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Geochemically anomalous phonolites from Lusatian Mountains, Czech Republic: Possible source materials and processes of their origin

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The study has been aimed at elucidation of source materials and processes leading to formation of anomalous phonolites from the Lusatian Mountains (Bohemian Massif, Czech Republic). For a detailed geochemical study of the phonolites, various modes of instrumental neutron (short and long time irradiation, including the epithermal and fast neutron mode) and photon activation analyses were utilized. Combination of these modes allowed assaying up to 48 major and trace elements. Strontium and neodymium isotopic compositions were determined by TIMS.

Phonolites represent the subvolcanic (hypabyssal) rocks, which solidified from magma at relatively low temperature and consolidated in shallow depths in the upper bed. They are mostly associated with Tertiary interplate magmatism, but can originate also from differentiation of the upper mantle under the oceanic crust. Phonolites are strongly depleted by compatible elements as Mg, Cr, Fe, Co, Ni, Sr, whereas Na, K, Rb, and Al are enriched.

The origin of the studied phonolites of ca. 30 Ma age is associated with the Lusatian Fault. Compared to phonolites from the Eger Rift in the Bohemian Massif, contents of incompatible elements Zr, Hf, Nb, Ta, Th, U, light rare earth elements, F and Cl in the Lusatian Mountains phonolites reach extremely high values. Their 143Nd/144Nd isotope ratio is monotonous, corresponding to the upper mantle, whereas the 87Sr/86Sr ratios reach extreme values up to 0.8605.

The geochemical and isotopic data indicate that the anomalous phonolites may have originated mainly from partial melting of lower crust of tonalite-monzonite character or metamorphic rocks –shales with high contents of, e.g., micas. Participation of matter from the differentiated upper mantle is negligible. The high content of incompatible elements is probably associated, besides nepheline, sanidine and other foids, with accessory minerals such as zircon or titanite.

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