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A Magnetic and Bathymetric Profile in the Pacific From the Cocos Ridge to Central California

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MIAMI, FLORIDA
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A MAGNETIC AND BATHYMETRIC PROFILE IN THE PACIFIC FROM THE COCOS RIDGE TO CENTRAL CALIFORNIA

Albert J. Semtner[1] and Paul J. Grim[2]

1. INTRODUCTION

In late August and early September of 1969, the U. S. Coast and Geodetic Survey ship OCEANOGRAPHER ran an uninterrupted deep sea trackline in the Pacific Ocean from an area south of Costa Rica to about 39° 30'N off the coast of central California (fig. 1). The distance covered was approximately 3200 n miles. This report presents the magnetic and bathymetric data of this trackline in profile form (fig. 2) and discusses briefly several of the more prominent aspects of the profile.

2. MEASUREMENTS

To position the ship a satellite navigation system was employed. Fixes were obtained at approximately 25 n mile

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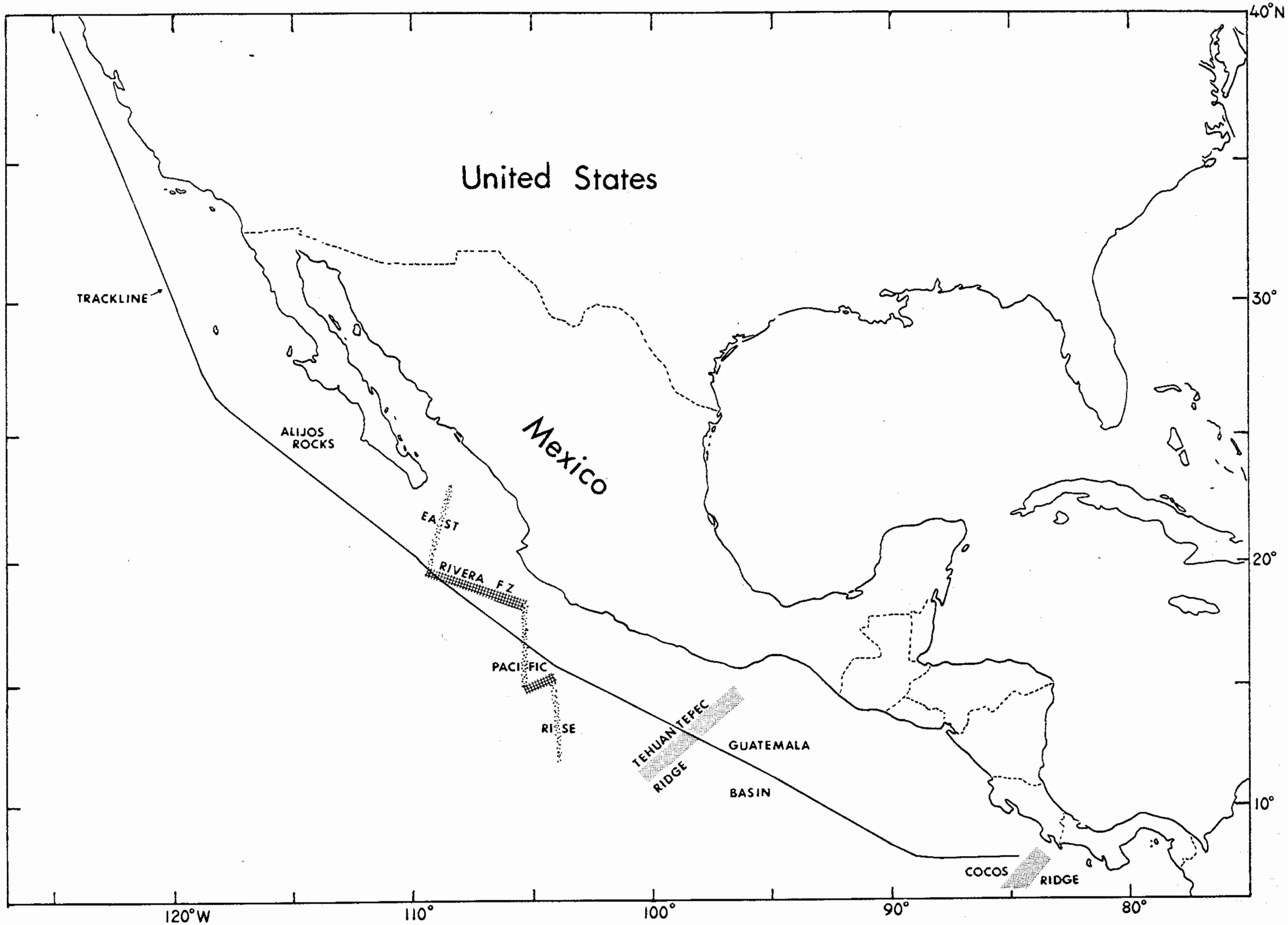
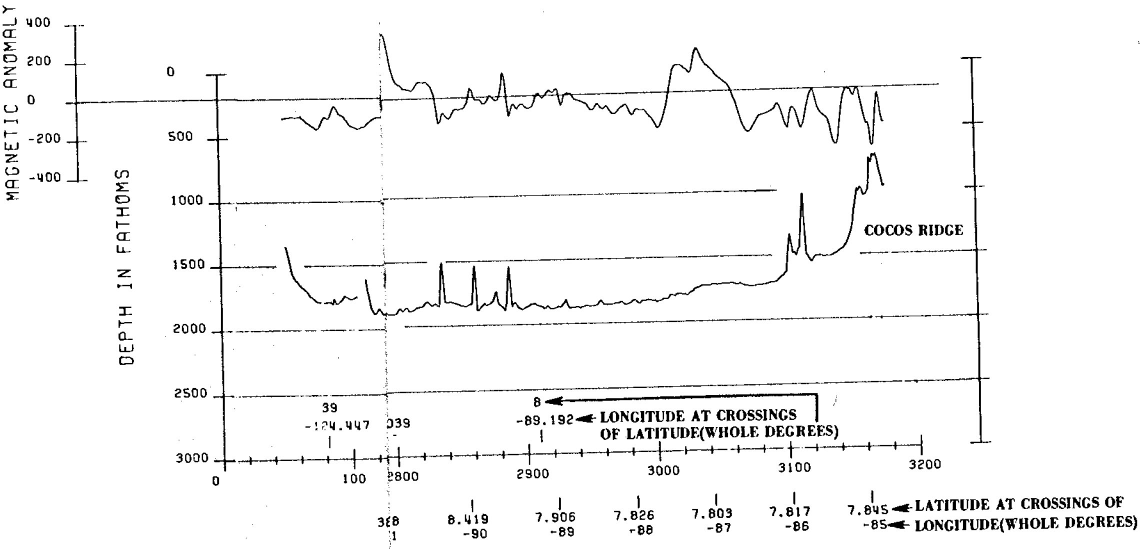


Figure 1. Location of deep sea trackline run by U. S. Coast and Geodetic Survey ship OCEANOGRAPHER. The magnetic and bathymetric profile along this trackline is presented in figure 2.



MAGNETIC ANOMALY
400
200
0
-200
-400
DEPTH IN FATHOMS
0
500
1000
1500
2000
2500
3000
COCOS RIDGE
39
039
8
-89.192 ← LONGITUDE AT CROSSINGS OF LATITUDE(WHOLE DEGREES)
0
100
2800
2900
3000
3100
3200
8.419
-90
7.906
-89
7.826
-88
7.803
-87
7.817
-86
7.845 ← LATITUDE AT CROSSINGS OF
-85 ← LONGITUDE(WHOLE DEGREES)

ERRATA SHEET

The magnetic anomalies referred to in the caption for Figure 2, have been inadvertently omitted. A corrected plate for Figure 2 is given below.

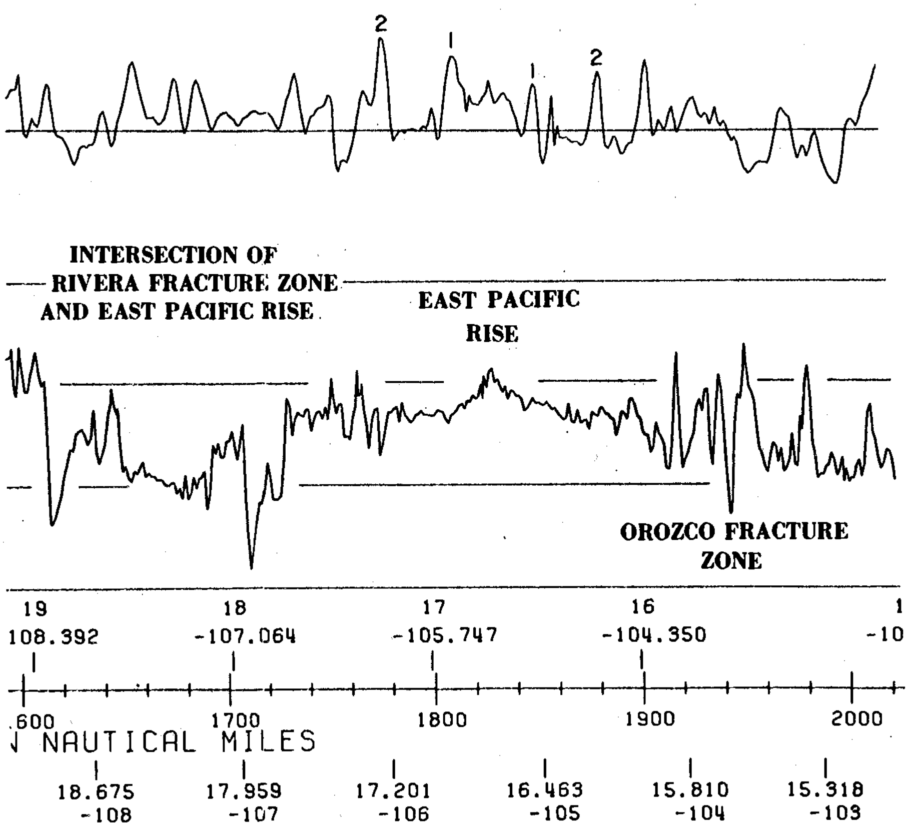


Figure 2. Magnetic and bathymetric profile. Figure 1 gives general location of profile. The trackline can be redrawn accurately on a plotting sheet by using the information (crossings of whole degrees of latitude and longitude) given at the bottom of the profile. See text. The units of the magnetic anomaly profile are gammas; the anomalies over the crest of the East Pacific rise are numbered according to the system of Pitman et al. (1968).

intervals. The estimated average error is less than 0.25 n miles (e.g., see Paulsen, 1966 and Talwani et al., 1966).

Depths were measured in uncorrected fathoms (assumed velocity of sound in water = 800 fathoms per sec) with a narrow beam echo sounder (20 KH_z with a 3° beam width). The earth's total magnetic field was measured in gammas with a proton precession magnetometer streamed 650 ft behind the ship. No corrections were made to the magnetic data for diurnal variations.

3. DATA PROCESSING

Depths and magnetic total field values were automatically recorded on punched tape every 5 min (about every 1.25 n miles) along the trackline. Fathograms were scanned to check the 5-min soundings and to provide additional values at peaks and troughs. A corrector tape containing this information and a position tape of fixes and smooth-plotted positions were prepared. All tapes were simultaneously processed by the ships computer system to obtain a final tape of edited raw data that included a computed position for each data point. New programs and techniques for this type of processing are described by Semtner (1969).

The final computer processing consisted of removing the earth's regional magnetic field from the observed total field to obtain magnetic anomalies. The regional magnetic field was determined by spherical harmonic coefficients and their first and second time derivatives given by Cain *et al.* (1967). Both magnetic and bathymetric profiles were drawn with an automatic plotter.

4. PRESENTATION OF DATA

Depths in uncorrected fathoms and magnetic anomalies in gammas are plotted against distance in n miles (fig. 2). The distance increases from the northwest on the left to the southeast on the right. Vertical exaggeration for the bathymetry is 100:1.

In addition to the distance scale, the geographical coordinates are labeled at points where the ship's trackline crossed whole latitude or longitude degrees. The whole latitude information is written above the distance axis (for example, at about 2407 n miles in fig. 2 the trackline intersected 12°N latitude at longitude 96.675°W). The whole longitude information is written below the distance axis (for example, at about 2055 n miles in fig. 2 the trackline intersected 102°W longitude at latitude 14.779°N). This information allows the ship's trackline to be redrawn on a plotting sheet and should permit any of the larger features shown on the profile to be relocated relatively accurately.

5. DISCUSSION

The general bathymetry is relatively well known along the OCEANOGRAPHER's trackline. The location of all the larger features crossed (those labeled on the profile) is in agreement with recent maps such as the physiographic map of Menard (1964) and the detailed set of contour maps of Chase (1968). Northwest of the Tehuantepec Ridge even most of the smaller features with relief of hundreds of fathoms can be identified on Chase's maps.

The depth profile clearly shows the nature of several of the tectonic and topographic features crossed. The great relief of the fracture zones, such as the Shirley Trough (the eastward extension of the Molokai Fracture Zone), the Orozco Fracture Zone, and the Rivera Fracture Zone are prominent on the profile. The bathymetry along the segment of the East Pacific Rise crossed between the Orozco and Rivera fracture zones appears to be bathymetrically symmetrical for about 60 to 80 n miles on either side of the crest. The Guatamala Basin is seen to deepen gradually away from the Cocos Ridge to its deepest part next to the Tehuantepec Ridge. In this location the Tehuantepec Ridge marks the abrupt boundary of two areas of different regional depth and, in this sense, resembles many of the great fracture zones of the northeastern Pacific (Menard, 1964).

Additional interesting features shown by this profile are the three peaks between 2800 and 2900 n miles. These have about 300 fathoms relief and appear to be equally spaced. (However, this symmetry of spacing and relief may not be real, since it is unlikely that the trackline crossed the summit of each of these peaks). These peaks may be related in some way to a minor fault to the northwest at 2780 n miles. This fault is suggested by a slight regional change in bathymetry and a relatively large magnetic anomaly.

The sea floor close to the Cocos Ridge is relatively smooth and becomes progressively rougher toward the Guatamala Basin. It seems likely that the smoother topography is the result of sediment burial caused by a more abundant supply of sediment from the Cocos Ridge and Central America.

The magnetic anomalies along the southeastern part of the trackline are generally more subdued than those from the northwestern part. There are several regions in the Guatamala Basin and northwest of the Tehuantepec Ridge where the peak to peak amplitudes are less than 200 gammas over distances of 100 to 200 n miles compared to anomalies of up to 800 gammas observed on other parts of the profile.

Sea floor spreading anomalies 1 and 2 (numbered according to the system of Pitman et al., 1968) are identified over the crest of the East Pacific Rise (fig. 2). After correcting for the angle between the ship's trackline and the strike of the rise, a spreading rate of about 3.5 cm/year, to one side, is indicated.

Northwest of the Rivera Fracture Zone it is difficult to number the anomalies according to the scheme of Pitman et al. (1968) because of complications caused by rough topography, the angle of the trackline with the strike of the anomalies, and the fact that the shapes of the anomalies appear to change over distances of tens of miles (e.g., see the profiles given by Chase et al., 1970).

It is interesting to note that a strong magnetic signature is shown in the vicinity of the Alijos Rocks (also noted by Schaefer, 1968) but that the large seamount at 650 n miles along the trackline has little, if any, effect on the magnetic field.

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