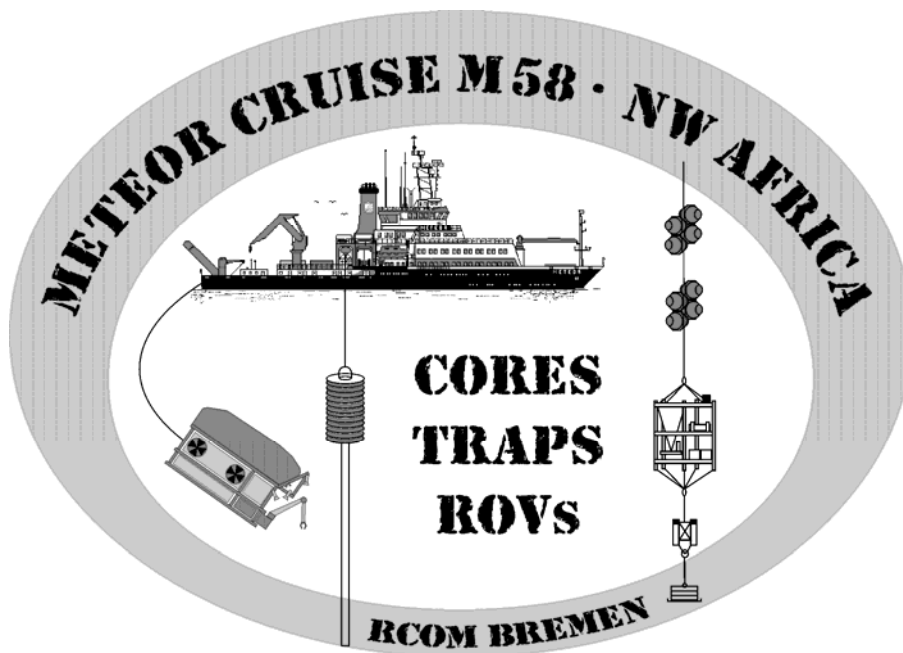


METEOR-Berichte 06-3

NW Africa: Cores, Traps, ROVs

Cruise No. 58

April 16 - June 24, 2003, Dakar – Ponta Delgada



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Abstract

With the three legs of R/V METEOR Cruise M58 the 'Research Center Ocean Margins' (RCOM) continued an expedition campaign, which started in January 2003 off Southwest Africa.

RCOM, sponsored by the Deutsche Forschungsgemeinschaft since 2001, is a joint venture of the University of Bremen, the Alfred-Wegener Institute for Polar and Marine Research, Bremerhaven, the Max-Planck Institute for Marine Microbiology, Bremen and the Senckenberg Institute, Wilhelmshaven. Long-term scientific objectives are basic and application oriented investigations of the transition zone between the oceans and continents.

The continental margin off Northwest Africa is largely shaped by a complex interplay of sediment transport processes directed both downslope and along slope. Specifically south of 26°N the considerably enhanced accumulation of sedimentary deposits originates from an intense marine productivity in the coastal upwelling regime. This results in widespread sediment movements and mass wasting events varying in style and velocity from slow motion slumps, where the original internal structures of the sediment column are mostly preserved, to debris flows, which typically display poor sorting, to turbidites transporting sediment material from the continental slopes far into the abyssal plains. Strong erosional bottom currents substantially contribute to the material transport and also to the development of large sediment drift bodies.

Main aim of the first leg was a quantitative account of sediment transport processes from local scales to dimensions of 10 to 100 km² extent. Individual episodes of massive sediment movements should be outlined in their temporal and spatial distribution and mass balances determined for the important constituents (organic and terrigenous components, carbonate). For this purpose, an integral representation and exact chronostratigraphic classification of the sedimentary sequences is an indispensable prerequisite to resolve the relation between mass wasting events and climate cycles, in particular sea level changes and glacial sea level low stands, as well as to identify and reconstruct the steering mechanisms of the sedimentation in the vicinity of high productivity regions.

Central topic of the second leg were sedimentological investigations off NW Africa, where one of the world's most important upwelling systems is located, additionally influenced by large amounts of Saharan dust deposits delivering nutrients into the ocean. Both processes are of fundamental importance for the particle formation in the ocean, considerably affect the biological and carbonate pumps and thus the global atmospheric CO₂ budget. High accumulation rate sedimentary deposits found east of the Canary Islands and west of Dakhla and Cape Blanc should comprise appropriate climatic archives for high-resolution paleoceanographic studies aiming at a documentation of very high rate climatic variations in the past. These rapid shifts of the climatic system as well as today's knowledge and rising concern about increasing anthropogenic influences attract more and more public interest to such investigations.

Tests of various modern technological developments in marine science were the primary goal of the third leg. Initial activities also involved control and maintenance of sensor arrays at several moorings about 60 nm north of Gran Canaria. The second and main topic of this cruise were multiple deployments of the newly acquired 4000 m WorkClass ROV (Remotely Operated Vehicle) 'QUEST' in deep waters. This RCOM owned automated submersible was operated from R/V METEOR for the first time.

Zusammenfassung

Mit den drei Fahrtabschnitten der FS METEOR Reise M58 setzte das 'Forschungszentrum Ozeanränder' (RCOM) eine im Januar 2003 vor Südwest Afrika begonnene Expeditionskampagne fort.

An RCOM, das seit 2001 von der Deutschen Forschungsgemeinschaft gefördert wird, sind die Universität Bremen, das Alfred-Wegener Institut für Polar- und Meeresforschung, Bremerhaven, das Max-Planck Institut für Marine Mikrobiologie, Bremen sowie das Institut Senckenberg am Meer, Wilhelmshaven, beteiligt. Sein langfristiges Forschungsfeld ist die Übergangszone von den Ozeanen zu den Kontinenten.

Der Kontinentalrand vor Nordwest Afrika wird durch ein sehr komplexes Zusammenspiel von hangparallelen und hangabwärts gerichteten Sedimenttransportprozessen geprägt. Insbesondere südlich von 26°N hat der küstennahe Auftrieb eine intensive marine Produktivität und dadurch eine erhöhte Akkumulation von Sedimenten zur Folge. Hieraus resultieren ausgedehnte Sedimentbewegungen. Sie variieren in Form und Geschwindigkeit von langsamen Rutschungen, bei denen die interne Struktur weitestgehend erhalten bleibt, über Schuttströme, deren Ablagerungen eine schlechte Sortierung aufweisen, bis zu Trübeströmen, die Sedimente von den Kontinentalhängen bis weit in die Ebenen der Tiefsee transportieren. Bodenströmungen tragen durch Erosion zum Materialexport bei und sind zusätzlich am Aufbau von großen Driftkörpern beteiligt.

Zielsetzung des ersten Fahrtabschnittes M58/1 war die quantitative Erfassung dieser Sedimenttransportprozesse von lokalen Dimensionen bis hin zu Größenordnungen von 10 zu 100 km² Ausdehnung. Einzelne Episoden von großen Sedimentumlagerungen sollten in ihrer räumlich-zeitlichen Verteilung dokumentiert und Bilanzen wichtiger Komponenten (organisches und terrigenes Material, Karbonat) erstellt werden. Eine umfassende Charakterisierung und exakte stratigraphische Gliederung der Sedimentfolgen sollte die Grundlage bilden, Beziehungen zwischen Massentransportereignissen und Klimazyklen, insbesondere Meeresspiegelschwankungen und glazialen Meeresspiegeltiefständen zu klären sowie die Steuerungsfaktoren der Sedimentation im Umfeld des Hochproduktionsgebietes zu rekonstruieren.

Zentraler Schwerpunkt des zweiten Fahrtabschnittes waren sedimentologische Arbeiten vor NW Afrika, wo sich eines der bedeutendsten Auftriebsgebiete der Welt befindet, das zudem durch große Mengen von Saharastaub beeinflusst wird, der wichtige Nährstoffe in den Ozean einträgt. Beide Prozesse sind von fundamentaler Bedeutung für die Partikelbildung im Ozean und beeinflussen über die biologische Pumpe und die Karbonatpumpe das globale CO₂ System nachhaltig. Sedimente hoher Akkumulationsraten östlich der Kanarischen Inseln sowie westlich von Dakhla und Cape Blanc ließen geeignete Archive für hochauflösende paläozeanographische Studien erwarten, die insbesondere abrupte Klimaschwankungen erfassen sollten. Diese kurzfristigen Änderungen des Klimasystems sowie die heutigen Kenntnisse und Sorgen über anthropogene Einflüsse haben solche Untersuchungen zunehmend ins öffentliche Interesses gerückt.

Auf dem dritten Fahrtabschnitt sollten in erster Linie einige moderne technologische Entwicklungen der Meeresforschung weiter erprobt werden. Zunächst wurden Wartungsarbeiten der Sensorsysteme mehrerer Verankerungen etwa 60 sm nördlich von Gran Canaria durchgeführt. Zweiter und besonderer Schwerpunkt der Reise waren Tauchfahrten des neuen 4000 m Work-Class ROV (Remotely Operated Vehicle) 'QUEST' im Tiefwasser. Dieser RCOM Tauchroboter wurde erstmals von FS METEOR eingesetzt.

Research Objectives

The research program of the three legs R/V METEOR Cruise M58 was entirely devoted to integral long-term scientific objectives of DFG ‘Research Center Ocean Margins’ (RCOM) aiming at basic and application oriented investigations of the transition zone between the oceans and continents. The working areas of the cruise are shown in Fig. 1, dates, ports, chief scientists and master of R/V METEOR of the individual legs are listed in the following table.

Leg	Dates	Ports	Chief Scientists	Master R/V METEOR
M58/1	16.04.2003 - 12.05.2003	Dakar (Senegal) Las Palmas (Spain)	Prof. Dr. H.D. Schulz	H. Papenhagen
M58/2A	15.05.2003 - 24.05.2003	Las Palmas (Spain) Las Palmas (Spain)	Prof. Dr. U. Bleil	H. Papenhagen
M58/2B	25.05.2003 - 08.06.2003	Las Palmas (Spain) Las Palmas (Spain)	Prof. Dr. U. Bleil	H. Papenhagen
M58/3	11.06.2003 - 24.06.2003	Las Palmas (Spain) Ponta Delgada (Portugal)	Dr. G. Meinecke	H. Papenhagen

In the focus of the **first leg** were hydroacoustic surveys (high-resolution seismic, PARASOUND and HYDROSWEEP profiling) on the Northwest African continental margin supplemented by sampling of the sedimentary deposits with a gravity corer, multicorer and large box corer. The sediment distribution in this region is controlled by complex interactions of transport systems carrying material downslope and parallel to the coast. Namely south of 26°N, intense upwelling and primary productivity results in an enhanced accumulation of sediments accompanied by extensive mass wasting. Exemplary investigations were planned in a selected area off Cape Blanc, where these processes should be studied in detail to establish quantitative budgets of the material fluxes. Pore water profiles and an immediate identification of main solid phase components were intended to discriminate undisturbed sequences from sediment units affected by mass wasting and also to an age assessment of recent mass movement events.

Additional reflection seismic surveys were projected to provide detailed regional information about the sediment structures at the African continental margin east and south of the Canary Islands for an optimal positioning of coring sites during the subsequent leg M58/2.

Primary objective of the **second leg** was the recovery of sediment sequences on the African continental slope between about 25 and 29°N operating conventional devices (gravity corer, multicorer and large box corer). Their comprehensive analyses aimed at reconstructing late Quaternary variations in productivity of the regional upwelling system together with the Saharan vegetation history at high temporal resolution. Early diagenetic processes in these sediments were of specific interest in this context as they provide clues to assess the influx of organic material and hence the intensity of past productivity and upwelling. With their precise quantification also the preservation of other primary climatic signals should be evaluated. Main working areas were the shelf regions north of Cape Yubi and south of Cape Bojador as well as the continental slopes there and off Dakhla.

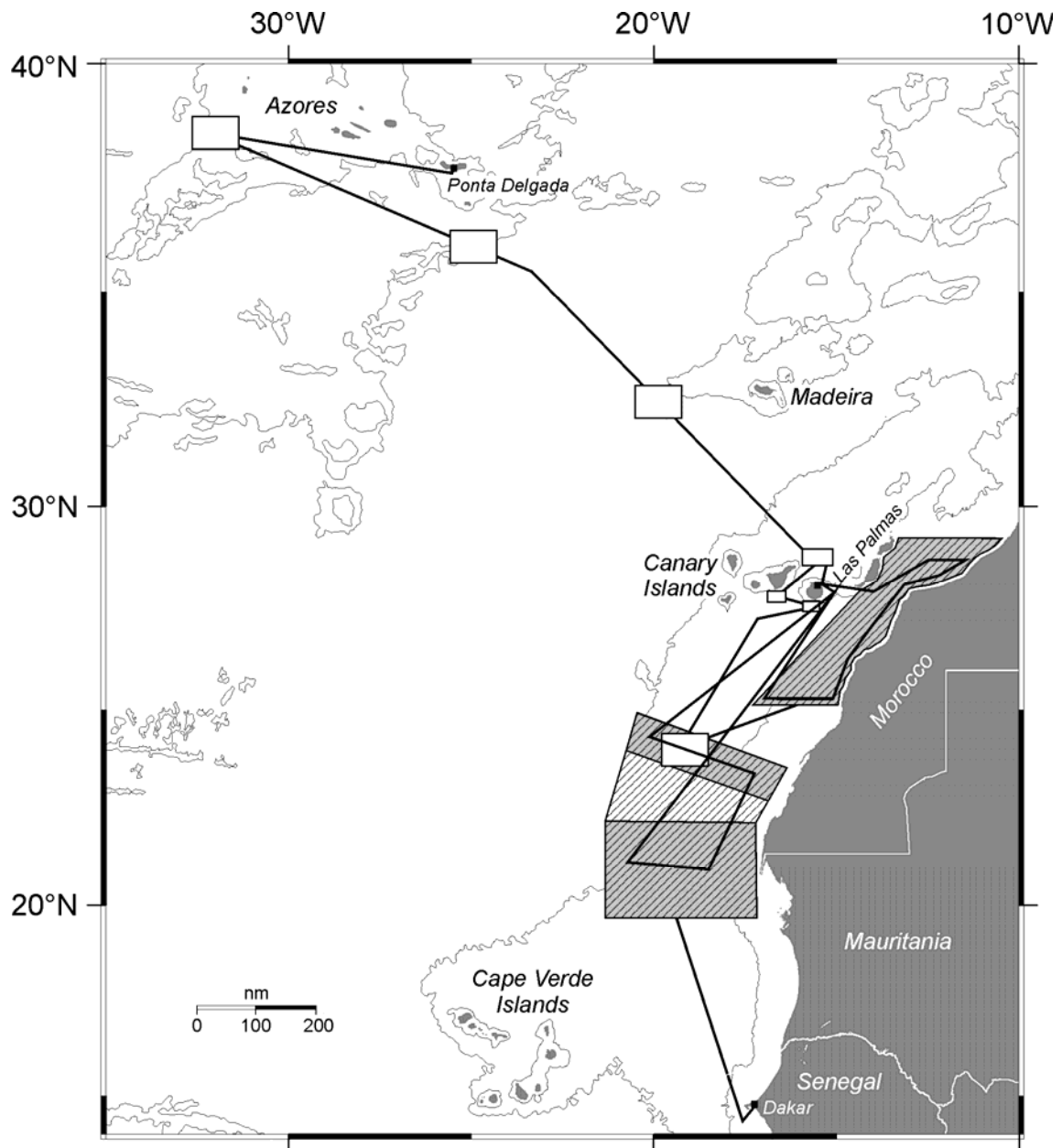


Fig. 1: R/V METEOR Cruise M58 ship's track and working areas (Leg M58/1 - hatched, Leg M58/2 - shaded, Leg M58/3 - open rectangles).

The second part of leg M58/2 was mainly engaged in investigations of the particle sedimentation in the Cape Blanc region. A moored sediment trap monitoring the seasonal particle flux since many years there was recovered and re-deployed, another new sediment trap had to be positioned in the same area closer to land. For chemical analyses of trace elements, suspended matter was collected from the water column by means of *in situ* pumps as well as rosette water samplers. A camera system equipped ROV was employed for specialized particle flux studies.

In the same region and also around 24°N, sediment sampling was projected for paleoceanographic and paleoclimatic purposes using a gravity corer and multicorer. During the entire cruise plankton samples were regularly collected from the surface waters and echographic measurement continuously performed with the two acoustic shipboard systems PARASOUND and HYDROSWEEP.

Initial activities of the **third leg** involved control and maintenance of sensor arrays at several moorings about 60 nm north of Gran Canaria. The program included the ESTOC Station (European Station of Timeseries in the Ocean, Canary Islands), the DOLAN Station (Datenübertragung im Ozean und Laterales Akustisches Netzwerk) as well as the ANIMATE Station (Atlantic Network of Interdisciplinary Moorings and Timeseries for Europe). The participating Spanish scientists from ICCM (Instituto Canario de Ciencias Marinas) performed various measurements in the water column on transit to the mooring stations.

A second topic of the cruise were multiple deployments of the newly acquired 4000 m Work-Class ROV 'QUEST' in deep waters. As this automated submersible of the 'Research Center Ocean Margins' was operating from R/V METEOR for the first time, all relevant technical and logistical details were carefully checked in advance. Depending on prevailing sea and wind conditions, the exact locations of diving operations had to be defined on site together with cooperating specialists from ALSTOM SCHILLING ROBOTICS, MBARI (Monterey Bay Aquarium Research Institute) and Portuguese colleagues from the Department of Oceanography and Fisheries, University of the Azores. At the beginning of the cruise, a number of test sites were positioned in the vicinity of the Canary Islands, final activities were investigations in the 'Lucky Strike' and 'Menez Gwen' hydrothermal fields near the Azores. On transit to this westernmost working area, various studies could be accomplished in the water column.

Acknowledgements

The scientific parties aboard R/V METEOR during Cruise M58 gratefully acknowledge the pleasant cooperation and very efficient technical assistance of Captain Henning Papenhagen, his officers and crew who substantially contributed to the overall scientific success of this cruise. We also appreciate the support of the Leitstelle METEOR, Hamburg. The work was funded by the Deutsche Forschungsgemeinschaft within the scope of the 'Research Center Ocean Margins' (RCOM) at Bremen University.