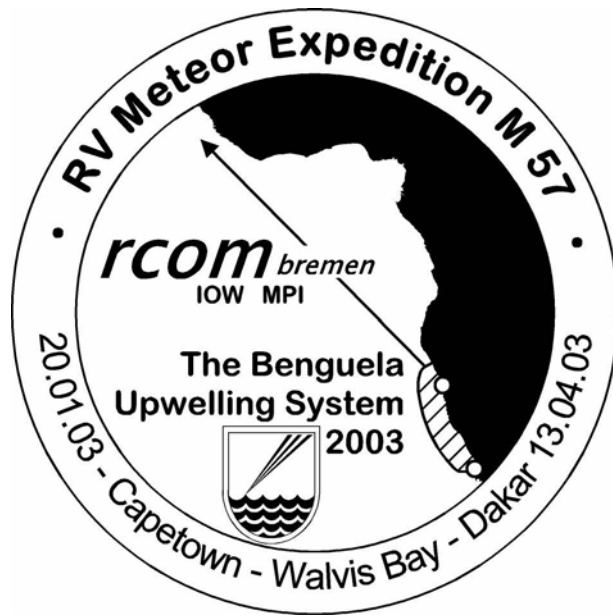


METEOR-Berichte 05-1

The Benguela Upwelling System 2003

Cruise No. 57

January 20 – April 13, 2003, Capetown – Dakar



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Leitstelle Meteor
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Table of Contents	Page
Table of Contents Part 1 (M57/1)	II
Table of Contents Part 2 (M57/2)	III
Table of Contents Part 3 (M57/3)	IV
Abstract	V
Zusammenfassung	V
Research Objectives	VI
Acknowledgements	VIII
Meteor-Berichte 05-1, Part 1 (M57/1)	1-1 to 1-59
Meteor-Berichte 05-1, Part 2 (M57/2)	2-1 to 2-58
Meteor-Berichte 05-1, Part 3 (M57/3)	3-1 to 3-53

Table of Contents, Part 1 (M57/1)

	Page
1.1 Research Program	1-3
1.2 Participants	1-5
1.3 Narrative of the Cruise	1-6
1.4 Preliminary Results	1-8
1.4.1 PARASOUND and HYDROSWEEP Surveys	1-8
1.4.1.1 Equipment / Instrumentation	1-8
1.4.1.2 Principle Survey Results	1-8
1.4.2 Gravity cores, Multicores, and Lithogenic Core Summary	1-16
1.4.3 Physical Properties Studies	1-17
1.4.3.1 Electrical Resistivity, Porosity, and Density	1-18
1.4.3.2 Magnetic Volume Susceptibility	1-19
1.4.3.3 Digital Mapping / Light Reflectance	1-19
1.4.3.4 Physical Properties Shipboard Results	1-20
1.4.4 Geochemistry	1-24
1.4.4.1 Pore Water Analysis	1-25
1.4.4.2 XRF Sediment Analysis	1-27
1.4.5 Preliminary Micropalaeontological Results	1-31
1.4.6 Core-to-Core Correlation	1-36
1.4.7 Water and Plankton Studies	1-39
1.4.7.1 Physical Oceanography	1-39
1.4.7.2 CTD Profiling and Plankton Sampling	1-45
1.4.7.3 Alkenone Membrane Pump Sampling	1-49
1.4.8 Calcareous Dinoflagellate Cyst Investigations	1-49
1.5 Ship's Meteorological Station	1-52
1.6 Station List M52/1	1-53
1.7 Acknowledgements	1-59
1.8 References	1-59

Table of Contents, Part 2 (M52/2)

	Page
2.1 Research Program	2-4
2.2 Participants	2-5
2.3 Narrative of the Cruise	2-6
2.4 Preliminary Results	2-8
2.4.1 PARASOUND and HYDROSWEEP Surveys	2-8
2.4.1.1 Equipment / Instrumentation	2-8
2.4.1.2 Preliminary Results	2-9
2.4.2 Sampling	2-12
2.4.2.1 Sediment Sampling With the Gravity Corer	2-12
2.4.2.2 Sediment Surface Sampling	2-13
2.4.2.3 The Benthic Lander System	2-13
2.4.2.4 Particle Sampling	2-14
2.4.2.5 CTD-Probe and Water Sampling	2-17
2.4.2.6 Water Sampling for Stable Isotope and Nutrient Analysis	2-18
2.4.2.7 Sampling of Living Planktonic Foraminifera and Dinoflagellates	2-18
2.4.2.8 Sampling of Suspended Organic Matter and Sr/Ca	2-19
2.4.2.9 Sampling for Chlorophyll Analysis	2-19
2.4.3 Visual Core Description and Smear Slide Analysis	2-23
2.4.3.1 Methods	2-23
2.4.3.2 Shipboard Results	2-24
2.4.4 Physical Properties Studies	2-25
2.4.4.1 Physical Background and Experimental Techniques	2-25
2.4.4.2 Shipboard Results	2-25
2.4.5 Pore Water Chemistry	2-30
2.4.5.1 Methods	2-30
2.4.5.2 Shipboard Results	2-33
2.4.6 Biogeochemical and Biological Studies	2-33
2.4.6.1 Reactivity Analysis and Geochemical Methods	2-34
2.4.6.2 Experiments and Rate Measurements	2-35
2.4.6.3 Microbial Parameters	2-36
2.4.6.4 <i>In situ</i> Experiments	2-37
2.4.6.5 On board Incubations	2-40
2.4.7 Characterization of Particle Transport	2-43
2.4.7.1 Methods	2-43
2.4.7.2 Shipboard Results	2-45
2.4.8 Hydrographic Studies	2-46
2.4.8.1 Time Series at 23°S 14°03'E	2-46
2.4.8.2 Hydrographic Transect at 23°S	2-50
2.4.8.3 Distribution of Central Water Masses	2-50
2.4.9 Dinoflagellate Cyst Investigations	2-51
2.5 Ship's Meteorological Station	2-52
2.6 List of GeoB Stations M57/2	2-53
2.7 Acknowledgements	2-57
2.8 References	2-58

Table of Contents, Part 3 (M57/3)

	Page	
3.1	Introduction and Objectives	3-3
3.2	Participants	3-4
3.3	Narrative of the Cruise	3-5
3.4	Preliminary Results	3-8
3.4.1	Water Column Work	3-8
3.4.1.1	Tabulated Overview of Water Column Sampling	3-8
3.4.1.2	Hydrographic Investigations	3-9
3.4.1.3	Ocean Color and Remote Sensing	3-14
3.4.1.4	CTD Profiling of Nutrients in the Water Column	3-20
3.4.1.5	Nitrogen Cycling on the Namibian Shelf: Water Column and Sediments	3-20
3.4.1.6	Dissolved Oxygen Sulfide and Methane in the Water Column	3-22
3.4.1.7	Structure and Function of the Bacterioplankton Community off the Coast of Namibia	3-23
3.4.1.8	Filtration of Suspended Particulate Matter	3-26
3.4.1.9	Grab Sampling Work	3-27
3.4.1.10	ROV Monitoring of the Water Column and Sediment Surface	3-27
3.4.2	Sediment Work	3-29
3.4.2.1	Tabulated Overview of Sediment Working Program	3-29
3.4.2.2	Acoustic Surveys	3-30
3.4.2.3	Micropaleontology	3-35
3.4.2.3.1	Benthic Foraminifera	3-35
3.4.2.3.2	Dinoflagellates	3-38
3.4.2.4	Large Colorless Sulfur Bacteria and the Nitrogen Cycle	3-44
3.4.2.5	Microelectrode Studies at Sediment/Water Interface	3-46
3.4.2.6	Sediment Profiling for Analysis of Gases, Dissolved Constituents, and Sediment	3-46
3.4.2.6.1	The Influence of Large Sulfur Bacteria on the Phosphorus Cycle	3-46
3.4.2.6.2	Pore water Analysis of Dissolved Constituents in Multicorer Samples	3-47
3.4.2.7	Sediment Sampling for Analysis of Physical Properties	3-49
3.4.3	Transit Namibia-Dakar	3-50
3.5	Meteorological Conditions During Cruise Leg M57/3	3-51
3.6	Acknowledgements	3-51
3.7	References	3-51

Abstract

R/V METEOR cruise No. 57 was divided into three different legs. The first leg was carried out on the shelf and continental slope off western South Africa. Legs 2 and 3 concentrated on the adjacent area to the north up to about 22°S (Fig. 1). The working program of the first leg focused on the recovery of sediment core material, which is needed for the reconstruction of Late Quaternary climate variabilities. Complemented by geochemical and geophysical investigations, a great number of sediment cores were recovered from the continental slope off South Africa as well as from the mud belt adjacent to the Orange River mouth. During the following leg (M57/2) intensive (bio)geochemical, geophysical, geological, micropalaeontological, oceanographical und hydrographical investigations were conducted to register the lateral particle transport, for a detailed description of the benthic carbon cycle, to determine the effect of the anaerobic methane oxidation on the sedimentary composition, to reconstruct variations in the importance of single water masses, and to understand diversity and spatial distribution of microorganisms in the water column and at the sea floor. Interrelations between biogeochemical flux or transfer rates and the physical phenomenon of gas eruptions on the shelf off Namibia were of main interest during the third leg. The cruise was funded by the *Deutsche Forschungsgemeinschaft* (DFG) and the *Bundesministerium für Bildung und Forschung* (BMBF).

Zusammenfassung

Die METEOR-Reise Nr. 57 umfasste drei Fahrabschnitte. Während des ersten Abschnitts wurden Untersuchungen auf dem Schelf und am Kontinentalhang vor dem westlichen Südafrika durchgeführt. Die Abschnitte 2 und 3 konzentrierten sich auf das sich nördlich anschließende küstennahe Gebiet bis etwa 22°S (Fig. 1). Auf dem ersten Fahrabschnitt wurden Schwerelotkerne mit kontinuierlichen Ablagerungsfolgen zur hochauflösenden Rekonstruktion der regionalen Klimavariationen im Spätquartär gewonnen. Es wurde umfangreiches Kernmaterial sowohl vom Kontinentalhang als auch aus dem küstennahen Schlammgürtel im Einflussbereich des Oranje gewonnen. Der darauf folgende Abschnitt M57/2 umfasste umfangreiche (bio)geochemische, geophysikalische, geologische, mikropaläontologische, ozeanographische und hydrographische Untersuchungen zur Erfassung des lateralen Partikeltransports, zur Beschreibung des benthischen Kohlenstoffkreislaufs, zur Beeinflussung der Sedimentzusammensetzung durch anaerobe Methanoxidation, zur Rekonstruktion der Variationen im Aufbau der Wassermasse sowie zur Diversität und räumlichen Verteilung der Organismenvergesellschaftungen in der Wassersäule und am Meeresboden. Während des dritten Fahrabschnitts standen Wechselbeziehungen zwischen biogeochemischen Stofffluss- bzw. Umsatzraten und dem physikalischen Phänomenen von Gaseruptionen auf dem Schelf vor Namibia im Zentrum des Interesses. Die Expedition wurde durch die *Deutsche Forschungsgemeinschaft* (DFG) und das *Bundesministerium für Bildung und Wissenschaft* (BMBF) gefördert.

Research Objectives

The intention of the **first leg** was to retrieve water samples, surface sediments and Late Quaternary sediment cores along transects on the shelf and perpendicular to the upper continental margin off western South Africa beneath the Benguela Current system (Fig. 1). The underlying major scientific goal was the detailed reconstruction of the Late Quaternary climate history of the southern Benguela system and the influence of the Agulhas warm water entrainment into the South Atlantic. In this context, latitudinal movements of the westerly wind belt and the winter rainfall region over western South Africa are of particular interest. Another major goal of this leg was the expansion and continuation of previous studies in the South Atlantic, which started to assemble a basin-wide knowledge of the diversity and geographical distribution of different microfossil species or groups and the validation of their relationship to certain hydrographic conditions in the entire Atlantic. So, this leg closed one of the gaps in the paleoclimatic and sedimentological investigation of the entire eastern Atlantic margin from Portugal to the southern tip of South Africa. This investigation has been a target at Bremen University for the last decade.

Furthermore, investigations on the geochemical composition of marine sediments were carried out with the intention of the reconstruction of climate changes on the African continent and to compare these results with continental climate records and the evolution of human settlements along the west coast. An additional geochemical goal was the identification and dating of sediment slide events by installing and using a new XRF-instrument under shipboard conditions.

Biological and micropalaeontological investigations were performed to gain a better understanding of the distribution of microfossil groups in the water column and surface sediments in relation to the ambient physical and chemical properties of the surface and deep ocean off South Africa. A further objective was the determination of the general composition of phytoplankton in surface waters by additional measurements of chlorophyll, bulk organic carbon, carbonate, biogenic opal and alkenones.

The main working area during the **second leg** was on the upper and middle continental slope off Walvis Bay (Namibia; Fig. 1). Two of the major scientific goals were the investigation of the lateral particle transport especially within the nepheloid boundary layer and the determination of the effect of pulse-like sedimentation events on the benthic degradation processes of organic matter. A central question in this context concerned the importance of these processes on the regional benthic carbon cycle and possible reasons for already known differences in their spatial distribution pattern.

Additional geochemical and geophysical investigations were carried out for a detailed examination of early diagenetic modification of the primary sediment composition and its rock magnetic properties, both connected to the anaerobic oxidation of methane.

The major goals of the geological and micropalaeontological investigations were the reconstruction of changes in the circulation, hydrographic structure, and biological production of the Namibia upwelling area during extreme climatic states of the Late Quaternary and the improvement of climate models using the new data set. Additionally, diversity, spatial distribution and ecology of microorganisms were studied to improve the validity of single species as proxies for environmental conditions.

An intense oceanographic program completed the work during this leg to describe the temporal and regional variability within the mixed layer between the Eastern South Atlantic Central Water (ESACW) and the South Atlantic Central Water (SACW).

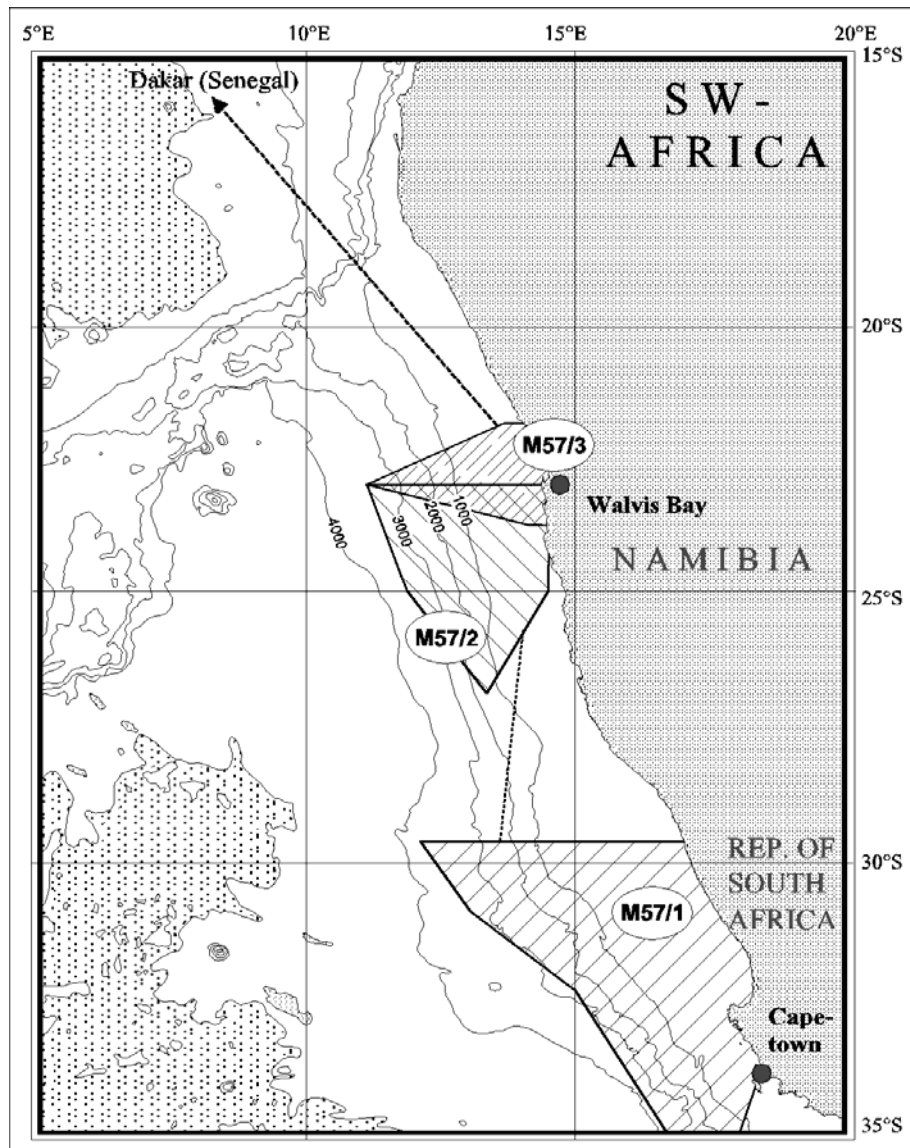


Fig. 1 Working areas of the three legs of R/V METEOR cruise M57. Cruise tracks and sampling stations are illustrated in the respective reports.

The **third leg** mainly focused on linkages between the biogeochemical carbon, nitrogen, and sulfur cycles in the shelf area off Walvis Bay (Namibia) between 22°S and 25°S. For this purpose, a range of hydrographic, biogeochemical, microbiological, acoustic, paleontological, and sedimentological investigations were conducted to explore the relationships between physical and biogeochemical processes in the water column, at the sediment surface, and in the sediments. The suggested close relationship between anoxic conditions in the water column and episodically recurring eruptions of biogenic methane which is formed by the intense bacterial degradation processes in the sediments may have significant implications for biogeochemical fluxes between sediment and bottom water and for the living resources (fish and crustaceans) in one of the largest marine ecosystems on earth. But, investigations that relate activity and distribution of anaerobic microbial consortia to the observed fluxes and physical processes were missing so far.

To record variations in coastal upwelling, current strength and direction, water mass composition, and oxygen and nutrient contents a further objective of this leg was to continue the weekly run CTD transect at 23°S and to recover a mooring at 23°S 14°E.

Table 1 Legs, chief scientists, and masters of R/V METEOR cruise M57.

Leg	Period	Ports	Chief Scientist	Master
M57/1	20.01.2003 – 08.02.2003	Capetown (South Africa) – Walvis Bay (Namibia)	Dr. R.R. Schneider	N. Jakobi
M57/2	11.02.2003 – 12.03.2003	Walvis Bay (Namibia) – Walvis Bay (Namibia)	Dr. M. Zabel	N. Jakobi
M57/3	15.03.2003 – 13.04.2003	Walvis Bay (Namibia) – Dakar (Senegal)	Dr. V. Brüchert	H. Papenhagen

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We also appreciate the most valuable help of Captain M. Berkenheger at the Leitstelle METEOR (Hamburg), K. Bohn at VTG-Lehnkering AG (Bremen), and the ship's managing owner, the RF Reederei Forschungsgemeinschaft GmbH (Bremen), during planning and implementation of the cruise. Financial support for the cruise was supplied by the *Deutsche Forschungsgemeinschaft* (DFG) and the *Bundesministerium für Bildung und Forschung* (BMBF).