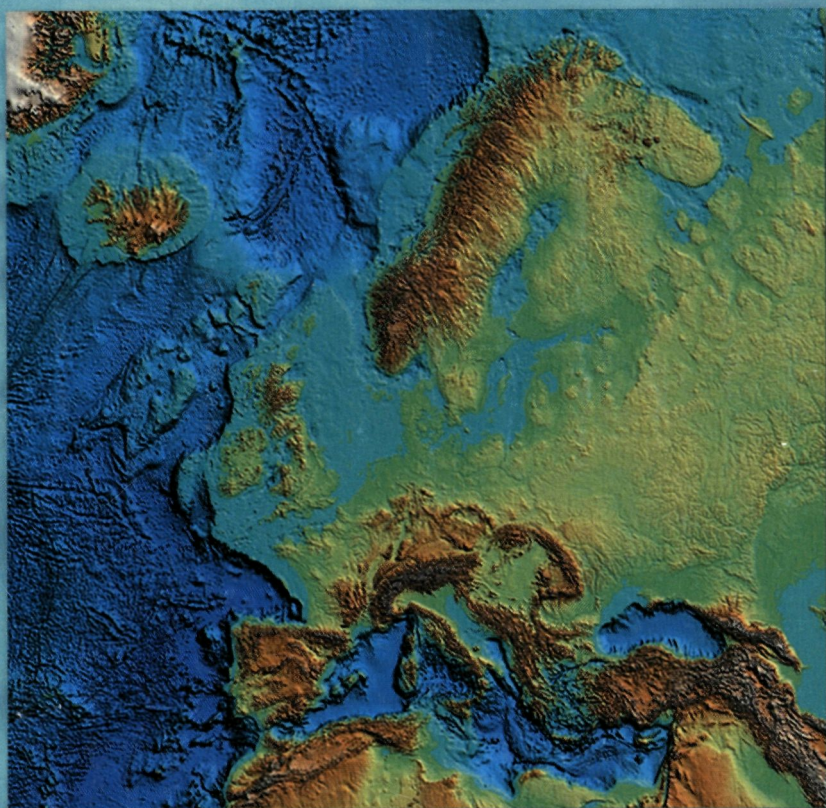


5

PROJECT II

# AN INTERNET DATABASE OF METADATA ON SEAFLOOR SEDIMENT SAMPLES HELD AT EUROPEAN INSTITUTIONS



EUROPEAN  
COMMISSION

DG XII

SCIENCE  
RESEARCH  
DEVELOPMENT

TEC

M A S T

A CONTRIBUTION TO THE KNOWLEDGE  
OF THE SEAFLOOR BY THE EUROPEAN GEOLOGICAL SURVEYS,  
RESEARCH INSTITUTES AND UNIVERSITIES

<http://www.eu-seased.net>

103434

# EU-SEASED

AN INTERNET DATABASE OF METADATA

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ON SEAFLOOR SEDIMENT SAMPLES

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HELD AT EUROPEAN INSTITUTIONS

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<http://www.eu-seased.net>

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EU-SEASED IS:

A SEARCHABLE INTERNET DATABASE  
OF SEABED SAMPLES AND CORES COLLECTED,  
AND HELD BY:

- THE MARINE GEOLOGY DEPARTMENTS OF  
THE EUROPEAN GEOLOGICAL SURVEYS
- EUROPEAN UNIVERSITIES AND MARINE  
RESEARCH INSTITUTES

A JOINT PROJECT OF TWO CONCERTED  
ACTION PROGRAMS, EUMARSIN AND EUROCORE,  
SUPPORTED BY THE MARINE SCIENCE AND  
TECHNOLOGY (MAST) PROGRAMME MANAGED  
BY THE EUROPEAN COMMISSION

DIRECTORATE GENERAL  
SCIENCE, RESEARCH  
AND DEVELOPMENT  
ENVIRONMENT DIRECTORATE

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J O I N T   C O O R D I N A T O R S

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INSTITUTE OF GEOLOGY  
AND  
MINERAL EXPLORATION  
GREECE

SOUTHAMPTON  
OCEANOGRAPHY  
CENTRE  
UK

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# P R E F A C E

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Marine cores and sediment samples form our primary raw data resource on the nature of the seafloor and the earth history it records. Such seabed samples have a wide range of applications and are the fundamental data source for information on seabed character and recent sedimentation. Such information is vital to a large number of end users in industry, governments and academia. Research into global climate change, palaeoceanography, slope stability, oil exploration, pollution assessment and control, surveying for laying telecommunication cables and offshore pipelines, national resource assessment and many other science areas all rely on data obtained from marine sediment samples. Within the countries of the European Union, collection of seafloor samples represents a considerable financial outlay.

Once cores and seafloor samples have been collected and analysed for the primary data requirement, they are usually stored under controlled conditions for further use. However, until the advent of EU-SEASED, it has been very difficult to find out what cores and bottom samples are available in Europe and where they are stored, in spite of the fact that the European

seas represent the most thoroughly explored sector of the world oceans. To meet this need the EU-SEASED project (“A searchable internet database of seabed samples from the European seas and ocean basins held at European institutions”) has been launched to compile metadata relating to European core and seafloor sample holdings and make this available to potential end-users through the Internet. Thus providing a time-efficient and cost-effective way of accessing the European seafloor sample archive. The EU-SEASED database only lists metadata, access to samples and any related accessory datasets will be for negotiation between the requestor and the repository where the sample is stored.

The EU-SEASED project is a MAST III (Marine Science and Technology Programme) community project consisting of two concerted actions, EUROCORE and EUMARSIN (European MARine Sediment Information Network), implemented under the supporting initiative activity of the MAST III programme. The general objective of the MAST III supporting initiative is to complement or co-ordinate research activities.

EU-SEASED is one initiative in a series of MAST III concerted actions that contribute to a better management and dissemination of marine data in Europe. Such concerted actions exclude community support for research activities, and are normally aimed at facilitating coordination activities.

The core elements of EU-SEASED, EUROCORE and EUMARSIN, are responsible for populating the database and share a common data management partner who is responsible for database construction and server maintenance. The data management partner is a small company and in this respect, EU-SEASED offers a good example of industrial involvement in a community research funded project.

End users - both industrialists and academics will benefit from the EU-SEASED initiative. It is highly desirable that all organisations holding seafloor samples participate actively. A very large number of sediment samples are stored at a large number of locations throughout the countries of the European Union and provide a legacy of continuing usefulness and importance. EU-SEASED provides the means by which this rich raw data

resource can be made accessible to researchers throughout the world. This being achieved at a relatively moderate cost when compared to the resources required to organize new sampling because the knowledge of what had already been collected was not available.

This project is also tuned with the international core curator's database (World Data Centre A, Boulder, USA) and the EU-ESPRIT GEIXS meta-database, another concerted action programme that has concluded and contains the geological land data. Thus the two combined data banks, GEIXS and EU-SEASED, will provide the raw geological information from both European land and sea floor, available to any interested users.

The European Commission strongly supports this initiative and regards it as a particularly important and meaningful step towards a pan-European effort to organize data banks containing scientific information.

**Gilles Ollier**  
*European Commission*

# I N T R O D U C T I O N

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From the first seafloor sediment description and classification by John Murray, following the landmark HMS Challenger expedition (1872-76), the study of the sediments of the ocean floor has progressed and now covers all oceans. Raw data in the form of observations, samples, cores and dredged material have accumulated in the world's laboratories and repositories, and sedimentological analyses and results have accumulated in offices and libraries. Methods of sampling the seafloor and analyzing the recovered samples has been continuously developed over time and as a result there has been always a tendency to overlook, or even disregard, older data.

Many hundreds of thousands of sea-bed samples have now been collected by European universities, marine research centers, Geological Surveys, and exploration and survey companies. Seafloor sample data is vital to a large number of end users in governments, industry and academia. For example, research into topics such as global climate change, slope stability, pollution control and assessment, hydrocarbon exploration, surveying for laying telecommunication cables and offshore pipelines, siting of offshore

structures and coastal development relies on data obtained from marine sediment samples.

The overuse, exploitation and degradation of some inshore marine environments, which started with the industrial revolution, continued at an increasing rate in the second half of the 20th century. This has made it important that in these areas, older marine sediment data should be available, in order to monitor environmental changes. At the same time, knowledge of the nature of the sea floor is no longer the preserve of academia and industry, but also the general public. This has been facilitated by the rapid development of electronic media and information transfer, such as the Internet, that has made scientific knowledge more accessible to everybody.

The marine sediment cores and other seafloor samples that have been collected by European organizations are a raw data resource of immense scientific value. These data need to be made more accessible to secondary users, to maximize the scientific return on the considerable financial and technological investment made in collecting the samples.

At present, these sediment samples are stored at a large number of different locations dispersed throughout the countries of the European Union. Although they represent a legacy of continuing scientific usefulness and importance, their use is currently seriously impeded by lack of knowledge of what cores and samples are available and where they are stored.

EU-SEASED aims to improve greater access to the European marine sediment archive. It is a European joint project of two concerted actions, EUMARSIN (European Marine Sediment Information Network) and EUROCORE, supported by the MAST III programme of the European Commission. It aims to set up a central-access searchable Internet database of seabed samples from the ocean basins held at European Institutions. The database will list the metadata (data describing data) on the cores and sediment samples. Access to the full data sets and/or actual samples (and associated analytical datasets) will have to be negotiated between the requestor and the institutions where the data are stored.

The EU-SEASED project comprises a consortium of fourteen European national

Geological Surveys and seven national marine core repositories which will populate the database and a Dutch data management company, responsible for database construction and server maintenance. The project utilizes already existing national networks and takes a strongly proactive approach using questionnaires and 'data scouts' to actively seek out data for the database. Apart from the participating partners, all other Institutions within EU member countries which hold sea floor sample data are invited to participate in the project by providing their own metadata. In the project more than 350 European organisation are being involved that have been sampling the ocean floor. However, metadata submittal is open to any institute or establishment that is willing to incorporate its data into the metadata bank.

The EU-SEASED Internet database provides the means by which scientists, engineers and other parties interested in the seafloor can find out quickly what seabed samples have been recovered and where they are stored; thereby promoting secondary usage of this currently underexploited raw data resource.

## O B J E C T I V E S

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The EUMARSIN and EUROCORE projects are conducting data management activities which will improve the coordination, cooperation and exchange of information amongst European Institutions. This is an important aim of European Commission to be implemented by DG XII through a number of programs such as MAST III. In addition, the worldwide coverage of the database (i.e. including cores stored at European institutions whatever their geographic origin) enhances the international importance of the database and contributes to increasing Europe's profile in international marine science.

The main objective of EU-SEASED is to develop and operate an electronic network for handling metadata information on marine samples collected from the European Seas and the world ocean basins, and held at European Institutions.

This objective is achieved by setting up a metadata and information-gathering structure to store data contributions both from partners and from other marine sediment data holders.

In order to carry out the programme efficiently the work is divided as follows:

- EUMARSIN will provide metadata from

samples and cores collected in the European Seas by 14 of the European Geological Surveys (Greece, United Kingdom, France, Netherlands, Norway, Sweden, Belgium, Italy, Spain, Germany, Portugal, Finland, Denmark, Ireland). As far as possible within the given framework and with respect to time and resources, samples from commercial and survey companies in each EU member state will be included.

- EUROCORE will provide metadata from cores collected from anywhere in the world oceans, providing the data was collected by, and is held at, a European marine research institute, marine station or university.

In this way the project team hopes to involve the cooperation and contribution of all European establishments that hold marine sediment data.

The end results will be to make the metadata available to government departments, academia, industry and the general public throughout the European Union and the wider international community through distribution by CD-ROM and unrestricted online access through a dedicated World Wide Web site.

# P R O J E C T D E S C R I P T I O N

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## E U M A R S I N

The program EUMARSIN started in November 1998 and will last for two years. The project uses the previously collected and analyzed public-domain marine sediment information required for first approach studies.

Although the European Seas represent the most thoroughly investigated sector of the world oceans they are still virtually unexplored. With the acceptance of the International Law of the Sea and the 200 miles economic exclusive zone, the area of the sea under EU jurisdiction is more than twice that of the land area. Particular attention is given to environmental parameters in the marine sector. While the marine projects were originally designed to meet national requirements, today such projects are attaining naturally a transnational character, since problems such as quality of coastal waters,

impact of human activities, transport patterns of contaminants and circulation of water masses have become subjects of multinational cooperation.

In order to meet these modern challenges the geological surveys of the EU and Norway formed a non-profit association in 1995 called EUROGEOSURVEYS (EGS). The 14 marine geology departments of the EGS formed a relevant topic network to propose EUMARSIN for funding within the framework of the EU MASTIII programme.

The Project Coordinator is the Greek partner (IGME) assisted by a Steering Committee, in which Norway (NGU), the UK (BGS) France (BRGM), the EGS Secretary General and MARIS, are responsible for the management and the technical direction of the program (Table I).

**Table 1:** EUMARSIN Partner links

<b>STEERING COMMITTEE MEMBER</b>	<b>RESPONSIBLE FOR LINKS WITH</b>	<b>REGIONAL SUBDIVISION</b>	<b>CO-ORDINATION</b>
Greece	Italy	Eastern Mediterranean	EUMARSIN Project Coordinator. Chair, National Representatives Committee
UK	Germany, Netherlands, Belgium, Ireland	North Sea, North-east Atlantic	Technical Advisory Task Group.
France	Spain, Portugal	Eastern Atlantic, Western Mediterranean	
Norway	Finland, Denmark, Sweden	Baltic Sea, North Sea, Norwegian Sea	
EuroGeoSurveys	All partners	all areas	Promotion and Marketing Task Group
MARIS	All partners	all areas	

The present estimate of the available partner samples is now much higher than the initial estimate, amounting to more than 110000 stations. An even larger additional amount of sample stations is expected from other European Institutes (Table 2). These sample stations are being incorporated into the metadata bank, according to the format developed by all the EU-SEASED partners and in compliance with the previous EGS GEIXS-ESPRIT project (1997-1999).

**Table 2:** Estimated numbers of samples identified during EUMARSIN project

Country	Institution	Surveys Samples	Non Surveys samples	Maps	Contacted organizations	Contributors
	NGU	2320	9419	2	3	3
	NSF	739	275	8	16	7
	SGU	4179	395	16	65	11
	GEUS	8066		10	83	5
	BGS	31200	53000	71	61	
	BGR	16499	9182	20	12	4
	TNO-NITG	12343	6095	10	39	39
	GSB	1697	1129	7	21	7
	GSI	610			5	
	BGRM	16851	28155	20	8	
	ITGE	9720	22000	8	10	
	IGM	2195	3000		13	
	IGME	2680	4421	7	7	7
	DSTN	2365	2600	9	30	30
TOTAL		111464	139671	188	373	113

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## E U R O C O R E

A fundamental problem which has long presented better exploitation of the existing European core archive has been lack of knowledge of what data is available. It has been difficult for interested parties to find out who holds core samples and what types of samples are available. Most organizations have limited money and time to spend on their sample holdings. Few organizations have published listings of their cores, even fewer have searchable databases. Although most research institutes and universities with Geology and Oceanography Departments hold some cores or other seafloor samples, the location of such samples and the number held are often poorly known, particularly outside national boundaries. However, cost-effective use of expensive raw data, such as marine sediment cores and other seafloor samples, requires multiple purpose use of existing data. The problems in fully exploiting sediment sample archives due to lack of knowledge of what is available have long been recognized in the USA. As early as 1977, several oceanographic research institutions which maintain core collections got

together in a collaborative effort to help researchers locate marine sediment and rock material for further analysis. This initiative has grown into the "Index of Marine Geological Samples" held at the US National Geophysical Data Center/World Data Center A for Marine Geology and Geophysics at Boulder, Colorado, which can be interrogated online. Consequently it has always been far easier to determine what American cores have been taken from European waters, and are stored at American institutions, than to find those that have been taken by European ships and held at European institutions.

In order to make the European sediment core and seafloor sample archive more accessible to potential users, nine of Europe's largest core repositories:

- SOC Southampton
- GEOMAR Kiel
- CSIC Barcelona
- NITG-TNO Utrecht
- IGM Lisbon
- IGM-CNR Bologna
- BRGM France

came together to develop the EUROCORE proposal with the aim of harnessing the Internet to provide instant, continuous access to the archive from anywhere in the world.

The EUROCORE project provides the infrastructure by which core metadata can be gathered, collated and entered into the database. Each EUROCORE partner is responsible for collecting metadata from participating institutions within their respective countries. Each is at the center of national curatorial networks and can gather data from other smaller core-holding institutions through already established links. However, EUROCORE takes a strongly proactive approach to data gathering, employing both questionnaires and active 'data scouts' to gather metadata where necessary. This proactive approach is most important since many organisations, especially smaller repositories, do not have the time, money or staff to provide comprehensive data listings as a service. EUROCORE provides the resources for such listings to be compiled.

Co-ordination with EUMARSIN, facilitated by

the use of a common data management partner (MARIS), has resulted in clear domains for each project in populating the meta-database. EUROCORE will collect

- data from European universities, research institutes and marine stations
- from sampling locations anywhere in the world ocean providing the data was collected by, and is held at, at European institution
- from areas seaward of the continental shelf (>200 m water depth)

The number of cores within these data catchment areas is unknown but preliminary surveys by EUROCORE Partners suggest a minimum figure of 47,000 cores, although the final figure may be considerably larger. Like EUMARSIN, the EUROCORE project began in November 1998, but will run for three years. This reflects the greater time needed to gather data from throughout Partner countries, in addition to collation and submitting metadata on samples held at Partner institutions. It is co-ordinated by Southampton Oceanography Centre, the UK partner.

# DEFINITION OF META-DATA CHARACTERISTICS

The EU-SEASED metadata format is tuned with:

- Metadata format GEIXS Project (Catalogue of European Geological Data)
- Metadata format of the international core curator's database of NOAA (Index to Marine Geological Samples)

Within the EU-SEASED metadata formats mandatory and optional fields are distinguished.

<b>MANDATORY METADATA FIELDS</b>	<b>OPTIONAL METADATA FIELDS</b>
<ul style="list-style-type: none"> <li>• RECORD NUMBER</li> <li>• MEASURING ID</li> <li>• MEASURING AREA TYPE</li> <li>• COORDINATES</li> <li>• SAMPLING DEVICE</li> <li>• DATA SOURCE HOLDER</li> </ul>	<ul style="list-style-type: none"> <li>• SAMPLE STATE</li> <li>• SAMPLE STORAGE CONDITION</li> <li>• INTERNAL REFERENCE NUMBER</li> <li>• OBJECTIVE MEASUREMENT</li> <li>• TREATMENT</li> <li>• MEASURED PARAMETERS</li> <li>• SURFACE/SUB-SURFACE SAMPLE</li> <li>• GEOGRAPHICAL AREA</li> <li>• MONITORING SITE</li> <li>• PHYSIOGRAPHIC PROVINCE</li> <li>• NAVIGATION SYSTEM</li> <li>• CORE/SAMPLE LENGTH</li> <li>• WATER DEPTH</li> <li>• CORE/SAMPLE PENETRATION</li> <li>• CORER SAMPLING PENETRATION</li> <li>• CORE/SAMPLE DIAMETER</li> <li>• DATE OF COLLECTION</li> <li>• PROJECT/CRUISE NAME</li> <li>• RESEARCH/SURVEY VESSEL</li> <li>• PROJECT/CRUISE REPORT</li> <li>• BASAL AGE OR PERIOD</li> <li>• PREDOMINANT SEDIMENT TYPE</li> <li>• SAMPLE RECOVERY</li> <li>• LIST OF MAPS</li> <li>• REFERENCE</li> <li>• COMMENTS</li> </ul>

**Within the meta-database system, the following parts can be distinguished**

- Data-Entry (online data-entry and online editing of metadata)
- Data-Retrieval, including GIS-based User Interface
- Data-Presentation

**Data - Retrieval**

Data-Retrieval can take place on indexes of cores/samples and indexes of maps:

- 1) Retrieval from a basic map: (see examples 1, p.18)
- 2) Retrieval by simple or advanced (including optional fields) search query: (see examples 2, p.18,19)

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UPDATING - IMPLEMENTATION PHASE

Data-entry of new metadata, as well as editing (up-dating) of existing metadata, can take place on-line, by the partners involved within the EUMARSIN and EUROCORE Projects.

The implementation phase takes place:

EUMARSIN Project      From January 2000 till November 2000 (Project End)

EUROCORE Project      From January 2000 till November 2001 (Project End)

After finishing of both projects, the partners involved will take care of updating of the EU-SEASED meta-database on regular basis. The editing/up-dating will be carried out on-line.

Moreover, EU Projects within the Fifth Framework, dealing with marine geological data, will be recommended to submit project metadata to the EU-SEASED meta-database.

# E X A M P L E S

<http://www.eu-seased.net>

Retrieval from a basic map

Example 1

The screenshot shows the EU-SEASED website interface. At the top, there is a navigation bar with the logo and a search bar. Below the navigation bar, there is a map of the North Sea region. A red circle on the map highlights a specific location, and a red arrow points from this circle to the 'Sample information' section of the 'Detailed information' panel below the map. The 'Sample information' section contains the following data:

Sample information	
Measuring id	P5005241
Project	EUMARSIN
National partner	Ecological Society of Norway
Country	Norway
Data source holder	Ecological Society of Norway
Project cruise name	8235
Period start	19100224
Period end	19100224
Sampling device	Neumark cover
Sample length (m)	0.75
Surface sample	Yes
Sub surface sample	Yes

Below the 'Sample information' section, there is a 'Location information' section with the following data:

Location information	
Measuring area type	Point
Water depth (m)	955
Navigation system	DGPS
Datum	WGS 84
GEO Coordinates (decimal)	NE: 18.883149 51.8036
UTM coordinates	NE446731 045309510
Central meridian	EX99 D

At the bottom of the page, there are two 'Detailed information' sections, each with a 'Sample information' section containing the measuring id P5005240.

Retrieval by simple or advanced (including optional fields) search query

Example 2a

The screenshot shows the EU-SEASED website search interface. The browser window title is 'EU-SEASED - EUMARSIN/EUROCORE META DATABASE - Microsoft Internet Explorer'. The address bar shows the URL <http://www.eu-seased.net/metadatabase/welcome.html>. The search interface includes a search bar and a 'Sort on' dropdown menu. Below the search bar, there are several search criteria with dropdown menus:

- Free search
- Project
- Country
- Sampling device
- Data source holder
- Sample state
- Sample storage condition
- Internal reference number
- Treatment
- Measured parameters
- Dive/In-situ

Example 2b

Project	Data source holder	Country	Sampling device	Measuring id	Period start	Period end	Show
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15879000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15880000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15881000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15882000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15883000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15884000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15885000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15886000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15887000	19931103	19931103	
EUMARSIN	Netherlands Institute of Applied Geoscience-TNO	Netherlands	Grab (Unknown Type)	gd15888000	19931103	19931103	

Example 2c

[New query](#) | [Results](#) | Found 16778 | [Show 1](#) | [Previous](#) | [Next](#)

<b>Detailed Information</b>	
<b>Sample information</b>	
Measuring id	gd15879000
Project	EUMARSIN
National partner	<a href="#">Netherlands Institute of Applied Geoscience-TNO</a>
Country	Netherlands
Data source holder	<a href="#">Netherlands Institute of Applied Geoscience-TNO</a>
Vessel name	m.s. mitra
Objective	to survey and map the subsoil (quaternary and tertiary) of the southern north sea, maximum coring depth = 80 meters.
Period start	19931103
Period end	19931103
Internal reference number	s05 0310 93g322
Sampling device	Grab (Unknown Type)
Surface sample	No
Sub-surface sample	No
Measured parameters	Other
<b>Location information</b>	

## P O S S I B L E E N D U S E R S

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Existing data on coastal and marine sediments can be used to underpin many areas of research and social and commercial enterprise, some of which are outlined as follows.

- Monitoring change in the marine environment. The rate and type of change taking place is increasingly influenced by anthropogenic factors. The meta-database will establish a baseline against which future change can be measured.

- Studies into the effect of contaminants on marine organisms, the maintenance of biodiversity and the implications of contaminants entering the human and wildlife food-chain.

- Environmental assessment of the potential impact of a given industrial activity such as oil and gas exploitation and the decommissioning of hydrocarbon industry structures on the sea bed, the effect of trawling by the fishing industry and dredging by the sand and gravel industry.

- Hazard assessments: For example geotechnical information on the stability of sea-bed sediments, particularly in slope environments, are relevant

to engineering projects such as the laying of pipelines and cables on the sea floor.

- Identification of economic mineral deposits such as offshore placer deposits or beach mineral sands and the economically important resource of sand and gravel used in construction.

- Improved interpretation of combined bathymetric and sea-bed sediment information on a pan-European basis.

On the other hand, the contrasting interests of people involved in the use of the coastal and marine environment requires an impartial systematic framework for the provision of information related to their activities. The creation of a European marine meta-database focused on geological and geochemical information for the sea floor would provide such a framework for scientific research, decision-making in government and management in the commercial sector.

Some of these activities and potential social and economic impacts are summarised below.

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<b>Sector</b>	<b>Information</b>
Fisheries	The effect of chemical pollutants on fish stocks. Impact of trawling and dredging on the sea-floor.
Agriculture and forestry	Use of fertilisers and the effect of nutrient enrichment in the seas through river and land run-off.
Energy	Hydrocarbon industry. Effect on sea bed of engineering (disturbance due to dredging, anchoring), exploration (discharge of fluids and drill cuttings), and decommissioning of offshore platforms and removal of pipelines.
Renewable energy	Utilisation of marine and tidal currents and wind energy. Environmental impact of offshore installations such as wind farms.
Nuclear industry	Waste disposal and groundwater effects and the transfer of pollutants in the marine environment.
Manufacturing industry	Location and sustainable exploitation of marine mineral and metal resources. Environmental impact of resource development.
Construction industry	Effects of civil engineering in coastal defence and land reclamation projects. Location, exploitation and environmental impact of marine sand and aggregate resources.
Tourism	Pollution in the coastal zone - effect on beaches and bathing water quality. Beach nourishment from dredged offshore sands
Transport and communication	Shipping - impact of new designs of environmentally friendly ships in limiting polluting emissions. Ports and harbours. Telecommunication cable routes.
Conservation	Preservation of coastal and marine habitats and wildlife conservation.
Waste management.	Sewage and dredge spoil disposal.
Human health	The effect of contaminants on marine life and the food-chain.
Defence	Acoustic properties of the sea bed.
Education	Awareness of the importance of the marine environment and the need to balance development and conservation.

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# P R O J E C T P A R T N E R S

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## E U M A R S I N

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