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REGIONAL MAPS OF VERTICAL MAGNETIC INTENSITY IN ILLINOIS

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ABSTRACT

Two maps of the regional vertical magnetic intensity in Illinois are presented. One contains observed values and the other shows the field remaining after a normal gradient due to the earth's field is removed. Magnetic data were obtained from observations at 118 localities by U. S. Coast and Geodetic Survey parties in 1955.

Alignment of magnetic trends with the trends of major geologic structures is apparent where control points are adequate. An aeromagnetic profile along the fortieth parallel and a coincident profile from the map of uncorrected values show marked correlation between magnetic maxima and minima. These regional maps are intended to be used as the basis for continued magnetic work in Illinois.

INTRODUCTION

Relationships between geologic structures and geophysical anomalies in Illinois have received little attention in the literature. An early paper by McClure (1931) is the only geophysical study of a regional nature. As a preliminary step in the study of the magnetic field in Illinois, maps of the vertical component of magnetic intensity prepared from a limited number of stations occupied by U. S. Coast and Geodetic Survey parties in 1955 (see Appendix) are presented in this report.

The horizontal intensity (H) and the inclination (I) were measured at 118 major stations. Where a number of observations were made in the vicinity of a major station, the average value was used. From H and I the vertical intensity (Z) was obtained: $Z = H \tan I$. These stations are reoccupied every ten years by the U.S.C.G.S. for use in providing magnetic intensity and dip charts of the United States.

A contour map of observed vertical magnetic intensity (pl. 1) and a map showing vertical magnetic anomalies (pl. 2) are included in this report. The maps are drawn from data obtained at the above-mentioned stations, most of which are at or near county seats. A map of Illinois outlining the various counties is shown in figure 1. An aeromagnetic profile along the fortieth parallel, reported by Jensen (1949), and a profile taken from the map of observed vertical intensity indicate

Fig. 1 - Counties of Illinois.

good correlation between the total magnetic field and the vertical component of the magnetic intensity (fig. 2).

We express our appreciation to the U. S. Coast and Geodetic Survey for permission to use their data.

MAJOR STRUCTURAL FEATURES OF ILLINOIS

Descriptions of the geologic structure of Illinois can be found in many places in the literature (Swann and Bell, 1958; Bell et al., 1956; Clark and Royds, 1948; Green, 1957). A discussion of the regional structure of the entire state and its relationship to the magnetic field is not within the scope of this paper, nor is the relationship between the very minor geologic features and the magnetic field. Because of the wide areal distribution and limited number of magnetic stations, only the major basement structures within the state can be related to observable magnetic trends. These structures are described briefly below.

LaSalle Anticlinal Belt

The LaSalle Anticlinal Belt is more than 200 miles long and extends from a point north of the Illinois River near La Salle to the Indiana state line on the Wabash River south of Vincennes. The general trend is south-southeast, but this is broken by numerous cross-folds in the southern part of the belt (Bell, 1943). The anticline is a broad step-fold or monocline having a maximum westward dip of approximately 2000 feet per mile and an eastward dip of less than 25 to 50 feet per mile (Willman et al., 1942).

Sandwich Fault

The Sandwich Fault arises in south-central Ogle County and strikes generally south 60° east through DeKalb County. It extends into southern Kendall County, where it either dies out or continues as a lesser fault zone into western Will County. The downthrown side of the fault is to the northeast, where it has a maximum displacement of 900 feet east of the Oregon-Dixon area (Templeton and Willman, 1952).

Cap Au Grès Faulted Flexure

The Cap Au Grès Faulted Flexure extends continuously from western Pike County, Missouri, southeastward through Lincoln County, then east across southern Calhoun County, Illinois, and into southwestern Jersey County, where it

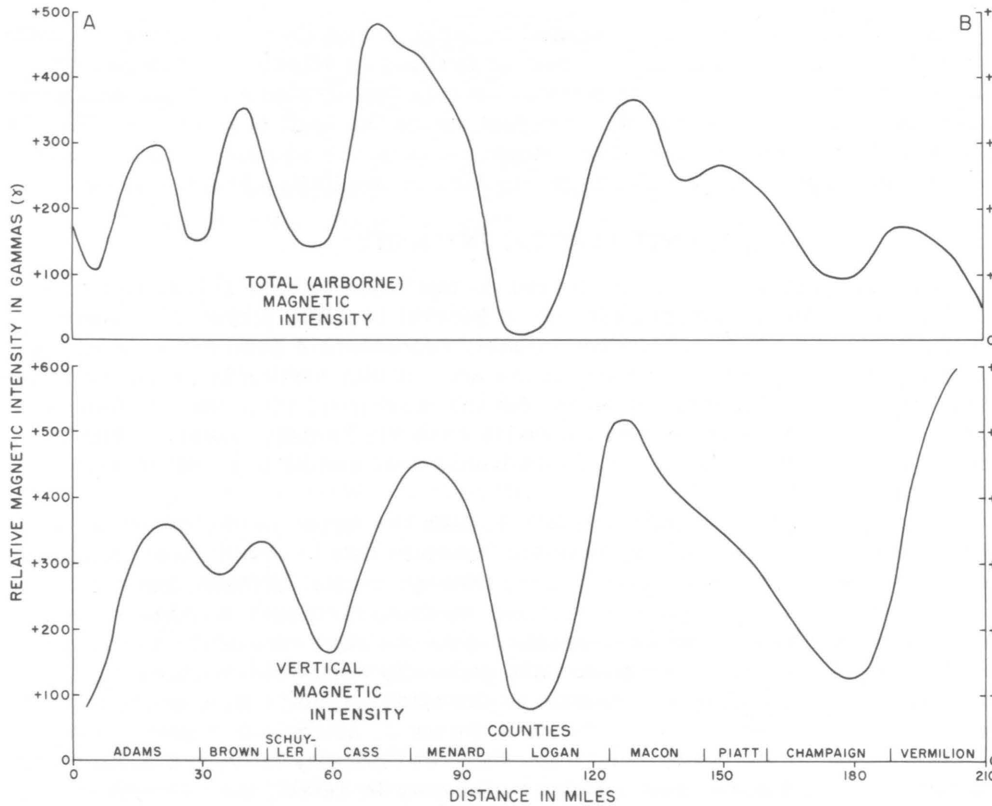

Fig. 2 - Total and vertical magnetic intensity profiles at the 40th parallel in Illinois. Total intensity profile from Jensen (1949). Vertical intensity profile from plate 1.

disappears beneath the broad alluvial valley of the Mississippi River. Throughout its length the flexure is a narrow zone along which the rocks dip steeply southward or southwestward. The total uplift, or "structural relief," along the flexure averages about 1000 feet, but it varies from place to place (Rubey, 1952).

DuQuoin Monocline

The DuQuoin Monocline is located in southwestern Illinois. It is a belt of relatively steep eastward dips that extends slightly east of north from the vicinity of DuQuoin to a point about 20 miles north of Centralia, a total distance of about 60 miles (Bell, 1943).

Shawneetown Fault System

The Shawneetown Fault System is located in southeastern Illinois. The system turns southward rather sharply at its west end, about 15 miles west of the Kentucky-Illinois line. However, there is a series of related faults and small anticlines extending nearly across the state of Illinois, directly in line with the Shawneetown-Rough Creek Fault, through Kentucky. This generally is known as the Campbell Hill - Cottage Grove structural trend. The major deep of the Illinois Basin lies north of the Campbell Hill - Cottage Grove - Shawneetown - Rough Creek Fault Zone and between the DuQuoin and LaSalle structures (Swann and Bell, 1958).

Ste. Genevieve Fault

The Ste. Genevieve Fault, located in Jackson and Union Counties in southwestern Illinois, is an extension of a belt of faulting in Missouri. The general trend is northwest-southeast, with a maximum relative displacement and associated monoclinal dip of approximately 3000 feet where the fault crosses from Illinois to Missouri. The upthrown side of the structure is to the southwest (D. H. Swann, personal communication; A.A.P.G. Tectonic Map of the United States, 1944).

OBSERVED VERTICAL INTENSITY

A map of magnetic values contoured on the basis of only 118 stations for such a large area can present at best only a general regional picture. However, the magnetic intensity at each station probably represents a good estimate of the average strength of the magnetic field in the area of that station because the basement of relatively high magnetization is, for the most part, thousands of feet below the surface and the sedimentary rocks lie essentially flat. Plate 1, with a contour interval of 100γ, displays definite trends that can be associated with known geologic trends.

The major magnetic trends on plate 1, like the major geologic trends, are primarily north-south. Two areas, however, contain trends that diverge from this north-south orientation. An east-west band through central Illinois, between Springfield and Peoria, is marked by features trending northeast-southwest on the west side of the band and northwest-southeast on the east side of the band. In the southern tip of the state, the trends are generally northwest-southeast.

A continuous aeromagnetic profile of the total magnetic field along the 40th parallel plotted by Jensen (1949) is shown in figure 2, along with a profile from plate 1 (A-B) showing the variations in the vertical intensity along the same profile. The essential features of the two profiles differ only in detail, the vertical profile showing less detail as a result of widely spaced control points and smoothed contouring. The similarity of these two profiles supports the validity of the magnetic trends shown for other parts of the state.

VERTICAL ANOMALIES

The map showing vertical anomalies (pl. 2) was obtained by correcting the observed map for the normal magnetic gradient of the earth's field. A correction of 9γ per mile southward was added by means of a 12-mile grid applied to the observed map. The correction factor was obtained from the U.S.C.G.S. Vertical Intensity Chart of the United States, 1955. A contour interval of 100γ again was used. The magnetic contours are shown on plate 2 along with the locations of the major geologic structures and the outline of the Pennsylvanian rocks, which roughly circumscribes the Illinois Basin.

Most magnetic anomalies are due to differences in the composition and topography of basement rocks or to intrusions of igneous rocks. In areas distinguished by great thicknesses of sedimentary formations, however, the magnetic field may be influenced considerably by magnetic sediments (Heiland, 1940). McEvilly (1957) has found that several sedimentary formations in eastern Missouri possess magnetite concentrations that give them susceptibilities as high as 22 percent of that observed for granite. It is therefore reasonable to assume that some of the magnetic variations observed in Illinois may be caused by magnetic sedimentary rocks.

As this paper is limited to a presentation of the regional features of the magnetic field in Illinois, a detailed interpretation of the anomalies cannot be made. Certain correlations, however, do indicate areas where more detailed exploration would be of value. The magnetic features associated with the major geologic structures are as follows:

1) The trend of a series of magnetic lows follows the trend of the LaSalle Anticlinal Belt. Magnetic highs projecting into Illinois from Indiana form the eastern flank of the series of LaSalle Anticline lows.
2) A triangular-shaped magnetic high in the area of LaSalle County is bordered on the north by the Sandwich Fault and on the southwest by the LaSalle Anticlinal Belt.
3) Lack of control points in the vicinity of the Cap Au Grès Fault Zone makes any correlation between the magnetic field and structure impossible in this area.
4) A magnetic high of about 700γ, trending northwest-southeast and centered in Washington County, is the predominant feature adjacent to the DuQuoin Monocline on the west.
5) The Shawneetown Fault System and the related faults and anticlines to the west divide the region of north-south trending features on the north from the northwest-southeast trending features on the south. The magnetic intensity decreases to the south of the faulted zone and the entire area appears as a magnetic low with some local variations.
6) The Ste. Genevieve Fault is located in the zone of contours trending northwest-southeast. The contours are aligned nearly parallel with the fault, but again the control points in this area are too few for further comparisons.

Magnetic features and geologic structures appear to be related for the most part. Magnetic features also may be related to less obvious conditions such as variations in the composition of the basement rocks or to thinning or thickening of magnetic sediments.

Other anomalies can be observed in certain areas on plate 2 that do not have obvious relationships with structure, although they represent areas where further studies may prove beneficial. Some of these anomalies are listed below.

1) An elongated 500 to 600γ magnetic high, trending slightly east of north, parallels the Mississippi River and is centered in Henderson County.
2) A narrow high of 200γ in Stephenson, Winnebago, and Ogle Counties is flanked on the east by a magnetic low and extends into north-central Illinois from Wisconsin.
3) An elongated 100γ low trends up the Illinois River from its mouth in Calhoun County.
4) A 400γ magnetic high is centered in Wayne County, directly over the deepest part of the Illinois Basin.

The magnetic anomalies of the regional magnetic map of Illinois show a definite relationship to known geology. These obvious correlations warrant further studies of a more detailed nature, including susceptibility determinations, more detailed surveying with the vertical magnetometer, and aeromagnetic surveying. It is hoped that further magnetic studies will provide information that may help to determine depths to the basement rocks, to locate unknown igneous intrusions and basement faulting, to determine the effects of sedimentary rocks on the magnetic field, and to find possible concentrations of magnetic mineralization.

REFERENCES

American Association of Petroleum Geologists, 1944, Tectonic map of the United States: Am. Assoc. Petroleum Geologists. Prepared under the direction of the National Research Council Committee on Tectonics.

Bell, A. H., 1943, Subsurface structure of the base of the Kinderhook-New Albany Shale in central and southern Illinois: Illinois Geol. Survey Rept. Inv. 92, 13 p.

Bell, A. H., Witherspoon, P. A., and Hautau, G. H., 1956, Oil and gas in the Illinois and Michigan Basins of the United States: XX Congreso Geólogico Internacional, Symposium Sobre Yacimientos de Petroleo y Gas, Mexico, v.III, p. 291-325. Reprinted as Illinois Geol. Survey Reprint 1957-G.

Clark, S. K., and Royds, J. S., 1948, Structural trends and fault systems in the Eastern Interior Basin: Am. Assoc. Petroleum Geologists Bull., v. 32, no. 9, p. 1728-1749.

Green, D. A., 1957, Trenton structure in Ohio, Indiana and northern Illinois: Am. Assoc. Petroleum Geologists Bull., v. 41, no. 4, p. 627-642.

Heiland, C. A., 1940, Geophysical exploration: Prentice-Hall, Inc., New York, p. 424-425.

Jensen, H., 1949, Airborne magnetic profile above 40th parallel, eastern Colorado to western Indiana: Geophysics, v. 14, no. 1, p. 57.

McClure, P. S., 1931, The magnetometer in Illinois: Illinois Acad. Sci. Trans., v. 24, no. 2, p. 341-349.

McEvilly, T. V., 1957, Abnormal sedimentary susceptibilities in eastern Missouri: Geophysical Society of Tulsa Proc., v. 4, p. 60-69.

Rubey, W. W., 1952, Geology and mineral resources of the Hardin and Brussels quadrangles (Illinois): U. S. Geol. Survey Prof. Paper 218, p. 139-140.

Swann, D. H., and Bell, A. H., 1958, Habitat of oil in the Illinois Basin: Habitat of Oil - a Symposium, Am. Assoc. Petroleum Geologists, Tulsa, Oklahoma, p. 447-472. Reprinted as Illinois Geol. Survey Reprint 1958-W.

Templeton, J. S., and Willman, H. B., 1952, Central Northern Illinois Guidebook for the Sixteenth Annual Field Conference of the Tri-State Geological Society, 47 p.

U. S. Coast and Geodetic Survey, 1955, Vertical intensity chart of the United States: U. S. Coast and Geodetic Survey, Washington, D. C.

Willman, H. B., Payne, J. N., and Voskuil, W. H., 1942, Geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles: Illinois Geol. Survey Bull. 66, p. 183.

APPENDIX

LOCATIONS OF MAGNETIC STATIONS AND OBSERVATIONS

	Station	Latitude	Longitude	I (degrees)	H (gammas)
1.	Albion	38°22.4'	88°03.7'	69.98	19753
2.	Aledo	41 12.2	90 45.3	71.67	18530
3.	Arpee	41 10.0	90 57.0	71.96	18025
4.	Belleville	38 30.2	89 58.3	69.97	19913
5.	Belvidere	42 14.6	88 52.1	72.80	17503
6.	Benton	38 00.2	88 55.4	69.33	20346
7.	Bloomington	40 30.6	88 59.0	71.23	18691
	Bloomington	40 30.7	88 59.8	71.32	18659
	Bloomington	40 30.7	88 59.8	71.31	18625
8.	Cairo	37 00.8	89 11.6	68.37	20862
	Cairo	37 00.8	89 11.6	68.43	20782
	Cairo	37 00.8	89 11.6	68.41	20674
9.	Caledonia	42 22.3	88 53.2	73.07	17089
10.	Cambridge	41 18.7	90 11.0	71.99	18095
11.	Carlinville	39 17.6	89 52.7	70.21	19544
12.	Carlyle	38 37.0	89 22.2	70.18	19505
13.	Carmi	38 05.1	88 10.5	69.53	20183
14.	Carrollton	39 17.8	90 24.7	70.11	19736
15.	Carthage	40 25.1	91 07.7	71.19	18894
16.	Charleston	39 29.4	88 10.4	70.66	19176
17.	Chatsworth	40 45.7	88 16.3	71.90	18132
18.	Chester	37 55.0	89 53.6	68.63	20784
19.	Chicago	41 55.8	87 37.2	72.86	17368
	Chicago	41 55.8	87 37.2	72.78	17343
20.	Chicago Jackson Pk	41 46.6	87 34.6	72.61	17566
21.	Clinton	40 10.1	88 57.8	71.25	18674
22.	Danville	40 07.1	87 35.3	71.29	18818
23.	Decatur	39 49.8	88 59.9	70.87	19153
24.	Dixon	41 51.1	89 27.9	72.43	17839
25.	Durand	42 26.1	89 19.1	73.17	17199
26.	Edwardsville	38 47.2	89 57.1	70.25	19399
	Edwardsville	38 49.4	89 58.0	70.47	19075
27.	Effingham	39 08.7	88 32.8	70.47	19329
	Effingham	39 08.7	88 32.8	70.47	19307
28.	Elizabethtown	37 28.1	88 19.3	68.63	20816
29.	Elwood	41 23.6	88 05.3	72.07	17965
	Elwood	41 23.6	88 05.3	72.02	17992
30.	Eureka	40 43.7	89 16.3	71.74	18341
31.	Fairfield	38 23.2	88 20.9	70.06	19783
32.	Freeport	42 18.8	89 36.0	72.88	17352
33.	Galena	42 23.6	90 22.9	73.23	17058
34.	Galesburg	40 57.2	90 24.7	71.62	18500
35.	Golconda	37 21.9	88 30.2	68.59	20585
36.	Greenville	38 54.0	89 24.6	70.33	19410

LOCATIONS OF MAGNETIC STATIONS AND OBSERVATIONS - Continued

	Station	Latitude	Longitude	I (degrees)	H (gammas)
37.	Harrisburg	37°43.7'	88°32.8'	69.07	20616
38.	Harvard	42 26.3	88 37.1	72.98	17263
39.	Havana	40 18.1	90 02.5	71.12	18850
40.	Hillsboro	39 09.8	89 30.3	70.36	19412
41.	Hennepin	41 14.6	89 21.0	72.07	18130
42.	Highland	38 44.2	89 40.8	70.23	19712
43.	Hoopeston	40 28.0	87 42.2	71.68	18437
44.	Jacksonville	39 43.0	90 14.0	70.75	19247
45.	Jerseyville	39 07.0	90 18.8	70.06	19683
46.	Joliet	41 30.0	88 02.8	72.25	17736
	Joliet	41 28.7	88 11.2	72.43	17724
	Joliet	41 28.7	88 11.2	72.45	17726
	Joliet	41 28.7	88 11.2	72.42	17634
	Joliet	41 28.5	88 11.5	72.45	17620
	Joliet	41 28.9	88 10.5	72.43	17589
47.	Jonesboro	37 27.1	89 18.7	68.58	20677
48.	Kankakee	41 08.0	87 51.0	72.11	18000
	Kankakee	41 07.0	87 51.0	72.11	17919
49.	Knoxville	40 54.0	90 18.5	71.69	18451
50.	Lacon	41 01.5	89 23.8	71.81	18215
51.	Lawrenceville	38 44.2	87 41.2	70.38	19405
52.	Lewistown	40 24.2	90 09.6	71.42	18624
53.	Lincoln	40 08.1	89 24.3	70.88	19026
54.	Louisville	38 47.2	88 31.2	70.23	19549
55.	McLeansboro	38 06.0	88 32.0	69.45	20343
56.	Macomb	40 27.1	90 40.2	71.12	18889
57.	Marion	37 44.9	88 55.4	68.74	20906
58.	Marshall	39 24.8	87 42.3	70.62	19277
59.	Mendota	41 34.6	89 07.3	72.65	17463
60.	Metropolis	37 09.2	88 42.4	68.77	20612
61.	Moline	41 31.5	90 28.9	72.03	18102
62.	Monmouth	40 53.7	90 39.3	71.54	18525
63.	Monticello	40 02.2	88 34.6	71.13	18734
	Monticello	40 02.4	88 34.6	71.11	18821
64.	Morris	41 21.3	88 26.2	72.32	17819
65.	Morrison	41 47.9	89 57.4	72.43	17794
66.	Mound City	37 06.2	89 10.0	68.51	20768
67.	Mt. Carmel	38 25.5	87 45.3	69.97	19796
68.	Mt. Carroll	42 05.6	89 59.0	72.60	17674
69.	Mt. Sterling	39 58.9	90 45.7	70.62	19335
70.	Mt. Vernon	38 18.4	88 55.0	69.72	19908
71.	Murphysboro	37 46.4	89 20.0	68.38	21102
72.	Nashville	38 20.0	89 22.0	70.03	19924
73.	Nauvoo	40 27.6	91 21.4	71.09	18740
	Nauvoo	40 27.8	91 21.3	71.14	18759

LOCATIONS OF MAGNETIC STATIONS AND OBSERVATIONS - Continued

	Station	Latitude	Longitude	I (degrees)	H (gammas)
74.	Newton	39°00.4'	88°09.5'	70.37	19381
75.	Olney	38 43.7	88 05.2	70.23	19466
76.	Oquawka	40 56.2	90 56.8	71.72	18551
77.	Oregon	42 02.6	89 20.0	72.61	17711
78.	Paris	39 38.9	87 40.6	71.00	19108
79.	Paxton	40 27.0	88 04.8	71.41	18680
	Paxton	40 27.0	88 04.8	71.37	18741
	Paxton	40 27.0	88 04.8	71.42	18702
	Paxton	40 27.0	88 04.8	71.37	18704
80.	Pekin	40 35.3	89 37.9	71.42	18570
81.	Peoria	40 44.7	89 35.8	71.61	18482
82.	Petersburg	40 01.2	89 49.6	71.00	18994
83.	Pinckneyville	38 03.3	89 23.2	69.10	20703
84.	Pittsfield	39 36.2	90 49.2	70.66	19219
85.	Pontiac	40 53.2	88 37.3	71.78	18299
86.	Princeton	41 23.0	89 27.7	72.02	18113
	Princeton	41 23.0	89 27.7	71.99	18089
87.	Quincy	39 54.2	91 25.3	70.69	19187
88.	Robinson	39 00.0	87 45.6	70.42	19350
89.	Rochelle	41 56.1	89 04.9	72.74	17467
90.	Rockford	42 16.8	89 04.7	72.65	17557
91.	Rockton	42 27.4	89 04.5	73.07	17122
92.	Rushville	40 07.7	90 33.8	70.78	19259
93.	St. Anne	41 01.3	87 43.3	72.24	18070
94.	Salem	38 37.6	88 56.2	70.19	19418
95.	Saybrook	40 24.9	88 30.7	71.30	18627
96.	Seneca	41 19.5	88 35.8	72.56	17799
97.	Shabbona	41 46.6	88 53.9	72.26	17943
98.	Shawneetown	37 42.7	88 08.8	69.44	20154
99.	Shelbyville	39 24.7	88 49.5	70.52	19298
100.	Springfield	39 50.0	89 39.0	70.77	19093
	Springfield	39 49.0	89 39.0	70.78	19066
	Springfield	39 49.7	89 39.4	70.82	19096
	Springfield	39 49.7	89 39.4	70.82	19027
	Springfield	39 49.7	89 39.4	70.79	19045
	Springfield	39 49.7	89 39.4	70.74	19040
	Springfield	39 49.7	89 39.4	70.73	18976
	Springfield	39 49.7	89 39.4	70.77	18914
	Springfield	39 49.3	89 39.3	70.80	18954
101.	Streator	41 08.9	88 50.0	72.01	18067
102.	Sullivan	39 36.3	88 35.5	70.77	19048
103.	Sycamore	41 59.3	88 41.0	72.90	17307
104.	Taylorville	39 32.5	89 18.2	70.51	19242
105.	Toledo	39 16.0	88 14.1	70.59	19180
106.	Toulon	41 05.2	89 51.4	71.92	18301

LOCATIONS OF MAGNETIC STATIONS AND OBSERVATIONS - Continued

	Station	Latitude	Longitude	I (degrees)	H (gammas)
107.	Tuscola	39°47.6'	88°16.1'	70.99	18942
108.	Urbana	40 05.9	88 13.9	71.08	18820
	Urbana	40 06.1	88 14.1	71.13	18740
	Urbana	40 05.9	88 13.9	71.15	18757
	Urbana	40 05.9	88 13.9	71.13	18750
	Urbana	40 05.9	88 13.9	71.10	18730
	Urbana	40 05.9	88 13.9	71.14	18647
	Urbana	40 05.9	88 13.9	71.11	18628
109.	Vandalia	38 57.4	89 05.9	70.21	19453
110.	Vienna	37 25.1	88 53.8	68.66	20697
111.	Virginia	39 57.6	90 13.9	70.92	18989
112.	Waterloo	38 19.9	90 10.8	69.31	20345
113.	Watseka	40 44.2	87 39.7	71.81	18204
114.	Waukegan	42 20.7	87 51.0	72.80	17398
115.	Wheaton	41 52.7	88 06.1	72.69	17483
116.	Winchester	39 37.2	90 27.2	70.64	19213
117.	Woodstock	42 19.3	88 25.2	73.00	17249
	Woodstock	42 19.3	88 25.2	72.85	17287
118.	Yorkville	41 38.9	88 26.3	72.54	17615

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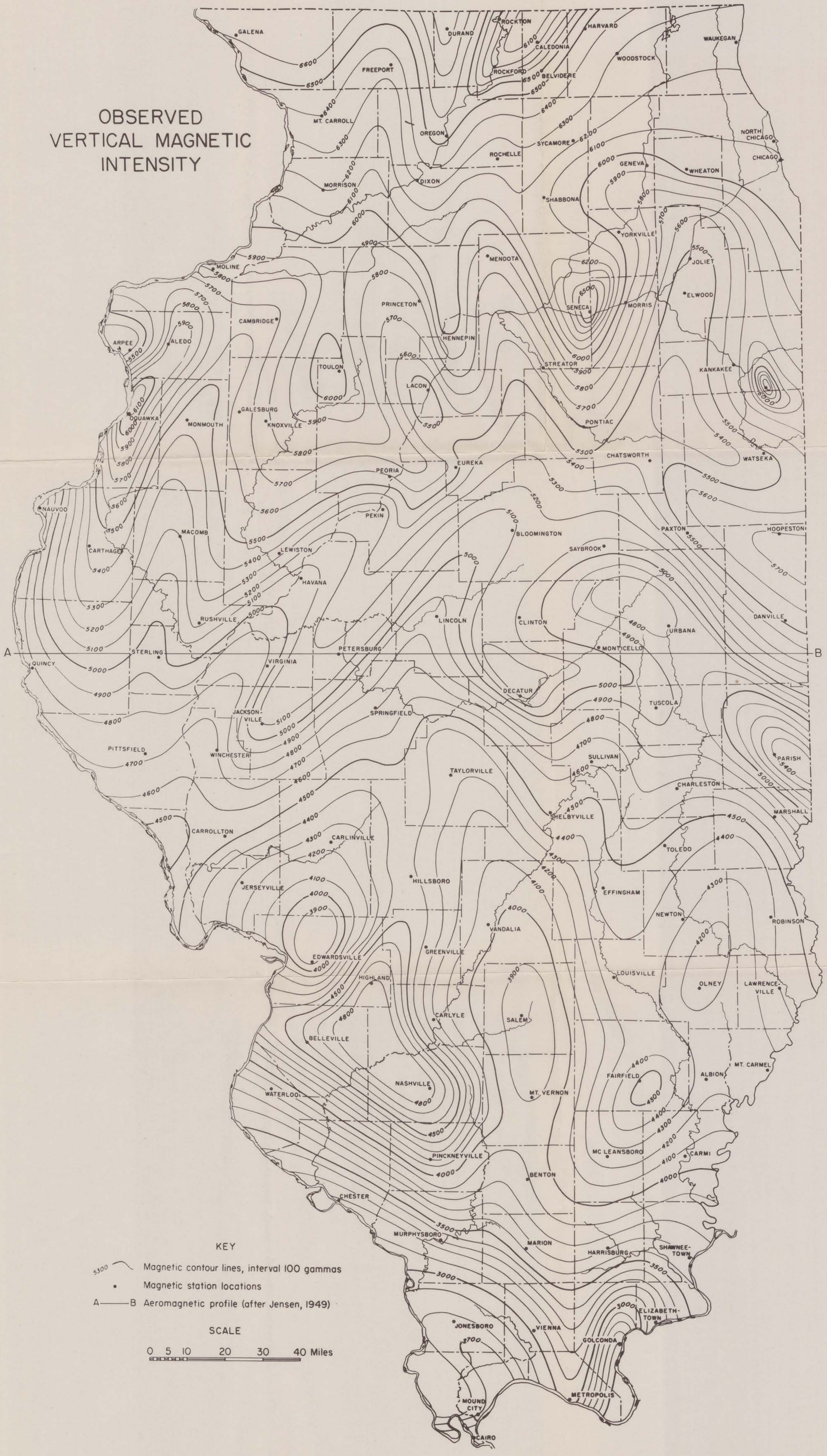
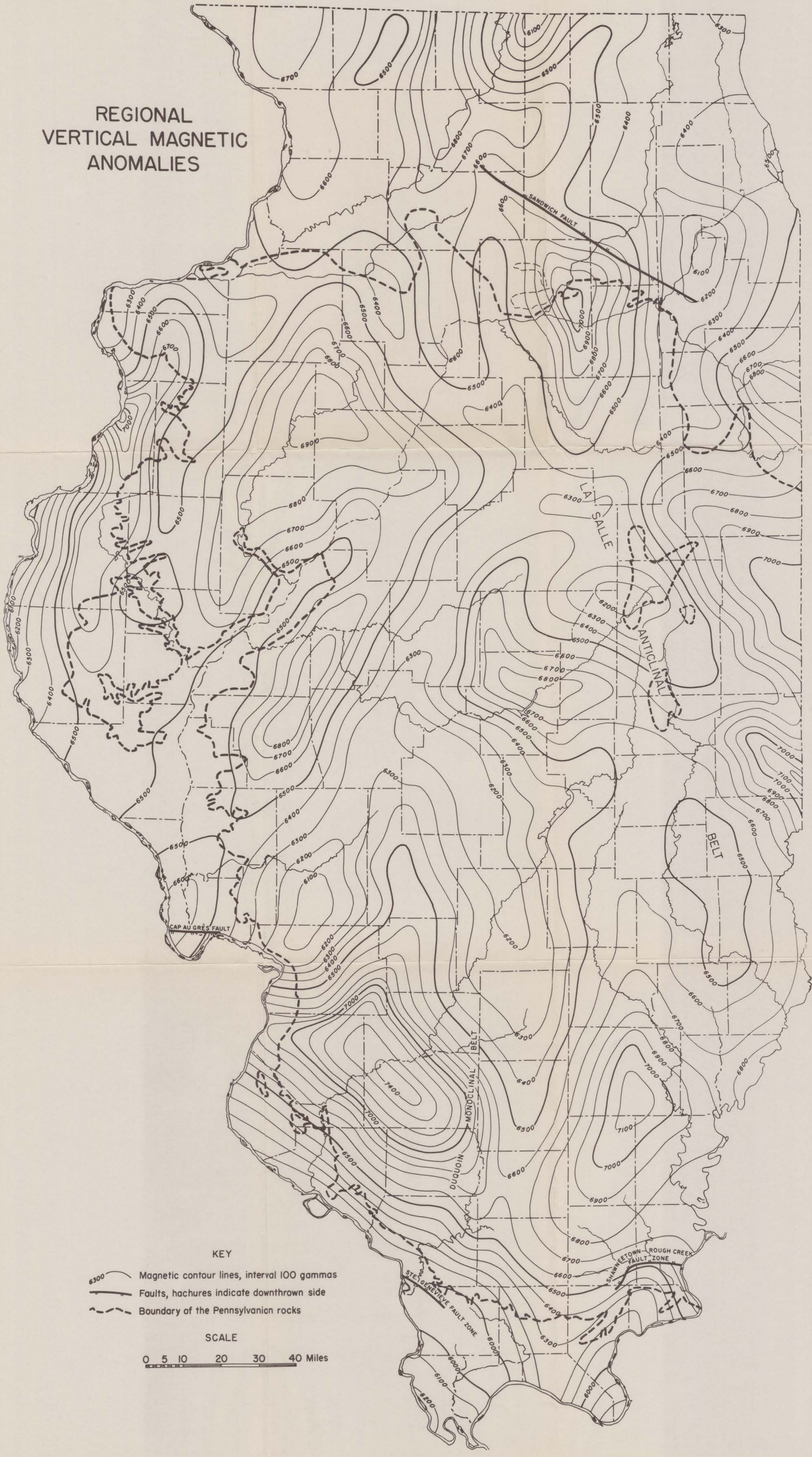
ILLINOIS STATE GEOLOGICAL SURVEY

URBANA

572 Litho in U.S.A.


OBSERVED
VERTICAL MAGNETIC
INTENSITY
KEY
5300 Magnetic contour lines, interval 100 gammas
Magnetic station locations
A——B Aeromagnetic profile (after Jensen, 1949)
SCALE
0 5 10 20 30 40 Miles
A
B
GALENA
DURAND
ROCKTON
HARVARD
CALEDONIA
WAUKEGAN
WOODSTOCK
FREEPORT
ROCKFORD
BELVIDERE
MT. CARROLL
OREGON
NORTH CHICAGO
CHICAGO
ROCHELLE
SYCAMORE
GENEVA
WHEATON
MORRISON
DIXON
SHABBONA
YORKVILLE
MENDOTA
JOLIET
MOLINE
PRINCETON
SENECA
MORRIS
ELWOOD
CAMBRIDGE
HENNEPIN
ARPEE
ALEDO
TOULON
STREATOR
KANKAKEE
LACON
OQUAWKA
GALESBURG
MONMOUTH
KNOXVILLE
PONTIAC
CHATSWORTH
EUREKA
WATSEKA
PEORIA
NAUVOO
PEKIN
BLOOMINGTON
PAXTON
HOOPESTON
MACOMB
SAYBROOK
CARTHAGE
LEWISTON
HAVANA
LINCOLN
CLINTON
DANVILLE
RUSHVILLE
URBANA
STERLING
PETERSBURG
MONTICELLO
QUINCY
VIRGINIA
DECATUR
JACKSON-VILLE
SPRINGFIELD
TUSCOLA
PITTSFIELD
WINCHESTER
SULLIVAN
PARISH
TAYLORVILLE
CHARLESTON
SHELBYVILLE
MARSHALL
CARROLLTON
CARLINVILLE
TOLEDO
HILLSBORO
JERSEYVILLE
EFFINGHAM
NEWTON
ROBINSON
VANDALIA
GREENVILLE
EDWARDSVILLE
HIGHLAND
LOUISVILLE
OLNEY
LAWRENCE-VILLE
CARLYLE
SALEM
BELLEVILLE
MT. CARMEL
ALBION
FAIRFIELD
NASHVILLE
WATERLOO
MT. VERNON
MC LEANSBORO
CARMI
PINCKNEYVILLE
BENTON
CHESTER
MURPHYSBORO
MARION
HARRISBURG
SHAWNEE-TOWN
ELIZABETH-TOWN
JONESBORO
VIENNA
GOLCONDA
METROPOLIS
MOUND CITY
CAIRO


REGIONAL
VERTICAL MAGNETIC
ANOMALIES
SANDWICH FAULT
LA SALLE
ANTICLINAL
BELT
CAP AU GRES FAULT
DUQUOIN
MONOCLINAL
BELT
SHAWNEETOWN - ROUGH CREEK
FAULT ZONE
STE. GENEVIEVE FAULT ZONE
KEY
6300 Magnetic contour lines, interval 100 gammas
Faults, hachures indicate downthrown side
Boundary of the Pennsylvanian rocks
SCALE
0 5 10 20 30 40 Miles