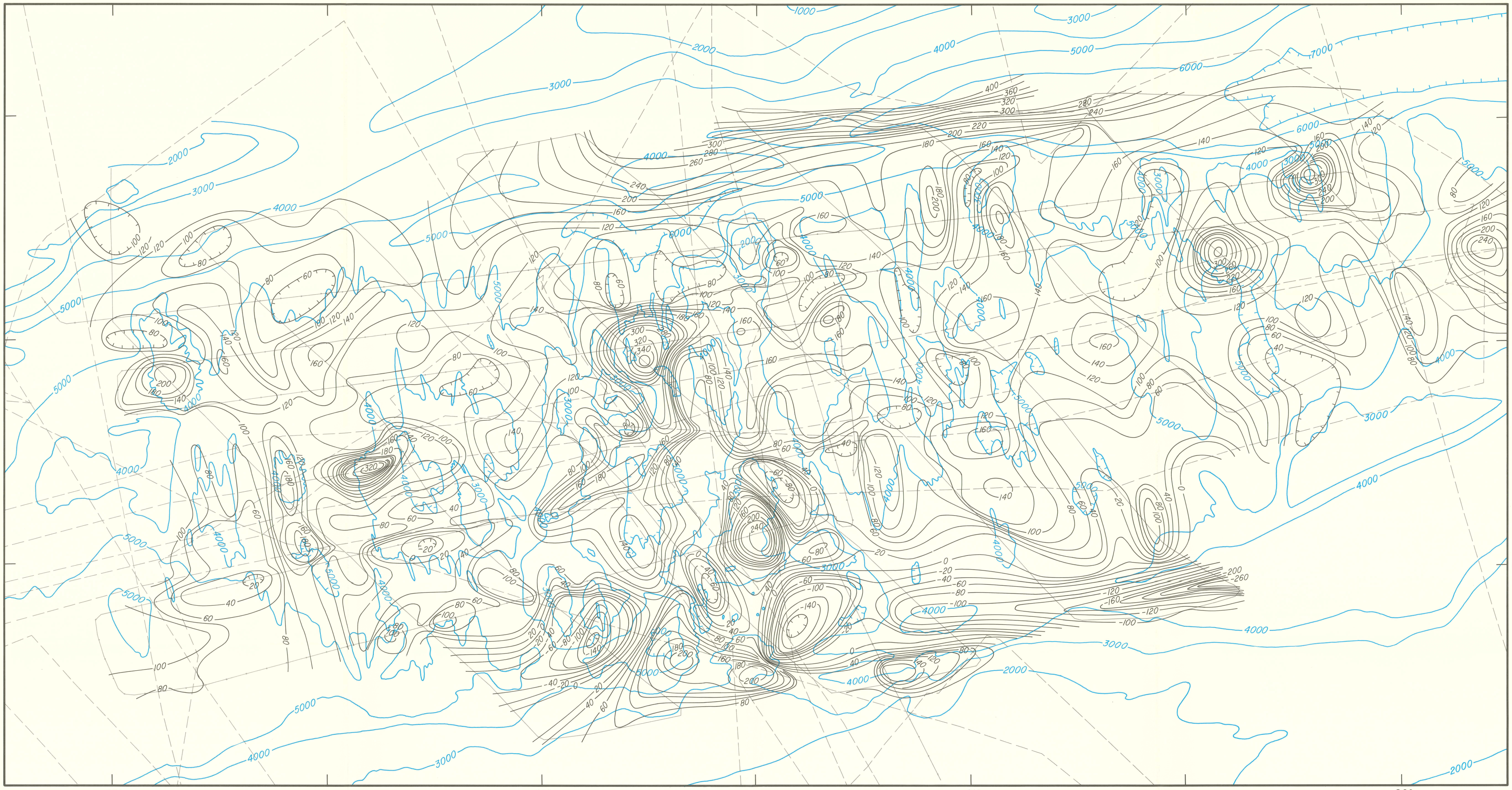


Bathymetry not intended for use in navigation

MERCATOR PROJECTION
SCALE 1:402 000 AT LAT 18°30′ N.

0 10 20 30 40 50 60 70 80 90 100 KILOMETERS

0 10 20 30 40 50 NAUTICAL MILES

Manuscript approved for publication September 16, 1989

## EXPLANATION

Magnetic anomaly contour; interval 20 nanoTeslas (nT). Closed, hachured contour indicates area of lower value

Trackline of RV *Farnella*, 1985, U.S. Geological Survey

Trackline of RV *Farnella*, 1990, U.S. Geological Survey

Trackline of USNS *Wilkes*, 1973, and of other vessels (primarily late 1960's and early 1970's); data were supplied by National Geophysical Data Center

Bathymetric contour, in meters; modified from Jacobs and others (1989). Closed, hachured contour indicates depression

## Introduction

This is the first large-scale published map of magnetic anomalies in the central Cayman Trough area. Two previously published very small scale maps based on much less data are a regional map (Gough and Heirtzler, 1969) and a map compiled from several tracklines running parallel to the axis of the Cayman Trough (MacDonald and Holcombe, 1978).

All magnetic data used for this map were collected as total-field values using proton precession magnetometers towed by surface ships. Solid tracklines on the map represent data collected in 1985 by the U.S. Geological Survey (USGS) aboard the RV *Farnella*, during a GLORIA (*G*eological *LO*ng *R*ange *I*nclined *A*sdic) sidescan-sonar survey of the central Cayman Trough that was navigated by Global Positioning System and transit satellites. Solid tracklines with dots also represent data collected by the USGS aboard the RV *Farnella*, with the same navigation methods, during a 1990 cruise. Dashed tracklines represent locations of data supplied by the National Geophysical Data Center (NGDC), Boulder, Colo. Most of this data set was collected by the U.S. Naval Oceanographic Office in 1973 aboard the USNS *Wilkes*, and these data have been discussed by MacDonald and Holcombe (1978), Rosencrantz and Sclater (1986), and Rosencrantz, Ross, and Sclater (1988). GLORIA sidescan-sonar imaging and its interpretation and a free-air gravity anomaly map of the area are given in Edgar and others (1991) and Dillon and others (in press), respectively.

## Data Processing

Anomaly values were calculated from all measured total-field intensity values by subtracting the Definitive Geomagnetic Reference Field for the appropriate date of acquisition (Alldredge, 1985; International Association of Geomagnetism and Aeronomy [IAGA] Division I, Working Group 1, 1986). Comparison of the anomalies calculated from the 1985 USGS data with those calculated from the older (mainly late 1960's and early 1970's) data supplied by NGDC showed that anomaly values based on the 1985 data were consistently greater than those derived from the older data. To evaluate this factor, we calculated the difference in anomaly value at the 43 locations where a 1985 and an "old" trackline crossed. At 37 of the crossings the mean of the differences between the 1985 and older data is 180 nanoTeslas (nT); this is a very consistent difference, with standard deviation of only 19 nT. The other six trackline intersections showed very large and variable differences that probably are not part of the pattern of consistent offset that exists at most crossings. The consistent offset of 180 nT at the large majority of crossings cannot be due to navigational errors, because such errors would be variable. We attribute the few large discrepancies to navigational errors in the older surveying. Thus we conclude that the 180-nT offsets result from incorrect estimation of the secular variation. Examination of the distribution of discrepancies at the 37 consistent crossings indicates that the difference does not vary spatially (that is, there does not appear to be any relative tilt between the 1985 and older calculated anomaly fields). Therefore, to correct for the difference in anomaly fields between the 1985 and older data, we added 180 nT to all values of the older data before contouring, resulting in generally very good agreement between the two data sets and indicating that positioning is fairly good for both sets. The 1990 set of anomaly values shows good agreement with the 1985 set; the mean difference between these data sets at the 31 locations where tracklines cross is 5.7 nT (standard deviation is 15.9 nT).

## Contours

Data were contoured at an interval of 20 nT. Only the area covered by the GLORIA sidescan-sonar survey was contoured. A preliminary computer-contoured version of the anomaly map was prepared as a guide, using the computer package Interactive Surface Modeling (ISM), developed by Dynamic Graphics, Inc. However, because data are sparse in many areas, the final hand contouring was guided to some extent by the outcrop pattern and by structural lineations of oceanic crust disclosed by the GLORIA mosaic (Edgar and others, 1991). The GLORIA lineations probably are caused by basement structures that would be expected to influence the magnetic anomaly pattern.

## Geologic Interpretation

Magnetic anomaly patterns in the Cayman Trough are complex, although some anomalies can be related to obvious features. For example, some positive/negative anomaly pairs mark bathymetric peaks on the sea floor that probably represent volcanic edifices; examples occur near lat 18°28′ N., long 82°55′ W. (marked by the 4,000-m bathymetric contour), and near lat 18°07′ N., long 81°28′ W. (marked by the 3,000-m bathymetric contour). The steep walls of the trough, formed of outcropping crustal rocks (Dillon and others, 1972; Perfit and Heezen, 1978), are sites of very high magnetic gradients.

The Cayman Trough is formed in a region of passive opening of the oceanic lithosphere at a spreading center (see location map) between the Caribbean plate to the south and the North American plate to the north (Holcombe and others, 1973). The primary boundary between these plates follows the northern side of the Cayman Trough to the east of the spreading center and the southern side of the trough to the west of the spreading center. The plate boundary jogs from the northern to southern sides of the trough along the spreading center. This jog in the plate boundary results in an east-west opening between the plates as the Caribbean plate moves eastward relative to the North American plate (Holcombe and Sharman, 1983; Rosencrantz and Sclater, 1986; Rosencrantz and others, 1988). This region of opening is continually being filled by new oceanic lithosphere formed of material that upwells from the asthenosphere (CAYTROUGH, 1979). The possibility that the southern side of the Cayman Trough to the east of the spreading center might also be an active fault, so that the floor of the trough east of the spreading center would form a separate small plate, was suggested by Rosencrantz and Mann (1991, 1992), but was challenged by Edgar and Dillon (1992).

The result of a simple opening at a jog in a plate boundary, as described above, would be an ocean floor with a simple north-south pattern of structure, which should be reflected in the magnetic anomalies. Offsets created by east-west fracture zones might be expected to disturb this simple pattern. However, the magnetic pattern in the Cayman Trough is significantly more complicated than the idealized model. Some north-south-opening anomalies may be interpreted; for example, a positive anomaly oriented at 347° is present at about long 82°35′ W., between lat 18° and 18°20′ N. Both the northern and southern sides of this anomaly may be interpreted as terminating at fracture zones that are weakly defined by approximately east-west-oriented (077°) anomaly trends. In general, though, the expected simple pattern is not apparent. The complexity probably results from fracturing and intrusion by asthenospheric material at the fractures. These deformations most likely are symptoms of a complicated history of stresses at this plate boundary due to relatively small adjustments of plate motion between the major plates.

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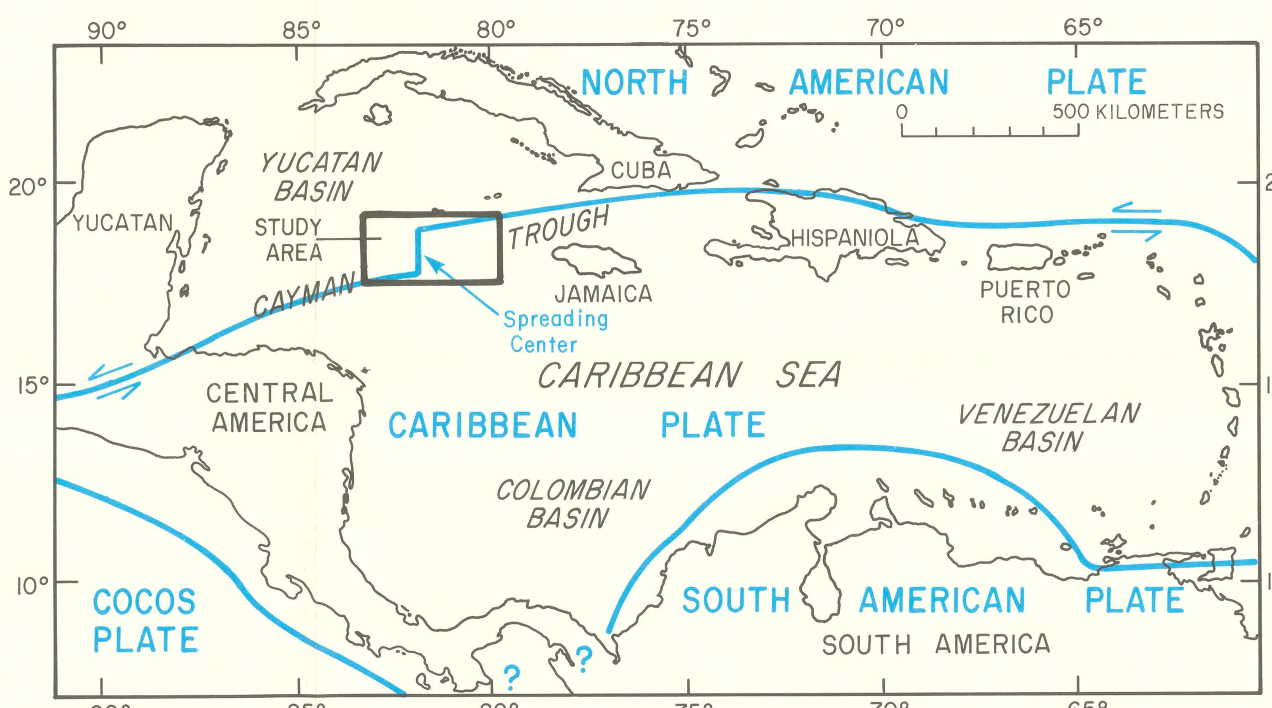


LOCATION MAP SHOWING STUDY AREA AND POSITION OF CARIBBEAN AND NORTH AMERICAN TECTONIC PLATES. PAIRED ARROWS INDICATE DIRECTION OF RELATIVE PLATE MOVEMENT. PLATE BOUNDARIES ARE QUERIED WHERE UNCERTAIN.

# MAGNETIC ANOMALY MAP OF THE CENTRAL CAYMAN TROUGH, NORTHWESTERN CARIBBEAN SEA

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