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BOUGUER GRAVITY ANOMALY MAP
NORTHEASTERN WISCONSIN

by

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This report summarizes information on the preparation and general geological significance of the Bouguer gravity anomaly map of northeastern Wisconsin. The map area is bounded on the north and east by the State of Michigan and by Lake Michigan, on the west by a north-south extension of the western boundary of Forest County, and on the south by approximately 45 degrees North latitude.

Precambrian igneous and metamorphic rocks, including gneisses, greenstones, and basic and acidic intrusives and extrusives, underlie the surficial glacial deposits and, in the southeastern corner of the study area a thin wedge of Lower Paleozoic sedimentary rocks. Geological investigations by Mancuso (1957, 1960), Cain (1964), Bayley and others (1966), Dutton and Bradley (1970), and others have shown that the Precambrian rocks in this area are structurally and lithologically complex. In spite of these studies the Precambrian geology is inadequately known because of sparse outcrop. Therefore, this gravity map has been prepared to aid in delineating the regional structure and lithology of the Precambrian basement rocks. Interpretation of the gravity map will be useful in extrapolating the outcrop geology into geologically unknown areas and in defining the subsurface configuration of the lithologic units, and it is a valuable guide to the determination of areas favorable for mineral exploration.

This study was undertaken as a Ph.D. thesis under the direction of Professor William J. Hinze, Michigan State University, and was sponsored by the Wisconsin Geological & Natural History Survey of University of Wisconsin-Extension and by Michigan State University, with the assistance of instrumentation provided by the U. S. Army Topographical Command.

Gravity Survey

Approximately 3500 gravity stations were established during the summers of 1967, 1968, and 1969 with LaCoste and Romberg geodetic gravity meters numbers 42 and 103. Observations were made at one-mile intervals along all available roads and tied to the international gravity network through University of Wisconsin base station GW3 (Behrendt and Woollard, 1961). Approximately one-half of the observations were made at points of known elevation, such as U. S. Geological Survey or U. S. Coast and Geodetic Survey bench marks, road corners, section corners, lake elevations, or other specific elevations taken from U. S. Geological Survey topographic quadrangle maps. Elevations for the remainder of the stations were determined by barometric altimeter surveying using two traveling instruments and a recording barograph at a nearby base station.

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Bouguer Gravity Anomaly Map

The Bouguer gravity anomaly values were computed using standard techniques as described by Dobrin (1960). The theoretical gravity was determined from the International Gravity Formula of 1930 and the combined elevation and mass correction factor was calculated using a vertical gravity gradient of .09406 mgal./foot and a density of 2.67gm./cc. for the material above sea level. Terrain corrections were unnecessary because gravity observations were not made in areas of marked local topographic relief. Evaluation of the potential sources of error indicates that the maximum probable error in the Bouguer gravity anomaly values is approximately 0.7 mgal. The major source of this error is due to the uncertainties in the barometrically determined elevations.

The Bouguer gravity anomaly map, which shows the location of the observation sites, was machine contoured at a two milligal interval utilizing a computer program prepared by California Computer Products, Inc. The principal facts of the gravity observations are available at the Wisconsin Geological and Natural History Survey.

Geological Significance of Anomalies

Bouguer gravity anomaly values are the summation of the effect of horizontal density variations, both in the nearsurface and in the deeper crustal and upper mantle layers. In northeastern Wisconsin the principal sources of the major gravity anomalies are variations in the composition of Precambrian rocks. Only minor gravity effects are attributed to bedrock topography, to the presence of Lower Paleozoic rocks in the southeastern corner of the area, and to lithologic variations within the glacial overburden. Resolution of local changes in lithology is limited by station interval and the precision of the reduction of the gravity data.

All gravity readings in the area mapped are negative, therefore the least negative anomalies are regarded as positive anomalies. Negative anomalies coincide with the lowest Bouguer gravity anomaly values.

In northeastern Wisconsin positive gravity anomalies are associated with basic rocks including greenstone, mafic gneisses, and intrusives. Examples of this type are the positive anomalies associated with the Quinnesec Formation and related mafic intrusives located in T.37N., R.21E., near the Michigan border east and northeast of Pembine and in the area between Niagara and Florence and especially in T.40N., R.18E., and R.19E. and another positive anomaly associated with a poorly known linear area of mafic rocks extending southeast from T.37N., R.12E., through the Argonne area.

Negative anomalies are associated with granitic intrusions and sedimentary synclinal belts. Examples of this type are located in the vicinity of Mountain and Langlade in the southwest quarter of the area which was described by Mancuso (1960) as a syncline, in the Pembine area which consists of the Newingham Granodiorite and other small acidic intrusives, in the Amberg area which consists of Amberg Granite, and in the Dunbar area which consists of Dunbar Gneiss. Isolated outcrops of gneiss occur along the extension of this negative but outside the area of mapped Dunbar Gneiss suggesting that gravity data can be used to refine geologic mapping in areas of sparse outcrop.

Many other anomalies are present whose cause remains to be determined.

Detailed quantitative studies of the gravity anomaly map, utilizing available geological information and density data, are currently underway.

REFERENCES CITES

Bayley, R.W., Dutton, C.E., and Lamey, C.A., 1966, Geology of the Menominee iron-bearing district Dickinson County, Michigan, and Florence and Marinette Counties, Wisconsin: U.S. Geol. Survey Prof. Paper 513, 96 p.

Behrendt, J.C., and Woollard, G.P., 1961, An evaluation of the gravity control network in North America: Geophysics, v. 26, p. 57-76.

Cain, J.A., 1964, Precambrian geology of the Pembine area, northeastern Wisconsin: Mich. Acad. Sci., Arts and Letters Papers, v. 49, p. 81-103.

Dobrin, M.B., 1960, Introduction to geophysical prospecting (2nd edition): McGraw-Hill, New York, 446 pp.

Dutton, C.E. and Bradley, R.E., 1970, Lithologic, geophysical and mineral commodity maps of Precambrian rocks in Wisconsin: U. S. Geological Survey Misc. Geologic Investigations, Map I-631.

Mancuso, J.J., 1957, Geology and mineralization of the Mountain area, Wisconsin: Master's thesis, Univ. Wisconsin, Madison, 32 pp.

_____, 1960, The stratigraphy and structure of the McCaslin district, Wisconsin, Ph.D. thesis, Michigan State University, 135 pp.