1 Research Objectives

During Leg M43/1 (Project DECOS, Destruction and Construction of Seamounts) submarine volcanoes on the flanks of the Canary Islands, especially their submarine rift systems and isolated cones and seamounts within and south of the Canary Island Archipelago, were sampled by dredging and mapped by swath bathymetry and a subbottom profiling system (Fig. 1). The goal of the cruise was to develop criteria to distinguish different types of seamounts and submarine flank volcanoes by their structure, general lithology, composition, age and therefore their origin. We wanted to reconstruct the development of submarine volcanoes depending on the composition of the magma, eruption rate and water depth. Active magmatic degassing was studied by taking reconnaissance water samples. A second aim of the cruise was to document major debris avalanche and debris flow deposits in more detail that resulted from the failure of subaerial and submarine flanks of some island volcanoes. With these data we hope to contribute to a better understanding of the evolution of the magma sources and volcanism in the boundary area between the oceanic and continental lithosphere off Northwest Africa.

Leg M 43/2 served the multidisciplinary joint project of the European Union OMEX II (Ocean Margin Exchange; period: 1997-2000), in which 40 institutes participate. During the first application phase, research was focused on the region between Meriadzek Terrace and Porcupine Sea-Bight, whereby benthic work concentrated on a transect over Goban Spur (Celtic Sea), an example for a broad shelf. During phase II the five sub-projects focused their research on the continental slope between northern Spain to Lisbon as an example for a very narrow shelf, which is affected by upwelling processes. The major aims were:

(1) Assessment of the physically controlled advective and diffusive transport processes at different shelf edges to elaborate a numerical 3-D model.
(2) Quantification of biologically influenced vertical transport processes in along -and cross-slope direction, which result in the material exchange at continental slopes. Also in this context, a numerical model to describe processes at continental slopes has to be elaborated.
(3) Characterisation and balancing of bio-geochemical processes, which are relevant for material fluxes of carbon, nutrients and bio-reactive elements.
(4) Analysis of transport, sedimentation, accumulation as well as deposition of particles under different oceanographic conditions. Characterisation of the bottom nepheloid layer at the European continental slope. Studies of the importance of benthos communities for the carbon flux into the sediment.
5) Quantification and modelling of the exchange of carbon and biogas through the water-air-boundary layer at the continental slope.

The specific aim of this leg was to determine physical conditions and biogeochemical fluxes during the winter season.

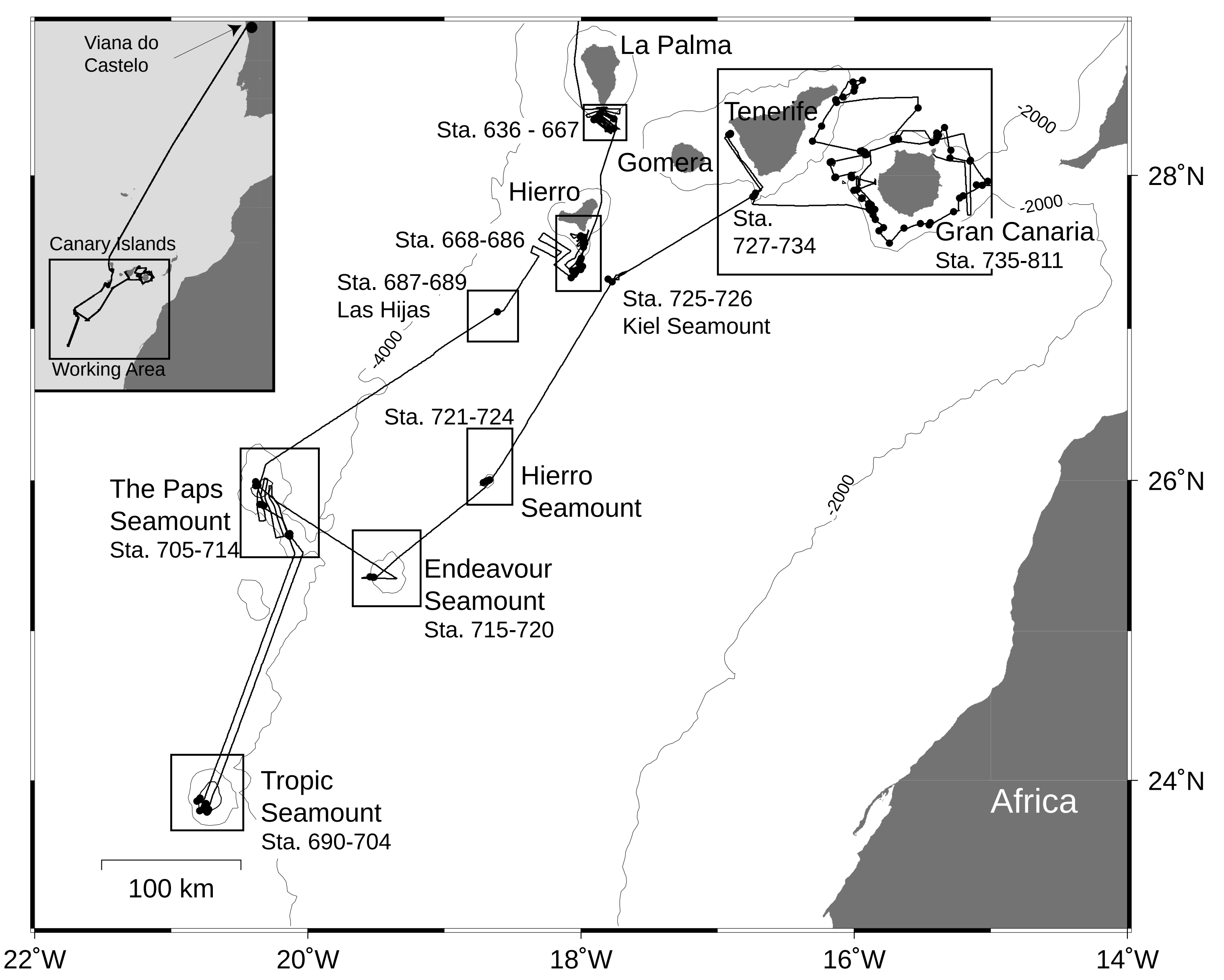

Figure 1: Overview map showing the ship tracks of METEOR cruise M43/1 and the main study areas within and south of the Canary Island Archipelago. Also marked by squares are the more detailed maps of individual target areas.

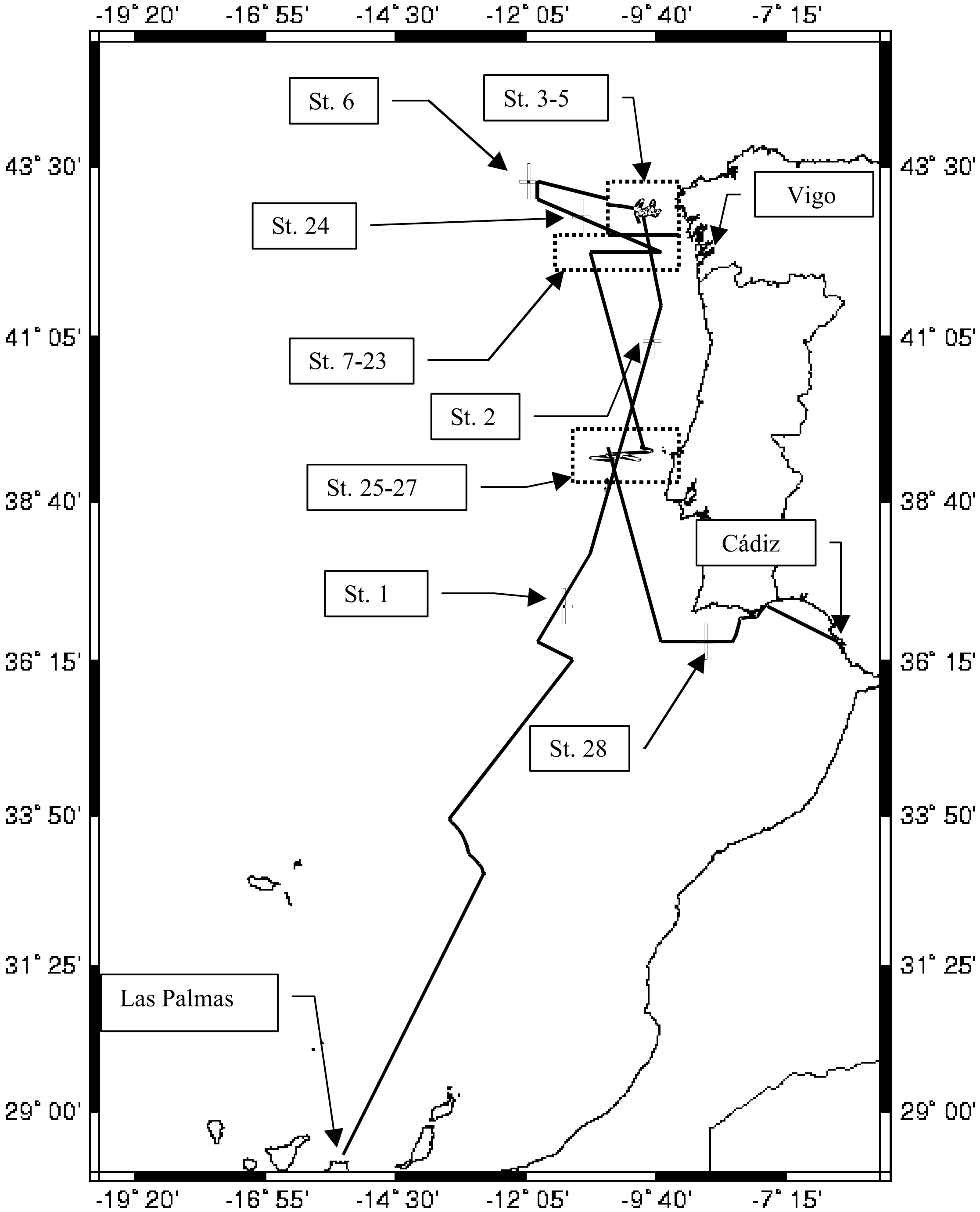

Figure 2: Cruise track M43/2.

Table 1: Legs and chief scientists of METEOR cruise no. 43

Leg M43/1	**Leg M43/2**
25. November 1999 - 23. December 1999	28. December - 14. January 1999
Viana do Castello - Las Palmas	Las Palmas - Malaga Cadiz
Chief Scientist: Prof. Dr. H.-U. Schmincke	Chief Scientist: Prof. Dr. G. Graf
Coordination: Prof. Dr. Hans-Ulrich Schmincke	
Master (RV METEOR): Captain M. Kull	

2 Participants

Table 2: Participants of METEOR cruise no. 43

Leg M43/1

Name	Specialty	Institute
Schmincke, Hans-Ulrich (Chief Scientist)	Volcanology	GEOMAR
Abratis, Michael, Dr.	Geochemistry	GEOMAR
Bassek, Dieter, Technician	Meteorology	DWD
Bayon, Germain, M. Sc. Geology	Geochemistry	SOC
Burri, Thomas, Student	Geology	UBE
Gurenko, Andrey, Dr.	Petrology	GEOMAR
Halmer, Martina, Dipl. Geol.	Volcanology	GEOMAR
Hansteen, Thor, Dr.	Petrology	GEOMAR
Hendry, Morag, B.Sc.(Hons.)	Geology	UCD
Hippler, Dorothee, Student	Geology	UF
Jacobs, Birgit, Dipl. Geophys.	Geophysics	IfG
Krastel, Sebastian, Dr.	Geophysics	GEOMAR
Leverty, Karl, B.Sc.	Geology	TCD
Lipka, Ulrike, Student	Geology	UF
Mata, Joao, Ph.D	Geochemistry	ULI
Meisel, Sören, Student	Geology	UJ
Öhmke, Holger, Technician	Technician	RASL
Pautlitz, Dirk, Student	Geophysics	IfG
Sachs, Peter, Dr.	Mineralogy	GEOMAR
Schimanski, Alex, Dipl. Geol.	Geology	IfG
Schmidt, Ralf, Dipl. Geol.	Volcanology	GEOMAR
Stroncik-Treue, Nicole, Dipl. Geol.	Geochemistry	GEOMAR
Strüfing, Reinhard, Dipl. Met.	Meteorology	DWD
Sumita, Mari, Dr.	Volcanology	GEOMAR
Troll, Valentin, Dipl. Geol.	Volcanology	GEOMAR
Urbanski, Nico, Dipl. Geol.	Volcanology	GEOMAR
Vespermann, Dirk, Dipl. Geol.	Volcanology	GEOMAR
Wienecke, Martin, Dr.	Geochemistry	IfG

Table 2: continued

Leg M43/2

Name	**Speciality**	**Institute**
Graf, Gerhard	Chief scientist	UR
Behr, Hein Dieter	Meteorology	DWD
Blohm-Sievers, Elke	Microbiology	MPI
Borges, Alberto	Geochemistry	UL
Bouma, Hilda	Benthosbiology	NIOO
Clement, Sian	Oceanograghy	UNWB
Franke, Uli	Benthosbiology	UR
Friis, Karsten	Geochemistry	IfM - Kiel
Garcia, Carla	Geology	UCTRA
Heeschen, Katja	Geochemistry	GEOMAR
Joao Luis da Silva Curdia	Benthosbiology	UCTRA
Kähler, Anja	Benthosbiology	GEOMAR
Karpen, Volker	Benthosbiology	GEOMAR
Keir, Robin	Geochemistry	GEOMAR
Lavaleye, Marc	Benthosbiology	NIOZ
Lowry, Roy	Data mangment	BODC
Moodley, Leon	Benthosbiology	NIOO
Nachtigall, Kerstin	Planktology	IfM - Kiel
Ochsenhirt, Wolf-Dieter	Meteorology	DWD
Peine, Florian	Benthosbiology	UR
Peinert, Rolf	Planktology	IfM - Kiel
Philip, Eva	Benthosbiology	GEOMAR
Pielenz, Holger	Benthosbiology	UR
Rehder, Gregor	Geochemistry	GEOMAR
Schmidt, Sabine	Geochemistry	UCTRA
Spyres, Georgina	Geochemistry	PML
Thomsen, Laurenz	Benthosbiology	GEOMAR
Torres, Ricardo	Oceanograghy	UNWB
Witzel, Karl-Paul	Microbiology	MPI

Table 3: Participating Institutions

BODC	Bidston Observatory, POL-CCMS Birkenhead, Merseyside L43 7RA, UK
DWD	Deutscher Wetterdienst, Geschäftsfeld Seeschiffahrt Bernhard-Nocht-Str. 76, D-20359 Hamburg, Germany
GEOMAR	GEOMAR Forschungszentrum für marine Geowissenschaften Wischhofstr. 1-3, D-24148 Kiel, Germany
IfG	Institut für Geowissenschaften der Universität Kiel Olshausenstraße 40, D-24118 Kiel, Germany
IfM	Institut für Meereskunde an der Universität Kiel Düsternbrooker Weg 20, D-24105 Kiel, Germany
MPI	Max-Plank-Institut für Limnologie August-Thienemann-Str. 2, D-24306 Plön, Germany
NIOO	Netherlands Institute of Ecology Center for Estuarine and Coastal Ecology (CEMO) Korringaweg 7, 4401 NT Yerseke, The Netherlands
NIOZ	Netherlands Institute of Sea Resaerch Postbox 59, Den Burg (Texel) 1790 AB, The Netherlands
PML	Plymouth Marine Laboratory, PML-CCMS West Hoe, Plymouth PL1 3DH, UK
RASL	Röntgen Analytik Service Dr. Frank Lechtenberg, Katenkoppel 12, D-25524 Itzehoe, Germany
SOC	Southampton Oceanography Centre European Way, Empress Dock, Southampton SO 14 3ZH, UK
TCD	Trinity College, Dep. of Geology Dublin 2, Ireland
UBE	Mineralogisch-Petrologisches Institut der Universität Bern Baltzerstraße 1, CH-3012 Bern, Switzerland
UCD	Cardiff University, Department of Earth Science PO Box 914, Main Building, Park Place, Cardiff CF1 3YE, UK
UCTRA	Universidade do Algarve P- 8000 Faro, Portugal
UF	Geologisches Institut der Albert-Ludwigs Universität Freiburg Albertstraße 23b, D-79104 Freiburg, Germany
UJ	Friedrich-Schiller Universität Jena, Institut für Geowissenschaften Burgweg 11, D-07743 Jena, Germany

Table 3: continued

UL	Univ. Liege B-4000 Sart Tilman, Belgium
ULI	Universidade de Lisboa, Departamento de Geologia Faculdade de Ciencias, Campo Grande C2-5° Piso, 1600 Lisboa, Portugal
UNWB	School of Ocean Sciences, Univ. Bangor Menai Bridge, Gwynedd LL 59 5EY, UK
UR	Universität Rostock, Meeresbiologie Freiligrathstrasse 7/8, D-18055 Rostock, Germany

3 Research Program

3.1 Leg M43/1

The goal of METEOR Cruise M43/1 was a detailed survey by bathymetric mapping and dredging of the submarine ridges south of La Palma and El Hierro, the Saharan Seamounts and the submarine flanks around Gran Canaria and Tenerife to obtain a better understanding of the destructive and constructive processes during the evolution of large intraplate volcanic edifices in the sea (Fig. 1).

Constructive processes
Volcanic activity on oceanic islands occurs synchronously on land and on the submarine flanks. The subaerial part of oceanic islands generally makes up less than 5% of the total volume. Our understanding of the growth processes and growth rates of volcanic islands therefore depends critically on the interpretation of bathymetric data, sidescan studies, submersible studies and sampling by dredging.

Several questions are relevant in the framework of the M43/1 project. Seamounts to be studied could represent:

- very young intraplate volcanoes in the submarine eruptive stage, perhaps precursors to an island;
- older submarine volcanoes which never reached the island stage;
- subsided and eroded former volcanic islands.

Eruptions in the recent past probably occurred both along the submarine southern extension of the rift zones of La Palma and El Hierro but possibly also at the submarine slopes of Tenerife and Gran Canaria. The most useful geobarometers to determine the initial water depth of eruption are the vesicularity of hyaloclastite particles and the sulfur content of fresh glasses. Types and mechanisms of the submarine eruptions, the composition and age of the lavas and hyaloclastites and therefore their petrologic significance are unknown and one of the aims of this research project.

Destructive processes
Oceanic islands become reduced in height and subaerial volume by slow erosive and alteration processes, by catastrophic failure and by sinking into the lithosphere. Large volcanoes are known to commonly experience flank failure, a process also characteristic for volcanic islands. Based on morphology and degree of dislocation, submarine landslides can be grouped into two major types: 1) slumps and 2) debris avalanches. Slumps are slow rotary movements of largely undeformed masses along discrete shear planes. In contrast, debris avalanches are fast long-runout mass movements in which fragmentation has reduced the landslide mass to individual blocks during sudden, catastrophic failures (MOORE ET AL., 1989; 1994). Submarine slumps and debris avalanches appear to be more common in the Canaries than in the Hawaiian Islands and also occur during late stages in the volcanic evolution of an island.

Evolution of magmas, magma sources and the lithosphere-volcano system
The spectrum of chemical and mineralogical compositions of volcanic rocks from oceanic islands raises several questions:
How many different mantle sources with contrasting geodynamic significance (plume, asthenosphere, oceanic and continental lithosphere) can be distinguished from each other? How strongly are magmas differentiated and by what processes?

The 3000 km long belt of islands and seamounts along the north-western African continental margin between 20°N and 35°N, here referred to as the East Atlantic Intraplate Volcanic Province, extends from the Madeira Island Group through the Canary Islands to the Cape Verde Islands, and therefore does not fit easily with the model of relatively small ocean island hot spots. The large number of islands and seamounts, their irregular distribution and the long evolution of volcanism on some of the islands (more than 15 million years for islands such as Porto Santo, Fuerteventura, Lanzarote, Gran Canaria and possibly La Gomera), as well as their close proximity to the coast of Africa are reasons to believe that their origin is due to rising mantle diapirs as well as the boundary between continental and oceanic lithosphere (SCHMINCKE, 1982).

This East Atlantic intraplate volcanic province represents an end-member of hot spot provinces in several aspects: the large number of islands and seamounts and their long evolution of volcanism would require a large number of long-lived mantle plumes of different sizes. The relationship between large fracture zones and the position and dynamic evolution of the Canaries advocated by some authors is controversial. Fracture zones on the African mainland such as the South Atlas Fault extension to the Canary Islands as well as the influence of fracture zones formed at the Mid-Atlantic Ridge were called on to explain the position and evolution of the Canary Islands.

The regional geodynamic relationships between the Canary Islands and the group of seamounts in the south as well as the Las Hijas Seamounts south-west of El Hierro found by us in 1997 is unknown. Apart from the general decrease in age of the shield phases of the Canary Islands from east to west, there seems to be no systematic age distribution of the volcanism in the East Atlantic. Volcanoes and seamounts running NNE-SSW, however, seem to be aligned sub-parallel to the African coast and therefore to the transitional area between continental and oceanic lithosphere. One aim of the present research project is to help clarify this large-scale geodynamic problem using the composition and age of the rocks.

The regional magma development shall be mapped by analyzing rocks from a large area to understand the composition and lateral extent of melting domains in the mantle. Central is the question if the development of the Canary Islands can be best understood in terms of hot spots or if other mechanisms, configurations of melting anomalies or old fracture systems are more important for the development of volcanism and magmatism in the entire volcanic belt off northwest Africa.

By analyzing the lithology and composition of dredged volcanic rocks we also hope to better understand the volcanic and magmatic evolution of seamounts which may or may not have experienced long-term systematic changes in magma production rates and magma composition, the latter of which is observed in the subaerial part of many volcanic islands.

The dredged lavas and hyaloclastites of submarine volcanoes at depths between 500 m and 2500 m bsl on the flanks of Tenerife, Gran Canaria, La Palma and El Hierro shall help (1) to determine the boundary between submarine and subaerial development, which should help clarifying the rate by which islands and seamounts subside due to the load on the lithosphere; (2) to determine the main eruptive centers, magma composition and therefore magma sources below the islands; (3) to calibrate geobarometers of alkalic volatile-rich magma depending on the depth of eruption.

3.2 Leg M43/2

Carbon remineralisation by the benthic community

Remineralisation of organic matter takes place already during carbon transport processes occurring in the water column. Parameterisation of the subsequent processes acting in the benthal will be required to estimate the fraction of carbon that is recycled back into the ocean versus that which is permanently buried. A better understanding of the biological, chemical and physical processes and the measurement of the corresponding rates are required for a balance of carbon flux through the sediment.

Measurements of benthic respiration rates, biomass production and activity are necessary to estimate the role of benthic organisms for the carbon flux through the sediment. Recent results from the temperate north-east Atlantic demonstrated a strong seasonality in benthic biomass production, respiration and activity rates which were coupled with sedimentation events. The major part of benthic carbon consumption goes into respiration, in the range of 80-95% of total benthic carbon consumption.

The main objective of the benthic program is the quantification of the biologically mediated carbon flux through the sediment by following the benthic reaction (remineralisation, burial rates) toward sedimentation pulses. The canyon areas will be studied in detail.
Additionally, a comparative study on the coral *Lophelia* living on the Iberian slope and on the Galicia Bank will be carried out. While the first population is potentially under the influence of the production in the upwelling zone, the one on Galicia Bank lives under more oceanic, on presumably nutrient poor, conditions. Comparisons of growth rates and elemental tracers in the calcium matrix, for instance, may shed light if there is an effect of the nearby continent.

Processes within the bottom boundary layer
At continental margins bottom nepheloid layers are commonly found. Lateral particle fluxes in the benthic boundary layer [BBL] far exceed the vertical fluxes from the euphotic zone. The fluxes are dominated by fast sinking particles whereas the mass of particles consists of fine slow sinking particles.

Aim of the project is the investigation of the following processes: particle transport within internal boundary layers, especially in canyons and gullies along the shelf edge, sedimentation, accumulation and mass fluxes of particulate matter. With the help of CTD-water samplers and a transmissiometer, samples shall be taken in the deep sea and in the canyon area at the continental margin. With the help of the Bioprobe bottom water sampler, flow velocity and light transmission will be determined and water samples at 5,10, 20 and 40 cm height above the sea floor will be taken. A particle camera will take video pictures of aggregates. Gravity cores will be used to determine sediment accumulation rates. Benthic flow simulation chambers will give information on sediment stability and particle behaviour. Thorium analyses will be done and sediment transport studies will be carried out along the shelf edge.

Microbial studies of aggregate dynamics in the benthic boundary layer
The focus of this group will be to study microbial activities and the genetic structure of the microbial communities in the water column, in the benthic boundary layer and the surface sediments on a transect across the continental margin of the OMEX area. These results will give information on the origin of particles in the BBL. Measurements of the microbial activities will address the role of bacteria in the dynamics of organic carbon across the continental margin.

To elucidate the genetic composition of the microbial communities PCR will be used with DNA-extracts from water and sediment samples to retrieve sequences of the genes coding for either 16S rRNA or the functional enzyme ammonia-monooxygenase of ammonia-oxidising bacteria. Sequence-specific electrophoresis of the PCR-products will give an overview of the species-composition within this group of bacteria. Cloning and sequencing of the PCR-products is used for identification and phylogenetic classification by DGGE. Samples will be retrieved from Niskin bottles, the bottom water sampler and the multiple corer.

Processes in the water column
The goal of the OMEX project is to determine spatial and temporal variability in the exchange of particulate and dissolved organic matter at the continental margin and thereby the role of the margins in regional elemental cycling and carbon sequestration. In this second phase, emphasis has shifted from the Goban Spur, with a gradual, wide slope and weak upwelling, to the Iberian

Margin with its steep slope and strong periodic up- and downwelling cycles. As part of a multidisciplinary joint approach the Institut für Meereskunde has deployed two moorings equipped with sediment traps, in situ pumps and current meters at the mid- and outer slope along a transect at 42°38'N, in water depths of 1500 m and 2230 m. During the current period of deployment (March 1998 - Jan 1999), a number of interesting features occurred at the Iberian Margin, the imprint of which we will record in the traps by use of bulk and marker variables and radionuclide analyses of samples. We thus hope to link processes occurring at the sea surface, as seen by remote sensing and recorded on OMEX cruises, to temporal and spatial patterns of vertical and lateral particle flux. Using samples of suspended particulate matter over this 9- month deployment period collected by the newly developed in situ pumps, we will gain insights in the qualitative and quantitative patterns of SPM flux and the role of scavenging that leads to settling. Moorings IM2 and IM3 at positions 42°38.5'N, 9°42.3'W and 42°37.5'N, 10°01.5'W respectively will be recovered yielding 100 sediment trap samples, 60 in situ pump samples and 9 months of current meter data from 5 RCMs. The moorings will not be redeployed. Gradients in suspended particulate matter along- and across the slope will be determined by water column sampling and in situ pump deployments. Special emphasis will be given to sampling of the surface, intermediate and benthic nepheloid layers that will be determined using a transmissiometer and nephelometer attached to the CTD. Bulk and marker variables will be determined in these samples and used to determine gradients in these properties around the mooring positions. Additionally ADCP measurements will give information on the surface current regime.

Distribution of Surface pCO_2, $\delta^{13}C$, ΣCO_2, CH_4, and Radiocarbon

Workpackage II of the OMEX Project is concerned with mesoscale variability of carbon and related fluxes in the shelf and slope waters of the Iberian Margin. Two of the objectives within this part of OMEX are (a) to trace principal water masses and their sources and (b) to assess the net air-sea exchange flux of CO_2 as well as the penetration of anthropogenic CO_2 in the region. In connection with the latter objective, the partial pressure of CO_2 in surface water as well as in the air will be surveyed continuously underway using two different equilibrator systems (intercalibration). The vertical distribution of the $^{13}C/^{12}C$ ratio in dissolved inorganic carbon will be determined on samples collected from the CTD casts in the shorebased Leibniz Laboratory at the University of Kiel. Since anthropogenic CO_2 produced by burning of fuel fuels carries a low $^{13}C/^{12}C$ ratio, these measurements provide an indication of the penetration of this CO_2 into the water column. The measurements also give an indication of the nature of the seasonal cycle of the biological pump of carbon in the area, which is dependent on upwelling and the net production of carbon.

The vertical and horizontal distribution of methane provides a contribution to the first objective above, the tracing of water masses. In relatively young deep waters, it appears that methane is oxidised on about a 50-year time scale. The proximity of possible sediment sources on the continental slope as well as the presence of water masses with ages less than 100 years in the upper 2000 meters in this region indicates that methane may provide a useful supplement to the information that one obtains from salinity, temperature and dissolved oxygen.

The vertical distribution of radiocarbon will be determined on samples collected from one or more deep CTD stations. This will also be valuable in connection with the tracing of water masses. By comparison to previous determinations 17 years ago, it should be possible to observe the temporal change in the radiocarbon distribution due to uptake of bomb-produced ^{14}C.

Determination of the net total radiation at sea

The knowledge of the spatial and temporal distribution of the net total radiation and its components at the sea-surface is important for numerous meteorological and oceanographic investigations. On the cruise of the vessel the following radiation components will be recorded: global solar radiation and atmospheric radiation. The other components closing the radiation balance equation - reflected solar radiation and terrestrial surface radiation - will be computed with the aid of numerical models tested in former cruises in the Atlantic Ocean. Further, direct solar radiation, sunshine duration, and UV-B global radiation will be measured

4 Narrative of the Cruise

4.1 Leg M43/1

The scientific crew boarded FS METEOR in Viana do Castelo on November 23rd and 24th, 1998. The scientific party included one scientist each from Berne University, Dublin University, Lisbon University, Southampton Oceanography Centre, Cardiff University, and Jena University, 2 scientists from Freiburg University, 2 meteorologists from the German Sea Weather Office, 4 scientists from Kiel University and 14 colleagues from GEOMAR Research Center. The ship departed from Viana do Castelo on November 25th 1998, 10:00 o'clock. After three days of transit, which were used for scientific meetings and set-up of the equipment, work began on November 28th at 14:42 by employing the systems PARASOUND and HYDROSWEEP north of La Palma.

Beginning on the morning of November 29th and ending December 2nd, 35 stations were dredged along the South La Palma Ridge, interrupted by some additional HYDROSWEEP mapping, to delineate the morphology of the ridge in detail for better placing dredge stations. A rich suite of rocks was dredged on the northern part of the ridge which extends to about 1000 m below sea level. Dredging on the apparently older seamounts on the southern half of the ridge, which are generally more strongly manganese-encrusted and covered by calcareous crusts, was less successful.

The 40 km long South El Hierro Ridge southeast of the island was mapped BY HYDROSWEEP and dredged successfully in 19 stations between December 2nd and 5th, with dredging starting on December 3rd at 08:00. Very fresh, glassy basalts were recovered along the proximal ridge section. Pumiceous alkali feldspar-rich trachytic rocks were dredged in the central part of the ridge. The seafloor south of El Hierro was mapped on our way to Las Hijas Seamounts by HYDROSWEEP and PARASOUND on December 5th in order to delineate a large debris avalanche fan in more detail.

Las Hijas Seamount group was reached on December 5th, dredged successfully at 3 stations, recovering large amounts of trachytic rocks. Paps Seamount was mapped in detail by HYDROSWEEP on December 6th. Tropic Seamount, the southernmost point of the cruise, was reached December 7th, dredged successfully at 15 stations (conglomerates, basalts, trachytes and volcaniclastic rocks) and left December 8th at 21:00. Paps Seamount was reached December 9th in the morning and was sampled at 10 stations with moderate results until December 10th 17:00. Endeavour Seamount was reached December 11th, dredged successfully at 6 stations and left December 11th at 19:00. El Hierro Seamount was reached December 11th at 21:00 and dredged at 4 stations until December 12th 6:00. An unnamed seamount - here called Kiel Seamount - 45 km southeast of the island of El Hierro was reached December 12th at 15:00 and was dredged at two stations.

Work in the third major region began when the southeastern point of Tenerife was reached December 13th. Dredging at the southwest flank northwest of Los Gigantes produced some basalt. Definite submarine lava was dredged following HYDROSWEEP mapping along the coast of Tenerife near Punta de la Rasca during the night December 13th to 14th. Following another stretch of HYDROSWEEP profiling between Tenerife and Gran Canaria, dredging along the southwestern flank of Gran Canaria began December 14th at 11:30. Most remarkably, this and the following dredges produced submarine rhyolitic and basaltic lavas corresponding exactly to the Güigüi, Horgazales and Lower Mogán formations on land, except that the flows dredged had been emplaced under water. Thus important evidence that the island has remained relatively stable with respect to sea level since the initial shield phase some 15 million years ago was gathered at the beginning of dredging the flanks of Gran Canaria. Dredging continued along several profiles along the southwest slope until December 15th. Following HYDROSWEEP profiling and a brief stop near Barranco de Güigüi, the wild part of Gran Canaria where all the Miocene formations are exposed, dredging some 12 km west of Güigüi in the evening of December

15th recovered remarkable glassy lava or welded ignimbrite. The flows appear to have entered the ocean possibly a few km offshore the present coastline because they occur at some 100 m asl along the coast and became quenched and contorted under water.

El Hijo de Tenerife Seamount, a conical volcano some 600 m high, discovered during Meteor Cruise M24 in April 1993 (Schmincke and Rihm, 1994) was dredged on December 16th in the hope to sample a young volcano on the lower eastern submarine slopes of Tenerife, an area of frequent albeit small earthquakes. The catch was spectacular with large amounts of bomb-like poorly vesicular but extremely fresh mafic phonolite with phenocrysts of amphibole and mica and many angular rock fragment inclusions. Evidence is strong that many fragments were produced by explosive activity remarkably similar to phreatomagmatic eruptions on land. Basically a small Pico de Teide is here growing under the sea. Water samples were taken just above the top of the volcano at different water depths. Dredging along the steep northwest flank of Gran Canaria off Agaete produced ol-, cpx-phyric basalts similar to those dredged off the southern flanks, again compositionally resembling picritic lavas near Agaete.

On the afternoon of the 17th until the late afternoon of the 18th, cone-shaped morphological features and ridges on the eastern submarine flank of Tenerife were dredged as far north as the tip of Anaga Peninsula. Basaltic lapillistones, in some places containing abundant fresh sideromelane, are most common. Dense basalts were recovered in some dredges. Water samples were taken at ODP drill Site 954, 40 km N of Gran Canaria where pore solutions and effervescent CO_2 in the drill cores had indicated young volcanism (Schmincke and Sumita, 1998). Dredging on the northern flank of Gran Canaria commenced early December 19th with fresh Miocene (?) shield basalts being recovered in several dredges. Dredging of a broad submarine ridge extending north of the coast near Arucas proved technically impossible because of abundant undersea cables crossing the area. Dredging of the prominent and wide submarine ridge off La Isleta, the northeastern peninsula of Gran Canaria, began before noon on December 19th, following a stretch of Hydrosweep mapping not covered in detail previously. Ol-, cpx-phyric basalts were recovered. Dredging continued until early afternoon of December 22 off the east and south coasts of Gran Canaria with variable success in water depths between 600 and 1500 m bsl. Highlights were the recovery of complex breccias most likely from the flanks of debris avalanche blocks of Pliocene age (Roque Nublo debris avalanche) due east of Gran Canaria, fresh glassy phonolite lava off the southeast coast, probably Miocene Fataga Formation lavas that entered the sea about 11 million years ago, and additional samples of Miocene glassy rhyolite lava off Barranco de Veneguera due south of the island. Hydrosweep mapping of previously uncovered areas west and north of Gran Canaria was carried out until the morning of December 23rd. The vessel entered the port of Las Palmas at 8:00 on 23.12.1998.

4.2 Leg M43/2

The cruise started on 28th December, 1998, at 10:45 am, in Las Palmas under perfect weather conditions and with all scientific equipment delivered in time. 29 scientists from 6 different nations (Germany, Belgium, France, The Netherlands, United Kingdom, Portugal) were on board, representing the OMEX II programme of the European Union. This programme of the EU aims to study fluxes across the ocean margin and processes along European shelf breaks facing the North Atlantic Ocean. The expected transit time to the northern Portuguese upwelling area was 3.5 days.

Due to deteriorating weather conditions, cruise speed had to be reduced already during the second day and finally we had to stop in order to wait for a heavy storm to pass the scheduled study site. On January 1st the first samples were taken with a CTD in the outflow of the Mediterranean water, where high methane concentrations were detected (Station 1). To follow the surface currents to the North, 4 drifter buoys from the University of Bangor were deployed on 41° N, which were from there on continuously tracked by satellites. On January 3rd the main working transect off Vigo was reached but due to heavy seas, CTD casts were cancelled. Surface water was then sampled and current measurements were performed. The next day a long term sediment trap deployment was released and successfully recovered and thus one major aim of the cruise was achieved. Another mooring, which had been damaged by fishermen, could not be recovered. On January 6th METEOR reached the Galicia Bank and due again to increasingly bad weather conditions, it was not risked to release a Dutch mooring from the NIOZ institute, Texel. This deployment of artificial hard substrate for the study of deep-sea corals was still working as was indicated by a successful hydrophone contact and it was decided to recover this experiment in spring.

Within the next 5 days weather conditions improved and a full transect at 42° N including all water and sediment samplers could be covered (Stations 7 to 23). A total of 30 CTD casts and many sediment cores were carried out from the shelf down to a water depth of 2500 m. This transect was a success and provided the first winter data for this key area of the OMEX programme. During the following days another transect in the Nazaré Canyon was also sampled, in order to study both the distribution of particles in the lower water column and the benthic biomass and activity (Stations 25-27). With a detailed bathymetric map provided by the British colleagues it was possible to sample directly in the central conduit of the Canyon. This Canyon serves as modern conduit of organic matter and pollutants to the deep sea and will be of great interest for future work.

Although the cruise was relatively short and the weather often being bad, the scientific programme carried out was very successful and the whole OMEX community was very happy with the results. On our way back to Cadiz an additional CTD was taken for the study of the Mediterranean outflow and in support of another European project a PARASOUND and HYDROSWEEP profile was run off the city of Faro. On January 13, METEOR reached the port of Cadiz in the early evening and immediately entered a dry dock .