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AUGITE MEGACRYSTS FROM ENMELEN VOLCANOES (BERING SEA BASALT PROVINCE)

by

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The 10 to 4 million year old lavas at Enmelen volcanoes, Chukchi Peninsula, NE-Russia, consist of olivine melanephelinites and basanites, and include the most undersaturated lavas of the Bering Sea basalt province [1]. These intraplate lavas brought to the surface xenoliths of spinel lherzolites, pyroxenites, and gabbronorites along with megacrysts of clinopyroxene, orthopyroxene, olivine, ilmenite and biotite. Previous study showed that most of the spinel lherzolites xenoliths are Mg-rich and have relatively high CaO, Al_2O_3 and Na_2O contents compared to the depleted peridotites found in the ocean basins. Chondrite-normalized REE patterns for those Groups I lherzolites range from relatively flat patterns to patterns with negative slopes, they equilibrated within a temperature range of 850 - 1030°C; two xenoliths equilibrated at much higher temperatures of 1230 - 1240°C and have relatively Fe-rich composition [2].

Among the nodules found in Chuckhi peninsula, approximately 7 - 10 % are pyroxene megacrysts that vary in size between 1 and 12 cm. The relative high abundance of the augite megacrysts indicates that their origin must be associated with major magmatic processes that influenced and modified the lithosphere in this region. We investigated in detail these pyroxene megacrysts using microprobe, ion probe, INAA, LA-ICP-MS, XRF and ICP-MS.

The pyroxene megacrysts are black in color, characteristically lacking cleavage and exhibiting conchoidal fracture. They are typically subcalcic augites with high Al_2O_3 (7.5 wt.%), significantly elevated TiO_2 (1.42 wt.%) and Na_2O (2.45 wt.%) and very low Cr (ca. 30 ppm) contents. Their CaO content, however, vary with Fe/Mg ratios allowing to classify pyroxenes in two groups: group one (augite1) with CaO = 17.3 wt.% and Fe/Mg = 0.38 and group two (augite2) with CaO = 14.6 and Fe/Mg = 0.26. This increase of Fe/Mg ratio with increasing of CaO has been interpreted as indicative for crystallization during slow upward moving of the magma [3].

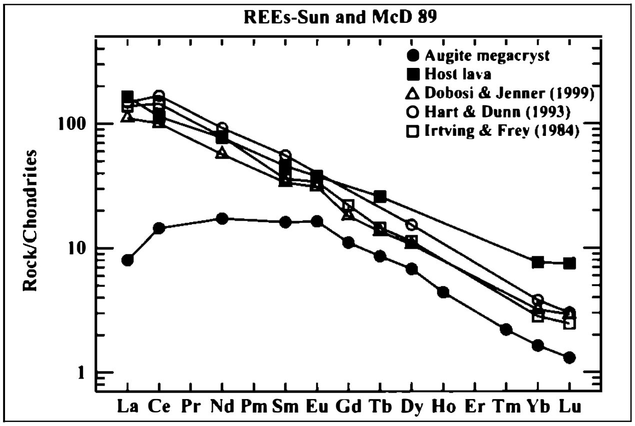

Fig. 1
Host lavas and hypothetical compositions of liquids in equilibrium with augite megacrysts, calculated using partion coefficients of [4, 5, 6].

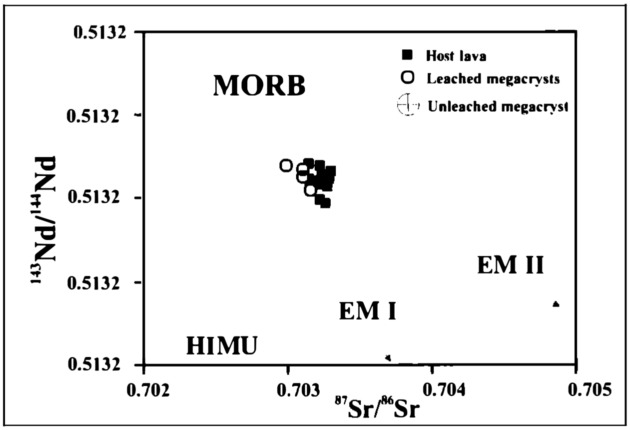

Fig. 2
Correlation diagram of Sr-Nd isotopic ratios for augite megacrysts and host melanephelinitic lavas.

The chondrite-normalized REE display LREE/MREE – enriched upward convex patterns with $La_N/Yb_N = 6.4$ (Fig. 1). Using existing partition coefficients [4, 5, 6] we calculated the hypothetical melt in equilibrium with augite megacrysts. The calculated liquids, compared to the host olivine melanephelinite lavas have similar LREE but significantly lower middle and heavy REE. It implies that the parental source of the augite megacrysts was not the host lava, but rather a source which experienced, in an earlier stage of the evolution, garnet fractionation causing the strong HREE depletion.

Alternatively, partial melting of the source in the garnet peridotite field leaving residual garnet can also be account for this HREE depletion (Fig. 1). In addition, megacrysts have isotopic compositions overlapping their host melanephelinites (Fig. 2). An initial alkali-picritic magma is proposed as possible source for their origin. However as inferred form the REE patterns, both, megacrysts and melanephelinites must have been formed under different conditions.

Literature

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