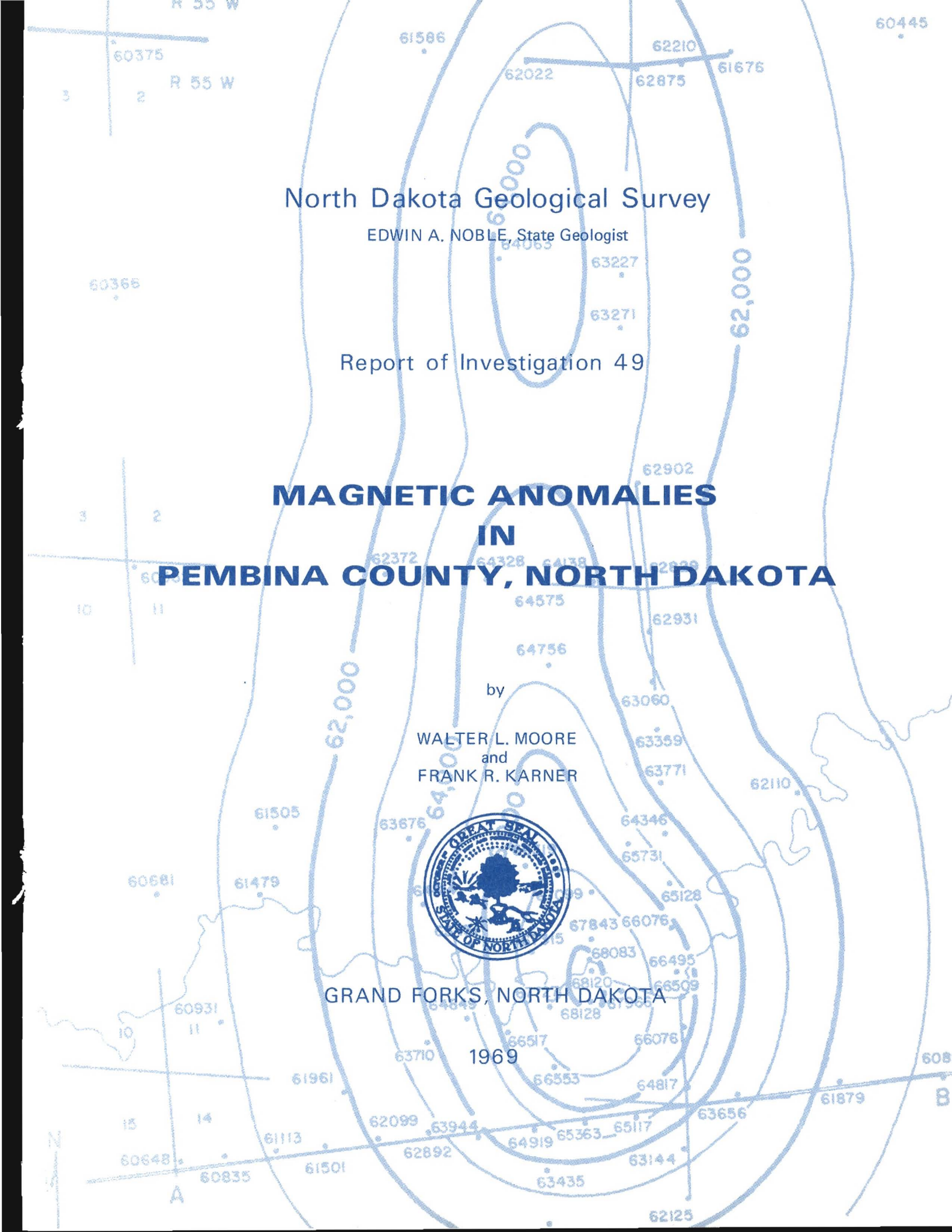

North Dakota Geological Survey

EDWIN A. NOBLE, State Geologist

Report of Investigation 49

MAGNETIC ANOMALIES IN PEMBINA COUNTY, NORTH DAKOTA

by

WALTER L. MOORE
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In a letter dated October 6, 1964, Mr. C. E. Harding of the Topographic Branch of the U. S. Geological Survey reported to the North Dakota Geological Survey that workers had encountered difficulty using magnetic compasses while mapping in northeastern North Dakota. He pinpointed two troublesome areas, one near Hensel and the other near Akra in the west-central part of Pembina County. Coincident with the arrival of this note, the Department of Geology of the University of North Dakota acquired a new magnetometer, an instrument designed to measure the strength of the earth's magnetic field. The letter and the arrival of the new instrument prompted the authors to investigate the area on a chill, late fall day in 1964.

Enclosed with the letter were two maps indicating the troublesome spots, and, with this accurate control, the sites of the unusually intense magnetic fields were quickly located. The earth's magnetic field in Pembina County would be expected to have a value of approximately 60,000 gammas, the gamma being the unit of magnetic field strength. Over the more intense anomaly near Hensel (called an anomaly because of its departure from the expected total field), the field was measured in excess of 71,500 gammas (11,500 gammas in excess of the usual field), or about 1/6 of the earth's field stronger than normal. The anomaly near Akra was found to be 7,500 gammas in excess of the usual field.

Later in the summer of 1966 more detailed studies by Tonis Tamm, a student at the University, outlined the anomalies as shown in figures 1 to 3. He found higher maximum values for the total field in the two previously located areas and located, near St. Thomas in south-central Pembina County, a third anomaly in which the total field was about 4,500 gammas larger than would normally be expected (fig. 4). The three anomalies known to date form an arcuate pattern extending northwestward across Pembina County (fig. 1).

The early magnetometer work was motivated largely by scientific curiosity prompted by the idea that possibly a buried meteorite might be involved as the cause of the unusual field. The large size of the magnetic discrepancy, both in intensity and area of expression, discouraged, though it did not disprove, this idea. Interest in the anomalies revived later when it was found that similar anomalies in Missouri were associated with economic deposits of iron ore, and it was at this time that Mr. Tamm's more detailed work was undertaken. This study was supported in part by a grant from the North Dakota Industrial Commission and in part by an Undergraduate Research participation Grant sponsored by the National Science Foundation.

The anomalies present a number of problems of which the foremost is whether they are due to ore bodies of economic value or to some other magnetic material. This question can be answered only by sampling, and in this case sampling means drilling. The deposit is almost certainly associated with a buried older suite of rocks, commonly called the basement. These rocks are overlain by a succession of younger sedimentary rocks topped by the deposits of glacial Lake Agassiz which form the present surface of the Red River Valley in this area. As shown in figure 5 the surface of the basement generally slopes westward from near sea level at St. Thomas to approximately 450 feet below sea level at Akra. The surface elevation, at or near 900 feet in this area, indicates required drilling depths ranging from 900 to 1350 feet from the surface to the deposit, if one presumes the deposit top is coincident with the upper contact of the basement. Such drilling remains for the future because of its relatively high cost.

At present, meaningful ideas about the origin of the anomalies can be placed in essentially three classes.

The anomalies are due to:

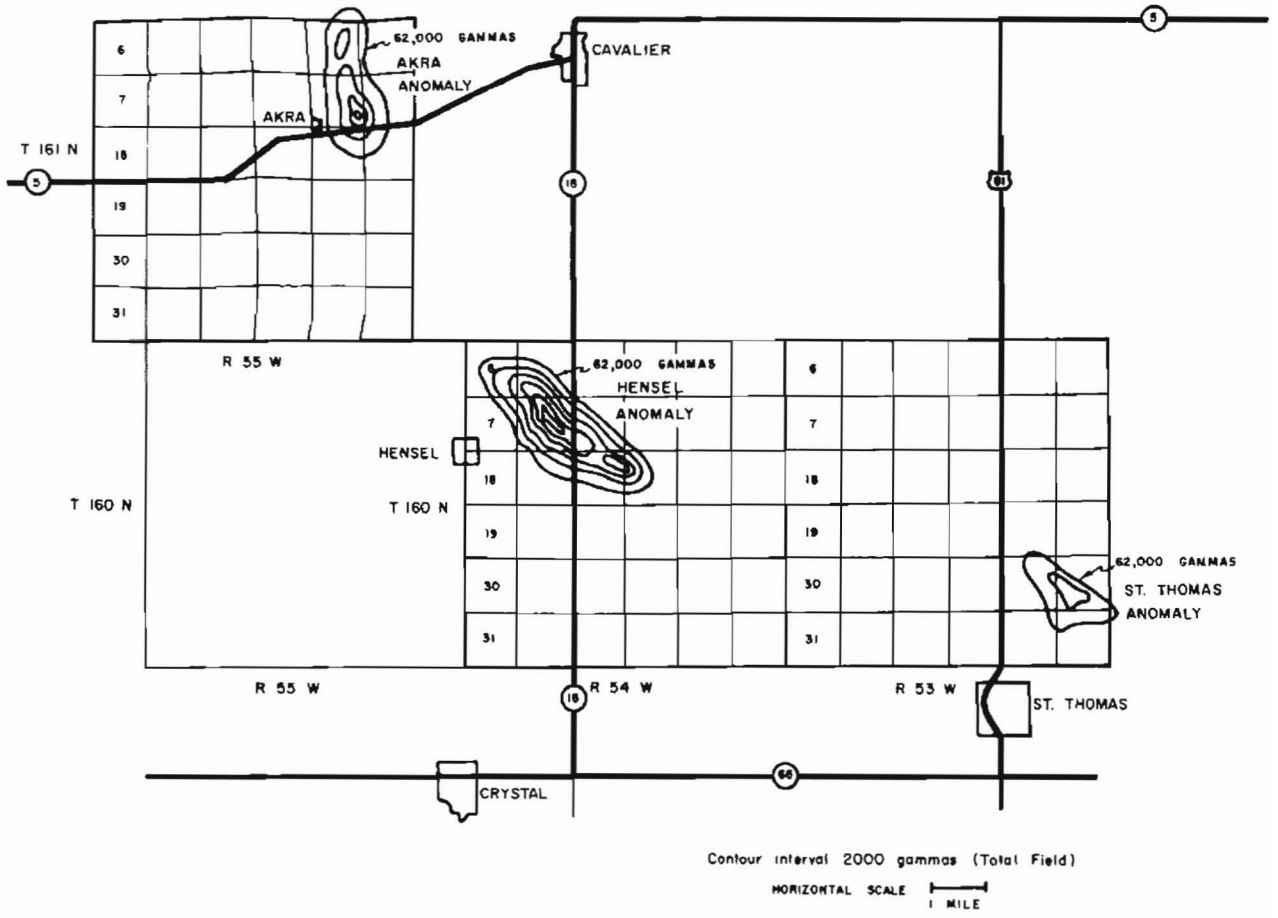
1. Hematite bodies, the red ore of iron.

2. Magnetite, the black magnetic ore of iron, disseminated in gabbros or similar rocks.

3. Magnetite-rich bodies of igneous or replacement origin.

Hematite bodies of class 1 and magnetite bodies of class 2 occur to the east in Minnesota where the basement is exposed at the surface. The magnetic anomalies associated with these bodies cover larger areas and do not exhibit the steep, magnetic field gradients of the Pembina County anomalies. A reasonable, but by no means certain, conclusion is that these anomalies are not due to the former but are caused by concentrated magnetite bodies of class 3.

At the present time, the Pembina sites are being investigated and mineral rights are being leased by several mining companies. It is probable that the anomalies will be explored by drilling in the near future. Hopefully, they will prove to have economic value which could make a significant contribution to the economy of North Dakota.



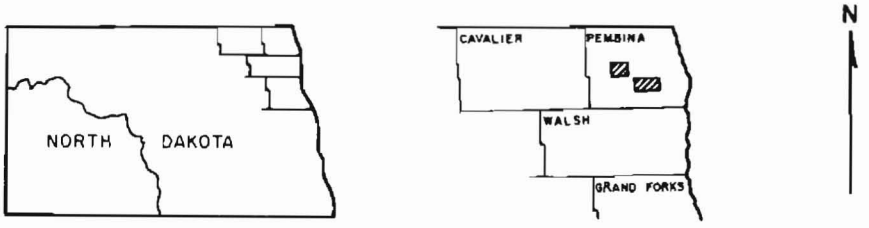


Figure 1. Generalized location map showing the known magnetic anomalies in northeastern North Dakota.

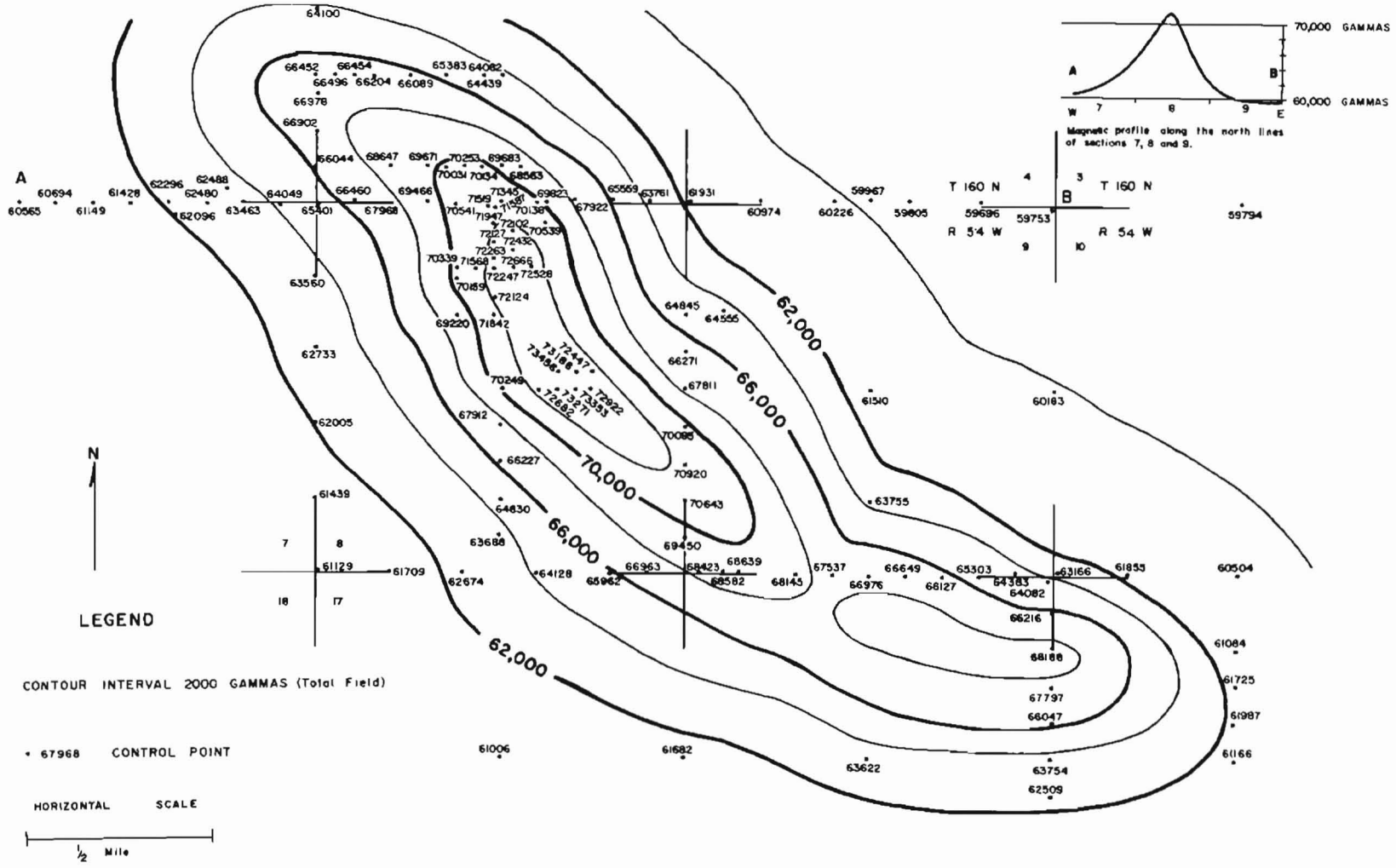


Figure 2. Map showing the total magnetic field of the Hensel anomaly which is centered on section 8, T 160 N, R 54 W, Pembina County, North Dakota.

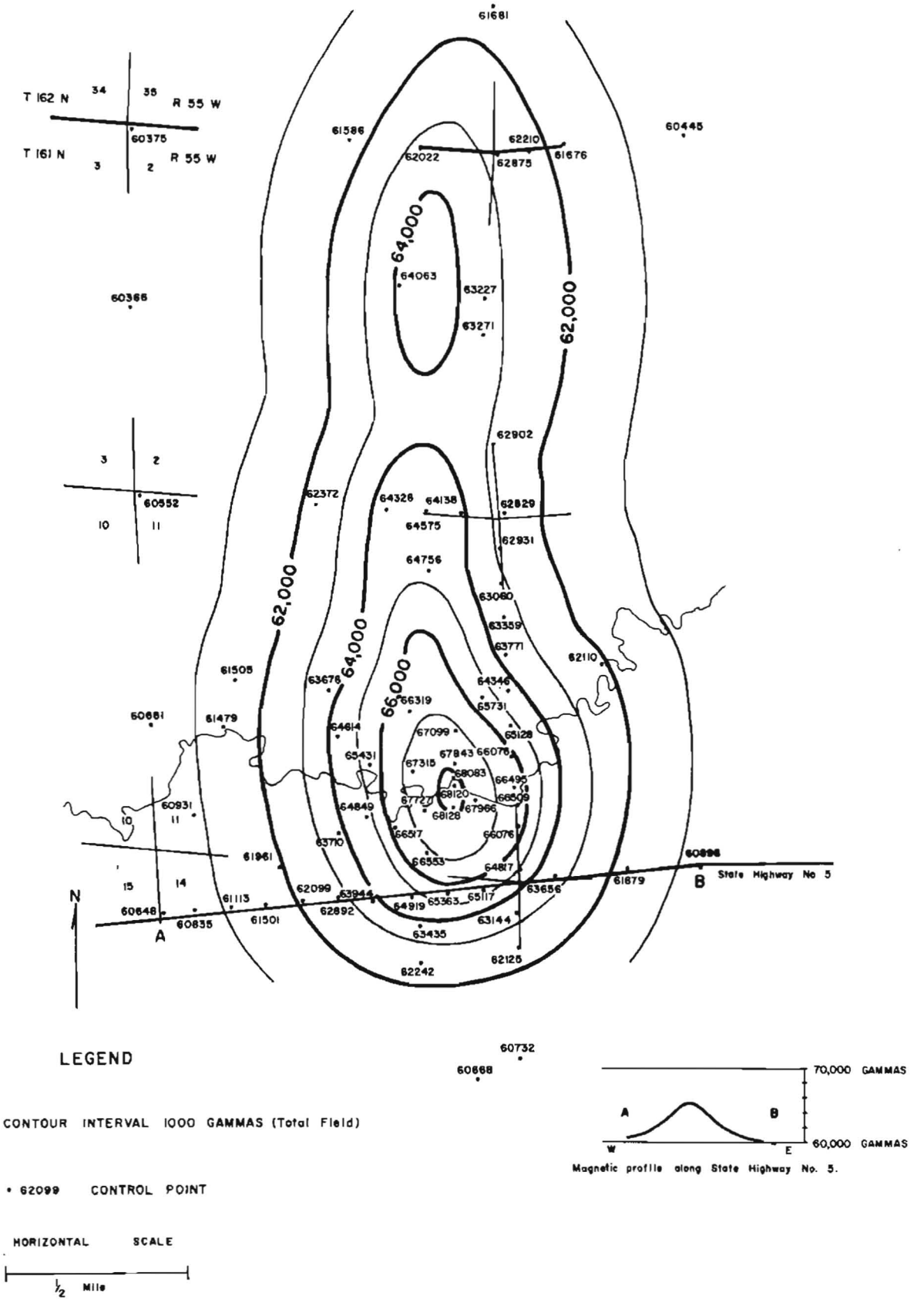


Figure 3. Map showing the total magnetic field of the Akra anomaly which is centered on the southeast quarter of section 11, T 161 N, R 55 W, Pembina County, North Dakota.

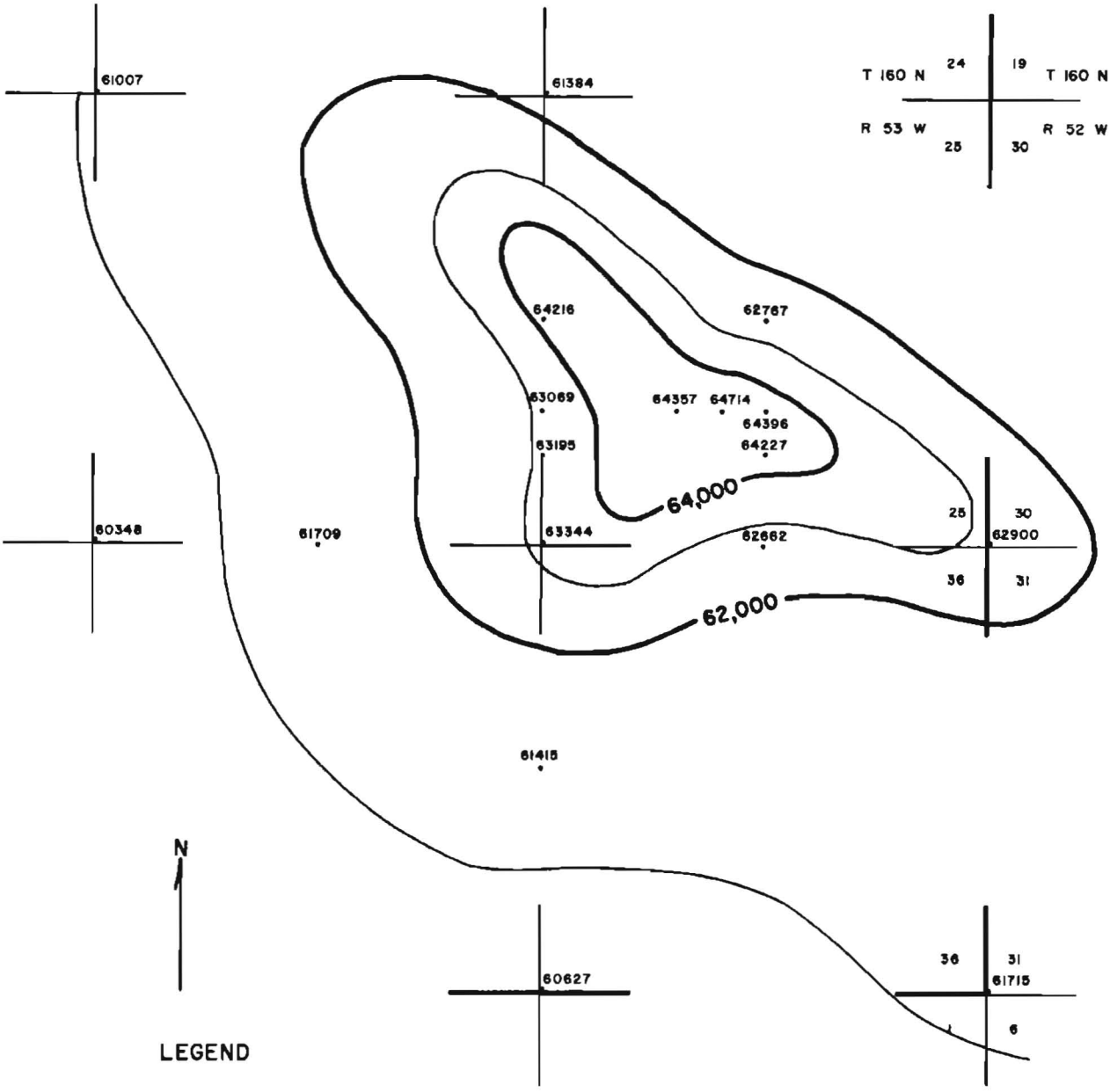


Figure 4. Map showing the total magnetic field of the St. Thomas anomaly which is centered on the southwest quarter of section 25, T 160 N, R 53 W, Pembina County, North Dakota.

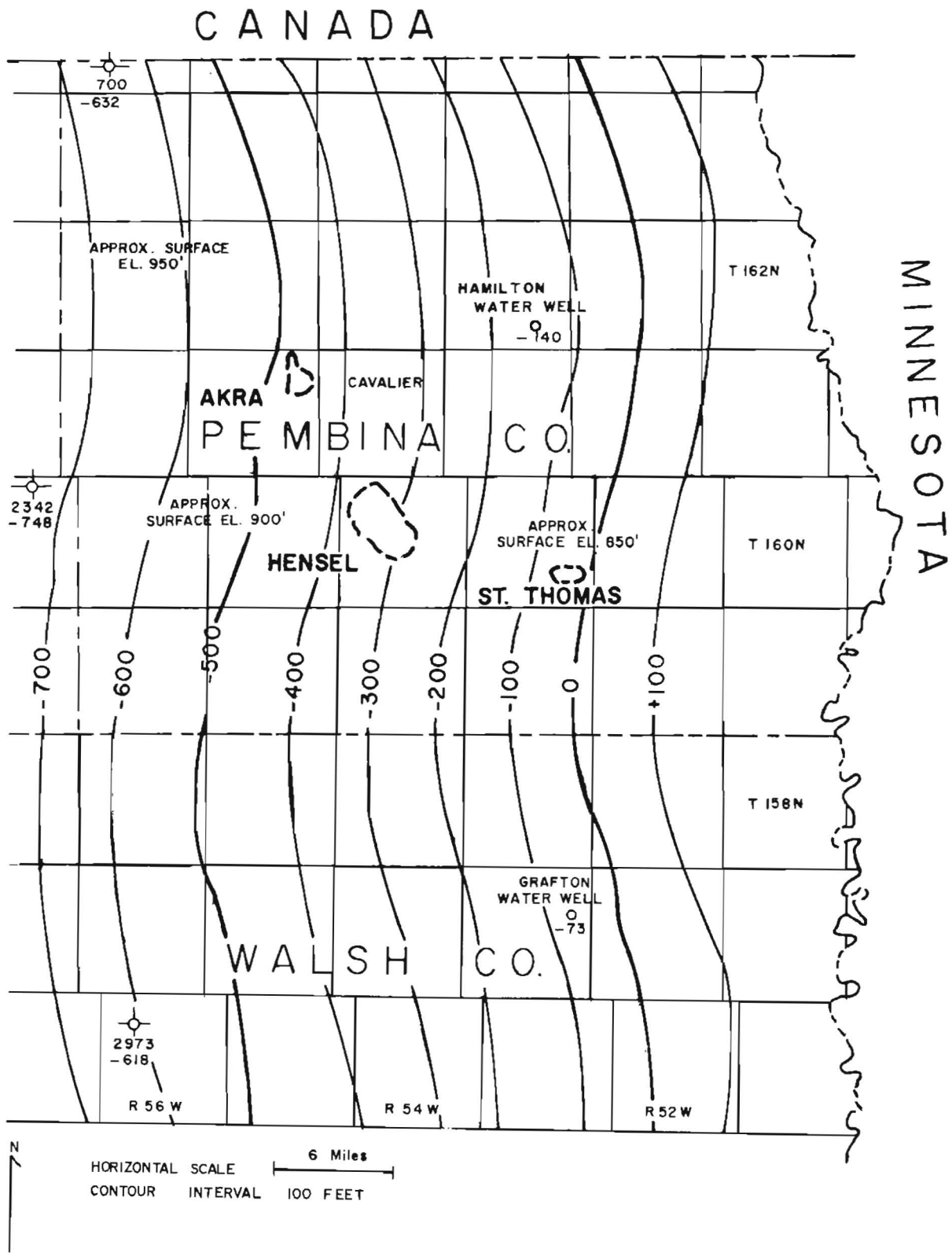


Figure 5. Generalized map showing the top of the buried surface of the Precambrian "basement" rocks of Pembina County, North Dakota. Datum is sea level. Limited control provided by oil exploration and water wells.