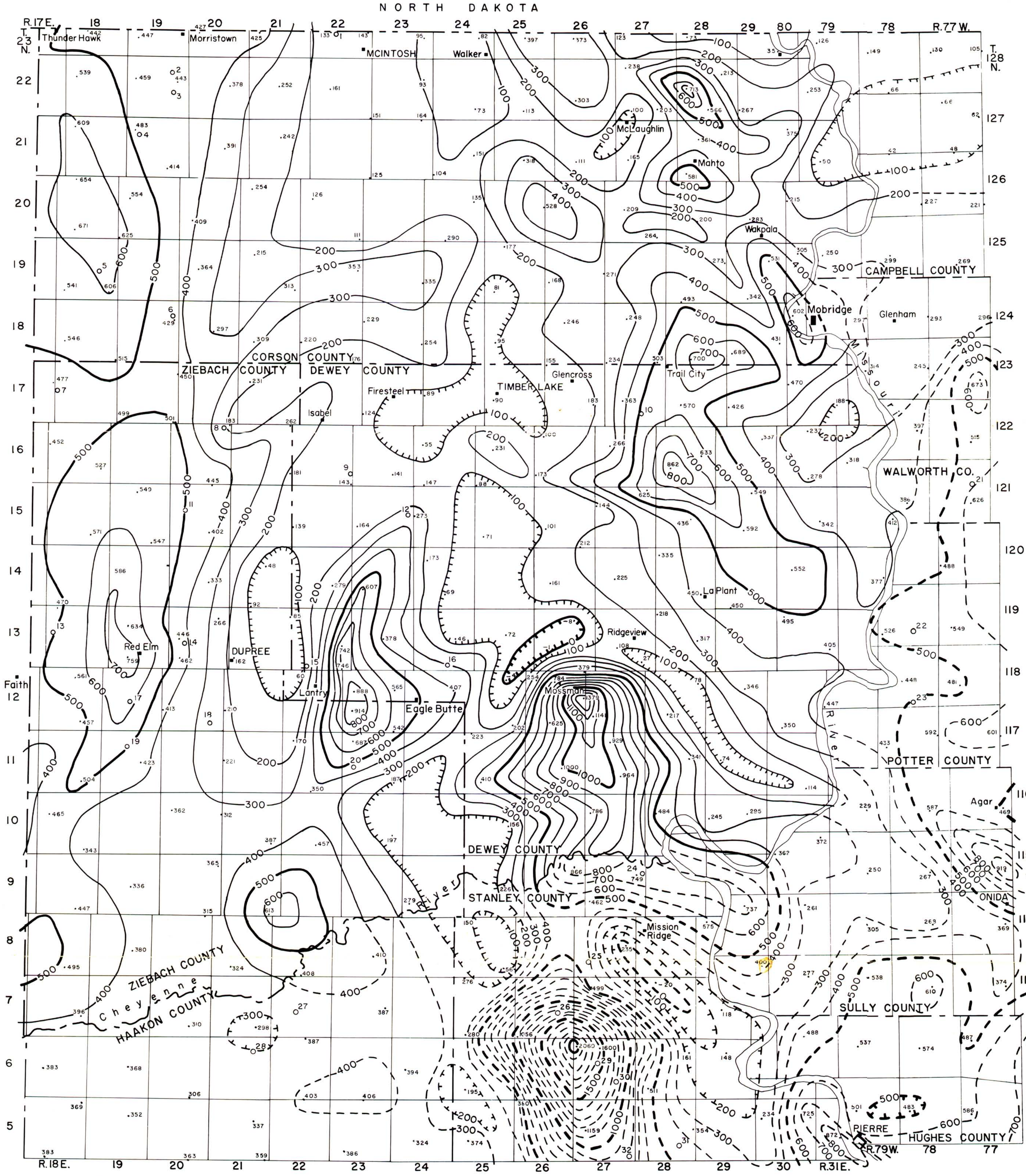
SOUTH DAKOTA GEOLOGICAL SURVEY
ALLEN F. AGNEW, STATE GEOLOGIST

STATE OF SOUTH DAKOTA
RALPH HERSETH, GOVERNOR

OIL and GAS INVESTIGATIONS
MAP 4



Oil Tests

1 Youngblood No.1 Draskovich, SE SE 20-22N-23E
2 Shell No.1 Winter, NW SW 11-22N-19E
3 Youngblood No.1 Winter, SW SW 23-22N-19E
4 Youngblood No.1 Macheel, SW SW 8-21N-19E
5 Shell No.11-23 Govt., NW NW 23-19N-18E
6 Shell No.22-12 Evridge, SE NW 12-18N-19E
7 Shell No.14-18 Dreis, SW SW 18-17N-18E
8 Herndon No.1 Young, NW NE 1-16N-20E
9 Youngblood No.1 Galvin, SE SE 25-16N-22E
10 Herndon No.1 Merkle, SE SE 27-17N-27E
11 Irish Creek, SE 17-15N-20E
12 Herndon No.1A O'leary, SE SW 13-15N-23E
13 Phillips No.1 Nelson, NW SE 18-13N-18E
14 Kerr-McGee No.1 Brammer, SE NW 20-13N-20E
15 Kerr-McGee No.1 Govt.-Cook, NW-SW 32-13N-22E
16 Herndon No.1 State, SW NW 34-13N-24E
17 Herndon No.1 Butler, NE NE 21-12N-19E
18 Dayton No.1 Olsen-Rural Credit, NE NE 35-12N-20E
19 Cosden No.1 Tanburg, SE NW 9-11N-19E
20 Phillips No.1 State, SE NW 20-11N-23E
21 Pray No.1 Kranzler, NW NW 14-121N-77W
22 Dakota-Texas No.1 Williams-Thompson, NW SE 27-119N-78W
23 Carter No.1 Whitlock-Smith, NE NE 34-118N-78W
24 Carter No.1 Loucks, SE SE 12-9N-27E
25 Shamrock No.1 Barrick, SW SW 29-8N-27E
26 Shamrock No.2 Barrick, SW SW 23-7N-26E
27 Pohle No.1 Govt., NE SE 21-7N-22E
28 Haakon Devel. No.1 Bierwagen, C NW 11-6N-21E
29 Phillips No.1 State-Dakota, NW NW 16-6N-27E
30 Benedum No.1 Shaffner, NW NW 26-6N-27E
31 Phillips No.1 Lang, NE SE 26-5N-28E
32 Phillips No.1 Stanley, NW NE 36-5N-27E

MAGNETOMETER MAP

CORSON, DEWEY AND ZIEBACH COUNTIES

SOUTH DAKOTA

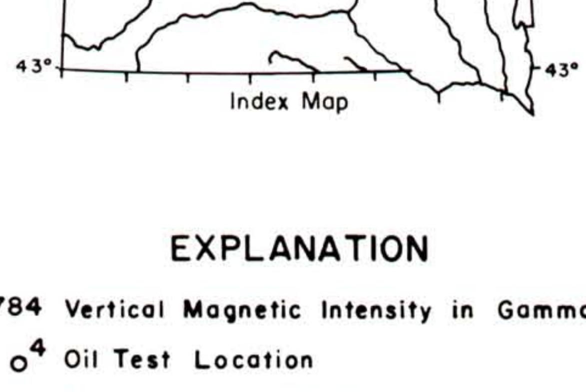
By

Bruno C. Petsch

1959

Scale of Miles

0 5 10 20 30 40



Index Map

EXPLANATION

.784 Vertical Magnetic Intensity in Gammas

o4 Oil Test Location

Contour Interval 100 Gammas

Magnetometer Survey of Corson, Dewey, and Ziebach Counties

SOUTH DAKOTA

by

Bruno C. Petsch

INTRODUCTION

A ground magnetometer survey was made during the summer of 1958 in Corson, Dewey, and Ziebach Counties. The survey was undertaken as a continuation of the magnetometer program of Dr. Allen F. Agnew, State Geologist; magnetometer maps will eventually be prepared for the entire State. About two-thirds of the state has been surveyed, and the results are published in five separate reports: Jordan, and Rothrock (1940a,b); Tullis (1942); Petsch and Carlson (1952); and Petsch (1958).

TOPOGRAPHY

Corson, Dewey, and Ziebach Counties lie in the north-central part of South Dakota. The area is bounded on the north by North Dakota, on the east by the Missouri River, and on the south by the Cheyenne River. It is drained by the Grand, Moreau, and Cheyenne Rivers, which flow eastward into the Missouri River. The gently rolling area, in the northern Great Plains, is interrupted by deep river valleys, and pointed buttes and flat-topped mesas are common throughout the mapped area.

The altitude of the land surface ranges from 1540 feet above sea level in the Missouri Valley to 2500 feet in the west; some of the buttes rise more than 200 feet above the general land surface.

SURFACE GEOLOGY

The area lies in the southeastern part of the Williston Basin. About 1600 feet of Mesozoic and Cenozoic rocks comprise the surface formations (see table 1).

Table 1. Exposed Rocks

ERA	SERIES	FORMATION AND LITHOLOGY		THICKNESS (feet)
Cenozoic	Paleocene	Cannonball	silt, clay, sand, limestone concretions, mollusks	200
		Ludlow	sandstone, sand, shale, lignite	130
Mesozoic	Cretaceous	Hell Creek	bentonitic clay, sand, silt, lignite, dinosaur bones	140
		Fox Hills	sandstone, shale, mollusks	300
		Pierre	shale, bentonitic and siliceous, clay-ironstone concretions, fossils	830+

The Pierre Formation is exposed along the eastern side of the mapped area, where it forms the walls of the Missouri River Valley, along the southern side including much of the Cheyenne River drainage, and through the central part along the Moreau River drainage. The Pierre is at least 2200 feet thick in the mapped area, but only 830 feet is exposed. The Pierre consists of dark-gray shales, bentonite seams, gray calcareous fossiliferous shales, siliceous shales, and clay-ironstone concretions.

The Fox Hills Formation, about 300 feet thick, is divided into four members. The Trail City Member at the base is bentonitic fissile shale; the Timber Lake Member is buff friable sandstone; the Bullhead is light- and dark-gray shale alternating with fine-grained sand; and the Colgate Member is a light-gray fossiliferous sandstone.

The Hell Creek Formation, about 140 feet thick consists of light- and dark-gray bentonitic clays interbedded with grayish sands and silts. It contains lignitic seams, including the Isabel-Firesteel coal near the middle of the formation, which is up to 6 feet thick. Dinosaur bones are present in the Hell Creek.

The Ludlow Formation is about 130 feet thick. It contains hard and soft sandstone, dark shale, carbonaceous shale, peat, and several lignite beds. At the base is a persistent unit of lignite and peat called the Shadehill, and near the top is another lignitic unit called the Hillen.

The Cannonball Formation is about 200 feet thick. It consists of interbedded silts, clays and sand, with abundant small gray limestone concretions which contain marine mollusks.

SUBSURFACE GEOLOGY AND STRUCTURE

The regional dip of the Greenhorn Formation on the southeastern flank of the Williston Basin is 12 feet per mile to the northwest (Petsch 1953a) (Figure 1), whereas the Precambrian surface slopes about 44 feet per mile in the same direction (Petsch 1953b).

Nearly all formations above the Precambrian thicken northwestward into the basin, with new units being added.

The maximum thickness of sedimentary rocks in the area, in the Shell #1 Winter oil test, is 3717 feet of Tertiary sands and clays, and Cretaceous shale, limestone and sandstone; 328 feet of Jurassic shale, sandstone, and limestone; 275 feet of Triassic red beds, with gypsum and anhydrite; and 4188 feet of Paleozoic rock that is mostly limestone and dolomite.

FIELD WORK

Observations were made with an Askania Vertical Magnetometer at intervals of four to six miles. This network probably outlines the major magnetic features. The magnetometer has a sensitivity of 19.9 gammas per scale division, and the magnet system has a zero temperature coefficient.

In South Dakota the vertical magnetic intensity increases from 56,000 to 58,000 gammas, from southwest to northeast (Howe and Knapp, 1938, map 4). This normal or regional variation was compensated for by subtracting 9 gammas per mile northward and 3.2 gammas per mile eastward from the base stations, in order to maintain a flat magnetic surface. The application of the regional correction to the observed magnetometer readings does not change the location of the anomalies, but merely affects the value. The correction is not applied to small surveys and is sometimes removed from large surveys (W. P. Haseman, personal communication, 1932), for interpretation purposes.

Diurnal variation was taken from a three-point curve and from daily magnetograms supplied by the Tucson Magnetic Observatory. The magnetogram shows the true daily variation curve, which cannot be shown by a three-point curve. The magnetogram is used when the noon check-in cannot be made; this happens when distances are too great to return to the base, or when a magnetic storm is in progress. All magnetic observations were made in fields or pastures, at least 100 yards from power lines, fences, buildings and other possibly magnetic objects.

MAGNETIC ANOMALIES

The total magnetic relief in the area is 1387 gammas, which includes a low reading of -8 gammas in sec. 10, T. 13 N., R. 26 E., to a high of 1379 gammas in sec. 13, T. 12 N., R. 26 E. The two extremes are only 7 miles apart, near Mossman. The Mossman high anomaly is the fourth highest mapped to date in South Dakota. The three other higher anomalies are the 2060-gamma high in Stanley County (Marshall, 1942), a 1530-gamma high at Parkston in Hutchinson County (Jordan and Rothrock, 1940a) and a 1401-gamma high in Hyde County (Jordan and Rothrock, 1940b).

Several other magnetic highs were outlined in the area. The Lantry high in southwestern Dewey County reaches 914 gammas, and is about 24 miles long. A twin high in the vicinity of Trail City in northern Dewey County reaches 700 and 862 gammas, and the summits are 11 miles apart. Another twin high is located at Mahto in eastern Corson County; its summits are 581 and 713 gammas, and are 8 miles apart. The Mahto, Trail City and Mossman highs appear to be alined north-south, and extend southward to join the large Stanley County high.

Local magnetic anomalies of moderate intensity are present in other parts of the area.

The smooth magnetic slope in eastern Perkins County (Petsch, 1958) which extends from Lemmon southward to Red Elm, terminates to the east in a north-south magnetic high that is more than 100 miles long and about 12 miles wide. It is outlined by a 500-gamma contour.

Between the Lemmon-Red Elm feature on the west and the Mahto-Stanley trend in the eastern part of the area low magnetic intensities are present, below the 200-gamma contour. These include the aforementioned minimum of -8 gammas, seven miles north of Mossman.

GEOLOGIC ANALYSIS

Magnetic surveys are used to indicate large regional geologic trends, and to serve as a starting point for more exact geological or geophysical surveys.

The areal extent and magnitude of magnetic anomalies depend upon several factors, among which are the topographic relief and the lithologic composition of the Precambrian basement, the magnetic mineral content of the sedimentary rocks, and the structure of the sedimentary formations.

The interpretation of a magnetometer map is greatly aided by comparing its magnetic features with other illustrations of anomalies that have been correctly interpreted.

A pronounced feature in the mapped area, the Lemmon-Red Elm magnetic high, indicates a tectonic origin; the linear design as shown by the contours suggests that the anomaly may be caused by structure with a buried granite ridge as a core. The broad uniform character of the anomaly is probably caused in part by the shielding effect of at least 8000 feet of sedimentary rocks, which tends to mask magnetic susceptibility changes in the Precambrian basement, and also equalizes changes in the formations which are here much more uniform than several miles to the east. This high is similar to the Hendriks-Redig high in central Harding County (Petsch, 1958 map). The crest near Lemmon is marked by a 600-gamma contour in T. 20 N., R. 18 E., which is about 18 miles long and 7 miles wide. The Shell #11-23 Government oil test was drilled on the southern end of this high, presumably on seismic information. This test, bottomed in the Mississippian Lodgepole limestone, had no shows of oil or gas.

A 700-gamma contour marks the crest of the high at Red Elm, where it is also 18 miles long and 7 miles wide. The Herndon #1 Butler oil test was drilled at the southern end, presumably on a seismic high. This test, which bottomed in the Ordovician Red River dolomite, had oil stains in the upper part of the Mississippian limestone section. The Phillips #1 Nelson was drilled on the western flank, and the Kerr-McGee #1 Brammer was drilled on the eastern flank. The former bottomed in the Jurassic Morrison shale, and the latter in the Cambrian Deadwood sand. The latter had an oil show in the Red River dolomite samples, but a drill-stem test recovered only salt water. Although these South Dakota oil tests were dry holes, many magnetometer highs like these coincide with oil fields in the Mid-Continent States.

A north-south magnetic high at Lantry is at least 25 miles long and about 15 miles wide. It is apparently on a seismic trend, and the Phillips #1 State was drilled at its southern end and the Herndon #1 O'Leary was drilled at the northern end. The Phillips well, bottomed in the Jurassic Morrison shale, had a gas show in the Cretaceous Niobrara-Codell; the Herndon well, which bottomed in the Mississippian Mission Canyon limestone, was dry. The Herndon #1 State was drilled on the eastern flank, and tested as low as the Ordovician Red River dolomite, but had no shows. The Kerr-McGee #1 Cook was drilled on the western flank of the magnetic high; this well drilled to the Precambrian, and recovered a small amount of gas and oil from the Ordovician Red River in a drill-stem test. The Lantry high resembles a similar high in Chico County, Arkansas, which was proved to be a Precambrian high buried under 3600 feet of sedimentary rocks.

The Mahto-Stanley trend along the eastern side of the area is a salient feature appearing as a ridge; it contains six closures with summits of 581 to 2060 gammas. Abrupt changes in the composition of the Precambrian basement from normal granite could yield this type of anomaly. The Mahto-Stanley trend is situated on the southeastern flank of the Williston Basin, in a region where the Piper Spearfish, Minnekahta, Charles, Devonian, Silurian and Cambrian formations are pinched out or are thinned (Figure 2, 3). The resulting unconformities could contain a concentration of magnetic minerals, which in turn could contribute to the magnetic intensity. The shielding effect of the sedimentary formations in the Williston Basin is here reduced by at least 3600 feet; this might account partly for the more pronounced highs. This Mahto-Stanley trend may be a continuation of the Sioux Ridge, which comes into Stanley County from the southeast.

The Mossman high of 1379 gammas in southern Corson County is similar to a magnetic high in Hyde County, South Dakota (Jordan and Rothrock, 1940b) in intensity. The latter has a summit of 1401 gammas, and its Precambrian core at 2555 feet depth is a diabase. In contrast, the Precambrian under the Mossman high is probably at least 4800 feet deep, but possibly consists of similar basic igneous rocks.

A long narrow magnetic low that trends northwest-southeast from Ridgeview possibly indicates a deep seated fault.

The magnetic low throughout the central part of the area may contain a combination of granitic igneous rocks and basic intrusive rocks in the basement. Magnetic susceptibility changes could cause local differences in polarization, which are shown by the non-linear configuration of the contour lines.

To date no oil tests have been drilled on the summits of the magnetic highs in the area under investigation.

CONCLUSIONS

The regional magnetic map of Corson, Dewey, and Ziebach Counties shows three prominent anomalies; (1) the Lemmon-Red Elm high on the west which may have a tectonic origin, (2) the Mahto-Stanley trend on the east which may be an extension of the Sioux Ridge, may be related to changes in the composition of the Precambrian basement rocks, or may possibly be due to stratigraphic pinch-outs in the subsurface Paleozoic rocks, (3) the central low which is interrupted by the Lantry high and small local highs. There is a northwesterly regional dip in all the sedimentary formations, and a northwesterly slope of the Precambrian surface, which corresponds roughly with the general slope of the mean magnetic profile.

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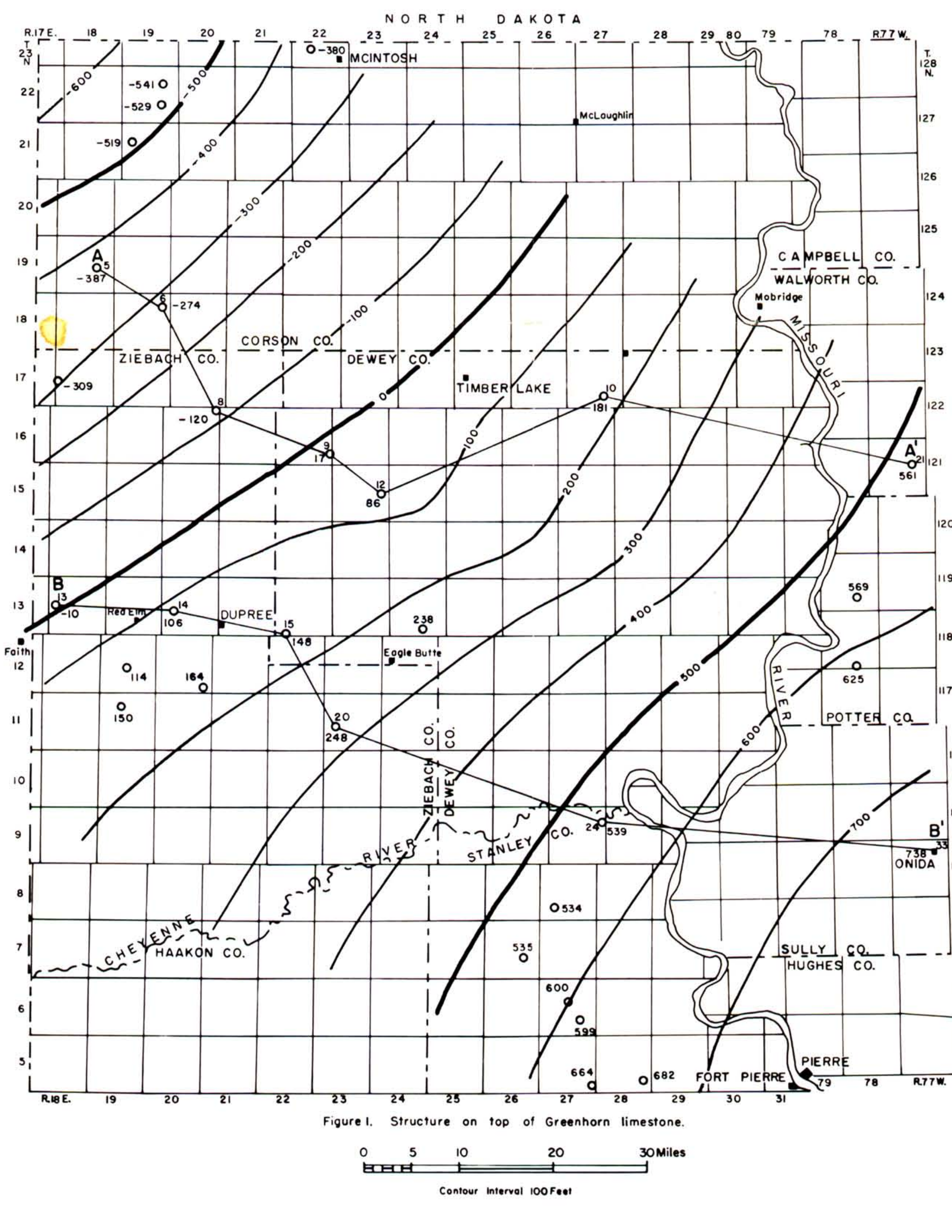

Figure 1. Structure on top of Greenhorn limestone.

0 5 10 20 30 Miles

Contour Interval 100 Feet

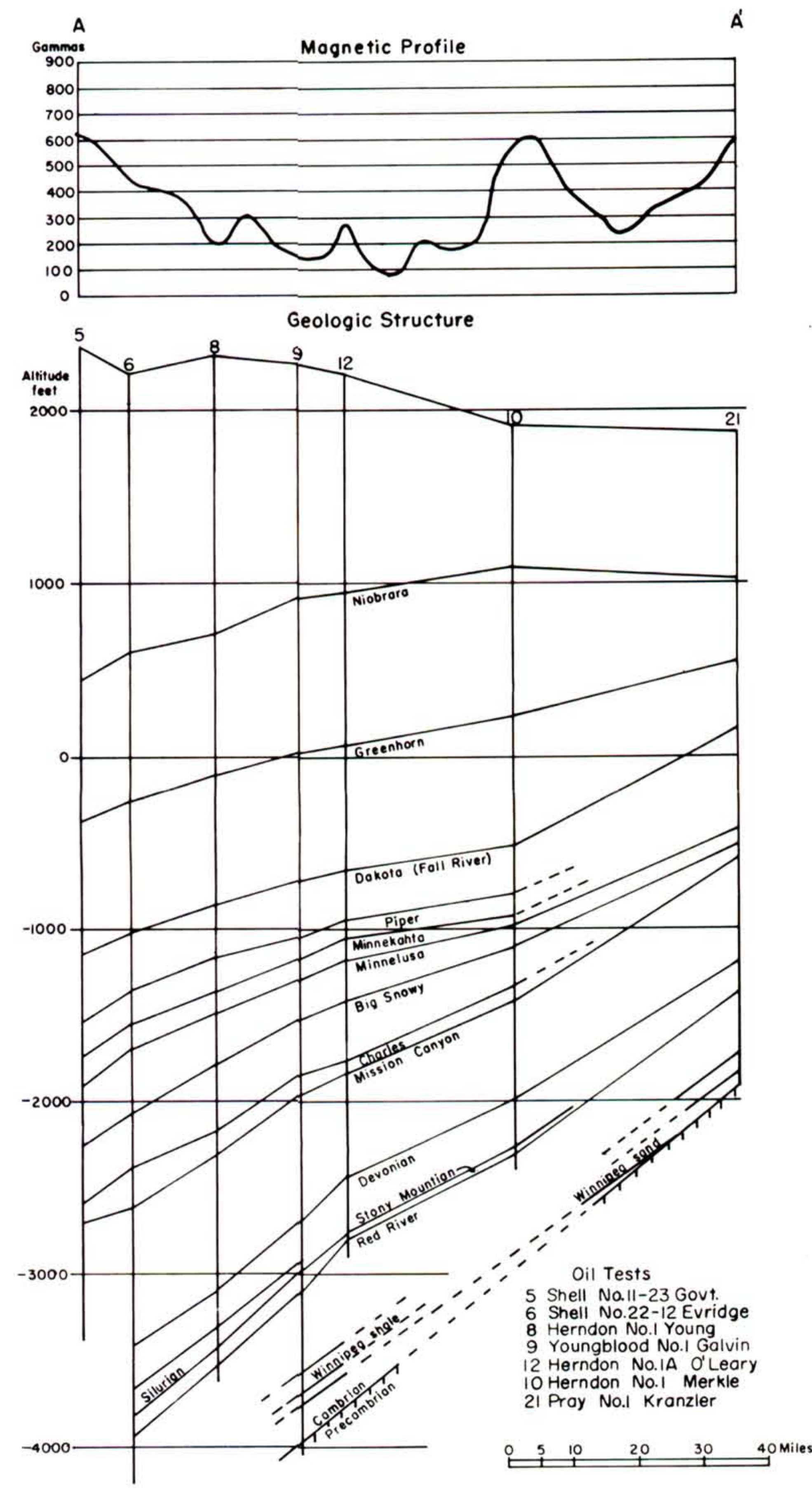

Figure 2. - Cross-section A-A', Showing Geologic Structure and Magnetic Profile.

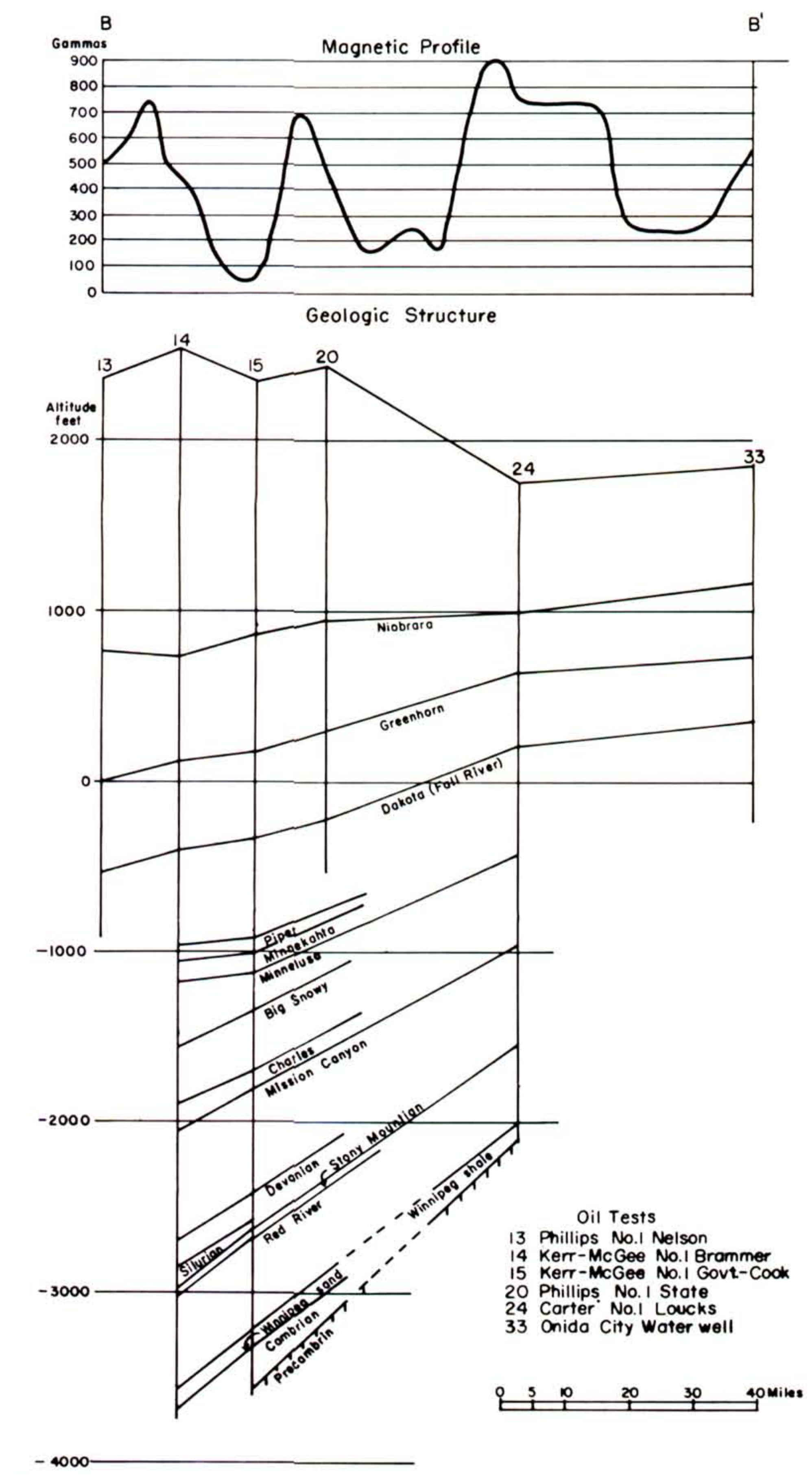

Figure 3. - Cross-section B-B', Showing Geologic Structure and Magnetic Profile.