☐ **MEMBER COUNTRY: RUSSIA**

National Report to SCAR for 2012/2013

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A BRIEF SUMMARY OF SCIENTIFIC HIGHLIGHTS

LIFE SCIENCES

In 2012-2013 field season a long-term ecological research under umbrella of the Russian Antarctic Expedition and Russian Academy of Sciences was conducted at Nella fjord (Prudz Bay) nearby the Russian continental station “Progress” (69° 22’ S and 76° 23’ E) located at Ingrid Christensen Coast (Larsemann Hills, Princes Elizabeth Land, Eastern Antarctic). The sea ice cores were collected for chemical and biological analysis. The sea ice thickness was varied between 180 and 210 cm in direction from the coastal area to center of fjord. Salinity was wide-ranging within the ice thickness from 0.1 ppt in upper layers to maximum 3,5 ppt in the bottom ones. As in previous years, the algae species distribution within the ice thickness and under-ice water samples was determined by salinity stratification: the dinoflagellates cists were dominated in collected ice cores but diatoms in the under-ice water samples. This phenomenon may be explained by differences in physiological adaptation of algae: dinoflagellates prefer to develop in brackish water condition in contrary to diatoms which are more adapted to marine conditions.

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GEOSCIENCES

ORGANIZATIONS INVOLVED:

Federal Research Institute for Geology and Mineral Resources of the World Ocean, VNIIOkeangeologia (Ministry of Natural Resources and Ecology, Federal Agency for Mineral Resources).

Polar Marine Geosurvey Expedition, PMGE (Ministry of Natural Resources and Ecology).

FIELD ACTIVITY

2011/2012 Season

Marine geophysics (PMGE).
Region: Prydz Bay (area between 72E and 81E; 64S and 69S).
Data: 2600 km of MCS data, c. 3800 km of magnetic data and c. 4900 km of gravity data; 8 OBS (along MCS line crossing the Prydz Bay shelf from SE to NW). MCS data were recorded with a 352-channels digital streamer and airgun array of 2860 cub. in. in total volume.

Airborne geophysics (PMGE)
Region: Princess Elizabeth Land (area between 81.6E and 85.5E; 69.3S and 68.6S).
Data: c. 5500 km of airborne survey including magnetic and radio-echo sounding observations.
Short-range airplane AN-2 was used for data acquisition in both seasons. The RES studies were carried out using a 60-MHz MPI-60 radio-echo sounder with a dynamic range of 180 dB and a pulse width of 750 ns. Flight lines were generally oriented north-south and spaced 5 km apart.

Ground-based geophysics (PMGE)
Activity (region): refraction seismic experiment on the western flank of Lake Vostok
Data: seismic data were acquired along the S-N striking line with use of explosive as a seismic source.

Geology (PMGE)
Activity (region): geological studies in the southern Vestfold Hills and Rauer Islands (Prydz Bay coast).

2012/2013 Season

Marine geophysics (PMGE).
Region: Lazarev Sea (area between 2E and 11E; 65S and 69S).
Data: 3200 km of MCS data, c. 7000 km of magnetic and gravity data; 7 OBS (along MCS line crossing Lazarev Sea in S-N direction from the upper continental rise to the Maud Rise).

Airborne geophysics (PMGE)
Region: Princess Elizabeth Land (area between 83E and 87E; 68.3S and 69.3S).
Data: c. 5500 km of airborne survey including magnetic and radio-echo sounding observations using the same technology as in the 2011/12 season.

Ground-based geophysics (PMGE)
Activity (region): refraction seismic experiment on the western flank of Lake Vostok.

Data: seismic data were acquired along the S-N striking line (continuation of studies started in the 2011/12 season).

Geology (PMGE, VNNIOkeangeologia)
Activity (region): geological studies on the Clemence Massif (southern Prince-Charles Mts.)

INTERNATIONAL & NATIONAL INDOOR PROJETCS

Tectonic Map of Antarctica, CGMW IPY Project.
Tectonic map of Antarctica at 1:10 M scale has been published in 2012. This map summarizes the historical knowledge of geological structure of the Antarctic continent, the findings of modern state-of-the-art isotopic and geochemical studies, and the results of recently obtained marine and airborne geophysical data. For the first time the tectonic structure of Antarctic mainland and Circum-Antarctic offshore were combined in one map, enabling significant refinement of earlier tectonic views and enhanced vision of geodynamic history of the whole Antarctic region. See http://ccgm.free.fr/Tecto_Antarctique_gb.html for more details.

Antarctic Digital Magnetic Anomaly Map, SCAR Expert Group.
An up-to-date catalog with metadata descriptions of the Antarctic magnetic surveys collected since 2003 has been compiled. This catalog is accompanied by a track-line map of all airborne and marine surveys conducted. See http://www.dna.gov.ar/mararg/admap/ for more details.

AntScape, subproject of the ACE SCAR Scientific Program.
The map of thickness of Cenozoic sediments on the East Antarctic margin has been compiled. This map is planned to be used for estimation of pre-Cenozoic paleobathymetry in the Southern Ocean.

Lambert GIS Project, National Project.
The project was launched in 2011 and aimed to integrate all available geological and geophysical data in the area of Lambert Glacier. At present, the data base includes more than 300 published U-Pb dates for various rock types, ice thickness and bedrock topography data, magnetic and gravity and other information. The compilation of geological and geophysical maps at 1:1M Scale is the part of this project.

SELECTED PUBLICATIONS OF 2012-2013

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Golynsky A.V., Ivanov S.V., Kazankov A.Ju, Jokat W., Masolov V.N., von Frese, R.R.B. and the ADMAP Working Group. 2013. New continental margin magnetic anomalies of East Antarctica. Tectonophysics, Recent advances in Antarctic geomagnetism and lithosphere studies, Vol. 585, pp.172-184.

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PHYSICAL SCIENCES

Physical oceanography

In January 2013 during 57th Russian Antarctic expedition (RAE) the CTD/O_2 transect was made from r/v *Akademik Fedorov* in the area to the west of Prydz Bay. Transect includes 18 soundings along 70° E (at the same station's positions as in 2011 and 2012 surveys). High spatial resolution of the section along 70° E at the shelf break and above the upper steep detailing of mesoscale peculiarities of the near-slope convective plumes. Section along 70° E was part of the slope has allowed repeated seven times during the period 2004 – 2013.

In February 2013 during the testing cruise of the new Russian heavy ice class research and support vessel *Akademik Treshnikov* the transect of 36 CTD stations was made in Margaret Bay starting from the front of George VI Ice Shelf. The data from the both cruises are analyzing in the Arctic and Antarctic research institute (AARI), St. Petersburg.

Magnetosphere studies

In the second half of 2012 the book by AARI scientists Oleg Troshichev and Alexander Janzhura *Space Weather Monitoring by Ground-Based Means: PC Index* was published in Springer Praxis Books Series (Subseries: Environmental Sciences, XXIII, 287 p.). This book demonstrates that the method, based on the ground polar cap magnetic observations is a reliable diagnosis of the solar wind energy coming into the magnetosphere Method for the uninterruptive monitoring of the magnetosphere state (i.e. space weather). It shows that the solar wind energy pumping power, can be described by the PC growth rate, thus, the magnetospheric substorms features are predetermined by the PC dynamics. Furthermore, it goes on to show that the beginning and ending of magnetic storms is predictable. The magnetic storm start only if the solar energy input into the magnetosphere exceeds a certain level and stops when the energy input turns out to be below this level.

Deep Vostok ice core studies

The size and number concentration of mixed air clathrate-hydrate crystalline inclusions and the total air content of ice have been measured between 3310 and 3539 m of the Vostok 5G-1 ice core. The data showed a sharp increase in the hydrate size and corresponding decrease in the hydrate number concentration within the lowest 40 meters of the meteoric ice, in close proximity to its interface with accreted ice formed from Lake Vostok water. Interpreting the data with the aid of a mathematical model describing the ripening of air hydrates below the bubble-to-hydrate transition allowed inferring the age of air hydrates (and that of enclosing ice) at the limiting depths. It has been shown that the age of meteoric ice amounts 1.85±0.2 million years at the contact with the Lake Vostok accreted ice. Since the air content of ice and the volume concentration of hydrates between 3310 and 3539 m have similar mean values, as observed in the upper section of the Vostok core covering the last four climatic cycles (~420 kyr), it is concluded that during the last 2 million years or so the ice-sheet surface elevation in the central part of the EAIS has been essentially stable and similar to that during the last 420 kyr. Although the continuous paleoclimatic record is not available from the Vostok core below 3310 m because of the ice-flow disturbance, the obtained results imply the potential for recovering stratigraphically undisturbed ice older than 1.5 Myr at a site located upstream of Vostok, in the vicinity of Ridge B.

Lake Vostok studies

In the 2012-2013 austral season, the drilling of the deep hole at Vostok Station was resumed with the aim of coring the refrozen lake water that entered the hole in the course of Lake Vostok unsealing in February 2012.

The first signs of the frozen water in the hole were observed at a depth of 3194 m (i.e. 575 m above the lake surface). In the depth range from 3415 to 3424 m, the hole was partly filled with the bright white porous and hard material preliminary identified as mixed clathrate-hydrate of air and hydrochloroflurocarbon (HCFC-141b) densifier of the drilling fluid. This material, retrieved at the surface in the core barrel, was estimated to fill up about 30% of the hole volume. The core of refrozen lake water completely filling the volume of hole was recovered from the depth range 3424-3458 m. In this 34-m depth interval, the glacial (meteoric) ice surrounding the hole gradually replaces the water ice in the core, as the new hole deviates from initial hole 5G-1. Deeper 3458 m, the drilling of the new branch hole 5G-3 was continued and the replicate core of the oldest Vostok meteoric ice was obtained. The interface between meteoric ice and accreted Lake Vostok ice was found in new hole 5G-3 at a depth of about 3537 m.

The average rate of the ice coring was about 2.2 m per drilling run and about 10 m per day which allowed to obtain more than 122 m of core from the depth range between 3415 and 3543 m. At the end of the season the drilling of the 5G-3 hole stopped at 227 m above lake surface.

A preliminary examination of the frozen water sample retrieved on the drill bit after Lake Vostok unsealing (February 5, 2012) allowed to detect the traces of the new species of microorganisms. Seven samples of the same species of bacteria have been found. The match between its DNA and any known organisms does not exceeded 86 percent. Attempts to build a phylogenetic tree have shown that the new species does not fit any of the main categories of microorganisms in its taxonomic domain. Additional samples needed for conclusive proof could be found in the refrozen water core obtained during the 2012-2013 season at Vostok. This core will be delivered at St. Petersburg in May this year.

Glaciological, geochemical and geophysical investigations in Lake Vostok area

Glaciological observations carried out in the region between subglacial Lake Vostok and Ridge B have provided snow stake data on the contemporary snow accumulation rate along the northern (NVFL) and southern (VFL) ice-flow lines passing through Lake Vostok. The mean accumulation rates in the NVFL and VFL profiles are found to be 29-37 kg m^{-2} yr^{-1} and 21-24 kg m^{-2} yr^{-1}, respectively. This region is characterized by a strong latitudinal gradient of the snow accumulation rate with a tendency of accumulation to increase towards the north, whereas in the west-east direction the accumulation rate is relatively constant. It is proposed that the ice-flow line passing through Vostok Station (VFL) may correspond to the axis of the minimum values of snow accumulation rate and isotope content, and thus likely is a divide between the two air masses feeding this region with precipitation from Indian and Pacific oceans. The latter supports the upper reaches of VFL as a suitable place for more careful quest for the future drilling site where the “oldest” (a 1.5 million year long or so) Antarctic ice core could be obtained.

Independently, the mean surface accumulation rates have been inferred for four surface segments between Ridge B and Lake Vostok from the accurate geodetic and geophysical data on the ice-flow velocity and ice thickness. This study confirms a steady increase of the snow accumulation towards the north as observed in the glaciological data.

A detailed history of volcanic events in the southern hemisphere for the last 900 years has been reconstructed from five snow cores drilled in the vicinity of Vostok Station. The obtained high-resolution stacked sulfate record accompanied by the SEM data on the microparticles of volcanic ash has allowed identification of 30 volcanic eruptions and refining the dating of the Antarctic snow pack.

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