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Report

VISITS TO GEOSCIENCE ORGANIZATIONS IN ST. PETERSBURG AND MOSCOW, RUSSIA JUNE 29 TO JULY 7, 1993

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EXECUTIVE SUMMARY

Transfer of Russian Arctic seismic data

We discussed access to Russian seismic observations from the Arctic, for use in projects presently in hand under the Russia-Canada Arctic Exchange Agreement, the Program of Cooperation of the US/RF Commission, and other initiatives. Significant quantities of seismic reflection and refraction observations are potentially valuable for delimiting sedimentary basins and for mapping tectonic structures related to the opening of the Arctic Ocean. The data are not presently accessible to Western investigators, but a channel of communication has been established to discuss terms of release.

Initiation of new contacts to assess availability of additional Russian data

The visit made us aware of the existence of large quantities of high quality geophysical data, now becoming available for joint research or public release. Direct outcomes of our visits include promises to consider the release of magnetic data in the North Atlantic Ocean and Barents Sea for incorporation in AGC's magnetic compilation project. We were also able to discuss prospects for exchanges of gravity data over the longer term.

Russian-American Arctic Submarine Mapping Project

Contacts were established with Russian proponents of the proposed Russian-American submarine project for regional mapping beneath the Arctic's permanent pack ice. Progress on the political front is apparently slow on account of internal factors. In anticipation of the program, a network of transects has been designed, and advancements were described to us in the design and development of geoscientific sensor systems for submarine deployment. It is essential that we maintain liaison and general awareness of future progress.

Feasibility of Russia-USA-Canada Program for airborne geophysical mapping in the Arctic

Informal proposals for a joint program of airborne geophysical mapping in the Arctic received little response on account of several factors: (a) budgetary constraints in the three participating countries; (b) the proposed Russian-American submarine project, which could engender substantial program redundancy; (c) ongoing Russian programs for mapping large parts of the Russian shelf; and (d) the general lack of time to pursue such discussions in any depth. Several scientists from the institutes doing airborne studies did show a strong interest in corresponding further, however, and these openings should be pursued in the future.

Identification of opportunities for exporting Western expertise and technology

Given the lack of hard currency in Russia, plus the fact that Western businesses need tangible returns in order to survive, exchange or barter may prove to be the most practicable basis for exporting commercial expertise and technology from the West to Russia in the foreseeable future. For instance, several groups indicated an interest in sharing high quality geophysical data in return for access to computer technology and for staff training.

General Impressions

Our strong impression is that while times are tough in Russia ecomonically and technologically, they are not as bad as the Western media may have led us to believe. Specifically, in both St.Petersburg and Moscow, there are large numbers of privately owned cars on the street; there are many kiosks which appear to be relatively well patronized by the local populace; and the street vendors are eager, but definitely not desperate, to make sales. Most of the major services such as local & long distance rail, subways, and tramlines appear to be in at least fair to good repair and operate dependably. There are still major readjustments that need to be made in the economy, specifically in terms of real salaries (for a typical scientist, 20-40,000 rubles/month or US$20-40), but these are offset by the low cost of many services (e.g., rent is typically 100-200 rubles/month for a 2 room flat; overnight Pullman train fare to Moscow from St.Petersburg is 3000 rubles). The shortage of hard currency may make it difficult to buy Western technology, but clearly the Russians are coping: many scientists we visited had PCs, which they are clearly able to use effectively. We are therefore left with the impression that there is a window of opportunity open right now for Western concerns to gain ready access to Russian data and technical expertise in return for technology transfer and funding support, but the window could soon begin to close.

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INTRODUCTION

For the past several years we have pursued joint interests with Russian colleagues from VNIIOkeangeologia (All-Russian Research Institute for Geology and Mineral Resources of the World Ocean) in St. Petersburg. This collaboration has assumed a variety of forms, including: compilation and processing of magnetic data from the Arctic and the North Atlantic; analysis of observations obtained during the Russian Canary-Bahamas Geotransect program; construction of a magnetic/tectonic map of Russia and adjacent land & marine areas; discussions of the feasibility of joint aerogeophysical mapping expeditions in the High Arctic; and production of a catalogue of seismic reflection & refraction data from the Arctic.

Much of this work has stemmed from a pair of exchange visits in 1990, when Yulian Pogrebitsky & Boris Lopatin visited the Atlantic Geoscience Centre, and Jacob Verhoef & Ron Macnab in turn visited VNIIOkeangeologia. Since that time, there have been encounters at AGC and at meetings in Europe & North America, but none on Russian territory. This trip was organized in an attempt to redress that balance, and to provide firsthand opportunities for advancing the work presently in hand, as well as for planning future initiatives. The trip was also seen as an opportunity to develop new contacts in VNIIOkeangeologia and elsewhere, and to augment our knowledge of Russian mapping & research in the Arctic and in other areas of scientific interest areas.

Names, affiliations, and interests of the contacts we made during our visits to different laboratories and agencies are listed in Appendix I.

Given their close ties and common scientific interests, it was decided right from the beginning that the authors should make this a joint trip, and that they would participate in all visits and discussions. Full participation did happen in most cases, except for a few instances where time was running short and it was more expedient to split the team temporarily in order to schedule parallel discussions. Consequently most of the discussions below were attended by the full visiting team. At our suggestion, many of these same discussions were attended by one or two of our primary hosts from VNIIOkeangeologia, to ensure that they were fully conversant with the scope and direction of the talks.

We acknowledge our indebtedness to Sergei Maschenkov and his team, whose arrangements made it possible to meet with so many Russian investigators in St. Petersburg & Moscow, and whose translation skills facilitated the efficient exchange of new information.

ST PETERSBURG: TUESDAY JUNE 29

VNIIOKEANGEOLOGIA

Opening discussion

Contacts: Vladimir Glebovsky, Sergei Maschenkov, Yulian Pogrebitsky, Valentina Verba, Vjatcheslav Volk and others.

Short overview of proposed visit schedule, essentially confirming the timetable that was outlined in Maschenkov's last E-mail with minor adjustments.

Maschenkov & Glebovsky review the situation with respect to relevelling the Russian & US Arctic aeromagnetic data, an activity to be proposed as a joint project at the July 14 meeting of the renewed US/RF Commission in Seattle. A plot is shown that displays a series of recently-digitized aeromagnetic profiles, complementing several profiles that were digitized last year and delivered to the AGC magnetic compilation project. VNIIOkeangeologia has not yet received official permission for release of the newly-digitized data, but it's possible to proceed with its analysis, and to begin discussing procedures for re-levelling & adjustment during the visit.

As a preliminary to our afternoon visit to her laboratory, Dr. Valentina Solovieva of VSEGEI (All-Russia Geological Institute) outlines progress in the preparation of a new magnetic anomaly map of the world that she proposes to unveil at the upcoming IAGA meeting in Buenos Aires.

ALL-RUSSIA GEOLOGICAL INSTITUTE (VSEGEI)

New magnetic maps of the world and Russia

Contacts: Tamara Litvinova, Valentina Solovieva.

Also known as the Karpinski Institute, VSEGEI is the main geological organization in Russia (it used to have about 2000 employees, but cost-cutting measures have reduced that to about 1000).

Solovieva shows us a series of map sheets covering the world, and which have been compiled and drawn by hand. The information is shown mainly in contoured form over land areas, while profiles are featured over many parts of the oceans. The map is drawn on a cylindrical projection (presumably sinusoidal) at scale 1:10 000 000. Funding to pay for map printing has yet to be obtained.

Solovieva draws our attention to particular features in the Arctic, the North and Equatorial Atlantic, and the Southern Oceans. She describes the procedures used for adjusting the constituent data sets through use of long reference profiles (2000 - 5000 km) that have been 'zero-levelled' by changing their zero axis so that the integral of their anomalies is null (the explanation is not very clear on account of translation difficulties). Judging from the

appearance of the final product, most data appear to be accurate enough for this scale of mapping.

Some time is spent discussing areas that feature substantial amounts of new Russian data, as well as blank regions where recently collected western data exist. Macnab offers to contact the Greenland Geological Survey regarding the availability of their south Greenland Ice Cap aeromagnetic data for inclusion in the new World Map. Kovacs promises information concerning joint mapping programs over the Argentine Shelf project and the Chilean Ridge. Areas with new Russian data include the Arabian Sea and Somali Basin, the Mid-Atlantic Ridge near Charlie-Gibbs Fracture Zone (originating with Mercuriev and Sochevanova, SPbIZMIRAN), and the Australian-Antarctic Ridge (Palinski of SPARC?).

Litvinova is editor of the new 1:5 000 000 map series of Russian magnetic data (to appear late 1993 or early 1994). She appears to have resolved the problem of the low magnetic level over the whole of the Taymir Peninsula, using a new control network of flight lines: level changes of about +100 and +200 nT over the west and east ends of the Peninsula, respectively, considerably improve the look of the map. Details on the correction procedure are unclear and unobtainable for the time being, as the work is still in progress. However, addition of a plane seems to be adequate, so perhaps we can reproduce the correction if we know the final contour lines. To be followed up.

After a lunch hosted by Solovieva, we're taken to the VSEGEI Museum, an impressive rock collection with over 60000 samples on display and millions more in storage. A large wall map of the former USSR is explained to us, covering some 30 square metres and constructed of different rock types. Shortage of time permits only the most cursory examination of some of the Museum's more spectacular specimens.

HEAD DEPARTMENT OF NAVIGATION AND OCEANOGRAPHY (HDNO), RUSSIAN NAVY

Opportunities for future collaboration

Contacts: Yuri Kiselev (in attendance, but actually a member of VNIIOkeangeologia), Captain Vadim Sobolev, Vice Admiral Yuri Zheglov, and various staff officers (including Captain Andrey Popov, a contact from last April's GEBCO meeting in Boulder).

Zheglov is positive in his opening remarks concerning the possibility of collaboration. While there is a strong desire to cooperate under the conditions of mutual benefit, information exchange and joint interpretation in areas of overlapping interests, the Admiral is careful to point out that HDNO needs access to new technology in order to participate effectively in any such work.

The Admiral turns the discussion over to Kiselev, who is known to have an extensive collection of seismic observations accumulated during decades of work from drifting ice stations. It's made very clear that the price of access to this motherlode of data is to provide Kiselev and his team with the technology to digitize the records and to carry out numerical interpretations. This request is backed up with a spec sheet (Appendix II) that details the

needed equipment at a total cost of about $115K (US).

It sounds like most of the archives are stored on paper records, but there seems to be little concern about their deterioration, and Kiselev is not interested in discussing their transfer to microfilm as a rapid means of preservation. Technical discussion with Dr. Kiselev is deferred to a meeting scheduled for tomorrow.

On the subject of the AGC magnetic compilation project, Captain Popov has a question about potential duplication of the functions of World Data Centre A in Boulder. Macnab explains why duplication is not a problem: (1) AGC has been very active in pursuing data sets specifically for purposes of the compilation, and hence has obtained substantial quantities of information that are not contained in the WDC(A) archives; (2) significant portions of the compilation data base are proprietary and subject to restrictions on further distribution, unlike the public-domain information held by WDC(A); and (3) a substantial part of the compilation project involves processing of the constituent data sets to ensure that they merge properly, which is not a usual procedure at WDC(A).

The visit concludes with a tour of HDNO's museum led by Captain Sobolev, who provides an entertaining and informative review of the long history of chartmaking in Russia.

GEODYNAMICAL RESEARCH CENTER TETHYS

Tectonic investigations over northern Russia and the Eurasian Shelf

Contact: Sergei Aplonov.

GRC Tethys is one of the new private research enterprises that has to earn its keep by performing directed research: in the West, it would probably be classified as a consulting company. The company has only three full-time staff members: Aplonov (the principal investigator), a manager, and a secretary. Other investigators are co-opted as required from major research institutions, notably VNIIOkeangeologia, Sevmorgeologia, and the Marine Geophysical Polar Expedition (described below).

Aplonov's personal research interests involve the geophysics of mid-ocean ridges and their gravity & magnetic fields. His company's primary research focusses on the application of geophysical methodologies to the study of the deep sedimentary basins of Russia and her Arctic continental shelf. In addition to maintaining an awareness of potential field measurements over all of Russia, Aplonov is overseeing the development of a geological-geophysical data base for information in the Kara Sea and the Novaya Zemlya region, notably magnetic and gravity data collected by Sevmorgeologia and the Polar Expedition. He has some relatively new magnetic data sets at his disposal (1980+), collected at line spacings < 500 m and gridded at 1 km spacing.

Aplonov has no specific propositions for collaboration, but expresses interest in scientific cooperation. He spends some time explaining the search for Triassic seafloor on the Siberian shelf. From an analysis of intermediate wavelength anomalies, he claims to have found Devonian seafloor in the some regions of the Siberian shelf. His techniques included

wavelength domain filtering and cross-correlation with model anomalies.

Other points of scientific discussion involve the detailed segmentation of the Mid-Atlantic Ridge near Kane Fracture Zone. A careful analysis of bathymetric and magnetic data has led to the identification of many ridge jumps in the crust, some reaching back to a few million years (anomaly 2).

Funding for Tethys comes primarily from oil companies; it works on the basis that while $10K is not a large sum for a Western company, it's a very useful amount for a Russian organization. The discussions with Aplonov are quite open and include descriptions of his experiences in dealing with EXXON Exploration and other companies.

ST. PETERSBURG: WEDNESDAY JUNE 30

VNIIOKEANGEOLOGIA

Arctic crustal thickness map

Contacts: Michael Kosko, Valentina Verba, Vjatsheslav Volk.

We meet with Volk and Verba to review progress in this activity, also known as Project 9 of the Russia-Canada Arctic Exchange Agreement. Work on Project 9 has been two-pronged so far, featuring: (a) the preparation at AGC of a catalogue containing published results of Arctic seismic reflection & refraction experiments; and (b) the development at VNIIOkeangeologia of a map based on the interpretation of Russian potential field observations. The seismic catalogue now contains information describing most published data sets and their interpretation; there have been no advances since last fall, owing to Ruth Jackson's absence during the first half of 1993.

Volk shows a 1:5M or 1:6M map which portrays crustal thickness over the Arctic, derived from gravity observations by means of an Airy compensation model. The map is very generalized, but where seismic cross-sections are available, the Airy model agrees reasonably well with observed Moho depth. The densities used in this derivation are 1.03, 2.67 and 3.08 g/cc for water, crust and mantle respectively; because it remains classified, the gravity data that were used to control the modelling cannot be shown. Volk has also used magnetic anomalies to derive the Curie temperature isotherm and to check for Curie/Moho commonality.

Verba (who is in charge of the geophysical aspects of the work) shows a crustal cross-section that extends from De Long Island through Makarov Basin. It includes gravity and magnetic profiles along with preliminary results of gravity modelling: the fit between modelled and observed gravity is good in some areas, but diverges significantly in other areas. This work is still in progress, and results will no doubt be refined.

Macnab expresses a concern about publishing maps based on interpretations without showing the basic input data. For instance the crustal thickness map is derived in large measure from

gravity interpretations: it may receive only limited acceptance from Western investigators because they like to look at the data before considering interpretations. Also, a lot of the deep seismic control appears to come from the shelf regions; extrapolating this information to the deep ocean basins could result in some invalid crustal models.

Given the general paucity of deep seismic information over the Arctic Ocean basin along with the classified status of the Russian gravity data, there is a consensus that we don't have enough publishable data at this stage to proceed with the preparation of a crustal thickness map for the entire Arctic. Subject to discussion with Ruth Jackson and other participants, it's suggested that we wrap up the seismic catalogue now and release it in its present form through Open File.

Pending the availability of data sets that cover all or most of the study area, it's further suggested that Project 9 be re-defined with the objective of preparing geotransects that display information which is currently at our disposal. These geotransects could be developed in accordance with specifications issued by the Inter-Union Commission on the Lithosphere, for the production of the Global Geoscience Transect (GGT) Project. Subject to discussion with Ruth Jackson and others, Macnab will inquire about the possibility of connecting up with the GGT Project.

Kosko, the Russian coordinator for the Russia-Canada Arctic Exchange Agreement, emphasizes the need for a detailed work plan that spells out objectives for Project 9 and a timetable through to the end of 1994.

Western access to Kiselev seismic data

Contacts: Yuri Kiselev, R. Mikhaelov (HDNO Staff Officer), Victor Posyolov, A.N. Other.

We resume yesterday's discussion with Kiselev to learn more about the data collected during 30 years of seismic reflection and refraction observations on military and civilian drift stations, beginning in the early 60's. A few sample records are unrolled on a long table and remain there for the duration of the interview: they appear to be printed on strips of semi-glossy photographic paper about 25 cm wide and 3-4 metres long, each with a dozen or so wiggly (analog) traces. Even with computer technology, digitizing these records would likely be a laborious, time-consuming process: many of the wiggly traces have large amplitudes and intersect several of their neighbours, making them hard to track. There is nothing to indicate the age of the material on display, but it seems to be in good to excellent condition, which may explain yesterday's lack of interest in microfilming the records. Other data sets exist on analog magnetic tape.

Kiselev explains that seismic work in the Arctic was done at the behest of the Russian Navy, which has only recently authorized use of the data for publishable research (this may explain why one of Vice-Admiral Zheglov's staff officers is present for the discussion). He outlines briefly the procedures for collecting the data, illustrating with photographs of ice camps, equipment racks, and aircraft that were used to transport instruments and operators to recording sites. Many plots and illustrations are unfolded and placed on the table in quick succession, then removed and put away before we have a chance to absorb what we're being

shown. The sample reflection and refraction records are contrasted with material published by western scientists (notably in the Arctic DNAG volume) and it's suggested that the Russian information is of a better quality. Also, there's a comment on the superiority of the Russian methodology of interpretation.

Because of the classified nature of the work, it appears that little of the data or interpretations have been published, if at all. Hence there are no reports or written information that we can take away to substantiate the extent of the data holdings, or to support recommendations for technical and financial assistance. Kiselev claims to have written a book summarizing the results of the Russian Arctic seismic program, but it's in Russian and it's not clear if it has been released yet. Apparently an English-language version is in preparation, but progress has been held up on account of 'financial difficulties'.

We ask if it would be possible to acquire a plot showing the locations of the seismic profiles, but are told that we need first to offer support for digitizing and processing the records (within the context of the discussion it's difficult to interpret this reply: it may be a mistranslation, or it may signal an intention to adopt a hard bargaining stance). Kiselev emphasizes that external funding is an absolute necessity if the data are ever to be properly processed, illustrating that point by showing a pie chart that breaks down some expenses incurred so far (excluding acquisition, but including preliminary efforts to digitize some records).

In an attempt to get a feel for the magnitude of the task, we ask how many records there are: we're told that observations from Canada Basin are stored on two or three thousand analog magnetic tapes, and about 30,000 paper records (we learn later from another source that there are about 50,000 paper records for all of the Arctic Ocean basin).

SPbFIZMIRAN

Arctic and North Atlantic magnetic data

Contacts: Valerie Carmonov(?), Valentina Kolesova, Nellie Sochevanova.

SPbFIZMIRAN is the acronym for the St. Petersburg Filial of the Institute of Earth Magnetism, Ionosphere, and Propagation of Radio Waves. To save visitor time, staff from this organization come to VNIIOkeangeologia for discussions.

Sochevanova is a close colleague of Sergei Mercuriev, who is on sabbatical at the *Institut de Physique du Globe* in Paris, and with whom we've corresponded extensively on the topics of data exchange and possibilities for collaboration. She shows plots of data collected by SPbFIZMIRAN in the Arctic, Atlantic and Indian Oceans. We are impressed by the data quality and quantity, and by the clarity of interpretation. Sochenanova is an enthusiastic scientist with a strong interest in collaboration. We promise to alert Jafar Arkani-Hamed & Jerome Dyment (McGill University, Montreal), Peter Vogt (NRL, Washington), and Chuck DeMets (University of Wisconsin) of her Indian Ocean interests.

We discuss with Sochevanova the possibility of acquiring a copy of her data southeast of

Greenland and other parts of the North Atlantic for inclusion in the AGC magnetic compilation, and ask about her chances of making a working visit to AGC to participate in the merging of that data into the AGC data base. She is personally willing to make the data available, but not on an exchange basis because she has more data now than she can handle. Travel to AGC would be possible only in October or afterwards, due to administrative problems such as visa acquisition, etc. She would also need financial support to pay for airfare (for her recent travel to France, she bought her ticket out of personal funds).

In a side discussion, Kovacs suggest that we ask for a table of SPbFIZMIRAN track endpoints in the North Atlantic, which would be used to indicate to the US Navy where Russian data are likely to be forthcoming, and to bolster requests for the release of American data that could be used to fill gaps in the magnetic compilation.

Sochevanova also shows an impressive plot of aeromagnetic profiles over the Eurasian Basin and the Lomonosov Ridge. These may be the data sets that were used to produce the 'zebra stripe' (i.e. positive-negative) map produced years ago by Karasik(?) and since then shown in Western circles by Russian investigators. Sochevanova is somewhat disparaging of the profiles, claiming that the poor quality of their navigation renders them unsuitable for reliable interpretation. If they were available in digital form, the profiles might possibly be amenable to adjustment after comparison with other data in the area. This is a point worth following up.

Kolesova's primary interests seem less oriented towards tectonic interpretation, and more towards data management & numerical analysis. She has studied large to intermediate scale features over the Arctic, Russia, Mongolia, and Cuba, and has prepared several 1:10M & 1:50M charts of inclination/declination. She has also written several in-house programs which together are called SPAN, and are used to look at the dynamic spectrum of the geomagnetic field. She's also done work with autocorrelation methods to calculate navigation errors in magnetic survey data.

MARS TECHNOLOGY

Software and data processing services

Contacts: Oleg Chirkov (Chief Geophysicist), Yuri Filippov (Vice-President), several others.

Founded in 1988 with 50 employees, Mars Technology is another of the many spinoff companies formed upon the wholesale dismantling of government laboratories. For the past two years the company has been doing geophysical and structural interpretations, primarily for the Russian Navy. Besides providing a service for geophysical data adjustment, they develop software for the analysis of gravity and bathymetry observations. Major regions of marine interest include the North & Central Atlantic and the Arctic; most of their work has been with data collected from ships, but they've also handled some ice station data.

Macnab briefly outlines the interests we have, based on magnetic compilation and Russian magnetic data. Roest shows potential field maps at different scales to illustrate local and global interests.

The rest of the session consists of a demonstration of software developed by the company for use in its contract work. Because the programs are installed on borrowed hardware, there are problems in operating the software for digitizing on a graphics screen; arrangements are made to complete this part of the demonstration tomorrow. There is better luck running programs for crossover analysis and determination of data accuracy. The data format is similar to MGD77 but allows more fields, e.g. up to 8 different gravimeters, for testing purposes. Marstec have also implemented a variety of gridding algorithms based on weighted averages.

ST. PETERSBURG: THURSDAY JULY 1

MARS TECHNOLOGY

Digitizing software

Contacts: Oleg Chirkov and A.N. Other

Resumption of yesterday's demonstration of PC-based digitizing software: paper records are scanned and stored in raster form for display on PC screen. Curves are manually digitized under mouse control as a series of discrete points, with various options for moving points, tagging with auxiliary information, etc. No facility for automatic tracing is demonstrated, but it's claimed that such an option exists in another program.

In discussion, Chirkov mentions that Mars Technology have been working with Kiselev in digitizing some of his 50,000 Arctic seismic records. He estimates it would take two years to finish the task, using 3-4 people and an unspecified number of PC's. This project is not presently active, having been suspended on account of 'administrative problems'.

While possibilities for marketing this software in the West may be limited (instructions are in Russian, etc) it was good to see that technology and expertise exist in St. Petersburg for possible use by potential partners who need to have collections of records digitized (e.g. Nellie Sochevanova and her aeromagnetic profiles, Yuri Kiselev and his seismic records).

MARINE GEOPHYSICAL POLAR EXPEDITION (MGPE)

Arctic geotransect and aeromagnetic mapping

Contacts: Igor Balashov, Balyutin, Nicolay Grupen, Victor Kalinin, Vladimir Kryukov (Director), Yuriy Pavlov, Yury Semenov, Michael Seryakov

The laboratory is situated in Lomonosov, about a one-hour drive from VNIIOkeangeologia. It has about 9000 sq m of relatively new lab space for a scientific staff of about 700. In principle, the Laboratory has worldwide interests, but nowadays its primary efforts are directed towards the geology and geophysics of the Arctic, the Russian Arctic islands, Novaya Zemlya, and Svalbard. Work in the Antarctic was terminated a couple of years ago due to lack of funds. In studies of marine mineral resources, MGPE carries out many joint projects with VNIIOkeangeologia.

MGPE's Arctic priority is to conduct geophysical investigations, particularly those requiring magnetic and gravity measurements. Work is not restricted to open water areas, but extends onto ice-covered areas and onto land. Functions include aeromagnetic mapping and ship operation for SEVMORGEOLOGIA; these extend to non-Polar regions, e.g. they provided a ship for VNIIOkeangeologia's recent five-month cruise in the Canary-Bahamas Geotransect.

We have a lengthy session in the laboratory boardroom where staff describe recent aeromagnetic surveys over the Lahovsky, Northern Spitsbergen, and Franz Josef Islands. Balyutin describes the mapping program around the latter islands, which is a multiyear project running until 1994 or 95. Some thirty aircraft have been used in the operation so far, and it's about 25% complete. Track spacing is 500 m; observations include total field magnetics, radar altimetry, radar ice sounding, and gravity, with raw GPS navigation. Results are claimed to be accurate to ~5nT and 4 mGal: this seems optimistic using light aircraft over land without differential (let alone interferometric) GPS. A differential survey is planned next year over Lake Ladoga, which has a detailed gravity test range.

Other results include a 20,000 sq km survey over the New Siberia Islands, which took three years to complete at a 500 m track spacing. The operation used a single-engined aircraft equipped with GPS and an MMS 200 (proton precession?) magnetometer with 0.1 nT accuracy. Measurements were recorded on digital magnetic (9-track?) tape; altitude measurements were reported to be the major source of error. A similar survey over northern Siberia was said to use an active GPS cockpit display and a Cesium magnetometer with a 0.01 nT accuracy. A Norwegian group (Amarok?) that processed the data from that survey estimated an overall survey accuracy of 2.5 nT (presumably the rms of all cross-over errors?)

Yuriy Pavlov discusses a transect situated between the Lomonosov and Alfa Ridges (we think it's an extension to the one shown earlier by Valentina Verba), with a side branch extending across the Lomonosov Ridge: this consists of seismic reflection and refraction lines executed on drifting ice stations between 1989 and 1992, complemented by specially-flown 100-km swath aeromagnetic surveys. Many questions remain to be answered, but the Russians' general view is that the crust in this area is not typically oceanic.

The visit concludes with a discussion on the desirability and possible mechanisms for future collaboration. Training and technology transfer are identified as being particularly useful for MGPE, in return for Canadian and US access to new Russian data. A suggested approach that might be economical and practical is to organize technical workshops attended by younger Russian staff and focussing on specific activities (e.g. processing data sets of particular interest) or the development of certain products (new maps, geotransects, etc). We agree to maintain an exchange of information on these and related topics.

MAGNIT COMPANY

Airborne geophysical mapping in the Arctic

Contacts: Victor Kalinin, Igor Balashov.

Magnit sounds like both a component and a commercial spinoff of VNIIOkeangeologia; we

don't fully comprehend the administrative and operational connections between the two organizations. The company is headed by Vasiliy Palamarchuk, and specializes in airborne geophysical observations. One of its current objectives is to fly regularly-spaced aeromagnetic and aerogravity profiles at high altitude (6 km) over the polar region; so far, the Russian sector between 70 and 80 has been covered with a series of N-S lines separated by 5 degrees of longitude; plans are in hand to extend regional coverage to other sectors (see sketch maps, Appendix III).

ST. PETERSBURG: FRIDAY, JULY 2

VNIIOKEANGEOLOGIA

Meeting with Academician Gramberg

Contact: Academician Igor Gramberg (Director VNIIOkeangeologia)

The day begins with a brief discussion with Maschenkov and colleagues, to prepare for a meeting with Gramberg. In addition to Maschenkov, the meeting with Gramberg is attended by Pogrebitsky, Glebovsky, Kosko, and interpreter Ivanova. Gramberg opens the session by stating that a recent meeting of the Russian Academy of Sciences has pointed to existing geophysical collaborations as models for scientific cooperation with the West. The discussion then moves to a consideration of the prototype Magnetic Anomaly Map of Russia and Adjacent Land & Marine Areas, produced at AGC last February. Conoco's contributions to the project are explained, as are current efforts by Jerry Kisabeth and Greg Jorgensen to detect and remove errors in the grid that was used to produce the prototype map.

It appears that VSEGEI, the institute which originated the original magnetic contour maps of the continental USSR in 1974, has objected to Gramberg that it was not given author status in the new map. This seems to be largely an internal issue: after a long and mostly Russian discussion that includes a review of the map's Acknowledgements (giving VSEGEI full credit as originators of the continental data), an explanation of the status of the digital version of the data in the West (being distributed in the public domain by NGDC), and a description of the digital technology used in the map's production, Gramberg seems ready to concede that VSEGEI has been treated fairly. He reserves final decision on the matter until he can hold further discussions with his VSEGEI counterpart. One possible outcome is that present authors could be re-identified as compilers, and the logos appearing in the title block could be shifted to another part of the map.

The status of Project 9 (crustal thickness map) in the Canada-Russia Arctic Exchange Agreement is then discussed, with a briefing for Gramberg to bring him up to date on the conclusion reached in previous discussion, i.e. that there exists a wealth of Russian seismic data in Kiselev's archives, but for various reasons virtually all of this information will remain inaccessible for the foreseeable future, and cannot therefore be used in the construction of the proposed new crustal thickness map.

Given that data presently in hand are insufficient for making a crustal thickness map of the region, it is proposed that the project in its present form be terminated upon the finalization

and open filing of the seismic catalogue that has been developed so far, and that we concentrate from now on on the preparation and publication of transects wherever warranted by data availability and quality. This proposition of course is subject to discussion with Ruth Jackson and GSC Management.

A related point of discussion concerns the desirability or otherwise of retaining this activity within the existing bilateral framework. There are reasons both pro and con, but it's felt that the existing arrangement has served a valuable purpose by spawning healthy working relationships between Russian and Canadian scientists. Where Project 9 is concerned, a formal framework is no longer needed to support continuing collaboration; indeed some of the Agreement's administrative and protocol requirements, along with altered circumstances, might actually impede the development of the sorts of interpersonal associations that are crucial to good cooperative science. On the other hand, by providing a formal 'environment' for interaction, the Agreement embodies official approval for maintaining communication and for exploring new areas of collaboration. It is agreed that each side will consider the question and advise the other of its viewpoint.

The executive composition of the IASC Working Group for Geophysical Compilation and Mapping is considered briefly. Coordinators have been identified and/or enlisted for bathymetry, gravity, and magnetics. We still need to identify someone who would look after seismic reflection/refraction. Given the preponderance of North American representation so far, it's felt that the remaining coordinator should be a Russian or a European. Gramberg promises to consider the matter and to nominate someone.

Finally, the general scope and objectives of the proposed US/RF aeromagnetic levelling project are outlined, and steps taken so far to implement the joint project are described by Kovacs and Maschenkov. Gramberg asks a question concerning Kovacs' and NRL's specific interests in Arctic magnetics, to which Kovacs replies that he personally has been collecting data in the region since 1975, and that scientific questions drive his involvement. It's agreed that Kovacs and Glebovsky will develop a working plan which Academician Gramberg can present at the meeting of the US/RF Commission in Seattle on July 14.

Joint presentation by visiting team

Macnab, Kovacs and Roest take turns speaking to an audience consisting of staff from VNIIOkeangeologia, the Marine Geophysical Polar Expedition, Sevmorgeo, and other organizations. The title of the joint talk is something along the lines of 'New mapping activities in the Arctic: opportunities for international collaboration'.

Macnab opens with a review of present compilation activities in the Arctic that already involve collaboration (magnetic data, seismic reflection & refraction) and mentions some activities that could flow out of this work. Among other things, the preparation of thematic maps for Northern Russia and for the Arctic as a whole is being considered. This would involve the assembly & evaluation of existing & new data; as demonstrated by AGC's magnetic compilation project, these actions would almost certainly suggest new directions for analysis and interpretation. Moreover as compendia of regional geological & geophysical knowledge, such maps would be useful to both Russian and Western investigators who were

looking for information summaries.

Kovacs describes work already done and proposed for adjusting and relevelling the aeromagnetic data collected over Amerasia Basin by US and Russian agencies. He reviews the complementary errors and accuracies of the two data sets, as well as work done over the past year in filtering and relevelling the US Navy data to create a data set that is compatible to the Russian data. Finally, he presents an overview of the aeromagnetic & aerogravity data collected in 1992 over Alpha Ridge, and talks about plans for similar surveys over Canada Basin and Chukchi Cap that he and his colleague John Brozena have proposed for 1994.

Roest finishes the presentation with an overview of his current research on the geodynamics of spreading ridges. He describes how the availability of more detailed geophysical data (such as that collected in the Canary-Bahamas Geotransect under Maschenkov's leadership) have changed the view of oceanic tectonics from one of simple systems to a picture of substantial complexity.

New mapping projects

Contacts: Vladimir Glebovsky, Sergei Maschenkov, Valentina Verba, Vjatsheslav Volk, and others.

This is a general discussion to review prospects for new mapmaking activities that could follow up and complement existing work. The work could be carried out within existing cooperative frameworks, or under the overall direction of an organization such as IASC.

Two approches have been informally proposed: (1) an Atlas of 1:6M thematic maps of the entire polar region, and (2) a multiparameter map of northern Russia & the Eurasian continental shelf, consisting of four adjacent panels portraying bathymetry & topography, gravity, magnetics, and regional geology.

The first project would assemble all available thematic information north of 64N for construction of a series of maps compatible with the standard GEBCO Chart of the Arctic Ocean and the two geology maps (Bedrock and Quaternary Geology) produced so far under the Russia/Canada Arctic Exchange Agreement. Given that the magnetic map is nearly ready for production, the initial effort would focus on: (1) the updating of geology particularly in the Russian sector, where there is new information; (2) the preparation of a (Bouguer?) gravity anomaly map. Concerning the latter, Russian gravity data may not be freely available for a while yet, but new gravity observations that have been derived from ERS altimetry can be obtained over the Eurasian shelf.

The second project would involve the assembly and presentation of information that is available in digital form (or which could be readily converted to that form) over Northern Russia and the continental shelf. The use of adjacent panels would facilitate correlation between the different types of information. Produced at a scale of 1:6M, this would offer a general overview of the geophysical and geological characteristics of the region, and could serve as a base for more detailed studies. While the map's primary beneficiaries would likely be Western investigators who are embarking for the first time on northern Russian studies,

Russian scientists should also find it useful as a summary and a compendium of available information in the area.

No decision is taken to proceed with either project on a joint basis for the time being, although it is recognized that the multiparameter map could be undertaken as a subset of the Arctic Atlas, and that both would entail a fair amount of common work. Principal Russian and Canadian investigators will exchange information on the availability and status of relevant data sets. Also, inquiries will be made regarding the availability of industry funding. Time and circumstances permitting, a mockup of the multiparameter map will be prepared at AGC and presented for consideration at a future discussion.

Proposed Russian-American submarine project

Contact: Georgiy Gaponenko.

Pogrebitsky describes his perceptions relating to three problem areas with the proposed Russian-American submarine project: (1) the program is not 'commercial' i.e. it isn't part of the Russian Government's current push to put large sectors of its activities on a business footing; (2) there are too many internal interests vying for control of the program; (3) there remain many technical problems to solve.

Nevertheless, the Russians have designed a network of transects in anticipation of the program; these would tie together major features of the Arctic Ocean basin, and could be used to check and adjust the results of local mapping operations. A series of representative study areas has also been targetted for detailed mapping. Pogrebitsky describes the proposed first transect: it would follow the Barents Margin from Svalbard to Franz Josef Land, and from there across the Eurasia Basin and Lomonosov Ridge to Makarov Basin, across Chuckchi Cap, and finally across Canada Basin to the Mackenzie Delta.

Kovacs points out that the proposed track through Amerasia Basin is similar to that being considered for the upcoming unclassified US Navy submarine operation in the region; he'll ask Marcus Langseth of Lamont-Doherty Earth Observatory to provide a copy of that track to Pogrebitsky.

Gaponenko has been involved in the design and development of geoscientific sensor systems for submarine deployment. His remarks touch upon two categories of instrumentation: equipment which could be installed on a submarine with little or no modification; equipment which would require modifications to the submarine. Compared to the latter, the former are relatively easy and economical.

In the first category of instrumentation, Russian gravimeters are available that feature a .1 to .3 mgal accuracy, and are submarine-deployable. Gravity observations will need to be integrated within an improved gravity network: currently the Russians have only a 'second-class' (equivalent to our second-order?) gravity network in the Arctic, and comparisons between US and Russian data show differences that need to be resolved. Consideration is being given therefore to performing absolute measurements with a 'ballistic' gravimeter. These would be made at key nodes of the underwater transects, in drift stations, and at

various points in Alaska, Arctic Canada, Greenland, and the Russian Arctic islands.

Other systems being proposed are a flow-through apparatus for in-situ measurements of water chemistry (simple to engineer), and a hull-mounted multibeam sounder such as the SeaBeam Model 2000 (apparently not difficult to install on a submarine).

In the second category of instrumentation, a hull-mounted GLORIA-type sidescan sonar is under consideration, as well as a towed low-frequency (2 to 5 kHz) sounder. If a reliable sound source can be devised, a seismic reflection system could also be deployed, featuring a solid-matrix ruggedized hydrophone array with a rectangular cross-section, and which is resistant to damage from ice contact and low temperatures (a sample is produced for inspection and photography); a suitable apparatus for towing and spooling the streamer remains to be designed and constructed. Devices for bottom sampling and even coring are being looked at as well (much more difficult to engineer).

Submarine positions will be derived with an INS, referenced from time to time with GLONASS fixes obtained at the sea surface.

A lot of development work is being done at the Technical University of St. Petersburg. Gaponenko indicates that continuing progress is highly dependent on the acquisition of advanced hardware and equipment (e.g. computers, piezo-electric crystals for proposed acoustic systems, instruments such as gravimeters) and on funding (for instance the compound used to fabricate the ruggedized hydrophone streamer costs about 1 500 000 R/kg).

ST. PETERSBURG: SATURDAY JULY 3

SEVMORGEO

Contracted geophysical surveys and related services

Contacts: Juriy Matveev (Director), Nikolai Rzhevsky (Vice-Director).

SEVMORGEO is an 'Engineering Centre' created as an independent commercial entity upon the re-organization of SEVMORGEOLOGIA; it reports to the Russian Geological Committee. The staff numbers about 200, of which 130 are said to work in geophysics. Its annual budget is in the order of 250 million Rubles.

The Centre's primary focus is the measurement and interpretation of gravity and magnetic data. It is the principal point of contact with Amarok, the Norwegian company that is co-producing a digital data base of Russian aeromagnetic data covering the Barents Sea: Matveev shows a plot of offshore flight lines that completely blanket the region, and offers to instruct Amarok to release a copy of the data for inclusion in the AGC magnetic compilation project.

Matveev also outlines current proposals to improve the magnetic mapping of the Kara, Chukchi and Bering Seas at a 1:1M scale, and to follow up on that with a project for numerical interpretation using techniques developed at the Centre. Money is a problem, and

the Centre is looking for partners who can provide funding. Matveev points out that the Laptev and East Siberian Seas are not well mapped either, and that he's interested in organizing proprietary surveys in those areas. All of the above-mentioned mapping operations, he says, fit in with SEVMORGEO's long-term interest in producing detailed maps of the circumpolar continental shelves.

Matveev outlines the capabilities of their newest aircraft: the IL-38. This was apparently developed as an ASW platform equivalent to the US P3, but the Russian military are now permitting its use on Arctic research missions. Cruising speed is 300 km/hr, endurance is 14 hours. Apparently the aircraft has full magnetic compensation, and is fitted with a 5 m titanium stinger; other characteristics are listed in a Russian spec sheet (Appendix IV). SEVMORGEO propose to install and test a magnetic gradiometer on the aircraft this year, but so far have not received the military's permission to do so. Details are not clear, but apparently the sensor system incorporates cesium and three-component ferrosonde (fluxgate?) magnetometers with correction for aircraft attitude.

The Centre is also interested in aerogravity work, having access to a new quartz gravimeter that was originally developed for military purposes. Test flights are slated for August over a gravity and magnetic range on Lake Ladoga (are these the same tests mentioned by MGPE staff?). These will be conducted on a smaller AN-30 aircraft, which will be completely fitted out with geophysical instrumentation and later deployed on mapping operations in the Chukchi and Bering Seas if the IL-38 is unavailable. Details are hazy, but navigation for these operations will be based on GPS and INS, complemented by Doppler radar; Matveev says they need a better altimeter (it's not clear how they presently measure aircraft height, but Matveev talks about slant radar). The aircraft will be fitted with an active cockpit indicator.

Apparently the Centre has been assigned a new navigation receiver for testing that handles input from 16 GLONASS and 21 GPS satellites, and which feeds into an autopilot; it doesn't sound like the package will be deployed on the above-mentioned trials or surveys.

The Centre has other interests: Rzhesvky describes Ocean Bottom Seismometers that can remain submerged for 30 days at depths of 6000 m. Analog storage capacity is equivalent to 7 gigabytes. The Centre has a/d and other facilities for converting and processing the records. In software development, substantial effort has gone into the creation of routines for managing and displaying the magnetic data base, and for numerical interpretation, i.e. Werner deconvolution, prism models, depth to basement calculations, etc. These capabilities are demonstrated in a brief session, which is quite noteworthy considering that the Centre took delivery of its first computer only three years ago.

VNIIOKEANGEOLOGIA

Canary-Bahamas Geotransect

Contact: Sergei Maschenkov.

Reviews of the paper 'Temporal Variations in the Atlantic Seafloor Spreading Process Between Kane and Atlantis Fracture Zones' by S. Maschenkov, W.R. Roest, J. Verhoef, R.

Macnab, E. Astaphurova, E. Bocharova, and V. Glebovsky came back from the *Journal of Geophysical Research*, just in time for this visit. The reviews are mixed, with one reviewer overall positive and the second very negative. The associate editor concludes that a major revision is needed, and acknowledges the high potential of this contribution.

The main criticism relates to the inclusion of a hand-contoured bathymetric map, without showing the original data. The bathymetric data were considered classified at the time of submission of the manuscript. However, the situation in Russia changes rapidly: the bathymetric data that were used to produce the hand-contoured map are now releasable in digital form, and are given to Roest to produce the final Figure. Other details of the revision are discussed, and adequate actions formulated. Roest will handle revision of the manuscript before the August deadline.

Both parties express an interest in continued research into the oceanic spreading process, ridge axis segmentation and crustal magnetization. Our first joint paper should be followed up by additional contributions in western scientific journals.

Some time is spent discussing the recently collected data under the Canary-Bahamas Geotransect Program. By the end of this 5 month cruise, Maschenkov and his team had produced a complete cruise report of over 150 pages with Figures and large maps, and 2 manuscripts (in Russian). Systematic magnetic profiles are of high quality, and show intriguing features that coincide with significant gravity anomalies. Deep seismic reflection profiles show considerable Moho relief.

US-RF aeromagnetic levelling project

Contact: Vladimir Glebovsky.

Kovacs and Glebovsky draft a working plan for levelling Russian and US aeromagnetic data in areas of overlap (Appendix V). Initial limits for the project are taken to be the union of the two intersecting data sets, though it's appreciated that changes to the Russian navigation will propagate into a wider area. Regarding the probable timing of the Russian data release, Glebovsky and Maschenkov suggest that a date in mid-October is most likely. Finally, provisional plans are made to reconvene at NRL or AGC later this year for a discussion of results.

Arctic Oil & Gas Geology Division

Contact: Mikhael Grigoriev.

Grigoriev is the Division's senior scientist. One of his functions is to oversee the management of offshore and onshore exploration leases granted to Russian and foreign companies. He also develops stratigraphic maps of the continental shelf; among accomplishments to date, he has investigated the stratigraphy of the southeast Barents Sea (in August he'll be presenting a paper on that topic at the Pangea Conference in Calgary), and has prepared 1:2.5M structural maps of the Laptev Sea that extend to within 100 km of the shelf break and which show: (1) the top of the acoustic basement; (2) the bottom of the

Cenozoic; and (3) the bottom of the Neogene. He also has personal interests in the structure and development of the Gakkel Ridge, and serves as the Russian contact person for tectonic issues that interest the IASC Working Group for Marine Geology.

MOSCOW: MONDAY JULY 5

SHIRSHOV INSTITUTE OF OCEANOGRAPHY

Paleoreconstructions, magnetic interpretations, Arctic investigations

Contacts: Boris Baranov, Georg Czerniawski, Oleg Levchenko, Lev Merklin, Elena Pristavakina, Leonid Savostin (Director), Anatoly Schreider, Nikolay Tsukanov.

Baranov and Pristavakina are members of the Paleodynamic Laboratory established by the late Lev Zonenshain. They describe their work in the Arctic Ocean, the Bering Sea and the Russian mainland. An Arctic reconstruction project is underway in collaboration with Harland of the Cambridge Arctic Shelf Project (CASP); a reconstruction atlas of the USSR mainland is also in the works, under Shell and Exxon sponsorship. The results of these activities are not likely to be published for another two years.

A diskette with a digital data base that includes locations and geological characteristics of sutures and other tectonic boundaries on the Russian mainland is provided by Pristavakina; this information is based on a continuation of Lev Zonenshain's work. We are invited to submit contributions to the next Tectonic Conference, to be held in Moscow in November.

Substantial effort is going into the analysis of data from the Komandorsky Basin, near the junction of the Aleutian and Kuril Trenches. Czerniawski shows a map of magnetic anomalies within the Basin and a reconstruction based on identified spreading anomalies. There is a discussion on the possible developmental relationships between this and the adjacent Bower Basin, within the overall context of Aleutian subduction. The team is familiar with Alan Cooper's analysis of magnetic data from Bower Basin; it is suggested that they might find it useful to merge their data with Cooper's in order to expand their investigations to cover a larger region. The digital technology available to the team is somewhat limited, but they may have enough computer power to handle this additional amount of data.

Schreider (who has contributed a small quantity of data to the AGC magnetic compilation project) describes his work with magnetic data in the central basin of the Indian Ocean. He would like to establish contact with Western scientists who share similar interests, with a view eventually to spending time in a Western laboratory to carry out some joint work. We promise to alert Jafar Arkani-Hamed and Jerome Dyment (McGill University, Montreal) of his interests.

In a meeting with Director Savostin, we outline our current interests and invite participation from staff of the Shirshov Institute. Savostin explains how the laboratory's research thrusts are being re-directed away from problems in the world ocean and towards Arctic research,

with significant emphasis on environmental and Global Change topics; he gives us a copy of their proposed new program (Appendix VI). He also talks briefly about an upcoming multinational expedition to the Laptev Sea involving environmental observations by a team of Russian, Norwegian and US on a Russian vessel with the objective of determining the distribution and dispersal of radioactive wastes.

In other discussions, Tsukanov outlines his work on accretion in the Kamchatka arc, while Merklin and Levchenko describe the results of their seismic investigations in the Indian Ocean and the Barents & Kara Seas. Their seismic data mainly consist of single channel reflection and 3.5 Khz echosounder profiles, collected at relatively high ship speeds. In the Indian Ocean, the data provide valuable information on the mode of intraplate deformation west of the 90° East Ridge, previously recognized from satellite altimeter data and earthquakes. Over the Arctic shelf regions, they map buried rivers and erosion channels.

MOSCOW: TUESDAY, JULY 6

SHIRSHOV INSTITUTE OF OCEANOLOGY

Results of recent investigations

Contacts: Lazar Kogan (Vice President, Black Sea Branch), Leopold Lobkovsky (Deputy Director Research and Leader Arctic Geodynamics Project), Alexey Ostrovsky.

Lobkovsky outlines his research interests in geodynamic modelling, including mantle convection and rifting. He has an impressive list of papers published in western journals, and cooperates with several western scientists, such as Sierd Cloetingh (Free University, Amsterdam).

He also explains efforts to produce a special volume of Tectonophysics as a follow up to the last Tectonics conference, this volume being dedicated to the late Lev Zonenshain. He will discuss with his co-editor (Academician Milanovsky, Moscow University) whether a contribution from our side could be incorporated if we had any interest in doing so.

The discussion of the new Arctic program is relatively vague, it being pointed out that the program is highly multidisciplinary, including global change, physical parameters, geology, biology etc.

Kogan describes the multi-institute (14) initiative to collect and process wide angle reflection seismic data (WASP) to study the structure of the crust under continents, shelf regions and inner seas. An important step is the collection of wide angle reflection data with a single ship. This is accomplished by towing a streamer attached to a buoy at a distance of about 6 km behind the ship; a 100-120 litre airgun (5-12 Hz source) is used for simultaneous reflection and refraction observations. Initially, major technical problems were to determine the exact location of the buoy, and to cope with noise in the cable. The first problem was solved by using a SYNTRAC positioning system (a company in Houston, TX), the second by using a floating fiber optic cable. Results obtained over the Blake-Spur fracture zone during

the latest Canary-Bahamas cruise show Moho at 10+ seconds depth, not 7 as previously reported by Mutter of LDEO; this suggest a large region of serpentinized lower crust in the fracture zone, as opposed to very thin crust. The data have been sent to Mutter for discussion.

Results from Kane FZ are also discussed, including measured crustal thicknesses of over 5 km on either side of the FZ, but only 3 km down the axis, with a very rapid transition between the two regions. All the data is said to be in digital "SEG-Y" format. The Russians are keen to enlist western participation in cooperative data processing and analysis. The lack of funds for seismic data processing is the major problem and many of the records we see are brute stack sections.

Kogan and Lobkovsky also have interests in global change issues (possibly as a result of real and perceived changes in western funding toward this issue?). Historically, the Institute's interests were global, but due to severe funding problems they are now much more territorial. For example we're shown an interesting report on rifting in the western Siberian rift zone.

Ostrovsky provides reprints and discusses some recent OBS results. He's planning to visit Keith Louden (Dalhousie University, Halifax) and possibly the Pacific Geoscience Centre (Sidney, British Columbia), for a total period of 3 months. His interests are oceanic seismicity and OBS investigations. We promise to make initial contacts on his behalf with PGC.

MOSCOW: WEDNESDAY, JULY 7

VERNADSKY INSTITUTE OF GEOCHEMISTRY

Contact: Gleb Udintsev.

Russian-American submarine project

Well-known geomorphologist and structural geologist Udintsev describes two important internal situations that are slowing progress in the proposed Russian-American submarine project. Firstly: volatile political and military circumstances in the south of the former USSR are delaying a proposed meeting in Washington between the Russian Minister of Defence and the U.S. Vice-President, at which time the accord to proceed with the project is to be formally sealed. Secondly: at least two ministries are vying for authority over the project, resulting in fragmentation of Russian efforts and the spectre of exclusion for scientists who are associated with the wrong ministry.

While the project is slated for discussion at the July 14 meeting of the US-RF Commission, Udintsev sees no early solution to either situation.

Investigations in the Equatorial Atlantic

Udintsev explains the situation with respect to release of magnetic data obtained during the course of two major mappping expeditions in the equatorial Atlantic aboard the NIKOLAI

STRAKHOV. He reports that the data were collected in digital form by IZMIRAN staff who provided equipment and expertise, but that various circumstances have delayed analysis of the data and the preparation of a report for publication. He invites Western participation in the processing and analysis of the data, suggesting that a direct approach to IZMIRAN's Director might secure release of the data where his own efforts have failed.

At his home later that day, Udintsev reviews detailed and good-quality plots of the various parameters that he's measured in the equatorial Atlantic: multibeam bathymetry, magnetics, gravity, and sediment thickness. He points to several factors: the morphological fabric of the sea floor; the exaggerated width of a feature that he's named the Strakhov FZ; very thin crust at the ridge-transform intersection; magnetic lineations that parallel the FZ; evidence of subduction-like seismic activity beneath the Ridge axis; the recovery of 'tectonic breccia'; and evidence of uplifted blocks. He admits to considerable perplexity in the analysis of these observations: unable to reconcile them with accepted models of sea floor spreading, he speculates on the possibility of crustal extension perpendicular to the spreading direction, or on uplift due to mantle activity. He recognizes the irony of his position: as one of the early Russian adherents to the the theory of plate tectonics, he now finds himself considering a contradictory hypothesis in explaining the history of the sea floor in this particular study area.

Udintsev also talks about plans to shift his team to the Shirshov Institute, where he's been promised ship time (Director Savostin is a former student of his). He asks about prospects for collaboration under the terms of the agreement signed in May between the Shirshov and the International Marine Biodiversity Development Corporation of Dartmouth, NS.

SHIRSHOV INSTITUTE OF OCEANOLOGY

Oceanic magnetic anomalies

Contact: Alexander Gorodnitski.

With time running out, we manage a short conversation with Alexander Gorodnitski, head of the Institute's Geomagnetism Group; respected throughout Russia as a geomagnetist, he's also a poet and songwriter of note (thirty years ago after visiting Halifax aboard the KRUZHENSTERN, he composed 'The Sky is Blue Over Canada', which became a hit in Russia). He presents a copy of his new book 'The Magnetic Field of the Ocean' (in Russian) and advises that the English language version is in the final stages of publication; he expresses appreciation for liaison provided by AGC in getting this version to press. He also expresses interest in collaborating in the analysis and interpretation of marine magnetic data.

FEDERAL COMMITTEE FOR GEODESY AND CARTOGRAPHY

Availability of Russian gravity data for joint mapmaking

Contacts: Nikolai Makarenko, Evgeniy Zhalkovsky, A.N. Other

Accompanied by Udintsev and Baranov who serve as translators, we describe our interest in establishing a collaboration for the development of gravity maps of northern Russia and the

Arctic Ocean, as well as for filling major blanks in the gravity map of the world. Given the Committee's geodetic mandate, we spend considerable time discussing measurement accuracy, spacing, and scale of presentation, explaining that our regional research objectives permit us considerable latitude for compromise on such factors.

Committee members explain that gravity data over the territory of the Former Soviet Union is still classified, and that questions relating to release and exchange need to be handled with sensitivity. It appears however that observations averaged over a 100-km grid could be made available as an opening gesture, and that further progress would depend on progressive data de-classification and other developments. Committee members appear to understand our objectives, and seem prepared to be supportive if proper procedures are adhered to.

Committee members agree with our assessment that the meeting has served an important initial objective, which is to re-affirm the contact established last year on our behalf by Leo Sayn-Wittgenstein of the Canada Centre for Remote Sensing. We also agree it's important to maintain this contact through continuing exchange of information; we will follow up with a formal proposal for collaboration, including a detailed definition of objectives and a description of North american gravity data that is presently in the public domain.

A description of NRL's aerogravity capability is met with considerable interest; even though this information is published, it appears as though this may be the first time they've ever heard about it from a US source, if at all. Copies of pertinent reprints are promised.

SOME OBSERVATIONS AND RECOMMENDATIONS

During our nine days in Russia, we estimate that we've met and spoken to nearly fifty persons from twelve different scientific organizations. Practically without exception, we find that our Russian contacts are eager to enter into cooperative relationships with their Western counterparts, either as collaborators working on an equal scientific footing, or as purveyors of data and related services in consideration of financial support or outright payment. Interest in the latter sort of arrangement is due of course to the intense pressure being placed on many Russian organizations to adopt an entrepreneurial approach in developing client bases and in becoming self-supporting. Western laboratories that seek to initiate collaborative projects should be prepared therefore to offer something of value in return for Russian participation in joint undertakings: this could take the form of purchase agreements, technological transfers (particularly in computer hardware and software), or financial support for international travel by specific individuals.

In many discussions, data and technology are described as being formerly under the control of the Russian military, but with varying degrees of restriction they can now be shared with Western investigators. Clearly these are resources that can be best exploited in concert with knowledgeable Russian partners who are already familiar with the data and potential applications. Western investigators who decide to take advantage of this new openness could well find themselves the beneficiaries of significant information breakthroughs or of important technological advancements.

Where research has not been subject to military restrictions, Russian scientists appear to have

achieved high publication rates in their periodical literature or in specialized monographs. Much of this published material is significant, and would be of interest to Western investigators if a way could be found to communicate the information in a timely and readable fashion. Unfortunately, it's likely to be a while before proficiency in Russian among Western investigators matches proficiency in English among their Russian counterparts. At present there exist some specialized bibliographic, search, and translation services that provide access to the mainstream Russian publications, but much of the gray literature (institutional reports, conference proceedings, etc.) seems to remain beyond Western reach. Western researchers would likely find it worth their while to promote the development of additional services that would facilitate access to this rich body of auxiliary information. Also, Westerners with special interests would find it useful to learn at least the rudiments of Russian, to the point where they can pick up a Russian paper and get the gist of its title, abstract, and figure captions.

In a related vein, the libraries in Russian institutions are not immune to the financial pressures that afflict their Western counterparts, with the result that Western scientific periodicals tend not to be readily accessible to the general research population in Russia. For instance, a researcher in one Moscow laboratory explains how he has to make a 40-minute trip by Metro to a central library in order to access a fairly complete collection of current Western periodicals. Add to this a general shortage of copying machines, and it becomes understandable that Western advances may be receiving little notice in many Russian laboratories. A cooperative program to equip Russian institutions with traditional microfilm and newer CD-ROM archival systems (and perhaps copying machines?) could help close this information gap.

Internal and external communication remains a challenge for many who toil in Russian research institutions. In the past couple of years, some of the Russian organizations that we deal with have implemented connections to Internet, and this has significantly improved our ability to exchange data and information in a timely and reliable fashion. Undoubtedly, tremendous advantages would be realized if more laboratories and investigators could be similarly connected to this communications medium. By partaking fully in this new form of global information exchange, Russian scientists could: (a) keep abreast of developments elsewhere; (b) inform others of progress in their own research; (c) explore opportunities for joint work; and (d) exchange data and other information necessary for long-distance collaboration.

An objective of this visit was to continue previous discussions on the feasibility of a joint Russia-US-Canada program for mapping the regional magnetic and gravity fields of the central Arctic Ocean by aircraft. While specific and proposed airborne mapping operations were discussed on several occasions and in several laboratories, consideration of a joint mapping program was deferred for the time being in the light of current efforts to mobilize the proposed Russian-American submarine project. Clearly, it would be more effective to develop plans for concurrent airborne mapping operations in conjunction with the submarine initiative, if the latter should become reality.

TOPICS FOR FOLLOW-UP ACTION

In many of the contacts and discussions described in this Report, we have identified a need for follow-up action through correspondence or additional exchanges of information. The following items (in no particular order of priority or importance) will need attention if the benefits of the visits are to be fully realized:

- Provide liaison for Solovieva of VSEGEI concerning acess to data sets from Greenland and the South Atlantic, to include in her Magnetic Map of the World;
- Obtain information from Litvinova of VSEGEI on methodology and results of levelling the magnetic field of the Taymir Peninsula, to incorporate if possible in the AGC compilation data base;
- In conjunction with Norm Cherkis of NRL, investigate opportunities for accessing Arctic bathymetric data held by the HDNO of the Russian Navy;
- Explore possibilities for collaboration with GRC Tethys with a view to including new Russian aeromagnetic data in present and future compilations;
- Discuss proposals to revise present scope of Project 9 of the Russia-Canada Exchange Agreement (Crustal Thickness Map of the Arctic), and to define more practicable objective(s);
- Establish working rapport with Kiselev of VNIIOkeangeologia in order to develop a mutually beneficial strategy for accessing his Arctic seismic archives;
- Investigate options for accessing Arctic and North Atlantic magnetic data held by Sochevanova and Kolesova of SPbFIZMIRAN, within a collaborative framework;
- Maintain liaison with Mars Technology as potential partners in joint work with Russian associates where digitizing or other specialized data handling services may be required;
- Exchange information with MGPE investigators concerning availability of new mag & grav survey data and geotransect information;
- Amend the new Magnetic Anomaly Map of Russia by Pogrebitsky et al to reflect arrangements agreed to in Gramberg's discussions with VSEGEI;
- Communicate with Gramberg concerning nomination of Russian representative on executive of IASC Working Group for Geophysical Compilation and Mapping;
- Organize and execute joint work in US/RF project to relevel Arctic aeromagnetic data;
- Discuss scope and objectives of new mapmaking projects with VNIIOkeangeologia and develop work plan;

- Maintain liaison and general awareness of progress in mobilizing proposed Russian-American submarine project; Contact Marcus Langseth of LDEO to provide a copy of planned US submarine track to Pogrebitsky.

- Liaise with SEVMORGEO and Amarok concerning access to Barents Sea aeromagnetic data for inclusion in AGC compilation data base;

- Maintain liaison with SEVMORGEO regarding proposals for continental shelf potential fields mapping and for possible linkages to Arctic 95;

- Advise interested industry associates of current Russian studies on the stratigraphy of the Barents and Kara regions;

- Provide liaison to facilitate access by investigators of the Shirshov Institute to existing magnetic data from the Bering Sea and the northwest Pacific;

- Develop contacts suggested by Udintsev for obtaining magnetic data from the Equatorial Atlantic;

- Develop working relationship with the Federal Service of Geodesy and Cartography of Russia with a view eventually to exchanging gravity data from Arctic onshore and offshore regions, and to cooperating in filling gaps in the Gravity Map of the World;

- Investigate prospects for scientific cooperation with the Shirshov Institute under the terms of the recent Agreement between the Shirshov and the International Marine Biodiversity Corporation of Dartmouth, NS.

APPENDIX I

List of contacts

VNIIOkeangeologia
All-Russian Research Institute for Geology and Mineral Resources of the World Ocean
1, Maklina Pr.
190121 St. Petersburg, Russia
E-mail: ocean@sovam.com (Sergei Maschenkov and team)
TELEX: 121430 ONICS

Name, Position	Telephone	Fax	Interests
Dr. Georgiy I. Gaponenko, Vice Director	(812) 210 9191		Submarine technology
Dr. Vladimir Glebovsky	(812) 210 9693 W	(812) 312 9385	Magnetic Processing and Interpretation
Academician I. Gramberg, Director			
Dr. Mikhail N. Grigoriev	(812) 210 9764	(812) 113 1470	Geology Division, Arctic oil and gas
Ms. Maria Ivanova	(812) 312 5514 W (812) 174 5113 H	(812) 312 5173	Translator
Prof. Yuri Kiselev			Arctic Seismic refraction/reflection
Dr. Michael Kosko	(812) 210 9410		Russia-Canada Exchange coordinator
Ms. Ludmila A. Kovalyova	(812) 219 5064		Information Department, translator
Dr. Sergei Maschenkov	(812) 210 9693 W (812) 293 2448 H	(812) 232 6690	Canary-Bahamas Geotransect, Multiparameter mapping, Arctic Ocean
Dr. Posyolov, Chief Engineer	(812) 219 5016		
Prof. Yulian Pogrebitsky	(812) 214 1636	(812) 232 6690	Tectonics
Dr. Valentina Verba		(812) 232 6690	Arctic Geophysics
Dr. Vjatcheslav Volk		(812) 232 6690	Arctic Crustal Thickness

VSEGEI
All-Russia Geological Research Institute
Sredny Prospect 74
199026 St. Petersburg
Russia

Name, Position	Telephone	Fax	Interests
Dr. Tamara Litvinova		(812) 291 4345	Editor, Russian Aeromagnetic Map Series
Dr. Valentina Solovieva		(812) 291 4345	Editor, World Magnetic Map
Foreign Relations Department	(812) 218 9202	(812) 213 5738	Maps and other requests

Head Department of Navigation and Oceanography
Ministry of Defence
8, 11 Liniya
199034 St. Petersburg
Russia
Telex: 121531 NAVIO SU

Name, Position	Telephone	Fax	Interests
Captain Andrey Popov	(812) 277 4362		Staff Officer, Bathymetry
Captain R. Mikhaelov			Staff Officer
Captain Vadim M. Sobolev	(812) 213 8109	(812) 213 7548	International affairs advisor
Vice Admiral Yuri I. Zheglov, Chief	(812) 213 7229	(812) 213 7548	Hydrography, seismo-acoustics

Geodynamical Research Center Tethys
24-1 Odoyevsky str.
199155 St. Petersburg
Russia

Mailing Address:
P.O. Box 788
199155 St. Petersburg
Russia

Name, Position	Telephone	Fax	Interests
Prof. Sergei Aplonov, Director	(812) 352 3018 (812) 352 3022	(812) 156 0522 (812) 352 2407	Exploration, Marine Geophysics, Geophysical databases, Magnetics and Gravity

MARS Technology
P.O. Box 90
197342 St. Petersburg
Russia
Telex: 121345 PTB SU

Name, Position	Telephone	Fax	Interests
Dr. Oleg A. Chirkov, Chief Geophysicist	(812) 224 3339	(812) 312 4128	Geophysical software and services
Dr. Yuri V. Filippov, Vice-President	(812) 311 1053	(812) 312 4128	

SPbFIZMIRAN
St. Petersburg Branch of Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation
23, Line 2
199053 St. Petersburg
Russia

Name, Position	Telephone	Fax	Interests
Dr. Valerie Carmonov (?)			
Dr. Valentina I. Kolesova, Head Magnetic Cartography	(812) 272 1234		Magnetic data base development, numerical analysis
Dr. Sergei Mercuriev			Plate kinematic reconstructions, seafloor spreading lineations
Dr. Nellie Sochevanova	(812) 246 0358 W (812) 291 4345 H	(812) 218 4172	Magnetic mapping in northwest Indian, north Atlantic and Arctic Oceans

Magnit Company (VNIIOkeangeologia)
Zaharyoska Street, 29
St. Petersburg
Russia

Name, Position	Telephone	Fax	Interests
Dr. Igor Balashov	(812) 275 104		High-level Arctic aeromagnetic surveys
Dr. Victor Kalinin	(812) 275 104		High-level Arctic aeromagnetic surveys

Polar Marine Geological Survey Expedition
The Russian Ministry of Geology
24 Pobedy St.
189510 St. Petersburg - Lomonosov
Russia
Telex: 121345 LENTG SU for TOPOC 309145

Name, Position	Telephone	Fax	Interests
Dr. Balyutin			Aeromagnetic surveys
Dr. Nicolay Grupen			Aeromagnetic surveys
Dr. Vladimir D. Kryukov, Director of Geology, Director of Expedition	(812) 422 1282	(812) 423 1900	
Dr. Yuriy Pavlov			Arctic Geotransect
Dr. Yury Semenov	(812) 422 1282	(812) 423 1900	
Dr. Micheal M. Seryakov	(812) 422 1282 (812) 422 0494	(812) 423 1900	Chief Engineer

SEVMORGEO
36, Rozensteina Str.
198095 St. Petersburg
Russia

Name, Position	Telephone	Fax	Interests
Dr. Juriy Matveev, Director	(812) 252 6767		Magnetic and gravity mapping, Arctic Shelf
Dr, Nikolai Rzhevsky, Vice-Director	(812) 252 6767	(812) 252 4416	Analysis and interpretation techniques

Russian Academy of Sciences, P.P. Shirshov Institute of Oceanology
23 Krasikova st.
117851 Moscow
Russia
Telex: 411968 OKEAN SU

Name, Position	Telephone	Fax	Interest
Dr. Boris Baranov	(095) 124 7942 W (095) 271 3196 H		Plate tectonic reconstructions of Arctic, Continental tectonics, Sutures and boundaries
Dr. Georg Czerniawski			Komandorsky Basin
Prof. Alexander Gorodnitski	(095) 433 6735		Marine magnetics
Dr. Lasar Kogan, Vice-president, Black Sea Branch			Single ship Wide Angle Seismic Profiling, Crustal structure, Seismic processing
Dr. Oleg Levchenko			Intraplate Deformation, Indian Ocean
Dr. Leopold I. Lobkovsky, Leader of Arctic Project, Deputy Director	(095) 129 2181		Geodynamic modelling, convection, rifting.
Dr. Lev Merklin	(095) 124 7396 W (095) 128 4375 H	(095) 124 5983	Single Channel Seicmics, Indian Ocean, Arctic Shelf Erosion and intraplate deformation
Dr. Alexey A. Ostrovsky			Ocean bottom seismometers (Keith Louden)
Dr. Elena Pristavakina	(095) 124 7942	(095) 124 5983	Plate tectonic reconstructions of Arctic, Continental tectonics, Sutures and boundaries
Dr. Leonid Savostin, Director			Plate Tectonics
Dr. Anatoly A. Schreider	(095) 129 2181 W (095) 930 7594 H		Magnetic Interpretation, Indian Ocean
Dr. Nikolay Tsukanov	(095) 124 5983		Accretion Kamchatka Arc

V.I. Vernadsky Institute of Geochemistry
Russian Academy of Sciences
19, Kosygin str.
117975 Moscow
Russia
Telex: 411633 TERRA SU

Name, Position	Telephone	Fax	Interests
Dr. Gleb B. Udintsev	(095) 210 2722 H	(095) 938 2045	Structural geology, geomorphology, Equatorial Atlantic

Federal Service of Geodesy and Cartography of Russia
2 korpus
14, Krzhizhanivskogo street
117801 Moscow
Russia
Telex 411222 KARTA SU

Name, Position	Telephone	Fax	Interests
Dr. Nikolai Makarenko, Director	(095) 456 9127	(095) 456 9371	Gravity mapping (Central Research Institute)
Dr. Evgeniy Zhalkovsky, Deputy Head	(095) 124 3381	(095) 124 3535	Geodesy and gravity data

Potentially useful contacts in Russia:

Travel/Hotel arrangements etc:

Igor Korneev, Director
KL Service Limited
6-3-499 Akademika Anokhina St.
117602 Moscow
Russia
Fax (7) 095 292 6511

APPENDIX II

Kiselev equipment request

(not available in computer-readable form)

for dr.KISELEV (Russia,Sankt-Petersburg)

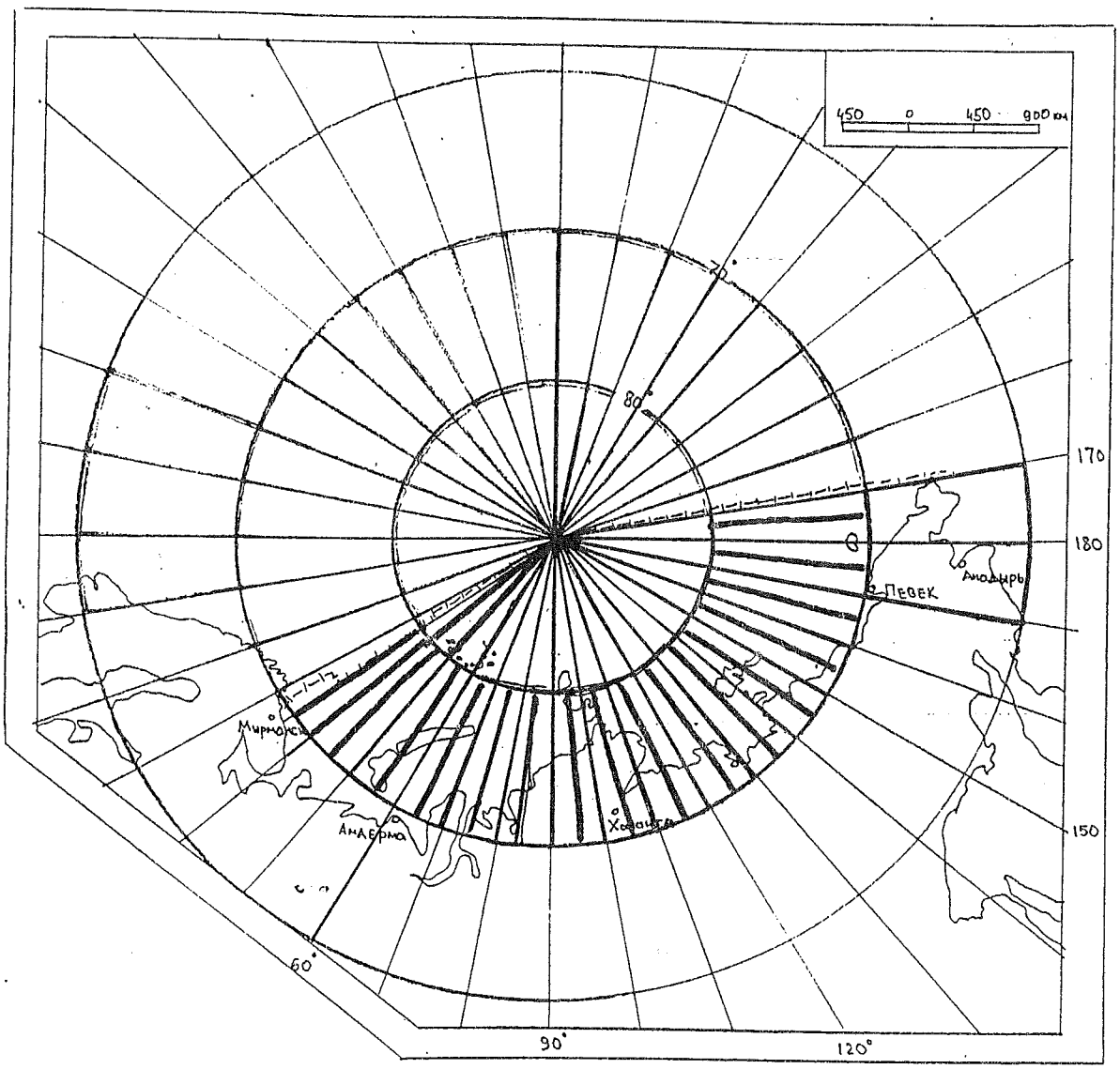
Item	Product Number	Diskription	Qty	Unit Price	Extended Price (US $)
1	4/50FGX--16-P40	SPARCstation IPX, Desktop Workstation GX 8-bit Accelerated 2-D/3-D Color Graphics 16-inch Color Monitor, 16-Mbyte,207-Mbyte Internal SCSI Disk, 1.44-Mbyte 3.5-inch Internal Floppy Drive	3	17,544	52,632.00
2	X116U	SPARCsystem IPX 16-Mbyte Memory Expansion (16-Mbyte SIMMs)	3	4,550	13,650.00
3	X2003U	SPARCserver IPX File Server Option Pack, 1.3-Gbyte SCSI Disk, 2,3-Gbyte 8 mm Tape Backup Drive,644-Mbyte Desktop SunCD Pack	1	12,344	12,344.00
4	SPRN-400	SPARCprinter Laser Printer,SBus Printer Card,NeWSprint 1.0 Software,10-meter SPARCprinter cabel, Adjustable Paper Tray, Toner and Drum	1	3,504	3,504.00
5	SPRN-TONER	Toner Catridge for SPARCprinter	1	254	254.00
6	SX-21	SunOS Software,CD-ROM All SPARCsystem	1	260	260.00
7	SS-23	System Software Answer Book online documentation.Includes CD-ROM and RTU for 1 system.Online doc for SunOS,Open Windows,Desktop SPARC Owner Sets,plus easy-to-use navigation and viewing app.with WYSIWYG view, hypertext,quick search, prinring.SPARC-only requires SunOS 4.1.X and OpenWindows V2.	1	644	644.00
8	THIN	Ethernet Transeiver with 15-meter Branch Cable and Thin Ethernet BNS Connectors	3	390	1,170.00
9	TT-M	Thin Ethernet Terminators (Qty.2)	1	46	46.00
10		DBMS ORACLE	1	8,000	8,000.00
11		GIS ER Mapper 3.0	1	19,500	19,500.00
12		Others (modem,fax, PC/AT 486 DX2 ...)		3,000	3,000.00
		Total:			115,004.00

APPENDIX III

Magnit Co. flight lines

(not available in computer-readable form)

Cheme of the base route in the SLO.



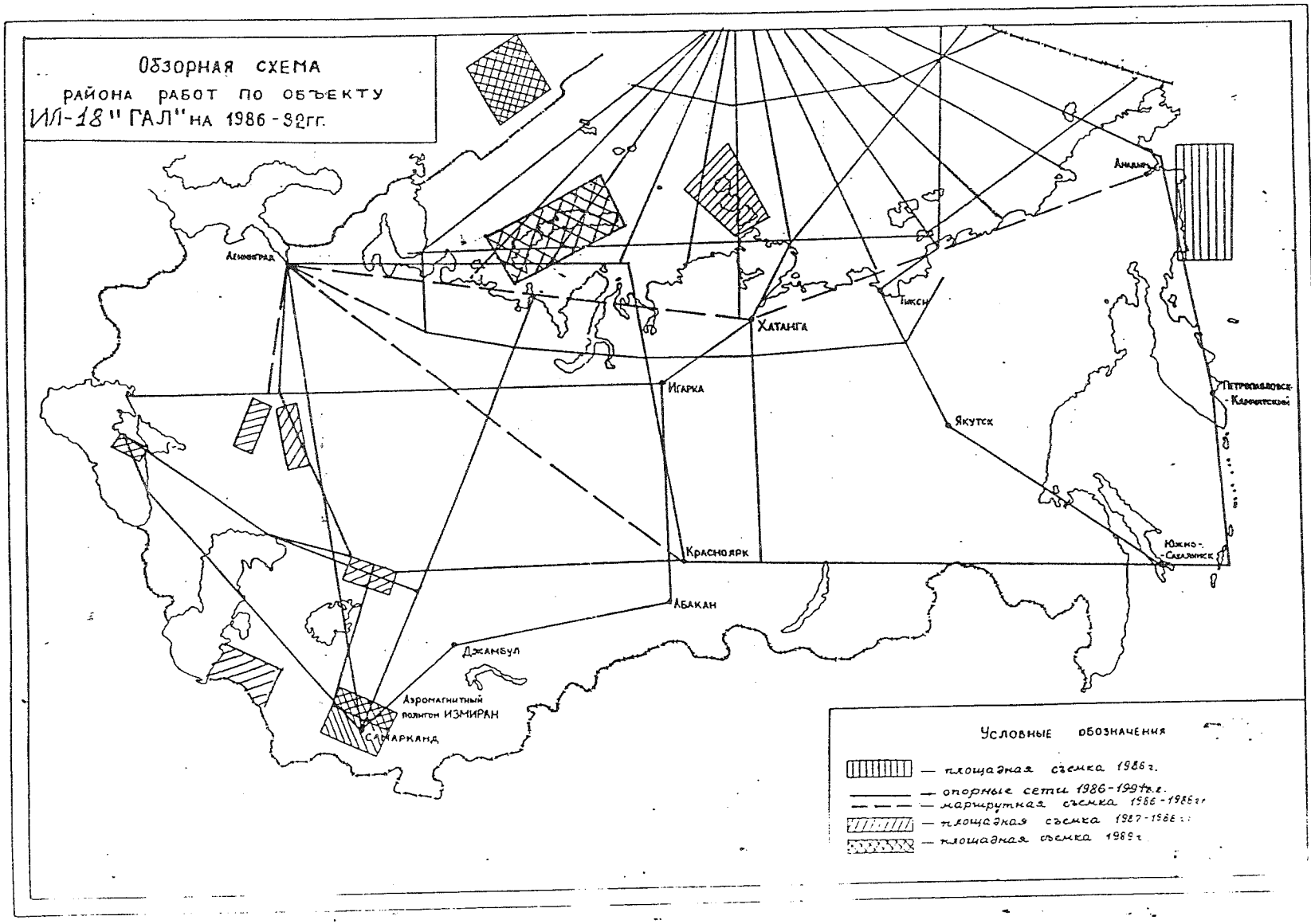
Base route (already done)

~~other route~~ (planned)

Aerogravimagnetic survey, 1991. (Aircraft - „Ilyushin-18",
Flying altitude - 6000meters.

Adress:

Dr. V.K. Palamarchuk
Zaharyevska street, 29
VNII Oceangeologia
MAGNIT
St. Petersburg
Phone № 2795104


Обзорная схема
района работ по объекту
ИЛ-18 "ГАЛ" на 1986-82гг.
Ленинград
Хатанга
Тикси
Игарка
Якутск
Анадырь
Петропавловск-Камчатский
Южно-Сахалинск
Красноярск
Абакан
Джамбул
Самарканд
Аэромагнитный полигон ИЗМИРАН
Условные обозначения
— площадная съемка 1986 г.
— опорные сети 1986-1994 гг.
— маршрутная съемка 1986-1988 гг.
— площадная съемка 1987-1988 гг.
— площадная съемка 1989 г.

APPENDIX IV

IL-38 specifications

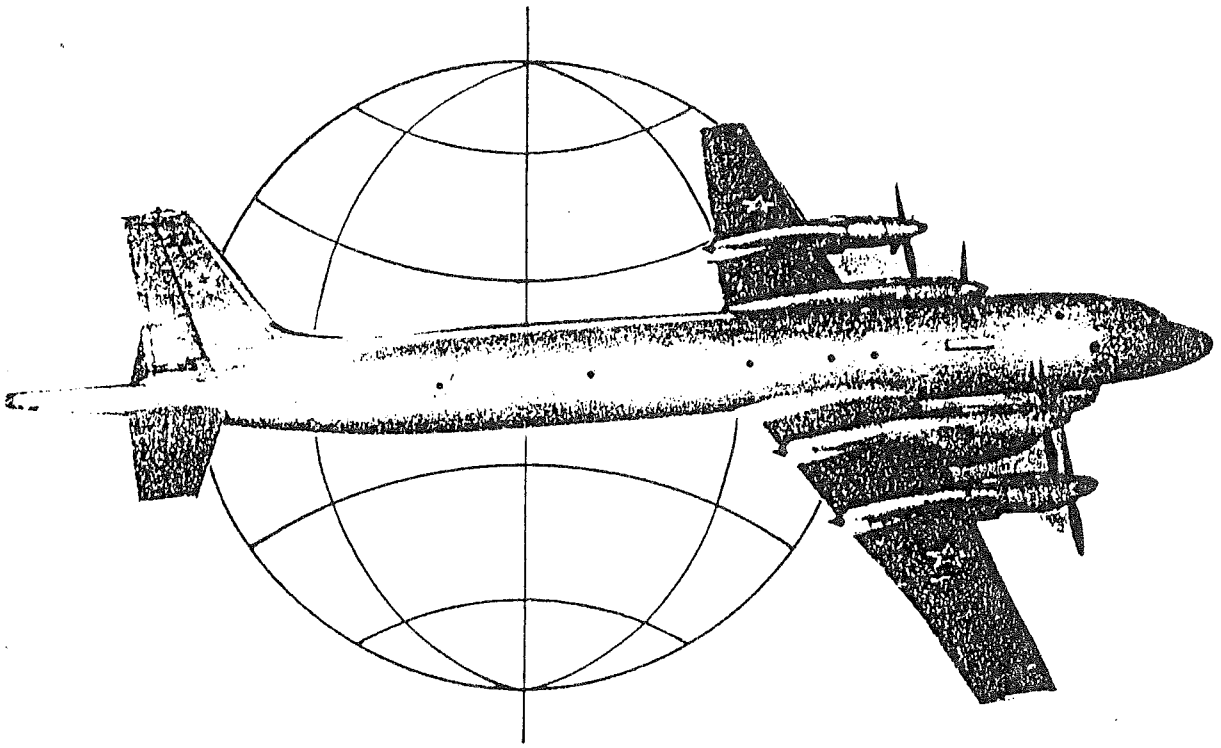
(not available in computer-readable form)

Холдинговая компания «ЛЕНИНЕЦ»
Научно-исследовательский иститут системотехники

Комитет РФ по геологии и использованию недр
ГП «СЕВМОРГЕО»

АО НИИС

ИЗМЕРИТЕЛЬНЫЙ КОМПЛЕКС АЭРОГЕОФИЗИЧЕСКОЙ РАЗВЕДКИ «ИКАР»



СПУТНИКОВАЯ НАВИГАЦИЯ

АЭРОМАГНИТНАЯ СЪЕМКА ВЫСОКОЙ ТОЧНОСТИ

ИЗМЕРЕНИЕ ВЕРТИКАЛЬНОГО ГРАДИЕНТА МПЗ

ГРАВИМЕТРИЧЕСКИЕ ИЗМЕРЕНИЯ С АЛЬТИМЕТРИЕЙ

ПРОДОЛЖИТЕЛЬНОСТЬ ПОЛЕТА - 14 ЧАСОВ

САНКТ-ПЕТЕРБУРГ 1992

ПЕРСПЕКТИВЫ РАЗВИТИЯ ИКАР

Для проведения экологической съемки в состав ИКАР предполагается включить дистанционный оптический комплекс в составе:

-Сканирующий радиометр	- спектральный диапазон	8.0-13.0 мкм (3.5-5.2 мкм)
	- порог чувствительности	0.01-0.03
	- разрешающая способность	3 мрад
-Дистанционный ИК-радиометр	- спектральный диапазон	7.5-14 мкм
	- порог чувствительности	0.02-0.03
-Фотометр спектральной яркости (6 каналов)	- спектральный диапазон	460-680 нм
	- ширина канала	5-12 нм
-Спектральный сканер (4 канала)	- спектральный диапазон	460-800 нм
	- ширина канала	5-12 нм

Для работ в районах Арктики и Антарктики предполагается установить ледовый локатор ЛЛ-5000 измеряющий толщину льда до 4.5км с погрешностью 5%.

Научно-исследовательский
институт системотехники
192102, г.Санкт-Петербург,
ул.Бухарестская, д.24, НИИС
телетайп: "СПИН", 122166
телефон : (812) 268-39-82

ГП "Севморгео"

198095, г.Санк-Петербург,
ул.Розенштейна, д.36.
телетайп: СПб 95 "Севморгео"
факс : (812) 252-44-16
телефон : (812) 252-67-67

ОСНОВНЫЕ РЕГИСТРИРУЕМЫЕ ПАРАМЕТРЫ

Наименование параметра	Частота обновления информации	Диапазон измерения
Полное магнитное поле	2/с	20000-70000 нТл
Полное магнитное поле	287/с	20000-70000 нТл
Составляющие МП по осям X,Y,Z	256/с	+/- 65000 нТл
Сила тяжести	5/с	+/- 50 Гал
Координаты	1/с	0-180 Град
Курс	1/с	0-360 Град
Время	1/с	24 ч
Параметры полета (высота, скорость, эволюции)	4/с	...

ТОЧНОСТНЫЕ ХАРАКТЕРИСТИКИ КОМПЛЕКСА

Статический фон магнитометра в полосе 1 Гц - не более 0.01 нТл
Динамический фон магнитометра в полосе 1 Гц - не более 0.02 нТл
Предельная скорость изменения магнитного поля - не менее 1000 нТл/с
Чувствительность датчиков 3-х компонентного феррозондового магнитометра - 8 нТл
Точность измерения силы тяжести - 2.5-3 мГал
Погрешность радиовысотометра - 1.5м+0.015Н
Погрешность навигации - +/- 10м

ТАКТИКО-ТЕХНИЧЕСКИЕ ДАННЫЕ САМОЛЕТА ИЛ-38

Продолжительность полета - 14 ч
Минимальная высота полета при съемке над акваторией - 60 м
Скорость на съемке - 360 км/ч
Крейсерская - 650 км/ч

Самолет сконструирован с учетом установки в немагнитных обтекателях двух высокочувствительных датчиков магнитометров. Один из них установлен в хвостовой части самолета. Другой на кромке киля. База между датчиками 6,5 м.

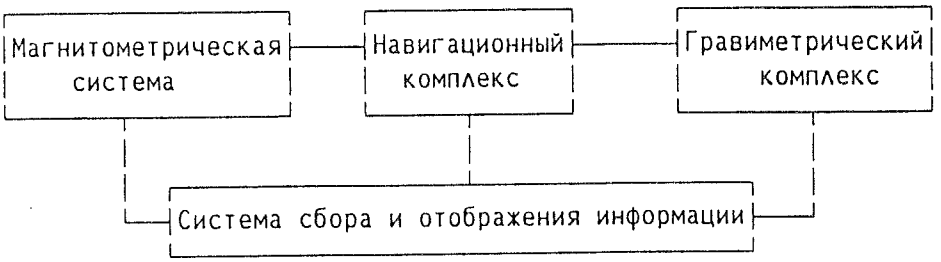
Результаты измерений регистрируются на магнитные накопители с возможностью обработки на IBM-совместимых компьютерах, а так же на магнитную ленту бортового накопителя "Узор-2В". Выходная информация комплекса представляется в виде магнитных и гравитационных потенциальных полей различных масштабов.

В герметичном отсеке предусмотрены рабочие места для четырех операторов.

Самолет сертифицирован для полетов с аэродромов на территории России и за рубежом.

Икар создан на базе морского патрульного самолета ИЛ-38 и предназначен для аэрогеофизических и научно-исследовательских работ над акваторией и сушей.

Состав ИКАР



Магнитометрическая система	- Два квантовых магнитрометра - Трехкомпонентный феррозондовый магнитометр
Навигационный комплекс	- Многоканальные спутниковые приемоиндикаторы NAVSTAR и А-724 - Радиосистема А-723 - Инерциальная система И-21 - Радиовысотометры РВ-21 - Доплеровский измеритель скорости и сноса
Гравиметрический комплекс	- Гравиметры с различными чувствительными элементами - Струнные измерители вертикальной скорости - Баровысотометр - Наружный и внутренний термометры
Система сбора и отображения информации	- Бортовой комплекс "Гамма" - Бортовой накопитель "Узор-2В" - Бортовая ЦВМ 80-400 - ЭВМ типа IBM PC для визуализации, первичной обработки и записи информации - ЭВМ типа IBM PC, используемая в качестве курсопрокладчика с выносным монитором для экипажа

APPENDIX V

US/RF joint project for aeromagnetic data levelling

A JOINT US/RF PROJECT

"The Adjustment of Aeromagnetic Data in the Deep Amerasia Basin for Mapping and Geological Interpretation"

The Object of the Investigation:

We seek to adjust the navigation and levelling of aeromagnetic profile data collected by the United States and by Russia in the Amerasia Basin, the deep Arctic basin bordered by Lomonosov Ridge and by the continental shelves of Siberia, Arctic Canada, and northern Alaska, in order to provide a unified, high quality data set for use in Arctic magnetic anomaly compilations, and for use in new geological and geophysical interpretations.

Scientific Reasons:

The evolution of Amerasia Basin is widely considered by eastern and western scientists to be one of the last remaining first-order problems in marine geophysics. In comparison to temperate oceans, the logistical difficulties of Arctic geophysical studies, combined with the nature of the basin and its associated ridges, has resulted in the origin and evolution of the region remaining the subject of strong scientific debate, particularly in contrast to the neighboring Eurasia Basin. Theories have been proposed by numerous investigators for the evolution of the Canada Basin, Alpha and Mendeleev Ridges, Makarov and Podvodnikov Basins, and the ridges and basins of Chukchi Cap, but none have gained the wide spread acceptance typical of theories for the evolution of other marine regions. The recent rapprochement of Russia with the west has made a wealth of data and scientific expertise available for the first time. One of the results of this is the recent collaboration of Russian scientists with Canadian colleagues from the Atlantic Geoscience Centre (AGC) in the production of a new Arctic magnetic anomaly compilation. Comparison of the contour/isoline magnetic data contributed by the scientists of VNIIOkeangelogia with data contributed by scientists from the US Naval Research Laboratory (NRL) have shown that many problems exist in both data sets: the levelling/diurnal correction and relative navigation of the individual profiles of the US Navy data is poor, although its absolute navigation is good; while for the Russian data the levelling and relative navigation are excellent, but the absolute navigation is poor. Because the strengths and weaknesses of the two data sets are complimentary, an opportunity for fruitful scientific collaboration by scientists of VNIIOkeangelogia and NRL was immediately recognized, both to adjust the data and to interpret the resulting new data set. Academician Igor S. Gramberg has invited Dr. V.J.Glebovsky of VNIIOkeangeologia and Mr. L.C.Kovacs of NRL to head the project.

Geographic Limits of the Project:

The primary region for data adjustment and levelling will be the region bounded by the outside of the survey blocks of both Russian and US data which overlap, that is, it is the mathematical union of the geographic data sets, rather than just their intersection. We recognize however, that once the initial adjustment and levelling have been completed, that the adjustment of Russian navigation will be propagated into other, neighboring surveys, and that final adjustment will probably include the whole Amerasia Basin. Certainly, for the purpose of scientific analysis, the data should justify an analysis of the whole region. Recent aeromagnetic data collected by NRL in 1992 will be included in the adjustment and analysis. Similarly, we hope that new Russian magnetic data collected by Polar Expedition of

Sevmorgeologia Association in the region of the Makarov and Podvodnikov Basin regions can be used in the project.

General Method of Work:

We propose that the initial adjustment of the data sets can proceed using the digitized Russian isoline data presently held by the AGC. This data will be divided into coherent survey blocks and cross-correlated with band-pass filtered US data, which has a power spectrum similar to the gridded Russian isoline data, to provide initial navigation correction vectors. At that point then, the initial vector correction will be applied to the original Russian profile data. (Both original profile data sets should therefore be available to both VNIIOkeangeologia and NRL for this adjustment). The original Russian profile data, also divided into coherent survey blocks, will then be gridded and cross-correlated with high-pass filtered US data to provide final navigation correction vectors. These vector(s) will then be applied to the original Russian profile data to provide a final Russian data set. The US data will then be level adjusted to the Russian data using a cross-track analysis proceedure to form the final combined data set. This data will then be sent to AGC for inclusion in their compilation.

Future Work:

Following adjustment of the data, work will proceed on a scientific analysis of the region, using the new data set as a starting point.

APPENDIX VI

Shirshov Institute Arctic plan

(not available in computer-readable form)

THE ARCTIC OCEAN AND ADJACENT SEAS:

a study of global change

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Arctic Ocean Science Programme for IGBP
(under consideration)

The main goal of the Programme is to study the role of the Arctic Ocean and adjacent parts of the Atlantic and Pacific in the global change of the climate and ecology.

Moscow 1993

THE ARCTIC OCEAN AND ADJACENT SEAS IN THE INTERNATIONAL GEOSPHERE BIOSPHERE PROGRAMME

The main goal of the Programme is to study the role of the Arctic Ocean and adjacent parts of the Atlantic and Pacific in the global change of the climate and ecology.

ABSTRACT

It is well known that the Arctic Ocean plays a key role in certain global processes. During a more than a hundred years history of research in the Arctic region a vast amount of scientific knowledge has been accumulated. Nevertheless our knowledge is not sufficient to describe and understand the processes that make the ocean a whole planetary system.

The existing ecological problems caused by pollution of the Arctic seas and by developing of oil and gas production on the Arctic shelf put forward the need of urgent integrated study of the Arctic Ocean as one of the most sensitive regions of the Earth. The main objective of modern scientific research in this region is to determine the permissible industrial load on marine systems that would not disturb the natural balance. It can be estimated only on the basis of fundamental knowledge of geological, hydrophysical, chemical and biological processes that occurred in the history of the Arctic Ocean and those that are actual now. This knowledge is important to understand and distinguish the natural changes from the changes caused by the industrial activities of the mankind.

This Programme is designed to link the geological, hydrophysical, chemical and biological processes that occurred in the ancient ocean during the meso-cenozoic period with the modern processes in order to understand the paleo-oceanographic evolution of the Arctic Ocean and adjacent areas of the North Atlantic and Pacific and their influence on the global climate and ecological changes.

FOREWORD

Intensive increase of human activities in the Arctic region associated with fisheries, mineral, oil and gas industries in the shelf areas put forward certain problems that need to be urgently solved, the main of them being climatic and ecological problems.

The water masses that had acquired properties of temperature and salinity at the surface of the Arctic Ocean sink and flow towards the equator to fill the deep sea basins. Warm waters transported North by the Norwegian current affect the temperature regime and ice formation and melting which in turn influence the atmospheric processes.

Nutrients introduced into the Arctic Ocean through the Bering Strait determine the intensity of biological processes in the Arctic basin. The variability of mass, heat and salt fluxes influences the Arctic climate and the pollution transported by currents changes the ecological situation in the regions located far from the pollution sources. The latter is extremely important in connection with the radioactive and chemical dumping on the Arctic shelf and transport of these substances by Siberian rivers outflow. Yet we know very little about the trajectories of pollution spreading and its influence on biological systems.

It is estimated that due to fuel burning an additional annual amount of carbon dioxide release into the atmosphere is equal to 6-7 gigatons. The main part of it is absorbed in the Northern Hemisphere, and 0.2 gigatons in the Arctic Ocean. The carbon dioxide is dissolved by cold waters and transported to other regions. The Arctic Ocean works as a powerful pump extracting carbon dioxide from the atmosphere. It can be converted in the ocean into organic carbon by the photosynthesis process and then mineralized and returned into the atmosphere or carried by drifting ice in the Northern Atlantic or transformed into solid particles and sedimentated. The carbon dioxide cycle is not completely understood yet. Our knowledge is not enough to forecast the behavior of marine systems under the anthropogenic influence.

During the long term studies of the Arctic region a great amount of data has been gathered. Nevertheless it is highly desirable to pay special attention to the following researches that were not carried out in the past decades:

- integrated measurements of all the Arctic ocean components (water, ice, sediments, matter fluxes, rivers discharge, etc.) and the study of the processes governing the interactions between them;
- continuous measurements of annual cycles covering summer and winter periods of physical and biological processes;
- estimates of Arctic ice influence on biological productivity in the Arctic ocean and its role in transformation and distribution of substances in the Northern Hemisphere;
- estimates of ice cover role in the processes of isotope fractioning and isotope exchange in the atmosphere-ocean system;
- carbon cycle measurements in the water-ice-bottom system and study of carbonate system behavior on the whole basin scale etc.

It is clear that a long-term research programme is needed. After the accomplishment of such a programme the peculiarities of the structures and interactions between various components of the Arctic Ocean and adjacent areas and the functioning of marine ecological systems under the anthropogenic influence would be described and understood.

The goals of the Programme match with the objectives of the International Geosphere-Biosphere Programme (IGBP) that are to study the interacting geological, physical, chemical and biological processes that govern the planetary system as a whole and to distinguish between the natural and anthropogenic changes.

THE PROGRAMME GOALS AND OBJECTIVES

The goal of the Programme is to connect the geological, hydrophysical, chemical and biological processes that occurred in the past with the anologous modern processes in the Arctic ocean in order to understand the natural changes in the region and on this basis to analyze the anthropogenic changes; to describe the processes that govern such changes and to elaborate integrated models that would adequately simulate these processes.

It seems reasonable to name the objectives for each scientific branch separately.

GEOLOGY

The main objective is to study the origin, geological evolution and structure of the Arctic region and its influence on the global climatic and ecological changes in the past. To solve these problems it is necessary to carry out the following esearches:

- analysis of the main Arctic tectonic elements origin and evolution;
- description of pre-Mesozoic geological history of the continental margins of the Arctic Ocean;
- contriving of tectonic and paleogeographic reconstruction of the Arctic region for the mesocenozoic period;
- reconstruction of the Arctic and adjacent areas paleohistory;
- study of the sedimentation history and structure accompanied by modeling of the Arctic shelf sedimentation evolution;
- study of geodynamic, glacioisostatic and seismo-tectonic processes in the Arctic Ocean and adjacent seas;
- integrated geophysical research (seismology, magnetology, gravimentry, heat fluxes, etc.) of the sediment layer and crystal foundation of the Arctic Ocean and adjacent areas.

The idea of this research is to reconstruct the configuration of the lithospheric plates for several periods of the geological past (Early Triassic, Late Jurassic, Early and Late Cretaceous) and to determine the character of interactions at their boundaries, to calculate the parameters of their relative displacements and, on this basis to study the geological history of the Arctic region.

Plate tectonics. The analysis of the Polar basin paleogeography, paleoceanology and paleobathimetry is an important part in the global change studies. Since the tectonic control of the planetary geographical elements is well known, the progress in the solution of the problem should be associated with the understanding of the platetectonic evolution of the Arctic region of the Earth. The history of the Polar Ocean formation is about 150-170 million years long. It seems to be a transitional link between the global geodynamic systems of the Eastern (Pacific) and Western (Atlantic) Hemispheres.

To solve the problem of the Arctic plate tectonics, geophysics and paleoceanology, the main attention should be paid to the analysis of the following data:

1. Data of the geological - geophysical survey of the Russia Polar shelf and adjacent territories.
2. Paleomagnetic data on tectonic-stratigraphic complexes of the Arctic islands and continental parts.
3. Geophysical and deep-sea drilling data in the Arctic.

Micropaleontology. Sediments of the Arctic region and adjacent areas are similar to those of the other parts of the oceans and contain microorganism skeleton remains. The structure and composition of relic complexes (thanatocoenosis) reflect those of the biocoenosis and hence the ecological environment during the life time of those organisms; in particular, they bear information about the temperature, as of the leading ecological factors in the ocean. Those relations illustrate the possibilities of paleoceanological reconstructions and modeling of climate and ecological environment during the pre-industrial period in the Northern Hemisphere. The principal goal of the micropaleontological part of the program is to determine the age of bottom deposits and sedimentary formations, including minerals, and to reconstruct the paleoenvironment of the Arctic basin

and adjacent regions by means of the micropaleoceanological objects research in the sea deposits.

This goal considers the solution of three principal problems:

1. Knowledge of the distribution of microfossils in the Recent sea and oceanic sediments as a function of oceanographic environment and further elaboration of actual techniques for paleoceanographic reconstructions.
2. Study of the Quaternary stratigraphy and paleoceanology from icropaleontological and isotope data to detect the chronology in the changes and interrelations between paleoceanological parameters.
3. Study of the stratigraphy and paleoenvironment from the data of icropaleoceanological analysis of the Mesozoic and Cenozoic deposits.

Lithogenesis. Three epochs of global climate cooling are known in the geological history of the Earth. They were accompanied by wide glaciation and formation of specific types of deposits. The first glaciation occurred during the Late Proterozoic, the second in the Late Paleozoic and the third one embraces the Pleistocene-Holocene periods. The latter differs from the previous two since it covered not only the continental parts but also the water basins. A new type of lithogenesis originated, namely the marine glacial (or polar), which has no analogs in the geological history. This type of lithogenesis can help to understand the causes of climate changes in the Pleistocene and the recent climate changes.

The goals of the modern lithogenesis in the Arctic are to study:

- the processes of under-ice sedimentation and sedimentary parameters determined by them;
- transportation of coarse detrital material by drifting ice;
- specific formation of fine-dispersed clay sediments due to the hydrological factors which are important during a short-time opening of the ice shield on the shelf of the shallow Arctic seas;
- factors determining the occurrence of suspension flows in the regions of depressive sedimentary basins;
- factors determining the specific features of hydrocarbon bed components in the zone of glacier effect;
- specific formation of gashydrades due to freezing of sedimentary layer on the shelf during the Pleistocene regression.

HYDROPHYSICS

The specific features of the Arctic region that influence the hydrophysical processes are the following:

- closed character of the basin with a wide opening to the Atlantic and anarrow one to the Pacific;
- wide shelf area of the Siberian seas;
- long winter period and permanent ice cover of the major parts of the ocean;
- sufficient river freshwater discharge;

The principal objectives are to study the basic properties of circulation in the Arctic Ocean and its variability; to identify the main physical mechanisms responsible for the formation of the circulation and its variability; to determine the propagation of chemical and biological substances in the ocean and to estimate the

role of currents, waves, turbulent diffusion and boundaries (especially the ice cover) in this process; to analyze the influence of the Arctic basin on the global climate changes.

To accomplish these objectives it is necessary:

- to develop the theory of dynamic processes in the Arctic ocean and to construct approximate numerical models for studying currents, waves, turbulent mixing and the propagation of chemical and biological substances in the basin;
- to study the dynamic processes in the upper and bottom boundary layers, and the transfer of energy through the surface of the ocean, its lateral boundaries and the bottom;
- to study the dynamic role of various mechanisms responsible for anthropogenic pollution in the Arctic ocean;
- to analyze and to predict the evolution of climate in the Arctic Ocean and its influence on the evolution of the climate.

CHEMISTRY

Chemical studies in the Arctic basin and adjacent areas are carried out to solve the two main problems:

Study of the modern biogeochemical elements cycles and their evolution in the paleobasin on the basis of hydro-, geo- and biochemical and isotope researches of ice water, biota, suspension, bottom sediments and silt waters.

Study of the character of modern anthropogenic influence on the Arctic environment and biota on the basis of background pollution levels which may be used for forecast and pollution monitoring.

To solve these problems it is necessary to carry out the following researches:

- study of biogeochemical cycles of elements in the Polar Ocean;
- study of chemical exchange processes in the system water-ice-atmosphere;
- study of elements contained in the rivers outflow and processes of substance transformations in the system river-sea-biota-sediments;
- study of substance fluxes in the system ice-water-bottom and also processes in the bottom sediments;
- study of isotope fractioning in the process of ice formation and isotope exchange in the system water-ice-atmosphere;
- study of isotope geochemistry and physico-chemical conditions on the Arctic shelf;
- study of modern anthropogenic influence on the Arctic environment and its biota;
- estimation of oil pollution influence on the sea ecology and on the sea and continental ice;
- estimation of natural processes influence on oil substances and oil combinations in the Arctic seas and search for methods of oil spill elimination at low temperature conditions;
- detection of radioactive pollution in the water - ice - bottom system.

BIOLOGY

The main objective is to make an ecological theory of the Polar Ocean where the main biological communities cryon, plankton, nekton and bentos and their environment - ice, water and bottom interacting on various vertical and horizontal

scales create a joint trophical structure, variety of species and element cycling within the system that provides to consider the ocean as an ecologically unique media.

For these purposes it is necessary to carry out qualitative and quantitative analysis of its biotic and abiotic components, to figure out the main communities and to show the ways of suspending their functional stability both on the vertical scale and on the basin geographical scales.

To solve these problems it is necessary to carry out the following researches:

- analysis of temporary and spatial characteristics and physico-chemical structure of the biotopes, i.e. sea ice, water masses and bottom sediments;
- study of taxonomic variety and distribution peculiarities of all Arctic biota representatives , i.e. cryon, plankton, nekton and bentos;
- study of functional links between biotic and abiotic components of the system;
- study of the annual cycle of the communities to reveal the mechanisms providing stability of the vertical and horizontal structure;
- study of the trophical structure, the matter fluxes and details of exchange by substances and energy in the water-ice-bottom system;
- study of the origin, evolution and formation of autochtonic fauna and flora in the marine Arctic and evolution of its ecosystems;
- study of the character and degree of various anthropogenic pollution, influence on biological systems including species, population and ecosystem levels.

The idea of the ecological approach in this Programme is to combine into a whole all biotic and abiotic components of the Polar Ocean. This work is to be carried out on the basis of historical and future data that characterize the ice-water-bottom system, the components of which have their own physico-chemical properties, dynamics and set of organisms, i.e. cryon (sea ice organisms), plankton (water organisms) and bentos (bottom organisms).

It is important to consider their interaction in the geological history and in modern processes, for example, in formation of sediments in the North Atlantic by particles that are carried by currents and ice, and formation of glaciers in Greenland and Canadian Arctic (participation in water isotope fractioning). On this basis a progress is feasible in understanding of the reasons of seasonal and interannual variability of the ocean and its ice cover and their influence on the global processes in the biosphere.

THE ARCTIC ENVIRONMENT

The modern Polar Ocean is a complex marine system which borders are loosely defined by spreading limits of Arctic water mass - a layer of surface waters 200-250 m depth covering the whole basin and prolonging to the South through the Straits of Fram and Bering. The Polar waters and Subpolar waters are characterized by low temperature and salinity at the surface. These waters are influenced by the rivers discharge and the ice cover.

Geographically the Polar Ocean is a unity of the central deep water basin - the Arctic Basin and the marginal Arctic seas but they play different roles in the formation of the hydrophysical and energetic balance of the Polar Ocean. The Siberian coast seas Chukchi, East Siberian and Laptev are the areas of surface Arctic water mass formation of the Pacific origin that spreads over the whole

basin. The ice formed in the area in winter is involved into the global ice circulation of the Arctic Basin.

The Eurasian coast seas White, Barents and Kara are essentially connected with the North Atlantic water masses. They are in ecological and hydrological senses the seas of Atlantic influence. The flora and fauna complexes of bentos and plankton are closely related and resemble those of the North Atlantic. As the ice cover is concerned its features are principally different from those of the Siberian coast. The ice of the White and Barents Seas does not play a significant role in the total ice balance. The ice cover of the Kara Sea is more complicated and is composed of the ice formed in the Kara Sea and the ice carried from the central part of the Arctic Basin and through the straits between the islands.

These differences are significant in the realization of the scientific ideas of the Programme because the ecological resemblance and hydrological unity of the Kara, Barents and White Seas allows to consider them in future models of the Polar Ocean as the *Atlantic bloc.* The Chukchi, East Siberian and Laptev Seas can be considered as the *Pacific bloc.* The deep water Arctic Basin must be analyzed independently from these two blocs as the third *Arctic bloc,* respectively.

RESEARCH METHODS

Integrated studies of the Polar Ocean will include:
- satellite methods of data collection for large scale estimates of hydrophysical and biological processes on the ice and water surfaces of the ocean;
- ship measurements and measurements on coastal and drifting stations;
- technical equipment for ecological monitoring;
- acoustic and optical means for monitoring, installation of moored and bottom measuring systems, as well as drifters and neutral buoyancy floats;
- organization of ecological measurements network of the Arctic environment for early forecast of undesirable anthropogenic effect on the Arctic shelf.

EXPECTED RESULTS

The researches carried out in accordance with this Programme will give a theoretical basis for constructing geophysical, geochemical, hydrophysical and biological prognostic models describing the structure and evolution of the system lithosphere-oceanosphere-cryosphere-atmosphere in temporal and spatial scales of the Arctic Ocean and adjacent territories.

GEOLOGY

- development of actualistic methods of paleomedia reconstruction;
- precise ideas of temporal and spatial laws of sea parameters evolution, climatic and paleogeographical changes in the Arctic region and adjacent territories, microorganisms evolution and their distribution under the anthropogenic and ecological conditions influence;
- new data on geological age of sediments.

HYDROPHYSICS

- data base of measurements in the Polar Ocean;
- new atlases of the Polar Ocean describing the influence of mesoscale and microscale processes (eddies, fronts, waves, fine and microstructure);

- ocean circulation models taking into account interaction with the atmosphere, formation and melting of ice, propagation and evolution of chemicals, carbon dioxide, methane and biological substances and transformations that occur with these substances;
- models of mesoscale and microscale physical processes in the ocean and in the shelf areas responsible for the variability of the mean state and circulation of the ocean, forecast of events of rare probability;
- variability of water mass and heat exchange with the Atlantic and Pacific determining the short period climate variability.

CHEMISTRY

- data base of chemical measurements in the water, chemical composition of sediments and isotope studies of the Polar Ocean;
- division of the ocean into districts in accordance with their chemical properties (maps, crossections, explanatory notes)
- dynamic model of the biogeochemical cycle for various elements;
- obtaining of data for the study of the sediment diagenesis specifics and comparing the ice and humid type of lithogenesis;
- data on the specifics of manganese ore process in the Arctic sediments;
- forecast estimates of the ecosystem elements evolution under various degree of anthropogenic influence.

BIOLOGY

- construction of the marine Arctic ecological theory, where the main biological communities - cryon, plankton, nekton and bentos and their environment - ice, water and bottom interacting on various vertical and horizontal scales create a joint trophical structure, variety of species and substances cycling within the system that provides to consider the ocean as an ecologically coupled media.
- scientifically based forecast on marine ecosystems conditions and recommendations of rational use of the biological resources of the Arctic Seas;
- obtaining the basic data characterizing the mean condition of the ecological systems for the estimation of observed changes and evaluation of natural and anthropogenic components of these changes;
- basic ideas for solving climatological problems involving the anthropogenic influence;
- data base of the Polar Ocean and adjacent seas ecological condition.

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