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Archean Arctic continental crust fingerprints revealing by zircons from Alpha Ridge bottom rocks

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Whereas thick Cenozoic sedimentary cover overlapping bedrock of the Arctic Ocean, some tectonic windows were sampled by scientific submarine manipulator, as well as by grabbing, dredging and drilling during «Arctic-2012» Russian High-Arctic expedition (21 thousands samples in total, from 400-km profile along Alpha-Mendeleev Ridges). Among others, on the western slope of Alpha Ridge one 10x10 cm fragment without any tracks of glacial transportation of fine-layered migmatitic-gneiss with prominent quartz veinlets was studied. Its mineral (47.5 vol.% plagioclase + 29.6% quartz + 16.6% biotite + 6.1% orthoclase) and chemical composition (SiO_2:68.2, $Al2O_3$:14.9, $Fe2O_3$:4.44, TiO_2:0.54, MgO:2.03, CaO:3.13, Na2O:3.23, K2O:2.16%) corresponds to trachydacite vulcanite, deformed and metamorphozed under amphibolite facies. Most zircon grains (>80%) from this sample has an concordant U-Pb age 3450 Ma with Th/U 0.8-1.4 and U content of 100-400 ppm, epsilon Hf from -4 up to 0, and ca 20% - ca 3.3 Ga with Th/U 0.7-1.4 and 90-190 ppm U, epsilon Hf -6.5 to -4.5, while only 2% of the grains show Proterozoic age of ca 1.9 Ga (Th/U: 0.02-0.07, U$\sim$500 ppm, epsilon Hf about 0). No younger zircons were revealed at all.

We suppose that magmatic zircon crystallized as early as 3450 Ma ago during acid volcanism, the second phase zircon crystallization from partial melt (or by volcanics remelting) under amphibolite facies metamorphism was at 3.3 Ga ago with formation of migmatitie gneisses. Last zircon formation from crustal fluids under low-grade metamorphic conditions was 1.9 Ga ago.

There are two principal possibilities for the provenance of this metavolcanic rock. The first one – this is ice-rafted debris deposited by melted glacial iceberg. However, presently there are no temporal and compositional analogues of such rocks in basement geology of peri-oceanic regions, including Archean Itsaq Gneiss Complex, Lewisian Complex and Baltic Shield but these regions are far from the places of nowadays iceberg formation. Moreover, no Grenvillian-age zircons were revealed in studied sample. The nearest areas of Paleo- and Mesoarchean rocks appearance are deeply inland territories like Acasta Gneiss Complex, Uivak Gneisses, the Superior Province, Anabar and Aldan Shields, Northern China craton (Anshan complex), thus, a only possibility to bring some fragments of basement rocks from these areas to oceanic coast is transcontinental river transportation. The second possibility – this gneissic clast has a local provenance and has undergone a submarine weathering, shallow marine avalanche, proximal transportation by alongside ocean flows, tidal waves abrasion, and as so, reflects local bedrock geology, i.e. adjacent Alpha Ridge rock composition. Additional confirmation of this can be seen in a wide distribution of Qu-sandstones with Paleo-Mezoarchean zircons, and finds of similar allochtonous zircons in dolerites along Alpha-Mendeleev Ridge profile.

The studied fragment is a unique evidence for the possible existence of Paleoarchean continental crust within the submarine Alpha-Mendeleev Ridge in Arctic Ocean.