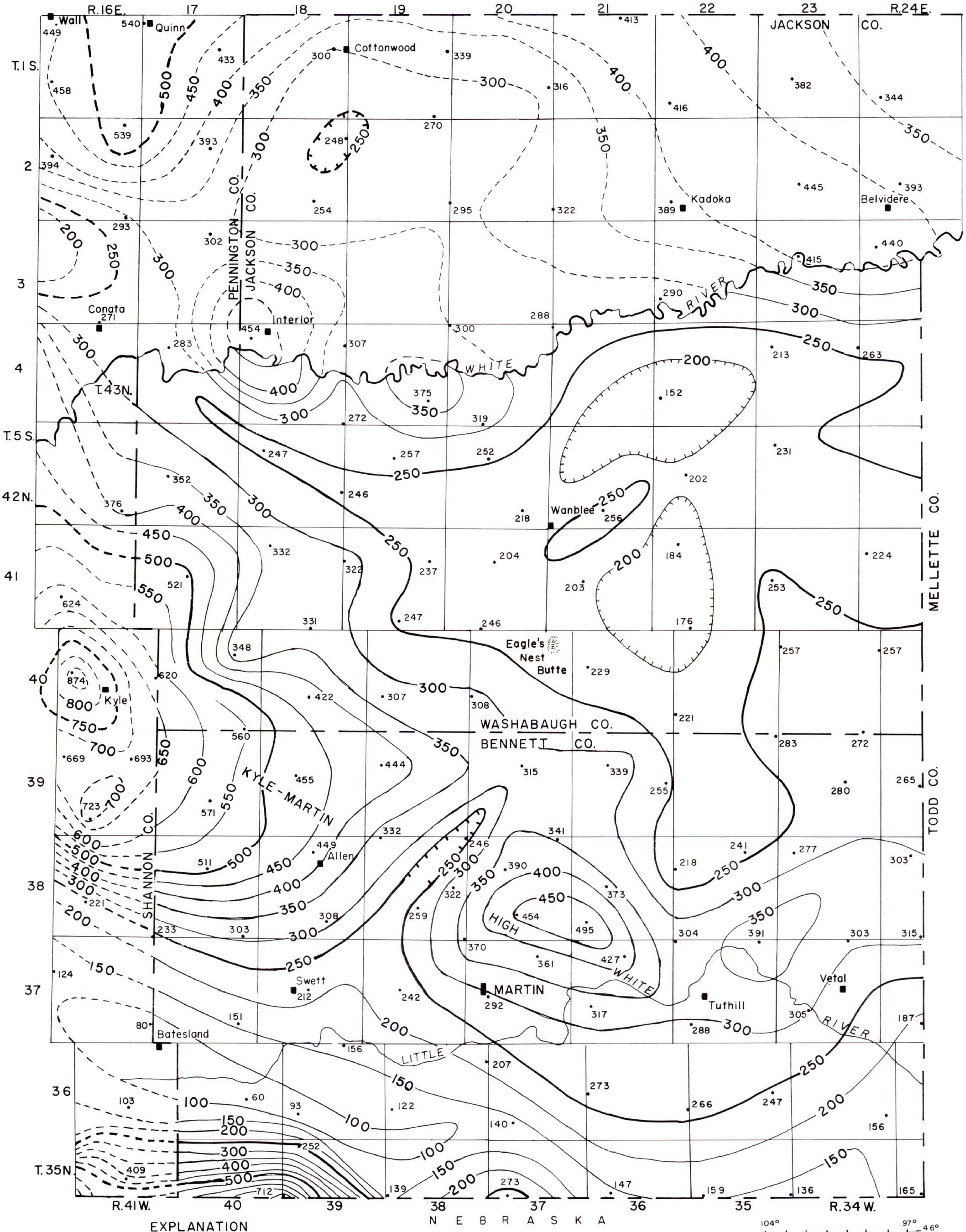
SOUTH DAKOTA GEOLOGICAL SURVEY
ALLEN F. AGNEW, STATE GEOLOGIST

STATE OF SOUTH DAKOTA
ARCHIE GUBBRUD, GOVERNOR

OIL and GAS INVESTIGATIONS
MAP 7



EXPLANATION

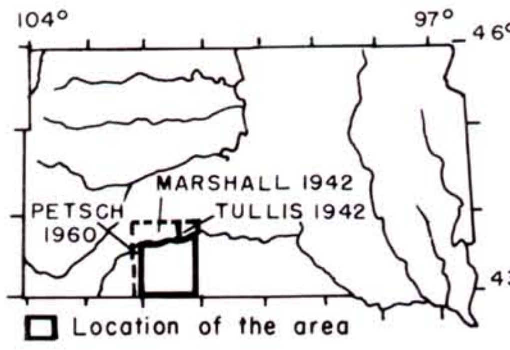
• 292 Vertical Intensity in Gammas

Dashed contours are modified from previous surveys.

Contour interval 50 Gammas

0 5 10 20 Miles

Scale



Location of the area

MAGNETOMETER MAP

BENNETT and WASHABAUGH COUNTIES

by

Bruno C. Petsch

1961

MAGNETOMETER MAP OF BENNETT AND WASHABAUGH COUNTIES

by

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INTRODUCTION

The magnetometer survey of Bennett and Washabaugh County was made in August, 1960, as part of the continuing magnetometer program of 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 closer spacing in an area northeast of Martin. This network of observations probably outlines the major magnetic features in the county. 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 increased 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 structure.

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

Bennett and Washabaugh Counties lie in the Missouri Plateau subdivision of the Northern Great Plains. A large portion of the area is rolling to hilly range land. Buttes and mesas are common. Erosional escarpments are at the edges of the highlands, and vast areas of impassible badlands occur in the northern part on the south side of the White River. The south part of the region is an area of great sand dunes or sandhills. Much of it is grassed over. It has no surface drainage, contains blowouts and drifting sand. Some dunes are 100 feet high.

The maximum topographic relief is 1327 feet, from the top of Eagle's Nest Butte south of Wanblee, to the valley floor of the White River.

SURFACE GEOLOGY

The area includes the extreme southern tip of the Williston Basin and the northern extension of the Kennedy Basin (Agnew, Gries, 1960). Mesozoic and Cenozoic sedimentary rocks and sediments comprise the surface formations of the area (see Table 1). They include alluvial, fluviatile, lacustrine, marine and eolian deposits. The youngest formations are in the southern part of the area.

The Pierre shale, a marine deposit of Cretaceous age, occurs in the northeastern part of the area along the White River, which constitutes only about ten percent of the area. The remaining ninety percent of Bennet and Washabaugh Counties is made up of Cenozoic formations.

The Cenozoic rocks are present in three areas; the Oligocene White River group is the northern part and makes up the badlands. The Chadron Formation at the base is mainly greenish to gray bentonitic fine silts and clays, with a conglomerate at the base. The Brule Formation is pinkish to grayish tuffaceous silts with channel deposits.

The central part of the area contains the Arikaree Group (Collins, 1959, 1960). The Sharps Formation at the base consists of calcareous soft clayey sandstone. The Monroe Creek Formation is well-sorted massively bedded sandstone. The Harrison Formation is composed of sands and silts with channel deposits and concretions.

The southern part of the area is the Sand Hills region, containing the Ogallala Group (Collins, 1959; Sevon, 1960). The Valentine Formation is a well-sorted poorly cemented sand; the material is quite porous and permeable. The formation contains dunes of drifting sand and blowouts. The Ash Hollow Formation at the top is a series of calcareous silt, limestone sandstone, and volcanic ash, and is present on the higher altitudes of the upland.

Table 1. --Stratigraphic Classification

Era	Series	Group or Formation
Cenozoic	Pliocene	Ogallala Ash Hollow Valentine
	Miocene	Arikaree Harrison Monroe Creek Sharps
	Oligocene	White River Brule Chadron
Mesozoic	Cretaceous	Pierre

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, the declination, horizontal intensity, dip or inclination, 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 large geologic trends which are then investigated by more exact geological and geophysical surveys.

Possible causes of magnetometer anomalies are: (1) lithologic composition of rocks in the Precambrian basement; (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 in magma; (4) changes in thickness of the "Red-Bed" section; (5) structure of the sedimentary formations; (6) depth to and relief of the Precambrian basement surface.

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

MAGNETIC ANOMALIES

The present magnetometer survey was added to the survey of Jackson County (Petsch and Carlson, 1952; Marshall, 1942; Tullis, 1942), and was continued eastward from the Shannon County survey (Petsch, 1960).

The outstanding feature mapped is the extension of the Kyle magnetometer high of Shannon County to the west. This high crosses Bennett County in a southeasterly direction, and appears to terminate near Tuthill. A 495-gamma reading is located north of Martin, and this high is separated from the remainder of the Kyle high by a sharp low northwest of Martin. A 391-gamma reading is present northeast of Tuthill.

A large portion of Washabaugh and the northeast part of Bennett County is low magnetically and contains a north-south alignment of three magnetometer lows, which turns northwestward into Jackson County. A lobe of this alignment trends northwestward through Conata in southeastern Pennington County. Two small highs are located in northwestern Washabaugh County along the White River.

The Southeast magnetometer high of Shannon County (Petsch, 1960) extends into the area as a larger high with a summit of 712 gammas along the State Line. This high anomaly is separated from the Kyle-Martin high by the Smithwick-Porcupine magnetometer low of Shannon County (Petsch, 1960), which continued southeastward through Batesland with readings as low as 60 gammas.

GEOLOGIC ANALYSIS

The Kyle magnetometer high is presumed to be caused by differences of rock type in the Precambrian basement (Petsch, 1960), owing to its irregular design. The present survey shows a southeasterly extension of the Kyle closure, about 50 miles long and 12 miles wide. The linear design of the extension indicates a tectonic origin. If it is related to tectonic forces it could have a buried granite ridge as a core. The two magmetic closures could then represent undulations on the structure.

The magnetometer high and low in southwestern Bennett County may be related to the Chadron Dome-Cambridge Arch. As there are only two oil test borings and one water well in the region, subsurface information is lacking; however certain significant observations can be made. The Greenhorn Formation dips northeasterly at 50 feet per mile between the English #1 Bucks oil test (NE¼SW¼ sec. 20, T. 36 N., R. 41 W.), and the English #1 Kocer oil test (SW¼SW¼ sec. 30, T. 37 N., R. 36 W). The Greenhorn dips northward at 6 feet per mile between the #1 Kocer and the Kadoka City water well. The Precambrian surface (Agnew, Gries, 1960) likewise shows a northeasterly slope. It is suggested that the region of steep dip on the Greenhorn in the southern part of the area is related to the Kyle-Martin high, the Smithwick-Porcupine-Batesland low, and the Southeast high, and that the area of low dips in northeastern Bennett County and the east half of Washabaugh County corresponds to the magnetically low area on the map.

A line drawn diagonally from northwest to southeast between the low smooth area of Washabaugh County and the rough high-low area of Bennett County, has about the same strike as the structure contours on the top of the Greenhorn Formation (Petsch, 1953) on the northeast flank of the Chadron Dome. In this respect there is an agreement between magnetic intensities and structure.

CONCLUSION

The regional magnetometer map of Bennett and Washabaugh Counties shows two prominent features--the high-low magnetic configuration in the southwestern half and the general low intensities of the northeastern half of the area. The former may be associated with the Chadron Dome or the Cambridge Arch. The general low corresponds to the low dips where the beds are passing from the flank of the Chadron-Cambridge Arch to the south end of the Williston Basin.

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