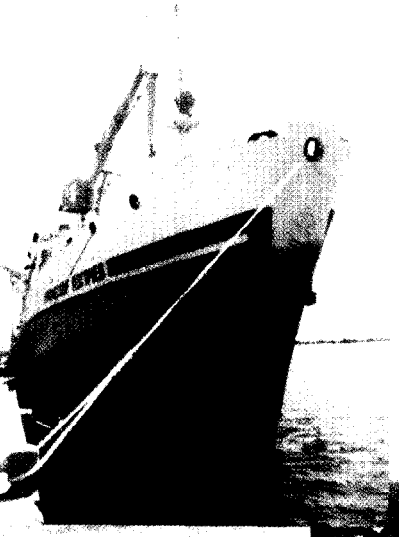
Floating University Facility



Training Through Research Programme

Annual Report, 1999

Floating University Facility

Training Through Research Programme

Summary of the activities of the UNESCO-MSU Research and Training Centre and the UNESCO Chair for Marine Geology and Geophysics

Intergovernmental Oceanographic Commission

Annual Report, 1999

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Table of contents

Activities described in this Report represent part of the overall international 'Training Through Research' (TTR) programme, also referred to as the 'Floating University' facility. Most of the TTR activities are inter-linked and inter-dependent. The current report presents activities executed by, or with the participation of, researchers and students from the UNESCO-MSU Research and Training Centre for Marine Geology and Geophysics. Given the international cooperative nature of the TTR programme, this document reports on the jointly executed projects. The important role of all cooperating partners from many countries in the implementation of the programme is fully recognized and appreciated.

Training-through-Research programme

In operation since 1990, the Training-through-Research (TTR) programme combines the advantages of the formal training of students and young scientists with the experiences gained in advanced research in the field of marine geology and geophysics. It blossomed in the summer of 1991 from buds that sprouted during a 1990 UNESCO-sponsored workshop; the latter was hosted by the Institute of Marine Geology, University of Bologna, Italy.

An initiative of Moscow State University (MSU), the programme's seeds had been planted during discussions at a UNESCO workshop on 'Marine Science Education and Training for the year 2000' (Paris, 1987) and subsequently at the UNESCO-sponsored workshop on 'University Field Courses in Marine Sciences' (Moscow and Poyakonda, 1989). Up until the end of 1995, UNESCO supported TTR through the Organization's Marine Training (TREDMAR) programme. Between 1992-1994, TTR was also co-sponsored by the European Science Foundation through its Network on Advanced Study Workshops on Mediterranean Marine Geosciences. Since 1996, the programme has been co-sponsored by the Intergovernmental Oceanographic Commission (IOC) of UNESCO through its Training, Education and Mutual Assistance (TEMA) component.

The TTR programme is managed by the Executive Committee (Coordinator: Dr. Neil Kenyon, Southampton Oceanography Centre, UK). The programme's Scientific Committee is responsible for formulating research tasks and targeting the TTR cruises.

The annual TTR cycle of activities includes: (i) preparation of a cruise by the Executive and Scientific Committees; (ii) the TTR cruise, with (when possible) a mid-cruise workshop and/or field excursion(s) for the participants and invited scientists; (iii) preliminary data processing, preparation and publication of scientific reports; (iv) a post-cruise conference to present and discuss the results of on-going analyses and interpretation of data, and to co-ordinate with other regional studies; (v) preparation of scientific publications.

In the period 1991-1999, nine major TTR cruises were conducted in the Mediterranean and Black Seas and in the northeastern Atlantic. Seven post-cruise conferences were held in: Moscow (1993 and 1996), Amsterdam (1994 and 1997), Cardiff (1995), Gent (1998) and Southampton (1999). A number of other field exercises (including smaller cruises), group and individual training activities, and presentation and publication of the research results were carried out.

At least 400 scientists and students have been taken part in the nine annual cruises. They hailed mostly from some 25 countries scattered around the North Atlantic, Black Sea and Mediterranean regions, but also some were from other regions (Latin America, Middle East, and Southeast Asia). Altogether, about one thousand people have been involved in TTR if one counts mid-cruise workshops and post-cruise meetings and other activities.

UNESCO-MSU Centre: its mission and structure

The UNESCO-MSU Research and Training Centre for Marine Geology and Geophysics was established in 1993 by the decision of the Rector of Moscow State University (MSU), which act was endorsed on 4 February 1994 by UNESCO's Director-General Federico Mayor thus consolidating UNESCO's ongoing support. The establishment of the Centre was strongly encouraged by a number of European universities and individuals involved in the TTR programme. However, the spirit of the Centre has existed *de-facto* since 1990, when the 'training-through-research' approach was tested aboard the MSU research vessel *Academic Petrovsky* by a small international group of scientists.

Affiliated with the MSU Geology Faculty, the Centre aims to provide advanced training and research for under- and postgraduate students. Its scientific and educational activities are based on international co-operative programmes involving universities and research institutions in many countries.

The Centre operates under the following arrangements. MSU provides the staff of the Centre (currently six persons). Eight postgraduate and ten undergraduate students from various Departments of the Geology Faculty are involved on a permanent basis in research projects of the Centre. Some 20 undergraduate MSU students have become involved in the Centre's training activities.

The Centre has three branches:
(i) Marine Geology and Sedimentology (including Micropaleontology),
(ii) Seismics and Geo-acoustics, and
(iii) Geochemistry.

It provides various laboratory and computing facilities and is supported by a series of the MSU central services, such as libraries, analytical laboratories, Internet and e-mail facilities, Science Park, etc. It is supported as well by the efficient services of the offices of the Dean of the Geology Faculty and the Rector. It cooperates with several departments of the Geology Faculty and ensures the necessary marine science-related training.

At national and international levels, co-operation was established, in 1999, with over 30 institutions (Annex I).

In 1999, funds for research and training were provided by MSU, Russia's Ministry of Natural Resources, Ministry of Science and Technologies, as well as by UNESCO (through the Participation Programme), the Flemish Government, Belgium (through the MSU-Gent University Cooperation Agreement), NIOZ (through the bilateral Cooperation Agreement, 1998-2000) and, for field activities, from several more sources (see next Chapter). This support is acknowledged and sincerely appreciated.

International 'training-through-research' is the major task of the Centre (J. Gardner, USA, with the students and staff of the TTR-9 cruise).

Research and Training Activities of the Centre in 1999

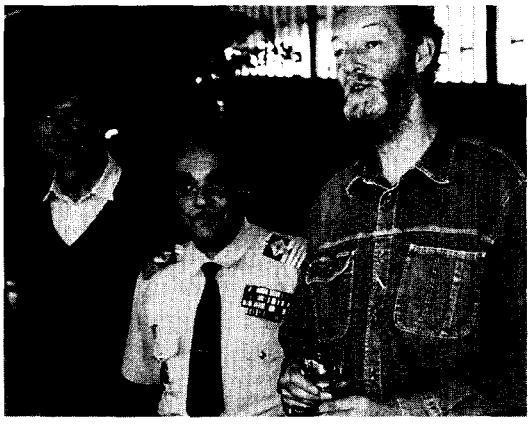
Research projects

A number of research projects, mostly regional, were continued at the Centre. They were carried out by the MSU research staff and students in cooperation with national and foreign universities and research institutions. This included:

- Slope instability in the Northeast Atlantic region;
- Mud volcanism/clay diapirism and related gas and gas hydrate occurrences:
  - Analyses of seismic and acoustic images of diapiric fields and gas-related structures (such as Bottom Simulation Reflectors, acoustic voids and bright spots);
  - Chemical composition of gas and gas hydrates;
  - Gas-related authigenic mineral assemblages in deep-water sediments;
  - Micropaleontological study of mud breccia clasts.
- Influence of turbiditic and contour currents on the deep-sea clastic sedimentation:
  - Contour current-induced sedimentation in the Feni Drift area (Rockall Trough);
  - Sediment transport and deposition in small-scale, sand-rich bottom current systems on the Faeroe and Rockall Trough margins, in the Porcupine Seabight and Gulf of Cadiz;
- Deep-water carbonate mud mounds;
- Stratigraphy and paleoclimate of the Iberian abyssal plain and Voring Plateau (Upper Pleistocene-Holocene, calcareous nannoplankton);
- Neogene-Quaternary Tectonics of the Eastern Mediterranean:
  - Analysis of seismic images of the accretionary prism (the Mediterranean Ridge);
  - Evolution of the Eastern Mediterranean (based on lithology of mud breccia matrix and clasts recovered from mud volcanoes);
- Dependence of backscattering on lithology from side-scan sonar data;
- Digital processing of seismic and acoustic images.

Field activities

In 1999, the Training-through-Research strategy was applied during two research cruises involving the participation of MSU research staff and students. These were cruises to the Northeast Atlantic and Western Mediterranean: the major TTR-9 cruise onboard the RV *Professor Logachev* and the RV *Belgica* cruise to the Porcupine Seabight.



Captain of the RV Logachev *A. Arutyunov (centre) with Dr. M. Ivanov (left) and Dr. N. Kenyon at a reception in Porto.*

TTR-9 cruise to the Northeastern Atlantic and Western Mediterranean: studies of the continental margins

The 9th cruise (TTR-9) of the UNESCO-IOC sponsored 'Training-through-Research' programme was carried out on board the Russian RV *Professor Logachev* (captain Alexander Arutyunov) from 3 June to 27 July 1999. The ship is owned by the Ministry of Natural Resources of the Russian Federation.

The cruise got underway from St. Petersburg (Russia) and terminated in Valencia (Spain). Four port calls were made for partial exchange of the Scientific Party: in Den Helder (The Netherlands) on 8-10 June, in Porto (Portugal), on 28-30 June, in Cadiz (Spain) on 17-18 July and finally in Valencia (Spain) on 27 July. Following the schedule of the port calls, the cruise was subdivided into a preparatory (to test the equipment) and three working legs:

- Preparatory leg: St. Petersburg to Den Helder (The Netherlands), 3 to 8 June;
- Leg 1: Den Helder to Porto (Portugal), 10 to 28 June;
- Leg 2: Porto to Cadiz (Spain), 30 June to 17 July;
- Leg 3: Cadiz to Valencia (Spain), 18 to 27 July.

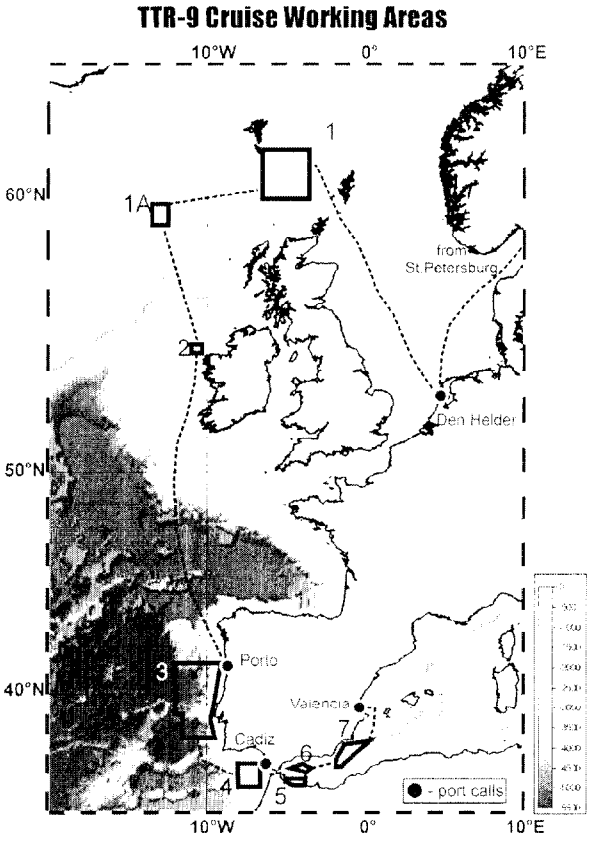
An international team of 62 scientists, post- and undergraduate students (in addition to a group of Russian technicians who had been working with the *Logachev* equipment) from over 20 institutions of 12 countries (Algeria, Bangladesh, Denmark, Ireland, Italy, Morocco, The Netherlands, Portugal, Russia, Spain, UK and USA) participated in the above legs (see Annex II).

During the cruise, the participating students were actively involved in all stages of acquisition and preliminary processing of a multidisciplinary set of geophysical and geological data, working together with leading marine science specialists from various countries. Daily seminars, lectures and discussions of the data that had been collected (Annex III), facilitated high-level on-the-job training of the students and young scientists from different countries.

The Co-chief Scientists of the cruise were:

- The preparatory leg: Dr. O. Krylov (Russia);
- Leg 1: Dr. Tove Nielsen (Denmark), Dr. Andy Wheeler (Ireland) and Dr. Mikhail Ivanov (Russia);
- Leg 2: Dr. Jose Hippolito Monteiro (Portugal), Dr. Neil Kenyon (UK) and Dr. M. Ivanov; and
- Leg 3: Prof. Menchu Comas (Spain) and Dr. M. Ivanov.

The objectives of the cruise were to study geological processes on continental margins and to train students in marine geoscience research.



Funding and logistic support

Besides the IOC sponsorship, financial support for the cruise was provided by the Geological

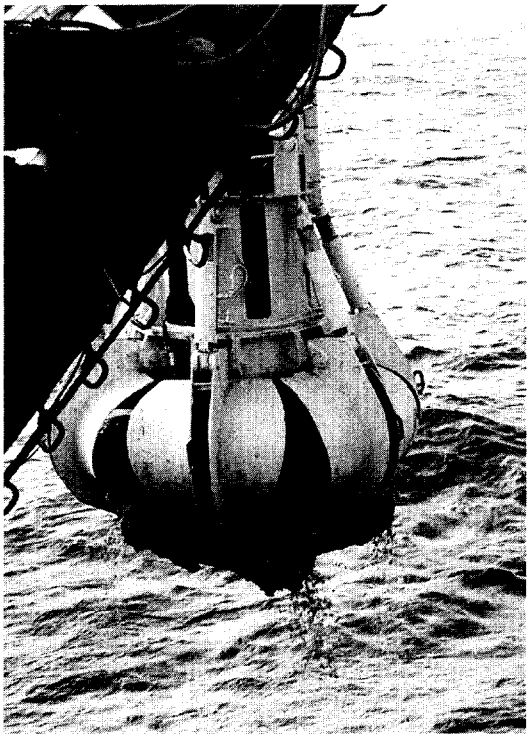
Survey of Denmark and Greenland (Denmark), Instituto Geologico e Mineiro (Portugal), Instituto Andaluz de Ciencias de la Tierra (Spain), Statoil UK, Southampton Oceanography Centre (UK) and Naval Research Laboratory (USA), this in addition to the national funding which came from Russia's Ministry of Natural Resources and Ministry of Science and Technologies.

Logistic support to the cruise was provided by NIOZ (The Netherlands) which coordinated financial inputs from the co-operating partners and effected various payments (such as for port calls). In this respect, sincere gratitude is due to Dr. M. van Arkel for his dedicated and efficient work.

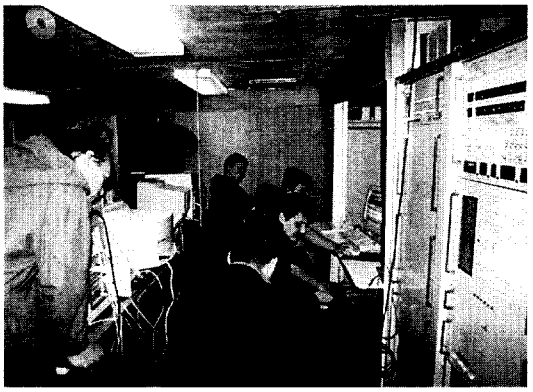
During the port call in Cadiz (Spain), invaluable assistance was provided by Dr. A. Izquierdo (Cadiz University) in solving various logistic problems.

Equipment

The equipment used for the research included: single-channel high-resolution airgun seismic system, six-channel high-resolution sleeve gun seismic system, OKEAN long-range side-scan sonar, hull-mounted 3.5 kHz profiler, O.R.E.-tech deep-towed system containing high-resolution side-scan sonar and a 7 kHz sub-bottom profiler. For more detailed studies, an under-water TV-system, 6 m and 3 m gravity corers, box-corer, kasten-corer, TV-controlled PRESSAUG grab, and dredges were used.



TV-controlled PRESSAUG grab



Students in the Lagachev *seismic laboratory*

Scientific programme of the cruise

The programme of the expedition was divided into seven study areas located within the Faeroe Margin, the Rockall Trough and Irish Margin, Portuguese Margin, Gulf of Cadiz, Alboran Sea and Balearic Basin. The research plans for each area were identified as follows:

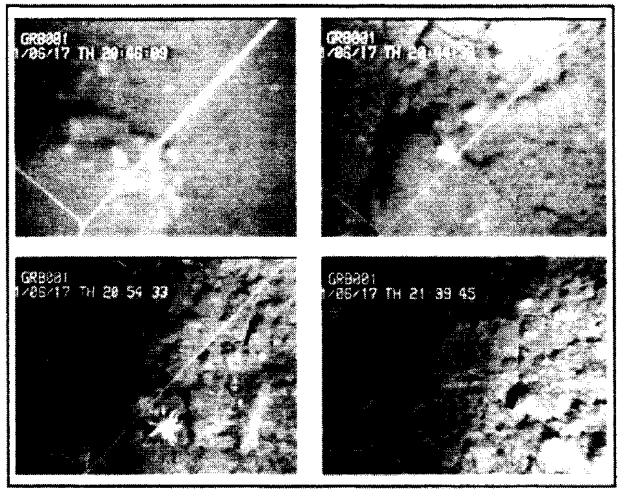
FAEROE MARGIN (AREA 1)

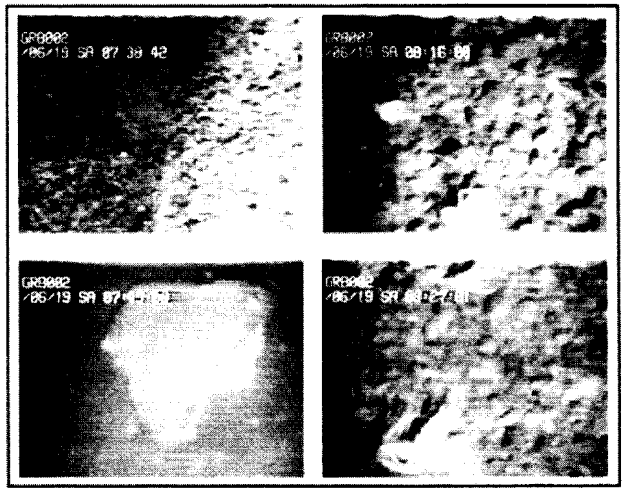
The aim of the TTR-9 investigations in the Faeroe-Shetland Channel was two-fold:

- to further elucidate the mass flow deposits and their origin, and in particular to date the latest slope instability event having occurred at the south-eastern margin; and
- to study current-induced bedforms in general, and more specifically at the southern outlet of the channel.

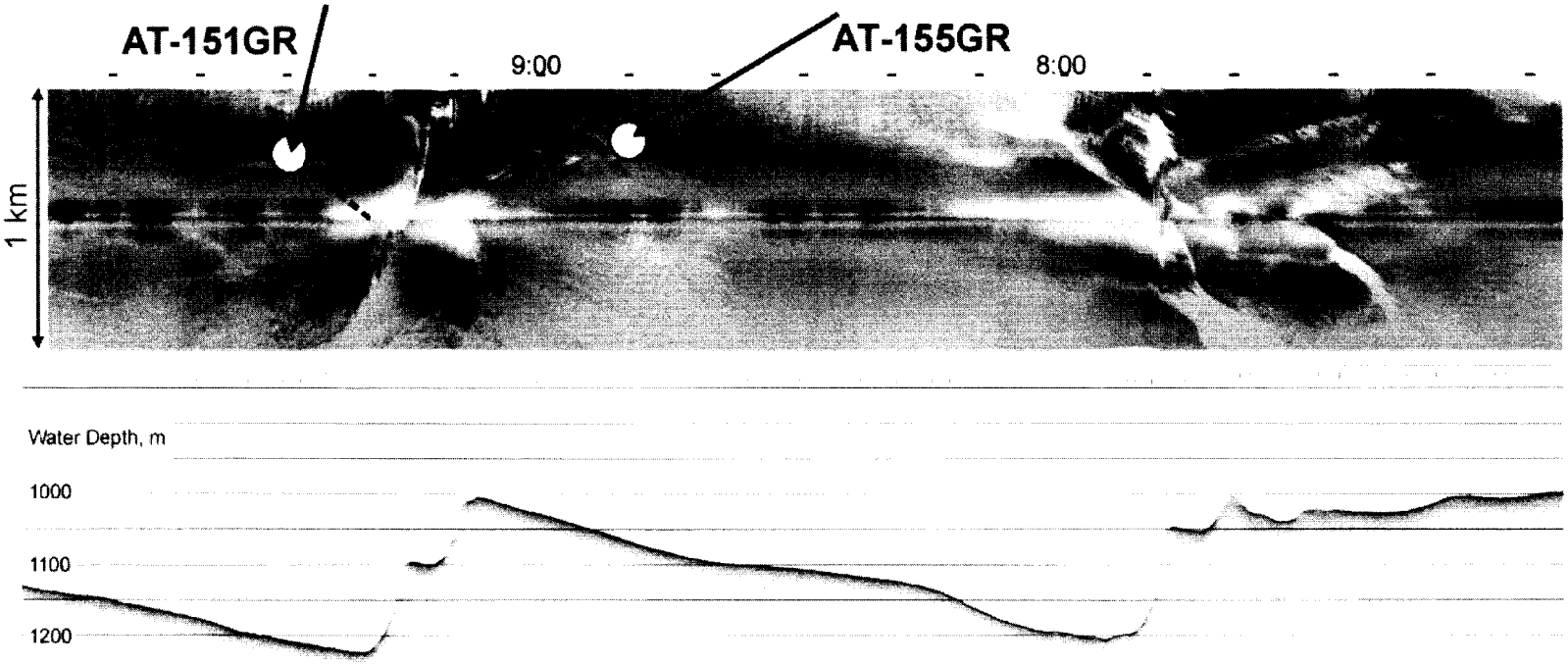
In addition to the TTR-8 lines, three high-resolution seismic lines were shot in the area of mass flows on the south-eastern Faeroe margin investigated during the TTR-8 cruise. It allowed the participants to outline the region of mud flow occurrence and choose the areas to be studied with a high-resolution deep-towed side-scan sonar.

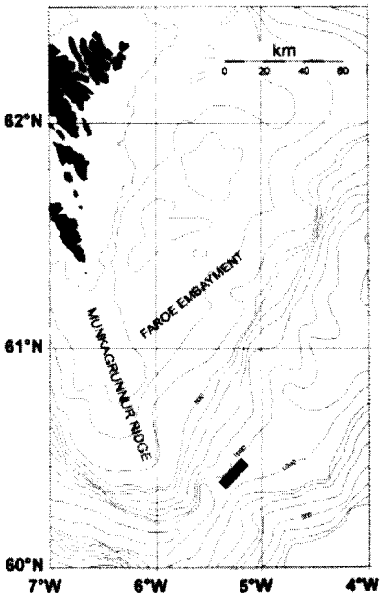
A high resolution side-scan sonar and a 3.5 kHz hull-mounted profiler were employed in selected parts of the Faeroe-Shetland Channel system studied by RV *Pelagia* (The Netherlands) earlier in the same year, as well as in the adjacent areas, with the aim to confirm the existence of and map the boulder/gravel





Snap shots from TV-recordings of the two sites near the escarpment (station AT-151GR, AT-155GR) clearly demonstrate the substrate's coarse character in these areas, characterised on the sonographs by very strong backscattering. The seabed here mainly consists of lag sediment of medium to coarse sand and gravel, with frequent pebbles and cobble stones. The TV records also show occasional boulders. The maximum boulder size recorded is up to nearly a meter.





Two escarpments crossed by the ORAT-29 30 kHz side-scan sonar line are located on the upstream sides of two very large enclosed deeps that are found in the southern part of the Faeroe-Shetland Channel, where it nearly reaches its most restricted cross-section. Their shape is presumably caused by the presence of a particularly resistant horizon that has been an obstacle to flow through the Faeroe-Shetland Channel for a considerable time. Erosion due to turbulence created by the scarps is believed to have maintained these giant scour holes, possibly for a very long period of time.

pavement in areas of suitable outcrops to be selected for further sampling. The above was followed by high resolution side-scan sonar and 3.5 kHz hull-mounted profiler recordings in an area formerly indicated, but not confirmed, by the results of the 1998 cruise with RV *Pelagia* - to be covered with sediment waves.

The geophysical surveying was completed by underwater television recording and photographing of selected seabed areas, as well as by bottom coring.

ROCKALL TROUGH AND IRISH MARGIN (AREAS 1A and 2)

These areas are of interest to the hydro-carbon industry, with particular reference to Statoil (UK) who have licenced the right to them and who co-funded this study.

The major objectives of this study were the:

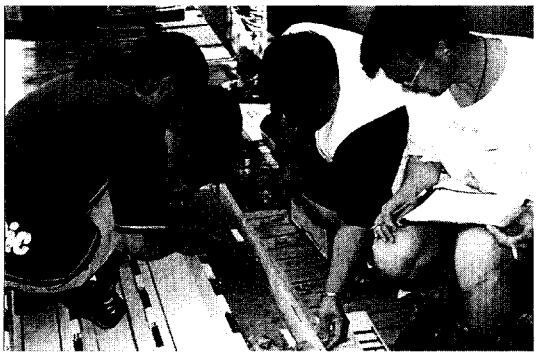
- acquisition of samples to test whether there exists any evidence for thermogenic gas in the seabed above fault lines; and
- geotechnical reconnaissance investigations in potential hydrocarbon exploration areas.

The study was carried out using a 3.5 kHz hull-mounted profiler, deep-tow video, gravity-, box- and kasten corers.

PORTUGUESE MARGIN (AREA 3)

The aims were:

- to collect data about contourite, slope and rise deposits in this area;
- offshore Lisbon, the survey aimed to complement the data already collected on the TTR-8 cruise; and
- to obtain core samples from the outer-shelf



Description of cores onboard the Logachev *(from left to right: L. Mazurenko, J. Soto, N. Hamoumi and G. Akhmanov)*

Conservation of cores in the lithological laboratory (I.Belenkaya, G. Akhmanov and A. Stadnitskaya)

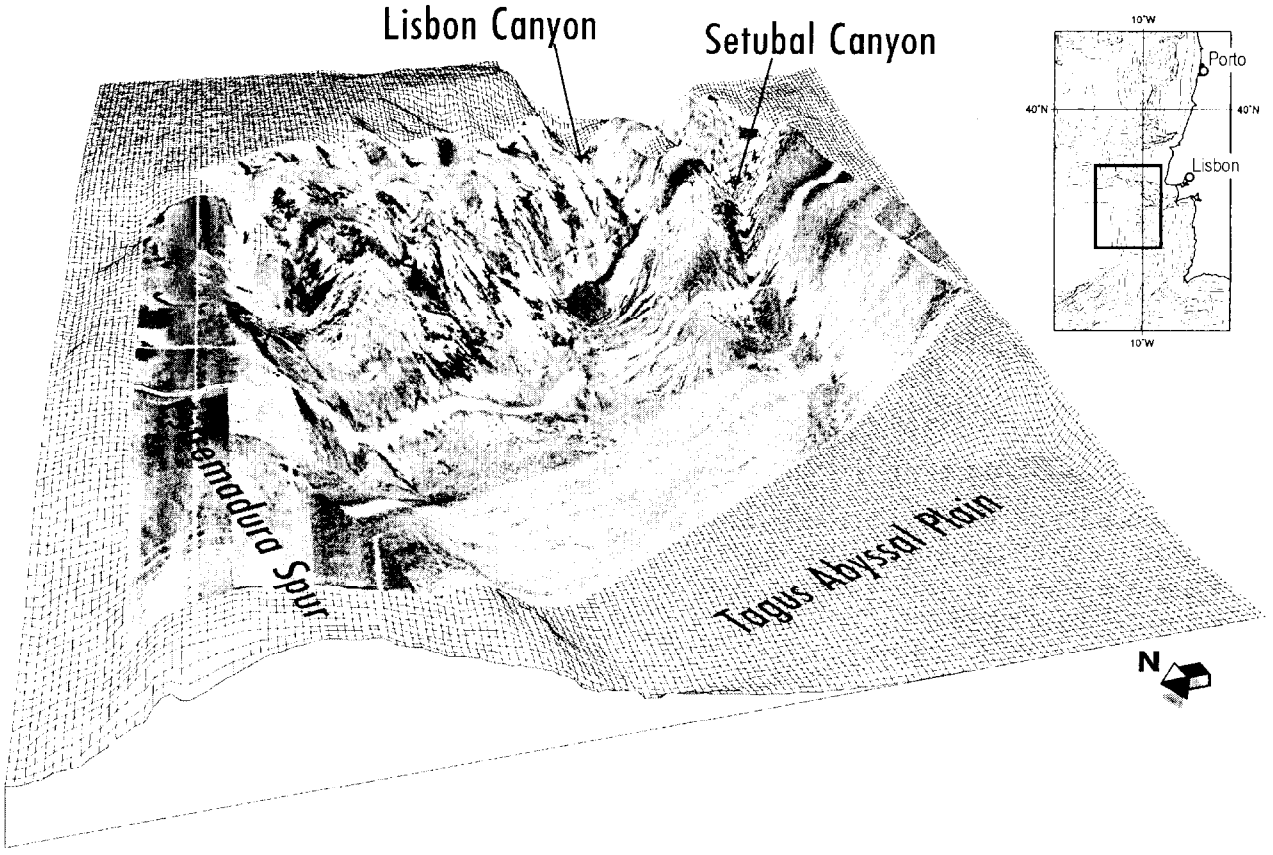
area adjacent to the Tagus River for further paleoceanographic and geochemical studies. A survey of the contourites and sediment drift was made using single-channel high resolution and six-channel high-resolution sleeve gun seismic systems. The TTR-8 investigations of the Lisbon Canyon System were continued by side-scan sonars, as well as by bottom sampling.

GULF OF CADIZ/MOROCCAN MARGIN (AREA 4)

In 1992, the Marine Physics Branch of the Naval Research Laboratory (USA), in co-operation with the Hawaii Mapping Research Group and the Naval Oceanographic Office, conducted a side-scan sonar and a multibeam bathymetry survey of the Gulf of Cadiz and Western Moroccan continental margin. Several seafloor structures believed to be methane hydrate-related mud volcanoes were identified during the cruise.

- Further sub-bottom information and groundtruthing was needed to better understand the genesis and development of these structures.
- Another aim of the short study in the northern part of the Gulf of Cadiz was to obtain high resolution data from a channel formed by contour currents.

A study of the tectonic framework and evolution of the area to the west of the Strait of Gibraltar was undertaken based on side-scan sonar and multibeam bathymetry coverage. This was complemented with single-channel high-resolution seismic data, OKEAN and O.R.E.tech side-scan sonar and a 3.5kHz



Perspective image of the Portuguese margin west of Portugal covered with TTR-8 and TTR-9 OKEAN long-range side-scan survey. Note the prominent high backscattering bottom of the Setubal canyon suggesting active sediment transport far off to the Tagus abyssal plain.

hull-mounted profiler data. Further subbottom information as well as groundtruthing was obtained by coring (gravity and box corers were employed) for the gas hydrate-related structures (such as mud volcanoes).

ALBORAN SEA and BALEARIC BASIN (AREAS 5 to 7)

The main objectives in these areas were to investigate:

- the composition and structural characteristics of the basin's basement;
- the composition and age of volcanic edifices forming residual or structural highs within the basin;
- the geometry of major tectonic lineaments and related faulting;
- the relationship between seafloor morphology and tectonics in actively deforming sectors; and
- the mud-diapir province of the Alboran Basin, and possible development of mud-volcanoes on the top of the diapiric belt.

The above objectives were attained through the following research approaches:

- A reconnaissance of the selected sectors based on the OKEAN long range side-scan sonar records and high resolution seismics. The aim was to collect information about the seismogenic faults, upper parts of volcanic edifices, and adjacent slopes, as well as the seismostratigraphic expression of the uppermost sedimentary sequences.
- More detailed investigation by survey with the O.R.E.tech deep-towed side-scan sonar over selected fault-escarpment sectors in which the basement may outcrops, and survey of outcropping volcanic rocks at the seafloor, this based on the OKEAN and seismic images.
- Further underwater TV recording and photography were taken at suitable points.
- Sampling the sea floor by dredging or grabbing hard-rock outcrops, and by coring the overlaying soft sediments.

Main results of the TTR-9 cruise (reported by the participants)

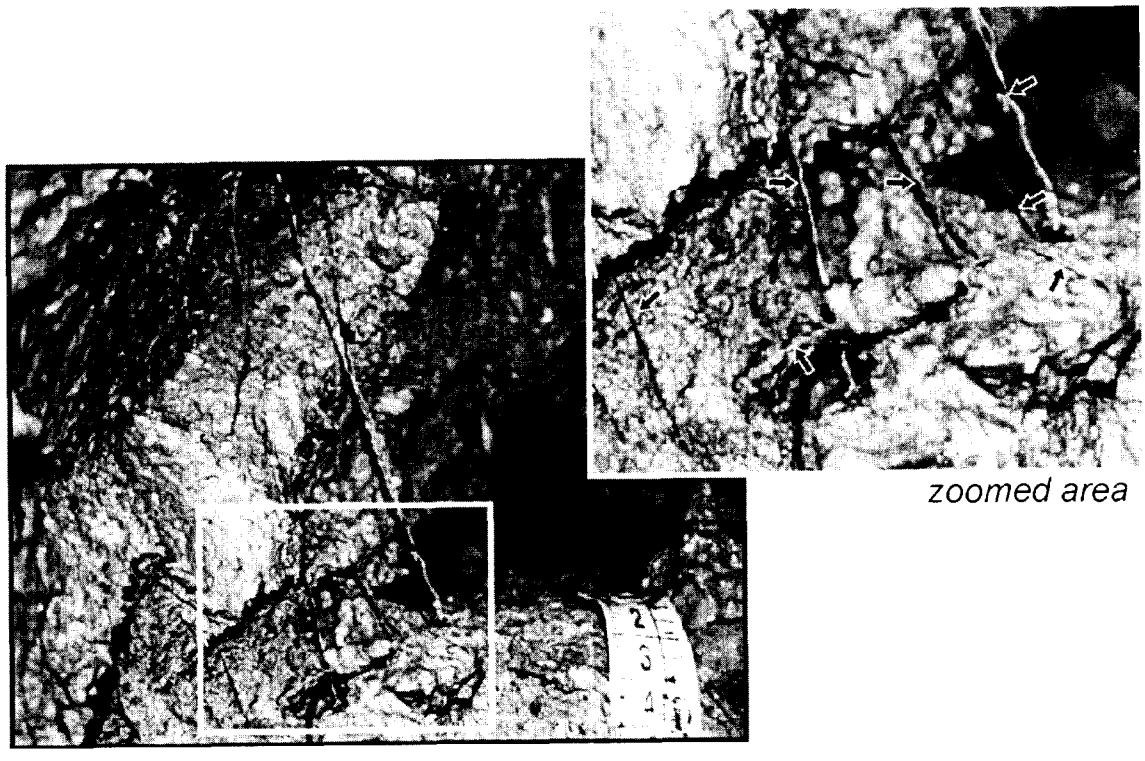
During the cruise, 55 seismic lines of a total length of 1500 km were shot simultaneously with the OKEAN side-scan sonar survey and 3.5 kHz hull-mounted profiling. The O.R.E.-tech deep-towed system survey was conducted along nine lines of a total length of 110 km. A deep-towed TV system was used in seven TV-runs of a total length of 20 km. A bottom sampling programme included 100 sampling sites.

Off the Faeroe Islands, the expedition discovered evidence of very strong bottom currents and recent bottom sliding. The new seismic data confirmed the presence of a buried slump complex of presumably Plio-Pleistocene age at the central western margin of the Faeroe-Shetland Channel, as was reported by the TTR-8 Cruise (*IOC Technical Report* No 54, 1999). Furthermore, the new seismic data gave evidence of a younger, minor slump unit, which is thought to be of Pleistocene age. The new acoustic data show that these superficial deposits can be traced as far upslope as 400 m water depth.

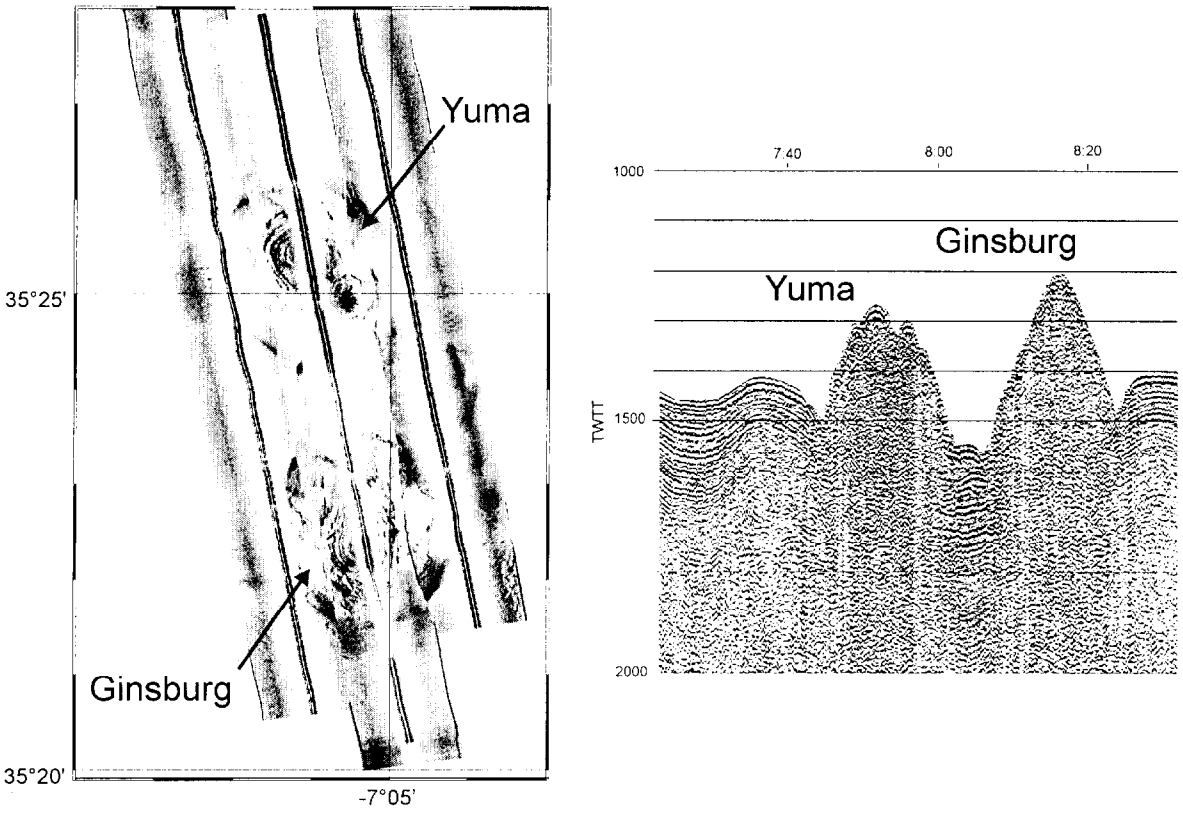
Preliminary investigations of cores taken from this slump suggest that the latest, large-scale mass flow event occurred around the last glacial maximum (18-20,000 years BP). Minor massflow activities may have occurred also in the postglacial/early Holocene time. The acoustic records and core data from the cruise prove that slope instability on the eastern Faeroe margin is more widespread than previously thought.

Evidence of strong current activity is provided by the occurrence of specific bedforms, and very coarse lag deposits showed a high percentage of non-basaltic material indicative of a non-Faeroes origin.

Two escarpments were surveyed with a high-resolution deep-towed side-scan sonar and a TV-controlled grab on the upstream sides of two very large enclosed deeps. The latter are found in the southern part of the Faeroe-Shetland Channel, where it nearly reaches its most restricted cross-section. These bedforms were first mapped with the GLORIA long range side-scan sonar, a medium range side-scan sonar and a single channel airgun seismic system in 1981 (RRS *Discovery* Cruise 123 Report, 1981). In a cross-section along the axis of the bottom current, the deeps have the profile of asym-metric scour holes, having steep upstream gradients and gentle down-stream gradients.



Brown tubes of pogonophores (arrows) found at Site AT-218G, TTR-9 cruise.



O.R.E.tech mosaic and seismic profile across the Ginsburg and Yuma mud volcanoes (Gulf of Cadiz, TTR-9 cruise).

Seismic profiles show that there is a seismic unit that outcrops at the escarpments and dips gently northwards. Presumably it is a particularly resistant horizon that has been an obstacle to flow through the Faeroe-Shetland Channel for a considerable period of time. Erosion due to turbulence created by the scarps is believed to have maintained these giant scour holes, possibly for a very long period of time.

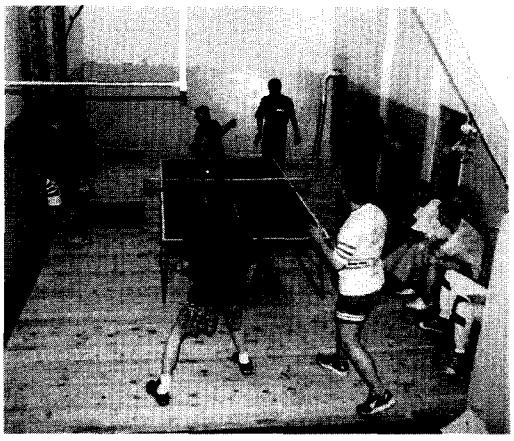
On the Portuguese margin, the contourites and sediment drift were studied, as well as mapping of the Lisbon Canyon System was continued, following the results of the TTR-8 expedition to the area. The existence of contourite deposits on the surveyed area was not fully confirmed. Potential areas were only recognised north and west of the Vigo Seamount, and in the basin located between the continental slope and the Porto Seamount. Bottom sampling within the Dom Carlos Valley yielded a small quantity of turbiditic sediments with no indication of contourites.

In future surveys, the packages showing the described wavy internal character should be considered as potential locations of sediment drifts formed by contour currents.

Three seismic lines were executed along with the OKEAN side-scan sonar scanning. This survey broadened the existing TTR-8 OKEAN mosaic and showed the development of the canyon system basinward down to the abyssal plain.

Three areas of mud volcanism and diapirism development were discovered in the Gulf of Cadiz. They were referred to as the Western Moroccan Field, Middle Moroccan Field and Eastern Moroccan Field for simplicity's sake. Six mud volcanoes were confirmed by bottom sampling. Acoustic data obtained suggest that there are at least five more mud volcanoes and four diapiric ridges.

The recovered deposits contain mud breccia frequently with evidence of fluid seepages. Moreover, in the Gulf of Cadiz gas hydrates and brown tubes of pogonophores were sampled for the first time. Chemo-synthetic communities and authigenic mineralization probably associated with hydrocarbon vents were found in several locations.



International championship onboard the Logachev

One underwater TV line showed a number of ripple types on the seabed within a channel cut by the Mediterranean Undercurrent, which is an active pathway for sand transport basinward.

In the Balearic and Alboran Basins, volcanic and metamorphic rocks of the basement were recovered allowing for better linking of complex marine-land geology of the area.

The OKEAN imagery obtained in the Balearic basin showed a variety of processes taking place in this part of the margin, such as basement outcropping, development of canyon systems and slope instability processes. These features were successfully mapped.

A mud volcano named Granada, associated with a mud diapiric field, was discovered on the Moroccan margin of the Alboran Sea. Some seismic, acoustic, and sampling data pointed to the presence of another mud volcano, named Marrakech, in the area.

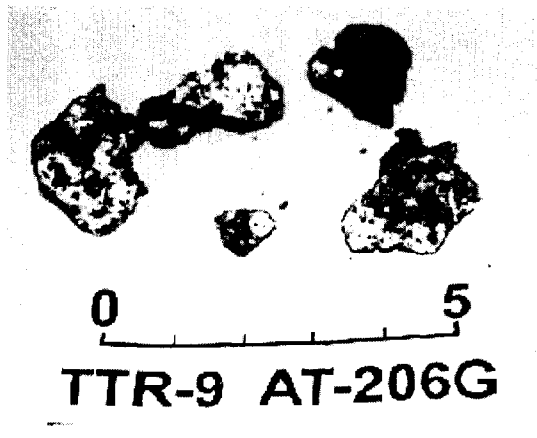
Coring on top of salt diapirs in the Balearic Basin allowed penetration of layers of sapropels.

Tribute to colleagues

Two mud volcanoes, discovered in the Gulf of Cadiz, were given names of two well-known marine scientists, who contributed substantively to studies of this and associated phenomena, in the Mediterranean-Black Sea region and other parts of the world: the late Cardiff University professor Rob Kidd (UK) and the late professor of the Research Institute for Geology and Mineral Resources of the Ocean Gabriel Ginsburg (Russia).

Rob Kidd, who died on 9 June 1996, was one of the enthusiastic supporters of the TTR programme. He took part in several TTR cruises as Co-chief Scientist and made a remarkable contribution to the training of students and young researchers from many countries.

The global geoscience community lost Gabriel Ginsburg, a world-renowned researcher in has hydrate studies, on 5 May 1999. Throughout his long career, Gabriel Ginsburg was an educator at heart, instilling in many students and post-graduates a real spirit of scientific research.



Samples of gas hydrates

TTR-related cruise

In 1999, one of the MSU young researchers, Pavel Shashkin, participated in a cruise, which took place in the NE Atlantic on board the RV *Belgica* (Belgium) (25 May - 7 June). During the cruise, a high resolution seismic survey was carried out in the area of carbonate mound development in the Porcupine Basin. Also a new underwater seismic system was successfully tested.

UNESCO Chair

In accordance with an Agreement between UNESCO and MSU (signed in 1994), the UNESCO Chair in Marine Geology and Geophysics is still functioning as part of the UNESCO-MSU Centre for Marine Geology and Geophysics, providing educational support to its research projects.

Particular attention was paid to the supervision of seven Ph.D. projects, in addition to a number of undergraduate projects.

Students carried out their research in the MSU laboratories, as well as in a number of research institutions in Russia, using data obtained during various TTR expeditions. Some of the researchers and students carried out their investigations abroad through agreements among the institutions participating in the TTR programme.

Research and training activities

In 1999, a series of group and individual training and research activities were carried out by the Chair. The selection of students for participation in the TTR-9 cruise was based on candidate submissions from the various Departments (such as Geology and Geochemistry of Fuel Minerals, Lithology and Marine Geology, Geophysics, Paleontology, etc.).

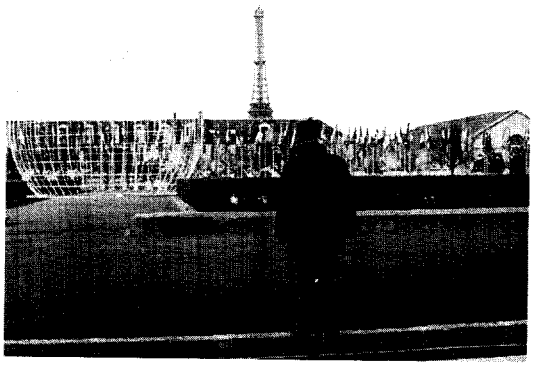
Well before the TTR expedition starts, students begin working in the laboratories and the MSU Science Park to learn the objectives of a particular expedition, to become acquainted with the geology of the study areas, the geological and geophysical methods to be used, and the equipment. Those selected are also given a series of lectures and seminars related to the subject of the cruise (March-May). Another series of seminar presentations (all together 29, June-July, see Annex III) took place onboard the RV *Logachev* during the TTR-9 cruise. Yet another series of courses was given in December, in preparation for the TTR-9 Post-cruise meeting (31 January-3 February 2000, Spain).

Professor Menchu Comas (Granada University, Spain) gives a talk to students (RV Logachev*)*

Individual training and research activities, undertaken through the Chair, included:

- P. Shashkin, a researcher from the Centre, participated in the RV *Belgica* cruise (May-June, see previous chapter) where, under the supervision of Prof. J.-P. Henriet (Gent University) he was involved in seismic investigations and data processing.
- S. Bouriak, an MSU Ph.D. student, visited (in March) the Department of Earth Sciences, University of Aarhus (Denmark) where, under the supervision of Prof. Holger Lykke-Andersen, Geophysical Institute, he processed multi-channel reflection seismic data acquired in 1998 during the RV *Pelagia* (The Netherlands) cruise to the Rockall Trough and Porcupine Basin.
- E. Kozlova, a researcher from the Centre, spent two months at the University Paris-VI (October to December) where, under the supervision of Dr. F. Baudin, she studied organic matter in rock clasts from mud volcano breccia. Data used for geochemical investiga-

tions were collected during the 1993-1999 TTR cruises in different mud volcanic areas, such as the Alboran Sea, Mediterranean Ridge, Anaximander Mountain area, the Central part of the Black Sea and the Sorokin Trough off Crimea, the NE Atlantic and the Gulf of Cadiz. Applied were methodology and techniques of the University's 'Laboratoire de Stratigraphie' and the 'Laboratoire de Chimie Bioorganique et Organique Physique' of CNRS. This visit was supported through the UNESCO Participation Programme grant.



E. Kozlova at UNESCO during her research visit to the University Paris-VI

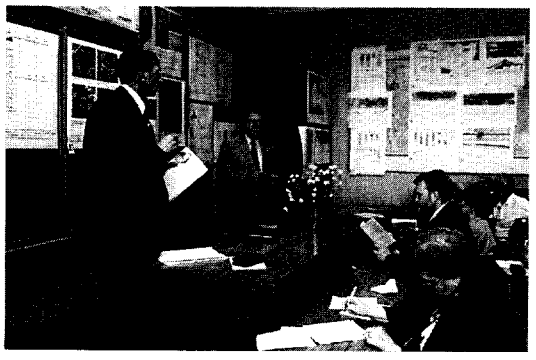
Dissertations defended

Tectonics of the Eastern Mediterranean during the Neogen-Quaternary

A D.Sc. thesis on the above subject was defended by A.F. Limonov (on 26 February 1999) at Moscow State University. This work is based on new data obtained during the TTR cruises of RVs *Gelendzhik* and *Professor Logachev* in the region (for more details, see the 'Floating University Facility Annual Report, 1998', UNESCO, 1999).

Focused hydrocarbon flows on deep-sea continental margins

M.K. Ivanov defended a D.Sc. thesis under the above title on 4 June at Moscow State University. Results of many years of investigations in newly discovered areas of extensive hydrocarbon gas flows in deep-sea parts of the Black and Mediterranean Seas and on the Norwegian continental margin are reported.



Dr M. Ivanov presents his D.Sc. thesis to the jury of the Geology Faculty, MSU

Critical analysis of data collected during the TTR cruises and comparison with published materials from other research projects have allowed to determine the main geophysical, geological, geochemical and biological indicators of focused fluid flows, as follows:
- presence of seismic and acoustic anomalies, such as BSR, 'bright spots', 'acoustic transparencies', 'acoustic turbidities', characteristic changes in the geometry of seismic boundaries due to velocity inversions, etc.;
- clay diapirs, mud volcanoes, pock-marks, large slides, fluidized mud flows, small-scale sedimentary folding and non-conformities;
- anoxic conditions in sub-bottom sediments, gas-saturated sediments, abnormal composition of pore-waters, crusts and nodules composed of carbonate (mainly aragonite, high-magnesium calcite and dolomite), presence of sulphides, phosphates, zeolites, etc. Moreover, the stable carbon isotope composition in carbonates is similar to that in methane in sediments;
- occurrence of bacterial mats, chemosynthetic communities, deep-water reefs.

Focused fluid flow areas are commonly attributed to basins with significant sediment thickness and volume; with high sedimentation rates or fast tectonic piling; and with the presence of thick clayey series enriched in organic matter; with deep faults connected to the surface.

The main sources for fluids in deep-sea basins are: water formed due to sediment lithification and dehydration of silica and clay

minerals; hydrocarbon gases; methane and hydrogen sulfide originating from methane-generation and sulfate reduction; fluids of gas hydrate dissociation.

The *causa proxima* for focused fluid flow formation is the occurrence of over-pressured sediments and the existence of zones with high vertical permeability. Faults, and particularly fault intersections, are ideal conductors of fluid flows where the vertical permeability increases by orders of three to four.

Hydrocarbons play the principal role in focused fluid flow formation and related processes. Methane charging through the seafloor is represented by a mixture of thermogenic methane, resulting from thermo-catalytic processes, and biogenic methane formed due to the bacterial destruction of organic matter and oil bio-degradation.

Feeder-channels of mud volcanoes and pock-marks serve as the main conduits for focused fluid flows. Processes taking place in the feeder-channel during the upward movement of liquefied pulp are very important for understanding the mechanisms of mud volcanism, and are discussed in the work for the first time.

Detailed descriptions of structures, morphologies, activities and erupted products of deep-sea mud volcanoes have demonstrated their similarity to on-land mud volcanoes. Major factors creating peculiarities in mud volcanic structures are the increased fluidization of mudflows and their migration velocity. The flow velocity is controlled by a pressure gradient, conduit permeability and the gas volume. With an increase in these parameters, the flow velocity also increases.

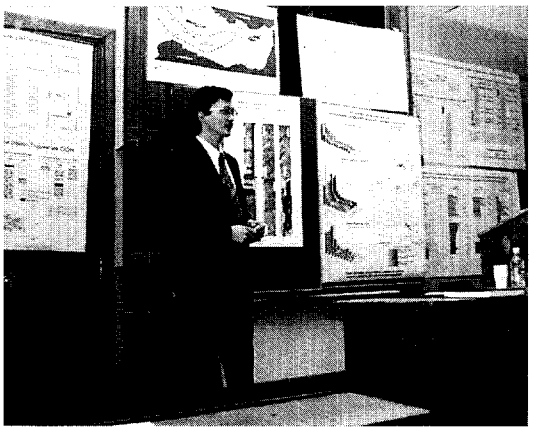
Continuous gas expansion during its upward migration causes a rapid density decrease (boiling-off effect) and turbulence in the flow. In a deep-sea environment, hydrostatic pressure limits the process of gas expansion. This negative effect is compensated by a significantly larger volume of fluids entering the feeder channel of a deep-sea mud volcano. A positive role is also played by the hanging effect, which diffuses the density difference between the erupted material and the host environment.

Areas of focused hydrocarbon flows on continental margins are shown to be indicators of oil and gas fields, which should be taken into account during the deep-sea exploration.

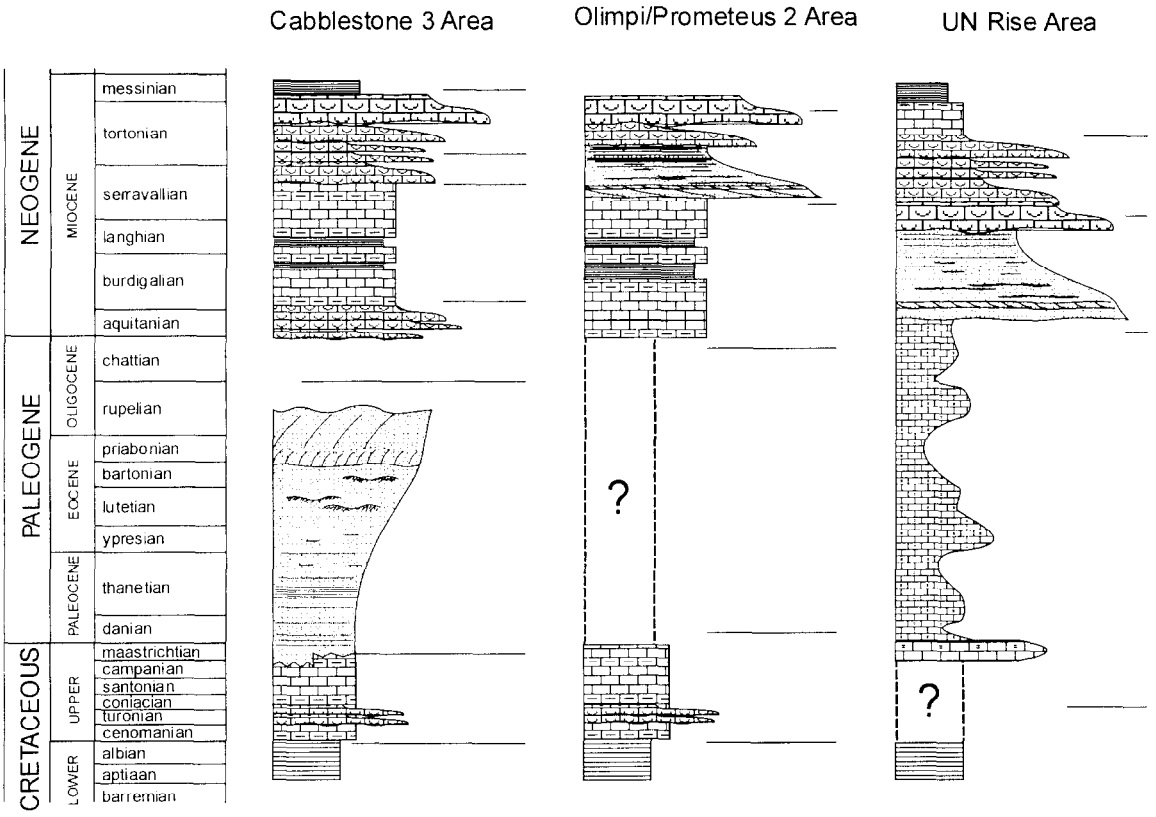
Lithology of Mud Volcanic Deposits in the Eastern Mediterranean

On 8 October, G.G. Akhmanov presented to the jury of the Geology Faculty (MSU), and successfully defended, his Ph.D. thesis on the 'Lithology of Mud Volcanic Deposits of the Eastern Mediterranean'. Included in this study are the results of several years of geological investigations in the TTR framework.

Mud volcanic deposits (mud breccia) of the Mediterranean Ridge are shown to be rather different from surrounding pelagic sediments and composed of very poorly sorted silty sandy clay, with significant gravel admixture. The composition of clay minerals in the matrix and clast lithologies vary for different mud volcanic areas of the Eastern Mediterranean and sometimes for different mud volcanoes within the same area. Large mud breccia clasts are represented by a wide variety of fragments of Early Cretaceous - Early Neogene sedimentary rocks, with different lithologies and genesis. Among mud breccia clasts of the Cabblestone-3 mud volcanic area, 16 main types of rock are defined. Rock fragments observed in mud volcanic deposits of the Olimpi/Prometheus-2 Area are represented by 12 main lithologies. Mud breccia clasts from the UN Rise Area can be described by 12 main rock types. Some lithologies, such as micrite, fossiliferous micrite and various mudstones, are common among the mud breccia clasts in all the mud volcanic areas studied. This indicates that some common sedimentary



G. Akhmanov presents his Ph.D. thesis to the jury of the Geology Faculty, MSU



Sedimentary series of the Mediterranean Ridge. Fragment of a reconstruction made on the basis of a study on mud volcanic deposits (G. Akhmanov, Ph.D. thesis, MSU, Russia).

series, through which the mud volcanoes erupted, extend throughout the whole Eastern Mediterranean. Most mud breccia clast types represented by various detritic carbonate and siliciclastic rocks are specific to certain mud volcanic areas and are not found in others. They reflect peculiarities of lithologies in their source formations, structural setting and geological evolution in different parts of the Eastern Mediterranean. Mud volcanic deposits provide important information on the deep-seated series composition and can be used for revealing the Eastern Mediterranean evolution: mud breccia clasts are the most informative source for these investigations. Optimal schemes for their study include: (a) detailed lithological description of every mud breccia clast recovered; (b) determination of lithotypes, groups of clasts of the same lithology - presumably fragments of the same series; (c) lithotype studies in thin sections, grain-size and XRD analyses, other precious methods and paleontological investigations; if required, correction of determined groups of rocks according to new data obtained; (d) lithotype genesis interpretation; (e) determination of assumed paragenetic association, the main sedimentary complexes, through which mud volcanoes erupted, on the basis of lithological peculiarities of determined groups of rocks, paleontological data and genetic interpretations; rocks of similar lithologies, dated with the same age interval, and deposited in the same environment represent one succession; (f) putting determined complexes in stratigraphic order, reconstruction of the whole sedimentary succession and geological evolution of the region.

Mud breccia composition suggests that a deep-sea basin has been present in the Eastern Mediterranean at least since Aptiaan time. A relatively narrow deep-water gulf of the south-western branch of the Neotethyan basin existed in the western sector of the Eastern Mediterranean at the end of the Early Cretaceous, serving as a cesspool for terrigenous clayey material. Thick clayey series have been deposited there. In the Late Cretaceous the gulf became bigger in size, the terrigenous input into its deep part diminished, carbonate pelagic sedimentation became predominant. At the end

of Late Cretaceous regional tectonic re-arrangement of Neotethyan basins caused intensive water circulation, leading to the accumulation of horizons of foraminiferal sands in narrow parts of the basin and on local highs. Paleogene time was characterized by diminishing basin areas and their possible separation from each other. Within dissociated basins a specific depositional environment was set up in accordance to the local geological and hydrological conditions. Clastic sedimentation prevailed. In the Miocene, several turbidite systems were widely developing in the region, with the predominant carbonate pelagic sedimentation.

The configuration of the Eastern Mediterranean basin has been changing significantly during its geological evolution, gradually approaching the present contours. Beside global sea-level fluctuations, sedimentation style has been affected by local tectonic movements in terrigenous provinces as well as within basins.

Dr. A.F. Limonov (MSU, Russia) supervised this work. At various stages of the study, supervision was also provided by Dr. M.K. Ivanov (MSU), Dr. M.B. Cita, Dr. I. Premoli (both University of Milan, Italy), and Dr. J.M. Woodside (Free University of Amsterdam, The Netherlands). Their assistance is highly appreciated.

'Grisha' Akhmanov at work, RV Logachev

Meetings and workshops

North-East Atlantic Slope Processes: Multidisciplinary Approaches (24-27 January, Southampton, UK)

International conference 'North-East Atlantic Slope Processes (NEASP): Multi-Disciplinary Approaches, Incorporating TTR-8 Post Cruise Conference, 4th ENAM II Workshop and IGCP Workshop 432 - Contourites and Bottom Currents' was organized and hosted by the Southampton Oceanography Centre. It was attended by 17 researchers and students from Russia, among over 140 participants.

The summary below is presented by Dr. Neil H. Kenyon, Chairman of the Organizing Committee.

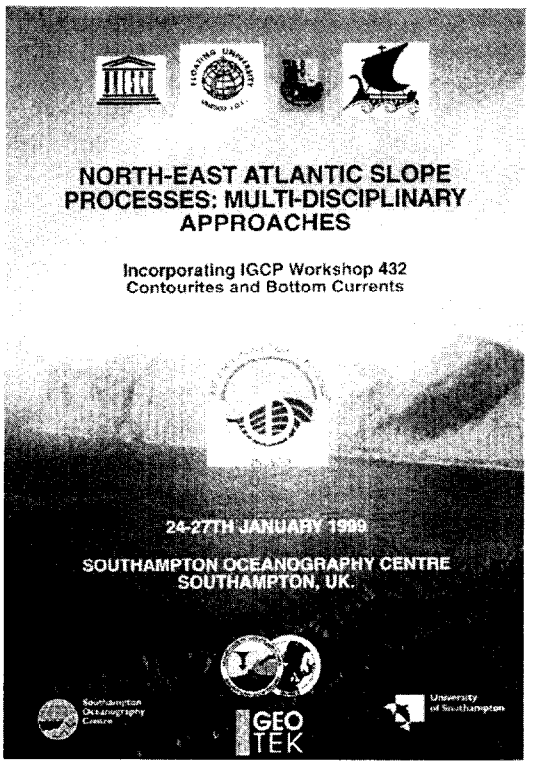
The meeting brought together over 140 participants from 16 countries (Belgium, Denmark (including the Faeroes), France, Germany, Ireland, Italy, The Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweden, Switzerland, the United Kingdom and the USA). Those attending included representatives of industry, international organizations, research organizations and students with research interests falling within the scope of the NEASP conference theme.

For two days prior to the conference, the annual meeting of the EC MAST supported ENAM (European North Atlantic Margins) programme was also held at the Southampton Oceanography Centre, and the same organizing team was responsible. About twenty delegates to this meeting stayed on for the conference.

The conference started with 45 delegates attending a field trip to the Isle of Wight, a nearby region of very variable Mesozoic and Tertiary rock, and complex geomorphology. It was led by Dr. Steve Hutt of the Museum of Isle of Wight Geology. Of particular interest were the areas of coastal landslides that resemble in some respect, though not in scale, the shape of large underwater landslides.

For the meeting to remain multidisciplinary in practice, a structure that mixed up the disciplines was adopted. The oral presentations were roughly ordered into:

- Instability on the European slope (including related ice-flow modeling)



- Weak currents and muddy sedimentation
- Strong currents and sandy sedimentation
- Cold water corals and carbonate mounds
- Mud diapirism

In total 47 papers were presented orally and some 21 posters were displayed.

The session on slope instability included the results of many new investigations of large submarine slides that have occurred in the North Atlantic. In addition to the well known Storegga Slide, there is now much data on other similar sized slide complexes. The Traenadjupet Slide of northern Norway has been found to be a composite of several sliding episodes. The North Faeroes Slide is also shown to have several failure events and the full extent of its area comparable to the Storegga Slide. North of the Faeroes a little known process of block transport, which has resulted in trail marks on the seafloor, was described. Even a small slide in the Faeroe-Shetland Channel was found to have several events. Glacigenic debris flows (GDFs) were shown to be widespread from the west of Ireland to northern Norway. An experimental approach revealed the conditions required for

hydroplaning such flows on a basal water layer. The observations of GDFs in the field were consistent with hydroplaning.

An overview of sand rich environments on continental slopes was given by Dr. Dorrik Stow. He pointed out the significance of studying sandy deep water environments; there are over 950 oil and gas discoveries from deep water turbidite systems. One such sandy fan on the floor of the Bay of Biscay has been found to include sands coming from the neighbouring Celtic Sea shelf during the present high sea level. In general, turbidity currents seem to be a subsidiary process in shaping the slopes off the North East Atlantic glaciated margin, but these were reported from the Rockall Trough and the Norwegian Sea. Currents strong enough to move sediment, as bedload, were reported from many places on the northeast Atlantic slopes. Modeling showed the potential for strong currents in the Rockall Trough. Support for the modeling work came from hydrographic measurements, as well as from observations of sandy sediments and bedforms. Sandy contourites and bedforms were observed at various depths in the Porcupine Seabight, the Rockall Trough, the Faeroe-Shetland Channel, the Greenland Basin and the Norwegian Sea.

Dr Laurenz Thomsen presented an overview of benthic boundary layer studies, including a possible solution to the benthic carbonate budget problem in relation to understanding soft bottom ecosystems. Studies of erosion and geochemistry at the soft bottom deep sea BENBO sites were discussed.

New techniques reported on included the SOC's autonomous vehicle, AUTOSUB, which is soon to be used on scientific missions below ice and in the deep ocean.

At the NEASP poster presentation

The new high resolution deep towed seismic system from the Renard Centre, Gent, showed promise as did the BOBO long term benthic lander. Several contributions showed the use of classification techniques for interpreting sidescan sonar imagery. Molecular genetic techniques were applied to bacteria and to the cold water coral *Lophelia porifera*. A technique for using chemical tracers to distinguish and assess the age of watermasses was applied in the Rockall Trough.

Several faunal types were reported on, such as foraminifera and cold water corals. Carbonate mounds have been discovered at new sites in the northern Rockall Trough, in addition to those first described at the 1998 post cruise meeting of the Training Through Research programme (IOC Workshop Report No. 143, UNESCO, 1998). The results of geochemical analysis on the giant mounds of the northern Porcupine Seabight show no evidence of methane, a disappointment for hydrocarbon prospecting.

A group of papers and posters were presented on gas hydrates, cold seeps and mud diapirism. Bottom simulating reflectors were discussed from the vicinity of the Storegga Slide. The same region has gas escape features such as pockmarks. Possible mud diapirs were reported from the Faeroe-Shetland Channel and the Porcupine Seabight. Proven mud diapirs were investigated on the northern Voring Plateau and from west of Bear Island (the Haakon Mosby mud volcano). There were reports on the geophysical results, the seep faunal studies and geochemistry of this spectacular mud volcano.

Within the multidisciplinary framework, the TTR-8 cruise reported a number of areas of interest. There were studies of canyons west of Lisbon, sliding processes north of the Faeroe Islands, the northern flank of the Storegga Slide and the nearby cemented floors associated with gas seepage. Solid gas hydrates were recovered from the Haakon Mosby mud volcano.

Subsidiary workshops included one on carbonate mounds and cold water corals, and another under the aegis of the IGCP 432 project on 'Contourites and bottom currents'. The Conference was very well attended. In fact, the venue was full. Unfortunately, the current turmoil in the hydrocarbon industry meant that fewer industry contributions were made than was hoped for. Many delegates

expressed their appreciation for the opportunity to discuss the exciting and timely new data presented at the meeting. The conference was a success mainly due to the diligence of the six student organizers from SOC, headed by Patrick Friend. These students had taken part in the 1998 TTR cruise to the northeast Atlantic continental margin. Necessary financial help came from the generosity of our sponsors, UNESCO/IOC, the Challenger
Division of SOC, Geotek Limited, the EC MAST ENAM project, the Atlantic Frontier Environmental Network and the Faeroes GEM Group.

One of the highlights during the conference at SOC was the visit of Mr. Yuri Fokin, the Russian Federation Ambassador to the UK, who met Russian scientists and students and talked about their work and involvement in international cooperation.

Ambassador Yuri Fokin meeting the Russian students during the NEASP Conference

Meetings of the TTR Executive Committee

The above Committee met twice in 1999. On 24 January, the meeting took place in SOC's Challenger Division. Results from the TTR-8 cruise, publication plans, as well as preliminary plans for the TTR-9 cruise were all discussed. M. Ivanov and A. Akhmetzhanov (MSU) both attended.

The second meeting of the Executive Committee was held on 23 October in UNESCO upon invitation by IOC. The meeting first discussed the main results of the TTR-9 cruise, and the cruise Summary Report was presented. The general agreement was that TTR-9 was a success.

Other items like conducting the TTR-9 post cruise meeting, preparation of the TTR-9 scientific report for publication by IOC, plans for the TTR-10 cruise in the year 2000, and a strategy for publication of the TTR results were also discussed.

Dr. J-P. Henriet (Gent University, Belgium) spoke of the advancement of a Practical Handbook (in preparation and in cooperation with the MSU team) for the TTR 10th Anniversary. This handbook will contain examples of seismic and side-scan images acquired during the last ten years of TTR cruises. Its preparation is funded by the Flemish Government.

M. Ivanov and E. Kozlova from MSU also attended this meeting.

Other meetings attended by the Centre staff and students

- VI International Conference of Undergraduate and Ph.D. Students on Fundamental Sciences ***Lomonosov - 99*** took place between 20-23 April at MSU, Moscow. A. Volkonskaya, a post-graduate student, presented two papers entitled 'Geological structure of the Mediterranean Ridge in the area between Crete and the Libyan continental margin' and (in co-authorship with E. Kozlova) 'Recent sedimentation on the Crimea-Caucasus continental margin (Northeastern Black Sea)'. A paper on 'Geochemistry of carbonate mud mound, Porcupine Basin, the Northeastern Atlantic margin' was presented by A. Stadnitskaya, a Ph.D. student. The Jury of the conference awarded diplomas to both the above Ph.D. students, in recognition of the results from their research.
- A. Sautkin, a Ph.D. student, attended the ***Annual Meeting of Young Paleontologists*** held in the Paleontological Institute of the Russian Academy of Science (14-15 May, Moscow), with a paper on 'Upper Pleistocene-Holocene calcareous nannoplankton stratigraphy and paleoclimate of the Iberian abyssal plain'.
- M. Ivanov attended the III International Conference ***New Ideas in Geology and Geochemistry of Oil and Gas*** (12-15 May, Moscow), with the paper 'Cold seeps on deep-sea floors', presenting an overview of the results from several years' investigations in the TTR framework.
- M. Baturin and E. Yakovlev, both undergraduate students, attended a short course on 'Introduction to seismic interpretation for students' organized during the ***61st EAGE***

Conference and Technical Exhibition (7-11 June, Helsinki).

• At the PACON 99 Congress ***Humanity and the World Ocean: Interdependence at the Dawn of the New Millennium*** (23-25 June, Moscow), several research papers on the results of TTR were presented by undergraduate and Ph.D. students. In co-authorship with prof. J.-P. Henriet (Gent University, Belgium), A. Almendinguer presented the paper 'Seismic study of ancient bottom currents in the Northern Porcupine Seabight'. M. Baturin presented a paper on 'Structure and origin of a large depression at the Faeroe Islands Margin'. A paper on 'Authigenic mineral formation in hydrocarbon gas-influenced sediments (Plateau Voring, NE Atlantic)' was presented by I. Belenkaya. E. Yakovlev presented a paper on 'Zones of distribution of the diapiric structures on the Voring Plateau'.

• In co-authorship with the Centre's staff and students, J. Gardner (Naval Research Laboratory, USA), presented to the ***American Geophysical Union Meeting*** (12-16 September, San Francisco, USA) a paper entitled 'Mud volcanoes on the Moroccan Continental Margin'. Providing the results of several TTR cruises, a paper on 'Geostatistical analysis of sidescan sonar imagery from the Porcupine Seabight, North Atlantic margin' was presented at the same meeting by V. Huvenne, an M.Sc. student (Gent University, Belgium), in co-authorship with the TTR team (incl. M. Ivanov).

• M. Ivanov and N. Kenyon (SOC, UK) participated in the ESF conference on ***Exploring the Deep Sub-Seafloor Biosphere*** (10-12 September, Leeds, UK) with a talk on 'Cold seeps on deep sea European Margins and related phenomena'.

• M. Ivanov attended, in his capacity as National coordinator of the Floating University project, the IOC-sponsored international seminar on the ***Caspian Floating University*** project (21-24 November, Astrakhan, Russia).

• At the EAGE International Conference ***Black Sea Geology*** (25-26 November, Kiev, Ukraine), A. Stadnitskayan and I. Belenkaya, both Ph.D. students, presented the joint paper 'Composition and Origin of Hydrocarbon Gas and its Influence on Diagenetic Carbonate Formation (Sorokin Trough, the Northeastern Black Sea)'. Dr. A. Limonov, in co-authorship with E. Kozlova and L. Meisner (Yuzhmorgeologiya, Genendzhik, Russia) presented a paper on 'Structure of the upper part of sedimentary cover in the Sorokin Trough (Crimean continental margin) and the origin of its folding'.

• Dr. A. Limonov attended, among others, the ***XIII International School for Marine Geology*** (22-27 November, Moscow) with a talk on the results of the TTR cruises.
I. Belenkaya, a Ph.D. student, presented a paper on 'Mineralogy and geochemistry of diagenetic carbonates formed in active hydrocarbon venting sites'.

• On 26 November, I. Belenkaya gave a talk on the 'Mineralogy-geochemical evidence of bacterial mediation in the formation of authigenic minerals in recent sediments of cold hydrocarbon seeps' at a ***Scientific Seminar of the Paleontological Institute***, RAS (Moscow).

• S. Bouriak and A. Akhmetzhanov, researchers from the Centre, presented results from the TTR-6 expedition at the International Conference ***Geological, Geophysical and Geochemical Investigations in the Black Sea*** (2-5 December, Tbilisi, Georgia). Their paper was entitled 'Origin of gas hydrates in the Sorokin Trough, Black Sea, based on geophysical data'. Another paper 'Evidence of authigenic carbonate precipitation in present-day cold hydrocarbon seeps (based on material collected through the TTR cruises)' was presented there by I. Belenkaya and A. Stadnitskaya. Dr. M. Ivanov gave an introductory talk on the 'Floating University' project.

• V. Krupskaya, associate Ph.D. student of the Centre and on behalf of TTR, attended a series of national and international meetings, which took place in Russia, namely: ***News in the Arctic and World Ocean Geology*** (1-3 January, St-Petersburg), ***Arctic-99*** (26-29 April, Moscow), ***Geodynamics and Geoecology*** (16-19 July, Arkhangelsk), and the ***XIII International School for Marine Geology*** (22-27 November, Moscow). She presented, in co-authorship with M. Ivanov and G. Akhmanov, several research papers on results from the TTR cruises in the North Atlantic.

• On 13-16 December, S. Bouriak attended the ***Schlumberger Forum*** (Paris, France) where he participated in discussions on the advancement of international cooperation in geophysics.

Cooperation and visits

Cooperation between MSU and Gent University (Belgium)

Under the MSU-Gent University Cooperation Agreement (signed in 1998), the Flemish Government continued providing funds for joint activities. Prof. J-P. Henriet and Dr. M. Ivanov have been supervising the preparation of the Practical Handbook containing examples of seismic and sidescan images acquired within the TTR programme. The Handbook is due for educational purposes and the work is run by P. Shashkin and S. Bouriak from MSU.

One Ph.D. student from MSU participated in a research cruise of RV *Belgica* (May-June) to the Porcupine Seabight (NE Atlantic).

Professor of Gent University (Belgium) J.-P.Henriet discussing the TTR results during the NEASP Conference (Southampton, January)

Two joint papers were presented by the MSU and Gent University researchers and students at the Conference on *'North-East Atlantic Slope Processes: multi-disciplinary approaches'* (NEASP, January, Southampton); one more paper was presented at the PACON-99 Congress *'Humanity and the World Ocean: Interdependence at the Dawn of the New Millennium'* (June, Moscow), and yet another paper at the *American Geophysical Union Meeting* (September, San Francisco, USA). Abstracts were published. S. Bouriak, A. Saoutkine (MSU) and M. Vanneste (Gent University) submitted a research paper to *Marine Geology* on 'Inferred Gas Hydrates and Clay Diapirs near the Storegga slide on the southern edge of the Voring Plateau, offshore Norway'.

Under the same Agreement, the MSU team was provided with some financial support.

Cooperation with NIOZ (The Netherlands)

In the framework of a cooperation agreement between the UNESCO-MSU Centre and NIOZ, S. Bouriak, an MSU Ph.D. student, visited the Department of Earth Sciences, University of Aarhus (Denmark), between 1 and 31 March. The aim of the visit was to process multichannel reflection seismic data acquired during a cruise to the Rockall Trough and Porcupine Basin, on the RV *Pelagia* (The Netherlands) in September-October 1998. Geological interpretation of processed data was fulfilled.

For several years now, NIOZ coordinates financial input to the TTR cruises from the co-operating partners and provides logistical support to the programme.

Cooperation with UNESCO/IOC

On invitation by the MSU Rector Prof. V. Sadovnichiy, Dr. Patricio Bernal, Executive Secretary IOC, visited Moscow State University on 19 May together with Dr. Yu. Oliounine, Deputy Executive Secretary IOC, and met with Vice-Rector and Dean of the Geology Faculty, Prof. V. Trofimov and Prof. B. Sokolov respectively. The meeting was also attended by a group of researchers and students from the UNESCO-MSU Centre. Dr. Bernal expressed the full support of IOC to the TTR programme. Among other items, Dr. Bernal raised the question of an extension of the Floating University project to other regions than Europe, specifically Latin America. Informal discussion with the demonstration of research results then proceeded in the Centre's laboratories, situated at the MSU Science Park.

On 25 October, Dr. M. Ivanov, Director of the Centre, met with Dr. Bernal in UNESCO and briefed him on the results of the TTR Executive Committee meeting, which took place on 23 October at the UNESCO Headquarters, on invitation by IOC. During this meeting, a final decision was made to send an IOC feasibility mission to Brazil, both to present the TTR results and approaches to Latin American colleagues and the Brazilian authorities, and to discuss the modalities of possible cooperation.

Dr. P. Bernal, IOC Executive Secretary (right) meets Prof. V. Trofimov, MSU Vice-rector

In 1999, IOC contributed to the TTR-9 cruise, supported travel for 17 researchers and students from the Centre to the TTR-8 post-cruise meeting (January, Southampton, UK), hosted and provided support to the TTR Executive Committee meeting (October, Paris) and organized and financed the feasibility mission to Brazil. Through IOC, the UNESCO-MSU Centre Annual Report (1998) and the scientific report from the TTR-8 cruise were published.

A proposal regarding the compilation of a Mediterranean Neogen-Quaternary Tectonic Map, put forward by Dr. A. Limonov, was considered at the IBCM Editorial Board Meeting held in Kaliningrad (Russia), in September 1999. It has a good chance of being included in time for the second edition of IBCM.

Between 8-13 November, the TTR mission (Neil Kenyon, Mikhail Ivanov and Serguei Bouriak) visited Brazil, on the initiative of IOC and invitation by the Brazilian Government. The aim of the visit was to investigate the possibility of an extension of TTR to Latin America. The mission visited principle scientific and university centres of the country in Rio de Janeiro, Porto-Alegre and Recife, and met with representatives of the Brazilian marine scientific community and oil industries. The Brazilian partners expressed their strong interest in both the scientific and educational components of the programme. It was emphasised that Brazil lacks research programmes for studying its deep margins, and that the TTR mission came just in time, as there is a strong need for training local specialists in the field of marine geoscience, in the use of modern equipment and methods of investigation, as well as in marine geological exploration. The discussions were summarised at a final meeting held at the Ministry of Science and Technology of Brazil, where His Excellency the Minister Ronaldo M. Sardenberg was informed about the results of the mission. The Minister expressed his interest in extending TTR to Brazilian waters and willingness to support these activities.

Visits to the Centre

- Already reported (see above) was the visit to the Centre, on 19 May, of the IOC Executive Secretary Dr. P. Bernal, together with Dr. Yu. Oliounine, Deputy Secretary, and Mr. V. Zhivago, Chief of the Department of the World Ocean, Climate and Earth Sciences of Russia's Ministry of Science and Technology.
- On 4-5 June, the Centre was visited by Dr. A. Suzyumov, UNESCO, regarding the TTR plans for the second half of 1999. Another visit was paid on 1-2 October, for further planning.
- In mid-September, a group of high-level representatives of the Max Plank Society (Germany) visited a number of Institutes of the Russian Academy of Sciences, in view of establishing bilateral co-operation. On 18 September, Professor of the Max Plank Institute of Microbiology and member of the delegation, Bo Barker Jorgensen, visited the UNESCO-MSU Centre. Researchers and students of the Centre demonstrated results of their studies, and a lively discussion took place focused on the importance of the development of new, dynamic research groups in Russia, and the ability of young scientists to participate in the international exchange of scientific ideas and data. It is hoped that the visit will lead to the establishment of mutually beneficial co-operation.

Awards and grants

• On 12 December, Dr. Ivanov was elected a Corresponding Member of the Russian Academy of Natural Sciences.

• Dr. M. Ivanov was also provided with a grant by the Soros International Science Foundation, in support of his educational activities related to the TTR programme.

• A. Volkonskaya, an MSU graduate student, A. Almendiguer and N. Amelin, both undergraduate students, were granted Soros Graduate Student Stipends in recognition of their results and to further support their research work.

• A special grant attributed to 'one thousand best young researchers of Russia and other States of the former Soviet Union' was awarded to A. Akhmetzhanov, a post-graduate student, by the Soros International Science Foundation, in support of his educational and research activities.

• O. Savotina and N. Amelin, both under-graduate students, were granted an award from the Southampton Oceanography Centre for best poster and oral presentations at the TTR Post Cruise Meeting held in Southampton, UK (January).

• In recognition of their advancement in research and education, A. Stadnitskaya and I. Belenkaya, both Ph.D. students, were granted fellowships by the President of the Russian Federation, to undertake further education and research activities in the best laboratories of their choice in Europe. The fellowships are awarded through the Russian Ministry of Higher and Professional Education, which selects the best students, in cooperation with the Administration of the President of the Russian Federation. Considering the very limited number of these fellowships, the selection of two students from the same group is in itself recognition that outstanding results have been achieved in professional education by the UNESCO Chair in Marine Geosciences at Moscow State University.

LIST OF INSTITUTIONS WHICH COOPERATED IN THE EXECUTION OF THE TTR PROGRAMME IN 1999

Algeria
Astrophysic, Astronomy and Geophysic Research Centre (AAGRC)

Belgium
University of Gent

Denmark
Geological Survey of Denmark and Greenland (GEUS)
University of Copenhagen

France
IFREMER Brest
University Paris-VI (Dept. 'Géologie sédimentaire')
Ecole Supérieure de Chimie ('Laboratoire de Chimie Bio-organique et Organique Physique' UA CNRS).

Georgia
Tbilisi University

Ireland
University College of Cork (UCC)

Italy
University of Genoa

Morocco
Mohamed V University

The Netherlands
Free University of Amsterdam
University of Utrecht
MEDINETH Dutch national programme
The Netherlands Institute for Sea Research (NIOZ)

Portugal
Instituto Geologico e Mineiro (IGM)
University of Aueiro
University of Porto

Russian Federation
Ministry of Natural Resources
Ministry of Science and Technologies
National Commission for UNESCO of the Russian Federation
National Oceanographic Commission of the Russian Federation
Paleontological Institute, RAS
Polar Marine Geological Expedition
P.P. Shirshov Institute of Oceanology, RAS
Research Institute for Geology and Mineral Resources of the Ocean
St. Petersburg University
V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS

Spain
Instituto Andaluz de Ciencias de la Tierra (IACT), University of Granada
University of Jaen

United Kingdom
Southampton Oceanography Centre (SOC)
University of Manchester
Statoil UK

USA
Naval Research Laboratory (NRL)

UNESCO
Intergovernmental Oceanographic Commission

NINTH TRAINING-THROUGH-RESEARCH CRUISE
RV *PROFESSOR LOGACHEV*

LIST OF PARTICIPANTS

Algeria
Lies Lakhal (Astrophysical, astronomy and geophysical research Centre (AAGRC), Bouzareah

Bangladesh
Asrarur Rahman Talukder (currently with University of Granada)

Denmark
Tove Nielsen (Geological Survey of Denmark and Greenland, Co-chief Scientist, Leg 1)
Anders Madsen (University of Copenhagen)
Antoon Kuijpers (Geological Survey of Denmark and Greenland)
Trier Pedersen (University of Copenhagen)
Malene Rank (University of Copenhagen)

Ireland
Andy Wheeler (University-College of Cork, Co-chief Scientist, Leg 1)

Italy
Adriano Mazzini (University of Genoa)

Morocco
Naima Hamoumi (Mohamed V University)

The Netherlands
John Woodside (Free University, Amsterdam)
Robin Koelewijn (Free University, Amsterdam)
Irene Zeldenrust (Free University, Amsterdam)
Tine Svaerborg (Netherlands Sea Research Institute, NIOZ)
Robert Janus (Marine Geological Group, Utrecht)

Portugal
Jose Monteiro (Instituto Geologico e Mineiro, Co-chief Scientist, Leg 2)
Luis Pinheiro (Instituto Geologico e Mineiro)
Fatima Teixeira (Instituto Geologico e Mineiro)
Rosa de Freitas (University of Aueiro)
Francisco Teixeira (Instituto Geologico e Mineiro)
Tiago Cunha (Instituto Geologico e Mineiro)
Monica Felicio (University of Porto)
Ana Hilario (University of Porto)

Russia
Research staff and students:
Michael Ivanov (Moscow State University, Co-Chief Scientist, Legs 1-3)
Oleg Krylov (Moscow State University)
Alexey Bobrov (Moscow State University)

Alexey Gongalsky (Moscow State University)
Sergey Buryak (Moscow State University)
Alexandr Grachev (Moscow State University)
Elena Zyryanova (Moscow State University)
Pavel Shashkin (Moscow State University)
Anna Volkonskaya (Moscow State University)
Nikolay Amelin (Moscow State University)
Evgeny Petrov (Moscow State University)
Grigorii Akhmanov (Moscow State University)
Andrey Akhmetjanov (Moscow State University)
Elena Kozlova (Moscow State University)
Alexander Sautkin (Moscow State University)
Alexey Sadekov (Moscow State University)
Dmitry Ovsyannikov (Moscow State University)
Dmitry Goncharov (Moscow State University)
Ellina Suslova (Moscow State University)
Alina Stadnitskaya (Moscow State University)
Irina Belenkaya (Moscow State University)
Leonid Mazurenko (St. Petersburg University, St. Petersburg)
Yulya Volkova (VNIIOkeangeologija, St. Petersburg)

Technical support staff from the Polar Marine Geological Expedition, St. Petersburg
Alexey Krotov (Shipboard Chief Scientist)
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Victor Sheremet
Valentin Konfetkin
Victor Sidorchuk
Alexandr Plakhotnik
Sergey Luybimov
Alexandr Ivanov
Alexandr Marakulin
Vyacheslav Gladush
Vasily Tokmenko
Vladislav Malin
Alexey Nazarov
Alexandr Nescheretov

Spain
Menchu Comas Minondo (University of Granada, Co-chief Scientist, Leg 3)
Francisca Martinez Ruiz (University of Granada)
Juan-Manuel Fernandez Soler (University of Granada)
Juan Ignacio Soto Hermoso (University of Granada)
Jose Miguel Azanyn Hernandez (University of Granada)
Mario Sanchez Gomez (University of Jaen)
Javier Prades Vilarroya (University of Granada)
Abel Zahinos Ruiz (University of Granada)
Guillermo Booth (University of Granada)
Jorge Gutierrez Meseguer (University of Granada)

UK
Neil Kenyon (Southampton Oceanography Centre, Co-chief Scientist, Leg 2)
Rasul Najeeb (Southampton Oceanography Centre)
Daniel Dixon (Southampton Oceanography Centre)
Marianthi Lavrentaki (Southampton Oceanography Centre)
Tiago Alves (University of Manchester)

USA
Joan Gardner (Naval Research Laboratory, Washington)

NINTH TRAINING-THROUGH-RESEARCH CRUISE
RV *PROFESSOR LOGACHEV*

LIST OF SEMINAR PRESENTATIONS

LEG 1

12 June Tove Nielsen (GEUS, Denmark): Phenomena to be investigated around the Faeroe Islands

13 June Tine Svaerdborg (NIOZ, The Netherlands): Tectonic, Sedimentation and Deep-water Circulation in the Rockall Trough Area

14 June Antoon Kuijpers (GEUS, Denmark): Norwegian Sea Overfloor Through the Faeroe-Shetland Channel and North Atlantic Circulation during the Late Quaternary

16 June Alexandr Sautkin (MSU, Russia): Calcareous Nannofossils from the Carbonate Mud Mounds and Paleoclimatic Reconstraction (Porcupine, North Atlantic)

17 June Andrey Akhmetzhanov (MSU, Russia): Strong Bottom Current-Related Features in the Eastern and Northern Porcupine Seabight

18 June Leonid Mazurenko (St. Petersburg University): Lithological Characteristics of Holocene- Late Pleistocene Sediments from the Carbonate Mounds of the Porcupine Seabight

19 June Andy Wheller (University College Cork, Ireland): Rockall's Return: New Baseline Data for Hydrocarbon Prospects

26 June Tove Nielsen (GEUS, Denmark), Anders Madsen and Trier Pedersen (both Copenhagen University, Denmark): Mass Flows and Current Induced Features: Preliminary Results of the TTR-9 Studies on the Eastern Faeroes Margin

27 June Andy Wheller (University College Cork, Ireland): Acoustic Seabed Detection and Classification Techniques

28 June Discussion on Preliminary Results of the Data Obtained, Leg 1 (Reports from the Heads of Research Teams)

LEG 2

2 July Jose Hipolito Monteiro (Instituto Geologico e Mineiro, Portugal): Sedimentary Processes on the Portuguese Margin

3 July Neil Kenyon (SOC, UK): High Input and Low Input Turbidite Systems: Indus Fan and West Corsica

4 July Joan Gardner (NRL, USA): Mud Volcanoes in the Gulf of Cadiz

5 July Alexander Sautkin (MSU, Russia): Upper Pleistocene-Holocene Calcareous Nannoplankton Stratigraphy and Palaeoclimates of the Iberian Abyssal Plain

6 July Michael Ivanov (MSU, Russia): Acoustic Evidence for Gas in Marine Sediments

7 July Najeeb Rasul (SOC, UK): Sediments of the Indus Fluvial-Marine System

8 July Alina Stadnitskaya (MSU, Russia): Geochemical Studies of Carbonate Mounds on the Eastern Rockall Trough Margin

9 July Tiago Alves (Instituto Geologico e Mineiro, Portugal): Tectonics and Deposition at the Deep-water Area Adjacent to Porto and Vigo Seamounts

10 July Jose Hipolito Monteiro (IGM, Portugal), Tiago Alves (University of Manchester), Neil Kenyon (SOC, UK), Grigorii Akhmanov, Alexander Sautkin (both MSU, Russia): Preliminary Results of the Data Obtained on the Portuguese Margin

12 July Irina Belenkaya (MSU, Russia): Authigenic Carbonates as Gas-related Phenomenon in Recent Sediments

13 July Malene Rank (Denmark): The Development of Salt Structures in Denmark and Adjacent Areas

14 June Preliminary Results of the Data Obtained, Leg 2 (Reports from the Heads of Research Teams)

LEG 3

20 July Menchu Comas (Granada University, Spain): The Alboran and South Balearic Basins: Background and Objectives of the BASACALB Leg

21 July Juan Ignasio Soto (Granada University, Spain): Tectonic Significance of the Metamorphic Basement of the Alboran Sea, at ODP-site 976

22 July John Woodside (Free University, the Netherlands): Eastern Mediterranean Mud Volcanoes Revisited by John Woodside (video)

23 July Grigorii Akhmanov (MSU, Russia): Mediterranean Mud Volcanoes: a Look into Deep Stratae

24 July Alina Stadnitskaja, Elena Kozlova, Irina Belenkaja (MSU, Russia): Set of Geochemical Investigations of Venting Areas

25 July Joan Gardner (NRL, USA): Preliminary results from TTR-9, leg 2, Gulf of Cadiz/Moroccan margin

26 July Menchu Comas, Juan Ignasio Soto (both Granada University, Spain), Grigorii Akhmanov and Alexandr Sautkin (both MSU, Russia): Preliminary results of the data obtained, Leg 3

LIST OF PUBLICATIONS
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LIST OF ACRONYMS

BSR	Bottom simulating reflector
EAGE	European Association of Geoscientists and Engineers
ENAM	European North Atlantic Margins project
GDFs	Glacigenic debris flows
GEUS	Geological Survey of Denmark and Greenland
GLORIA	long range sidescan sonar system (UK-made)
IBCM	International Bathymetric Chart of the Mediterranean
IFREMER	French Institute for the Sea Exploration
IGCP	International Geological Correlation Programme (of UNESCO and IUGS)
IOC	Intergovernmental Oceanographic Commission of UNESCO
IUGS	International Union of Geological Sciences
MSU	Moscow State University
NIOZ	Netherlands Institute for Sea Research
OKEAN	long range sidescan sonar system (Russia-made)
O.R.E.tech	deep towed sidescan sonar system
RAS	Russian Academy of Science
RV	Research Vessel
TEMA	Training, Education and Mutual Assistance programme of IOC
TTR	Training-through-Research programme
UNESCO	United Nations Educational, Scientific and Cultural Organization