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Magmatic diversification of dykes is controlled by adjacent alkaline carbonatitic massifs

Maya Kopylova[1,4], Anna Nosova[1,2], Ludmila Sazonova[1,3], Alexey Vozniak[1,2], Alexey Kargin[1,2], Natalya Lebedeva[1,2], Galina Volkova[1,2], and Ekaterina Pereseckaya[3]

[1]Vernadsky Institute of Geochemistry and Analytical Chemistry of Russian Academy of Sciences, Moscow
[2]Institute of Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Russian Academy of Sciences, Moscow
[3]Geological Department, Lomonosov Moscow State University, Moscow
[4]University of British Columbia, Earth, Ocean and Atmospheric Sciences, Vancouver, Canada

The study reports petrography, bulk major and trace element compositions of lamprophyric Devonian dykes in three areas of the Kola Alkaline Carbonatite Province (N Europe). Dykes in one of these areas, Kandalaksha, are not associated with a massif, while dykes in Kandaguba and Turij Mys occur adjacent (< 5 km) to coeval central multiphase ultramafic alkaline-carbonatitic massifs. Kandalaksha dyke series consists of aillikites - phlogopite carbonatites and monchiquites. Kandaguba dykes range from monchiquites to nephelinites and phonolites; Turij Mys dykes represent alnoites, monchiquites, foidites, turjaites and carbonatites. Some dykes show extreme mineralogical and textural heterogeneity and layering we ascribe to fluid separation. The crystallization and melt evolution of the dykes were modelled with Rhyolite-MELTS and compared with the observed order and products of crystallization. Our results suggest that the studied rocks were related by fractional crystallization and liquid immiscibility. Primitive melts of alkaline picrites or olivine melanephelinites initially evolved at P=1.5-0.8 GPa without a SiO_2 increase due to abundant clinopyroxene crystallization controlled by the CO_2-rich fluid. At 1-1.1 GPa the Turij Mys melts separated immiscible carbonate melt, which subsequently exsolved carbothermal melts extremely rich in trace elements. Kandaguba and Turij Mys melts continued to fractionate at lower pressures in the presence of hydrous fluid to the more evolved nephelinite and phonolite melts. The studied dykes highlight the critical role of the parent magma chamber in crystal fractionation and magma diversification. The Kandalaksha dykes may represent a carbonatite - ultramafic lamprophyres association, which fractionated at 45- 20 km in narrow dykes on ascent to the surface and could not get more evolved than monchiquite. In contrast, connections of Kandaguba and Turij Mys dykes to their massif magma chambers ensured the sufficient time for fractionation, ascent and a polybaric evolution. This longevity generated more evolved rock types with the higher alkalinity and an immiscible separation of carbonatites.