TECHNICAL REPORT

# A STUDY OF AEROMAGNETIC COMPONENT DATA PLANTAGENET BANK

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## ABSTRACT

Magnetic elements observed with a Vector Airborne Magnetometer, under Loran-C control, are used to calculate the directional components for the anomaly associated with Plantagenet Bank. Also determined are the total intensity, inclination, and declination of the anomalous magnetic field. A theoretical source body is presented as a possible solution to the Plantagenet Bank anomaly.

# FOREWORD

Although many oceanic crustal features are known to have magnetic anomalies associated with them, the description of these anomalies by airborne methods has been limited by a lack of navigational control. Project MAGNET aircraft have now acquired a positioning capability in areas of Loran-C coverage which is commensurate with the accuracy of the Vector Airborne Magnetometer. This report contains the results of the first aeromagnetic component survey using Loran-C for navigational control.

DENYS W. KNOLL
Rear Admiral, U. S. Navy
Commander

CONTENTS

## FIGURES

# I. INTRODUCTION

Using Vector Airborne Magnetometers (Schonstedt and Irons, 1955), extensive aeromagnetic surveys of the magnitude and direction of the earth's magnetic field have been carried out by the Oceanographic Office since 1953. The primary purpose of this work has been to chart the earth's main magnetic field, and as such the surveys have been conducted at relatively high altitudes (6,000 - 20,000 feet), at track spacings of 200 miles, and the reduction of data has been limited to measurements at intervals of 15 - 20 miles along each track line.

Other requirements have necessitated fine grain, low level airborne surveys of specific ocean areas, from which detailed total intensity information has been used to depict the magnetic field. The processing and analysis of detailed vector data over oceanic features have heretofore not been attempted. Using aeromagnetic survey data collected over Plantagenet Bank, this report describes a method for calculating the direction and magnitude of the anomalous field. In addition, a computer technique is applied to estimate the shape, location, and magnetic properties of the source body.

## II. DISCUSSION OF DATA

The test data used for calculating the anomalous field components were provided from an aeromagnetic survey over Plantagenet Bank (Fig. 1) carried out on 7 January 1961. Plantagenet Bank is one of three flat-topped guyots of volcanic origin, on the same platform as Bermuda (Woollard, 1953), and rises from 2400 fathoms to 30 fathoms below sea level (Fig. 2). The survey track spacing was 0.5 mile, and positioning was provided by Loran-C with an estimated accuracy of $\pm$ 1000 feet.

Figures 3, 4, and 5 are contour charts depicting the total intensity (F), inclination (I), and declination (D) of the magnetic field observed at 500 feet above sea level. The survey data were measured within a 4.5-hour period thus minimizing the effects due to temporal variations. The amplitude of the magnetic anomaly in the survey area is approximately 4200 gammas which is in agreement with an overall magnitude of 5000 gammas reported by Keller et al (1954).

The following procedure was used to compute the components of the magnetic anomaly over Plantagenet Bank: F, I, and D data in relatively undisturbed areas near Plantagenet Bank were extrapolated into the survey area. These data were then averaged to approximate the normal field values, ($F_n$ = 51,280 gammas, $I_n$ = 65.0°N, $D_n$ = 13.8°W). A grid overlay with an interval of 0.5 mile was used for scaling F, I, and D values from Figures 3, 4, and 5. For each of 240 grid intersections, north (X), east (Y), and vertical (Z) components were computed. These directional components were then subtracted from their respective components of the normal magnetic field. The residuals represent anomalous X, anomalous Y, and anomalous Z components of the magnetic field (Figs. 6, 7, and 8). The total intensity, inclination, and declination of the anomalous magnetic field are shown on Figures 9, 10, and 11, and were calculated from the anomalous X, Y, and Z components.

Several observations regarding the nature of the magnetic source may be made from an inspection of the anomalous components. Since the anomalous dip and declination represent the orientation of the lines of force referenced to the vertical direction and geographic north, respectively, the point at which the anomalous dip goes to 90° and the anomalous declination contours converge locates the dip pole in the plane of observation. The distortion of the anomalous declination and dip isolines in the northern portion of the survey area can be attributed to a localized secondary source. The direction of the anomalous X axis indicates the horizontal direction of magnetization. This is supported by the agreement between the computed direction of magnetization (339°, see Sec. III) and the orientation of the anomalous X axis (340°).


North (X), East (Y), Vert (Z)

$F_{nx} = 51,280 \times \cos 65° \times \cos 13.8° = 21046.3$

$F_{ny} = 51,280 \times \cos 65° \times \sin(-13.8°) = -5169.5$

$F_{Tx} = F_{nx} + F_{ax} = 21046 + 2100 = 23150\gamma$

$F_{Ty} = F_{ny} + F_{ay} = -5169 + 1000 = -4170\gamma$

$F_H = 23522.6\gamma$ @ $10.2°W$

$F_{nz} = 51,280 \times \sin 65° = 46476\gamma$

$F_{az} = 250$    250

$F_{Tz} =$    46726



$|F| = \sqrt{(46726)^2 + (23523)^2} = 52313\gamma$

## III. ESTIMATES OF SOURCE BODY

Estimates of the probable shape, location, and magnetic properties of the source body were made with a modified computer technique of Vacquier (1962). Given a three dimensional, uniformly magnetized body and the observed anomaly, the program computes a direction and intensity of magnetization. A theoretical anomaly is then determined from the computed magnetization and the source body. The difference between the observed anomaly and the computed anomaly is a measure of the "goodness of fit."

For the Plantagenet feature, the anomalous vertical intensity was used as the input, and two source configurations were tested as possible solutions. The observed topography was discounted as being the source body, due to the localized areal extent of the magnetic anomaly; however, the slope characteristics of the bank were assumed to be a reflection of the source body.

An east-west and north-south cross section through the center of the first model (run no. 1) is illustrated on Figure 12. The depth to the top of the model was based upon depth estimates from Stearn's method (Heiland, 1946), and Peters' method of tangents (1949). The slopes and base were arbitrarily chosen. This model resulted in a poor fit and excessive intensity of magnetization. The second model (run no. 2, Fig. 13) resulted in a better fit with a computed intensity of magnetization of 1200 gammas, and horizontal and vertical directions of $339^{\circ}$ and $85^{\circ}$, respectively. From the results of run no. 2, it is evident that a body located between the model of Figure 13 and the observed topography would yield a closer fit. This is commensurate with the investigations of Officer et al (1952) which indicated that the volcanics beneath the Bermuda Islands are close to the top. Further computations were not made because additional geophysical and geological information is required for a more significant solution.

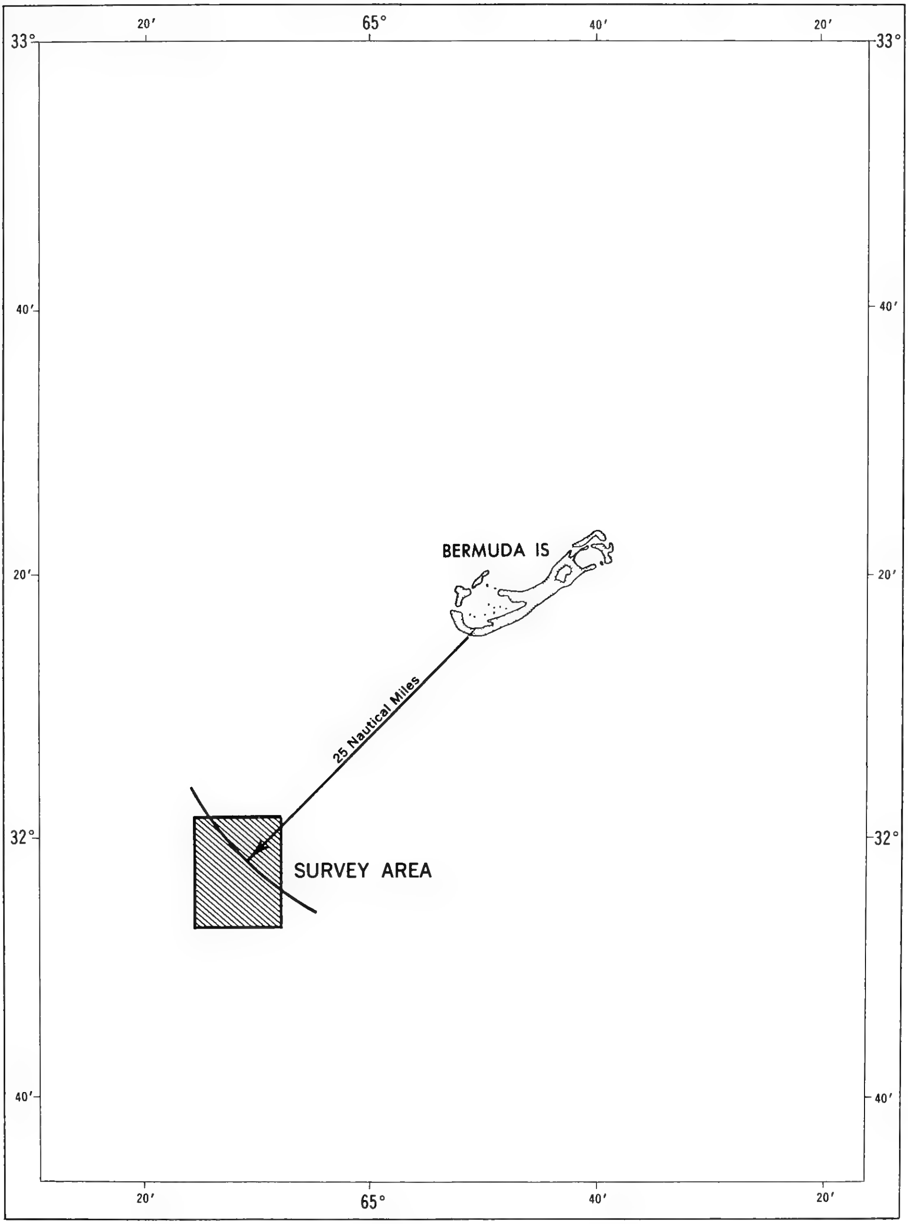
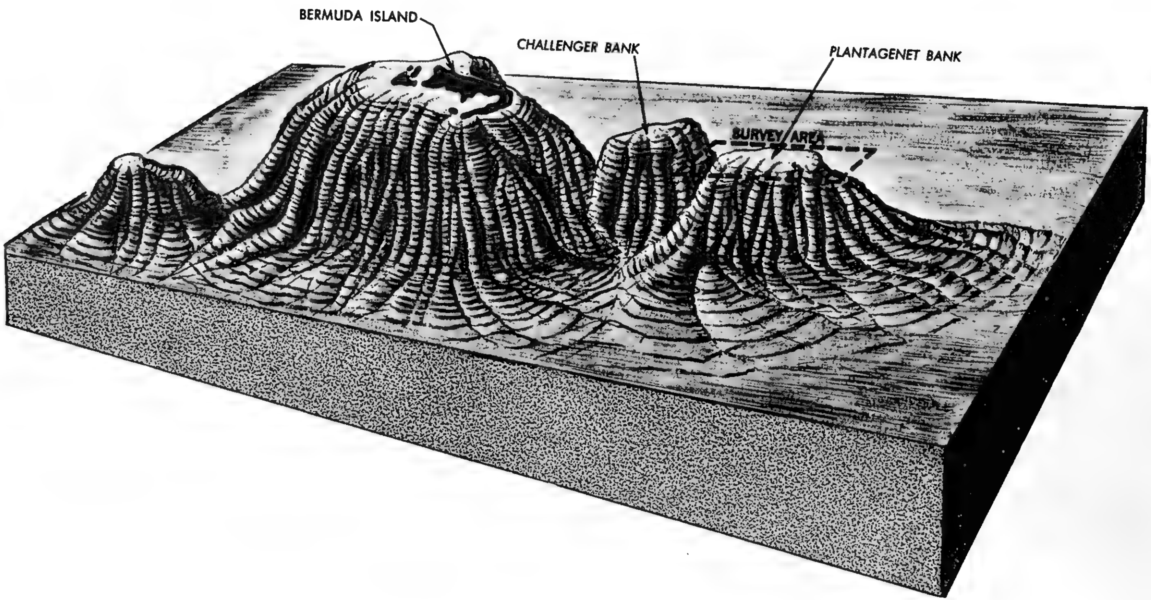


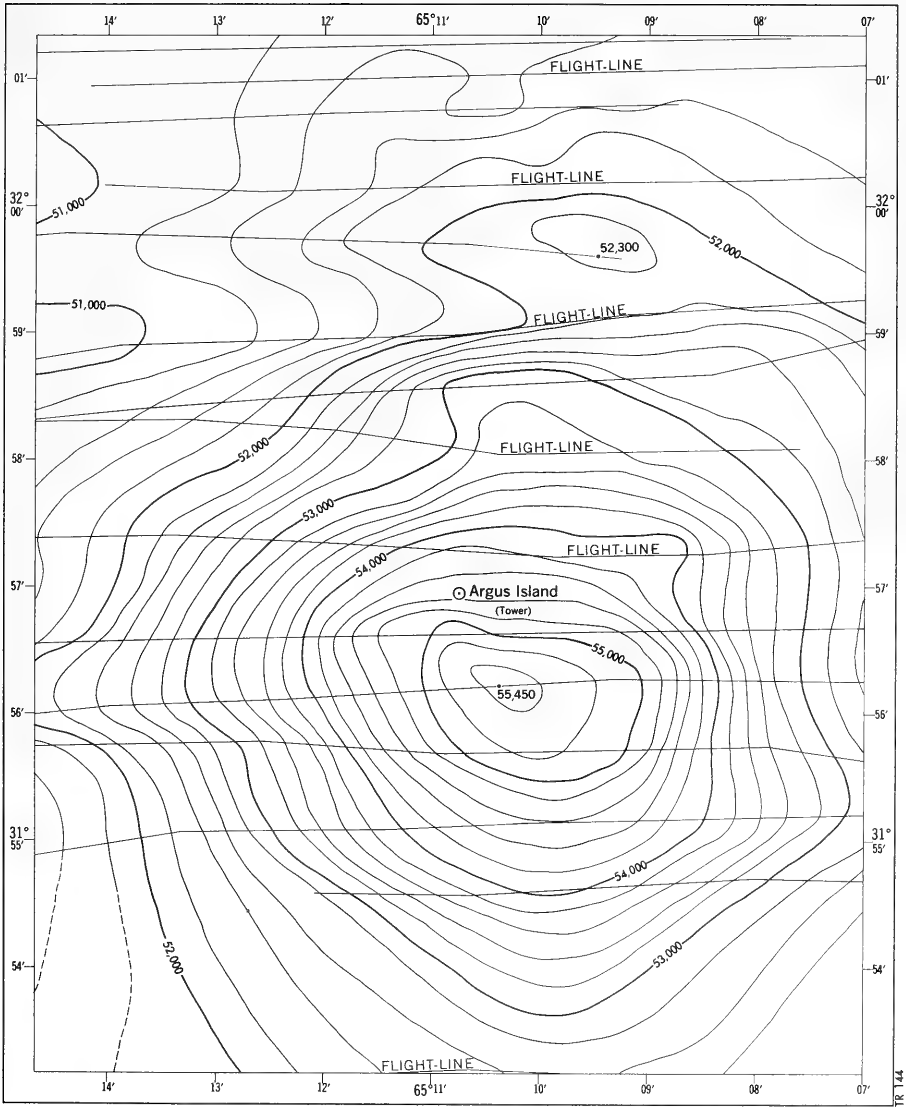

**FIGURE 1—SURVEY AREA**




From the proceedings of the Royal Society, A, Volume 222, p 371, 1954.

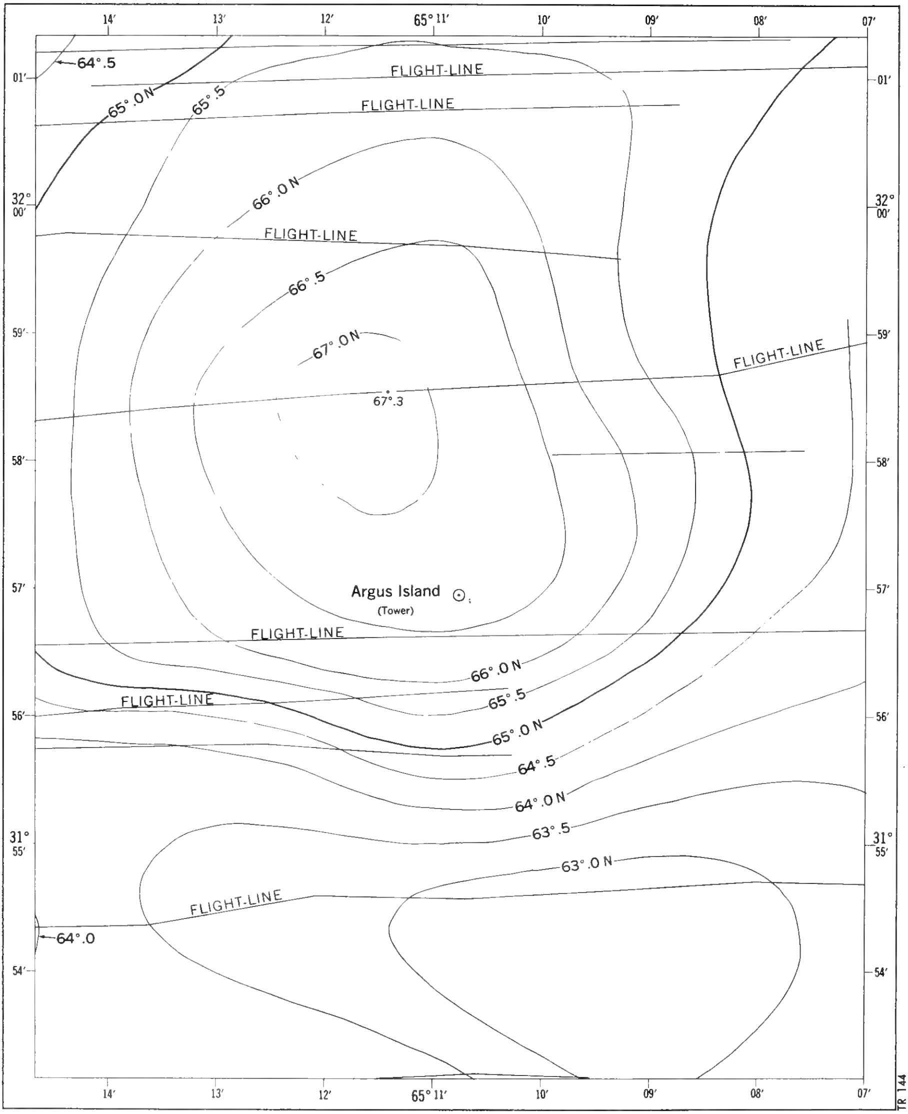
TR 144

FIGURE 2—BERMUDA RISE
(from photography of a model)




Magnetic contours with flight-lines which provided Total Intensity data
Contour Interval 200 Gammas

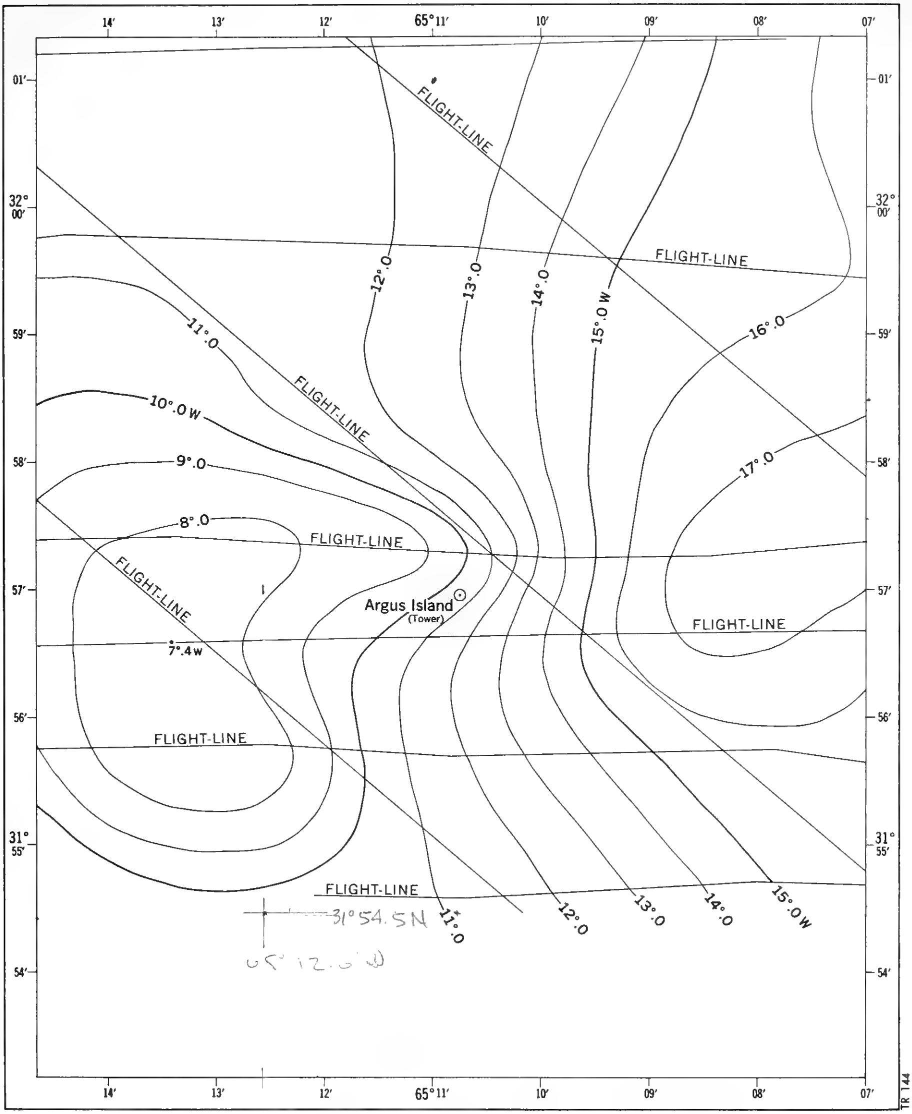
**FIGURE 3—TOTAL INTENSITY (F) CONTOUR CHART—PLANTAGENET BANK**




Magnetic contours with flight-lines which provided Inclination data

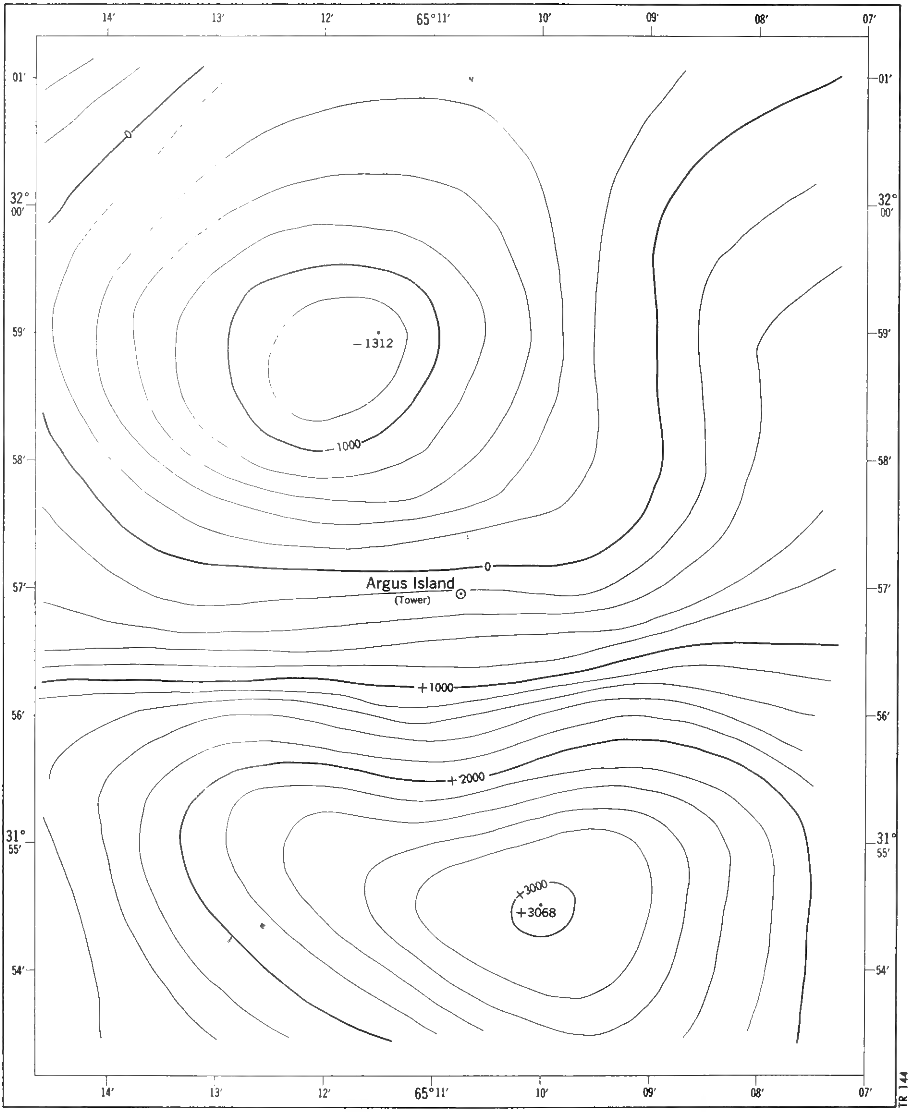
Contour Interval 0.5 Degrees

FIGURE 4—INCLINATION (I) CONTOUR CHART—PLANTAGENET BANK



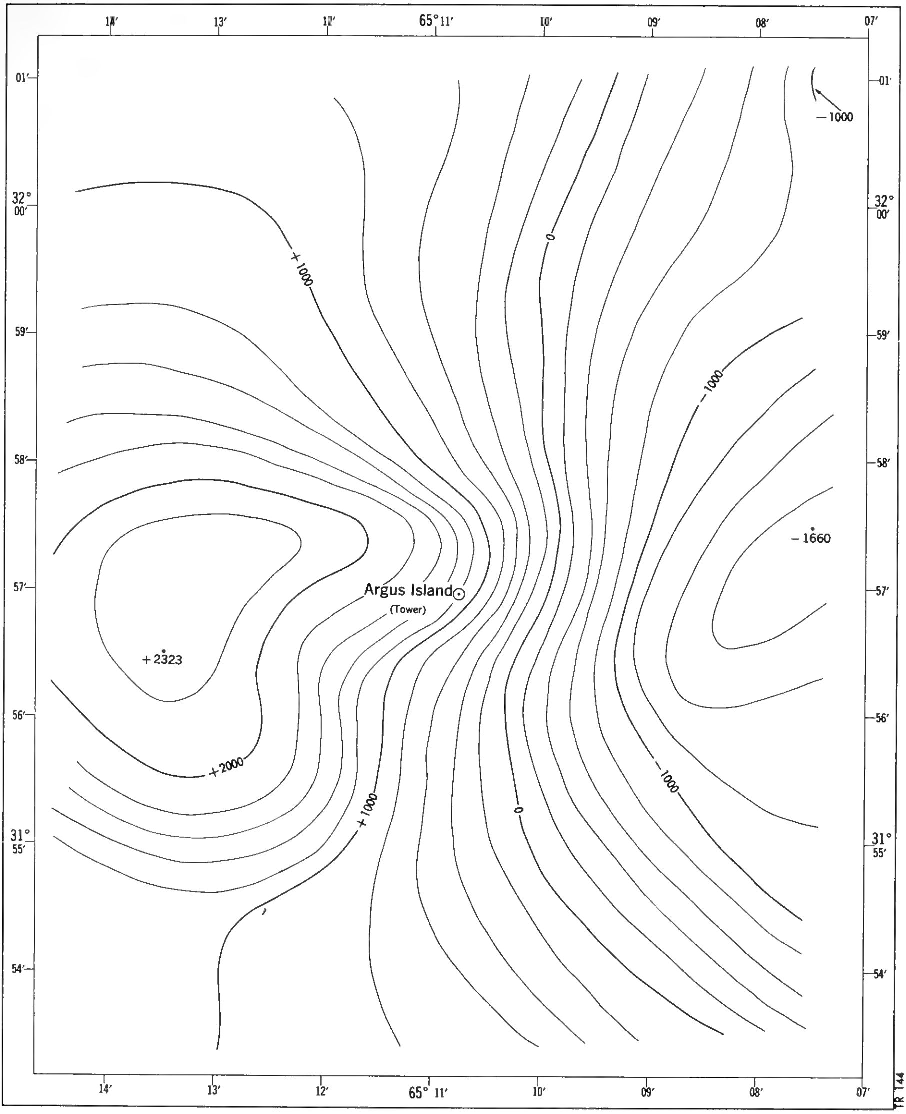

Magnetic contours with flight-lines which provided Declination data
Contour Interval 1 Degree

**FIGURE 5—DECLINATION (D) CONTOUR CHART—PLANTAGENET BANK**



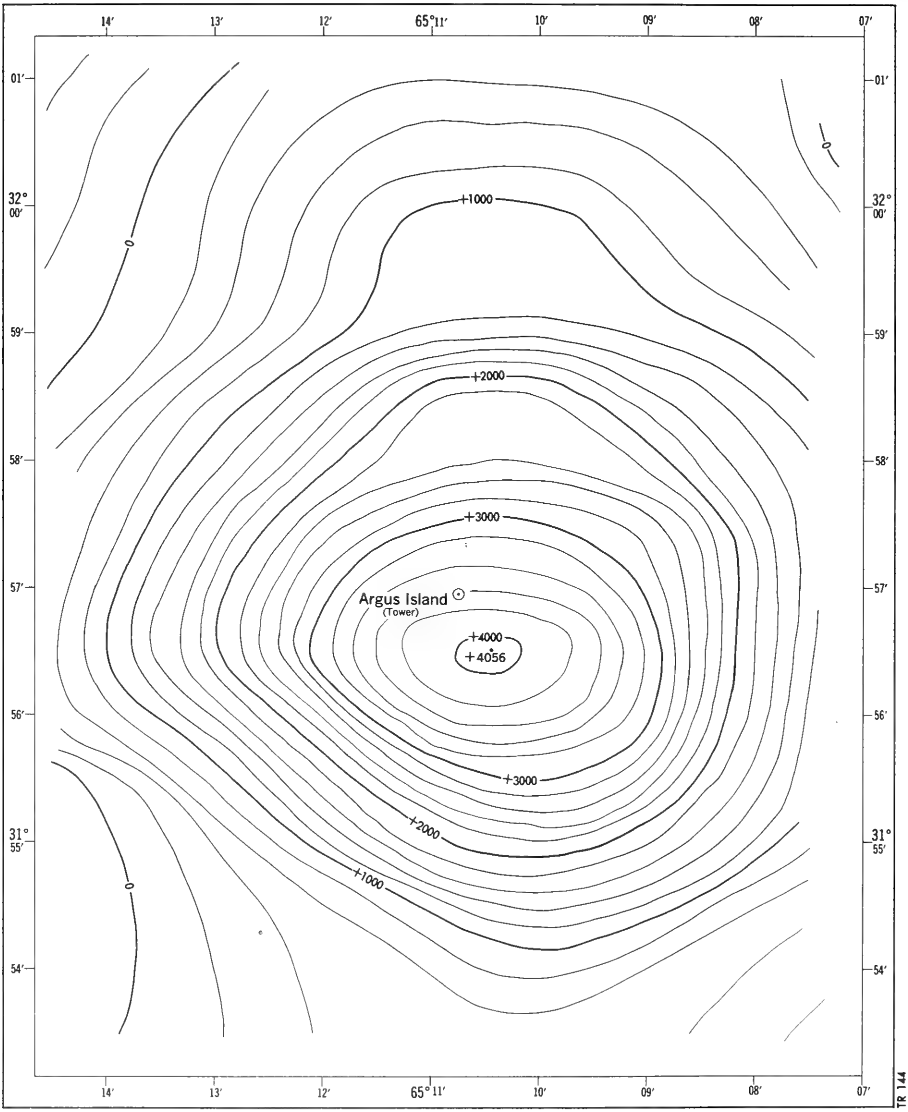

Contour Interval 200 Gammas

FIGURE 6—ANOMALOUS X CONTOUR CHART—PLANTAGENET BANK



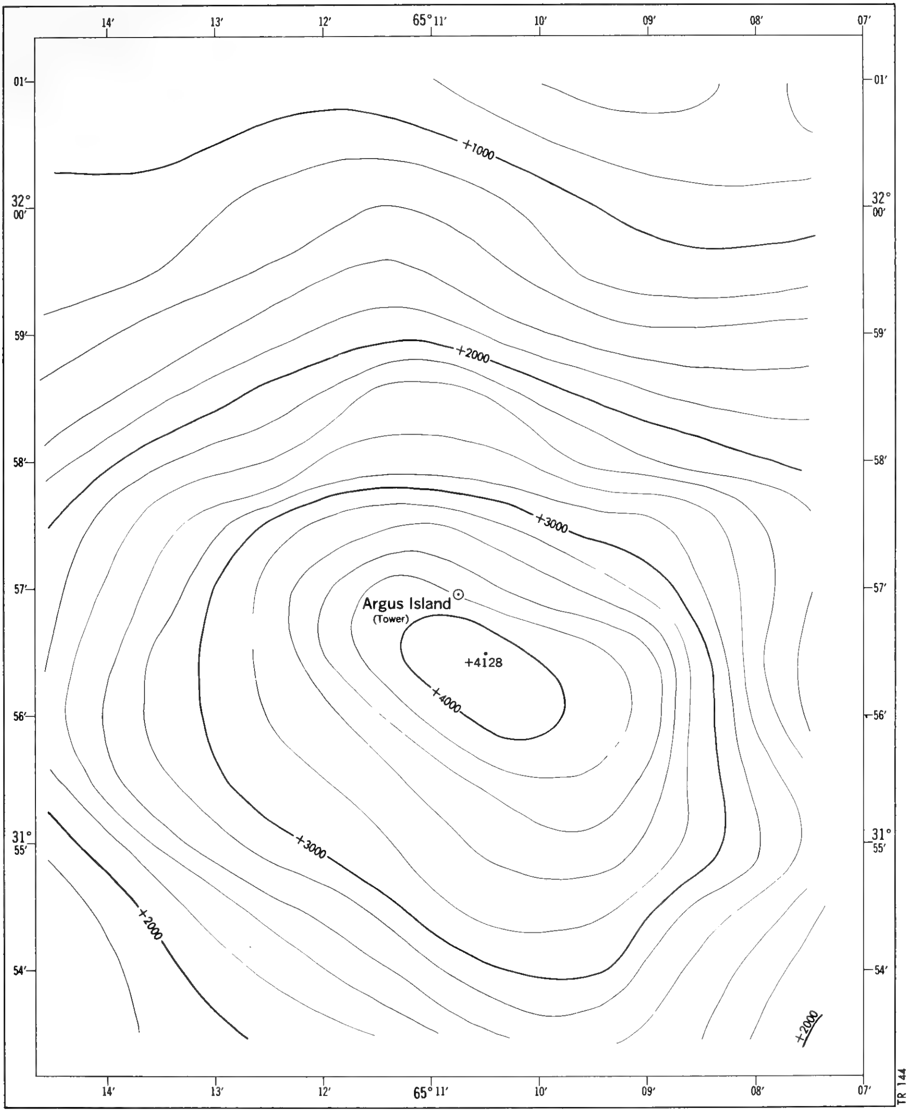

Contour Interval 200 Gammas

FIGURE 7—ANOMALOUS Y CONTOUR CHART—PLANTAGENET BANK



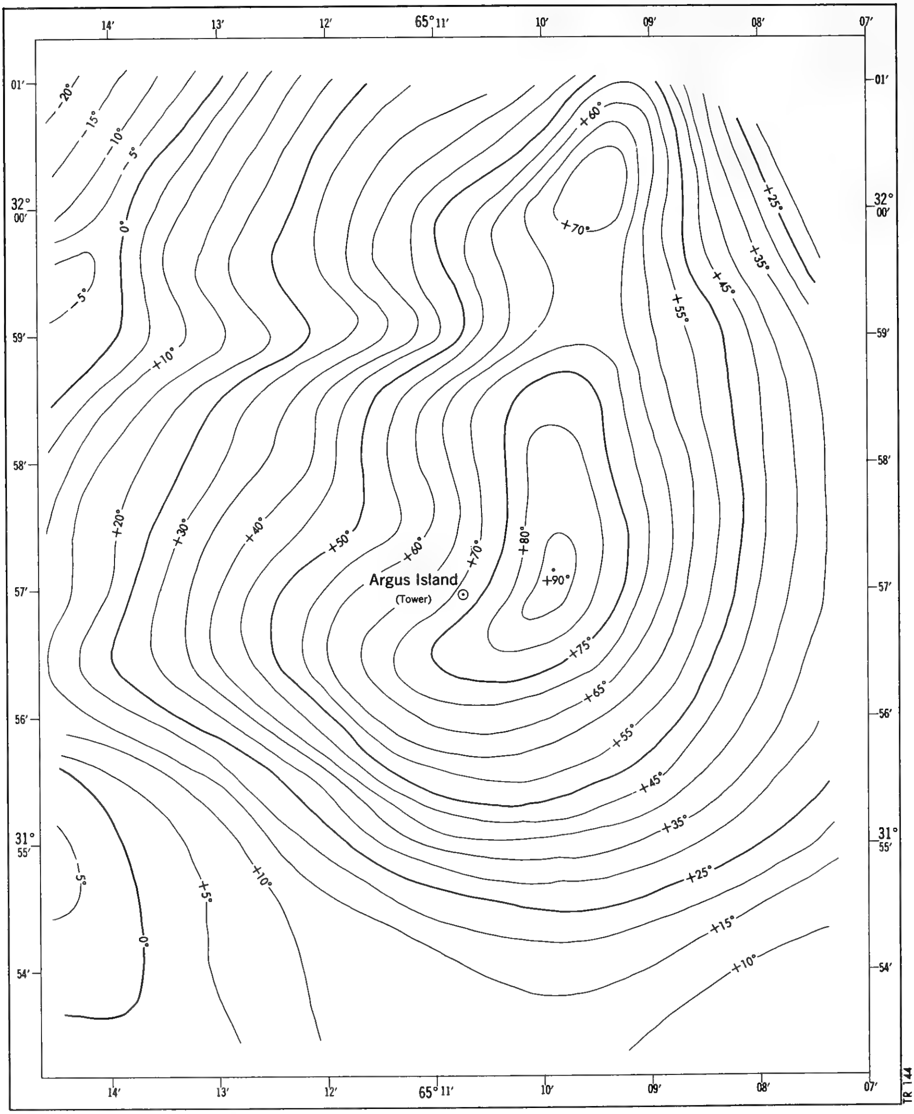

Contour Interval 200 Gammas

FIGURE 8—ANOMALOUS Z CONTOUR CHART—PLANTAGENET BANK



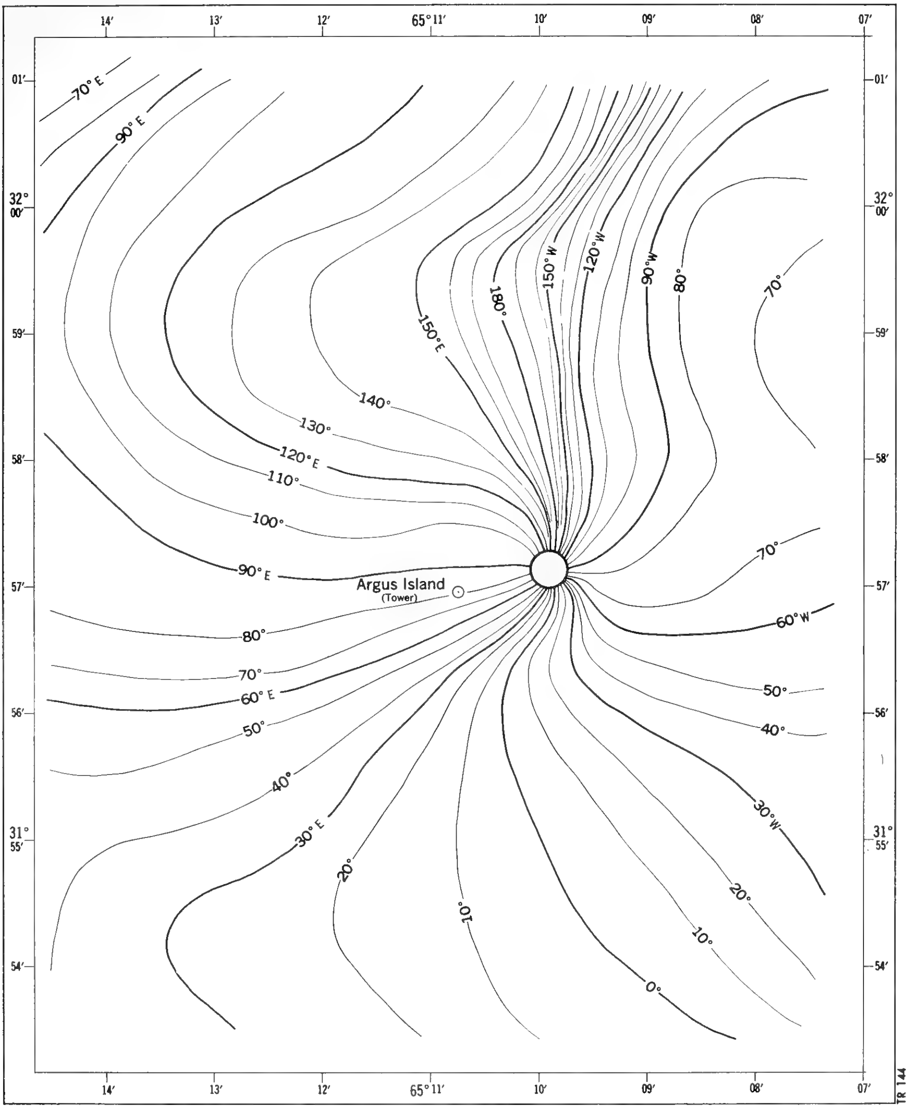

Contour Interval 200 Gammas

FIGURE 9—ANOMALOUS F CONTOUR CHART—PLANTAGENET BANK




Contour Interval 5 Degrees

FIGURE 10—ANOMALOUS I CONTOUR CHART—PLANTAGENET BANK




Contour Interval 10 Degrees

FIGURE 11—ANOMALOUS D CONTOUR CHART—PLANTAGENET BANK

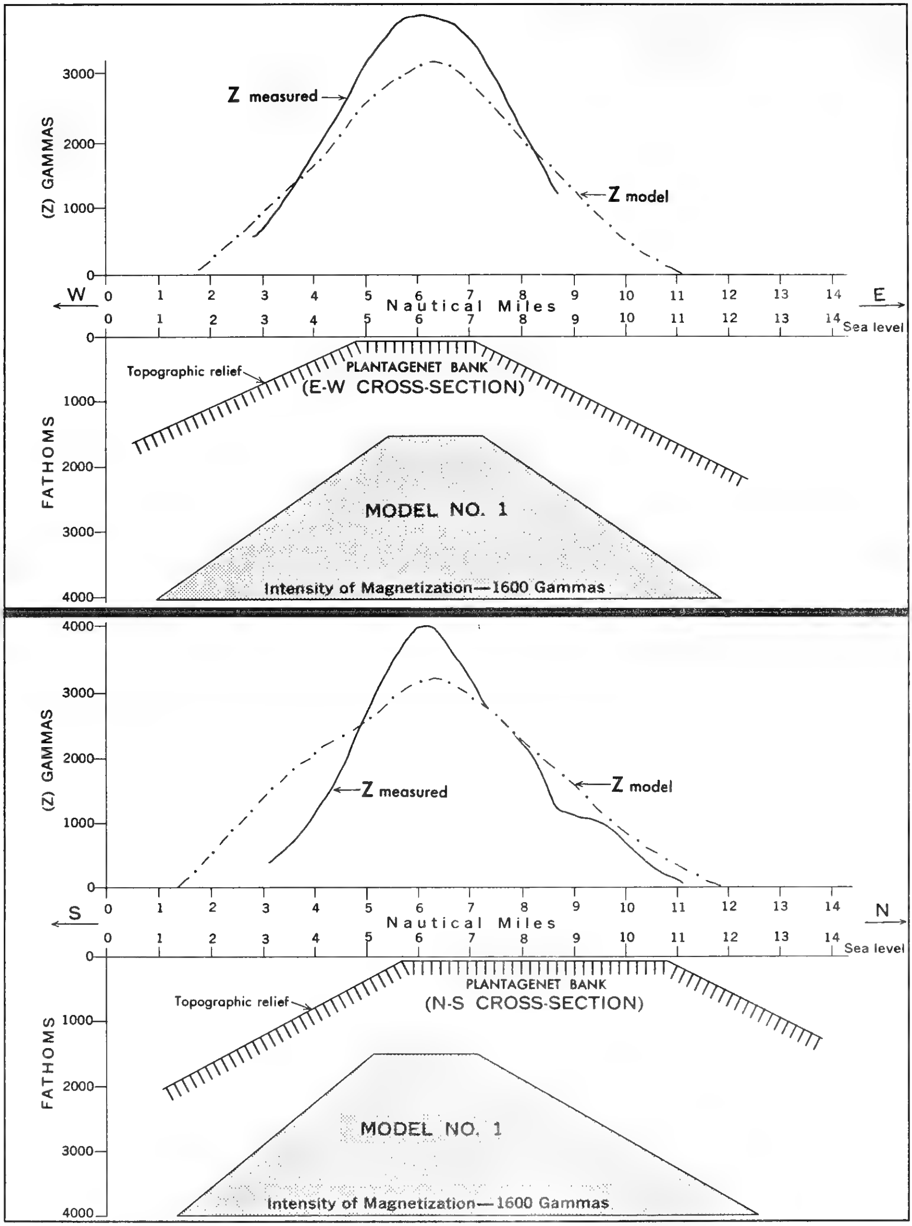



FIGURE 12—MODEL CALCULATION OF SOURCE BODY—RUN NO. 1

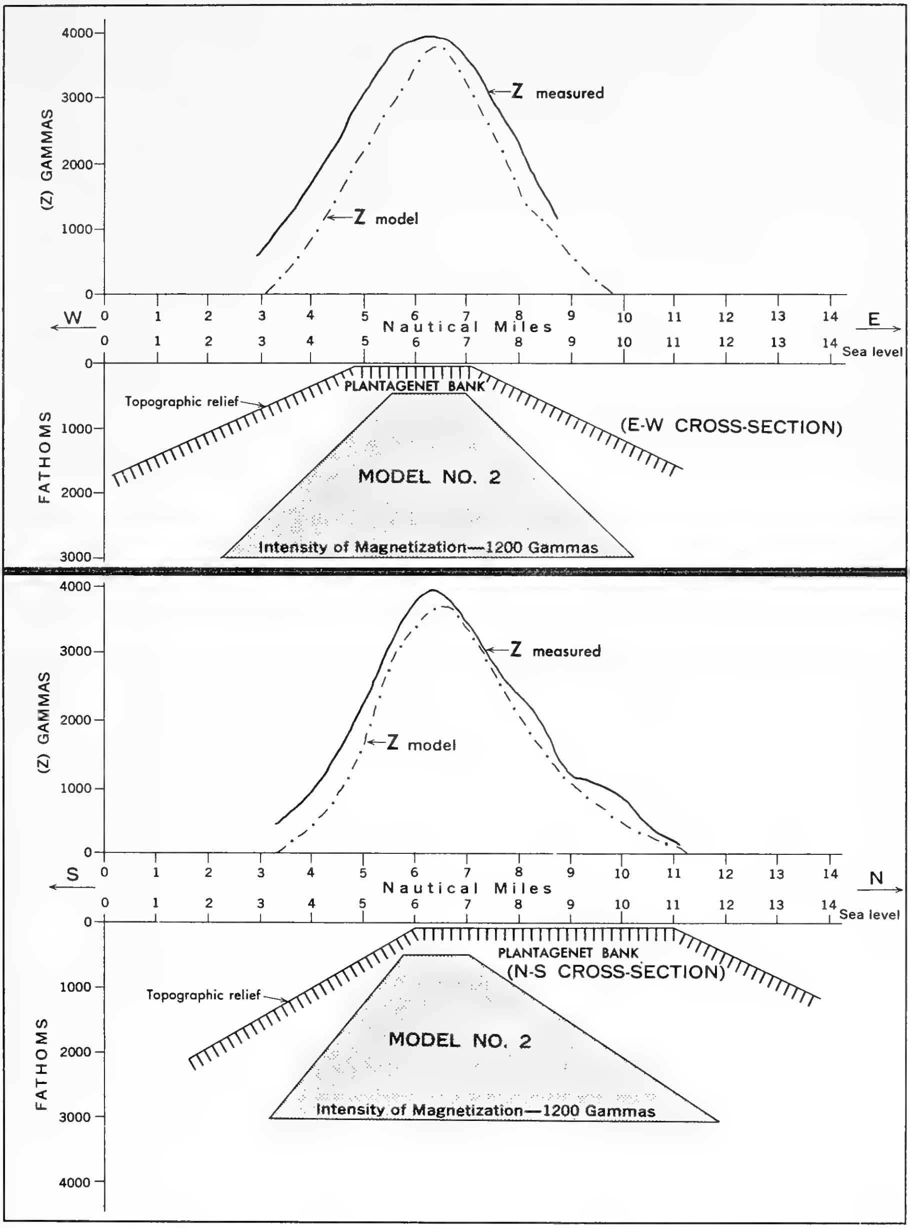



FIGURE 13—MODEL CALCULATION OF SOURCE BODY—RUN NO. 2

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A STUDY OF AEROMAGNETIC COMPONENT DATA - PLANTAGENET BANK, by G. A. Young and A. L. Kontis, 1963. 18 p., including 13 figs. (TR-144)

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