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Detrital zircons – the unique source of information on tectonics, paleogeography and denudation processes of East Antarctica (subglacial challenge)

Boris Belyatsky (1), German Leitchenkov (1), Nickolay Rodionov (2), Anton Antonov (2), Sergey Sergeev (2), and Helen Savva (3)

(1) VNIIOkeangeologia, Antarctic Geology, St.Petersburg, Russian Federation (bbelyatsky@hotmail.ru), (2) VSEGEI, CIR, St.Petersburg, Russian Federation, (3) IPGG RAS, St.Petersburg, Russian Federation

Vast (about 7 billions km^2) almost wholly (98%) covered with ice continental mass of East Antarctica is the central fragment of ancient supercontinents of Rodinia and Gondwana. Any information on its geologic structure is of the greatest importance for solving the problems of formation and amalgamation of lithosphere of ancient continents, processes of intraplate activity, denudation and peneplanation of the earth crust and for geodynamic reconstruction. Geologic structure of central part of the East Antarctica is still absolutely unknown due to the thick (up to 4000 m) ice cover, which is the obstacle even for modern drilling technology to sample directly the underlying rocks. The main goal of the study has been to make an attempt in fill up the hiatus in geologic knowledge on the origin of subglacial continental crust of the Antarctica.

We studied detrital zircons from sedimentary and metasedimentary rocks outcropped in Prince-Charles Mts (PCM, East Antarctica). Rock specimens were sampled from the Permian-Triassic sedimentary succession outcropped along the Beaver Lake coast (sandstones and siltstones) and from moraine of the Fisher Massive (metasandstone) and Meridith Massive (sandstone). A lump of zircons which are characterized by different grain morphology from well-rounded to poorly-rounded has been extracted from rock specimens for isotopic studies and dating. The age determinations of 302 zircons from 6 specimens were conducted using secondary ion-microprobe SHRIMP-II and laser-ablation ICP-MS. The age of zircons ranges from 500 to 3200 Ma. Isotopic analysis and probability distribution diagrams for zircon populations show heterogeneity of provenance. Zircons of 500 Ma old are proposed to come from the eastern flank of Lambert Glacier and/or from central Antarctica; 900–1100 Ma old - from Proterozoic Mobile Belt (central-northern PCM); while 2400–3200 Ma old - from granite-greenstone terrain (southern PCM). Additionally, 21 trace elements and isotopic composition of hafnium in detrital zircons from two moraine samples was studied using SIMS CAMECA-4f and laser device coupled with HR-MC-ICPMS. Distribution of trace elements allows us to suggest that 70–85% zircons have been crystallized from magma of intermediate-silicic composition with temperature of crystallization of 700-800˚C (65% SiO2) and about 10–15% - from low-temperature water-saturated granitoid melts. Only 5–7% zircons are formed as a result of metamorphic processes. Four zircon grains from metasandstone (Fisher Massive) have specific distribution of trace elements which are typical to high-temperature (up to 950˚C) magmas of alkaline or mafic affinity. Hf isotope signatures show according to two-step evolution model that zircons from metasandstone of Fisher Massive were formed in crust protoliths of 1400-2200 m.y. old, whereas zircons from sandstone of Meridith Massive – in protolith of 1400-1600 m.y. and 3000-3400 m.y. old. Generally, Hf isotope composition of studied zircons corresponds to composition of chondrite unfractionated reservoir (CHUR).

The first opportunity to obtain direct information about the bedrock geology of the central East Antarctic arose when the 3650 m deep borehole at the Vostok station, located in the southern part of Lake Vostok (largest subglacial freshwater lake in Antarctica) recovered the basal layer of the ice sheet. We studied a small (4.7 mm long) clast of siltstone extracted from the 3607 m depth ice core of the Vostok Station Borehole. This clast was entrapped from bottom sediments in the shallow area of the lake and incorporated into the accreted ice. Siltstone consists of poorly-rounded quartz and a minor amount of accessories including zircon and monazite. We infer that the bedrock upstream (northwest) of Lake Vostok from where the siltstone clast was scraped off bedrock by ice and transported

to the lake is of sedimentary nature. 23 zircon and 5 monazite grains in the siltstone clast have yielded two age clusters ranging between 0.8 - 1.2 Ga and 1.6 -1.8 Ga. These ages testify that their provenance presumably the area of Gamburtsev Subglacial Mountains; central part of East Antarctica is dominated by 1.6-1.8 Ga and 0.8-1.2 Ga assemblages. Younger rocks are not excluded because one zircon grain has an age of 600 Ma although this determination is so far statistically very poor.

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