Atlantic Data Base for Exchange Processes at the Deep Sea Floor

”ADEPD”

A proposal to the European Network for Research in Global Change (ENRICH)

Part I: anonymous part

1. Objectives

This scientific proposal falls under the Marine Science and Technology work programme related to global change (area A.2.1.). It addresses in particular the deep sea floor of the Atlantic with special emphasis on the North Atlantic. It builds up a network for the exchange of biogeochemical benthic data and aims at integrating present knowledge of processes at the deep sea floor. It is a supporting action contributing to JGOFS and with benefits for natural resource management.

1.1. Background - State of the art

The global cycling of carbon and associated elements through the world’s oceanic systems is one cornerstone of the understanding of the linkage between climate and oceanic processes addressed by the international Joint Global Ocean Flux Studies (JGOFS), a core project of the International Geosphere-Biosphere Programme (IGBP). In order to achieve a comprehensive view of oceanic biogeochemical cyles, the role of the long-term reservoirs of the deep waters and in particular the bottom sediments must be assessed. It is one of the major goals within the JGOFS programme to reconcile rates of surface water production and rates of vertical export with data on benthic turnover to arrive at a full description of transport, burial and turnover of matter within ocean basins. Furthermore, the deep sea ocean fluxes, albeit much smaller than those in surface waters, can be measured directly at a physical boundary and are less subjected to annual variability or short term variation. Therefore, they represent average flux rates and mirror, with some aberrations, average surface water productivity. Although the different national JGOFS programmes did not include specific benthic projects, there are a number of national and international European projects investigating benthic processes which are to some degree collaborating with JGOFS (see section 2). Therefore, it would represent a substantial optimization to make the deep

sea biogeochemical data from various projects compatible with JGOFS data from the upper water column.

Since many biogeochemical key parameters describing standing stocks and rates of turnover can for practical reasons only be obtained at a few selected stations, the extrapolation of such data from individual points/stations to a larger spatial scale is difficult. It requires the determination of empirical correlations or modelling of processes which link these limited data to ”master” variables for which a large data base is already available. In this way, the the global ocean flux of particulate organic carbon was recently assessed from benthic data (Ref. 1). This very commendable work, however, suffers from scarce data and can, therefore, only arrive at approximate estimates. This work shows that the approach is feasible and that a general regional classification of the sea floor in terms of biogeochemical characteristica is be possible. Such a description of ”benthic biogeochemical provinces” of the Atlantic deep sea floor, analogous to the concept of upper ocean biogeochemical provinces (Ref. 2), will be one aim of this proposed project. The emphasis will be placed on the North Atlantic, since it is this area for which we have the most comprehensive data sets in particular from British, French, German and American projects. Furthermore, the North Atlantic is the most perturbed region due to human activities. The South Atlantic will naturally be included to arrive at a complete description of the whole Atlantic Ocean.

Such an areal biogeochemical description of the deep sea floor would not only contribute to the assessment of the role of oceanic processes in climatic changes, but is also a basic prerequisite for evaluation of any potential anthropogenic use of the deep oecan. It would enable the identification of particularly sensitive areas and, thereby, aid political, economical and legal decisions. The deep sea floor has been generally recognized as a key global environment and improvement of the knowledge about this environment has been recommended as one European Grand Challenge in marine research (Ref. 3, Ref. 4).

1.2. Objectives

The proposed project will establish a network of European researchers involved in geochemical and biological deep sea work. Through workshops, the build up of a joint data base and geographical analysis of these data this group will address the following objectives:

-to compile biogeochemical data from Atlantic deep sea sediments (benthic boundary layer) from various projects and from the literature. This compilation includes harmonisation of data (common units, conversion to uniform variables).

-to extrapolate data of biogeochemical processes at the sea floor obtained at individual stations to a basin wide scale using empirically established correlations to widely measured ”master” variables.

-to link biological (biomass) to geochemical (fluxes of chemical species, etc.) data.

-to develop an areal description of ”benthic biogeochemical provinces” in the deep sea of the Atlantic.

-to compare the biogeochemical processes at the sea floor to data on surface water productivity and sedimentation from JGOFS projects.

-to make the results of this study available to a wide user group, particularly within the JGOFS community, and to authorities involved in decisions about utilization of deep sea resources and deep sea protection.

-to identify gaps in regional coverage and to specify advanced data analysis approaches (kinetic models, coupling of different variables etc.) to be addressed by future projects.

1.3. Progress beyond the state of the art

The data, which have been produced within a number of different national or international projects, as well as relevant data from the literature will be made available in an easily accessible form. Since a number of these data sets are as yet unpublished or variables may have to be converted to common units, this compilation will produce a data base much larger than hitherto available. This is particularly so, if Russian data are incorporated.

The compilation of these data will allow to produce at a basin wide evaluation of processes at the deep sea floor. Based on this extensive data base, a much more detailed areal description than presently available would be possible. Such a compilation will be a valuable basis for assessments of oceanic carbon cycles and for an evaluation of potential use of deep sea areas by European nations.

It has to be made clear, however, that within this limited project only the foundations for a more advanced analysis of the data can be laid. Once the data base has been established, based on the projects outlined in section 2.1., future data additions can easily be made. It is also possible to transfer the data into the Geographic Information System (GIS) for advanced or specialized data analysis in future projects.

1.4. Originality and innovation

At present no compilation of data for deep sea biological and geochemical data of this extent exists for the Atlantic. It is also an important new step to combine biological and geochemical data for a geographical analysis of deep sea processes. The description of deep sea biogeographical provinces is not entirely new, but in view of the range of variables to be used for this analysis it is to be expected that a significantly improved geographical classification of the Atlantic deep sea floor will be achieved.

2. Work content

2.1. General approach

The tasks outlined below will be achieved by: a) two workshop meetings, b) the build up of the data base and c) first analysis of the compiled data according to the discussions during the work shops. Each partner participates in the compilation of data and undertakes some special tasks as outlined below. There are further interested researchers from the scientific community who wish to join in the workshops and contribute to the data base. Their participation in this project will be coordinated by the partners according to nation or field of research. Communication between the partners will be organised by the coordinator of the project via e-mail.

The main projects to be considered within this project are:

Acronym	*Area*	*Funding*
SFB 261	South Atlantic	German
div. AWI projects	Atlantic sector of the Southern Ocean	German
EUMELI	tropical North Atlantic	French
SEDORQUA	tropical North Atlantic	French
BOFS	Northeast Atlantic	British
PAP/MAP	Northeast Atlantic	British
BIOTRANS	Northeast Atlantic	German
BIO-C-FLUX	Northeast Atlantic	German
BIGSET	Northeast Atlantic	German
BENBO	Northeast Atlantic	EU
ALIPOR	Northeast Atlantic	EU
OMEX	Northeast Atlantic continental margin	EU
BIOGAS	Northeast Atlantic continental margin	French
SFB 313	North Atlantic, Norwegian Sea	German

In addition to these ongoing or recently finished projects, data from various American and Russian investigations in the Atlantic will be incorporated. This will strengthen the data coverage in the West Atlantic. There will be further smaller

projects not mentioned here which will also be considered. Available literature data will be included.

The following variables may be included into the data base subject to the discussions on the first workshop:

Benthic flux measurements:

- oxygen flux (benthic chambers and profiles)
- nitrate flux (profiles)
- phosphate flux (profiles)
- silicate flux (benthic chambers and profiles)
- inorganic carbon flux (benthic chambers and profiles)
- radionuclide fluxes (inventories)

Biological parameters:

- concentration of specific components, biogenic tracers
  (e.g. pigments, barium)
- biomass of organisms of different size groups in carbon
  (derived from several variables:
  -abundance and size of organisms for macro- and megafauna,
  -ATP, Phospholipids, DNA for meio- and microfauna)
- rate of bioturbation

Sediment particle composition:

- concentration of organic carbon in surface sediments*
- concentration of carbonate*
- concentration of opal*
- sediment accumulation rates*
- sediment facies*

* = available from literature compilations

The project has four phases (see time table). In the initial phase, the first workshop of 3 days will be held during which the available data will be reviewed, the conversion to common units and variables will be established and build up of the data base will be discussed. The second phase is devoted to the compilation of data in the data information system and first analysis of data. In the third phase, the second workshop of 3 days will be held during which the achieved results will be evaluated, the final analysis of data will be discussed and publication and dissemination of results will be prepared. The last phase is used for final analysis of results, publication and dissemination of results.

2.2. Tasks

Task 1- Workshop I

Identifiy suitable datasets and variables to be collected in the data base.
Establish units and, where required, conversion factors to harmonize data.
Discuss procedure for data collection.
Introduce participants to the interactive use of the data information system (SEPAN).

Task 2 - Collection of data from various projects

For the collection and integration of data the interactive data bank system SEPAN will be used. At present the available data are very heterogeneous both in respect to the variables determined and sampling strategy / frequency. Thus, the integration requires normalizing of data and, particularly for biological data, the conversion of proxies (e.g. ATP) to basic data (biomass), where possible. Data of prime interest are those from oceanic regions, but data from continental slopes up to 500m water depth will also be included in the data base.

Task 3 - Data analysis and areal description of biogeochemical provinces

The different variables within the data base will, as a first approach, be analysed for correlations. This will provide information on relationships which may be utilized to extend the geographical coverage of data obtained at only a few stations. Spatial representation of key variables and description of “biogeochemcial provinces” will be prepared. Benthic turnover of matter will be compared with estimates of export of organic material from the upper water column for selected ocean regions. For advanced analysis of data the Geographic Information System (GIS) may be used. An export of data from SEPAN to GIS will be provided, but advanced analysis of data can not be achieved within this small project.

Task 4 - Workshop II

Review the data collection and their analysis for areal representation.
Identify gaps of knowledge and make suggestions for advanced analyses in future projects.
Prepare joint publications and WWW-presentation.

Task 5 - Publication and dissemination of results

The achieved results will be made available to the scientific public via joint publications in relevant journals. A wider user group will be addressed by a WWW site presenting the most pertinent results.

2.3. Data management plan and quality control

The data management plan includes the following steps:
- Data collection.
- Quality control (completeness of metainformation for the data sets, validity and objectivity of measuring and calibration methods, error checking within the data sets).
- Data publication (long term banking of data sets using an appropriate information system within the European science network providing retrieval via WWW, downloading of any portion of data and links to the scientific publications.
- Data retrieval and data handling support for working groups in the phase of interpretation.

Approach

The working groups in the different partner institutions will provide quality checked data in suitable form to the coordinator.The coordinator is responsible for supplying these data to the data bank. This will be done in close cooperation with the partner involved in data management. The data management partner is responsible for the processing and dissemination of data sets by providing the information system SEPAN (Sediment and Paleoclimate Data Network) for this purpose. In particular, the SEPAN-group will

- prepare data sets for publication (including transformation of data sets into consistent formats and procedural quality checking within the information system),
- provide a WWW homepage for project specific information including an entry level for data retrieval, and links to relevant home pages of project members
- prepare data sets and related metadata for mirroring on other sites,
- will support working groups by collecting project relevant data from previous works and
- supply software, data products, and interfaces for the visualization of data in mapping tools and Geographical Information Systems (GIS) for the synthesis of results.

The information system SEPAN was developed by partner B) (see section 7) as the first subsystem of PANGAEA (PaleoNetwork for Geological and Environmental Data) (Ref. 5). The project was financed by the German Ministry of Education, Science, Research and Technology (BMBF). The PANGAEA/SEPAN system uses client/server technology through the Intranet/Internet; the main database server is a DEC Alpha 8200 (4 processor, 2 GB internal memory, 50 GB hard disc capacity) running SYBASE Version 11 under DEC/UNIX as the database software. The user-friendly client software for access to the server was written in 4th Dimension and can be used for MacOS and Windows as well.

• The system PANGAEA/SEPAN is operable. From the beginning of the project, it can be used as the central facility to store all information, metadata as well as analytical data.
• Access to the data is realized in two ways. The client software allows a high functionality in retrieving data and can be installed in any group of the project. For simple world wide access on published data of the project, a web interface is provided.
• Due to the installation of the system in a computer center experienced in data management within a major research institute, the long time archiving of the data is ensured. There is no similar system available at this time.

3. Project milestones and deliverables

3.1. Milestones

The project milestones comprise the two workshops and the publication of the results. The time table gives an overview of the temporal distribution of the tasks. The project is envisaged to start in January 1998 and to run for two years. The workshops are planned for March 1998 and March 1999 and will last 3 days each. Collection of data and build up of the data bank will occupy the largest time section of the project from January 1998 to April 1999. Data analysis and dissemination of results occupy the second half of the project.

Table 1: Time table:

	1998												1999											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Task 1 -			**																					
Task 2 -			**********	**********	**********	**********	**********																	
Task 3 -													**********	**********	**********	**********	**********							
Task 4 -														**										
Task 5 -																		**********	**********					

3.2. Deliverables

a) Data bank of deep sea biogeochemical data of the Atlantic

b) Spatial representation of key biogeochemical benthic variables

c) Areal description of ”deep sea biogeochemical provinces”

d) Publications (in scientific journals, WWW site)

e) Report of the project including identification of the gaps of knowledge and suggestions for advanced analysis of the data

4. Benefits

4.1. Added value

Data spread in a number of individual projects are of little use when trying to come to large scale assessments. The individual projects cannot achieve the integration of data called for. This particular task can be provided by the supporting action ADEPD for benthic biogeochemical data of the Atlantic. It therefore helps to extend the use of the data beyond the scope of the individual projects.

The areal biogeochemical description of the deep sea floor would contribute to the assessment of basin wide fluxes across the deep sea sediments. In addition to this objective, which contributes to the international climate change project JGOFS, it provides also an important data base for the evaluation of any potential anthropogenic use of the deep ocean. It would enable to identify particularly sensitive areas and, thereby, aid political, economical and legal decision finding processes.

4.2. Relevance of carrying out at European level

As pointed out above, the relevant data have been collected by a number of different European international and national projects. Only by compiling all these data and also including available American and Russian data (see 4.3.) a wide enough data coverage of the Atlantic ocean can be achieved to tackle the objectives of this proposal. The main target area of this project is the North Atlantic, an area of relevance for the European nations.

4.3. Transnational participation

The partners are from 10 different institutions located in 6 nations (Britain, France, Germany, Netherlands, USA and Russia). The inclusion of participants from outside the European Union is vital to this project, since important data particularly from the western Atlantic have been produced by American groups and need to be included in the data bank. Similarly, benthic data from various regions of the Atlantic have been collected by Russian groups. These data are not easily available and an attempt will be made to include relevant, qualitiy checked data as far as they are accessible.

5. Economic and social impacts

Understanding the natural processes at the deep sea floor and identification of potentially sensitive areas is a key requirement for assessments in respect to any anthropogenic use or protection of the deep sea. Thus, the basic information service provided by this project may aid in developing regulations/legislations for the use and protection of the deep sea floor.

Atlantic Data Base for Exchange Processes at the Deep Sea Floor

”ADEPD”

Part II: participants identified

6. Project management

The project comprises the coordinator and 9 partners.

The coordinator is responsible for management of the project and organization of the workshops, for maintaining communication between all partners, for input of data supplied by the partners to the data bank and will lead the dissemination of results. The input of data to the data bank will be carried out in close cooperation with the partner responsible for the data management. A SEPAN interface will be installed at the coordinators institute.

Each of the partners will participate in the workshops, supply quality checked data in correct format for the compilation in the common data bank and undertake specific tasks as outlined under section 7. This includes analysis of data and participation in the publications.

There are further scientists who are interested to join in the discussion and compilation of data. These additional experts will be invited to join the workshops and discussions. If they wish to contribute data, this will be coordinated by the partner who is resident in the same country or working in the same field of research. By this involvement of external experts, the extent of the data base, the quality of data analysis and the general discussions will be improved and widened to include a broader view.

Communication between all partners and interested scientists will be maintained via e-mail and the WWW homepage of the project.

7. The Partnership

7.1. Participants and task distribution

Partner A) Coordinator:
K. Lochte, A. Boetius
Institut für Ostseeforschung Warnemünde (IOW), Germany

- -coordination of the project
- -maintaining communication between all partners
- -input of data to data bank
- -leading dissemination of results
- -organisation of workshops
- -contributing data from the following projects: BIOTRANS, BIO-C-FLUX, BIGSET

Partner B):
H. Grobe, M. Diepenbroek, H. Thiel
Alfred-Wegener-Institut für Polar- und Meeresforschung Bremerhaven (AWI), Germany

- -providing and maintaining data information system SEPAN
- -supervising collection of data
- -WWW publication of data
- -transfer of data from SEPAN to GIS
- -contributing to the analysis of data
- -areal description of ”benthic biogeochemical provinces”
- -contributing data from the following projects: BIOTRANS, BIO-C-FLUX, OMEX

Partner C):
M. Zabel
Fachbereich Geowissenschaften, Universität Bremen (Uni Bremen), Germany

- -contributing to the analysis of data
- -areal description of ”benthic biogeochemical provinces”
- -contributing data from the following projects: SFB 261

Partner D):
M. Schlüter, O. Pfannkuche
Forschungszentrum GEOMAR Kiel (GEOMAR), Germany

- -contributing to the analysis of data in GIS
- -areal description of ”benthic biogeochemical provinces”
- -contributing data from the following projects: AWI Projects in the Southern Ocean (Atlantic sector), BIOTRANS, BIO-C-FLUX, BIGSET, OMEX

Partner E):
G. Shimmield
Dunstaffnage Marine Laboratory Oban (Dunstaffnage ML), UK
-contributing to the analysis of data in GIS
-areal description of ”benthic biogeochemical provinces”
-contributing data from the following projects: BOFS, BENBO, ALIPOR

Partner F):
C. Rabouille, S. Charbit, F. Bassinot
Centre des Faibles Radioactivites Gif-sur-Yvette (CFR Gif-sur-Yvette), France
-leading the analysis of data
-areal description of ”benthic biogeochemical provinces”
-contributing data from the following projects: EUMELI, SEDORQUA

Partner G):
M. Sibuet, A. Khripounoff, J. Galeron
IFREMER Centre de Brest (IFREMER Brest), France
-areal description of ”benthic biogeochemical provinces”
-contributing data from the following projects:EUMELI, BIOGAS, OMEX

Partner H):
W. Helder
Netherlands Institute for Sea Research (NIOZ), Netherlands
-areal description of ”benthic biogeochemical provinces”
-contributing data from the following projects: OMEX

Partners from outside the European Union:

Partner I):
R. Jahnke
Skidaway Institute of Oceanography (SIO), USA
-contributing to the analysis of data
-areal description of ”benthic biogeochemical provinces”
-contribution of data from American projects

Partner K):
A. Gebruk
P. P. Shirshov Institute of Oceanology Moscow (Shirshov Inst.), Russia
-areal description of ”benthic biogeochemical provinces”
-contribution of data from Russian projects

Table 2: Tasks and working groups

Involvement of the partners in the different tasks is indicated by
+ = minor involvement, ++ = major involvement, +++ = leading the task.

	task 1	task 2	task 3	task 4	task 5
partner A	+++	+	+	+++	+++
partner B	+	+++	++	+	+
partner C	+	++	++	+	+
partner D	+	++	++	+	+
partner E	+	++	++	+	+
partner F	+	++	+++	+	+
partner G	+	++	++	+	+
partner H	+	++	++	+	+
partner I	+	++	++	+	+
partner K	+	++	++	+	+

7.2. Competence of partners

The partners are all actively involved in biological or geochemical deep sea research for many years. They are experts in their field of research with numerous publications and have access to the relevant data. Most of the recent major deep sea programmes in Europe are represented by this group of experts as indicated by the list of projects from which data will be contributed to the ADEPD data base. The partners from outside the European Commission have been selected for their experience in this field. The previous assessment of oceanic fluxes by R. Jahnke (Ref. 1) is an important background information for this project and, therefore, he was chosen as the most suitable partner from USA. At the Shirshov Institute in Moskow biological and geochemical deep sea data from the Atlantic have been collected. A. Gebruk is an experienced deep sea biologist and will provide biological data. We hope to be able to include a further scientist involved in geochemical analyses.

The computer center has 15 years of experience in data management and in the design and implementation of databases. They are experienced particularly with benthic and geological data (Ref. 5).

The project will be coordinated by K. Lochte, who has been involved in serveral deep sea projects in the last 16 years. She has led the discussion on “Benthic exchange processes in the deep sea” as part of the Grand Challenge “Variability of the deep sea floor” formulated by ECOPS as a long term goal for European marine research (Ref. 4). The Institut für Ostseeforschung is presently coordinating the large European project BASYS in the Baltic Sea and has the appropriate experience for the coordination task.

8. Financial information

A breakdown of costs according to tasks is given in the following. The two figure label of each individual position of this breakdown appears in Table 3 to identify the costs. An annual breakdown has not been provided here, as the expenditures in both years are nearly equal.

A nominal effort of 10 day was fixed for each partner to make the respective data sets available for the data base. This time does not nearly cover the actual amount of effort spent, as each partner contributes more time in order to carry out the tasks.

The central server of the PANGAEA-System will be operated by the center free of charge (contribution 180 000 ECU/year) and 6 scientists are involved in the development and management of the PANGAEA/SEPAN information system. But the data management plan needs financial support for the application of the information system to the ADEPD project, including installation, software support and data retrieval.

Task 1): Workshop I

1.1. travel costs for all partners and invited additional scientists (in total approx 20 persons) (partners B - G)
1.2. costs for administration of workshop (partner A)

Task 2): Collection of data from various projects
2.1. Licence for SEPAN data bank system (partner A)
2.2. costs for data bank management (partner B)
2.3. cost for making data available (effort 10 days) (partners A-G)

Task 3): Data analysis and areal description of biogeochemical provinces
no extra costs

Taks 4): Workshop II
4.1. travel costs for all partners and invited additional scientists (in total approx 20 persons) (partner B-G)
4.2. costs for administration of workshop (partner A)

Taks 5): Publication and dissemination of results
no extra costs

Table 3: Breakdown of costs according to partners and tasks

All costs in Table 3 are given in ECU. The costs for the effort spent to compile the data has been estimated as 10 days for each partner; the cost per day are estimated as 200 ECU. This may be used to pay assistance.
For the travel costs to the two workshops the number of participating persons per partner is indicated. The workshops are running for 3 days each.

	task 1	task 2	task 3	task 4	task 5	SUM
partner A	2 000 (1.2.)	6 000 (2.1.) 2 000 (2.5.)		2 000 (4.2.)		12 000
partner B	300 (1.1.) 1 pers.	15 000 (2.2.)		300 (4.1.) 1 pers.		15 600
partner C	600 (1.1.) 2 pers.	2 000 (2.5.)		600 (4.1.) 2 pers.		3 200
partner D	1 000 (1.1.) 3 pers.	2 000 (2.5.)		1 000 (4.1.) 3 pers.		4 000
partner E	3 300 (1.1.) 3 pers.	2 000 (2.5.)		3 300 (4.1.) 3 pers.		8 600
partner F	3 300 (1.1.) 3 pers.	2 000 (2.5.)		3 300 (4.1.) 3 pers.		8 600
partner G	3 200 (1.1.) 3 pers.	2 000 (2.5.)		3 200 (4.1.) 3 pers.		8 400
partner H	1 000 (1.1.) 2 pers.	2 000 (2.5.)		1 000 (4.1.) 2 pers.		4 000
partner I	2 500 (1.1.) 2 pers.	2 000 (2.5.)		2 500 (4.1.) 2 pers.		7 000
partner K	2 500 (1.1.) 2 pers.	2 000 (2.5.)		2 500 (4.1.) 2 pers.		7 000
SUM:	19 700	39 000	19 700	78 400		

9. Exploitation plan

The results of this project will be primarily exploited by making the data bank available to the international JGOFS scientific community. The data bank will be maintained after termination of the project, since future expansion of the data base is desirable and provided for by the data information system SEPAN.

The project will also in its final report suggest further ways of advanced data analysis to make optimal use of the complied data. This may form the basis for future research projects. Such analyses may for instance be focussed specifically on questions related to exploitation of the deep Atlantic.

9.1. Dissemination of results

The results of this project will be made available in two ways:

Publications in scientific journals and JGOFS news letter: This will address the scientific community involved in JGOFS and related fields of research.

Production of a WWW information: This will show the most pertinent results in an easily understandable form and also give information how to access the data information system. This way the results will be made available to a wider public (e.g. from industry, governmental agencies etc.).

9.2. Target user group

The international Scientific Steering Committee of JGOFS has implemented a Benthic working group with the aim to link the processes in the upper oceanic water masses established by direct measurements and modelling to the processes at the sea floor. This will finally provide a link between JGOFS and PAGES. The results of this project will therefore make the necessary benthic information available for global flux estimations of JGOFS. The data bank will be made available to members of this community upon request.

The results of this project will be made available to governmental agencies involved in environmental protection and potential anthropogenic use of the deep ocean. The project will provide basic information required for environmental protection measures or exploitation. Up to now, this information is not available in such condensed and easily accessible form.

9.3. Contribution to management for the sustainable use of the ocean

The North Atlantic Ocean surrounded by industrialized nations will be more subjected to anthropogenic disturbances than other oceanic regions. In particular,

the need to dump different types of waste may increase as storage on land is limited. Such activities require well founded assessments of their impacts on the respective environment in order to protect sensitive areas and to regulate the exploitation of this resource. The data bank will contribute the essential information for such an assessment.

11. References cited

5) Diepenbroek, M, Grobe, H., Reinke, M. (1997) SEPAN - Sediment and Palaeoclimate Networks. In: . M. Lautenschlager, M. Reinke (eds) Climate and Environmental Data Base Systems. Kluwer Acadademic Publishers, Boston, 147-161 pp.

1) Jahnke, R. A. (1996) The global ocean flux of particulate organic carbon: areal distribution and magnitude. Global Biogeochemical Cycles, 10: 71-88.

3) Le Pichon, X. (1995) Deep sea floor as a changing environment. In: Hempel, H. (ed.) The Ocean and the Poles - Grand Challenges for European Cooperation, G. Fischer Verlag, Jena, pp 147-156.

4) Lochte, K. (1995) Benthic exchange and transformation in the deep sea - the need for high resolution four dimensional studies. In: Hempel, H. (ed.) The Ocean and the Poles - Grand Challenges for European Cooperation, G. Fischer Verlag, Jena, pp 157-169.

2) Longhurst, A. (1995) Seasonal cycles of pelagic production and consumption. Progress in Oceanography, 36, 77-167.

Relevant Publications of the Coordinator:

Lochte, K. & Turley, C.M. (1988) Bacteria and cyanobacteria associated with phytodetritus in the deep-sea. **Nature**, 333, 67-69.

Turley, C.M., Lochte, K. & Patterson, D.J. (1988) A barophilic flagellate isolated from 4500m in the mid-North Atlantic. **Deep-Sea Res.**, 35, 1079-1092.

Thiel, H., Pfannkuche, O., Schriever, G., Lochte, K., Gooday, A.J., Hemleben, Ch., Mantoura, R.F.C., Turley, C.M., Patching, J.W. & Riemann, F. (1988/1989) Phytodetritus on the deep-sea floor in a central oceanic region of the Northeast Atlantic. **Biol. Oceanogr.**, 6, 203-239.

Turley, C.M. & Lochte, K. (1990) Microbial response to the input of fresh detritus to the deep-sea bed. **Palaeogeogr., Palaeoclimatol., Palaeoecol. (Global and Planetary Change Section)**, Elsevier Science Publishers B. V., Amsterdam, 89, 3-23.

Lochte, K. (1992) Bacterial standing stock and consumption of organic carbon in the benthic boundary layer of the abyssal North Atlantic. In: G.T. Rowe & V.Pariente (eds) **Deep-Sea Food Chains and the Global Carbon Cycle.** Kluwer Academic Publishers, Netherland, pp. 1-10.

Lochte, K., Ducklow, H., Fasham, M.J.R. & Stienen, C. (1992) Plankton succession and carbon cycling at 47°N 20°W during the JGOFS North Atlantic Bloom Experiment. **Deep-Sea Res. Part II**, 40, 91-114.

Pfannkuche, O. & Lochte, K. (1993) Open ocean pelago-benthic coupling: cyanobacteria as tracers of sedimenting salp faeces. **Deep-Sea Res. I**, 40, 727-737.

Lochte, K. (1993) Mikrobiologie von Tiefseesedimenten. In: L.-A. Meyer-Reil (ed.) **Mikrobiologie des Meeresbodens**. Fischer Verlag, Jena. pp.258-282.

Boetius, A. & Lochte, K. (1994) Regulation of microbial enzymatic degradation of organic matter in deep-sea sediments. **Mar. Ecol. Prog. Ser**., 104, 299-307.

SCOR Working Group 76 Members (1994) Suggested Criteria for describing deep-sea benthic communities; the final report of SCOR Working Group 76. **Prog. Oceanog**. 34, 81-100.

Turley, C.M., Lochte, K. & Lampitt, R.S. (1995) Transformations of biogenic particles during sedimentation in the North Eastern Atlantic. **Phil. Trans. R. Soc. Lond. B** 348, 179-189.

Lochte, K. (1996) Benthic exchange and transformation in the deep sea - the need for high resolution four-dimensional studies. In: G. Hempel (ed.) **The Oceans and the Poles: Grand Challenges for European Cooperation**. G. Fischer Verlag, Jena, pp. 157-169.

Boetius, A. & Lochte, K. (1996) High proteolytic activities of deep sea bacteria from oligotrophic polar sediments. **Arch. Hydrobiol. Spec. Issues Advanc. Limnol.** 48, 269-276.