Melilite-Bearing Rocks within Alkaline-Ultrabasic Complexes: Derivatives from SiO_2-Poor, Ca-Rich Mantle Magma?

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Two series composing the alkaline-ultrabasic association are distinguished: melilite-bearing rocks, high in Ca, and melilite-free varieties, low in Ca (Kravchenko and Rass, 1985). The sequence of melilite-bearing mineral associations, according to their segregation during the formation of alkaline-ultrabasic complexes, both in the Karelo-Kola and Maimecha-Kotuy (NW Siberian Platform) provinces, is the following: kugdite (Ol+Mel) - unkompahgrite (Mel+Cpx) - turjaite (Mel+Cph+Ne) - okaite (Mel+Ne) - micaceous okaite (Mel+Ne+Phl). Melilite-bearing rocks in Karelo-Kola massifs (Kovdor and Cape Turii, at least) are the third intrusive phase, following olivinites and pyroxenites, also jacipirangites and melteigites, and are, in turn, transsected by ijolite, nephelite and alkaline syenite (Kukharenko et al., 1965; Bulakh, 1977). The melilite-bearing rocks of Maimecha-Kotuy massifs represent the second phase of intrusion following the intrusion of dunite-peridotites and ore pyroxenites (in the Guli massif), or olivinites (e.g. in the Kugda and Odikhincha massifs), and are, in turn, transsected by jacupirangite-melteigites and ijolites, and also syenites (Egorov, 1991). Autonomous displays of melilitic rocks do also exist, e.g., in Central Europe (Wimmenauer, 1974; Wilson et al., 1995).

The systematic study of mineral composition and zoning of rock-forming and accessory minerals provides new data to evaluate their essential distinctions that depend on their affinity to rocks of the melilite-bearing or melilite-free series. Clinopyroxenes, olivines and nephelines from the series with melilite are enriched in Ca-content as compared with the same minerals from the series without melilite. Thus, CaO in olivines is 0,42-2,08 wt.% contre 0.28-0,46, and in nephelines 0,32-2,93 contre 0,04-0,61 wt.% According to experimental melting data (Gee and Sack, 1988; Shi, 1993; Rass et al., 1996), the Ca-content in olivine and nepheline depends on the Ca-content in the melt, from which the minerals crystallized.

The zoning of clinopyroxenes, titaniferrous garnets, and especially apatites and perovskites from the two series are characterized by persistently different trends of component microfractionation. Thus, apatites from the rock sequence pyroxenite - melanephelinite - melteigite-ijolite - nepheline syenite are enriched in SrO in the consecutive differentiates, but SrO diminishes from crystal core to rim. The REE contents remain nearly constant. On the other hand, the apatites from melilite-bearing rocks have more or less constant Sr contents and shaw REE increasing from crystal cores to rims (Rass and Laputina, 1995).

Clinopyroxenes from melilite-bearing rocks in any massif are enriched by REE, as compared with clinopyroxenes from melilite-free rocks in the same massif. When taken into account that REE concentrations in melilites themselves are of the similar magnitude (Rass,1982), it may inferred the parental magmas for melilite-bearing rocks are enriched by REE.

Compositions of alkaline-ultrabasic igneous rocks, when traced on almost each petrochemical diagram, especially those using Ca-content as a coordinate, demonstrate two different trends related to melilite-bearing and melilite-free rocks, with more and less Ca, respectively. The normative tetrahedron Ln-Fo-Q-Ne (Yoder, 1979), is the best approximation to real chemical features of the rocks under investigation. The diagram with traced rock compositions shows that two rock sequences could not be from one parental magma, and, as compared with the parental magma for melilite-free rocks, a possible parental magma for melilite-bearing rocks must be enriched in Ca, and be compositionally close or similar to Siberian kimberlites with approximatly 14 wt.% CaO, and to the IB kimberlite type (Smith et al., 1985).

We have melted such kimberlite (the sample kindly put at our disposal by Dr. Ilupin), and melilite crystallized at a pressure 7 kbar and a temperature 1050^{0}C (Rass et al., 1996). This result, and the experiments on Ca-rich kimberlite from Wesselton (Edgar and Charbonneau, 1993), and isotope data on melilitites in Central Europe (Wilson et al., 1995) support the idea, that melilite-bearing rocks may be derivatives from deep, Ca-rich, mantle magma. One of the necessary conditions for the differentiation of kimberlite-like or kimberlite magma is the existence of an intermediate magma chamber under pressures at least as low as those within the melilite stability field. Hence kimberlites themselves should be an explosive facies (as it is the case) of some primary mantle magma.

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