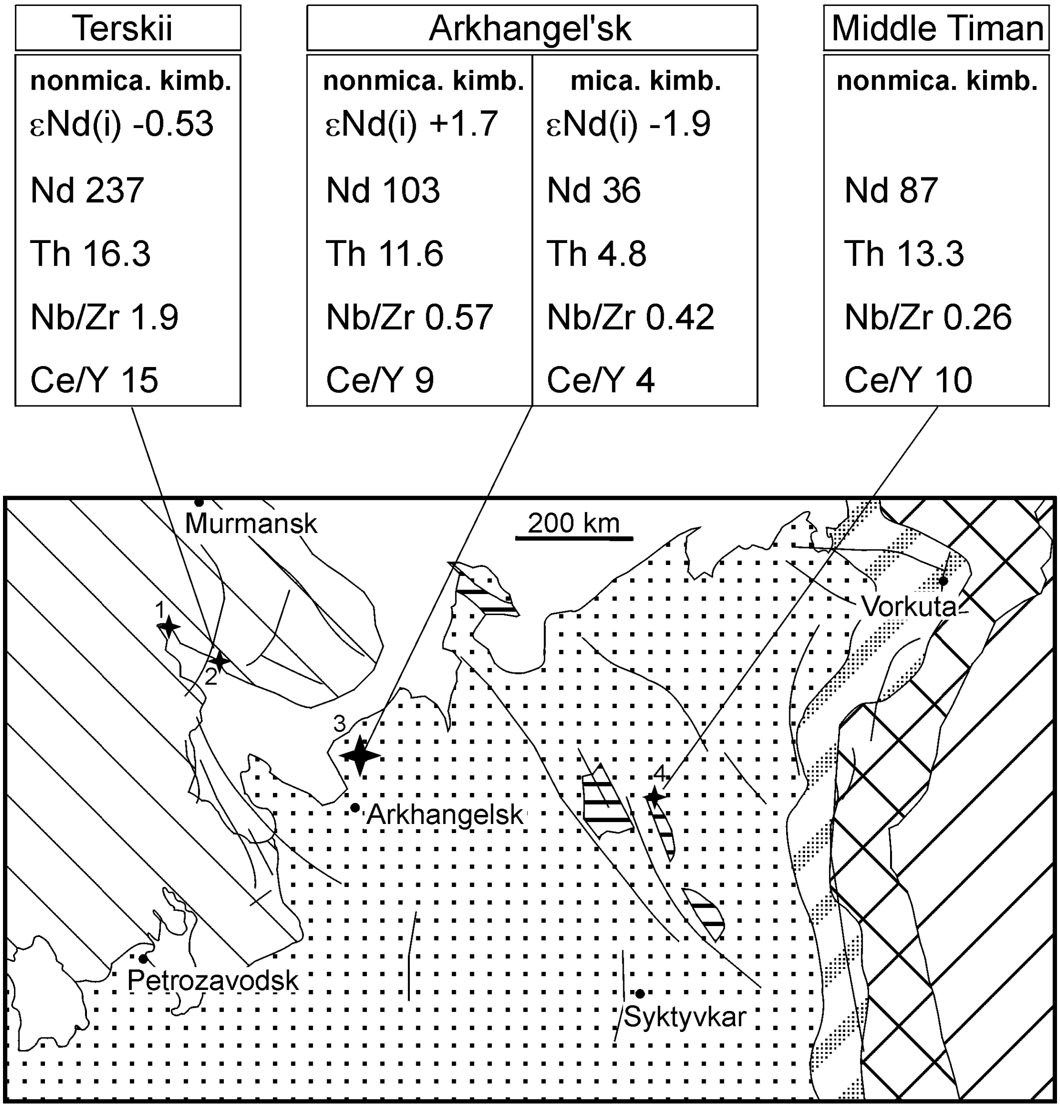

Figure 1: Location of kimberlite occurrences in the northern margin of the Russian Platform (1) Kandalaksha kimberlites associated with lamprophyres, 365 Ma; (2) Terskii Coast kimberlites associated with melilitites, 382 Ma, two kimberlite pipes with diamonds (Beard et al., 1998); (3) Arkhangel'sk kimberlites associated with melilitites and basalt, D_2; (4) Middle Timan kimberlites, 380-400 Ma.

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