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Cruise No. 51

12 September – 28 December 2001



Christoph Hemleben, Kaj Hoernle, Bo Barker Jørgensen and Wolfgang Roether

Editorial Assistance

Frank Schmieder

Fachbereich Geowissenschaften, Universität Bremen

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Addresses of the editors:

Prof. Dr. Christoph Hemleben  
Institut und Museum für Geologie  
und Paläontologie  
Sigwartstrasse 10  
D-72076 Tübingen / Germany

Tel.: +49-7071-29 72496  
Fax: +49-7071-29 5766  
e-mail: [christoph.hemleben@uni-tuebingen.de](mailto:christoph.hemleben@uni-tuebingen.de)

Prof. Dr. Kaj A. Hoernle  
GEOMAR  
Abteilung Vulkanologie und Petrologie  
Wischhofstrasse 1-3  
D-24148 Kiel / Germany

Tel.: +49-431-600 2642  
Fax: +49-431-600 2978  
e-mail: [khoernle@geomar.de](mailto:khoernle@geomar.de)

Prof. Dr. Wolfgang Roether  
FB 1 - Physik  
Universität Bremen  
Postfach 330 440  
D-28334 Bremen / Germany

Tel.: +49-421-218-3511 /-4221  
Fax: +49-421-218 7018  
e-mail: [wroether@physik.uni-bremen.de](mailto:wroether@physik.uni-bremen.de)

Prof. Dr. Bo Barker Jørgensen  
Max Planck Institut für  
Marine Mikrobiologie  
Celsiusstrasse 1  
D-28359 Bremen / Germany

Tel.: +49-421-2028 602  
Fax: +49-421-2028 580  
e-mail: [bjoergen@mpi-bremen.de](mailto:bjoergen@mpi-bremen.de)

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## Abstract

METEOR cruise M51 started on September 12, 2001 at Warnemünde (Germany) and ended on December 28, 2001 at Istanbul (Turkey) comprising stops at Malaga (Spain), Valletta (Malta), Rhodes (Greece) and Istanbul (Turkey). The scientific programs of at least 27 different working groups used several approved but also new methods to characterize the earth-system. The scientific objectives focused on the volcanology of the East Atlantic Ocean and Alboran Sea, the hydrography and planktology of the Eastern Mediterranean Sea, the paleoceanography and the sapropel formation of the Levantine and Aegean seas, and the climate history and biochemistry of the Black Sea. The scientific programs used a multi-proxy approach to study processes of the present and past Earth's system. Cruise M51 was divided into four legs to obtain insitu measurements and samples from the water column and the sea floor for general biological, microbiological, micropaleontological, geochemical, volcanological and sedimentological studies.

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 METEOR-Reise 51 startete am 12. September 2002 in Warnemünde (Deutschland) und endete am 28. Dezember 2001 in Istanbul (Türkei) mit Zwischenaufenthalten in Malaga (Spanien), Valletta (Malta), Rhodos-Reede (Griechenland) und Istanbul (Türkei). Das wissenschaftliche Programm der mindestens 27 Gruppen benutzte zahlreiche erprobte, aber auch neue Methoden, um das System Erde zu charakterisieren. Die verschiedenen Unterprogramme waren auf vulkanologische und sedimentologische Fragen im östlichen Atlantik (M und Kanaren) und der Alboran See gerichtet. Im östlichen Mittelmeer, der Ägäis, dem Marmara Meer und dem Schwarzen Meer standen hydrographische, mikrobiologische geochemische und sedimentologische Untersuchungen im Vordergrund. Ein besonderer Schwerpunkt waren Untersuchungen und Probennahme zur Paläoozeanographie und Klimageschichte des östlichen Mittelmeeres, der Ägäis und des Schwarzen Meeres. Dieser Bericht fasst die Ziele und Durchführungen (Methoden), sowie erste Resultate zusammen, inklusiv einer Stationsliste, die während der vier verschiedenen Reiseabschnitte gewonnen wurden. Die Reise 51 wurde von der *Deutsche Forschungsgemeinschaft* (German Research Foundation) finanziell unterstützt.

## Research Objectives

Cruise M51 was divided into four legs (Fig.1) It started on September 12, 2001 at Warnemünde and ended on December 28, 2001 at Istanbul. The following table lists the chief scientists and leg dates. Master of R/V METEOR cruise 51 was M. Kull.



**Table 1:** Legs and chief scientists of R/V METEOR cruise M 51.

| Leg    | Ports             | Period                             | Chief scientist          |
|--------|-------------------|------------------------------------|--------------------------|
| M 51/1 | 12.09.01-15.10.01 | Warnemünde-Malaga (Spain)          | Prof. Dr. K. A. Hoernle  |
| M 51/2 | 18.10.01-11.11.01 | Malaga (Spain) – Valletta (Malta)  | Prof. Dr. W. Roether     |
| M 51/3 | 14.11.01-10.12.01 | Valletta (Malta)-Istanbul (Turkey) | Prof. Dr. C. Hemleben    |
| M 51/4 | 13.12.01-28.12.01 | Istanbul-Istanbul (Turkey)         | Prof. Dr. B.B. Jørgensen |

### Leg 1

The causes for the existence of a volcanic belt extending ca 1.700 km between 23°N and 38°N in the eastern north Atlantic as well as the reasons for the volcanism in the Alboran Sea (western Mediterranean) are a subject of ongoing debate. Proposed geodynamical models include 1) a plume swarm, 2) a single mega-plume, 3) subduction, 4) delamination/ detachment of lithosphere and 5) rifting. Recent geochemical studies and age dating indicate at least two independent active hot spot systems (mantle plumes) in the eastern north Atlantic, which can be retraced to ca 70 million years (Ma) B.P.. In contrast, the volcanism in the Alboran region is probably associated with Miocene subduction of oceanic lithosphere or delamination/ detachment of subcrustal lithosphere. The aim of this research project was to test these models based on a temporal and spatial reconstruction of the volcanism in the working areas by using major- and trace element as well as Sr-Nd-Pb-O isotope and laser-<sup>40</sup>Ar/<sup>39</sup>Ar- age data. This will also serve as a contribution for the understanding of the causes of the drying down of the Mediterranean Sea roughly between 5-6 million years ago (Messinian Salinity Crisis). The long-term objective is the reconstruction of the Cenozoic mantle dynamics in the eastern north Atlantic and in the western Mediterranean.

In addition to these investigations the sediment facies distribution in the Cabo de Gata area and epibenthic organisms from dredged samples were studied.

### Leg 2

During METEOR cruise M51/2 highly precise measurements of the distribution of CFCs (CFC-11, CFC-12, CFC-113), tritium and helium isotopes/neon were carried out along a west/east transect in the eastern Mediterranean Sea. This tracer study is closely connected to the hydrographic program including measurements of nutrient, oxygen and CO<sub>2</sub> concentrations. The circulation and formation of water masses in the eastern Mediterranean Sea is recently characterized by a transient phase. Main objectives of the oceanographic investigations were to assess the adaptation in a new state of equilibrium and to quantify the impact of these changes on the biochemical characteristics.

On the background of the oceanographic changes in the Levantine Sea, the biological program studied the abundance, variability and structure of the zooplankton communities. For the first time it will be possible to compare the impact of oceanographic and biological changes on the flux rates within the bathypelagic (>1000 m) and abyssopelagic (>2000 m) zooplankton, and to the deep-sea floor. In addition, carbon fluxes to the deep-sea have been studied by means

of sediment traps. The data will be compared with the turnover rates of the zooplankton. The intensity of the degradation of organic matter in the water column has been investigated and compared to the data obtained during 1999 (M44/4).

### **Leg 3**

During METEOR cruise M51/3 several long sediment cores were obtained from the Ionian Sea, Levantine Sea, Aegean Sea, and Sea of Marmara. The investigations focus on the reconstruction of abrupt climatic fluctuations during selected time intervals (e.g., Holocene, Eemian) of the last 150 kyr and their impact on the different marine ecosystems in the eastern Mediterranean Sea during glacial and interglacial boundary conditions. The paleoceanographic onshore studies include the reconstruction of temporal and spatial gradients of surface water temperature, productivity, nutrient distribution, and deep water ventilation. For the paleoceanographic studies different proxies will be applied comprising geochemical (stable isotopes, alkenones, lignin), micropaleontological (foraminifera, coccoliths, siliceous plankton) and sedimentological (e.g., clay mineralogy) investigations.

In addition to the paleoceanographic investigations, the bacterial communities have been studied in the water column, the sediment surface, and selected sapropel layers to document the differences to results obtained during cruise M40/4 in 1998. Furthermore, the distribution pattern of calcareous dinoflagellates in the water column and in the sediment have been investigated. The bathymetric distribution of selected macrobenthic communities (e.g., Scleractinia) have been studied off Rhodes to obtain ecological information for the paleo-ecological and paleoceanographic interpretation of fossil faunas from Plio-Pleistocene land sections.

### **Leg 4**

The Holocene sedimentary sequences of the Black Sea which were deposited predominately under anoxic conditions provide a unique opportunity to study biogeochemical budgets in relation to the Holocene climate evolution with highest temporal resolution. This specific sedimentary environment resulted in thinly laminated sediments that contain mainly annual layers for the last ca. 7500 years. The expected high resolution paleoclimate records provide the potential to study Holocene climate variations on up to interannual/decadal time-scales. Through comparisons with other high resolution records both from the continent (e.g., Greenland ice-cores and lake sediments/tree-rings from Europe) and the marine realm (e.g., Arabian Sea, eastern Mediterranean Sea, and Red Sea), we aim to detect global or at least hemispheric climate signals (e.g., ENSO and NAO) in order to contribute to a better understanding of their long-term variability. On the other hand, as the type-locality for TOC-rich deposits in the geological past, the Black Sea provides an ideal area to study biogeochemical cycles. Through the planned multi-disciplinary approach combining solid and liquid phase analyses on high-resolution sediment profiles and in the water column with modeling, contribute to the understanding of biogeochemical processes leading to the development of specific element signals during sediment formation under oxic and anoxic conditions.

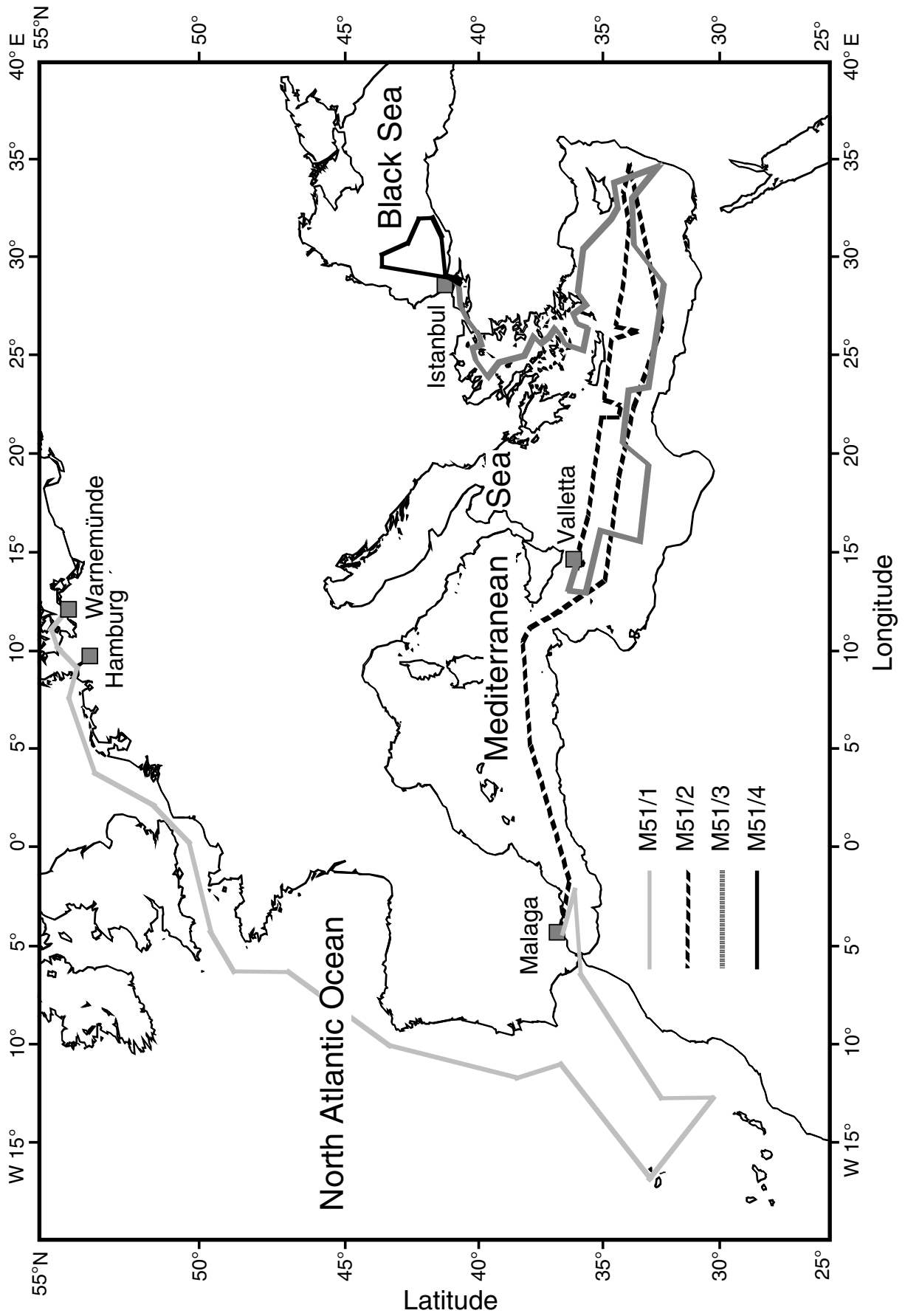


Fig. 1: M51 Cruise track

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