SOUTH DAKOTA GEOLOGICAL SURVEY
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STATE OF SOUTH DAKOTA
ARCHIE GUBBRUD, GOVERNOR

OIL and GAS INVESTIGATIONS
MAP 8

MAGNETOMETER MAP

TODD and MELLETTE COUNTIES

by

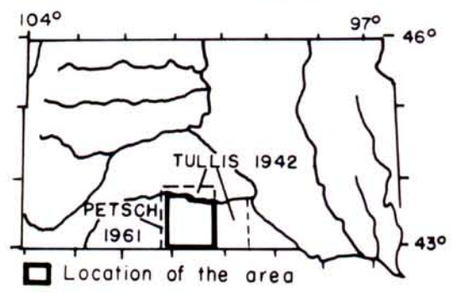
Bruno C. Petsch

1962

EXPLANATION

· 284 Vertical Intensity in Gammas
Dashed contours are modified from previous surveys.
Contour interval 50 Gammas

0 5 10 20 Miles
Scale



Magnetometer Survey of Todd and Mellette Counties
South Dakota

by
Bruno C Petsch

INTRODUCTION

A ground magnetometer survey of Todd and Mellette Counties was made in August, 1961, as part of the continuing magnetometer program of the South Dakota State Geological Survey under the direction of Dr. Allen F. Agnew, State Geologist. Magnetometer maps will eventually cover the entire State.

FIELD WORK

Observations were made with an Askania Vertical Ground Magnetometer at intervals of five miles with the assistance of Charles Mickel. This network of observations probably outlines the major magnetic features in the area.

In addition to changes in the earth's magnetic field caused by rock types and geologic structures, there is a gradual increase in the magnetic intensity toward the north magnetic pole. In this area the vertical intensity increases about 9 gammas per mile north and 3.2 gammas per mile east (Tullis, 1942). The application of this regional correction to a survey tends to result in a flat magnetic surface. Therefore any anomaly on this surface should be a geologic feature.

The diurnal (daily) variation was taken from repeated observations at a base station and from daily magnetograms supplied by the Tucson Magnetic Observatory of the U. S. Coast and Geodetic Survey. All magnetic observations were made in fields and pastures away from power lines, fences and other possibly magnetic objects.

TOPOGRAPHY

Mellette and Todd Counties lie in the Missouri Plateau subdivision of the Great Plains physiographic province. A large portion of the area is rolling to hilly range land and some is wheatland. There are some buttes and mesas. There is a 400-foot difference in elevation from the upland into the valleys of the White River and the Little White River. The drainage is northward into the White River for the most part, except in the eastern half of Todd County where it is eastward into the Keyapaha River. The southwest part of Todd County is in an area of large sand dunes or Sand Hills, and much of it is grassed over. Although a few creeks flow in the area, it is poorly drained. The area has drifting sand and blowouts; some dunes are 100 feet high and the blowouts are more than 10 feet deep.

The highest altitude is 3025 feet above sea level in the southwestern part of Todd County; the lowest is in the flood plain of the White River in the northeastern corner of Mellette County, which is between 1700 and 1800 feet above sea level.

SURFACE GEOLOGY

The area includes the extreme southern tip of the Williston Basin and the northeastern portion of the Kennedy Basin (Agnew, Gries, 1960).

Mesozoic and Cenozoic sedimentary rocks and sediments comprise the surface formations (table 1). They include alluvial, fluviatile lacustrine, marine, and eolian deposits.

Table 1.--Stratigraphic Classification

Era	Series	Group or Formation
Cenozoic	Pliocene	Ogallala Group Ash Hollow Formation Valentine Formation
	Miocene	Arikaree Group Mellette facies
	Oligocene	White River Group Brule Formation Chadron Formation
Mesozoic	Cretaceous	Pierre Shale

The Pierre Shale, a marine deposit of Cretaceous age, occurs over most of Mellette County. There is also a small area in the northeast corner of Todd County that has Pierre bedrock.

Cenozoic rocks are present over the remaining part of the area; the Oligocene White River Group lies directly on the horizontal Pierre with a contact that is easily traced and mapped. The White River sediments lose the "badlands" characteristics, which are so prominent just a short distance to the west, mainly due to the fact that they are at higher altitudes and out of the reach of headward erosion of the streams. The Chadron Formation at the base of the White River is mainly greenish to gray bentonitic fine silt and clay, with a poorly cemented gravel at the base. The Brule Formation is pinkish to grayish tuffaceous silt with channel deposits.

The Miocene Arikaree Group consists of siltstone, silicified claystone, and poorly cemented sandstone. It is generally more than 300 feet thick, and contains thin layers of fossiliferous limestone which are the Mellette facies of the Arikaree.

The southwestern part of the area is the Sand Hills region, containing the Ogallala Group. The Valentine Formation is a well sorted poorly cemented sand, it contains dunes of drifting sand and blowouts. The Ash Hollow Formation is a series of cemented calcareous silt, sand, and volcanic ash; it is present at the highest altitudes.

GENERAL STATEMENT

Theoretically the earth itself is a natural magnet. The forces set up between the north and south magnetic poles are made up of four components, declination, inclination, horizontal intensity, and the vertical intensity. The vertical component has been determined to be the most satisfactory to measure in geophysical research and magnetometer surveying because this force is a composite of all conditions that influence the magnetic field emanating from the crust of the earth. These conditions are composed of paramagnetic, diamagnetic, and non-magnetic substances which are in the basement complex, the subsurface sedimentary column and the ground surface.

The vertical intensity of the terrestrial magnetic field is illustrated by contour lines (isogams) on maps; the lines connect points of equal value. Variations of the intensity are recognized as positive and negative forces commonly known as magnetic highs and lows, or anomalies. The composite effect of the earth as a great magnet and the local variations in a given area, caused by geologic features, determine the size and shape of anomalies. Magnetic highs are generally considered when prospecting for oil and mineral deposits.

Magnetic surveys are used to indicate trends which are then investigated with more exact geological and geophysical surveys.

Possible cause of magnetometer anomalies are: (1) lithologic composition of rocks in the Precambrian, (2) concentration of magnetic minerals in the overlying sedimentary rocks and the "granite wash" or basal conglomerate developed on the basement, (3) deep-seated iron body, (4) changes in thickness of the "red bed" section, (5) structure of the sedimentary formations, (6) depth and relief of the Precambrian surface.

It is advantageous to make magnetometer surveys over areas where the geology is known. The solution of a magnetic problem is aided when the configuration of the anomaly can be compared with one that has been correctly interpreted in another area.

MAGNETIC ANOMALIES

The present magnetometer survey is bordered on the north by the survey of Jones County (Tullis, 1942), on the west by the survey of Bennett and Washabaugh Counties (Petsch, 1961), and on the east by the survey of Tripp County (Tullis, 1942).

The eastern end of the Kyle-Martin magnetic high (Petsch, 1961) continues in western Todd County between Parmalee and Rosebud. Except for a broad 400 gamma high in eastern Todd County, most of the mapped area is magnetically low. This is part of a regional low area that lies to the east. A magnetic low of four gammas is in southeastern Mellette County and is the lowest intensity in the entire region.

A magnetometer high apparently lies south of the Nebraska-South Dakota State boundary because along the line there are 356, 394 and 462 gamma observations over a distance of 15 miles.

GEOLOGIC ANALYSIS

The southeasterly extension of the Kyle-Martin magnetometer high which terminates in western Todd County is about 70 miles long and its eastern end trends slightly northeastward with a magnetic closure on it. If it indicates a structure of tectonic origin, it probably has a granite core.

All of Mellette County and the adjoining counties to the north and east is a regional magnetic flat low. The region apparently contains uniformly light-colored acidic igneous rocks in the Precambrian basement, probably granites, and the Paleozoic and Mesozoic Formations do no contain an unusual amount of magnetic minerals. If topographic undulations are present on the Precambrian surface, the magnetic low in southeast Mellette County is probably a basement topographic low area as compared to the magnetic high in the southeast part of Todd County, which may be a basement high.

The surface of the Precambrian basement slopes to the west, from about 500 feet below sea level in the northeast corner of Mellette County, to about 1200 feet below sea level at St. Francis in Todd County.

REFERENCES CITED

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