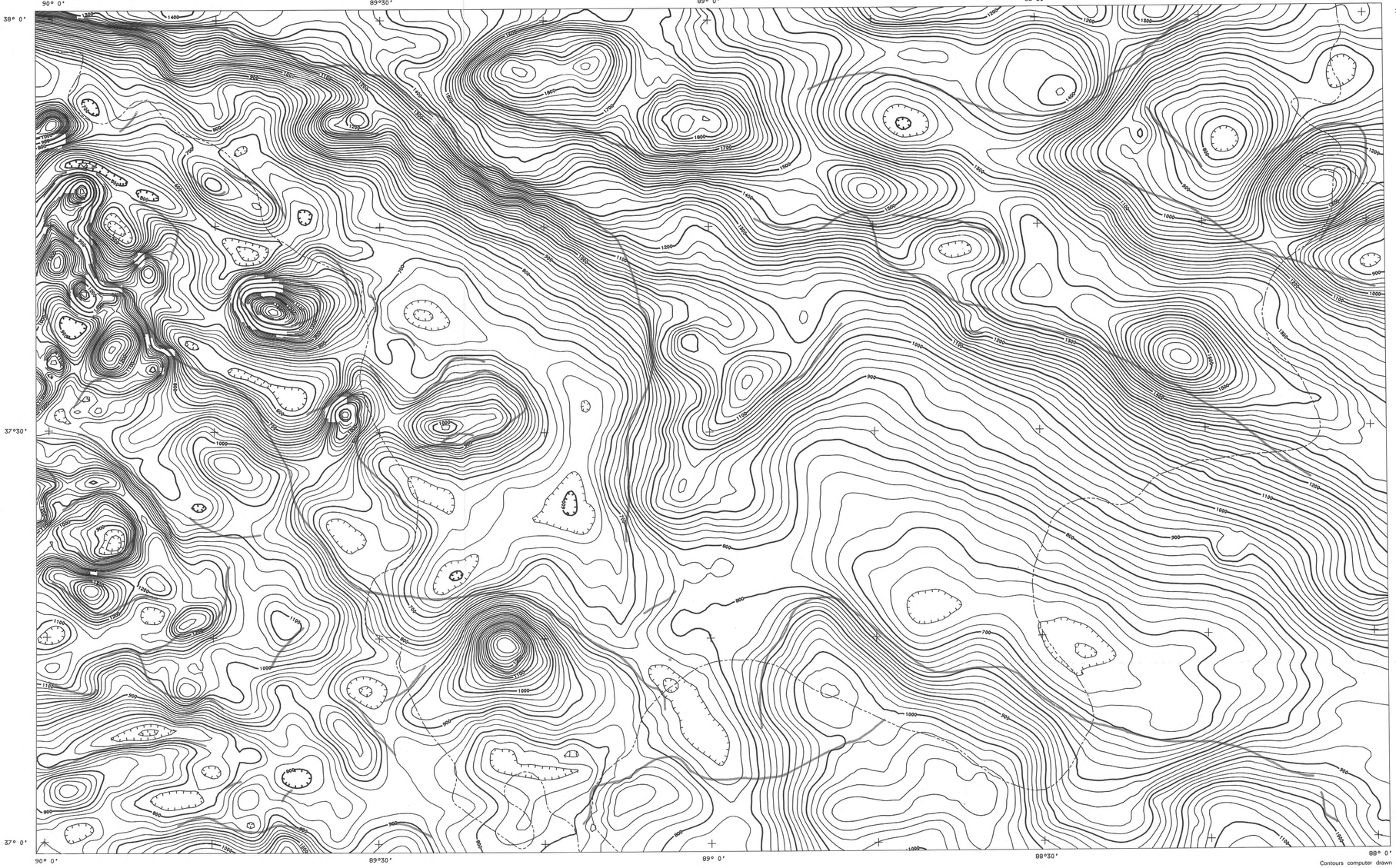
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-2131



AEROMAGNETIC ANOMALY MAP OF THE PADUCAH 1°X2° QUADRANGLE, MISSOURI, ILLINOIS, AND KENTUCKY

By

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Introduction

A digital set of aeromagnetic data for the Paducah 1^{0} x 2^{0} quadrangle, a part of the CUSMAP project, has been compiled using a variety of existing sources. The final grid of values consists of 0.5 km x,y cells on a UTM projection with a central meridian of 89^{0} W. longitude. The grids were analytically continued to a consistent 0.305 m (1000 ft) above mean terrain draped mode before compositing to create a compatible data set. The primary source of data was the Tennessee Valley Authority (TVA) but also included additions from Michigan State University and the Missouri Geological Survey. The availability of this compatible data set allows the application of a variety of analytical techniques that can be used to enhance anomalies and provide new interpretive information.

Data Reduction

The magnetic anomaly map was compiled from five unique magnetic surveys (see index map). The aeromagnetic surveys were flown with specifications ranging from 0.8 to 1.6 km (0.5 to 1.0 mi) for line spacing to flight altitudes of either 0.305 m (1000 ft) above mean terrain (AMT) or 0.914 m (3000 ft) mean sea level (MSL). Data spacing along flight lines ranges from 70 to 700 m of ground distance for digital data (referred to as "Precision" on the index map). Where digital data were not available, digitized data control on existing contour maps was flight line-contour line crossings with interpolated values at contour-line inflection points. After projecting the data to the forementioned specifications, each of the survey sets were gridded, using a computer program (Webring, 1982) based on minimum curvature (Briggs, 1974) at a representative 0.5 km interval, with the exception of the more detailed survey E that was gridded at 0.25 km. A definitive International Geomagnetic Reference Field (Peddie, 1982a, 1982b) was removed from each total magnetic field grid, after an originally removed reference field was added back in with some surveys, to produce a residual total-intensity magnetic grid. The final chosen flight altitude of 0.305 m above mean terrain was consistent for all surveys except D. In this case, a technique called "chessboard", developed by Cordell (1985), was used to drape survey D in grid form and recorded at a constant elevation of 0.914 m, onto a surface 0.305 m AMT. All surveys were then adjusted to a common datum, using survey A as the reference. The resultant 0.5-km grids were then merged, using the one-dimensional splining techniques described by Bhattacharyya and others (1979) in an unpublished computer program (R.E. Sweeney, U.S. Geological Survey). The technique was applied, in this case, by removing one grid interval from the edges of adjoining data sets and splining across two grid cells. Artifacts of the process can occur at merge boundaries and are occasionally observed in derivative products. The final grid was then contoured, using a program by Godson and Webring (1982).

Sources of Error

The precision of merge boundaries is difficult to estimate because of the irregularity of these boundaries. Although these boundaries will at times be definable in derivative products, the specifications for merging can alter or remove anomalies less than 1 km at merge boundaries. Another source of error occurs in the draping of survey D to maintain consistent altitude; however, considering the minimal topographic relief in the area this does not present much of a problem. The most recognizable errors on the contour map are the wavy patterns such as those observed in the southeast corner. They are most likely due to a lack of diurnal field corrections for surveys B and C.

Pseudo-gravity gradient

Cordell (1979) made use of horizontal gravity-gradient maxima to map graben-bounding faults. The principal of this technique, designed to delineate lithologic or structural boundaries, was later extended to the analysis of magnetic data, through use of the pseudo-gravity transformation (Cordell and Grauch, 1985).

Having made the pseudo-gravity transformation on the residual total-intensity magnetic grid, using a program by Hildenbrand (1983), the magnitude of the horizontal pseudo-gravity gradient g' is determined by an unpublished computer program (R.W. Simpson, U.S. Geological Survey) using the following equations:

$$|g'(x,y)| = \left[\left(\frac{\partial g}{\partial x}\right)^2 + \left(\frac{\partial g}{\partial y}\right)^2\right]^{\frac{1}{2}},$$

$$\frac{\partial g}{\partial x} \approx \frac{g_{i+1,j} - g_{i-1,j}}{2\Delta x},$$

and

$$\frac{\partial g}{\partial y} \approx \frac{g_{i,j+1} - g_{i,j-1}}{2\Delta y},$$

where x is the longitudinal coordinate, y is the latitudinal coordinate, and $g_{i,j}$ is the pseudo-gravity field defined at grid point i,j.

Pseudo-gravity gradient maxima occur immediately over steep or vertical boundaries separating units having contrasting magnetizations. On the pseudo-gravity gradient map, lines drawn (Blakely and Simpson, 1986) along ridges formed by enclosed high horizontal gradient magnitudes correspond to these boundaries (see red lines on map). If the boundaries dip, if remanent magnetization is strong, or if contributions from adjacent sources are significant, the maximum gradient will be shifted somewhat from the actual position of the boundary (Grauch and Cordell, 1987).

EXPLANATION

2000 — **Magnetic contours**--Showing residual total-intensity magnetic-field values. Contour interval is 20 nanoteslas. Hachures indicate closure of magnetic low

Lines of maximum horizontal gradient--Determined by the pseudo-gravity horizontal-gradient field of the magnetics

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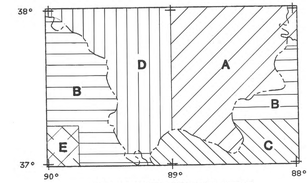

INDEX MAP SHOWING AEROMAGNETIC COVERAGE

[AMT, above mean terrain; MSL, mean sea level; n.a., not applicable]

Survey	Data type	Direction	Spacing (mile)	Altitude (feet)	Precision (ground feet)
A	digital	N-S	1.0	1000 AMT	700
B	digital	E-W	1.0	1000 AMT	700
C	digital	E-W	1.0	1000 AMT	n.a.
D	digitized	N-S	1.0	3000 AMT	n.a.
E	digitized	N-S	0.5	1000 AMT	n.a.

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