

Training-through-Research Programme

over a decade of efforts



towards understanding geosphere-biosphere coupling processes

General Information

Facilities

Cruises

Research

Contacts





Training-through-Research Programme

General Information

In operation since 1991, the Training-through-Research (TTR) programme puts together the advantages of the formal training of undergraduate and post-graduate students and young scientists with the experiences gained in advanced research. Its main operational field is marine geology and geophysics combined in an interdisciplinary way with studies in benthic biology and physical oceanography. The new TTR focus is on studying processes of geosphere-biosphere coupling in high-seas.

The programme's seeds were planted during discussions at a UNESCO workshop on 'Marine Science Education and Training for the year 2000' (Paris, 1988) and subsequently at the UNESCO 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 component and more recently through the Ocean Sciences Programme.

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

The annual TTR cycle of activities includes:

- preparation of a cruise by the Executive and Scientific Committees;
- the TTR cruise, with (when possible) a mid-cruise workshop and/or field excursion for the participants and invited scientists;
- data processing and analyses, preparation and publication of scientific reports;
- a post-cruise conference to present and discuss the results of on-going analysis and interpretation of data, and to co-ordinate with other regional studies;
- preparation of scientific publications.

In the period 1991-2001, eleven major TTR cruises were conducted in the Mediterranean and Black Seas and in the northeastern Atlantic. Ten post-cruise conferences were held in: Moscow (1993, 1996 and 2001), Amsterdam (1994 and 1997), Cardiff (1995), Gent (1998), Southampton (1999), Granada (2000) and Aveiro (2002). 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.

About 500 scientists and students have taken part in the cruises. They hailed from some 25 countries mostly scattered around the North Atlantic, Black Sea and Mediterranean regions, but 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. TTR is open for co-operation to all those interested in making break-through research and gaining new experience through training in multi-disciplinary science.

*P. Bernal, Executive Secretary IOC
N.H. Kenyon, TTR Co-ordinator, SOC*

Training-through-Research Programme

Facilities



TTR uses large, well equipped, marine geoscience research ships to do both leading edge research and provide training to young geoscientists. Five cruises in the Mediterranean and Black Seas were carried out onboard R/V *Gelendzhik* and more recent work in the northeast Atlantic was carried out onboard R/V *Professor Logachev*, both ships belonging to the Ministry of Natural Resources of the Russian Federation.

The main TTR work area is the deep-water part of continental margins. The suite of onboard equipment normally includes:

- GPS/DGPS navigation system

Linked to the system thrusters provide highly accurate dynamic positioning of the ship. A short base underwater navigation system is used for accurate positioning of deep-towed instruments and corers

- High-resolution single-channel air gun seismic system

- Hull-mounted 3.5-7 kHz profiler

- 10 kHz OKEAN long range sidescan sonar

The system is used primarily for regional scale acoustic seafloor mapping in the depth range from 500 to 6000 m

- 30/100 kHz dual-mode high resolution deep-towed sidescan sonar system (OREtech or MAK) with built-in sediment profiler (3.5-7 kHz)

The instrument allows high resolution (on meter scale) acoustic seafloor mapping in both shallow and deep-water environments

- Deep-towed video survey system

- TV guided grab sampler

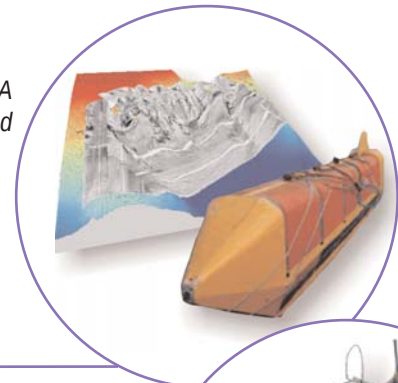
- Variety of dredges

- Box corer

- Large diameter (146 mm), 6 m long gravity corer

- Kastenlot corer

- CTD



Training-through-Research Programme

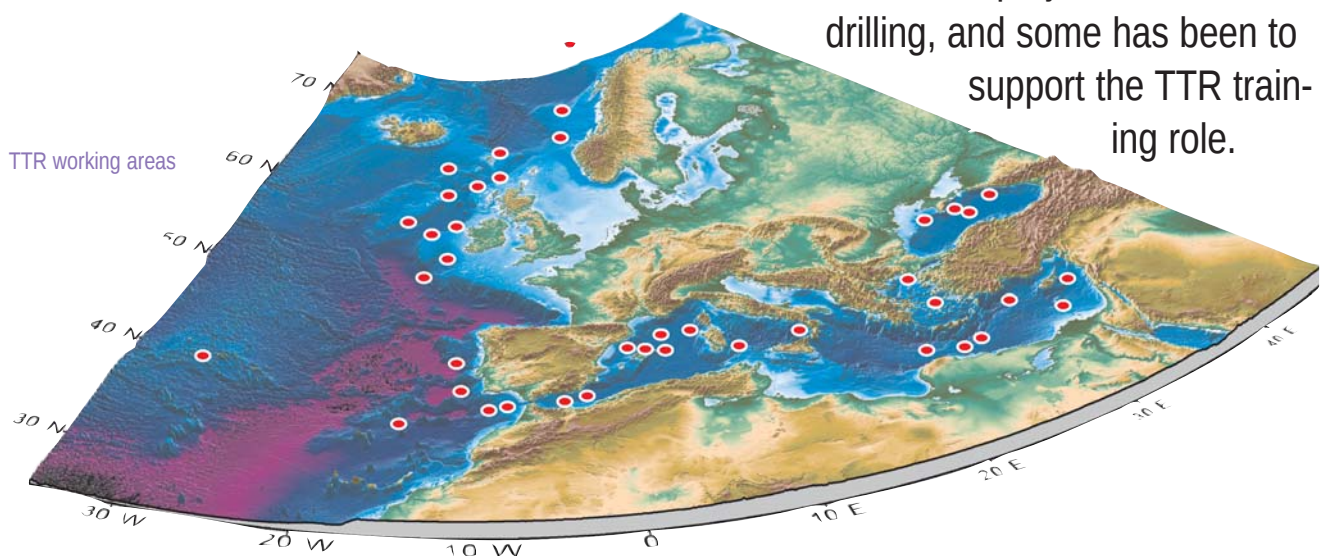
Cruises

Since 1991 TTR Programme has been carrying out annually at least one major research cruise to the deep ocean. A typical campaign includes:

- Several legs of up to 3 weeks long led by an international group of co-chief scientists
- An international scientific party of 30-40 people (researchers and students) on each leg
- A mixture of experiences, disciplines and cultures
- A post-cruise meeting about 6 months after a cruise



Funds come from a number of sources. The funding is ensured by making (i) first-rate scientific proposals and (ii) making full use of the wide range of advanced equipment and the high standard of technical support provided on the ships. Long-term funds have come from the European Science Foundation and currently from the Intergovernmental Oceanographic Commission of UNESCO. Some of the funding has come from sources that appreciate the fundamental science being done, some has been for hydrocarbon exploration and environmental studies in areas of projected offshore drilling, and some has been to support the TTR training role.



Training-through-Research Programme

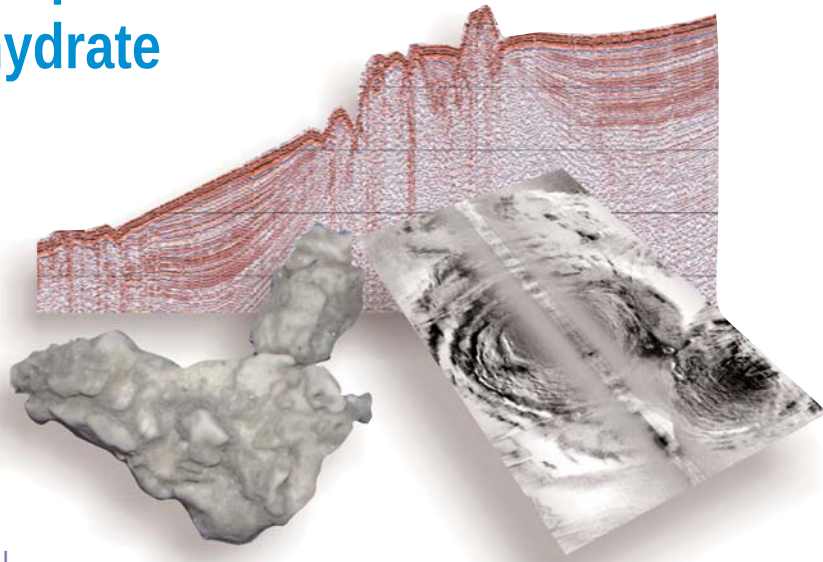
Research



Since 1991, TTR has been actively involved in multi-disciplinary deep-sea geoscience studies. In addition to cruises, the research includes data processing in leading universities and laboratories of the countries involved. The results of this work have appeared in more than 50 refereed papers in scientific journals including special issues of *Marine Geology* (#132, 1996) and *Geo-Marine Letters* (#18, 1998) and in annual comprehensive cruise reports published by UNESCO and the IOC.

Mud volcanism/clay diapirism and related gas and gas hydrate occurrences

Areas with active processes of mud diapirism/volcanism and fluid venting were a focus of most of the TTR cruises. Locations studied extend from the Black Sea to the Bear Island margin off Norway. Dozens of mud volcanoes and diapirs were mapped, directly observed by underwater video surveys and sampled in the Mediterranean and Black Seas, Gulf of Cadiz, Voring Plateau and Bear Island Trough area. A broad range of studies has been conducted as the result of this work:

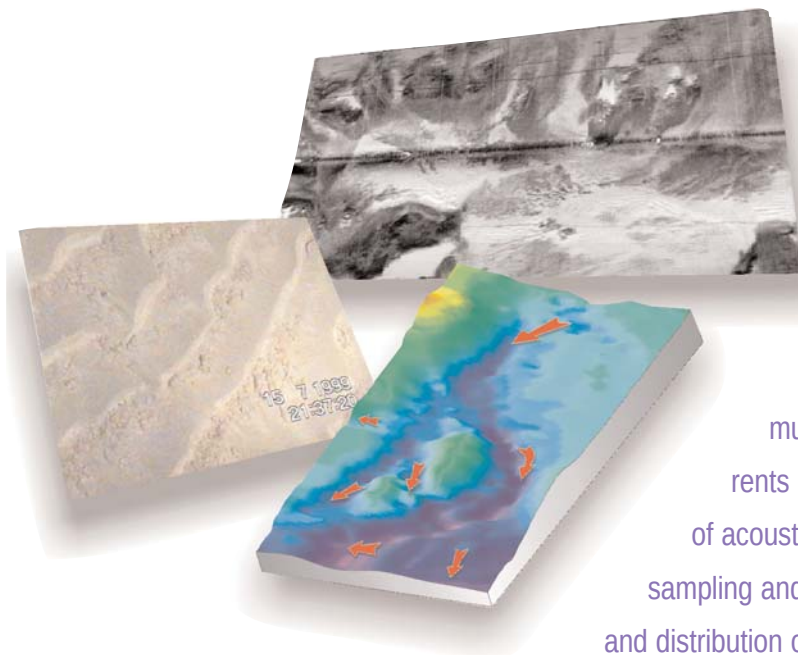


- Analyses of mud breccia clasts for partial reconstruction of the stratigraphic succession (which reduces the need for expensive deep-sea drilling);
- Analyses of seismic and acoustic images of diapiric fields and gas-related structures (such as Bottom Simulation Reflectors, acoustic voids and bright spots);
- Chemical composition of gas and gas hydrates;
- Gas-related authigenic mineral assemblages in deep-water sediments;
- Multi-disciplinary studies of geosphere-biosphere coupling processes

SELECTED PUBLICATIONS

- Gardner, J.M. 2001. Mud volcanoes revealed and sampled on the Western Moroccan continental margin. *Geophysical Research Letters*, 28/2, 339-342.
- Bouriak, S., Vanneste M., Saoutkine A., 2000. Inferred gas hydrates and clay diapirs near the Storegga Slide on the southern edge of the Voring Plateau, offshore Norway. *Marine Geology*, 163, 125-148.
- Akhmanov, G.G. and Woodside J.M., 1998. Mud Volcanic Samples in the Context of the Mediterranean Ridge Mud Diapiric Belt. In: Robertson, A.H.F., Emeis, K.-C., Richter, C., and Camerlenghi, A. (Eds.), *Proc. ODP, Sci. Results*, 160: College Station, TX (Ocean Drilling Program), 597-605.
- Bouriak, S.V. and Akhmetjanov, A.M., 1998. Origin of gas hydrate accumulations on the continental slope of the Crimea from geophysical studies. In: J.P. Henriet and J. Mienert (Eds.) *Gas Hydrates: Relevance to World Margin Stability and Climatic Change*. *Geol. Soc. of London Spec. Publ.*, 137, 215-222.
- Egorov, A.V. and Ivanov, M.K., 1998. Hydrocarbon gases in sediments and mud breccia from the central and eastern part of the Mediterranean Ridge. *Geo-Marine Letters*, 18, 127-138.
- Gaynanov, V.G., Bouriak, S.V. and Ivanov, M.K., 1998. Seismic evidence for gas accumulation related to the area of mud volcanism in the deep Black Sea. *Geo-Marine Letters*, 18, 139-145.
- Ivanov, M.K., Limonov, A.F., and Woodside, J.M. Extensive deep fluid flux through the sea floor on the Crimean continental margin (Black Sea). 1998. In: J.-P. Henriet and J. Mienert (Eds.). *Gas Hydrates: Relevance to World Margin Stability and Climatic Change*. *Geol. Soc. of London Spec. Publ.*, 137, 195-214.
- Kopf, A., Robertson, A.H.F., Clennell, M.B. and Flecker, R., 1998. Mechanisms of mud extrusion on the Mediterranean Ridge accretionary complex. *Geo-Marine Letters*, 18, 97-114.
- Woodside, J.M., Ivanov, M.K., Limonov, A.F., and Shipboard Scientists of the ANAXIPROBE Expedition. Shallow gas and gas hydrates in the Anaximander Mountains region, Eastern Mediterranean Sea. 1998. In: Henriet, J.-P. and Mienert, J. (Eds.) *Gas Hydrates: Relevance to World Margin Stability and Climatic Change*. *Geol. Soc. of London, Spec. Publ.*, 137, 177-193.
- Cronin, B.T., Ivanov, M.K., Limonov, A.F., Egorov, A.V., Akhmanov, G.G., Akhmetjanov, A.M., and Kozlova, E.V., 1997. New discoveries of mud volcanoes on the Eastern Mediterranean Ridge. *Journ. Geol. Soc., London*, 154, 173-182.
- Limonov, A.F., van Weering, T.C.E., Kenyon, N.H., Ivanov, M.K., and Meisner, L.B. 1997. Seabed morphology and gas venting in the Black Sea mud volcano area: observations with the MAK-1 deep-tow sidescan sonar and bottom profiler. *Marine Geology*, 137, 121-136.
- Akhmanov, G.G., 1996. Lithology of mud breccia clasts from the Mediterranean Ridge. *Marine Geology*, 132, 151-164.
- Cita, M.B., Erba, E., Lucchi, R., Pott, M., van, d.M.R. and Nieto, L., 1996. Stratigraphy and sedimentation in the Mediterranean Ridge diapiric belt. *Marine Geology*, 132, 131-150.
- Corselli, C. and Basso, D., 1996. First evidence of benthic communities based on chemosynthesis on the Napoli mud volcano (eastern Mediterranean). *Marine Geology*, 132, 227-239.
- De Capitani, L. and Cita, M.B., 1996. The "marker-bed" of the Mediterranean Ridge diapiric belt; geochemical characteristics. *Marine Geology*, 132, 215-225.
- Galindo, Z.J., Nieto, L. and Woodside, J.M., 1996. Structural features of mud volcanoes and the fold system of the Mediterranean Ridge, south of Crete. *Marine Geology*, 132, 95-112.
- Ivanov, M.K., Limonov, A.F. and van Weering, T.C.E., 1996. Comparative characteristics of the Black Sea and Mediterranean Ridge mud volcanoes. *Marine Geology*, 132, 253-271.
- Limonov, A.F., Woodside, J.M., Cita, M.B. and Ivanov, M.K., 1996. The Mediterranean Ridge and related mud diapirism; a background. *Marine Geology*, 132, 7-19.
- Premoli Silva, I., Erba, E., Spezzaferri, S. and Cita, M.B., 1996. Age variation in the source of the diapiric mud breccia along and across the axis of the Mediterranean Ridge accretionary complex. *Marine Geology*, 132, 175-202.
- van der Meer, R., 1996. Grading in mud volcanic breccia from the Mediterranean Ridge. *Marine Geology*, 132, 165-173.
- Volgin, A.V. and Woodside, J.M., 1996. Sidescan sonar images of mud volcanoes from the Mediterranean Ridge; possible causes of variations in backscatter intensity. *Marine Geology*, 132, 39-53.
- Wakefield, S.J. and O'Sullivan, G.M., 1996. The inorganic geochemistry of a Mediterranean Ridge mud breccia. *Marine Geology*, 132, 203-214.
- Woodside, J.M. and Volgin, A.V., 1996. Brine pools associated with Mediterranean Ridge mud diapirs; an interpretation of echo-free patches in deep tow sidescan sonar data. *Marine Geology*, 132, 55-61.

Sands on continental margins

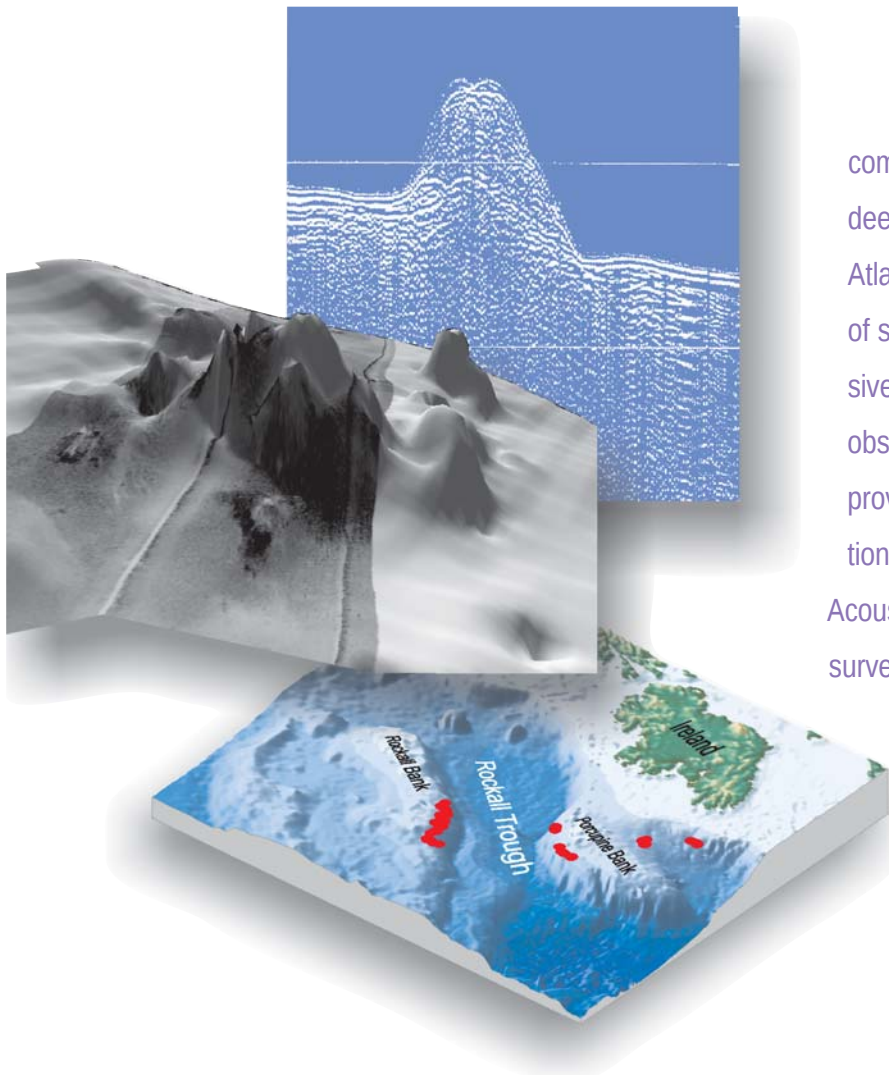


Investigation of sand-dominated margin systems as analogues for hydrocarbon reservoirs is one of the major tasks of TTR. Several sand-rich deep-sea fan systems in the Western Mediterranean have been mapped and cored. In many places on the North Atlantic continental margin significant accumulations of sand deposited by strong bottom currents have been discovered and investigated. Integration of acoustic seafloor mapping with ground truthing by bottom sampling and video observations helps to understand geometry and distribution of sand bodies in such sedimentary systems.

SELECTED PUBLICATIONS

- Kenyon, N.H., Akhmetzhanov, A., Nielsen, T., Kuipers, A., Ivanov, M. and Shashkin, P., Sandy contourites and pathways of the Norwegian Sea overflow water, west of the Faeroe Bank Channel. In: Mienert, J. and Weaver, P. (Editors), European margin sediment dynamics. Side-scan sonar and seismic images. *In Press*
- Wheeler, A.J., Kenyon, N.H., Ivanov, M.K., Cronin, B.T., McDonnell, A., Schenke, H.W., Akhmetzhanov, A.M., Satur, N. and Zaragosi, S., Canyon heads and channel architecture of the Gollum Channel, Porcupine Seabight. In: Mienert, J. and Weaver, P. (Editors), European margin sediment dynamics. Side-scan sonar and seismic images. *In Press*
- Cronin, B.T., Hurst, A., Akhmanov, G., Spadini, G. and Rocchini, P. 2000. Predicting deep-water turbidite reservoir quality and geometry: deepwater examples off West Africa, Rockall. *Offshore Magazine (International Edition)*, 60, 11, 98-101.
- Kidd, R.B., Lucchi, R.G., Gee, M. and Woodside, J.M., 1998. Sedimentary processes in the Stromboli Canyon and Marsili Basin, SE Tyrrhenian Sea; results from side-scan sonar surveys. *Geo-Marine Letters*, 18, 146-154.
- Lucchi, R.G. and Kidd, R.B., 1998. Sediment provenance and turbidity current processes at the Lametini Seamounts and Stromboli Canyon, SE Tyrrhenian Sea. *Geo-Marine Letters*, 18, 155-164.
- Morris, S.A., Alexander, J., Kenyon, N.H. and Limonov, A.F., 1998. Turbidites around an active fault scarp on the lower Valencia Fan, northwest Mediterranean. *Geo-Marine Letters*, 18, 165-171.
- Morris, S.A., Kenyon, N.H., Limonov, A.F. and Alexander, J. 1998. Downstream changes of large-scale bedforms in turbidites around the Valencia channel mouth, north-west Mediterranean: implications for palaeoflow reconstruction. *Sedimentology*, 42, 365-377.
- Torres, J., Droz, L., Savoye, B., Terentieva, E., Cochonat, P., Kenyon, N.H., and Canals, M. 1997. Deep-sea Avulsion and Morphosedimentary Evolution of the Rhone Fan Valley and Neofan during the Late Quaternary (North-western Mediterranean Sea). *Sedimentology*, 44, 457-477.
- Palanques, A., Kenyon, N.H., Alonso, B., and Limonov, A.F., 1996. Erosional and depositional patterns in the Valencia Channel Mouth: an example of a modern channel-lobe transition zone. *Mar. Geophys. Res.*, 18, 103-118.
- Cronin, B.T. Structurally-controlled Deep-sea Courses: Examples from the Miocene of Southeast Spain and the Alboran Sea, Southwest Mediterranean. 1995. In: A.J. Hartley and D.P. Prosser (Eds.), Characterization of Deep Marine Clastic Systems. *Geological Society Special Publication* No 94, 115-135.
- Cronin, B.T., Kenyon, N., Woodside, J., den Bezemer, T., van der Wal, A., Millington, J., A., Ivanov, M., and Limonov, A., 1995. The Almeria canyon: a meandering channel system on an active margin, Alboran sea, Western Mediterranean. Pickering, K.T., Hiscott, R.H., Kenyon, N.H., Ricci Lucchi, F., and Smith, R.D.A. (Eds.), *Atlas of Deep Water Environments. Architectural Style in Turbidite Systems*, London: Chapman and Hall, 84-88.
- Kenyon, N.H., Millington, J., Droz, L., and Ivanov, M.K., 1995. Scour holes in a channel-lobe transition zone on the Rhone cone. Pickering, K.T., Hiscott, R.H., Kenyon, N.H., Ricci Lucchi, F., and Smith, R.D.A. (Eds.), *Atlas of Deep Water Environments. Architectural Style in Turbidite Systems*, London: Chapman and Hall, 212-215.

Giant cold water carbonate mounds

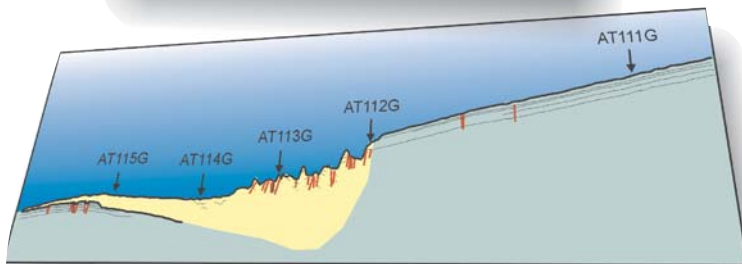
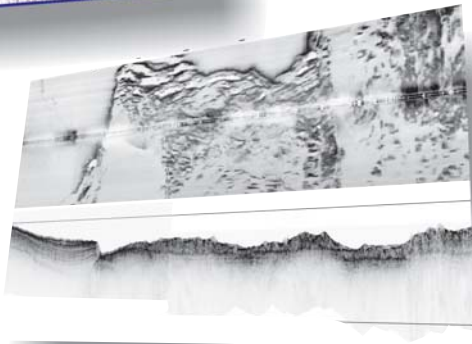
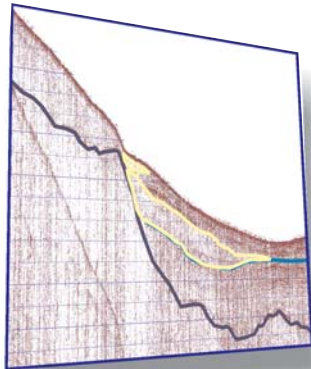


The TTR cruise in 1997 made the first comprehensive study of these spectacular deep-water phenomena in the northeastern Atlantic. Seismic and sidescan sonar surveys of several frequencies combined with extensive bottom sampling programme and direct observations by deep-towed video systems provided clues for understanding the distribution and morphology of the carbonate mounds. Acoustic seafloor mapping and underwater video surveys revealed the connection between the mounds, cold water corals and fast flowing bottom currents.

SELECTED PUBLICATIONS

- Boetius, A., Jorgensen, B.B., Amann, R., Henriët, J.P., Hinrichs, K.U., Lochte, K., MacGregor, B. & Voordouw, G., 2001. Microbial systems in sedimentary environments of continental margins. In: Wefer, G., Billett, D., Hebbeln, D., Jorgensen, B., Schluter, M., Van Weering, T. (eds). *Ocean Margin Systems*. Springer-Verlag, Heidelberg. 479-495.
- De Mol, B., Van Rensbergen, P., Pillen, S., Van Herreweghe, K., Van Rooij, D., McDonnell, A., Huvenne, V., Ivanov, M., Swennen, R. & Henriët, J.P. Large deep-water coral banks in the Porcupine Basin, southwest of Ireland. *Marine Geology*. In press.
- Henriët, J.P., De Mol, B., Vanneste, M., Huvenne, V., Van Rooij, D. & the "Porcupine-Belgica" 97, 98 and 99 Shipboard Parties, 2001. Carbonate mounds and slope failures in the Porcupine Basin: a development model involving fluid venting. In: Shannon, P.M., Haughton, P. & Corcoran, D. (eds.) *Petroleum Exploration of Ireland's Offshore Basins*. Geological Society Special Publication, 188, 375-383.
- Henriët, J.P., Guidard, S. & the ODP "Proposal 573" Team, 2001. Carbonate mounds as a possible example for microbial activity. In: Wefer, G., Billett, D., Hebbeln, D., Jorgensen, B., Schluter, M., Van Weering, T. (eds) *Ocean Margin Systems*. Springer-Verlag, Heidelberg. 439-455.
- Henriët, J.P., Van Rooij, D., Huvenne, V., De Mol, B. & Guidard, S. Mounds and sediment drift in the Porcupine Basin, west of Ireland. In: Mienert, J. and Weaver, P. (Editors), *European margin sediment dynamics. Side-scan sonar and seismic images*. In press.
- Huvenne, V., Croker, P. & Henriët, J.P. A refreshing 3D-view of an ancient sediment collapse and slope failure. *Terra Nova*. In press.
- Kenyon, N.H., Akhmetzanov, A.M., Wheeler, A.J., van Weering, T.C.E., de Haas, H. and Ivanov, M.K., Giant carbonate mud mounds in the Southern Rockall Trough. *Marine Geology*. Accepted.

Slope stability and geohazards



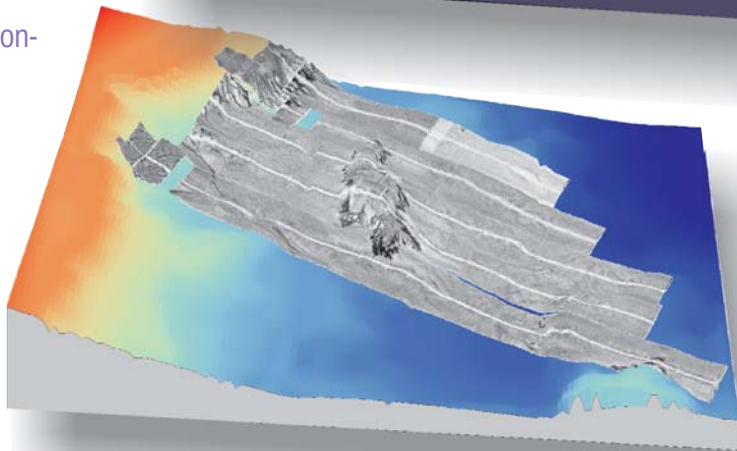
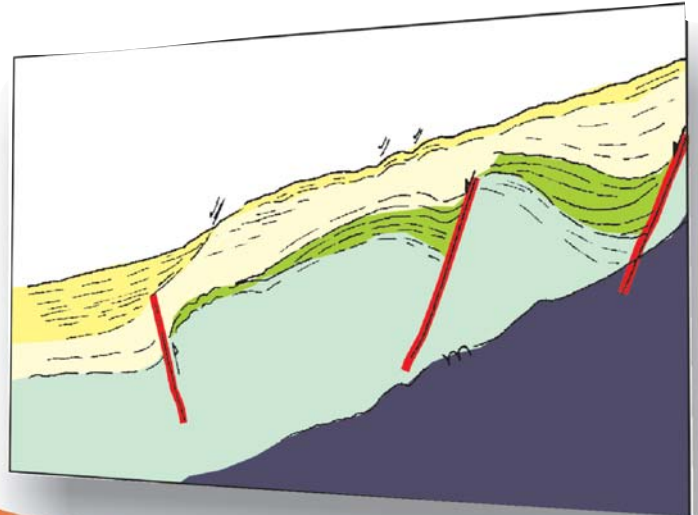
The issues of slope stability and other geohazards are of particular importance as the continental margins are a new frontier for deep-water exploitation. Several areas to the east and north of the Faeroes and in the area of giant Storegga Slide (off Norway) were studied by TTR in 1998-1999. High-resolution acoustic seafloor mapping was particularly useful for recognising the areas affected by sediment failures. Sidescan sonar images, sediment profiler data and bottom samples helped to determine different stages of sediment instability development.

SELECTED PUBLICATIONS

Kuijpers, A., Nielsen, T., Akhmetzhanov, A.M., de Haas, H. Kenyon, N.H., and van Weering, T. C. E. 2001. Late Quaternary slope instability on the Faeroe margin: mass flow features and timing of events. *Geo-Marine Letters*, 20, 149-159.

Tectonics of continental margins

Neotectonic processes have been the focus of studies conducted during several TTR cruises. In most cases the areas where these processes were encountered are also characterized by active mud diapirism/volcanism and related fluids expulsion. Manifestations of compressional tectonics were studied in the eastern Mediterranean collision zone, in the Sorokin Trough (Black Sea) and in the Gulf of Cadiz (Northeast Atlantic). In 1998-2001 neotectonic processes taking place on a passive continental margin west of Portugal and along the extension of the North Anatolian Fault in the North Aegean Sea were studied. Particular attention was paid to seismogenic and potentially tsunamigenic faults which might affect densely populated areas. A historical example is the 1755 earthquake and tsunami which destroyed much of Lisbon.



SELECTED PUBLICATIONS

- Felser, E., Woodside, J.M. and van Hinte, J.E., 1998. Sequence boundaries and salt diapirism in the Balearic abyssal plain, Western Mediterranean. *Geo-Marine Letters*, 18, 172-177.
- Limonov, A.F., 1998. Shallow structure of the eastern segment of the Mediterranean Ridge deduced from seismic and side-scan sonar data. *Geo-Marine Letters*, 18, 90-96.
- Limonov, A.F., Ivanov, M.K. and Foucher, J.P., 1998. Deep-towed side-scan survey of the United Nations Rise, Eastern Mediterranean. *Geo-Marine Letters*, 18, 115-126.
- Ben-Avraham, Z., Tibor, G., Limonov, A.F., Leybov, M.B., Ivanov, M.K., Tokarev, M.Yu., and Woodside, J.M. 1995. Structure and Tectonics of the Eastern Cyprean Arc. *Marine and Petroleum Geology*, 12, 263-271.

- Robertson, A.H.F., Kidd, R.B., Ivanov, M.K., Limonov, A.F., Woodside, J.M., Galindo-Zaldivar, J., Nieto, L., and the Scientific Party of the 1993 TTR-3 Cruise, 1995. Eratosthenes Seamount: Collisional Processes in the Easternmost Mediterranean in relation to the Plio-Quaternary Uplift of Southern Cyprus. *Terra Nova*, 7, 254-264.
- Robertson, A.H.F., Kidd, R.B., Ivanov, M.K., Limonov, A.F., Woodside, J.M., Galindo-Zaldivar, J., Nieto, L., and the Scientific Party of the 1993 TTR-3 Cruise, 1994. Probing Continental Collision in the Mediterranean Sea. *EOS*, 75, 233-238.

Training-through-Research Programme

Contacts

TTR EXECUTIVES

Dr. Neil H. Kenyon



**Southampton
Oceanography Centre**
UNIVERSITY OF SOUTHAMPTON AND
NATURAL ENVIRONMENT RESEARCH COUNCIL

**TTR Co-ordinator
Challenger Division
Southampton Oceanography Centre**

Empress Dock, Southampton, SO14 3ZH, U.K.

tel.: +44 2380 596570
fax.: +44 2380 596554

Email: n.kenyon@soc.soton.ac.uk

Prof. Dr. Michael Ivanov



**UNESCO-MSU Centre for Marine Geology
and Geophysics
Faculty of Geology, Moscow State
University**

Vorobjevy Gory, Moscow, 119899, Russia

tel: +7 095 939 30 22
tel/fax: +7 095 939 49 17

Email: fu@geol.msu.ru

Dr. Patricio Bernal



**Assistant Director-General, UNESCO
Executive Secretary IOC**

1, rue Miollis, 75732 Paris cedex, France

tel: +33 1 4568 39 83
fax: +33 1 4568 58 12

Email: p.bernal@unesco.org

www.ioc.unesco.org/ttr



