***MINERALOGIA* - *SPECIAL PAPERS*, 43, 2015**
www.Mineralogia.pl

MINERALOGICAL SOCIETY OF POLAND
POLSKIE TOWARZYSTWO MINERALOGICZNE

Subcreted oceanic crust melting beneath the Southeastern-Carpathians: evidence from garnet pyroxenite xenoliths from Quaternary basalts of the Perşani Mts.

Peter LUFFI[1], Ioan SEGHEDI[1], Mihai DUCEA[2]

[1]*Institute of Geodynamics, Romanian Academy, 19-21 Jean-Luis Calderon Str., Bucharest 020032, Romania; e-mail: peter.luffi@gmail.com; seghedi@geodin.ro.*
[2]*Department of Geosciences, University of Arizona, Tucson, AZ, 1040 E. Fourth Str., Tucson, AZ 85721, USA*

A wealth of ultramafic xenoliths hosted in Quaternary alkali basalts erupted in the Perşani Mts. of the Southeastern–Carpathians, Romania, provide insight into the deep lithospheric processes shaping the south-eastern part of the Carpathian–Pannonian region. Here, abundant peridotite xenoliths have been studied extensively; they document the mantle's thermal state prior to eruption as well as its melting, metasomatism, and deformation history (Vaselli et al. 1995, Chalot-Prat, Boullier 1997, Falus et al. 2011). In contrast, the origin and significance of less-common pyroxenite xenoliths have not been addressed yet. Using petrographic and geochemical data from rare garnet pyroxenite xenoliths, we refine the current view on the thermal state of the shallow mantle beneath the region and identify an altered oceanic crust component in the lower lithosphere.

We constrain the geotherm beneath the Perşani Mts. by combining major and trace element thermobarometry on twenty garnet clinopyroxenites and garnet websterites. Two-pyroxene thermometry and garnet-pyroxene barometry indicate that these xenoliths equilibrated at T = 800–1050 °C and P = 8–12 kbar. The temperature interval overlaps with that obtained from peridotites in previous studies and thus suggests that all pyroxenites represent—as revealed by few composite xenoliths—veins and dykes in the peridotite-dominated mantle lithosphere. In addition, thermobarometry on garnet pyroxenites constrains the extraction depth of peridotite xenoliths as well, suggesting that all observed xenoliths originate from the near-Moho mantle at 30–42 km depths. The conductive geotherm defined by xenolith P-T data corresponds to an elevated heat flux of ~100 mW/m^2 and coincides with the conductive geotherm imposed by the same tectonothermal event that generated the host alkali basalts at the base of lithosphere (60–70 km) at a potential temperature of ~1350 °C (Harangi et al., 2013 updated with our own estimates). For the estimated lithospheric thickness, the transition from any stable continental conductive geotherm to the estimated 100 mW/m^2 geotherm is accomplished in less than 10 Ma, regardless of the invoked geodynamic scenario. Thus it is plausible that the xenoliths record the thermal perturbation induced by the asthenosphere upwelling accompanying the ongoing foundering of the Vrancea seismogenic block (Seghedi et al., 2011). The pyroxenites, however, do not bear signs of heating; instead, microtextural features such as garnet coronas around spinels as well as chemical zonation of pyroxenes indicate cooling. Therefore, it is likely that the pyroxenites formed in response of the above-mentioned tectonothermal event, i.e. the melts from which they originate were products of fusion ultimately triggered by the sinking Vrancea block. In order to constrain the source of these melts, we have carried out O, Sr, and Nd isotope analyses on minerals making up the garnet pyroxenites. $^{143/144}$Nd (0.51179–0.51295) and $^{87/86}$Sr (0.7032–0.7088) isotope systematics indicate multiple subducted crustal components in the source, while the range of δ^{18}O values (3.5–6.7‰) strongly suggests that at least one of these components must have been a hydrothermally altered oceanic crust. Therefore it is plausible that the observed pyroxenites represent reaction products between silicic—probably dacitic—melts resulted from the partial fusion of a subducted oceanic crust and ancient lithospheric mantle peridotites through which they percolated. One possibility is that this crust represents leftover fragments of the steepening oceanic Vrancea slab, as suggested by seismic data (Bokelmann, Rodler 2014). Alternatively, the involved oceanic crust may represent relics of an ancient subducted slab accreted to the lower lithosphere, which partially melted during the invoked recent tectonothermal event. Distinguishing the two possibilities requires further investigations.

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