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Caribbean Atlantic Geotraverse, NOAA-IDOE 1971, Report No. 2, Magnetic Data

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BOULDER, COLO.
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CARIBBEAN ATLANTIC GEOTRAVERSE, NOAA-IDOE 1971, REPORT NO. 2, MAGNETIC DATA

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Studies of the Lesser Antilles Island Arc, the adjacent Atlantic Basin, and the Mid-Atlantic Ridge were undertaken in 1971 as part of the NOAA-IDOE-supported Caribbean Atlantic Geotraverse (CAG) project. During these investigations, approximately 30,000 km of bathymetric, magnetic, and gravity data and 1,500 km of seismic reflection data were collected in an area bordered by latitudes 14° and 17°30'N and by longitudes 42° and 62°W.

This report describes the acquisition, processing, and results of the marine magnetic data taken during the CAG project and presents a magnetic total-intensity anomaly map and a series of magnetic anomaly profiles.

Based on the magnetic data collected, the entire Cenozoic magnetic anomaly sequence has been identified east of the Lesser Antilles Island Arc to the Mid-Atlantic Ridge. From this identification, it can be concluded that the evolution of the Mid-Atlantic Ridge in the study area from the Cretaceous to the present was essentially similar to that of the rest of the North Atlantic. Possible structural control is suggested for the northern margin of the Barbados Ridge by an east-west-trending magnetic anomaly band.

INTRODUCTION

In 1971, NOAA received 1-year support from the Office for the International Decade of Ocean Exploration (IDOE) of the National Science Foundation (NSF) for geophysical studies along a 380-km wide strip extending from the Lesser Antilles Island Arc to the Mid-Atlantic Ridge (fig. 1). Studies under this project (the Caribbean Atlantic Geotraverse—CAG) were designed to test the working hypotheses which are generally proposed to explain the evolution of the Atlantic and Caribbean Basins.

Data collection commenced in 1971 aboard the NOAA ship *Researcher*. A system of east-west-oriented tracklines, spaced 38 km apart, formed the basis of the survey in the area bordered by longitudes 42° and 62°W and by latitudes 14° and 17°30'N (fig. 1). Distances between the north-south tielines varied between 200 and 360 km. Four north-south crosslines were extended southward to latitude 10°N to provide reconnaissance information for future studies.

Processed and original data collected during these investigations are available from the National Geophysical and Solar-Terrestrial Data Center (NGSDC) of NOAA in Boulder, Colo. This report in the series describes the instrumentation, acquisition, and processing of the marine total-intensity data and the major results of the magnetic studies. The reduced data are shown in the appendix in the form of stacked total-intensity anomaly profiles. Description of the overall CAG project is given in *Report No. 1* by Peter et al. (1973a).

INSTRUMENTATION AND DATA ACQUISITION

A continuous recording of the earth's total magnetic field intensity was made along the tracklines of the *Researcher*, using a Varian direct-reading proton-precession magnetometer. The sensing head of this instrument was towed approximately 215 m astern of the ship. The polarization rate was set at 6.0 seconds, and the measured field values were recorded on an analog recorder. At 1-minute intervals, the observations were also recorded on a digital magnetic (raw-data) tape. Spurious values were checked onboard and were either deleted or corrected on the tape.

DATA PROCESSING

The first phase of the data processing consisted of the merger of the navigation tape of the ship with the raw-data tape and the development of a processed data tape containing the geophysical data (depth, magnetic, and gravity) and the observation positions at 5-minute intervals. These data were available onboard ship, both in the form of digital printouts and as profiles.

The 5-minute values were adequate to describe the magnetic field in most locations. However, in the laboratory, the analog records were checked again; wherever the tracklines ran near the islands, the additional peaks and troughs of the magnetic field were read, key punched, and added to the processed data tape. The International Geomagnetic Reference Field (IGRF-1965) was computed for each data position, and the total magnetic field anomaly was obtained (Cain et al., 1967). We found the IGRF values too high in the study area; to obtain more representative anomalies, a -230 gamma correction was added to the IGRF values.

ACCURACY

The distance between the tracklines, approximately 38 km, did not warrant correction for diurnal variations. Because of its comparatively small value, the influence of the ship on the sensor was assumed to be negligible. Data accuracy is estimated to be better than ± 25 gammas from repeated observations at trackline crossings.

DATA PRESENTATION

From the final-processed magnetic data tape, listings and profiles were prepared in the laboratory. The listing contains the following columns: (1) index number; (2) Julian Day number; (3) Greenwich Mean Time—GMT (hour, minutes, and 0.1 minute); (4) latitude; (5) longitude (items (4) and (5) in degrees and decimal fractions); (6) nautical miles traveled; (7) kilometers traveled; (8) magnetic anomaly; (9) observed magnetic field; and (10) theoretical magnetic field.

In the Appendix, a presentation of the magnetic anomaly data is shown in the form of stacked profiles. The magnetic total-intensity anomaly data are plotted against latitude or longitude, depending on the heading of the profile. An index number on each profile refers to the trackline chart (fig. 1) where the location of the profiles is indicated. The time interval for each profile is given in table 1.

Table 1. Profile start and stop times for project RP-12-RE-71

Profile Number	Start JD	Start Time	Stop JD	Stop Time
1	261	0800	262	0130
2	262	0405	263	1515
3	263	2330	264	1740
4	264	1835	265	1230
5	265	1420	266	0600
6	266	1010	266	1620
7	266	1625	267	0740
8	267	0745	267	1610
9	267	1615	268	2200
10	268	2205	269	1330
11	269	2125	270	1240
12	270	1245	271	0420
13	271	0425	271	1920
14	271	1925	272	0310
15	272	1315	272	1320
16	272	1325	274	1005
17	274	1010	274	1535
18	274	1540	274	2240
19	274	2245	275	1730
20	275	1835	276	2240
21	276	2245	277	0815
22	277	0820	277	1400
23	277	1405	279	1710
24	279	1725	279	2200
25	279	2205	280	1230
26	280	1505	280	1910
27	280	1915	281	0055
28	286	0100	286	0830
29	286	0905	290	2040
30	290	2300	294	1505
31	294	1717.5	299	0100
32	299	0240	302	0555
33	306	2115	309	2240
34	310	0015	312	1645
35	312	2230	315	1835
36	315	2005	318	1710
37	318	1715	320	1830
38	320	2000	322	1650

An interpretive magnetic total-intensity anomaly contour map is included in this report as figure 2. This map was prepared in two steps. First, a magnetic total-intensity map was prepared, and a regional grid was constructed over it on the basis of these observed data. This procedure allowed the determination of the true regional values, reflecting the actual magnetic field of the earth far better than even the corrected IGRF. Second, the differences between the observed and theoretical (regional) values were plotted at each crossing of the observed field and the grid lines, and these values were contoured.

DISCUSSION

Before the magnetic survey of the CAG project was made, it was not known whether a magnetic anomaly-lineation pattern, typical of mid-ocean ridges, exists east of the Lesser Antilles Island Arc. The difficulty in recognizing lineations in the existing data could have resulted from: (1) large distance and angle between tracklines; (2) small anomaly amplitudes; (3) complex fracture patterns; (4) severe topographic influences; or (5) these magnetic lineations could have been absent from the area as the Funnell-Smith (1968) hypothesis predicted. According to this hypothesis, the sea floor east of the Lesser Antilles Island Arc was formed through north-south extension, over which either east-west-oriented magnetic lineations or a completely chaotic magnetic pattern should exist. A careful correlation of the east-west magnetic anomaly profiles of this project revealed that, although the amplitude of the magnetic anomalies is small and their correction on adjacent profiles is difficult, the entire Cenozoic magnetic-lineation sequence is present in the area. The conclusion from this finding is that from the Cretaceous to the present the evolution of the Mid-Atlantic Ridge east of the Lesser Antilles Island Arc was essentially similar to that of the rest of the North Atlantic (Peter et al., 1973b). In terms of plate tectonics (Le Pichon, 1968; Morgan, 1968), the magnetic anomalies support the view that North and South American separated from Africa during this period as a single plate (minor rotations and faulting disregarded).

The identifiable magnetic lineations are located to the east of longitude 54°W. These, with the exception of the immediate area of the crest of the Mid-Atlantic Ridge, are not obvious on the magnetic anomaly map (fig. 2). A trackline system with closer than the 38-km line spacing would be needed to improve on the mapping of the magnetic lineations and on the outline of the magnetic anomalies over the topographic features and offset zones. However, one very strong east-west-trending anomaly discontinuity is outstanding on the magnetic anomaly map along latitude 15°N. Over the crest of the Mid-Atlantic Ridge, this discontinuity is associated with the 15°20'N fault zone (Collette and Rutten, 1972). The large anomalies between longitudes 48° and 51°W are over the Researcher Ridge, and the anomalies extending to longitude 54°W outline the Researcher fracture zone (Peter et al., 1973b). Large anomalies are located also over large topographic elevations at latitude 16°50'N, longitude 53°30'W; but, surprisingly, over the Barracuda Ridge, the only noticeable ridge-related anomalies are over its western and eastern edges.

The magnetic field over the Barbados Ridge is generally quiet. However, there is a group of distinct east-west-trending magnetic anomalies over the extreme northern part of the ridge (lat. 15°N). These anomalies are at the direct westward extension of similarly trending anomalies over the Atlantic Basin (discussed above) and together with topographic trends suggest that the northern terminus of the Barbados Ridge is structurally controlled.

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