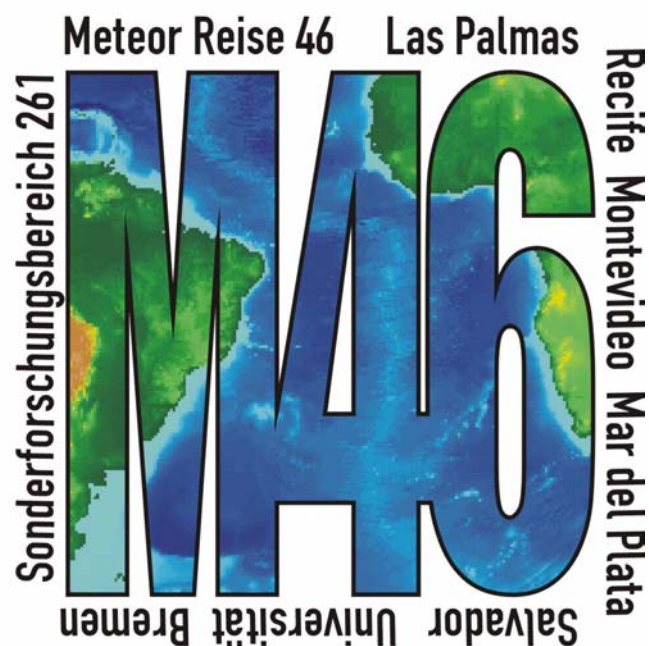


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Geo Bremen South Atlantic 1999/2000

Cruise No. 46

6 November 1999 – 13 March 2000



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Abstract

Consisting of four legs, the German Research Vessel METEOR carried out its 46th cruise from 6 November 1999 to 13 March 2000 in the South Atlantic Ocean. The cruise started at Las Palmas (Spain), continued with stops in Recife (Brazil), Montevideo (Uruguay), and Mar del Plata (Argentina), and ended in Salvador (Brazil). The expedition was a part of the long-term geoscientific project Sonderforschungsbereich (SFB) 261 at Bremen University, as the final cruise of the funding period. The goal of the SFB 261 is to reconstruct the mass-budget and current systems of the South Atlantic during the Late Quaternary. The principal objectives during cruise M 46 were the recovery of sample material from the water column and the sea floor for micropaleontological, geochemical, geophysical, and isotope analyses, the recovery of sediment traps, and the study of sedimentary structures using geoacoustic methods. This report summarizes the main goals of the various working groups, provides complete lists of all stations and equipment employed on each leg, and presents the preliminary results obtained during the cruise. The cruise was funded by the *Deutsche Forschungsgemeinschaft* (German Research Foundation).

Zusammenfassung

Die 46. Reise des deutschen Forschungsschiffs METEOR fand in vier Abschnitten vom 6. November 1999 bis zum 13. März 2000 im Südatlantik statt. Die Expedition begann in Las Palmas (Spanien), wurde fortgesetzt mit Aufenthalten in Recife (Brasilien), Montevideo (Uruguay) sowie Mar del Plata (Argentinien) und endete in Salvador (Brasilien). Mit der Expedition wurden langfristige geowissenschaftliche Projekte des Sonderforschungsbereichs (SFB) 261 an der Universität Bremen fortgeführt. Die Reise M 46 war die letzte Fahrt innerhalb der Förderperiode des SFB 261, der die Rekonstruktion von Stoffhaushalt und Stromsystemen im Südatlantik während des Spätquartär zum Ziel hat. Schwerpunkte der Arbeiten während der METEOR-Fahrt waren Probennahmen aus der Wassersäule und vom Meeresboden für mikropaläontologische, geochemische, geophysikalische und Isotopen-Analyse, das Aufnehmen von Sedimentfallen und die Untersuchung von Sedimentstrukturen mit geoakustischen Methoden. Dieser Bericht fasst die wichtigsten Arbeitsziele der verschiedenen Arbeitsgruppen zusammen. Er enthält vollständige Listen der Stationen und der eingesetzten Geräte sowie erste an Bord erzielte Ergebnisse. Die Expedition wurde durch die Deutsche Forschungsgemeinschaft (SPP METEOR-Expeditionen) gefördert.

Research Objectives

An extensive network of samples has been acquired from the South Atlantic in recent years during numerous METEOR expeditions with the aim of reconstructing the variability of current systems and productivity over a broad area. The broad objective of this final cruise of the SFB 261 funding period (M 46) was to fill gaps in the existing sample network, particularly in the region of the mid-oceanic ridge and on the continental slope off southern Brazil, Uruguay, and Argentina, and in the Argentine Basin. The working areas of the four legs of METEOR cruise M 46 are shown in Fig. 1, periods, ports and chief scientists of the individual legs are listed in table 1.

During METEOR cruise M 41, time series sediment traps were deployed in the western equatorial South Atlantic to obtain long-term records of seasonal particle sedimentation. These traps were recovered during the **first leg** of the present cruise whilst in transit to Recife. The sediment-trap material will be analysed to determine the species composition of planktonic organisms (ptero-pods, foraminifera, radiolarians, coccolithophorids, and diatoms), their chemical and isotopic

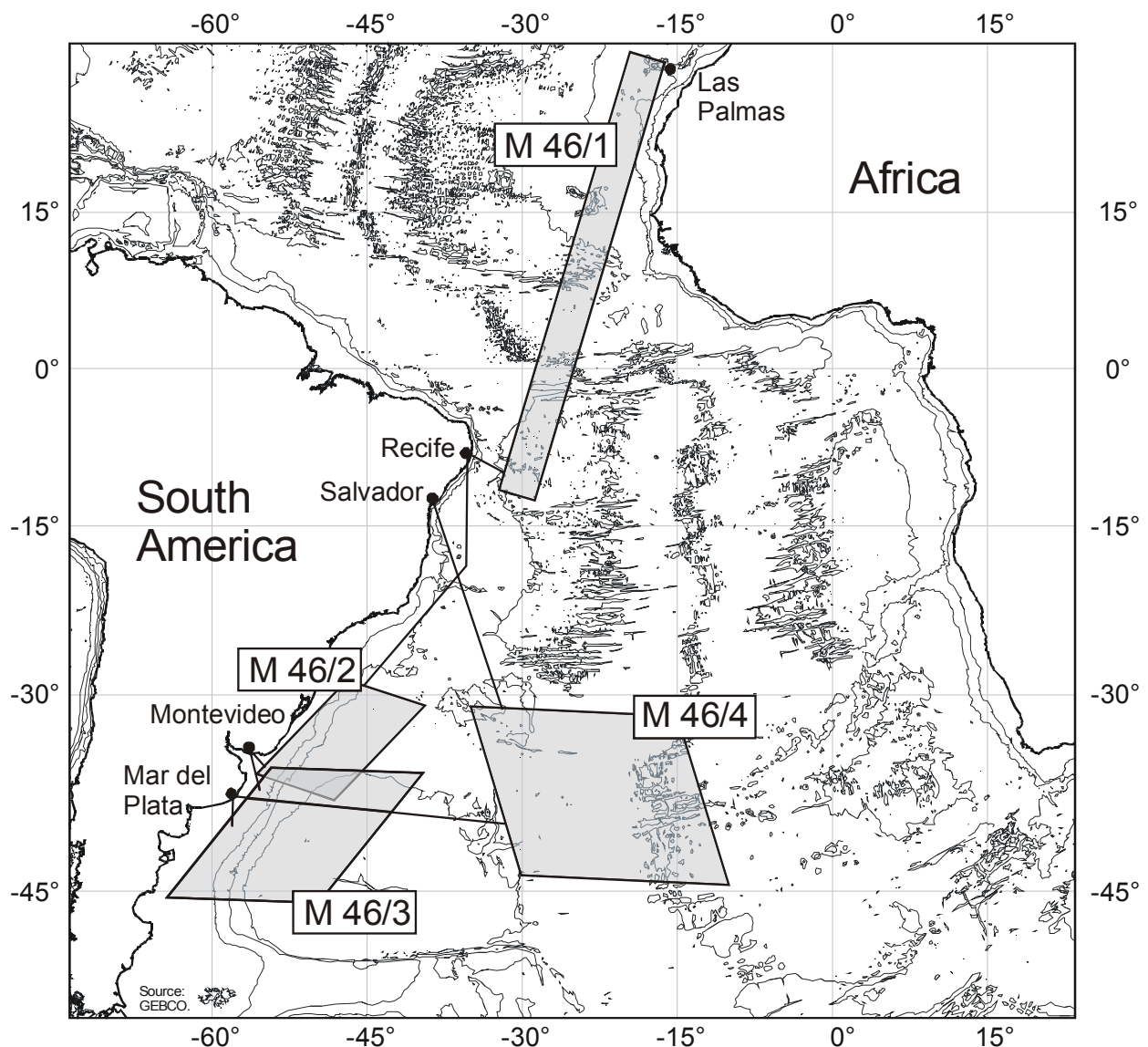


Fig. 1: Working areas of the four legs of METEOR cruise M 46. Cruise tracks and sampling stations are illustrated in the respective reports.

compositions, and the compositions of the organic substance and terrigenous material. These will provide significant signals of the seasonal fluctuations of important sediment components. The investigations are a critical prerequisite for reconstructing past ocean current systems and former productivity relationships in the South Atlantic from sedimentary deposits.

On the **second leg**, cores were retrieved from the continental slope off southern Brazil, in an area extending from the Santos Plateau to the Uruguayan border. Four sediment-core profiles from the shelf edge to the deep sea were sampled. Samples will be employed for reconstructing the history of the Brazil Current and the front between the Brazil Current and the Malvinas (Falkland) Current. The study area lies in the northern reaches of the confluence of the southward-flowing Brazil Current transporting subtropical water masses, and the northward-flowing Malvinas Current with its sub-polar water masses. The location of the present-day front fluctuates seasonally between about 32° and 40°S.

The continental slope off the Rio de la Plata farther to the south is characterized by numerous canyons and slides. In this study area, however, large-scale canyons do not appear to be present. Complete sediment sequences with high sedimentation rates (>10 cm/1,000 yrs) have been encountered here. High-resolution sediment series are needed for the study of many new topics and questions in paleoceanography because they can be compared with the ice-core data from polar regions.

The study area represents a gap in the existing sample base of the SFB 261, and no new results have been published by other working groups. With this sampling a complete N-S transect of the western Atlantic was achieved for the SFB 261 program. The upcoming synthesis phase will be involved with, among other concepts, a summary of the history of the current system in the South Atlantic. The data will also be used to reconstruct time slices, for example, of the last glacial maximum (LGM), for which the western boundary currents in the South Atlantic represent a key region.

A detailed solid-phase analysis will be carried out on selected cores. Material retrieved from the central and northern Santos Plateau during cruise M 23/1-2 reveals element-enrichment zones in the glacial-interglacial transitions, similar to samples from the western equatorial Atlantic at the Holocene-Pleistocene boundary. Because of the incomplete lateral sample base, attributing this geochemical signal indisputably to varying influences of the relevant water masses has not

Table 1 : Legs and chief scientists of Meteor cruise M 46.

Leg	Period	Ports	Chief scientist
M 46/1	6.11.99 – 29.11.99	Las Palmas (Spain) – Recife (Brazil)	Prof. Dr. W. Balzer
M 46/2	2.12.99 – 29.12.99	Recife (Brazil) – Montevideo (Uruguay)	Prof. Dr. H.D. Schulz
M 46/3	4.1.00 – 7.2.00	Montevideo (Uruguay) – Mar del Plata (Argentina)	Prof. Dr. U. Bleil
M 46/4	10.2.00 – 13.3.00	Mar del Plata (Argentina) – Salvador (Brazil)	Prof. Dr. G. Wefer

Masters: M. Kull (M 46/1), S. Bülow (M 46/2 – M 46/4)

been possible so far. These studies, especially those on the southern Santos Plateau, should provide significant progress with respect to the contribution of geochemical investigations for reconstructions of current patterns in the northern Argentine Basin.

The **third leg** of the cruise was devoted to sampling the continental slope off Argentina and to the retrieval of core material for reconstructing the history of the Falkland Current (Malvinas Current) during the Late Quaternary. The working area lies within the sphere of influence of the Falkland Current where it is directed along the contours of the continental shelf edge. The continental margin off Argentina is characterized by numerous steep slopes and submarine canyons that make prior targeting of locations for long continuous sediment cores difficult. Previous METEOR and POLARSTERN expeditions to the continental slope off Argentina retrieved, in part, disturbed cores (hiatuses, reworked sediments, turbidites). Strong currents in this region inhibit continuous sedimentation over broad areas. The presence of local basins and less steep slope segments, however, made it possible to carry out a successful sampling program. Sufficient time on station had been planned for the choice of appropriate core stations and to account for bad weather conditions. Good prior seismic mapping contributed to the successful deployment of the coring instruments.

This study area is critical for reconstructions of the Falkland Current, which, in turn, can be combined with reconstructions of the Brazil Current and the front between the two currents, to address the question of Pacific influence on the climatic history of the South Atlantic.

Due to the extensive reworking processes acting in shelf and slope regions, the area off the southern mouth of the Rio de la Plata is especially well suited for studying the effects of strong intermittent sedimentation events (mainly turbidite sequences) on (bio)geochemical turnover processes. Considering the assumption of temporally defined steady-state conditions in marine surface sediments, it is important to expand our knowledge of short-term changes in sediment composition and deposition rates, both for the general interpretation of concentration profiles and for estimating early diagenetic overprints on the geochemical paleosignals. The investigations will also contribute to the evaluation and further interpretation of corresponding core material from the eastern South Atlantic.

Additional sub-bottom profiles and multi-channel seismic measurements were carried out in the area of the deep Argentine Basin in order to reconstruct temporal variations of the deep-water currents. Previous PARASOUND profiles taken in the area during POLARSTERN and METEOR expeditions showed the presence of a gradual transition from the central erosion zone to the drift sediments (Zapiola Drift, Argyro Drift, Ewing Drift) with a successive development of sediment waves. So far, it is unknown how this phenomenon is expressed in a north-south direction. Since it is assumed that portions of the bottom water flow back to the east in closed gyres long before reaching the Vema Channel, it must be possible to document a change in the lateral current profile at these latitudes. Therefore the work included multiple E-W profiles extending from the central erosion zone to the region of the developed sediment waves.

To address the questions discussed above, a coring program was carried out in the region of the mudwaves. Because of the water depth and absence of carbonate it will probably be impossible to obtain an oxygen isotope curve, but the 'bulk' sedimentation rate and the influx of marine organic substance are relatively high, so a dependable ^{14}C stratigraphy can be produced from the organic material. Several cores, up to 14 m long, were retrieved from the three mudwave areas in order to obtain a high-resolution record of the last 50 to 60 thousand years.

The material will provide data for interpreting fluctuations in bottom-water intensity and productivity as they relate to short-term climate changes.

The **fourth leg** of the cruise was dedicated to sampling the mid-oceanic ridge (MOR) from around 30° to 45°S. Samples from the MOR will be employed in paleoceanographic reconstructions of the South Atlantic Current and the subtropical front. A possible northward shift of the front should be recorded in the assemblages of planktonic foraminifera and in the siliceous microfossil communities, as well as in the stable isotopes. The area of interest lies in the eastward-directed counterflow of the South Atlantic subtropical eddy within the South Atlantic Current. In the the South it includes the present-day subtropical front. Located within the transitional region between POLARSTERN investigations of the Alfred-Wegener-Institute (AWI) and METEOR expeditions by the Department of Geosciences of the University of Bremen (GeoB), the area has been sparsely investigated in the past. For logistical reasons, sampling in the area has so far been limited to single isolated cores. A close link between the two sampling regions is an important requirement for the synthesis phase of SFB 261. Surface materials were also employed to further calibrate the various paleoceanographic proxies.

Three E-W sediment-core profiles were sampled on the western flank of the MOR at between 40° to 45°S in water depths from 3,000 to 4,000 meters. A fourth profile provides a S-N transect between 40° and 32°. The recovered sediments impressively document the transition between siliceous sediments in the south and carbonate sediments to the north.

The on-board acoustic system will be continuously deployed through all working areas of expedition M 46. With the advantage of extensive previous experience, a general comprehensive view of the morphological situation will be provided by local HYDROSWEEP swath sounding in order to identify appropriate locations for the coring stations.

High-resolution measurements (core logs) of compression-wave velocity, magnetic susceptibility, electrical conductivity, and thermal conductivity were carried out on all the core material retrieved. The great majority of this work was completed on board in order to reflect as near as possible the *in situ* conditions. In conjunction with other basic physical sediment parameters, the seismograms provide quantitative interpretations. In particular, magnetic data sets have yielded very interesting initiatives for paleoclimatic- and paleoceanographic-related topics, which will now be investigated in further detail. An additional goal employing paleo-magnetic analyses in cooperation with biostratigraphic and isotope-stratigraphic methods, is to develop the necessary chronostratigraphic framework for all other investigations.

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