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INTERNATIONAL STUDY OF THE EQUATORIAL SEGMENT OF THE MID-ATLANTIC RIDGE (EQUARIDGE)

This document is submitted in accordance with the request of the Twenty Third Session of the IOC Executive Council (doc. IOC/EC-XXIII/3, paragraph 196), to the Delegate of the USSR to keep the IOC informed of the scientific results of the EQUARIDGE programme.

Preliminary results of the first EQUARIDGE cruise of R/V "Academik Nikolai Strakhov" are presented in this paper by the EQUARIDGE project co-ordinator, Dr. Gleb B. Udintsev (Soviet Geophysical Committee, Molodezhnaya 3, Moscow 117296, USSR).

The first sea-going expedition under the international EQUARIDGE programme took place from 10 August to 9 December 1990. The expedition was supported by the Intergovernmental Oceanographic Commission (IOC) and by the UNESCO through its Programme of Marine Sciences (PROMAR). The EQUARIDGE project is co-ordinated with the United Kingdom's BRIDGE programme, which has a similar objective, and with a research programme of the Institute of Geophysics of the University of Hamburg (Germany).

The cruise was organized by the Geological Institute of the USSR Academy of Sciences on board R/V "Akademik Nikolai Strakhov". The programme was based on data collected during the 7th cruise of " Akademik Nikolai Strakhov" in 1988.

An analysis of the data shows that the geological structure of the Equatorial Segment of the Mid-Atlantic Ridge (MAR) is anomalous and differs greatly from the adjacent parts of the Ridge. Spreading processes are apparent only in the narrow axial zone of the segment, characterized by the horst-&-graben structure of the sea bottom, absence of the sedimentary layer, linear anomalies of the Earth's magnetic field, juvenile magmatic activity and high seismic activity. Unlike the above zone, the flanks of the Segment resemble a plateau of mosaic morphostructure, with the mosaic structure of an anomalous magnetic field; they are covered by a relatively thick sedimentary layer, with Upper Cretaceous sediments dredged in the outcrops of the basement and even in proximity to the axial zone, whereas some metamorphic and ultramorphic rocks of the upper mantle, typical of continental areas, were found in the basement rock.

If these features of the Equatorial Segment structure are not of a haphazard but of a systematic character, they should affect our understanding of the development of the Mid-Atlantic Ridge. However, the data gathered during the earlier 7th cruise of "Akademik Nikolai Strakhov" were not sufficiently comprehensive and detailed to allow such important conclusions.

Therefore, the Institute of Geology, jointly with the Department of Geology, Geophysics and Geochemistry of the USSR Academy of Sciences proposed that two additional research expeditions be undertaken by R/V "Akademik Nikolai Strakhov" during its 11th and 12th cruises for a more detailed study of the Equatorial Segment, within the framework of project EQUARIDGE. The Oceanographic Committee of the Soviet Union suggested that EQUARIDGE be made an international programme and invited the Intergovernmental Oceanographic Commission of UNESCO to support their initiative.

Among those participating in the 11th research cruise were scientists of the USSR Institutes of Geology and Physics of the Earth Physics, University of Hamburg, Germany (W. Fogg, M. Vosselemann, A. Sabetian, I. Voitsekhovsky, S. Ohland, F. Evers), the Geological Survey of Israel (J. Hall), and the Center for Ocean Mapping Development of the University of Rhode Island, USA (R. Tyce). The vessel was fitted with satellite navigation

Global Positioning System equipment - RAYTHSEON 920, providing for ± 30 m accuracy of observation which permitted a detailed geophysical survey with high density (2.6 mile) line spacing, while multi-beam (swath) echo-sounding ensured practically 70-90% coverage of the sea floor.

Simultaneously, one-channel seismic profiling and gravity measurements were made. The comprehensive geophysical survey covered an area from 5°N to 2°N and from 35°W to 31°W and the limit of S~ao-Paulo island territorial waters in the East (see Fig. 1). Thus, the study included the axial rift zone north of the Strakhov Fracture Zone (4°N) and the two flanking plateaux on its Eastern and Western sides, as well as the Western flanking plateau - to the South of the Strakhov Fracture Zone. For this area bathymetric maps on a scale of 1:250,000 were compiled. Seismic experiments on reception of reflected and refracted waves by means of a multi-channel array and a set of bottom seismographs were carried out in the rift valley, the Strakhov Transform Fault and in the 2°40'N fault of the Western flanking plateau. The basement rock was dredged at 43 stations where it outcropped in transform faults, the rift valley, horst blocks and the flanking plateaux.

Such a detailed survey has permitted discovery of many previously unknown features of the Equatorial Segment morphostructure. The segmentation of the axial rift was found to consist of the rift valley, separated into segments, and the framing rift crests divided into blocks.

The Segment's flanks were found to have numerous horsts, most of which run parallel to the rift zone structures, while the few remaining, are NW-SE oriented at an angle to the axial rift extensions. Earlier unknown lateral latitudinal faults have also been identified. However, the existence of differences between the axial rift zone and the Segment's flanks has been confirmed. The rift valley segments and framing rift crests are of considerable length (20-30 miles) and have slopes of 20-30°. The mean inclination of the flanking plateaux surface is less than 1°, while horsts found on them do not extend beyond 10-15 miles, and are less than 10 miles in width. In some places, however, such horsts are as steep as 20°. The flanking plateaux are covered by 600-to 1000-metre thick sediment, whereas the amount of sediment in the axial rift zone is negligable and is found only in the relief's pockets. In many cases, the sediment of the plateaux is upthrust on the horsts and, in a number of cases, gently folded on their summits. In some places the sediment surface declines from the axial rift zone towards the segment periphery with a quasi-horizontal surface of the basement.

The segmentation of the flanking plateaux along lateral faults is apparent and is observed both in the basement and the sediment layer depths, and in the stratification of the bottom

sediment-bearing witness to recent vertical movements.

On the whole, the morphostructure of the flanking plateaux gives the impression of basement block dislocation produced by stretching, whereas the horst blocks can be regarded as the remains of the sediment.

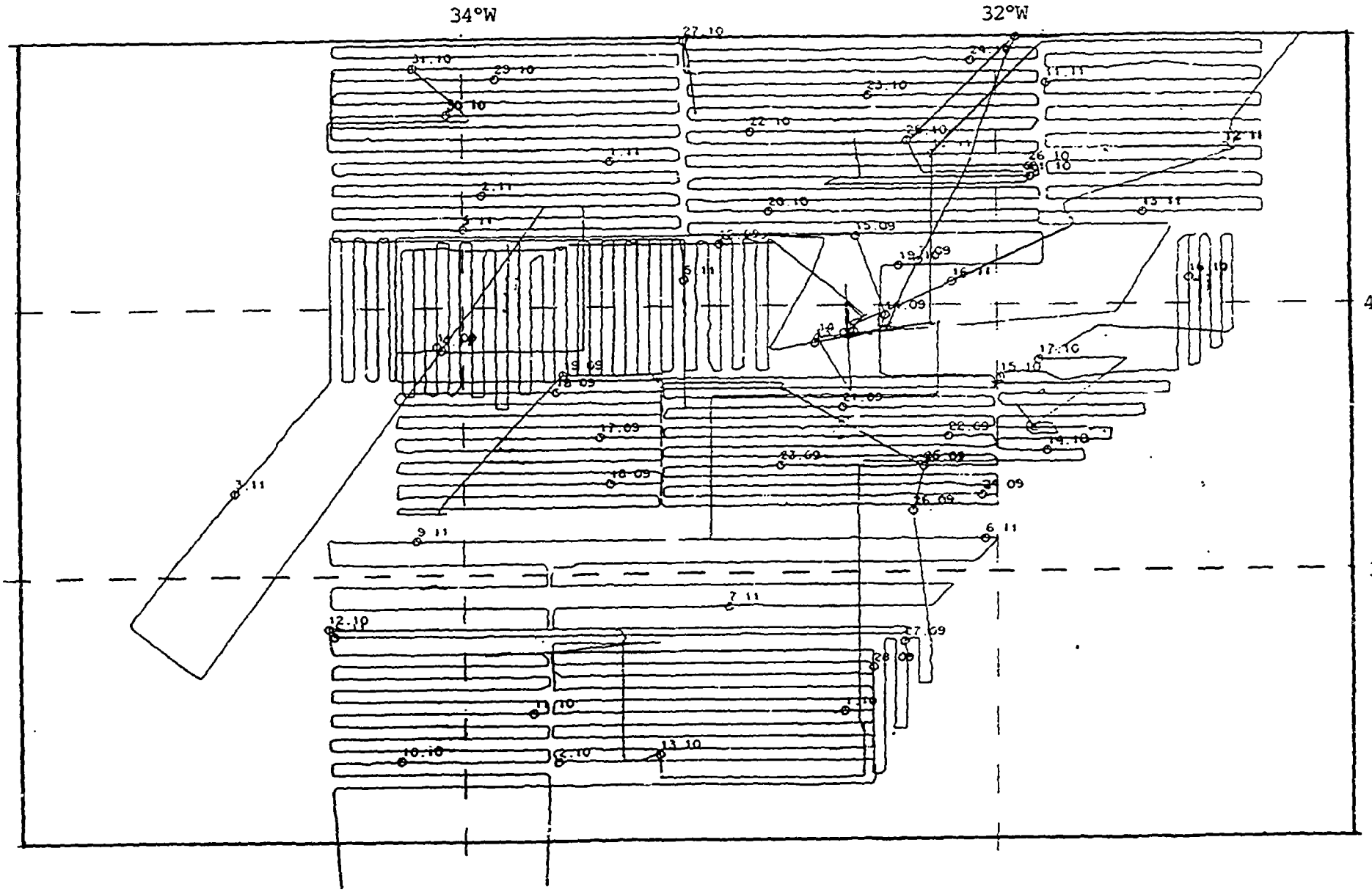
The structure of the lateral faults appear to be different from axial rift structures. All identified faults seem like gaping fractures in the basement, formed as a result of stretching along the axis of the Segment. However, not all of them intersect the structures of the axial zone: only the Strakhov Fracture Zone dissects them and continues from the western on to the eastern flank, while the structures of the axial rift zone along the fault are shifted by some 50 miles. The other faults (at 4°30'N, 2°40'N and 2°20°N) appear to be running blind into the rift mountains. The fault at 4°30'N is practically filled up with sediment. One gets the impression that the faults are of varying age and relate with the structures of the axial rift differently in time and space. The assumption that the lateral faults may be the result of the stretching fractures helps to understand the nature of nodal depths in places where rift valleys intersect transform faults (rift-transform intersection) as a cumulative effect of stretching vectors across the Segment axis (as in a rift valley) and along it (across the transform fault). The nodal depths at the rift-transform intersection in the Strakhov Fracture Zone lie 1,000 metres deeper than the rift valley and the Strakhov Fracture Zone floor.

Among the magmatic basement rocks on the Segment's flanks we have encountered rocks, rarely found in the ocean, that have clearly undergone regional metamorphism (metasomatic gabbro-amphibilites, as well as plagiogranite, quartz sienite, sienito-diorite, anorthosite).

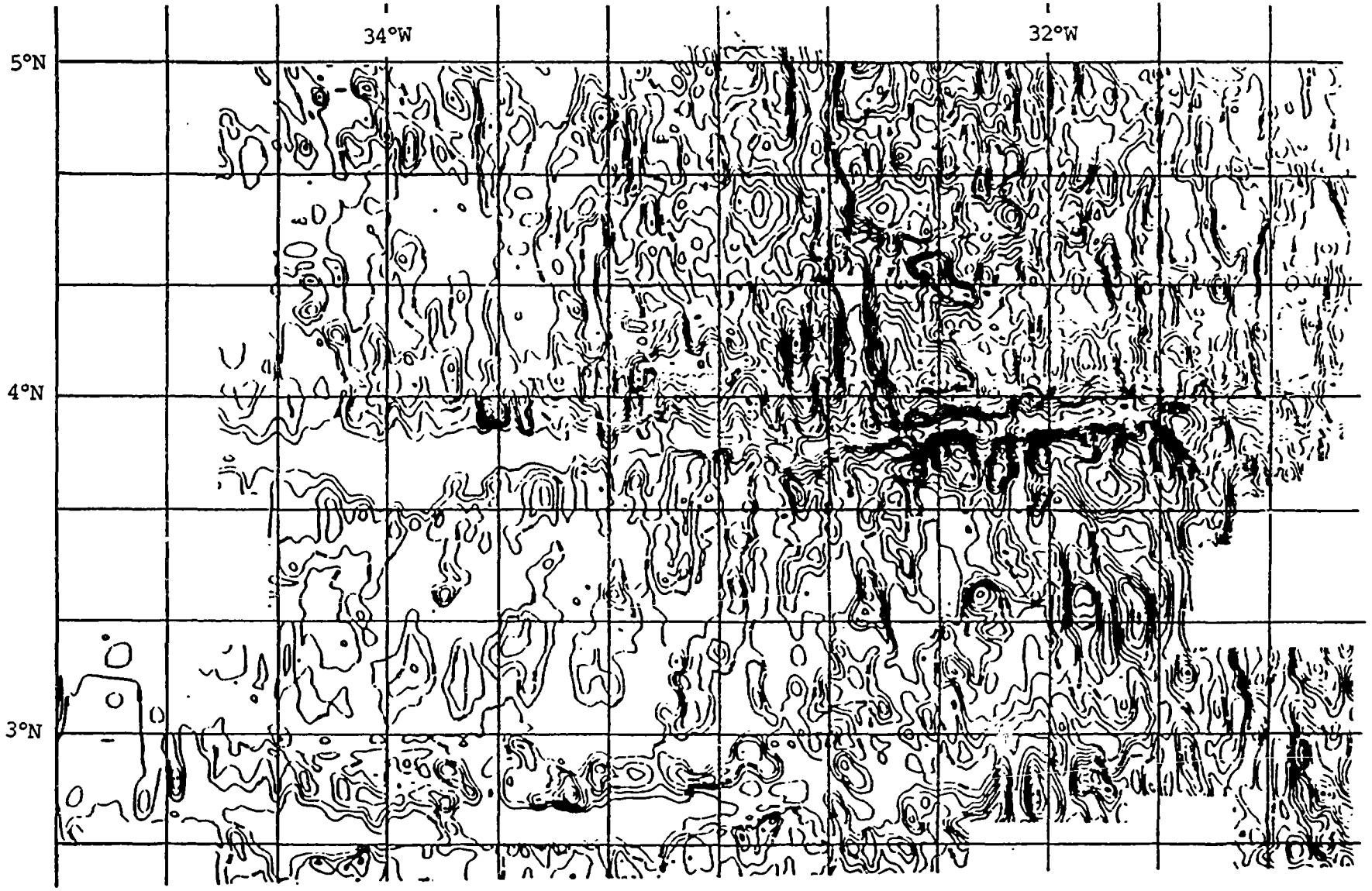
Expedition data will be processed in the USSR Academy of Sciences Institutes - Geological, Physics of the Earth and Lithosphere, in Rostov-na-Donu University and in a number of foreign research establishments: the Institute of Geophysics of the University of Hamburg, Germany, the Institute of Oceanographic Sciences Deacon Laboratory at Wormley, U.K., in the Center for Ocean Mapping Development at the University of Rhode Island, USA, and by the Geological Survey of Israel.

The second sea-going expedition under EQUARIDGE began on 31 January 1991. During the cruise the detailed survey of the Equatorial Segment will be continued. A contract for joint studies of the axial rift zone and the eastern plateau of the Segment in the Sao Paulo Island (St. Paul Rocks) territorial waters has been signed with the Universidade Federal Fluminense of Brazil. Research scientists from Germany, the United Kingdom, Italy and Sweden have been invited to participate. The

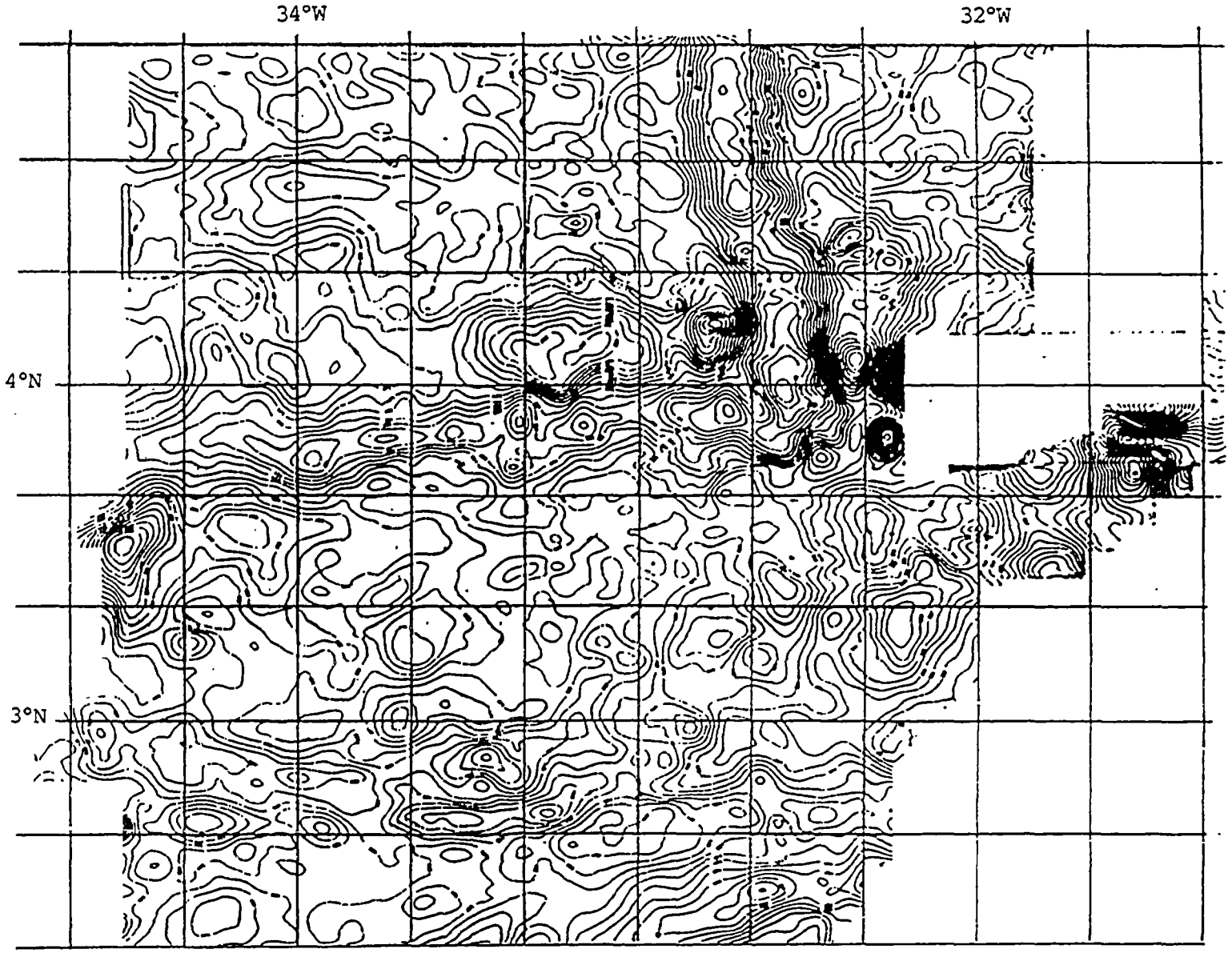
expedition will last 125 days, from January to June 1991. The Oceanographic Committee of the Soviet Union has requested IOC to hold a symposium in 1992 on the findings of the expedition undertaken within the framework of EQUARIDGE and other mid-oceanic ridge research programmes.



«EQUARIDGE» Figure 1. R/V AKADEMIK NIKOLAI STRAKHOV, cruise 11
Diagram of shiptracks for the detailed geological/geophysical survey of the Equatorial segment of the Mid-Atlantic Ridge.



«EQUARIDGE» Figure 2. R/V AKADEMIK NIKOLAI STRAKHOV, cruise 11.
Bathymetry of the Equatorial segment of the Mid-Atlantic Ridge compiled on the results of the detailed multibeam echo-sounding.



«EQUARIDGE» Figure 3, R/V AKADEMIK STRAKHOV Cruise 11.
Bouguer Gravity Map of the Equatorial segment of the Mid-Atlantic Ridge compiled on the results of the detailed survey.