

MEMBER COUNTRY: RUSSIA**National Report to SCAR for 2018**

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A BRIEF SUMMARY OF SCIENTIFIC HIGHLIGHTS

PHYSICAL SCIENCES

Physical oceanography

In January 2018 CTD/O₂ section of 23 stations was undertaken from r/v Akademik Fedorov in the Mawson Sea. Oceanographic stations were performed by SBE-911+ probe with water sampling to determine the nutrients on the particular levels. Additionally 43 SBE-911+ stations and 35 SBE 19+ SeaCat stations were made in Mawson Sea and Prydz Bay. Three sections (45 stations) were made from r/v Akademik Tryoshnikov in April 2018 in the northern part of Bransfield Strait and on the continental slope of the South Shetland Islands in the southern Drake Passage.

Deep drilling at Vostok and glaciological studies

Drilling and studying old Antarctic ice with age exceeding 1 million years in order to investigate possible reasons for the Mid-Pleistocene Transition is one of the key priority tasks for the Russian Antarctic community. During the 2017–2018 austral season at Vostok Station, we carried out microscopic study of geometrical properties of the crystalline inclusions of air hydrates in ice core samples from boreholes 5G-3 (Vostok) and DC2 (EPICA DC) in depth intervals where the age of the ice exceeded 400,000 years. The obtained data confirmed the existence of a robust linear relationship between the mean radius of the hydrates and the age of the ice in the bottom part of the East Antarctic ice sheet, and will be useful for further development of the new dating technique based on the phenomena of hydrate growth in polar ice. Preliminary, the age of the atmospheric ice bedded at Vostok at a depth of 3538 m, inferred from the data on the size of the hydrates, amounts to 1.3 ± 0.17 million years (Lipenkov, Ekaykin, 2018).

Experimental results for 22 ice cores from Antarctica and Greenland provide insights into principal mechanisms that govern the formation and evolution of air bubble systems in polar ice. A semi-empirical model has been suggested to relate the size and number of bubbles in ice with snow accumulation rate and temperature during ice formation. Air bubble sizes and number concentrations can be used for refining paleoclimate reconstructions based on ice core data (Lipenkov, 2018).

Reconstruction of paleoclimatic conditions in the MIS-11 era (the 11th sea isotope stage, i.e. 370–440 thousand years ago) was performed using the method of interpretation of the results of isotopic studies of ice, which is based on the joint analysis of three independent parameters: δD , d-excess, $17O$ -excess. The isotopic composition (δD) and the deuterium excess depend on the following three meteorological parameters – the condensation temperature near the Vostok station, relative humidity, and the sea surface temperature at the source of moisture, whereas $17O$ -excess depends only on the first two parameters. Accordingly, the proposed method of interpretation allows reconstructing the paleoclimatic conditions (the condensation temperature and surface air temperature at the Vostok station; sea surface temperature and relative humidity above the ocean) in two different regions in past epochs. The results obtained on the basis of isotopic analysis of ice cores from stations Vostok and Concordia indicated that in the optimum

MIS-11 the air temperature was 4 °C higher, and in the Termination V – 8 °C lower than the present-day values. The similarity of data between the marine columns DSDP 94-607 (North Atlantic), ODP 177-1090 (South Ocean) and our results points to the global nature of changes in the sea surface temperature during the MIS-11 era (Veres et al., 2018).

A new project of small-scale drilling ice in the area of the Vostok station was started in order to obtain a detailed climatic series with the length of 2000 years. There are plans to drill a minimum of 3 deep boreholes with the depth more than 70 m and investigate the extracted ice core. For drilling operations, the light mechanical drilling equipment was used, provided by French colleagues from the glaciological laboratory in Grenoble. In total, 161 drilling operations were completed for the first borehole, the average yield of the core was about 44 cm per run. On January 25, 2018, drilling of the second borehole was started and the depth of 40.2 m was reached by the end of the season. Isotope core samples were delivered to St. Petersburg and analyzed in the CERL at the AARI. In general, this project will last for another 2-3 years, and will provide not only a reliable detailed reconstruction of climate of Central Antarctica over the past 2 thousand years, but also an estimate of the signal-to-noise ratio in the isotopic composition of snow-firn sediments.

References:

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GEOSCIENCES

ORGANIZATIONS INVOLVED:

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Polar Marine Geosurvey Expedition, PMGE (The Joint-Stock Company “ROSGEO”).

FIELD ACTIVITY

Marine geophysics (PMGE, VNIIOkeangeologia).

Region: Northwestern Weddell Sea (area between 43W and 52W; 60.5S and 63.5S) and South-Orkney Island Shelf (area between 45.5E and 46E; 61 and 61.5 S).

Data: 2 765 km of MCS, magnetic and gravity data; 2765 km of multibeam echosounder (MBES) data along geophysical profiles and 2500 km of MBES data on the survey area.

Technology: MCS data were recorded with a 560-channel, 7-km-long digital streamer and airgun array of 40 liters in total volume. MBES data were obtained using Atlas HYDROSWEEP MD/30.

Airborne geophysics (PMGE)

Region: Princess Elizabeth Land (area between 88E and 92E; 67.3S and 68,5S).

Data: c. 5500 km of airborne survey including magnetic and radio-echo sounding observations.

Technology: Short-range airplane AN-2 was used for data acquisition. The RES studies were carried out using a 130-MHz radio-echo sounder. Flight lines were generally oriented north-south and spaced 5 km apart.

Geological studies (PMGE)

Region: Western part of Banger Hills, East Antarctica. Geological mapping and study of tectonic, igneous and metamorphic events.

INTERNATIONAL PROJECTS (VNIIOkeangeologia)

Commission for Geological Map of the World (CGMW). Subcommission for Antarctica.

<http://www.cgmw.org>

The second edition of the "Tectonic map of Antarctica" was launched in 2016 and is currently in progress. The new map will provide: more realistic presentation of actually mapped tectonic units against their inferred subglacial extrapolations; advanced characterization of East Antarctic crystalline basement complexes by the age of protolith emplacement and subsequent reworking events; improved visual reflection of the polyphase magmatic arc history of the onshore part of the present-day Pacific margin; more accurate image of the Antarctica's continental margin, including the location of marginal rifts and COB, sediment thickness distribution, evidence of pre-breakup basin history, etc. The map and explanatory notes are expected to be ready in 2020.

Antarctic Digital Magnetic Anomaly Map (ADMAP). SCAR SSG GS Expert Group.

<http://www.scar.org/admap>

The paper on compilation of ADMAP-2 was published by ADAP Project contributors.

Past Antarctic Ice Sheets (PAIS). SCAR Scientific Research Program

Digital data base with thicknesses of syn-glacial (post-34 Ma) sediments from the Prydz Bay area was created within the PAIS Project "Paleobathymetry and Paleotopography of Antarctica".

NATIONAL PROJECTS (VNIIOkeangeologia)

Geological map of Mac.Robertson Land, Princess Elizabeth Land, and Prydz Bay (East Antarctica) in scale 1:1 000 000.

The project was launched in 2011 and finished in 2018. The Map (A0 Sheet with insets and A1 Legend Sheet) as well as accompanying Explanatory Notes (82 pages) and U-PB zircon dataset (350 samples) integrate all geological data obtained from mid-1950-th to present; give an overview of previous studies; defines tectonic composition. Insets (compiled in 1: 5 000000 scale) include: 1) magnetic anomaly map, 2) bedrock topography map and sketch with distribution of tectonic provinces. The set is distributed on request.

Russian Science Foundation (RSF) Project (2016-2018): Deep structure, thermal evolution and magmatism of the East Antarctic transitional zones and adjacent oceans.

SELECTED PUBLICATIONS OF 2018

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- Golynsky A. V., Ferraccioli F., Hong J. K., et al. 2018. New Magnetic Anomaly Map of the Antarctic. *Geoph. Res. Let.*, doi.org/10.1029/2018GL078153
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- Leitchenkov G.L., Belyatsky B. V. and Kaminsky V. D. 2018. The Age of Rift-Related Basalts in East Antarctica. *Doklady Earth Sciences*. Vol. 478, Part 1, pp. 11–14.
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- Leitchenkov G.L., Dubinin E.P., Grokholsky A.L., Agranov G.D. 2018. Formation and evolution of Kerguelen Plateau Microcontinents, Southern Indian Ocean. *Geotectonics*. In Press.
- Mikhalsky E.V., Leitchenkov G.L. (Eds.). 2018. Geological map of Mac.Robertson Land, Princess Elizabeth Land, and Prydz Bay (East Antarctica) in scale 1:1 000 000 (Map Sheet and Explanatory Notes). St.-Petersburg. VNIIOkeangeologia.
- Mikhal'skii E.V., Borovkov N.V., Gonzhurov N.A., Gogolev M.A., Svetov S.A., Kunakkuzin E.L.. 2018. Reconstruction of the Neoproterozoic–Cambrian Orogenesis in Princess Elisabeth Land (East Antarctica) from a Study of Granitic Rocks. *Geotectonics*, Vol. 52, No. 4, pp. 421–446.
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- Sustchevskaya N.M., Belytsky B.V., Tkacheva L.A., Leitchenkov G.L., Kusmin D.V., Jhilkina A.V. 2018. Early cretaceous alkaline magmatism of East Antarctica (specific, conditions of formations, interaction with Kerguelen Plum). *Geochemistry International*. No 11, pp.1-22.
- Tkacheva D.A., Mikhalsky E.V., Sushchevskaya N.M., Kunakkuzin E.L., Skublov S.G., Sergeev S.A. 2018. Age and Geochemistry of the Cape Burks Gabbroids (Russkaya Station Area, West Antarctica). *Geochemistry International*. Vol. 56, No. 7, pp. 628-650.

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BIOLOGY

ORGANIZATION INVOLVED:

Shirshov Institute of Oceanology, Russian Academy of Sciences

FIELD ACTIVITY. Sea Ice Biology

Region: Nella fjord, Princess Elizabeth Land (area between 72.22 E and 72.21 E; 69.22 and 69.21 S).

Data: Sea ice, under-ice water and plankton samples.

Technology: GPS “Garmin78s”, SBE 19plusV2 Seacat, Kovacs ice corer, Niskin bottle, Juday plankton net.

Field research data. In the season of RAE-63 (2018) fieldwork was carried out at Cape Biological in three reference points of the Nella fjord. The ice core sampling points were determined by GPS and carried out in the coordinates of the previous 52-62 RAE surveys in the direction from the shore to the center of the fjord. Collection of water and ice samples was carried out during the beginning of the melting of the ice cover. Works included: 1- collections of ice cores in three points on the section from the coast to the center of the fjord; 2-sampling of ice water from the surface horizon for measurement of hydrochemical parameters; 3-CTD-sounding at the core sampling points of the water column from the surface to the bottom.

For the selection of the ice samples it was used ring manned ice corer with an inner diameter of 180 mm. At each selection of an ice core drilled hole with the plastic syringe, samples were taken of surface seawater. The ice core was divided into multiple sections of 10 or 20 cm depending on the thickness of the ice. The collected samples were stored in the freezer to the measurements. The salinity of the sea ice was measured on the Beckman SoluBridge (model RB-5-349A, the measurement precision is $\pm 0.1\%$). Concentrations of mineral forms of silicate and phosphate in samples of melted ice and seawater were measured in stationary conditions on board of icebreaker. Part of the melt water of the ice sample was used to concentrate ice organisms to identify the species composition of the ice flora and phytoplankton. To do this, the melted ice-water was concentrated to a volume of 50 ml by reverse filtration through a filter with a pore size of $1\mu\text{m}$. Concentrated samples were fixed with formalin to the concentration of 1% for later analysis of species composition in stationary laboratory conditions of the Institute of Oceanology and Moscow state University.

NATIONAL PROJECT: "Evaluation of the ecology of the area of Antarctic sea ice" ("Krial"). The present work is executed at financial support of the topic of state assignment No 0149-2018-0008.

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