DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOPHYSICAL INVESTIGATIONS
MAP GP–931 (SHEET 2 OF 2)

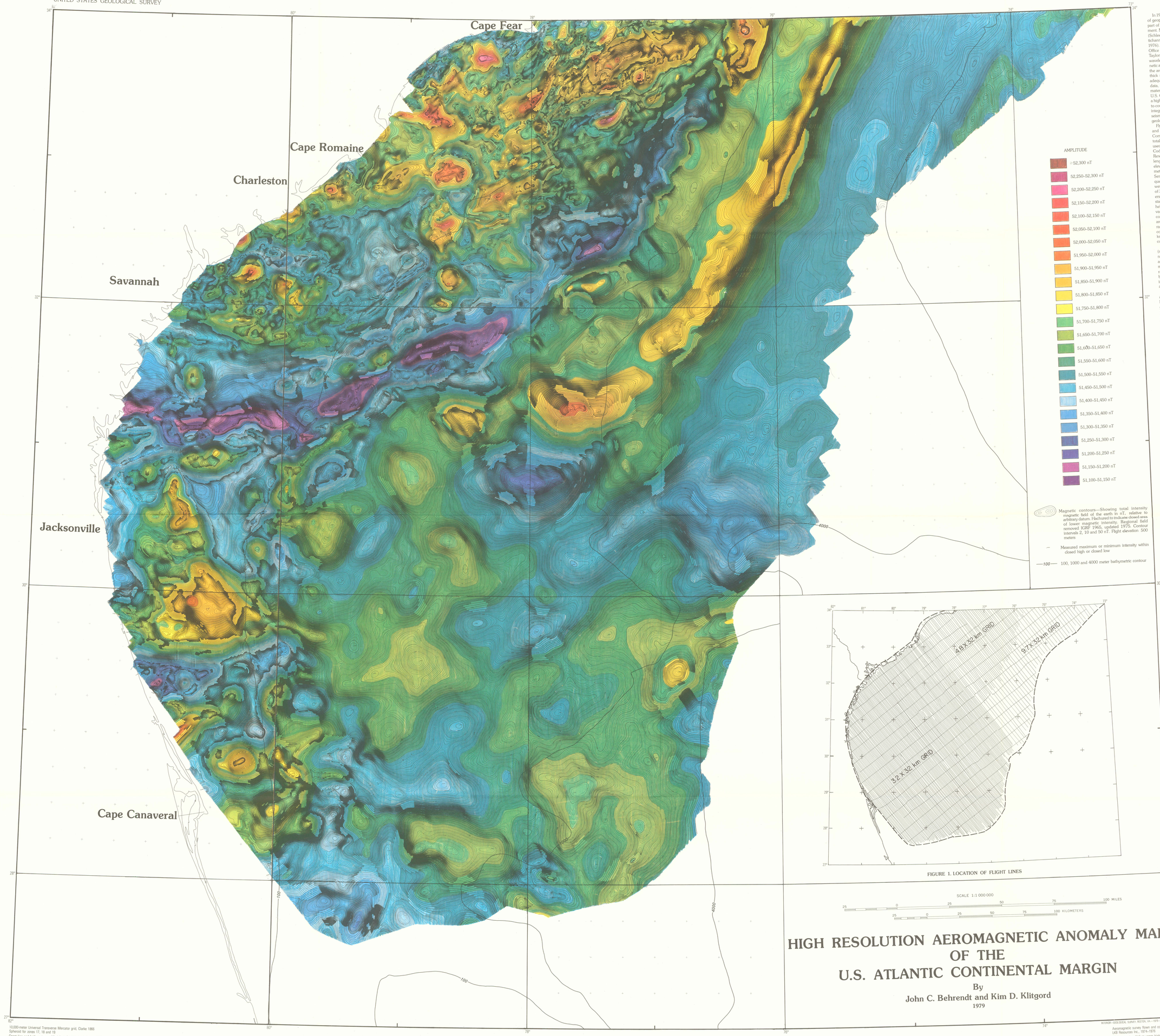

FIGURE 1. LOCATION OF FLIGHT LINES

HIGH RESOLUTION AEROMAGNETIC ANOMALY MAP OF THE U.S. ATLANTIC CONTINENTAL MARGIN

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INTRODUCTION

In 1973 the U.S. Geological Survey began an expanded program of geophysical investigations of the Atlantic Continental Margin as part of its national program of offshore oil and gas resource assessment. Multichannel seismic data collection was undertaken in 1973 (Schlee and others, 1976). Gravity surveys were made along multichannel seismic lines and at closer spacing (Grow and others, 1976). Examination of the 1964-1966 U.S. Naval Oceanographic Office aeromagnetic survey for the Atlantic margin reported by Taylor and others (1968), showed a good resolution of long wavelength, high amplitude anomalies such as the east coast magnetic anomaly. However, for the purposes of the present program, in the areas of the continental shelf and upper slope over an inferred thick section of sedimentary rocks, this work appeared to be inadequate. In particular, the lack of well navigated digital magnetic data, made the wholesale determination of magnetic depth estimates impractical. Therefore, in 1974 a contract was made by the U.S. Geological Survey with LKB Resources, Inc. to fly and compile a high resolution survey, and with International Exploration (INTEX) to compile depth analyses for the entire survey. The objective was to integrate the magnetic data and interpretations with gravity and seismic data to arrive at a unified geologic interpretation of the geologic structure of the U.S. Atlantic continental margin.

Flying of the aeromagnetic survey started on November 3, 1974 and was completed on February 11, 1976. Two aircraft, an Aero Commander (13 months) and DC-3 (11 months) were used for a total for 24 aircraft months. About 2,000 hours of flight time were used in the LKB data collection. A portion of the data east of Cape Cod was collected in 1966 by Aero Service and acquired by LKB Resources and recompiled to the overall map system. The total length of profiles for the entire survey is 185,000 kilometers. Flight elevation determined by radar and barometric altimeters, was 500 meters over the area flown by LKB and 300 meters in the Aero Service area. Navigation was by Loran C and VLF (very low frequency) navigation systems, plus Doppler radar systems. All data were recorded digitally and contouring was done by computer south of 34° N and by hand north of 34° N. High sensitivity magnetometers utilizing optical absorption of energized helium vapor were installed in attached tail cones on both aircraft. A high sensitivity helium vapor magnetometer was also used to monitor the diurnal variation of the magnetic field on the ground. Profiles which were collected during magnetic storms were reflown. Figure 1 shows the area of the survey and the flight line intervals. The track coverage ranged from a 2.5 x 16 km grid to a 5 x 32 km grid between the coastline and the 2,000 m water depth contour, and from a 10 x 32 km grid to a 32 x 64 km grid between 2,000 and 4,000 water depth contours.

The magnetometer had a sensitivity of about ±0.035 nanotesla (nT; 1 nT = 1 gamma). The system operated in the aircraft had a nominal sensitivity of ± 0.1 nT, which was the limit of accuracy approached by the actual data although errors probably were as much as 0.2–0.3 nT where rough air was encountered. This accuracy allows a greater resolution of small features than has hitherto been available in published data. Our detailed study of all of the data indicates that we can correlate and analyze anomalies of a few nT amplitude with confidence.

The compilation of the magnetic data included cross line leveling and regional field removal using a system which enabled each flight line intersection to be evaluated for level, diurnal variations and ground positioning of the identified Loran coordinates used. The regional field was removed from the adjusted total field data using the IGRF 1965 tables (IAGA 1969) updated to mid-1975. A value of 52,000 nT was then added to the magnetic anomalies to adjust the survey to a datum approximating the main Earth field. The magnetic data were compiled by LKB at a scale of 1/250,000 using a contour interval of 2 nT, and 10 or 50 nT intervals where steep gradients required it. The area of the survey having a flight line spacing of 32 km (fig. 1) is actually inferior to the Taylor and others (1968) compilation. Klitgord and Behrendt (1977) used that compilation and other available data to supplement the new data in that area in preparing a 50 nT, 1/1,000,000 scale magnetic contour map of the United States Atlantic continental margin.

Aeromagnetic data are normally displayed and used as profiles and contour maps. Examples of the profiles have been discussed by Klitgord and Behrendt (1979). Contour maps provide a greater insight on an areal basis, their value is usually limited by scale and contour interval. The contour maps of the high sensitivity data discussed here show a greater detail than has been previously available for the U.S. in published data. Comparison of the new high sensitivity aeromagnetic survey with the older survey published with a 100 nT contour interval (Taylor and others, 1968) demonstrates the increased definition of the various magnetic anomalies. Even without using the depth calculation method described by Klitgord and Behrendt (1979), a feel for the relative variations in magnetic basement elevation can be easily obtained by visual inspection of the contours presented here.

Under the terms of the contract for the aeromagnetic survey, data release can be made over a period of several years. The magnetic anomaly contours at 2 and 10 nT intervals for eight 2° × 2° maps have already been published at 1/250,000 scale (U.S. Geological Survey, 1976a through 1976h) covering the area of the continental shelf from Cape Hatteras to Cape Cod. Klitgord and Behrendt (1977) published a 50 nT contour map at 1/1,000,000 scale of the entire Atlantic margin from Canada to the Bahama Islands using the data presented here and other available data in the surrounding area. This map is the 1/1,000,000 scale magnetic map of the high sensitivity data at a contour interval of 2 nT. Although some individual features are too small to be resolved in the figure, a presentation such as this allows geologic inference to be made more easily on a regional basis than with either the large scale 2 nT contour maps or the 50 nT contour interval map at this scale. We plan to publish 1/250,000 scale maps at 2 nT contour interval for the entire area of the high sensitivity magnetic survey shown in figure 1 in the near future.

Detailed discussions of the method of analysis of magnetic depths, correlation with multichannel seismic data and integration into a unified geologic framework of the U.S. Atlantic continental margin are presented in Klitgord and Behrendt (1979). Additional interpretation is proceeding.

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10,000-meter Universal Transverse Mercator grid, Clarke 1866 Spheroid for zones 17, 18 and 19
Coast line and bathymetry modified from Belding and Holland, 1970

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Aeromagnetic survey flown and compiled by LKB Resources Inc., 1974–1976
Magnetometer: Helium vapor high sensitivity