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Interpretation of an aeromagnetic anomaly in McMullen and Live Oak Counties, Texas

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Abstract

An anomaly about 300 gammas in amplitude has been observed in data from an aerial magnetic survey flown over parts of Duval, Live Oak, McMullen, and Webb Counties, Tex. A two-and-one-half-dimensional model was used to interpret the data, and the anomaly is apparently caused by a large mafic body centered near $28^{o}10'$N and $98^{o}22'$W, with an area of about 1800 km^2 at a depth of 10 km.

Introduction

In December 1974 an aerial magnetic survey was flown over parts of Duval, Live Oak, McMullen, and Webb Counties, Tex., as part of a gamma-ray project. The contour map of these data shows a large anomaly in Live Oak and McMullen Counties. Computer modeling of a profile across the anomaly suggests a large mafic body at a depth of about 10 km.

Survey description

The contoured data presented here are from a survey flown for the U.S. Geological Survey by Geodata International, Inc., near Freer, in

Duval, Live Oak, McMullen, and Webb Counties, Tex. Figure 1 is an index map of the survey area; the bold lines on the figure indicate the approximate boundaries of the survey. The data were obtained continuously along flight lines spaced at 1.6-km intervals. The flight lines were oriented northwest-southeast at an angle of about 34° west of north. Fifty-two lines, each 40 km long, were flown 120 m above the ground surface. This low altitude was used because the data were obtained simultaneously with gamma-ray data.

The total magnetic field was measured using a proton precession magnetometer towed 30 m below the aircraft. A radar altimeter was used to measure the altitude of the aircraft above the ground surface. The aircraft location was determined from the output of a doppler radar navigation system using a crosscheck provided by 35 mm film showing pictures of the ground below the aircraft. The nominal ground speed of the aircraft was 192 km per hour.

The regional magnetic field, calculated using the spherical harmonic expansion given by Cain (1968), was subtracted from the data; an arbitrary value of 1000 gammas was added to the residual field to ensure that all values were greater than zero. Corrections for diurnal changes in the magnetic field were determined from the data of the magnetic observatory of the U.S. Geological Survey in Dallas, Tex. The validity of using the observatory in Dallas as a measure of the field change in the vicinity of Freer was established by comparing data from the observatory to data obtained using a ground magnetometer operated as a base station in Nueces County, Tex., for a separate survey flown in December 1974.

Discussion of the data

The contour map of the residual magnetic field is shown in figure 2. The dominant feature of the map is the large anomaly, which has a peak-to-valley amplitude of about 300 gammas. Figure 3 shows a profile of the residual magnetic intensity along the line B-B', shown in figure 1, of longitude $98^{o}22'$ from $27^{o}15'$ to $28^{o}45'$. The data shown in figure 3 (shown as black dots) were taken from ERDA (1975) and USGS (1974) and were corrected for the regional gradient using the regional field values of Fabiano and Peddie (1969). The calculated magnetic intensity (shown as a solid curve) was calculated using a two-and-one-half-dimensional model based on the formalism of Shuey and Pasquale (1973). The center of the top of the magnetic body is located at approximately $28^{o}10'$N and $98^{o}22'$W. Using a simple rule given by Peters (1949), the depth to the top of the body was estimated as 10 km, which agrees with the 1967 Basement Map of North America. The 35-km depth to the bottom of the body (which was arbitrarily chosen) is reasonable, because the data of Lee and Uyeda (1965) indicate that the curie temperature will not be reached before a depth on the order of 40 km. The inferred magnetic susceptibility contrast of 1.8×10^{-3} emu may be somewhat high; however, a contrast of this magnitude is consistent with a mafic body in the crystalline basement.

Thus, our interpretation of this anomaly is that it reflects the presence of a large mafic body at basement depth, centered at about $28^{o}10'$N and $98^{o}22'$W, with a surface area of about 1800 km^2. Also, the body probably extends below the top of the basement more to the south

than to the north, because the model required to fit the data has a southern extension. This aspect of the model suggests that the body may be an intrusive in the crystalline basement.

Although the magnetic body has been described as mafic, the magnetic anomaly could be caused by a highly magnetic granitic body. Gravity data could be used to determine whether the body is indeed mafic.

Because this body is clearly localized and, therefore, truly three-dimensional, further work that would include the regional setting as well as three-dimensional modeling with gravity data would have to be done to understand the full significance of this anomaly.

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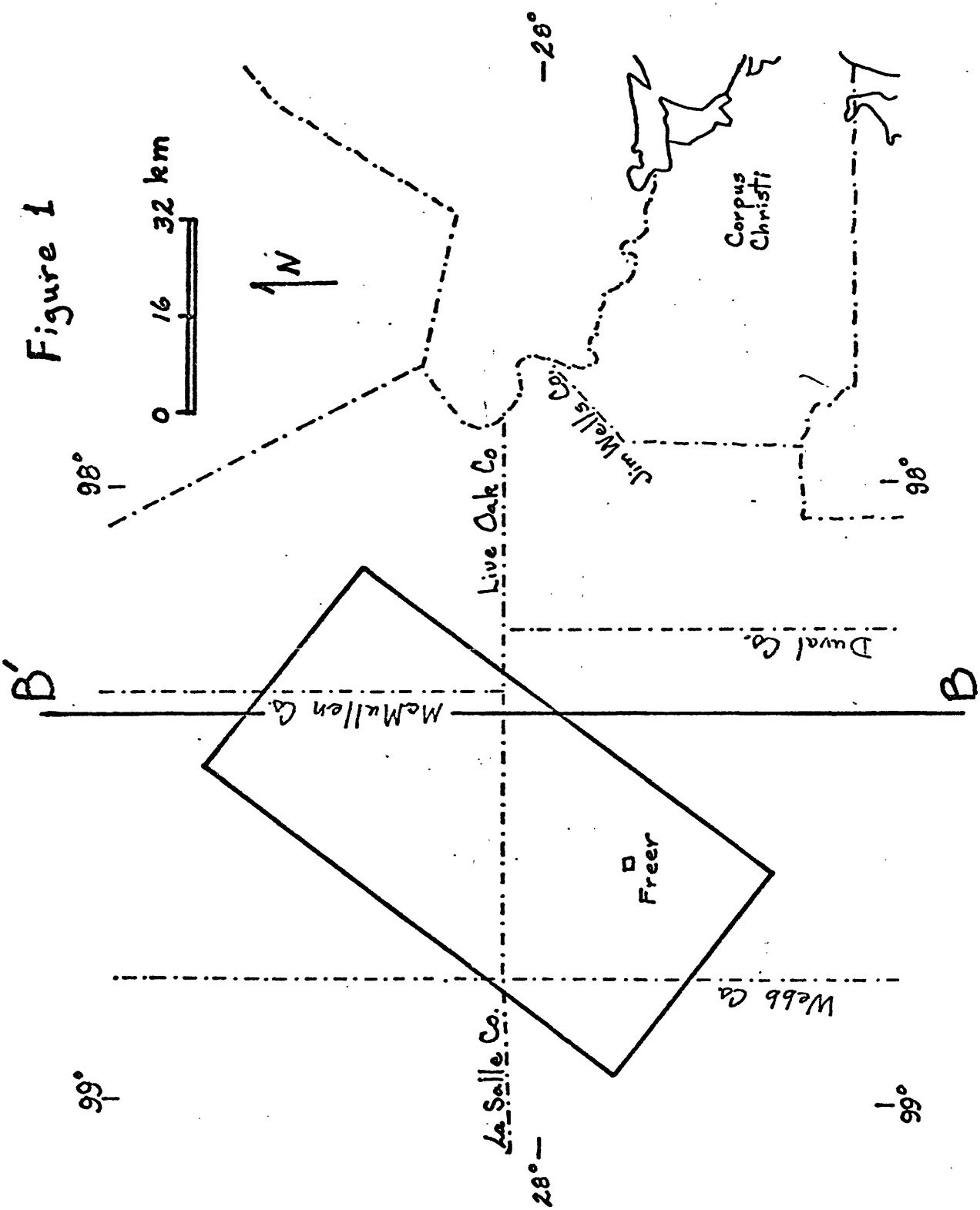

Figure 1.--Index map of the survey area.

Figure 2

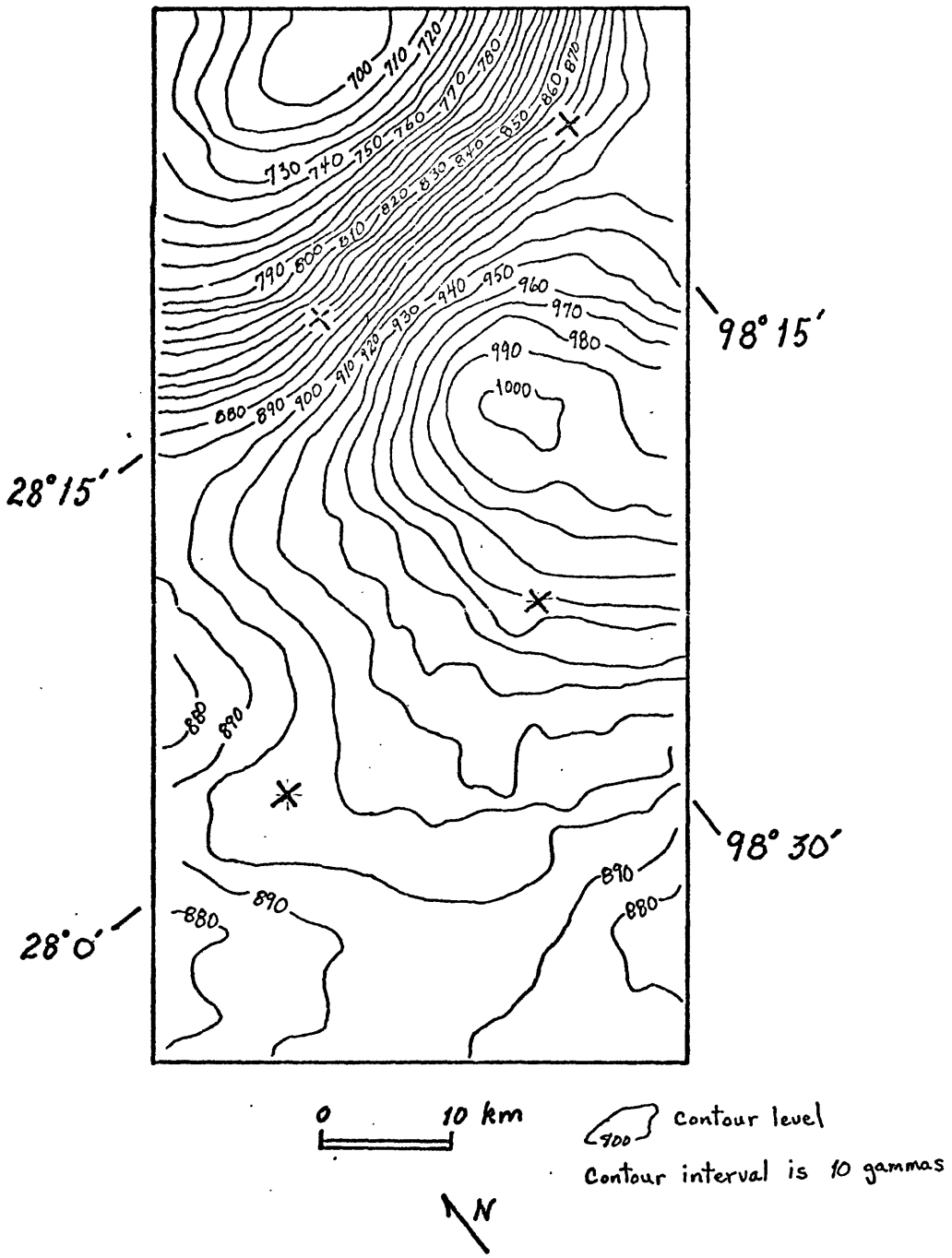

Figure 2.--Contour map of the residual magnetic field.

Figure 3

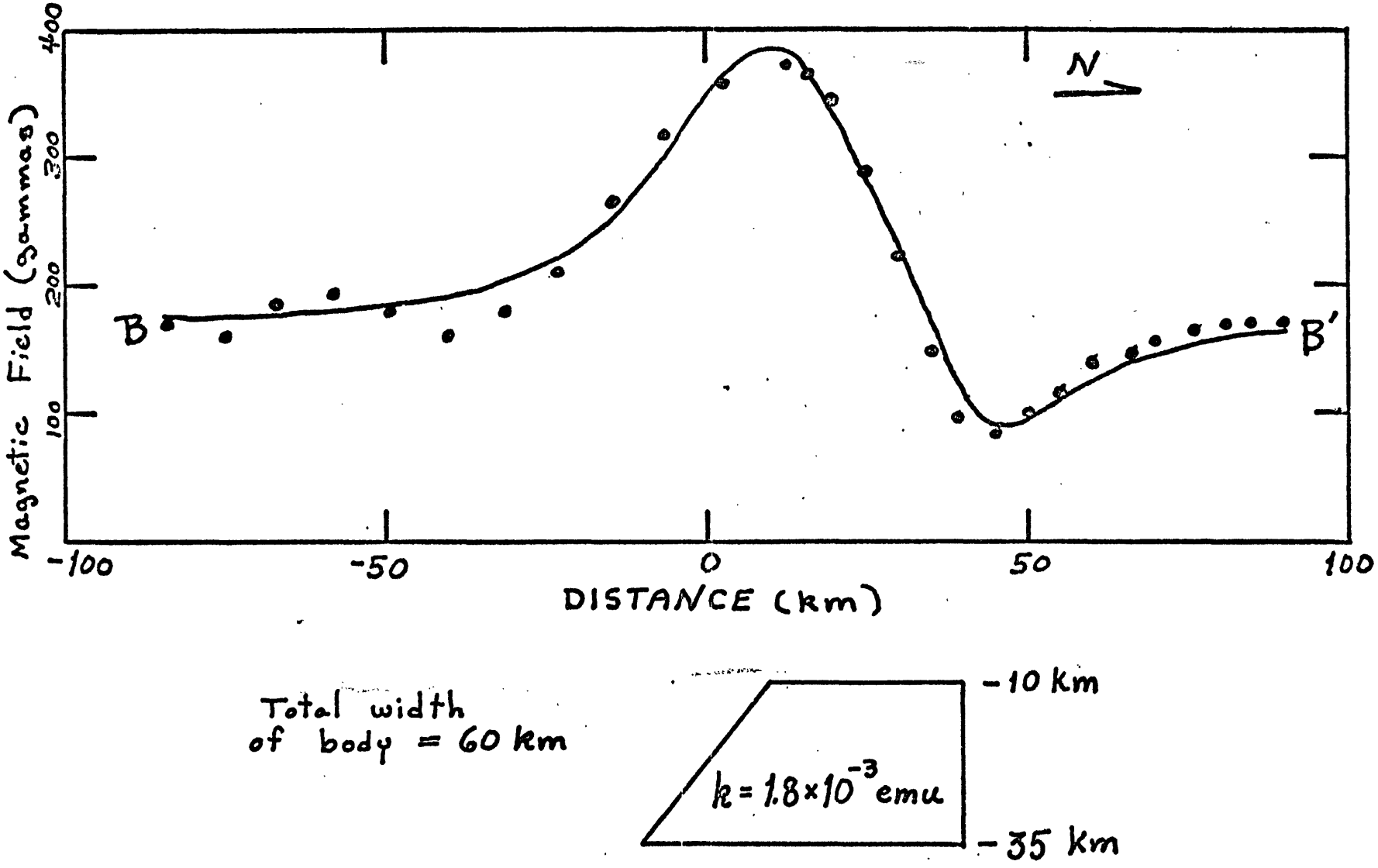

Figure 3.--Calculated magnetic field along the line B-B'.