

STC Project No. 97/51
ETC Project No. 97/52

Data Gathering Projects

Final Report

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BIBLIOGRAPHIES

STC BIBLIOGRAPHY

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INTRODUCTION

The importance of compiling and evaluating existing data in the Rockall Trough and surrounding areas was identified at the first meetings of the Petroleum Infrastructure Programme Group 2 (PIP 2) participants. Initially the Seabed technical committee (STC) identified this as an early requirement in its review programme and CSA Oil & Gas Services Ltd were asked to carry out the work (RSG Project No 97/51). At a later stage the Environmental technical committee (ETC) asked CSA Oil & Gas Services Ltd to carry out a similar review for them as an extension of the ongoing STC review (RSG Project No 97/52). Other reviews are being carried out for the Sub-Sea technical committee (SSTC) by ERA-Maptec (RSG Project No 97/3) and for the Metocean technical committee (MTC) by the Irish Marine Data Centre (IMDC) (RSG Project No 97/29). Efforts have been made to try and avoid unnecessary overlap between the projects.

The STC and ETC projects were designed to undertake a quick review of the marine data available for the Irish offshore designated area west of Ireland. Particular emphasis was placed on the Rockall Trough, the Rockall and Porcupine Banks and the marginal basins on the flanks of the Rockall Trough.

Over the last 40 years, the vast majority of cruises were carried out by government research vessels as a part of national maritime research programmes (for example NERC funding from the UK Government). Some international programmes, such as the Deep Sea Drilling Project (DSDP), have been working throughout this period, but others, such as the various EU programmes and UNESCO, have generally started in the last 10 years. Additional work, mostly hydrographic, has been carried out by naval vessels on behalf of national defence agencies.

CSA Oil & Gas Services (CSAOG) worked closely on these projects with the Geology Department of University College Dublin (UCD) and with the Coastal Resources Centre at University College Cork (CRC-UCC). Pat Shannon supervised the UCD team comprising Vikram Unnithan, Angela McDonnell and Josta Vermeulen. At CRC-UCC most of the work was carried out by Andy Wheeler with assistance from post-graduate students.

UCD concentrated on data available in Dublin at UCD, DIAS (Dublin Institute of Advanced Studies), GSI (Geological Survey of Ireland) and PAD (Petroleum Affairs Division of the Department of Marine and Natural Resources).

CRC-UCC concentrated on data available at UCC and the extensive collections held by Southampton Oceanographic Centre (SOC) and the Scottish Association for Marine Science (SAMS). A number of other data sets, such as IOS (UK Institute of Oceanographic Science) and Deacon Labs are now held by SOC.

Cruises carried out by other European countries, such as Norway, Denmark, Germany, Netherlands, Belgium and France were covered by both groups. North American and older cruises were researched over the internet using the NGDC data system in the US.

CSAOG co-ordinated the project and concentrated on the bibliography and on sourcing data from the internet. CD-ROM data searches were organised by CSAOG at the Geological Society in London and at the Fisheries Research Centre (FRC) in Dublin. Additional bibliographic data was received from UCD, CRC-UCC, PAD and BGS.

DATA SOURCES

Substantial progress has been achieved in identifying the major cruises of the past 25 years. The Department of Geology, University College Dublin has been involved in a large number of the recent cruises and much of the data is available in-house. Information was also obtained from the Geological Survey of Ireland (GSI), Marine Data Centre, Petroleum Affairs Division (PAD), British Geological Society (BGS) and Southampton Oceanographic Centre (SOC). The GSI in particular has a very large collection of cruise reports and cruise proposals. Unfortunately, many of documents are incomplete. The PAD provided a list of cruises. The Marine Data Centre suggested a number of very useful sites on the World Wide Web. The BGS and the SOC libraries contain nearly all the cruise reports relating to the UK oceanographic fleet but we do not have direct access to these databases.

The World Wide Web has a number of searchable databases relating to marine research activity in the northern Atlantic. The most important of these are the ROSCOP (Appendix 10) and the U.S. National Geophysical Data Centre's GEBCO (Appendix 10) databases which contain concise details on the various cruises in the region. The ROSCOP database contains oceanographic, geological, meteorological and biological information regarding all the cruises in the Atlantic dating back to 1960 (see <http://www.ices.dk/ocean/roscop.htm>). One of the problems with this database is that there is a backlog in processing the various cruise reports. The procedure of submitting cruise reports in a specific format is time consuming and depends solely on the diligence of the reporting institution. Generally speaking, the ROSCOP database does not have a complete record of cruises for the last 10 years.

The NGDC GEODAS database consists of trackline geophysics data which includes sidescan sonar, refraction and reflection seismics, bathymetry etc. collected by survey vessels of a number of nationalities. The data is freely available on-line for downloading from the site http://www.ngdc.noaa.gov/mgg/gdas/gd_sys.html. There is also a separate NGDC database for geological core data.

The French SISMER site <http://www.ifremer.fr/sismer/> provides excellent cruise summaries of most French cruises world-wide. The summaries available on the WWW are concise and give a very good overview of the cruises. Most of the summaries also include a cruise track. Data from 1995 to date is often unavailable or incomplete.

The British Oceanographic Data Centre (BODC) at the WWW site <http://www.nbi.ac.uk/bodc/bodcmain.html> provides information regarding cruises that have taken place as a result of joint international scientific ventures i.e. OMEX, LOIS, MAST, ENAM, etc. There is no information relating to cruises funded or sponsored by UK based institutions i.e. NERC, SOC (formerly IOS), BGS and various universities.

The main problem encountered while dealing with these various databases was the lack of consistency in data formats. Extraction of information on geology- and geophysics- based cruises in the North Atlantic and its amalgamation into a single spreadsheet has been difficult.

The following are some important WWW sites:

- | | |
|---|--|
| 1. http://www.ucc.ie/ucc/research/crc/enam1.htm | ENAM II site |
| 2. http://www.nioz.nl | The NIOZ WWW Pages |
| 3. http://www.ices.dk/ocean/project/mast | MAST site |
| 4. http://www.nbi.ac.uk/bodc/bodcmain.html | British Oceanographic Data Centre |
| 5. http://www.ifremer.fr/sismer/ | French Cruise Reports |
| 6. http://www.marine.ie | Irish Marine Institute |
| 7. http://www.ngdc.noaa.gov/mgg/geology/geology.html | NGDC Marine Sediment & Rock Data |
| 8. http://www.ngdc.noaa.gov/mgg/curator/curator.html | NGDC-Index to Marine Geology |
| 9. http://www.ngdc.noaa.gov/mgg/gdas/gd_sys.html | GEODAS - Marine Geophysical data |
| 10. http://www.cms.udel.edu/ships | Research Ship Information & Schedules |
| 11. http://www.ices.dk/ocean/roscop.htm | ROSCOP - Cruise Summary Reports |
| 12. http://www-odp.tamu.edu/publications/prelim/162_Prelim/162TABLE.HTML | Leg 162 Preliminary ODP Report |

A more detailed list of websites is included as Appendix 3.

LINE DATA

Line data is predominantly geophysical and bathymetric and is collected whilst the vessel is sailing along a specific course. This data type covers seismic reflection and refraction (deep, intermediate and shallow), gravity, magnetics, side-scan sonar (various types including GLORIA and TOBI), swath bathymetry (SIMRAD EM 300 or similar) and echo-sounding. Other imagery systems such as sea-bottom TV can be line or point data. Other data, such as temperature, salinity and other oceanographic data is also acquired on some surveys.

POINT DATA

Point data is the other main data type. This includes cores and dredge samples for geological, geotechnical and biological purposes. A wide variety of techniques are used with variable success. Most samples range from a few centimetres to a few metres in depth and the techniques used to recover the sample from the seabed severely limit the analyses that can be carried out on the samples.

Another major category is cored boreholes. Most of these have been carried out by organisations such as the BGS in shallower waters or by the DSDP or ODP in deeper waters. The BGS shallow coring data (mainly in 1994) over the UK Rockall Sector is still confidential, but may be due for release shortly. There are also some oil industry deep stratigraphic tests, but none so far in Irish waters. A number of DSDP and ODP

boreholes have been drilled on and around the Rockall micro-continent in the last 30 years. Some rock samples have also been recovered using submersibles such as CYANA and PISCES III.

Some data, such as dredge or grab samples, are generally considered point data, as are photo systems such as WASP or Photo-sledge.

SOC AND SAMS DATA

Lists of core samples held by SOC and SAMS, predominantly collected for biological data, are given in Appendix 9. The data for the samples is incomplete, but represents the best available at present

OTHER DATA

Fisheries data, bird and cetacean data and much of the oceanographic and meteorological data, can be both point and line data, but is largely outside the scope of this study. It has been included where the data is available, usually from multi-disciplinary cruises.

MAPS

Maps have been prepared for most of the more important cruises showing the cruise tracks (Appendix 11). In some cases maps have also been prepared showing core or dredge locations. Detailed lists of core samples can be found in Appendix 10 of this report and on the attached CD-ROM.

DATABASES

Data has been compiled on Excel spreadsheets. There is a summary spreadsheet listing all the main cruises offshore the West of Ireland. This lists, where known, the programme name, ship, source of funding, cruise dates, descriptive location, co-ordinates, chief scientist, contact address, data types and comments. Five versions are provided in the text: an alphabetical list by vessel name, a list by cruise year, a list of cruises with geological/geophysical data, a list of cruises acquiring imagery and a list of cruises with biological data. A list of upcoming cruises (1998 and later) is also included. These spreadsheets are also on the CD-ROM and can be searched or input into database systems by the RSG members.

Numerous more detailed spreadsheets have been prepared for each of the more important cruises listing the exact data acquired, samples recovered and their location, where known. This has proved difficult and time-consuming to compile, as the data and samples

are often dispersed to a wide number of locations over the years. This data is incomplete as the amount of effort and time required to undertake this task proved excessive. Most of this detailed data has been placed on the CD-ROM as it would make the report unnecessarily bulky.

DATA QUALITY

There are several aspects to data quality.

First there is the quality of the original data acquired at the time of the survey. Obviously technology has advanced with time and many older surveys (especially seismic or imagery) are less useful than the more modern ones. This does not however generally apply to core samples providing they were properly analysed at the time.

Second there is the accuracy to which that data is positioned. In the older surveys, pre satellite navigation, accuracy was often poor when far from the coast (as in Rockall). This may not be a problem in a general sense, but can become one when attempting to repeat sampling or line surveys in the same place some years later.

Third, the data quality has often deteriorated with time. Tapes of seismic or imagery data are often in poor condition and may be unusable after 20 years. The core and biological samples may have been completely used up or have decayed to dust.

DATA GAPS

Data gaps tend to be type specific. For example, an area that is well covered by seismic may have few core samples. It also depends on what the data is being used for. A plot of core samples may suggest the area is well sampled, but few or even none of them may be suitable for geotechnical studies. Identifying this level of data gap is difficult as it relies on detailed lists of all the analyses carried out on samples from a particular cruise. This data is difficult to obtain.

Some generalisations can be made:

1. Generally there are more samples of all types on the east flank of the Rockall Trough.
2. The northern part of the east flank, near the UK boundary, is better sampled and surveyed than the area further south off the Porcupine Bank.
3. Deep cores are very sparse and are concentrated in certain areas (see DSDP / ODP map).
4. Specific sample types, such as "basement" samples are obviously related to areas of known outcrop. A review of the regional seismic cover, both commercial and academic, may be able to suggest other areas where additional samples could be

obtained. There is considerable uncertainty about whether some samples are in-situ or are boulders dropped from icebergs (especially drag, grab and even submersible samples).

5. Biological samples are concentrated in certain areas such as the Porcupine Seabight. Other clumps of samples are in and around long-term observation sites in the Rockall Trough. The vast majority of biological samples were collected by UK research vessels and are held in SAMS in Scotland or at SOC.
6. Imagery is more widespread than expected, but much of the data is not yet released. Nearly all the relevant GLORIA data is held by UCD and is currently being interpreted as a part of PhD studies. The data will be released when these studies are completed.
7. Shallow seismic is often hard to distinguish from deep seismic in the ROSCOP, ICES and other databases. Many vessels have acquired Sparker data in conjunction with bathymetry or deep seismic surveys. Most of the recent geoscience cruises have acquired two or even three types of seismic data (e.g. Pelagia, Belgica, Logachev, etc.)

BIBLIOGRAPHY

Very extensive bibliographies have been compiled for the both the STC and ETC studies. There is some overlap with both the SSTC (deep geology and geophysics) and the MTC (meteorology, climatology, oceanography).

A number of organisations deserve particular thanks for their contribution to the bibliographies. These include the PAD, BGS, UCD Geology Dept, UCC-CRC and FRC.

The very extensive nature of the bibliographies compiled for the RSG suggest that they could be suitable for publication. Such bibliographies are often published and could serve to assist and encourage research in the region.

ADDRESSES OF MARINE RESEARCH INSTITUTIONS

The addresses of all the main European institutions and selected North American institutions are given in Appendix 2.

LIST OF KEY RESEARCH PROGRAMMES AND ACRONYMS

As the reviews progressed it was realised that a vast array of abbreviations and acronyms are used in the marine research sector. It was decided to list these in Appendix 1, along with brief descriptions. This list is by no means exhaustive, but should prove useful to those confused by the multiplicity of names.

APPENDIX 1
LIST OF ACRONYMS AND SUMMARY OF
KEY MARINE RESEARCH PROGRAMMES

AFEN Atlantic Frontier Environmental Network - an oil industry group formed to carry out environmental surveys (TOBI and benthic sampling) along the NW UK shelf margins (mainly West of Shetlands).

AIR An EU fisheries research programme.

ALIPOR Autonomous Lander Instrumentation Packages for Oceanographic Research - a seabed lander being developed as part of the EU MAST III programme. Project led by SOC. Partners IFREMER, GEOMAR, Chambers University Goteborg, Technical University of Harburg-Hamburg, NIOZ, UCG, Aberdeen University, Alfred Wegener Institute, IMBC Greece and SAMS

ASFA Aquatic Sciences and Fisheries Abstracts - international CD-ROM database.

BENBO The deep ocean BENThic BOundary layer - a UK thematic programme on the Deep Ocean Benthic Boundary. Three sites chosen for monitoring - mouth of Rockall Trough, Hatton-Rockall Basin and Flank of Feni Drift. Links to BENGAL, SES, LOIS, OMEX and ALIPOR. Project led by SAMS. NERC funding (plus EU?).

BENGAL BENThic biology and Geochemistry of a NE Atlantic abyssal locality - an EU programme funding benthic lander technology; organic, inorganic and radio-chemical analytic techniques and modelling. 17 partners in 9 countries, including data management by IMDC. Responsible for cruises to Porcupine Abyssal Plain site to monitor benthic community structure 1996 to date.

BGS British Geological Survey, formerly IGS (Institute of Geological Sciences). Incorporates GSNI (Geological Survey of Northern Ireland).

BIRPS British Institutions Reflection Profiling Syndicate - founded in 1981, acquires, processes and interprets seismic data from the lithosphere. Series of deep seismic lines offshore NW Europe, including several off West of Ireland. Co-ordinated by Dept of Earth Sciences, Cambridge University.

BODC British Oceanographic Data Centre - based at POL in Birkenhead. Repository for all oceanographic data acquired in UK waters or in UK vessels overseas.

BSH Bundesamt fur Seeschifffahrt und Hydrographie - Federal Maritime and Hydrographic Agency of Germany, responsible for Oceanographic Data Centre and cruise planning by all German research vessels. Extensive data on internet, some in English.

CCMS Centre for Coastal and Marine Sciences - a NERC-funded body encompassing SAMS/DML, PML and POL

CHAOS Chemical and Hydrographic Atlantic Ocean Survey - SOC programme in North Atlantic to support WOCE.

CLAMS Oceanographic model by CLS Toulouse

CONSLEX Continental Slope Experiment - a UK collaborative effort by SOC, POL, SAMS and Min of Agriculture to study water movements across Scottish continental margin in 1982-1983.

CORSAIRES EU programme co-ordinated by the Renard Centre of Marine Geology at the University of Gent (Jean-Pierre Henriët). Includes The Norway-Faroe-Rockall Core Group studying area from Bill Bailey Bank northwards, specialising in shelf stratigraphy, sedimentation, fans, slides and debris flows and contourite deposits. The Porcupine-Celtic Sea-English Channel Core Group covers the Porcupine Seabight southwards, specialising on carbonate build-ups in the Porcupine the Celtic Sea Shelf Edge and Fan and the Hurd Deep in the Channel.

DML Dunstaffnage Marine Laboratory at Oban on west coast of Scotland. Home of SAMS and part of CCMS. Centre for research in benthic communities off west coast of Scotland and Ireland.

DSDP Deep Sea Drilling Project - a major international world-wide deep coring programme in the deep oceans. Now replaced by ODP.

ENAM European North Atlantic Margin - an EU research programme along Atlantic Margin addressing mass wasting, slope stability, benthos, etc. Split into 3 phases: ENAM I (1993-1996 - pathways, processes and fluxes) concentrated on Portuguese/French margin and Faroe/Norwegian margin and ENAM II (1996-1999 - quantification and modelling of large-scale sedimentary processes and fluxes) concentrated on Rockall Trough and Irish margin. Current phase co-ordinated by GEOMAR including partners: SOC, IFREMER, Bergen, Kiel, Goteborg, Aberystwyth, NERC, SOC, DGU, Oslo, Tromso, Gent and UCC/CRC. Data management by IMDC.

EUROGOOS European Global Ocean Observing System - European arm of international oceanographic programme.

FAR An EU fisheries research programme.

FAIR An EU fisheries research programme.

FRC Irish Fisheries Research Centre, a part of the Irish Marine Institute. Closed involved in ICES programme.

GEBCO General Bathymetric Chart of the Oceans - Bathymetry database of the world co-ordinated and maintained by POL on behalf of international community. Originally published as maps, now published as a CD-ROM.

GEOMAR The German Institute of Marine Studies based in Kiel.

- GEOREF International geological CD-ROM database
- GEOSTAR An EU MAST programme to develop a geophysical and oceanographic station for abyssal research. Led by ING in Italy.
- GLORIA A surface towed side scan sonar system developed by SOC. Widely used in the NW European offshore and off the US coast. Extensive surveys in Irish waters. Produces lower quality, but cheaper imagery than TOBI.
- GSI Geological Survey of Ireland.
- ICES International Council for the Exploration of the Sea - Intergovernmental organisation set up in 1902. Fisheries, Pollution and Oceanographic databanks. Based in Copenhagen. Home of North Atlantic ROSCOP.
- HEBBLE High Energy Benthic Boundary Layer Experiment - UK research programme in early 1980's.
- IfM Institute for marine research at University of Kiel, Germany. Actively involved in oceanographic research in North Atlantic, including Irish waters.
- IFREMER The French Institute for Marine Research. Major centres in Brest, Marseilles and Bordeaux.
- IOS Institute of Oceanographic Sciences in UK, now a part of SOC.
- JASIN Joint Air-Sea Interaction Project designed to study the interaction of atmospheric and oceanic boundary layers with large scale motions of sea and air. Major project in 1978 in UK Rockall Trough.
- JGOFS Joint Global Ocean Flux Study.
- JNCC Joint Nature Conservation Committee - UK government group responsible for, amongst others, the offshore monitoring of seabirds and cetaceans. Extensively involved in Irish waters, especially Rockall Trough.
- LDEO Lamont-Doherty Earth Observatory- US organisation involved in North Atlantic research, especially geology and geophysics. Home of LDEO Deep Sea Core dataset - can be searched online.
- LOIS Land Ocean Interaction Study - an NERC/EU MAST programme.
- MAFF UK Ministry of Agriculture, Fisheries and Food. Often funds fisheries cruises.
- MAST Major EU programme covering all aspects of marine science and technology. Now in MAST III (1996-1999), but will be discontinued in 1999. ENAM is a component of MAST.

NERC National Environmental Research Council - UK government agency responsible for all UK scientific research. Owner of UK research vessels based at SOC.

NESS An oil industry group formed to model NE European Atlantic Margin weather data. Hindcast 1964-1995. Current members are Amoco, BP, Conoco, Esso, Marathon, Mobil, Saga, Shell, Statoil, Texaco, RWS and HSE.

NGDC National Geophysical Data Centre in US. An international repository for all geological, geophysical and bathymetric data from scientific and naval cruises world-wide. Both geophysical and geological core data can be searched for and plotted online, but unfriendly interface.

NOAA US government organisation responsible for oceanographic research.

NWAG North Western Atlantic Group - an oil industry group formed to model currents and oceanographic data. Current members are Amerada, Amoco, Arco, BP, Chevron, Conoco, Elf, Enterprise, Esso, Marathon, Mobil, Phillips, Saga, Shell, Statoil, Texaco, Total and HSE.

OCEANIC US based oceanographic programme. Extensive database of world-wide research vessels and their research programmes.

ODP Ocean Drilling Programme - the current international world-wide deep coring programme. Dataset currently hosted by Texas A&M University - can be searched online.

OMEX Ocean Margin EXchange - OMEX I, an EU MAST II programme (1993-1996) for physical and chemical oceanography focused on Goban Spur area initially with some work on Hebrides Shelf Edge. OMEX II (1996-1999) will focus on Iberian margin, with some data from Irish and UK waters. POL co-ordinates physics component.

PML Plymouth Marine Laboratory. A centre in SW England, part of CCMS, specialising in oceanographic research.

POL Proudman Oceanographic Laboratory located in Birkenhead, near Liverpool. Part of CCMS. Specialises in physical and chemical oceanography and is closely involved in OMEX and LOIS. Also the home of GEBCO and BODC (British Oceanographic Data Centre).

POSEIDON EU programme, under MAST III, to develop new technology for surveying the sea floor and sub-bottom and predicting slope stability hazards in water depths between 300m and 2000m. Co-ordinated by GEOMAR. Several tools being developed including TOBI by SOC and other modules by GEOMAR and IFREMER.

RAPIDS A deep seismic research programme carrying out seismic acquisition off western Ireland. Jointly run by Kiel and UCD. RAPIDS 1 (1988), RAPIDS 2 (1990), RAPIDS 3 (planned 1999).

ROSCOP Reports of Oceanographic Cruises and Oceanographic Programmes - a standardised international reporting format for scientific research cruises conceived by IOC in late 1960s and revised in 1990. Published by ICES for North Atlantic.

SAMS Scottish Association for Marine Science located at Dunstaffnage near Oban in Scotland. Part of CCMS and works closely with SOC. Leading researchers into marine and deep sea invertebrates and biomarkers. Involved in BENGAL, BENBO, ALIPOR, SES, LOIS.

SEFOS Shelf Edge Fisheries Oceanographic Study. UK based study with particular interest in the Porcupine Bank spawning area.

SES Shelf Edge Study - a constituent of the LOIS programme. Study area is Irish shelf edge from offshore Mayo north to the UK shelf edge in the Hebrides. Includes imagery, benthos, and metocean, especially current meters. POL co-ordinates and participants are: SAMS, SOC, IFREMER, PML, 6 universities.

SISMER French organisation responsible for databasing oceanographic, biological, geological and geophysical datasets. Associated with IFREMER.

SOC Southampton Oceanographic Centre. The premier UK centre for all forms of oceanographic research. The base for the NERC fleet of research vessels. Now incorporates the former Institute of Oceanographic Science, Deacon Labs, SAMS, PML, etc.

Challenger Division covers Benthic Biology, Sedimentary Processes, Crustal Processes and Chemical Changes and Fluxes groups. George Deacon Division covers hydrography, biology and chemistry. James Rennell Division covers Satellite imagery, Modelling Ocean Circulation and Climate, Meteorology and Surface Fluxes, and Hydrography. The is also an Ocean Technology Division.

TOBI A deep towed side scan sonar system developed by SOC. Widely used in Norwegian and UK waters and elsewhere. Limited use in Irish waters to date. High quality imagery, but slow and expensive to acquire.

TOPEX/POSEIDON a joint US/French programme to monitor global ocean circulation and to discover the tie between the oceans and the atmosphere. Uses joint US/French satellite since 1992. Follow-on programme called Jason-1.

TTR Training Through Research - A UNESCO-IOC programme of world-wide international co-operation utilising post-graduate students as crew on various vessels (often Russian). The TTR7 cruise, Legs 1 and 2, used the RV Professor Logachev in the Porcupine and Rockall in 1997. The programme is run by Mikhail Ivanov out of Moscow State University (MSU) with Neil Kenyon (SOC) as western co-ordinator.

UCC University College Cork, part of the National University of Ireland

UCD University College Dublin, part of the National University of Ireland

UCG University College Galway, part of the National University of Ireland

VIVALDI UK contribution to WOCE in 1991. Series of seasonal trails in North Atlantic. But also going in 1996 in Rockall.

WAM Climate model (ECMWF) developed by Hamburg University.

WESTLINE A deep seismic line west of Ireland, acquired in 1993 by BIRPS.

WHOI Woods Hole Oceanographic Institution, a leading US oceanographic research institution that carries out work in the North Atlantic and in Irish waters.

WOCE World Ocean Circulation Experiment - a world-wide programme to study (1990 to date) ocean circulation by satellite and surface measurement. In North Atlantic major partners are US, UK, Germany and France with virtually all European countries involved at some level.

APPENDIX 2**LIST OF UNIVERSITIES AND INSTITUTES INVOLVED IN****MARINE RESEARCH IN THE NORTH-EAST ATLANTIC**

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- <http://www.nbi.ac.uk/bodc/bodcmain.html> British Oceanographic Data Centre
- <http://rock.esc.cam.ac.uk/pub.html> Earth Sciences Library, University of Cambridge
- <http://www.geophysics.dias.ie> DIAS Geophysics Group
- <http://www.nerc-oban.ac.uk/dml/home.htm> Dunstaffnage Marine Laboratory
- <http://www.soton.ac.uk/~imw/journals.htm> Geological Journals and Periodicals; Section of West's Geology Directory
- <http://www.liv.ac.uk/Geophysics/> Geophysics at the University of Liverpool
- <http://www.ifremer.fr> IFREMER
- <http://www.esc.cam.ac.uk/Library/Journals/BIRPS/birps.html> BIRPS, Cambridge
- <http://www.marine.ie/datacentre/projects/Bathymetry> Irish Marine Data Centre – Bathymetry
- <http://www.ncl.ac.uk/~nmscmweb/mscm/> MSCM Newcastle
- http://www.ifm.uni-kiel.de/ph/sfb460/m39_ze/m39_ze.html METEOR Cruise 39-2
- <http://www-odp.tamu.edu> Ocean Drilling Program
- <http://www.ehis.navy.mil/onrnews.htm> ONR Newsletters
- <http://sio.ucsd.edu/> Scripps Institution of Oceanography
- <http://allserv.rug.ac.be/~mfaure/ttr7/> Renard Centre of Marine Geology, Ghent
- <http://www.ucc.ie/ucc/research/crc/> UCC Coastal Resources Centre
- <http://www.bgs.ac.uk/> BGS Home Page
- <http://www.nioz.nl/> NIOZ – Netherlands
- <http://seaweed.ucg.ie/mri/Introduction.html> UCG - Marine Science
- <http://www.mth.uea.ac.uk/ocean/vl/europe.html#ireland> Virtual Library Oceanography Europe
- <http://www.whoi.edu> Woods Hole Oceanographic Institution

<http://www.esc.cam.ac.uk/emin/home.html> European Marine Interdisciplinary Network

<http://www.npm.ac.uk/rsdas/omex/atlas/index.html> OMEX Hydrographic Atlas

<http://www.ukooa.co.uk/environment/index.html> UKOOA Environmental Issues

<http://geo.polymtl.ca/personel/xli/geophysics.html> Useful Geophysics Links

<http://www.getech.leeds.ac.uk> GETECH Leeds

<http://www.mth.uea.ac.uk/ocean/vl/europe.html#ireland> Oceanography Europe

<http://www.maris.nl/> Maris MARine Information Service

http://www.ifremer.fr/sismer/sommaire_e.htql SISMER Data Service

<http://www.geocities.com/SiliconValley/Peaks/6731/Journal.html> Journals of Earth Sciences

<http://europa.eu.int/comm/dg12/marine1.html> EU DGXII – Marine Science & Technology

<http://www.nbi.ac.uk/> Proudman Oceanographic Laboratory

<http://www.ices.dk/> ICES WWW Home Page

<http://www.geomar.de> GEOMAR, Kiel

<http://webhost1.cerf.net/journals/eps/jnl/articles/S0012821X96002282/Menu.html>
Temperature anomalies under the NE Atlantic

<http://ioc.unesco.org/iyo> International Year of Oceanography - Home Page

<http://georef.cos.com/geofields.html#summary> GeoRef Database Text Fields

<http://www.nhm.ac.uk/mineralogy/collections/obd.htm> NHM Mineralogy, London

<http://www.ncdc.noaa.gov/coare/> COARE Data Info System

<http://www.ifm.uni-hamburg.de/> IfM Hamburg Homepage

<http://www.ifremer.fr/lpo/eurofloat/> The Eurofloat Project - Home Page

http://www.ngdc.noaa.gov/mgg/gdas/gd_sys.html NGDC-GEODAS Marine Geophysical Data

http://janusxpc.tamu.edu/predef_queries/general/dbtable.cgi ODP Database

<http://www.nerc-oban.ac.uk/cgi-bin/frame.pl?benbo/benbo.htm> Dunstaffnage Marine Laboratory Research Projects

<http://www.ldeo.columbia.edu/> Lamont Doherty Earth Observatory

<http://www-ocean.tamu.edu/Nav/research.html> Oceanography, Texas A&M University

<http://www.bsh.de/bsheng.htm> BSH Germany Marine Research Home Page

<http://diu.cms.udel.edu/ships/index.html> Research Ship Information and Schedules

<http://www1.npm.ac.uk/pml/home.htm> Plymouth Marine Laboratory

<http://www.soc.soton.ac.uk/RVS> Southampton Oceanography Centre

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