Geophysical Research Abstracts
Vol. 13, EGU2011-12158, 2011
EGU General Assembly 2011

Isotope-geochemical features of tholeiites from the Spiess Ridge (South Atlantic)

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Oceanic crust formation is a complicated nonlinear process enhanced by tectonic activity which course origination of numerous geochemical anomalies in the composition of MOR basalts and involves the ancient material like non-spreading blocks or subducted slabs into the crust formation. The regions of triple-junction of spreading ridges where the tectonic processes are often of the leading role and determine the character and evolution of magmatism, are marked by especially complicated construction and evolution. One of such regions is Bouvet triple-junction in the South Atlantic where three ridges meet: Mid-Atlantic, American-Antarctic and South-West Indian (SWIR). At the most western point of the SWIR there is situated the rift segment with massive volcanic structure formed not more than 2 m.y. ago with which the modern position of plume – Spiess Ridge is correlated (Peive, Skolotnev, 2001).

One of the samples represented by olivine-plagioclase porphyritic basalt dredged within central part of the small separate volcanic edifice within Spiess Ridge has been studied for trace element and isotope geochemistry. The studied sample is a typical tholeiitic basalt: SiO2 – 50.75÷51.19, Al2O3 – 16.4÷16.7, FeO – 8.7÷9.1, MgO – 7.9÷8.01, CaO – 12.4÷12.6, K2O – 0.2÷0.3, Na2O – 1.92÷1.99 %; with phenocrysts of olivine (up to 1-2 mm) and plagioclase (up to 1 mm) and aphanitic groundmass composed mainly by three mineral phases – plagioclase microlites (60 vol.%), pyroxene microlites (35 vol.%) with more abundant FeO and CaO in the grain cores and accessories (Ti-magnetite up to 3 vol.%). Phenocrysts constitute not more than 20% of the sample volume. Olivine phenocrysts are characterized by clear composition zoning: from center to grain margin FeO content is growing and MgO decreasing and mainly correspond to Fo 81.2-89.5 (aver. 85.4). At the same time, this sample has evidently lower titanium content – TiO2: 0.63÷0.65 and negative Ta and Nb anomalies, and positive – Pb and Sr – well-known characteristics for arc volcanics and typical for subduction tectonic settings (Niu, O'Hara, 2009). Isotope composition for studied sample and mineral separations varies within: 143Nd/144Nd: 0.513010-0.513024; 87Sr/86Sr: 0.703632-0.704345; 206Pb/204Pb: 17.863-18.638; 207Pb/204Pb: 15.522-15.631; 208Pb/204Pb: 37.750-38.683 that means more radiogenic Sr and less radiogenic Nd and Pb content in comparison with published data for Spiess Ridge basalts: 143Nd/144Nd: 0.512910-0.513074; 87Sr/86Sr: 0.703260-0.703634; 206Pb/204Pb: 19.005-19.28; 207Pb/204Pb: 15.53-15.65; 208Pb/204Pb: 38.69-38.99. Moreover, Re-Os isotope systematics of the studied constituent phases of the basalt allows to construct some line which corresponds to the age 13.44±0.77 Ma and initial 187Os/188Os = 0.1714, but the whole-rock sample after acid leaching has clearly less radiogenic composition 187Os/188Os = 0.14758 corresponding only to the 1.6 Ma model age comparable with the supposed age of magmatic activity within Spiess Ridge (Peive, Skolotnev, 2001). Moreover, in the course of mineral separation we found two zircon grains in this sample of tholeiite with morphology and geochemistry typical for the zircons of primary magmatic origin and studied their U-Pb system on SIMS SHRIMP II. The age of these grains is Archean, as old as 2418 and 2720 Ma, and is comparable in time with the processes within Kalahari Craton – Limpopo orogeny, metamorphism and volcanism accompanying accretion Barberton Craton with Limpopo mobile belt and Zimbabwe Craton which resulted in formation of Kalahari Craton 2.7 Ga ago (Jacobs et al., 2008; Zeh et al., 2009).

Thus the whole data-set of isotope-geochemical characteristics of the studied sample of abnormally enriched porphyry basalt unequivocally evidence to the presence of old crust (oceanic or low continental) material within magma source. The share of this ancient matter can be estimated as 45% on the basis of Os and Sr isotope data (Krymsky et al., 2009) and not less than 50% by Pb and Nd isotope data. One of the plausible explanations of such considerable amount of the ancient substance is the formation of Spiess Ridge over the ancient crustal block – Lafonia microplate (Ben-Avraham et al., 1993) which was separated from Kalahari Craton in the course of complicated tectonic movements during or after Gondwana break-up.