Geochemical and isotopic (Sr, Nd, Pb, O) variations of Oligo-Miocene Alkaline basalts in Bulgaria: implications for the role of asthenosphere, mantle lithosphere and the crust in their petrogenesis

Геохимични и изотопни вариации (Sr, Nd, Pb, O) на олиго-миоценските алкални базалти в България: Изводи за ролята на астеносферата, мантийната литосфера и кората в техния петрогенезис

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Резюме. Олигоцен-миоценските алкални базалти (28–19 млн. г.) от Мизийската платформа, Балканската и Средногорска зони и Родопския масив в България представляват най-югоизточното продължение на Неозойската европейска вулканска провинция. В настоящата работа се привеждат първите изчерпателни химически и Sr-Nd-Pb-O изотопни данни за алкалните базалти от тези зони. Елементите-следи и изотопните характеристики на базалтите в Мизийската платформа и Родопите са в съгласие с генерирането им от набогатен астеносферен (OIB) източник подобен на Европейския астеносферен резервоар (EAR) или Нискоскоростен компонент (LVC). Взаимодействието на тези магми с обеднена мантийна литосфера и долно- и горнокорови литоложки разновидности може да обясни геохимичните и изотопни различия на алкалните базалти от Балканската и Средногорската зони.

Ключови думи: алкални базалти, химичен състав, изотопи, петрогенезис, България.

Oligocene-Miocene alkaline basalts (28–19 Ma) in Bulgaria are the south-easternmost extension of the Cenozoic European Volcanic Province. Unlike the rest of European alkaline volcanism, however, the Bulgarian portion is poorly known and has received comparatively little attention (Marchev et al., 1992; Vaselli et al., 1997; Marchev et al., 1997, 1998). Here, we present the first comprehensive chemical and Sr-Nd-Pb-O isotopic compositions for these basalts. The most peculiar feature of the Bulgarian alkaline basalts is that they are the only one in Europe arranged in a 250 km long north-south strip, cutting across all four major tectonic units presented in the country. These include the Moesian Platform (MP), and 3 zones involved in complicated Hercynian and Alpine orogenic evolution, named the Balkan Zone (BZ), the Srednogorie Zone (SZ), and the Rhodope Massif (RM). Thus, the Bulgarian alkaline basalts are an excellent laboratory for investigating variations in magma chemistry of basalts traversing the lithosphere of a stable platform and several orogenic areas and to provide insight into the nature of their mantle sources and evidence for modification through the processes of interaction with the mantle lithosphere, lower- and upper- crustal lithologies. The major rock type of MP, BZ and SZ are basanites, whereas those from the RM are slightly more silica and alkali rich alkali basalts and trachybasalts. Trace element and isotopic compositions fail to reveal any significant differences between southernmost (RM) and the northernmost (MP) basanites. Their Sr (0.70303–0.70369), Nd (0.512969–0.512836) and O (5.8–6.8‰) isotopic signatures are indistinguishable from the European Asthenospheric Reservoir (EAR)

and the Low-Velocity Component (LVC) and appear to have been generated in the asthenosphere, but small amounts of depleted lithospheric components are detected in the Pb isotope compositions ($^{206}Pb/^{204}Pb$=19.31–18.91; $^{207}Pb/^{204}Pb$=15.52–15.68; $^{208}Pb/^{204}Pb$=38.43–38.87). The rocks from BZ and SZ form a distinct group, which is characterized by enrichment in Pb and depletion in Nb and Ti compared to MP and RM rocks. In addition, they show more scattered Sr (0.70351–0.70503) and Nd (0.51297–0.51275) isotope ratios, and less radiogenic $^{206}Pb/^{204}Pb$ (18.59–18.80) and more radiogenic $^{208}Pb/^{204}Pb$ (38.62–39.0) at similar $^{207}Pb/^{204}Pb$ ratios (15.53–15.72). A clinopyroxene megacryst from this zone, shows the least radiogenic Pb isotope compositions ($^{206}Pb/^{204}Pb$=17.86; $^{20}Pb/^{204}Pb$=15.61; $^{208}Pb/^{204}Pb$ =37.75), very similar to those recorded in Pleistocene alkaline basalts in Sardinia (17.55–18.01; Lustrino et al., 2000) and clinopyroxenes in incompatible element depleted spinel lherzolite xenoliths in Carpathian-Pannonian region (Rosenbaum et al., 1997). Trace element modeling of the rocks is consistent with derivation of the alkaline rocks by different degrees of partial melting of a garnet-bearing lherzolite source. Trace element, Sr-Nd-Pb-O isotope signatures, and geological observations, are consistent with an origin by decompression melting of an enriched asthenospheric source, similar to EAR or LVC. Interaction of these magmas with a depleted shallower mantle lithosphere and lower/upper crustal lithologies, gives rise to magmas with observed geochemical and isotopic characteristics in the BZ and SZ.

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