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Age and genesis of accessory zircon from MAR gabbroids

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Development of local U-Pb-Th isotope dating and its successful applying to oceanic crust zircons in last decade permitted to extend our knowledge about the formation of modern and Paleozoic oceans (John et al., 2004; Schwartz et al., 2005; Muntener et al., 2004; Bea et al., 2001). We have studied the zircons, separated from the least of all altered oceanic rocks (gabbro-norite, gabbro-dolerite, troctolite) of the modern Ashadze sulfide ore field which were dragged at 13˚N MAR (Beltenev et al., 2005). Remarkably, the amount of zircon separated from ordinary samples (1-2 kg) of basic-ultrabasic rocks is very different – from several grains to some milligrams. Nevertheless, careful control and precise separation technique allowed us to exclude any contamination by accidental material. Zircon characteristics (optic, BSE, CL) and its U-Pb isotope age were done by local analytical methods (SEM CamScan 2500S, SIMS SHRIMP-II, LA-MC-ICPMS). All studied zircons may be divided into two crystal types: 1) Short to long prismatic weakly colored grains (10-100 mkm sized) with dominating well preserved simple prism [100] facets. CL images show typical magmatic planar or sectorial zoning; 2) Yellow-brownish (sometimes non-transparent) grains of mainly "hyacinth" habit with ill-defined facets and edges. Grains are different in size but less than 150 mkm. Zoning in CL is concentric, primary magmatic but overlapped by bright irregular stripes in the outer zones. Numerical proportion of 1 and 2 zircon types vary from sample to sample from 10:1 to 1:10.

U-Pb isotope age of two zircon groups confirms its genetic difference: for group 1 ages are not older 1 Ma (the best value - 861$\pm$29 Ky), the group 2 is characterized

by pre-Mesozoic ages, 260 Ma and more, depending on certain sample. Majority of dated grains (main peaks on the age probability diagram) have the ages of 2700$\pm$20 and 1750$\pm$12 Ma. Geochemical features (U, Th, Pb, Hf, REE) of two revealed zircon groups are also very different. Group 1 has U content of 450-850, rarely up to 1800 ppm and Th/U 0.7-2.95, whereas for group 2 U$<$ 350 ppm and Th/U is 0.4-0.9. Zircons from group 2 demonstrate enriched REE patterns with weakly pronounced Ce peak [Ce/Ce]* from 1 to 12 (group 1 zircons [Ce/Ce]* from 30 to 90) and weak negative Eu anomaly [Eu/Eu]* from 0.1 to 0.07 (group 1 zircons - $<<$0.1). LREE distribution has flat character: $[Sm/La]_n$ from 1-10 to 150, and zircons 1 show sharply fractionated LREE distribution ($[Sm/La]_n$: 100-750), but the degree of HREE fractionation for zircons of group 1 and 2 is similar – $[Lu/Gd]_n$ from 2 to 30. Young (group 1) zircons are characterized by higher U/Yb$>>$1.0 as well, but on diagrams Y *vs*. U/Yb and Hf *vs*. U/Yb (Grimes et al., 2007) all studied zircons are out of the oceanic crust field due to their high U content. Temperature of zircon crystallization by titanium-in thermometer (Watson, Harrison, 2005) corresponds to 700˚C for group 1 zircons and 800-850˚C for the group 2. Measured $^{176}Hf/^{177}Hf$ isotope ratio increases monotonously from old to young zircons: from 0.281115 to 0.283397, which corresponds to variation from +0.2 till +22.1 in recalculation to ε value of primary isotope composition. It is necessary to point out, that Hf isotope composition implying origin of studied zircons from differently depleted source. Whereas for the young and for the 2700 Ma-old zircons this source may be directly compared with the depleted mantle (Blichert-Toft, Albarade, 1997, Scherer et al., 2001), for the 1750 Ma-old zircons this source was more enriched (ε=+0.2 $\div$ +3.4).

The presented data suggest the participation of Precambrian substance in formation of basic-ultrabasic rocks founded within the Middle Atlantic Ridge. Similar results were obtained earlier for the zircons from gabbroids from drill hole ODP 153 in the region of Kane transform fault (Pilot et al., 1998), where number of 330 and 1650 Ma-old grains were found together with rather young zircons. Geochemically continental nature of these old zircons allowed to consider their presence in oceanic gabbroids as the result of contamination of the upper mantle by the continental crust material during oceanic opening. In our case, the possibility of involvement of continental substance into oceanic crust formation due to recycling of the old lithosphere is not very realistic – there are no any marks of paleosubduction zones and geochemical signs of contamination. Moreover, all studied zircon are typically magmatic, without clear traces of deposition-metamorphic history. However, the presence of two genetically different groups among the studied zircons, especially young magmatic grains, which origin is straightly connected to the oceanic basalt flows formation, and evidence to considerable influence of young magmatic process on the gabbro-peridotites complex of the oceanic crust, may indicate long-lasted evolution of the MAR gabbroids. Our results coincide with data obtained for the oceanic peridotites from the slow-spreading Southwestern-Indian Ridge, which obviously demonstrate restite character, but believed to be formed due to continental mantle melting under preoceanic conditions (Seyler et al., 2004). Thus, the scenario that the studied gabbro-peridotites are older than Mesozoic opening of the Atlantic Ocean should not be excluded.