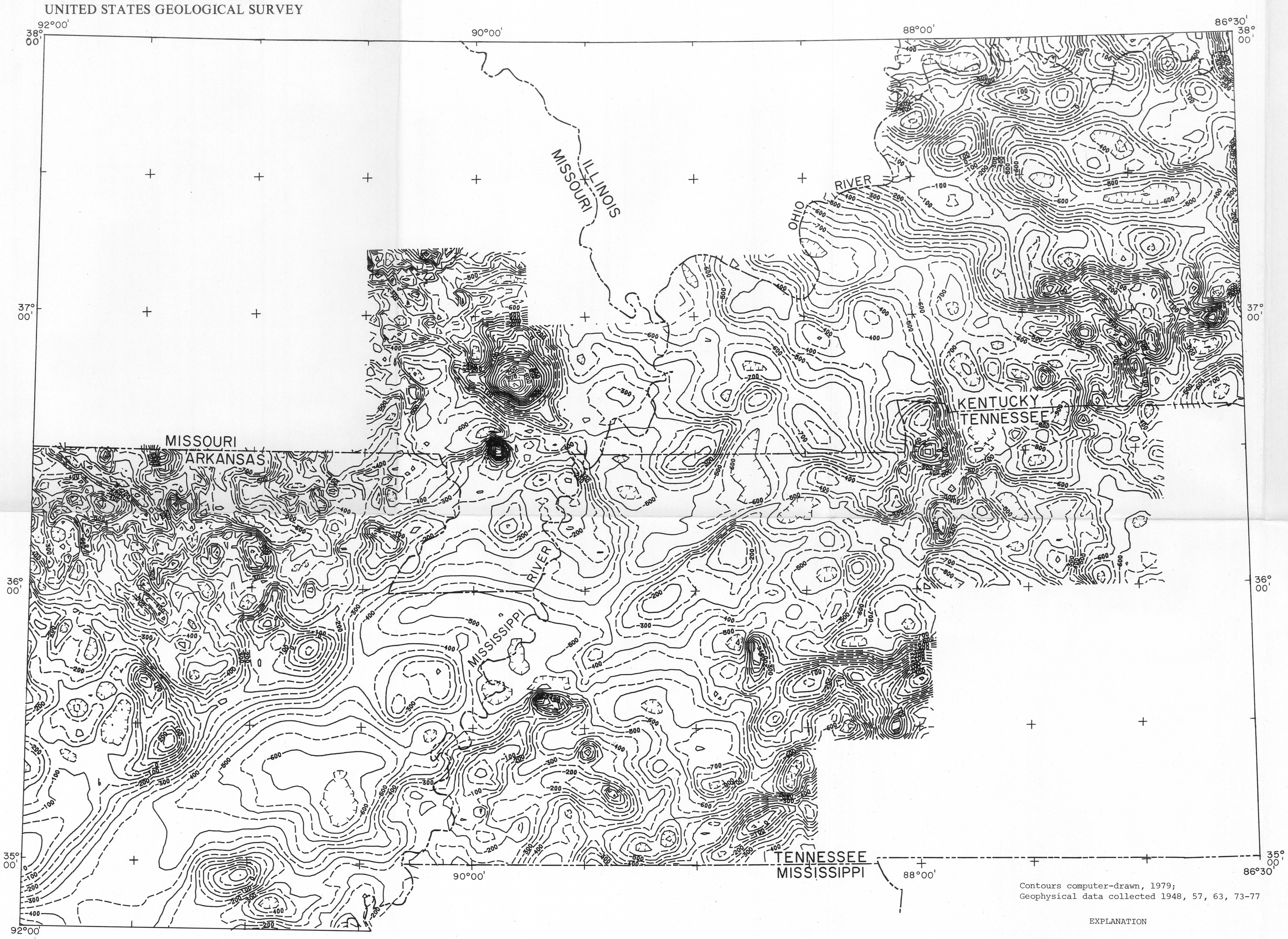


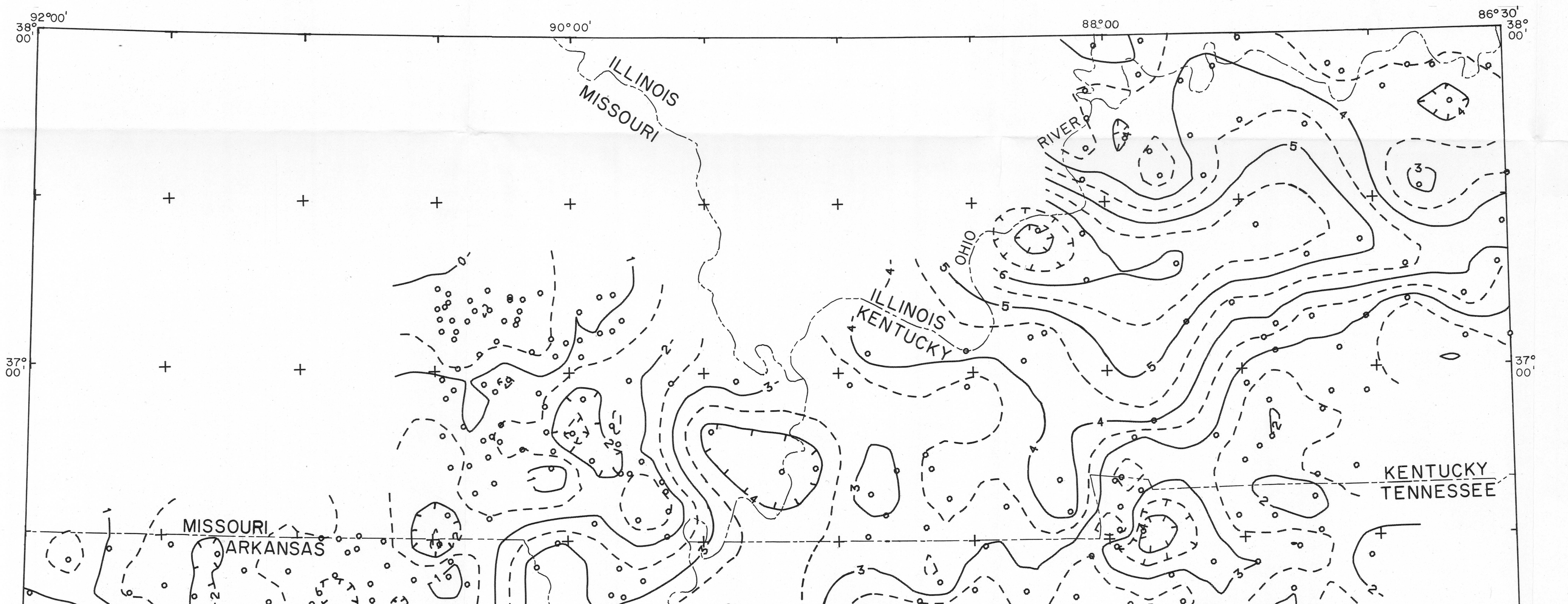
Data gridded at spacing of 2 km; on Lambert projection with 87° W. as central meridian

Contours computer-drawn, 1979;
Geophysical data collected 1948, 57, 63, 73-77

RESIDUAL AEROMAGNETIC MAP

EXPLANATION

MAGNETIC CONTOUR--Contour interval 50 gammas. Dashed between index contours. Hachures indicate magnetic lows



Data gridded at spacing of 6 km; on Lambert projection with 87° W. as central meridian

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1979, REPRINTED 1982

Contours computer-drawn, 1979;
estimates made on data collected 1979

MAXIMUM DEPTH TO MAGNETIC BASEMENT

EXPLANATION

—3— DEPTH CONTOUR--Contour interval 0.5 km; datum is mean sea level. Dashed between index contours. Hachures indicate closed depressions

o LOCATION OF DEPTH ESTIMATE

SCALE 1:1 000 000

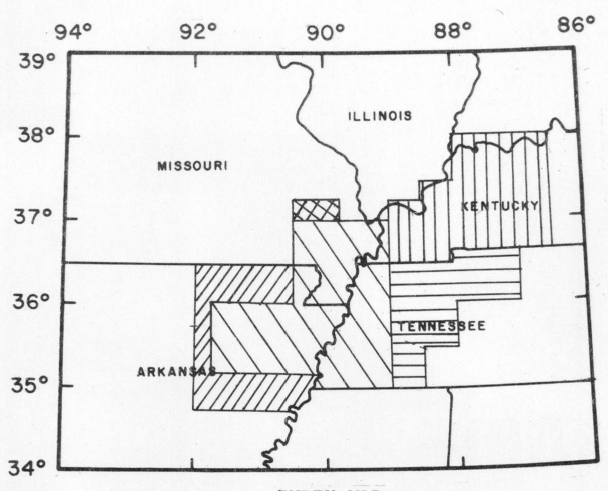
25 0 25 50 75 100 MILES

25 0 25 50 75 100 KILOMETERS

AEROMAGNETIC MAP AND ASSOCIATED DEPTH MAP OF THE UPPER MISSISSIPPI EMBAYMENT REGION

By
T. G. Hildenbrand, R. P. Kucks, M. F. Kane, and J. D. Hendricks

1979



INDEX MAP

SOURCES OF DATA

- Hendricks and Hildenbrand (1979)
- Hildenbrand and Johnson (1977)
- Tennessee Valley Authority (Unpublished Data)
- Johnson and others (1978)
- Missouri Division of Geological Survey and Water Resources (1963, 1968a,b)

DISCUSSION

The purpose of these maps is to present recently compiled aeromagnetic data and associated depth estimates to magnetic basement in the upper Mississippi embayment region. This area is one of the most seismically active regions in the the eastern United States. In 1974, the U.S. Geological Survey initiated magnetic surveys to delineate major geologic or tectonic features that may be responsible for the generation or control of seismic energy.

Preliminary interpretations of the geophysical data require that the upper Mississippi embayment region experienced a long and complex tectonic history (Hildenbrand and others, 1977). A major tectonic event involving the development of a large northeast-trending graben or rift zone occurred in late Precambrian or early Paleozoic time. The post-rifting phase included thick accumulation of Paleozoic sediments within the rift zone and emplacement of alkalic intrusions both within the rift zone and along its margins. Contemporary earthquakes primarily occur within the geographic limits of the graben.

Studies by the U.S. Geological Survey are continuing in this extremely complicated region. The maps presented here are useful in understanding the complex history of the embayment and intra-cratonic tectonics.

Aeromagnetic surveys

The map of the residual total magnetic intensity was compiled from several aeromagnetic surveys. These surveys, encompassing a total area of about 41,000 mi^2, were flown at elevations ranging from 900 ft (0.27 km) to 2000 ft (0.61 km) barometric and with flight line spacings of 1/2 mile (0.85 km) or 1 mile (1.61 km). Flight line directions were east-west. All surveys were corrected for the diurnal variations of the Earth's field and changes in flight elevation. The residual aeromagnetic field was obtained by removing the international geomagnetic reference field (IGRF) updated to the years in which the surveys were flown.

To merge the various surveys, an elevation of 1000 ft (0.305 km) barometric was selected as the reduction datum level. Surveys flown above or below this datum level were analytically upward- or downward-continued so that the data are compatible. The surveys were merged utilizing one-dimensional splining techniques described by Bhattacharyya and others (1979). The resulting residual aeromagnetic map reflects structure and lithologic contrasts in the rocks of magnetic basement.

Maximum depth of magnetic basement

Magnetic basement is defined as any lithologic unit having a susceptibility or remanent magnetization of sufficient magnitude to produce measurable distortion in the magnetic field. In the Mississippi embayment region, magnetic basement is interpreted as Precambrian crystalline rocks together with igneous rocks of younger age. Phanerozoic sedimentary units observed in this region generally lack magnetic properties and, therefore, produce little or no effect on the magnetic field.

An interpretational method developed by Vacquier and others (1951) has been employed to estimate the maximum depth to magnetic basement. In this method, an observed anomaly is compared with theoretical anomalies produced by vertical prisms of various dimensions and by different orientations of the Earth's ambient field. One generally assumes that the magnetic source is uniformly polarized in the same direction as the Earth's present field. When the shape of a theoretical anomaly closely matches that of the observed anomaly, maximum depth to the magnetic source is determined by comparing the widths of uniform horizontal gradients associated with the two anomalies. The method yields maximum depths to magnetic sources because the theoretical models used in the curve matching process are assumed to extend to infinity. In real geologic situations, the causative body has finite thickness; therefore, its actual depth of burial is more shallow than the computed depth. The estimated average error of depth to a magnetic rock body is 10 percent (Vacquier and others, 1951).

The accuracy of depth estimates greatly depends on the validity of the geometric and magnetization assumptions. The method yields suitable depth estimates if these assumptions are reasonably valid, but large errors occur when the magnetic source is characterized by gently dipping sides, a substantial remanent component of magnetization, or non-uniform magnetization. The probable error associated with the computed depths to magnetic basement underlying the Mississippi embayment is difficult to assess due to sparse drill-hole information. The depth estimates reported here must, therefore, be regarded as generalized. The computed depths (4.1 - 4.7 km) near the No. 1 Carter Cockrell well (35° N., 91° W.) are, however, in excellent agreement with the known depth (approx. 4.4 km) to Precambrian basement (Howard Schwalb, personal communication, 1979).

Another consideration in estimating the error associated with the computed depths is the grid spacing of the magnetic maps analyzed. Due to the limitations of interpretational methods, the depths of magnetic sources should be, generally, greater than twice the grid spacing. Because a grid spacing of 0.8 km was used in our analysis, greater error can be anticipated for sources lying at depths shallower than 1.6 km.

REFERENCES

Bhattacharyya, B. K., Sweeney, R. E., and Godson, R. H., 1979, Integration of aeromagnetic data acquired at different times with varying elevations and line spacing: Geophysics, v. 44, no. 4, p. 742-752.

Hendricks, J. D., and Hildenbrand, T. G., 1979, Aeromagnetic map of northeast Arkansas: U.S. Geological Survey Open-File Report 79-1208.

Hildenbrand, T. G., and Johnson, R. W., 1977, Aeromagnetic map of the northern Mississippi embayment: U.S. Geological Survey Open-File Report 77-229.

Hildenbrand, T. G., Kane, M. F., and Stauder, W., 1977, Magnetic and gravity anomalies in the northern Mississippi embayment and their spatial relation to seismicity: U.S. Geological Survey Miscellaneous Field Studies Map, MF-914.

Johnson, R. W., Jr., Haygood, C., Kunselman, P. M., 1978, Residual total intensity aeromagnetic map of Kentucky: Western sheet, Kentucky Geological Survey, University of Kentucky.

Missouri Division of Geological Survey and Water Resources, 1963, Aeromagnetic contour map of the Advance 15′ quadrangle, scale 1:250,000.

____________1968a, Aeromagnetic contour map of the Greenville 15′ quadrangle, scale 1:250,000.

______1968b, Aeromagnetic contour map of the Zalma 15′ quadrangle, scale 1:250,000.

Vacquier, V., Steenland, N.C., Henderson, R. G., Zietz, Isidore, 1951, Interpretation of aeromagnetic maps: Geological Society of America Memoir, no. 47, 151 p.

For sale by Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202 and Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225