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National Report to SCAR for year: 2008

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SCIENTIFIC HIGHTLIGHTS 2007/2008

RUSSIAN GEOSCIENS ACTIVITIES FOR 2006-2008

ORGANIZATIONS INVOLVED:

Polar Marine Geosurvey Expedition (PMGE), St.-Petersburg, Lomonosov. Ministry of Natural Resources.

Federal Research Institute for Geology and Mineral Resources of the World Ocean (VNIIOkeangeologia), St-Petersburg. Ministry of Natural Resources.

Arctic and Antarctic research Institute (AARI), St.-Petersburg. Ministry of Natural Resources.

1. FIELD ACTIVITIES:

Season 2006/2007

Marine geophysics (PMGE, VNIOOkeangeologia)

Marine geophysical studies were conducted in the area between the Prydz Bay and the southern Kerguelen Plateau (SCP) in cooperation with Alfred Wegener Institute (AWI) as the IPY Project "Geodynamic, depositional and environmental history of the region off the Amery Ice Shelf". PMGE/VNIIOkeangeologia have collected about 4000 km of MCS lines (using 240-chanel 4400 m long streamer) and about 4500 km of magnetic and gravity data with RV "Akademik A. Karpinsky" while AWI (RV "Polarstern") have deployed 37 Ocean Bottom Seismographs (OBS) along two MCS lines crossing the continent-ocean transition (along about 73ºE and 83ºE). Additionally two-ship (long-aperture) seismic experiment has been carried out along the of MCS/OBS line off the Prydz Bay.

On-land airborne geophysics (PMGE)

Airborne survey including magnetic and radio-echo sounding (RES) measurements were conducted in western Prince-Charles Mts. (between 61.6E and 64.3E and between 71S and 73S) over the area of about 20 000 km^2 with use of short-range airplane (AN-2). Flight lines were oriented north-south and spaced 5 km apart. 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. Totally about 5 000 km of profiles have been acquired.

On-land ground-based geophysics (PMGE, RAE)

About 600 km of oversnow radio-echo sounding (RES) observations were conducted in the northern and western part of Lake Vostok and along the route from Vostok Station to Mirniy Station. 30 reflection seismic soundings (RSS) along 2 lines (across and along the lake) have been acquired in the northern part of Lake Vostok. The lake depth in the study area ranges between 700 and 1250 m.

On-land geology (PMGE)

Geological research was carried out at the central and south-eastern parts of the Fisher Massive (Prince-Charles Mts.) where low grade metamorphic rocks are developed. The south-eastern part of the Fisher Massive (studied in more details) consists of parallel mafic dykes emplaced into schist assemblages while the central one is dominated with schist, gabbro and gabbro-diorite. Subsequent analytical studies will be centered on the definition of geochemistry and nature of metamorphic rocks as well as their ages and tectonic settings in which they formed.

Season 2007/2008

Marine geophysics (PMGE)

About 4200 km of multichannel seismic (MCS), gravity and magnetic (gradientometric) data as well as 10 sonobuoys were acquired on the Wilkes Land and Terre Adelie margins (between 102ºE and 115ºE) during cruise of RV "Akademik A. Karpinsky". MCS data were recorded using a 352-channel, 4400 m long digital streamer and airgun array of 2860 cub. in. in total volume.

On-land airborne geophysics (PMGE)

Airborne survey including magnetic and radio-echo sounding (RES) measurements were conducted in western Prince-Charles Mts. (between 62.0º E and 64.5ºE and between 69.3ºS and 71.2S) over the area of about 20 000 km^2 with use of short-range airplane (AN-2). Flight lines (about 5 700 km) were oriented north-south and spaced 5 km apart. The RES studies were carried out using a 62-MHz radio-echo sounder with a dynamic range of 180 dB and a pulse width of 750 ns.

On-land ground-based geophysics (PMGE, RAE)

About 650 km of oversnow radio-echo sounding (RES) observations and 26 reflection seismic soundings (RSS) have been carried out in the northern part of Lake Vostok. Geophysical survey of the 2007/08 season finished the mapping project aimed to outline the bathymetry and grounding line of Lake Vostok

On-land geology (PMGE, VNIIOkeangeologia)

Geological investigations were carried out in Mt. Willing (central Prince Charles Mts). A field party camped at Mt. Willing for five weeks during January–February 2008. Geological documentation was accompanied by measurements of rock magnetic susceptibility. The eastern half of Mt. Willing is represented by a layered gabbro intrusion of Mesoproterozoic age while its western half comprises high-grade metamorphic strata with abundant migmatite and cutting felsic veins. A geological map of Mt. Willing in scale 1:25000 and detail cross-sections of layered gabbros has been compiled based on the field studies.

2. INTERNATIONAL PROJECTS:

Tectonic Map of Antarctica (VNIIOkeangeologia)

Tectonic map of Antarctica is compiled within the IPY Project "Tectonic Map of the Earth's Polar regions") managed by CGMW. The main objectives of the project and its Antarctic component include: 1) integrating abundant geological data and tectonic interpretations disseminated in multinational literature into a coherent generalized legend that would allow the presentation of principal structural elements and historical particularities of both Polar Regions in a unified system of graphical designations and basic terms; 2) compiling 1:10 M maps and smaller scale insets; 3) preparing textual supplements to the cartographic products in the form of a short booklet and more extensive explanatory notes highlighting the tectonic essentialities of the Polar Regions in a comparative context; 4) producing the first products by the time of 33rd Session of IGC (Oslo, 2008) and within the scope of IPY activities.

Antarctic Digital Magnetic Anomaly Map (ADMAP Project, VNIIOkeangeologia and ADMAP consortium)

VNIIOkeangeologia is responsible for compilation and upgrade of the Antarctic magnetic anomaly map within the ADMAP Project. The first edition of map was issued in 2001 and a last one - in 2007 (the data base increased continuously). The 2007 map version includes more than 500,000 km of new airborne and shipborne data acquired after 2000 by different organizations and gives substantial improvements in magnetic anomaly pattern recognition. New data have been matched in one inverse operation by minimizing the data differences for the areas of overlap. The aeromagnetic data show many previously unknown magnetic patterns, lineaments and trends, defining the spatial extent of Ferrar volcanics and plutonic Granite Harbour Intrusives in the Transantarctic Mountains and previously unknown tectonic trends of the East Antarctic craton.

Antarctic Bedrock Topography and Ice Sheet (ABRIS Project; PMGE and VNIIOkeangeologia)

A new bedrock topography map has been compiled for the central region of East Antarctica using ice thickness data available in the BEDMAP Project data base and new information obtained after 2000 by the Russian Antarctic Expedition (when the BEDMAP product finished). Moreover, airborne radio-echo sounding data acquired during the Soviet Antarctic Expeditions (before 1992) between Enderby Land and the Gamburtsev Subglacial Mountains and recorded on films have been revised and reinterpreted. This work allowed imaging of improved bedrock topography for this area. Unlike the previously published bedrock topography map produced by the BEDMAP Project, the new map shows real bathymetry of Lake Vostok and some earlier not recognized morphological features of the Gamburtsev Subglacial Mountains and area to the north of them.

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4. PLANNED FIELD ACTIVITIES FOR 2009-2010

Field plans for two coming seasons include: 1) geological investigations in the northern Prince Charles Mountains; 2) marine geophysical survey in the Davis Sea and on the George V Land Margin; 3) reflection and refraction seismic experiment in the southern Lake Vostok; 4) RES measurements along the pathway from the Progress Station to the Vostok Station.

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SALE

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1. Solar wind influence on atmosphere processes in winter Antarctica

It was shown that the atmospheric effects, usually assigned to Forbush decreases, are related, in reality, to sharp changes in the solar wind parameters (i.e strong variations of the interplanetary electric field). The high efficiency of the disturbed solar wind has been demonstrated for the solar minimum epochs (1974-1977 and 1985 -1987), when Forbush decreases were practically absent. The link between the interplanetary and atmospheric electric fields is confirmed by experimental measurements of atmospheric electric field carried out at the Antarctic station Vostok during more than 10 years. The results of analyses demonstrate the strong influe nce of the interplanetary electric field on atmospheric processes in the central Antarctica, where the large-scale system of vertical circulation is formed during the winter seasons. The influence is realized through acceleration of the air masses, descend ing into the lower atmosphere from troposphere, and formation of cloudiness above the Antarctic Ridge, where the descending air masses income into the surface layer. The acceleration is followed by sharp increase of the atmospheric pressure in the near-pole region, which gives rise to the katabatic wind strengthening above the entire Antarctica. The cloudiness formation is resulted in the sudden warming of the surface atmosphere, since t he cloud layer efficiently backscatters the long wavelength radiation g oing from the ice sheet, but does not affect the adiabatic warming process of the descending tropospheric air masses. While the drainage strengthening the circumpolar vortex about the periphery of the Antarctic continent decays, and the surface easterlies typical of the coast stations during the winter season are replaced by southerlies and the cold Antarctic air masses flow out to the Southern ocean. It seems evident that the connecting link between the polar cap voltage and the polar atmosphere is realize d by the global electric circuit. Influence of the solar wind on the global electric circuit is well documented [***Tinsley, 1996***]. To develop the mechanisms for influence of the global electric circuit on the Antarctic atmosphere the additional evidences on specific features of atmosphere at the Antarctic Ridge and their relation to the solar wind variations are required.

2. Relation of substorms to polar cap magnetic activity

The polar cap magnetic activity is estimated by the PC index, which is calculated on the base of magnetic data from two near -pole stations Thule in Greenland and Vostok in Antarctica. Relation of the polar cap magnetic activity (the PC index) to magnetic disturbances in the auroral zone (the AL index) was examined for the isolated and p rolonged substorms. It was shown that the growth phase is typical of all substorms. The growth phase beginning is seen first of all as the PC index persistent increase preceding the substorm sudden onset. The growth rate and the substorms intensity are det ermined by the energy pumping into the magnetosphere during the growth and expansion phases. For conditions when 2?PC?4 mV/m the growth phase duration lies in the range from 60 to 15 minutes. For conditions of PC>6 mV/m the growth phase can shorten up to z ero. The polar cap magnetic activity, being related to the solar wind energy input, does not practically respond to the substorm development. The results suggest that neither driven mode no loading -unloading mode of the magnetospheric substorm do work in p ure form, but rather the threshold-dependent mode is realized. Since the incoming energy is continuously spent on the Joule heating, the energy store process starts only when the energy input rate exceeds the energy loss rate (for conditions PC>2 mV/m). If the energy input rate is extremely high (PC>6 mV/m), the energy lost can be neglected, and the magnetosphere begins to respond to the energy input immediately. In this short time the driven mode is realized. The extremely high energy losses typical of the expansion phase deplete the magnetosphere capacitor, and the next loading stage can start only when the substorm finishes, providing the external energy input exceeds the

LIFE SCIENCES

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Sea ice ecosystem observations at Nella fjord, Prudz Bay, Eastern Antarctic

During the 2007-2008 field seasons, the IPY project "Study of the Antarctic Sea Ice Ecosystems" (SASIE) was launched. SASIE is a part of the IPY cluster project "Integrated analyses of circumpolar Climate interactions and Ecosystem Dynamics" (ICED) which is an international initiative aimed at coordinating integrated, multidisciplinary, circumpolar analyses of Southern Ocean ecosystems. The IPY field observations were 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). During the 2007 period there were collected both sea ice cores and under ice water samples at the profile across the Nella fjord for salinity, mineral and organic compounds measurements and species composition identifications. It was shown that sea ice flora consists of mainly by dinoflagellate cysts, but marine diatoms were presented only by single cells, that are probably caused by freshening of ice. The multicomponent system was detected which is consisted of: (i) ice with fresh and sea water influence, (ii) under ice brackish water layer with salinity of 4-5‰ and 50–60 cm thick, and (iii) sea water layer with salinity of 34-35‰. This "multifloor" sea-ice-water system is synchronous vertically displaced due to tides up to 2 m, but sufficiently stable during the melting season while the sea-ice cover is "put off" the water-wave mixing. The SASIE is planned to continue after the IPY as a long-term ecological research project under umbrella of the Russian Antarctic Expedition and Russian Academy of Sciences.