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A geomagnetic survey of Pembina, Grand Forks, and eastern Walsh counties, North Dakota

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A GEOMAGNETIC SURVEY OF PEMBINA, GRAND FORKS, AND EASTERN WALSH COUNTIES, NORTH DAKOTA

by
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This thesis submitted by Howard D. Okland in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

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Title A GEOMAGNETIC SURVEY OF PEMBINA, GRAND FORKS, AND EASTERN WALSH COUNTIES, NORTH DAKOTA

Department Geology

Degree Master of Science

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Signature Howard D. Oldland

Dated 28 July 1978

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ABSTRACT

From August, 1977, to March, 1978, total field geomagnetic readings were taken at 948 sites in the following counties in North Dakota: Pembina County, Grand Forks County, and Walsh County east of 98°W. longitude. The field data was contoured by computer using the SYMAP commercial computer program. Nine major and several minor magnetic anomalies were discovered. Trends present on the aeromagnetic map of Minnesota continue westward into North Dakota. Limited borehole data and the geomagnetic map suggest that the study area is underlain by Precambrian rocks of the Superior geologic province. The northernmost trend may indicate a western extension of the Vermilion fault.

INTRODUCTION

Previous work

In October of 1964, Mr. C. E. Harding of the Topographic Branch of the U.S. Geological Survey reported to the North Dakota Geological Survey that his workers were experiencing difficulties using magnetic compasses near the towns of Hensel and Akra in Pembina County, North Dakota. Drs. Moore and Karner of the Department of Geology, University of North Dakota, investigated the area outlined in the letter (Moore and Karner, 1969). The total magnetic field in this area was expected to be 60,000 nanoteslas (Cain and Cain, 1971), but near Hensel the magnetic field exceeded this value by 11,500 nanoteslas (nT), and near Akra the expected value was exceeded by 7,500 nT (Moore and Karner, 1969).

During the summer of 1966, Tonis Tamm, a student at the University of North Dakota, undertook a more detailed study. Higher maxima were measured for the Hensel and Akra anomalies, and a third anomaly was discovered northeast of the town of St. Thomas, in Pembina County, North Dakota. The results of all the geomagnetic work done by the University of North Dakota in Pembina County were reported by Moore and Karner (1969).

The rock bodies causing the Akra and Hensel anomalies were cored by Amerada-Hess Petroleum Corporation in July, 1966. Richardson (1975) reported on the petrography of Precambrian basement rocks from the cores. He found them to contain up to 33% magnetite, and concluded that the magnetic anomalies were caused by metasedimentary rocks.

Purpose

Dr. Walter Moore suggested that other anomalies might be present in Pembina County. Sidney Anderson of the North Dakota Geological Survey pointed out that certain section roads in Grand Forks County show the same divergence from geographic north as do section roads near the Akra anomaly in Pembina County. He suggested that similar anomalies might be present in Grand Forks County. In addition, the pattern of magnetic anomalies shown on aeromagnetic maps of northwestern Minnesota certainly looked as though it would carry over into North Dakota. After consideration of the equipment and transportation resources available, it was decided to make a ground geomagnetic survey to produce a geomagnetic map of all of Grand Forks and Pembina Counties, North Dakota, and the part of Walsh County east of 98° W. longitude (Figure 1).

Geologic setting

Grand Forks, Walsh, and Pembina Counties are located in the northeastern corner of North Dakota. The eastern portion of these counties is covered with lake sediment deposited in glacial Lake Agassiz and has little topographic relief. Westward, Lake Agassiz beach sediments are encountered. Farther west deltas, outwash plains, end moraines, and sand dunes occur. The elevation is about 250 m above sea level at Grand Forks and increases westward at an average rate of 0.4 m per km.

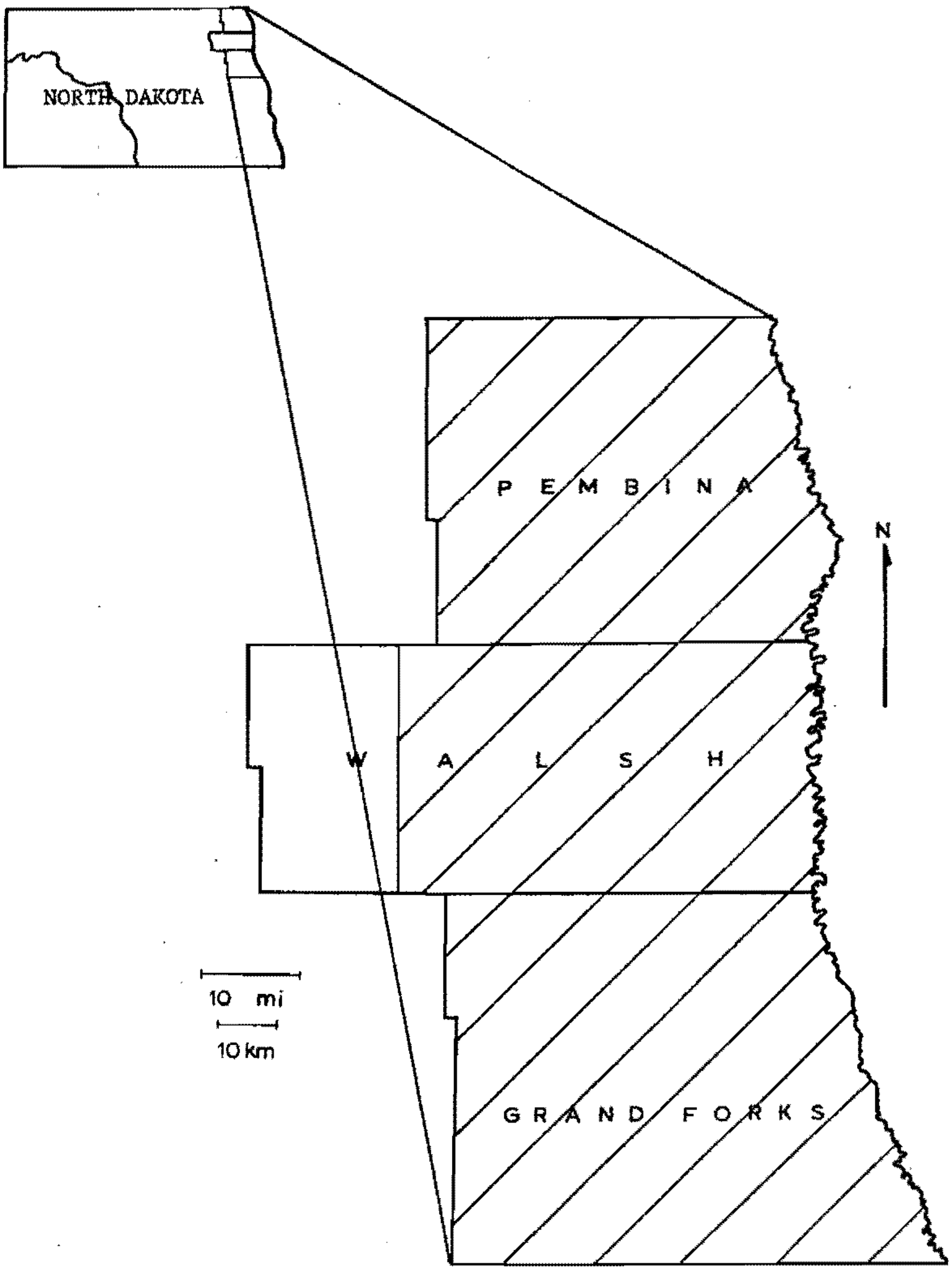


Fig. 1. Location of study area.

The Quaternary deposits are underlain by Mesozoic and Paleozoic sedimentary rocks that dip westward toward the Williston basin. These sediments are underlain by Precambrian basement rocks whose upper surface dips westward. At the eastern margin of the study area, the elevation of the Precambrian surface is about 160 m above sea level, and at the western margin it is about 200 m below sea level (Hansen, 1957; Richardson, 1975). Richardson (1975) suggested that the Precambrian rocks in eastern North Dakota are alternating linear belts of predominantly amphibolite schists and granites of the Superior province which outcrop in northeastern Minnesota, eastern Manitoba, and western Ontario.

METHODS

Instrument

An Elsec Type H proton precession magnetometer (serial number 197) was used. The proton precession magnetometer measures the total earth's magnetic field vector by measuring the precession frequency of protons in this field. Nussbaum (1966) gave the relationship between precession frequency of the protons and magnetic field vector as:

$$\omega = \gamma H$$

where ω is the angular frequency, γ is the gyromagnetic ratio of the proton, and H is the value of the magnetic field.

The instrument consists of three units: the detector bottle, the control unit which measures the precession frequencies, and the power supply. The detector bottle is an epoxy-covered coil of wire coaxial with a bottle of water. This can be mounted on a sectioned aluminum alloy rod that is inserted into the ground or snow. The detector bottle is connected by coaxial cable to the control unit. The control unit contains the detection and timing circuits and operator controls. The detection circuitry is essentially a radio receiver with a tuning range from 1000 Hz to 3000 Hz (Cook, 1973). The instrument is battery powered with provision for use of internal batteries or an external 12 volt d.c. (positive ground) source. While in the field, the battery of the vehicle was used as a power source. Since all recently manufactured automobiles have negative ground, care must be taken to prevent the ground of the instrument and all connecting cables from coming in contact with the chassis. Blow fuses occur if such contact is made.

This instrument does not directly measure the proton precession frequency. It measures the time required for a certain number of proton precession cycles to be completed. The number of cycles to be completed is determined by the position of the red portion of switch S-3. If this switch is in the "C" position, the instrument measures the time for 1,024 proton precession cycles to be completed. If the switch is in the "B" position 512 cycles are timed, and if it is in the "A" position 256 cycles are timed.

The timing standard is a 100 kHz quartz crystal. Since the accuracy of the measurement is dependent upon the frequency of the timing standard, the frequency was checked against a secondary frequency standard. It measured 100 kHz ± 0.1 Hz, which exceeded the ± 1 count ambiguity of the timing circuitry of the instrument. The overall accuracy of the instrument is ± 1.5 nT (1 nT = 1 gamma).

To obtain the magnetic field strength, a constant is divided by the reading of the instrument, then multiplied by 100,000. This gives the value of the geomagnetic field strength in nanoteslas (nT). The constant to be used is determined by the position of the red portion of switch S-3. For switch position "A" the constant is 6,012.78, for position "B" it is 12,025.55, and for position "C" it is 24,051.1. During this study, position "C" was used almost exclusively.

Procedure

Measurements were taken as close to a two mile grid as was possible on serviceable roads. The location of a measuring site was also affected by its position relative to power lines. The magnetic field generated by the electric current can interfere with the reading. This can be predicted and the interference can be avoided by moving the measuring site several tens of meters away from the power line. Less predictable is the electrical noise propagated in the form of radio waves by powerlines acting as antennas. Sources of this noise are electric motors, transformers, power factor correction capacitors, and insulator leakage. The frequency spectrum of this noise is broad-banded and includes the frequency band to which the instrument is sensitive. This interference can also be avoided by moving away from the power line.

Electrical noise is also radiated from the ignition systems of vehicles. Electrical noise interference is characterized by erratic readings. The engine of my vehicle had to be shut off during the time measurements were being taken. Measurements were not taken when passing vehicles were within about 100 m of the detection coil.

The detector coil was approximately 0.5 m above the ground. At each sampling site, five readings were taken with a measurement cycle of 6.6 seconds and recorded. The time of the readings was recorded to the nearest quarter hour, the location was recorded in computer format and marked on a field map (Figure 2), and the positions of the instrument controls were recorded. A sample field log page is included in appendix A.

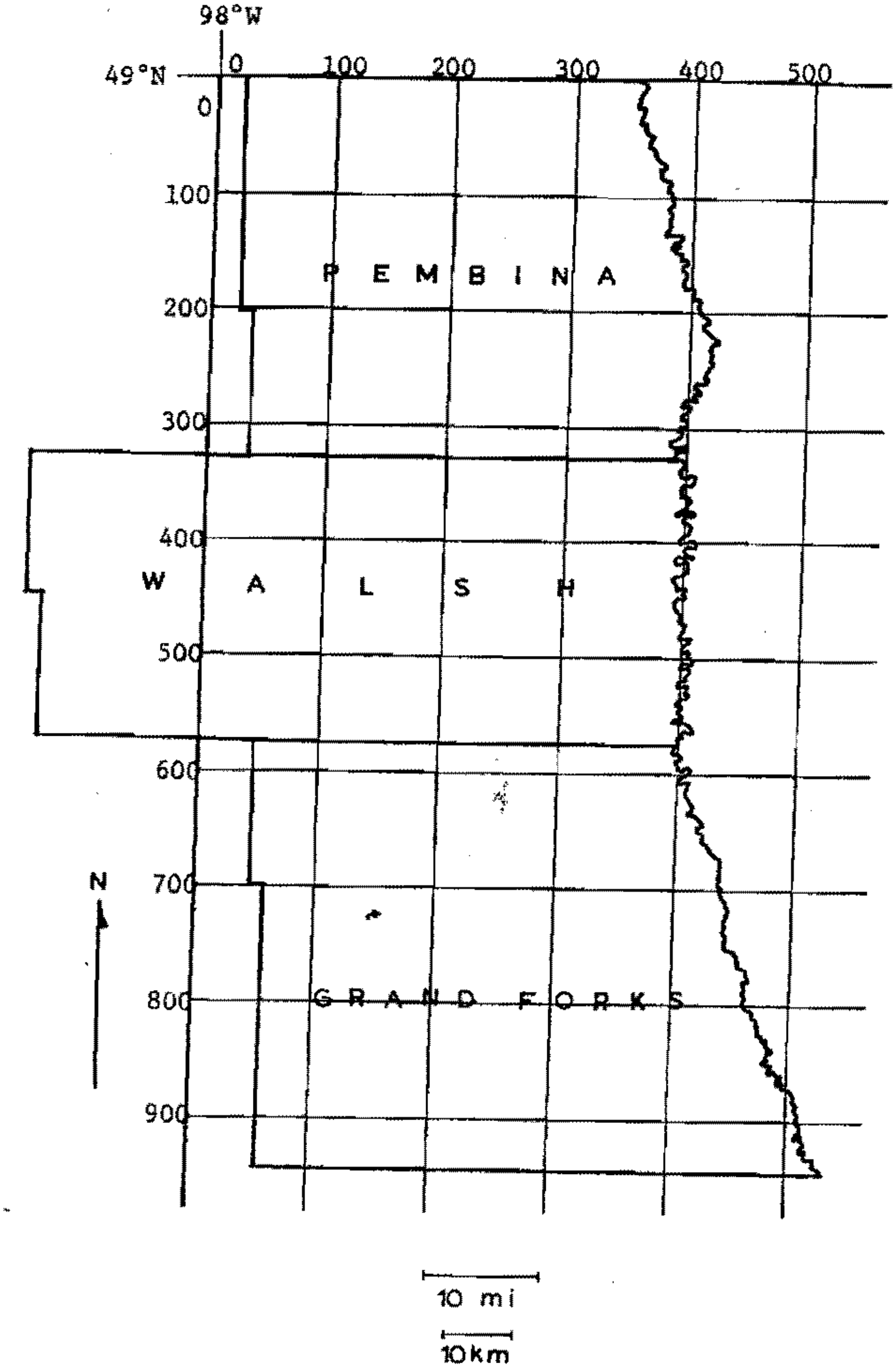


Fig. 2. SYMAP coordinate system used to locate data points in computer format.

In order that measurements would be reproducible, field work was done only when the geomagnetic field was quiet. Information about the state of the geomagnetic field was obtained before the start of each day's field work by monitoring National Bureau of Standards stations WWV or WWVH. At 18 minutes after each hour, WWV broadcasts solar terrestrial indices. Each announcement contains the "A" index from the previous Coordinated Universal Time (UTC) day, the most recent "K" index from Boulder, Colorado, the solar flux, the predicted activity of the geomagnetic field for the present UTC day, and present solar flare or geomagnetic storm alerts, as appropriate. This same information is broadcast by WWVH at 44 minutes after each hour.

The primary index of the magnetic field's activity is the "K" index. It is a measure of the variation of the field during 3-hour periods throughout the day at certain magnetic observatories worldwide. The variation of the field is a function of time as well as location (Lincoln, 1967). If the Boulder "K" index was 3 or less, the geomagnetic field in the study area was considered quiet. If it was greater than 3, the field was considered disturbed or active, and no readings were taken that day.

There were three base stations, one of which was occupied at least once each day of field work. Two were located south of the city of Grand Forks, and at least one of these was occupied on days that field work was done in southern and western Grand Forks County. The third was located north of the city and was occupied on days when measurements were being taken in the rest of the study area.

The total geomagnetic field varied about 75 nT from quiet day to quiet day. From the start of field work in the morning to the end of work in the evening the variation was generally less than 30 nT.

At the end of each day, the value of the geomagnetic field was calculated for each site occupied that day and transferred, along with the location data, to computer card coding forms for keypunching. Because of the very low relief in the study area, terrain corrections were not made on the measurements.

When the completed cards were returned from the keypunch center, the deck was prepared for a computer run. A commercial computer program titled SYMAP was used for contouring the field data (Dougenik and Sheehan, 1975). The A-OUTLINE, B-DATA POINTS, E-VALUES, and F-MAP SYMAP packages were used. The A-OUTLINE package was used to specify to the computer the boundaries of the study area. The locations of the measuring sites were specified by the B-DATA POINTS package. The E-VALUES package was used to define the magnetic field values mapped. These values were read into the computer in the same order as their corresponding data points in the B-DATA POINTS package. The F-MAP package instructed the computer to produce a map using the specified map scale, number of contour intervals, and values of the contour intervals. Computer maps of Pembina, Walsh, and Grand Forks Counties, North Dakota, were produced (plates 4, 5, and 6). For the Grand Forks and Walsh County maps, a contour interval of 200 nT was used. The Pembina County map used a 200 nT interval below 61,000 nT, and a 1,000 nT interval above. Final copies of the maps were traced with minimal interpretation from the computer-produced maps onto mylar base maps obtained from the U.S. Geological Survey in Bismarck.

RESULTS

The geomagnetic field in Grand Forks County, Pembina County, and the part of Walsh County east of 98° W. longitude was mapped using approximately 3.2 km (2 mi) grid. Over 8,700 square km was mapped during 25 days in the field from August, 1977, to March, 1978. Magnetic measurements were taken at 948 sites.

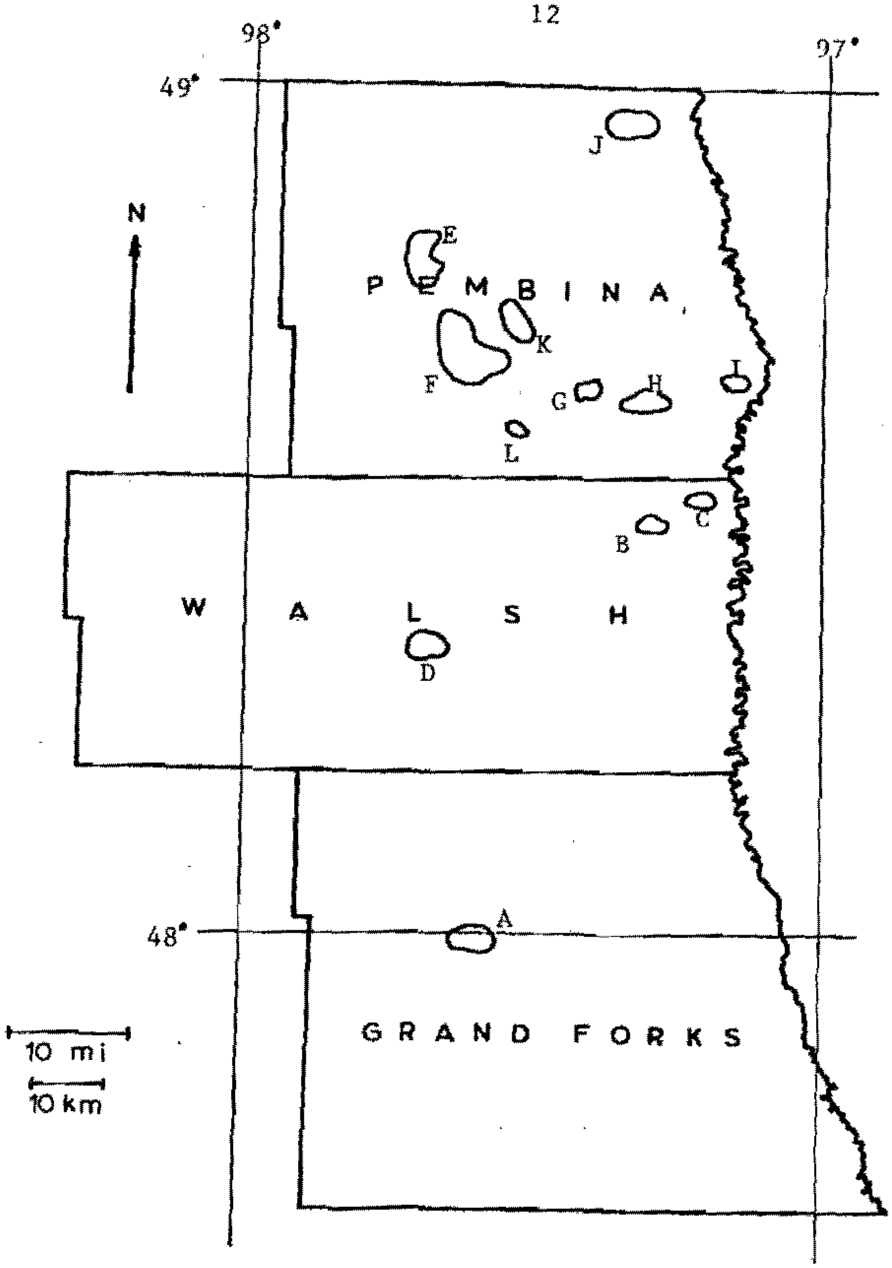
Grand Forks County

In Grand Forks County, approximately 10 km (6 mi) northwest of Turtle River State Park, an anomaly of about 600 nT was mapped (Figure 3). The anomaly is roughly circular in shape, based on the 60,200 nT contour line, and is about 4 km (2.5 mi) across. The maximum measured value was 60,671 nT. This anomaly is designated the Turtle River anomaly. It does not appear to be part of a trend.

In the eastern part of the county there appear to be two trends of small (less than 200 nT) anomalies. The direction of one trend is north-south through the city of Grand Forks, and the other has an arcuate shape trending west from the city of Grand Forks and then to the northwest.

Walsh County

In Walsh County three major anomalies were discovered. Two 900 nT anomalies occur in the northeastern part of the county near the town of Cashel (Figure 3). One of these anomalies is centered around the



A Turtle River
B Cashel West
C Cashel East
D Pisek
E Akra*
F Hensel*
G St. Thomas*
H St. Thomas East
I Pittsburg
J Pembina
K Hensel East
L Crystal

*Previously reported by Moore and Karner (1969).

Fig. 3. Major geomagnetic anomalies in Pembina, Walsh, and Grand Forks Counties, North Dakota, listed in order of discussion in text.

town of Cashel and has a maximum measured value of 60,952 nT. The other anomaly is approximately 7 km (4 mi) northeast of Cashel with a maximum measured value of 60,937 nT. Both are approximately circular in shape with a diameter of about 3.2 km (2 mi). They are enclosed by the same 60,400 nT contour line. This contour line encloses an oblong area about 11 km (7 mi) along the long dimension, which trends northeast-southwest. The southwestern-most maximum is described as the Cashel West anomaly, and the northeastern-most maximum is described as the Cashel East anomaly.

About 32 km (20 mi) to the southwest is a third major anomaly. It is located about 4 km (2.5 mi) northeast of Pisek. The Pisek anomaly is circular in shape, about 3.2 km (2 mi) across, and has a maximum measured value of 60,662 nT.

Near a line between the Cashel anomalies and the Pisek anomaly, two less intense anomalies were found. One anomaly is about 400 nT, and the other is about 200 nT. Another 400 nT anomaly was mapped about 11 km (7 mi) south-southwest of the Pisek anomaly. All these anomalies form a trend that is northeast-southwest. This trend apparently dies out to the southwest and is not related to the Turtle River anomaly in Grand Forks County.

Pembina County

Moore and Karner (1969) found three major anomalies in Pembina County; the first near the town of Akra, the second northwest of the town of Hensel, and the third northwest of the town of St. Thomas (Figure 3). Five additional major and several minor magnetic anomalies were mapped in Pembina County during the present study.

The most intense of the newly discovered anomalies is somewhat circular in shape, about 3.2 km (2 mi) across, and centered about 11 km (7 mi) east of St. Thomas (Figure 3). The maximum measured value is 66,377 nT. This anomaly is identified as the St. Thomas East anomaly, and is enclosed by the same 62,000 nT contour line as the St. Thomas anomaly. The 62,000 nT contour line outlines the approximate shape of a dumbbell about 13 km (8 mi) across the long dimension. The shaft of the "dumbbell" is slightly bent convex to the south.

The next most intense anomaly is centered about 2 km (1.3 mi) north of Pittsburg. Pittsburg is near the eastern border of Pembina County, 6.5 km (4 mi) north of Drayton. The 62,000 nT contour line encloses an oblong area a little over 1.6 km (1 mi) across the long dimension. The maximum measured value of the Pittsburg anomaly is 62,259 nT.

About 11 km (7 mi) west of the city of Pembina is the Pembina anomaly. The maximum measured value is 61,284 nT. The shape of the anomaly, based on the 61,000 nT contour line, is oblong. The long dimension trends east-west and is about 3 km (1.8 mi). West of the Pembina anomaly, there is an east-west trend of low intensity anomalies extending out of the study area.

About 13 km (8 mi) northeast of Hensel is a 700 nT oblong anomaly that apparently is associated with the much more intense Hensel anomaly 6 km (4 mi) to the southwest. The maximum measured value of the Hensel East anomaly is 60,772 nT. Its long dimension is oriented southeast-northwest, and is about 5 km (3 mi).

A 600 nT anomaly occurs 10 km (6 mi) east of Crystal. It is oblong in shape, trends southeast-northwest, and is about 1.6 km (1 mi) long. The Crystal anomaly has a maximum measured value 60,637 nT.

INTERPRETATION

The geomagnetic map for Pembina, Walsh, and Grand Forks Counties, North Dakota, looks like an extension of the aeromagnetic maps for adjacent portions of Minnesota (Figure 4) (Zeitz and Kirby, 1970; Bath, Schwartz, and Gilbert, 1964).

Across northern Kittson County, Minnesota, there is an association of magnetic highs trending to the west-northwest into Pembina County, North Dakota, near the city of Pembina. From the western part of Pembina County, the trend goes north into Canada. In Minnesota, Sims (1972) infers that this trend reflects a westward extension of the Vermilion fault. The continuation of this trend in Pembina County suggests a further extension of the fault through the extreme northeastern corner of North Dakota and then into Canada.

In southern Kittson County, a trend of magnetic highs crosses into southern Pembina County westward first to the Pittsburg anomaly, then the St. Thomas East anomaly, St. Thomas anomaly, Crystal anomaly, and then to the north-northwest to the Hensel and Akra anomalies.

From south-central Walsh County, North Dakota, there is a trend of magnetic anomalies to the northeast that crosses into Minnesota in northern Marshall County.

Running east-west in central Polk County, Minnesota, is a band of magnetic anomalies that crosses into North Dakota in Grand Forks County near Thompson. Radiating from the city of Grand Forks are

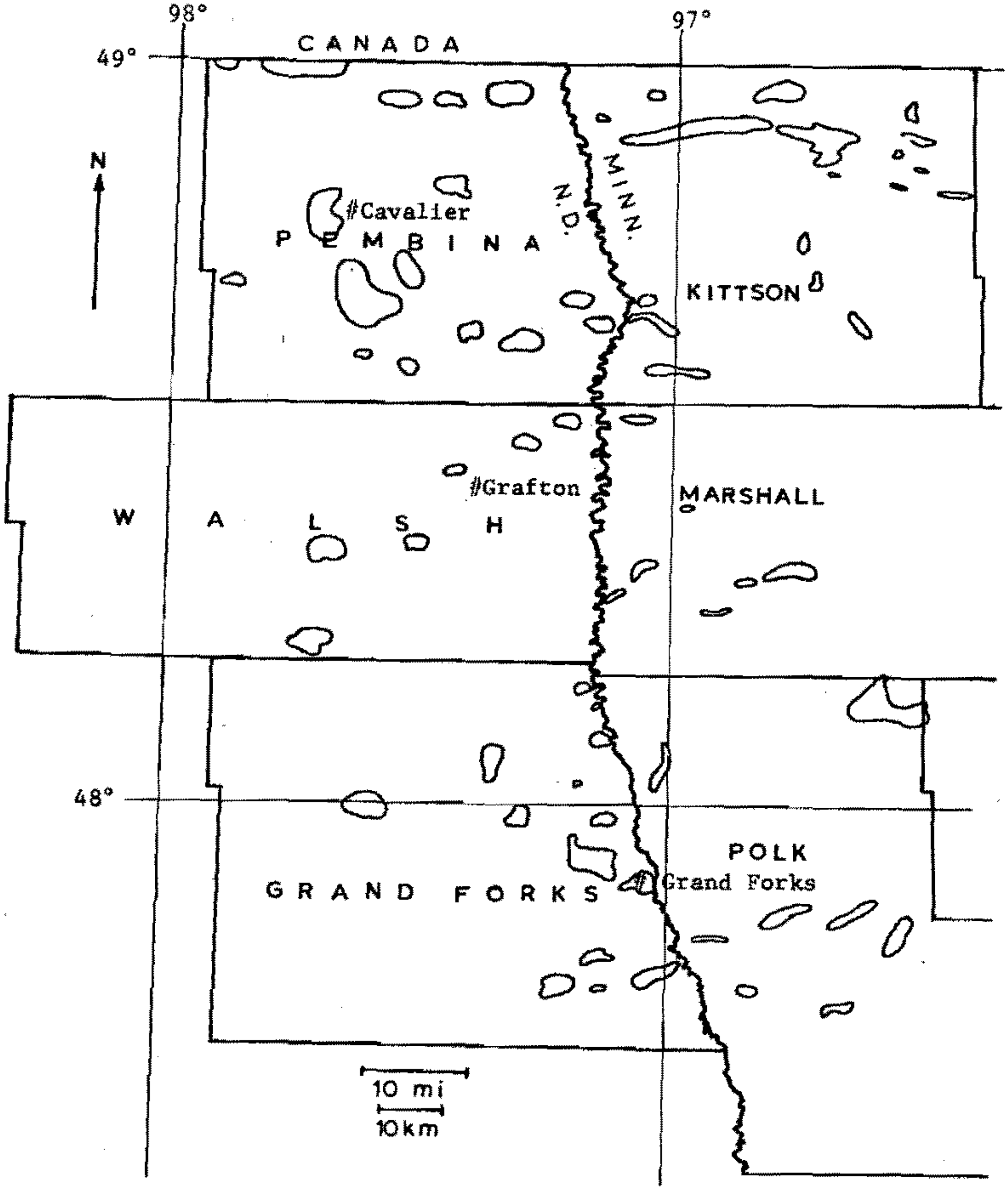


Fig. 4. Geomagnetic anomalies and trends of anomalies in northeastern North Dakota and adjacent Minnesota. Minnesota map after Zeitz and Kirby (1970).

two trends of low-intensity magnetic anomalies. One trends north-south, crossing into Minnesota in southern Marshall County and curving to the east. The other trends in an arcuate shape to the west and then northwest.

Magnetic anomalies of the intensity and area of those in Pembina, Walsh, and Grand Forks Counties, North Dakota, are probably caused by magnetic susceptibility contrasts in the underlying rock, rather than by variation in the relief of the rock surface. Additionally, the magnetic susceptibility contrasts are likely to be in the crystalline Precambrian basement rocks rather than the overlying sedimentary rocks. Although there is a great variation in susceptibility values, even for a particular rock, and a wide overlap between different rock types, sedimentary rocks have the lowest average susceptibility and basic igneous rocks have the highest. In every case, the susceptibility of a rock depends only upon the amount of ferrimagnetic minerals present, mainly magnetite and sometimes ilmenite or pyrrhotite (Telford and others, 1976).

In northeastern North Dakota, the trends formed by magnetic anomalies of less than 1000 nT are apparently caused by greenstone belts. The magnetic anomalies greater than 1000 nT form trends over belts of metasedimentary iron formation containing considerable magnetite. The areas between the trends are quite probably underlain by granitic rocks. The relationship of these rock types suggests that this area in North Dakota is underlain by Precambrian rocks of the Superior geologic province. The limited data from drill holes that penetrate Precambrian rocks in the study area correlates well with the magnetic data. Where geomagnetic readings are high, the rocks are metasediments rich in magnetite. Where there are no geomagnetic anomalies, the rocks are granitic (Ray, 1978).

Vacquier and others (1951) suggested that the following criteria be used for interpreting the depth and shapes of subsurface rock bodies from magnetic data: (1) the spacing of the measuring stations should be equal to or less than one-half the depth of burial; (2) the magnetic relief of the anomaly should be at least several hundred nanoteslas; (3) the anomaly should be large in area; (4) the anomaly should be isolated from other magnetic anomalies. Only the first of these criteria is controlled by the investigator. None of the anomalies in this study met all of these criteria. For example, the Hensel anomaly has adequate spacing of the data, is large enough in area, and has high magnetic relief, but it is not isolated from the Hensel East, Akra, and St. Thomas anomalies. The Turtle River anomaly in Grand Forks County, Pisek anomaly in Walsh County, and Pembina anomaly in Pembina County, have high magnetic relief, are large enough, and are isolated, but there are not enough data points for adequate interpretation.

A relatively simple method for outlining the shape of a magnetic body using vertical magnetic gradient has been described by Hood and McClure (1965). It involves taking two readings at each site, one several meters above the other. An additional advantage of this technique is that the vertical gradient measurement tends to minimize the diurnal change in the geomagnetic field (Hood and McClure, 1965). It would be interesting to try this technique to provide more information on the newly discovered anomalies, as well as the previously reported anomalies.

Because the measurements were taken over an eight month period, secular change could potentially have required a considerable correction to be made to the data. Fortunately, the secular change in the study area is less than 10 nT per year (Cain and Cain, 1971).

Surface geomagnetic mapping of an area the size of this study, although relatively inexpensive in transportation costs, is very inefficient time-wise. Surface geomagnetic mapping is better suited to a smaller area, such as Grand Forks County. If the financial resources are available, an airborne magnetometer could be used to cover large areas. This would take much less time, and interesting areas could be outlined quickly, then explored in more detail.

CONCLUSIONS

Surface geomagnetic mapping of Pembina, Grand Forks, and eastern Walsh Counties, North Dakota, discovered nine major and many minor anomalies. In Pembina County, five major anomalies were mapped. Three were mapped in Walsh County east of 98° W. longitude, and one was mapped in Grand Forks County. The intensity and trends of the magnetic anomalies suggest that northeastern North Dakota is underlain by Precambrian rocks of the Superior geologic province. In Pembina County the northernmost trend may indicate a western extension of the Vermilion fault.

APPENDIX A

SAMPLE FIELD LOG

SAMPLE FIELD LOG

No.	Y	X	Mag Field	Date/UTC	I	II	III	IV	V	S-3 R/B	CT3/CT2	CT1
771	677	426	59984	235/16A	10023	10024	10023	10023	10025	A/D	4/42	1
772	670	402	60184	235/16B	19990	19991	19990	19990	19989	B/D	4/42	1
773	657	405	59928	235/16B	40133	40132	40132	40132	40133	C/D	4/42	1
774	655	423	59937	235/16C	40126	40127	40126	40127	40126	C/D	4/42	1

APPENDIX B

MAGNETIC FIELD DATA

TABLE 1

SYMAP GRID LOCATIONS, GEOMAGNETIC FIELD VALUES, AND DATES: GRAND FORKS, PEMBINA, AND EASTERN WALSH COUNTIES, NORTH DAKOTA

Number	Y	X	Magnetic Field (nT)	Julian Date
1	316	33	60068	270
2	316	64	60090	274
3	315	48	60056	274
4	297	43	60125	274
5	276	43	60153	274
6	254	43	60195	274
7	235	43	60069	274
8	214	43	59958	274
9	195	43	60238	274
10	174	33	59978	274
11	155	24	60108	274
12	136	23	59984	274
13	116	23	60041	274
14	96	23	60186	274
15	71	35	60322	274
16	62	33	60266	274
17	46	33	60509	274
18	26	33	60466	274
19	6	34	60883	274
20	6	53	60698	274
21	6	73	60812	274
22	6	92	60971	274
23	6	112	60847	274
24	6	133	60820	274
25	5	153	60741	274
26	6	171	60419	274
27	0	191	60427	274
28	6	211	60503	274
29	6	232	60174	274
30	6	251	60164	274
31	6	272	60588	274
32	6	292	59652	274
33	6	311	59809	274
34	6	332	59835	274
35	315	84	60062	279
36	295	63	60101	279
37	275	63	60120	279
38	255	63	60120	279
39	234	63	60042	279
40	215	63	59899	279
41	174	54	59999	279
42	155	43	59991	279

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
43	136	43	59963	279
44	117	43	60056	279
45	96	43	60177	279
46	76	48	60309	279
47	218	62	60117	279
48	294	83	60083	279
49	296	102	60099	279
50	317	102	59969	279
51	315	360	59826	303
52	316	340	59878	303
53	315	320	59785	306
54	313	300	59933	306
55	315	280	59897	306
56	315	262	59896	306
57	315	243	60026	306
58	315	222	60017	306
59	315	201	60015	306
60	315	182	60024	306
61	315	162	60081	306
62	315	142	60047	306
63	315	123	60065	306
64	293	360	59948	317
65	273	359	59824	317
66	274	339	59796	317
67	293	339	59849	317
68	293	320	59888	317
69	273	319	59870	317
70	273	300	59726	317
71	293	300	59978	317
72	293	280	59955	317
73	273	279	59921	317
74	273	262	60111	317
75	295	262	59979	317
76	293	241	60146	317
77	274	241	60378	317
78	275	221	60309	317
79	294	221	60093	317
80	294	202	60045	317
81	275	202	60637	317
82	276	181	59911	317
83	294	181	60039	317
84	297	162	60059	317
85	275	161	60006	317
86	274	141	60104	317

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
87	295	141	59999	317
88	295	123	59882	317
89	275	121	60036	317
90	275	101	60101	317
91	275	82	60134	317
92	256	83	60095	317
93	255	103	60093	317
94	255	121	60126	317
95	235	122	60000	317
96	236	102	60045	317
97	235	83	59958	317
98	214	83	60068	317
99	195	83	59970	317
100	176	73	59991	317
101	160	63	60033	317
102	154	83	60086	317
103	176	88	59969	317
104	175	103	60021	317
105	195	103	59926	317
106	215	103	60105	317
107	214	122	60014	317
108	194	123	60060	317
109	176	124	59930	317
110	175	141	59940	317
111	194	142	59762	317
112	216	142	60263	317
113	236	142	59994	317
114	255	142	60192	317
115	86	331	60425	320
116	86	311	60328	320
117	87	292	60345	320
118	87	270	60393	320
119	86	252	60307	320
120	84	232	60223	320
121	86	212	60343	320
122	85	192	60304	320
123	86	171	60383	320
124	87	152	60331	320
125	86	131	60397	320
126	85	112	60309	320
127	87	92	60284	320
128	106	92	60050	320
129	104	83	60117	320

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
130	106	72	60054	320
131	106	53	60093	320
132	87	53	60291	320
133	87	74	60297	320
134	66	92	60431	320
135	66	73	60275	320
136	47	73	60485	320
137	61	53	60422	320
138	46	53	60497	320
139	27	53	60747	320
140	26	73	60564	320
141	45	94	60498	320
142	24	92	60463	320
143	26	112	60469	320
144	24	132	60544	320
145	27	152	60629	320
146	46	151	60561	320
147	46	133	60546	320
148	47	113	60539	320
149	66	113	60434	320
150	66	133	60506	320
151	66	151	60567	320
152	66	171	60515	320
153	46	170	60462	320
154	27	171	60494	320
155	27	191	60649	320
156	47	191	60450	320
157	66	192	60503	320
158	66	211	60518	320
159	46	211	60393	320
160	29	211	60927	320
161	27	231	60570	320
162	47	231	60535	320
163	65	231	60491	320
164	65	252	60498	320
165	46	252	60456	320
166	27	252	60757	320
167	25	270	60494	320
168	27	291	61284	320
169	27	311	60746	320
170	27	331	60087	320
171	46	330	60371	320
172	46	311	60465	320

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
173	46	291	60303	320
174	46	272	60374	320
175	66	272	60584	320
176	65	292	60482	320
177	66	312	60363	320
178	66	331	60212	320
179	107	331	60129	322
180	67	351	60535	322
181	46	347	60307	322
182	88	351	60424	322
183	106	352	60268	322
184	128	358	60235	322
185	144	353	60137	322
186	183	370	60116	322
187	202	374	60171	322
188	225	376	60038	322
189	244	376	62259	322
190	264	376	59832	322
191	285	376	59960	322
192	253	358	60014	322
193	253	339	60315	322
194	253	319	63431	322
195	253	314	63414	322
196	253	309	64586	322
197	253	304	66377	322
198	253	299	64246	322
199	253	294	62349	322
200	253	289	61757	322
201	253	284	62289	322
202	253	278	62733	322
203	253	271	61335	322
204	253	266	60786	322
205	253	261	60629	322
206	253	256	60313	322
207	253	324	62341	322
208	253	331	60800	322
209	244	399	61818	336
210	224	399	60649	336
211	204	399	59957	336
212	186	392	60230	336
213	165	381	60090	336
214	174	351	60236	336
215	193	351	60126	336
216	214	359	59864	336

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
217	235	357	60550	336
218	235	338	59788	336
219	235	319	59446	336
220	235	299	59466	336
221	249	299	61476	336
222	246	290	59562	336
223	235	281	59537	336
224	137	332	60179	052*
225	137	312	60183	052*
226	137	291	60110	052*
227	137	271	59981	052*
228	136	253	60180	052*
229	138	232	60066	052*
230	135	212	60262	052*
231	136	191	60018	052*
232	136	173	59815	052*
233	136	153	59978	052*
234	137	133	62142	052*
235	137	112	60027	052*
236	137	88	59928	052*
237	126	77	59930	052*
238	115	103	60104	052*
239	100	132	60171	052*
240	114	142	60348	052*
241	105	153	60104	052*
242	105	171	60245	052*
243	120	172	59970	052*
244	115	191	60083	052*
245	106	212	60023	052*
246	116	222	60316	052*
247	106	242	60578	052*
248	126	242	60353	052*
249	127	261	60418	052*
250	127	280	60186	052*
251	116	291	60122	052*
252	107	281	60257	052*
253	107	311	60377	052*
254	254	242	59927	054*
255	254	222	59899	054*
256	255	202	59815	054*
257	255	182	60328	054*
258	255	162	59930	054*
259	235	162	59866	054*

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
260	215	162	61172	054*
261	154	173	59817	054*
262	163	161	60275	054*
263	156	142	59726	054*
264	158	123	60363	054*
265	151	114	59600	054*
266	152	191	59881	054*
267	164	201	59814	054*
268	163	221	59781	054*
269	150	221	59873	054*
270	184	175	60235	054*
271	185	202	60695	054*
272	194	211	60772	054*
273	230	202	59757	054*
274	236	182	59665	054*
275	240	222	59855	054*
276	245	242	59896	054*
277	223	272	59612	054*
278	225	249	59872	054*
279	214	231	60174	054*
280	215	213	59890	054*
281	193	232	60223	054*
282	173	243	60011	054*
283	163	240	59869	054*
284	149	250	60018	054*
285	165	250	59879	054*
286	184	251	60048	054*
287	193	332	59915	087*
288	214	328	59704	087*
289	214	309	59710	087*
290	193	311	59908	087*
291	193	291	59885	087*
292	214	290	59608	087*
293	193	271	59784	087*
294	204	257	59673	087*
295	183	272	59927	087*
296	183	292	60108	087*
297	183	311	59951	087*
298	163	315	59967	087*
299	163	291	60072	087*
300	163	271	59990	087*
301	144	271	60081	087*
302	143	316	60146	087*

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
303	137	122	60375	not available
304	136	138	60445	not available
305	149	129	64063	not available
306	145	123	60552	not available
307	146	133	62829	not available
308	152	132	68128	not available
309	155	137	60898	not available
310	200	162	64100	not available
311	205	157	61428	not available
312	205	182	59753	not available
313	210	169	73456	not available
314	220	182	63754	not available
315	244	252	60348	not available
316	244	262	63344	not available
317	244	272	62900	not available
318	235	252	61007	not available
319	234	262	61384	not available
320	242	266	64714	not available
321	555	391	59918	235
322	545	392	59936	235
323	527	389	59927	235
324	527	373	59654	235
325	507	394	59891	235
326	507	380	59855	235
327	507	365	59906	235
328	525	362	60051	235
329	543	362	60000	235
330	558	362	59890	235
331	556	343	59818	245
332	557	323	59881	245
333	557	302	59905	245
334	557	284	59815	245
335	558	263	59734	245
336	537	302	59888	250
337	536	282	59855	250
338	536	262	59821	250
339	536	241	59903	250
340	536	225	59902	250
341	536	203	59826	250
342	537	183	59830	250
343	535	165	59750	250
344	537	143	59843	250
345	537	123	59866	250
346	536	104	60186	250

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
347	536	83	60090	250
348	536	65	59887	250
349	536	44	59905	250
350	539	24	59667	250
351	536	6	59897	250
352	555	3	59906	250
353	556	37	59785	250
354	556	242	59933	254
355	556	223	59821	254
356	556	203	59838	254
357	556	182	59857	254
358	556	161	59664	254
359	516	284	59902	270
360	516	263	59917	270
361	516	243	59875	270
362	516	222	59994	270
363	517	203	59915	270
364	516	182	60039	270
365	517	163	59890	270
366	516	142	60083	270
367	516	123	59969	270
368	516	104	60530	270
369	516	84	60324	270
370	516	65	60065	270
371	517	44	60012	270
372	516	24	60044	270
373	516	6	59982	270
374	496	5	60012	270
375	477	5	59852	270
376	456	3	59891	270
377	437	5	59857	270
378	417	3	59985	270
379	396	5	60009	270
380	375	-2	60048	270
381	353	3	60137	270
382	335	2	60087	270
383	313	3	60195	270
384	316	33	60068	270
385	335	33	60066	270
386	356	33	60066	270
387	376	34	60060	270
388	396	33	60015	270

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
389	416	36	60033	270
390	435	33	59931	270
391	453	37	59972	270
392	477	34	59751	270
393	497	34	60000	270
394	496	66	59894	270
395	497	83	59948	270
396	497	104	59888	270
397	496	123	60021	270
398	496	144	59997	270
399	497	165	59926	270
400	496	183	59914	270
401	497	202	59964	270
402	497	223	59969	270
403	495	243	59969	270
404	498	262	60041	270
405	497	284	59967	270
406	497	302	59928	270
407	517	302	59900	270
408	476	262	60006	274
409	476	244	59933	274
410	475	223	59928	274
411	476	202	59942	274
412	475	183	59917	274
413	476	163	59800	274
414	476	143	59809	274
415	476	124	59914	274
416	476	104	59897	274
417	475	84	59873	274
418	476	66	59882	274
419	457	65	59948	274
420	435	63	59948	274
421	415	63	59981	274
422	396	64	60003	274
423	376	64	59978	274
424	356	64	60089	274
425	334	64	60075	274
426	316	64	60090	274
427	457	261	60128	279
428	457	242	60129	279
429	457	222	60119	279
430	451	204	59969	279

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
431	457	182	60129	279
432	457	163	59979	279
433	458	143	60662	279
434	456	121	59988	279
435	457	103	59864	279
436	457	84	59924	279
437	437	84	59882	279
438	418	83	59914	279
439	396	83	60015	279
440	376	83	59978	279
441	356	83	60080	279
442	333	86	60018	279
443	315	84	60062	279
444	317	102	59969	279
445	335	102	60038	279
446	356	102	60005	279
447	377	103	59976	279
448	396	103	59976	279
449	416	102	59964	279
450	436	103	60123	279
451	436	122	59705	279
452	437	143	59866	279
453	438	163	59863	279
454	438	183	59867	279
455	437	205	60000	279
456	437	224	60480	279
457	437	243	60107	279
458	437	263	60122	279
459	489	391	60005	303
460	467	390	60108	303
461	468	371	59863	303
462	446	382	60015	303
463	428	382	60047	303
464	408	381	60050	303
465	386	381	60042	303
466	367	380	60006	303
467	347	380	60194	303
468	327	380	59949	303
469	315	360	59826	303
470	316	340	59878	303
471	336	341	60380	303
472	335	360	60937	303
473	355	360	60170	303

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
474	356	340	60483	303
475	376	360	60032	303
476	377	341	60128	303
477	398	341	59943	303
478	398	361	60006	303
479	417	360	60002	303
480	418	341	59961	303
481	437	341	59942	303
482	438	361	59969	303
483	457	361	59951	303
484	458	341	59903	303
485	478	342	59990	303
486	478	361	59970	303
487	491	357	60006	303
488	496	342	59942	303
489	499	322	60065	303
490	517	322	59879	303
491	535	322	59855	303
492	536	343	59928	303
493	516	343	59979	303
494	398	322	60051	306
495	377	322	60152	306
496	355	322	60952	306
497	335	321	59683	306
498	315	320	59785	306
499	313	300	59933	306
500	315	280	59897	306
501	315	262	59896	306
502	315	243	60026	306
503	315	222	60017	306
504	315	201	60015	306
505	315	182	60024	306
506	315	162	60081	306
507	315	142	60047	306
508	315	123	60065	306
509	335	121	60110	306
510	356	122	60021	306
511	377	122	59960	306
512	397	122	59976	306
513	417	121	60017	306
514	418	143	59796	306
515	396	143	60026	306

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
516	375	143	60018	306
517	355	143	60057	306
518	336	143	60052	306
519	336	162	60072	306
520	357	162	60030	306
521	377	162	59973	306
522	397	162	60000	306
523	414	162	60012	306
524	415	183	59936	306
525	395	183	60066	306
526	376	183	60036	306
527	357	183	60052	306
528	336	183	60092	306
529	336	202	60062	306
530	357	202	60071	306
531	376	202	60084	306
532	395	202	60029	306
533	416	204	60039	306
534	415	223	59917	306
535	395	223	60057	306
536	376	223	60125	306
537	355	223	60159	306
538	336	223	60107	306
539	336	244	60039	306
540	336	262	60041	306
541	356	261	60068	306
542	356	243	60081	306
543	377	242	60117	306
544	395	242	59996	306
545	417	243	59987	306
546	417	264	60081	306
547	400	263	60008	306
548	376	263	60325	306
549	376	281	60003	306
550	356	281	60012	306
551	337	281	59966	306
552	337	300	59881	306
553	357	300	59911	306
554	377	300	59973	306
555	396	298	60068	306
556	477	321	59955	310
557	477	302	59991	310

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
558	477	283	59991	310
559	457	283	59940	310
560	456	301	60014	310
561	457	323	60030	310
562	436	321	60039	310
563	417	320	60032	310
564	417	302	60015	310
565	437	300	59942	310
566	437	281	60197	310
567	417	281	60035	310
568	391	282	60087	310
569	777	452	59855	024*
570	803	453	59705	024*
571	824	453	59997	024*
572	827	470	60020	024*
573	848	483	59812	024*
574	869	493	59790	024*
575	888	493	59562	024*
576	916	509	59765	024*
577	908	502	59818	024*
578	918	484	59924	024*
579	918	464	59750	024*
580	918	446	59833	024*
581	897	443	59905	024*
582	897	459	59762	024*
583	897	473	59599	024*
584	879	473	59787	024*
585	878	458	59879	024*
586	877	441	59800	024*
587	858	442	59829	024*
588	856	436	59848	024*
589	837	462	59991	024*
590	837	440	60038	024*
591	816	432	59878	024*
592	798	434	59809	024*
593	778	434	59951	024*
594	749	442	60060	221
595	749	442	60060	221
596	773	442	59588	221
597	786	420	59900	221
598	788	414	59734	221
599	798	418	59976	221

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
600	808	423	60049	221
601	823	424	59791	221
602	839	422	60012	221
603	861	422	59032	221
604	882	422	59277	221
605	901	422	59185	221
606	916	422	59350	221
607	917	409	58977	221
608	918	385	58992	221
609	917	366	59319	221
610	917	346	59791	221
611	917	336	59804	221
612	917	317	59855	221
613	917	294	59868	221
614	917	274	59919	221
615	917	254	59876	221
616	917	230	59864	221
617	917	210	59825	221
618	907	196	59796	221
619	905	172	59741	221
620	910	156	59734	221
621	916	134	59706	221
622	916	116	59608	221
623	907	94	59918	221
624	908	75	59673	221
625	904	57	59745	221
626	784	56	59679	221
627	806	55	59690	221
628	807	74	59662	221
629	824	74	59672	221
630	766	406	59879	223
631	778	403	59883	223
632	796	403	59747	223
633	808	412	60053	223
634	807	418	60045	223
635	807	422	60026	223
636	826	422	59659	223
637	826	409	59849	223
638	826	395	59894	223
639	838	393	60056	223
640	852	393	60224	223
641	858	399	59897	223

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
642	879	403	60015	223
643	886	403	59878	223
644	907	401	59866	223
645	907	382	59836	223
646	907	362	59839	223
647	905	345	59802	223
648	906	326	59870	223
649	889	326	59870	223
650	887	342	59861	223
651	887	365	59903	223
652	887	383	59838	223
653	866	383	59873	223
654	865	364	59885	223
655	866	342	59903	223
656	866	326	59912	223
657	836	334	59896	223
658	846	322	59891	223
659	848	341	59936	223
660	849	364	59851	223
661	848	380	60117	223
662	826	382	59957	223
663	826	364	59833	223
664	827	343	59841	223
665	827	329	59939	223
666	817	330	59920	223
667	799	324	59905	223
668	798	342	59893	223
669	799	363	59930	223
670	807	347	59811	223
671	807	339	59875	223
672	817	360	59893	223
673	766	384	59711	228
674	766	353	59826	228
675	777	363	59778	228
676	795	383	59876	228
677	818	383	59704	228
678	806	371	59863	228
679	798	314	59719	228
680	807	303	59321	228
681	818	313	59823	228
682	838	313	59896	228
683	856	304	59903	228

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
684	878	305	59855	228
685	898	304	59805	228
686	897	286	59914	228
687	897	266	59817	228
688	897	244	59814	228
689	898	223	59863	228
690	897	204	59763	228
691	877	207	59852	228
692	877	226	59827	228
693	877	243	59824	228
694	878	267	59864	228
695	877	285	59742	228
696	856	285	59742	228
697	856	264	59854	228
698	856	245	59858	228
699	856	225	59785	228
700	856	205	59777	228
701	838	205	59790	228
702	838	223	59790	228
703	838	246	59783	228
704	837	265	59754	228
705	837	285	59565	228
706	817	283	59955	228
707	816	273	59726	228
708	826	253	59846	228
709	817	233	59787	228
710	817	214	59751	228
711	798	216	59725	228
712	798	236	59808	228
713	796	255	59888	228
714	798	276	59799	228
715	798	292	59757	228
716	766	57	59739	230
717	836	55	59466	230
718	847	67	59636	230
719	865	65	59851	230
720	884	65	59698	230
721	887	84	59780	230
722	866	86	59772	230
723	846	86	59600	230
724	827	96	59512	230
725	787	75	59630	230

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
726	766	75	59665	230
727	766	97	59826	230
728	743	95	59702	230
729	777	115	59732	230
730	777	132	59636	230
731	796	133	59637	230
732	796	115	59671	230
733	806	94	59574	230
734	818	115	59719	230
735	817	137	59748	230
736	836	134	59707	230
737	837	115	59640	230
738	846	106	59680	230
739	856	116	59702	230
740	868	106	59543	230
741	877	114	59775	230
742	887	106	59719	230
743	896	117	59731	230
744	896	136	59759	230
745	895	156	59671	230
746	897	177	59763	230
747	884	188	59833	230
748	877	174	59774	230
749	878	156	59777	230
750	876	136	59732	230
751	855	137	59769	230
752	856	156	59769	230
753	857	183	59621	230
754	837	178	59722	230
755	836	156	59600	230
756	818	156	59725	230
757	818	173	59674	230
758	818	193	59781	230
759	797	194	59704	230
760	797	173	59671	230
761	797	156	59751	230
762	776	155	59811	230
763	777	173	59775	230
764	777	194	59739	230
765	778	213	59760	230
766	777	236	59820	230
767	778	256	59954	230
768	779	273	59829	230

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
769	717	430	59748	235
770	696	431	59930	235
771	677	426	59984	235
772	670	402	60158	235
773	657	405	59928	235
774	655	423	59937	235
775	628	412	59994	235
776	636	401	59993	235
777	634	384	60002	235
778	618	385	59849	235
779	615	401	60071	235
780	599	374	59802	235
781	597	394	59722	235
782	566	391	60033	235
783	578	378	59905	235
784	558	362	59890	235
785	578	362	59301	235
786	588	362	59926	235
787	600	362	59915	235
788	618	362	59973	235
789	638	362	59957	235
790	658	363	59841	235
791	657	383	59903	235
792	677	383	59881	235
793	677	402	59931	235
794	697	382	59829	235
795	697	402	59866	235
796	697	418	59832	235
797	556	343	59818	245
798	557	323	59881	245
799	557	302	59905	245
800	557	284	59815	245
801	558	263	59734	245
802	578	263	59939	245
803	596	263	59861	245
804	596	283	59918	245
805	579	283	59846	245
806	577	308	59851	245
807	577	323	59796	245
808	577	341	59899	245
809	597	342	59885	245
810	597	332	59896	245
811	598	322	59846	245

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
812	597	313	59937	245
813	593	303	59942	245
814	597	295	59870	245
815	607	294	59841	245
816	617	283	60162	245
817	617	279	59960	245
818	617	264	59917	245
819	635	263	59993	245
820	637	287	59994	245
821	637	305	59991	245
822	637	323	59949	245
823	637	343	59912	245
824	618	343	59984	245
825	617	322	59928	245
826	617	303	59937	245
827	617	294	59924	245
828	658	263	59954	245
829	677	266	59870	245
830	676	284	59957	245
831	657	284	59857	245
832	676	304	59915	245
833	661	304	59979	245
834	676	324	60039	245
835	657	324	59975	245
836	658	343	59931	245
837	676	342	59945	245
838	677	361	59984	245
839	695	361	60009	245
840	717	361	60014	245
841	717	342	59873	245
842	696	341	59869	245
843	697	322	59927	245
844	717	321	59890	245
845	717	303	59899	245
846	697	301	59943	245
847	697	283	59942	245
848	697	263	59873	245
849	718	263	59849	245
850	738	264	59936	245
851	575	16	59876	250
852	560	25	59876	250
853	656	56	59817	250

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
854	675	55	59722	250
855	721	53	59664	250
856	740	55	59818	250
857	745	73	59809	250
858	726	77	59826	250
859	707	77	59735	250
860	685	74	59637	250
861	697	92	59729	250
862	714	103	59946	250
863	726	94	59842	250
864	747	95	59866	250
865	754	115	59830	250
866	735	115	59667	250
867	736	135	59734	250
868	754	135	59698	250
869	758	155	59753	250
870	758	171	59732	250
871	737	153	59748	250
872	576	242	59903	254
873	556	242	59933	254
874	556	223	59821	254
875	556	203	59838	254
876	556	182	59857	254
877	556	161	59664	254
878	566	144	59857	254
879	566	122	59943	254
880	560	104	59867	254
881	566	81	59772	254
882	564	66	59836	254
883	587	64	59902	254
884	607	64	59887	254
885	625	64	59852	254
886	645	66	59717	254
887	670	76	59794	254
888	685	105	59757	254
889	665	106	59829	254
890	645	104	59704	254
891	645	87	59854	254
892	625	86	59933	254
893	626	103	59905	254
894	606	104	59667	254
895	606	84	59991	254
896	586	86	59921	254

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
897	585	104	59836	254
898	581	123	59923	254
899	596	123	59900	254
900	617	123	59999	254
901	637	123	59766	254
902	657	123	59790	254
903	677	124	59893	254
904	698	123	59829	254
905	715	123	59717	254
906	715	144	59793	254
907	716	164	59803	254
908	698	164	59808	254
909	696	144	59888	254
910	671	145	59791	254
911	676	167	59841	254
912	656	167	59781	254
913	656	145	59843	254
914	636	145	59852	254
915	636	167	59914	254
916	616	163	59866	254
917	616	144	59839	254
918	598	144	59833	254
919	581	146	59894	254
920	576	167	59793	254
921	596	167	59846	254
922	576	182	59791	254
923	576	204	59765	254
924	576	223	59808	254
925	738	247	59830	256
926	715	245	59884	256
927	697	245	59821	256
928	677	246	59864	256
929	657	244	59857	256
930	636	243	59952	256
931	615	244	59821	256
932	597	242	59860	256
933	597	223	59936	256
934	597	203	59931	256
935	597	181	59806	256
936	616	184	59759	256
937	616	205	59809	256
938	616	224	59872	256

TABLE 1--Continued

Number	Y	X	Magnetic Field (nT)	Julian Date
939	636	223	59887	256
940	636	203	59923	256
941	636	183	59954	256
942	657	184	59760	256
943	657	205	59803	256
944	657	224	59872	256
945	676	223	59785	256
946	676	205	59826	256
947	677	183	59860	256
948	697	184	60671	256
949	677	187	59784	256
950	677	302	59867	256
951	678	224	59835	256
952	719	226	59858	256
953	718	204	59882	256
954	717	183	59821	256
955	737	186	59806	256
956	755	194	59814	256
957	758	214	59906	256
958	757	233	59972	256
959	737	204	59909	256
960	742	224	59958	256
961	757	255	59912	256
962	757	272	59939	256
963	747	283	59966	256
964	739	383	59961	256
965	739	343	59948	256
966	738	362	59903	256
967	717	403	60101	258
968	715	382	60116	258
969	754	353	59839	258
970	787	352	59832	258
971	787	333	59872	258
972	787	312	59882	258
973	786	295	59882	258
974	767	295	59867	258
975	767	313	59882	258
976	767	333	59829	258

*1978, all other dates 1977.

TABLE 2

SYMAP GRID LOCATIONS, GEOMAGNETIC FIELD VALUES, AND DATES FROM NELSON COUNTY, NORTH DAKOTA, USED BY COMPUTER TO DEVELOP MAPS

Number	Y	X	Magnetic Field (nT)	Julian Date
977	905	36	59611	221
978	888	36	59752	221
979	864	36	59796	221
980	846	36	59654	221
981	824	36	59650	221
982	803	36	59670	221
983	788	36	59678	221
984	806	55	59690	221
985	690	33	59823	230
986	706	33	59680	230
987	727	33	59621	230
988	747	33	59668	230
989	768	34	59748	230
990	836	55	59466	230
991	555	3	59906	250
992	556	37	59785	250
993	576	37	59838	250
994	595	35	59931	250
995	616	35	59728	250
996	637	35	59768	250
997	656	35	59698	250
998	675	55	59722	250
999	697	52	59708	250

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REFERENCES

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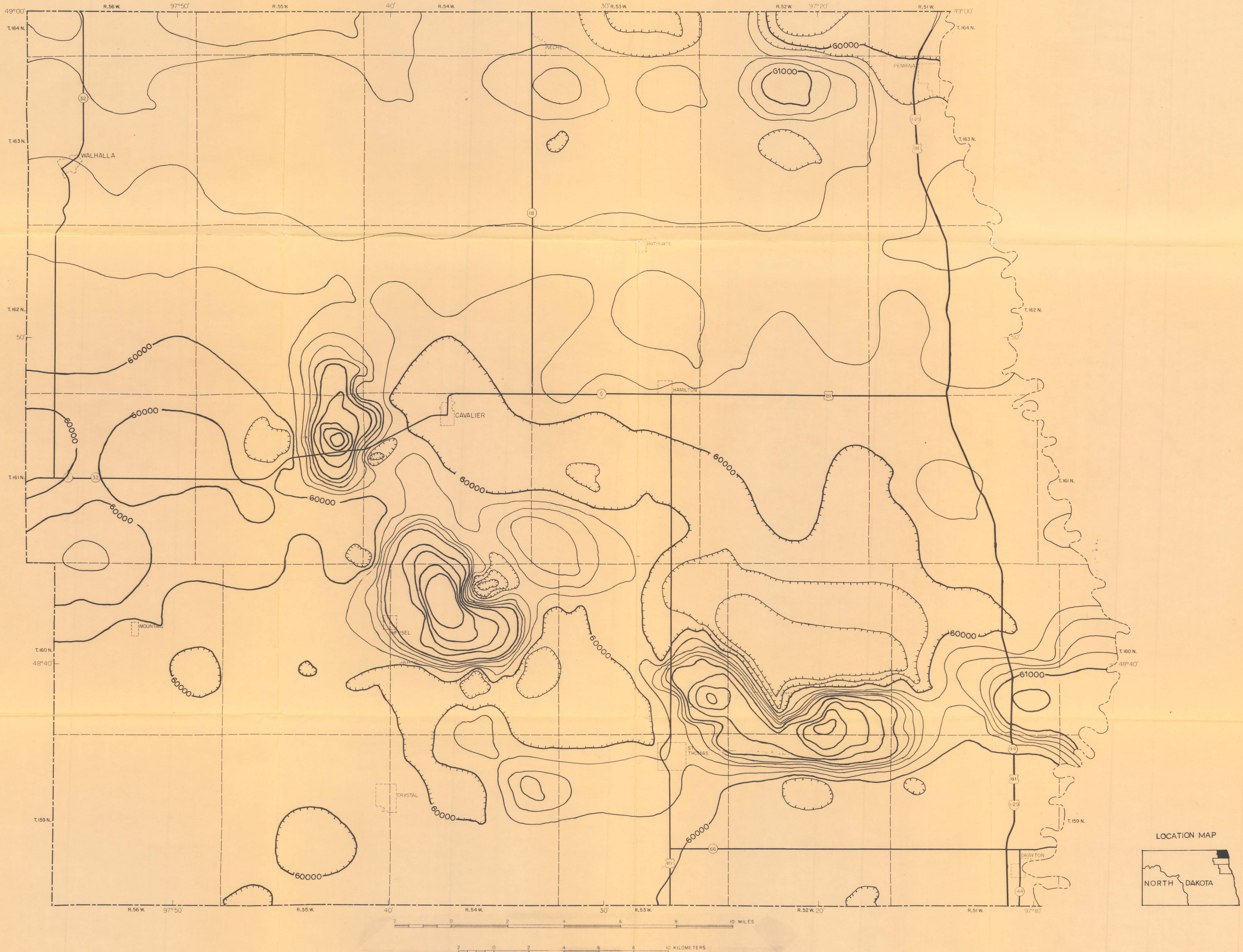
GEOMAGNETIC MAP OF PEMBINA COUNTY, NORTH DAKOTA

PLATE I

OKLAND, 1978



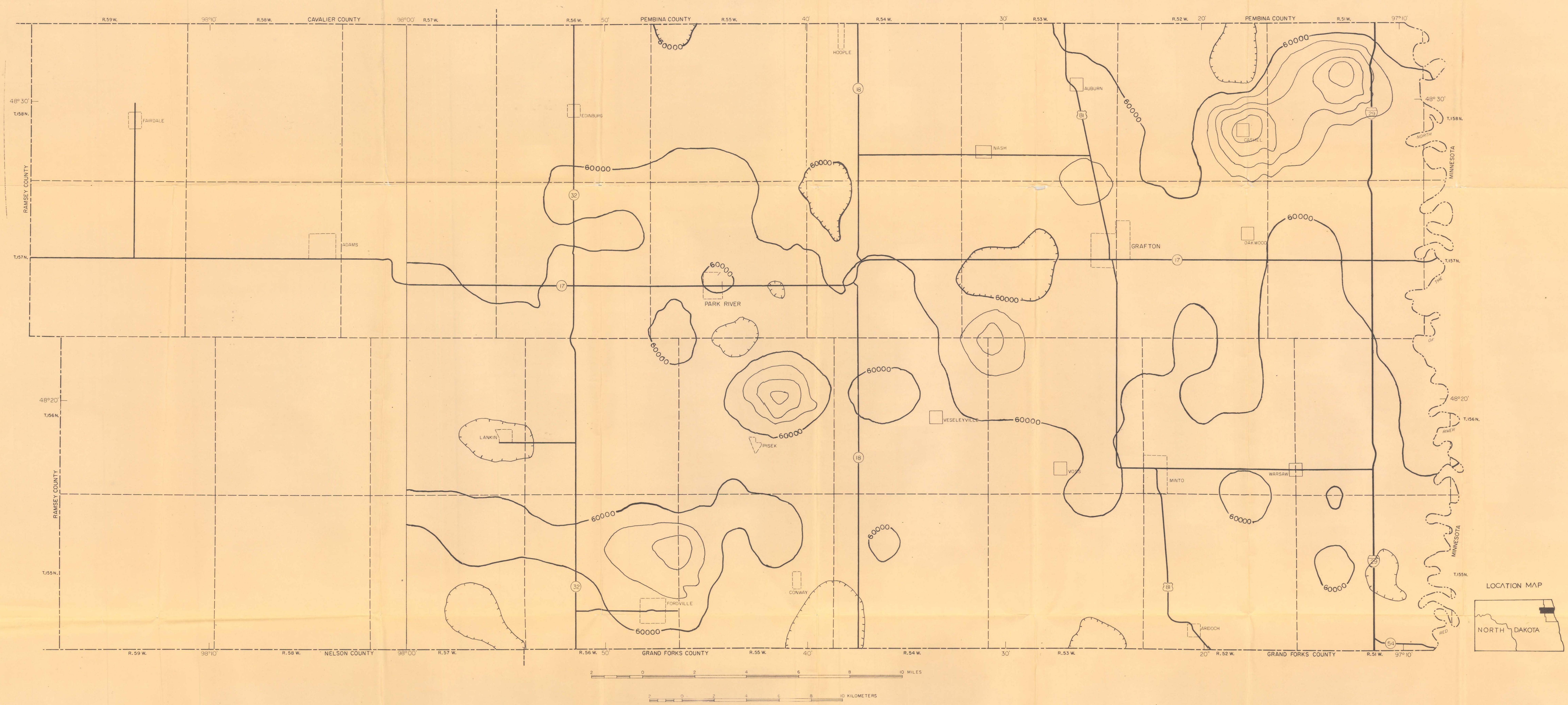
CONTOUR INTERVALS

200 nanoteslas (gammas) below 61,000 nT
1000 nanoteslas (gammas) above 61,000 nT

GEOMAGNETIC MAP OF WALSH COUNTY, NORTH DAKOTA

PLATE 2

OKLAND, 1978

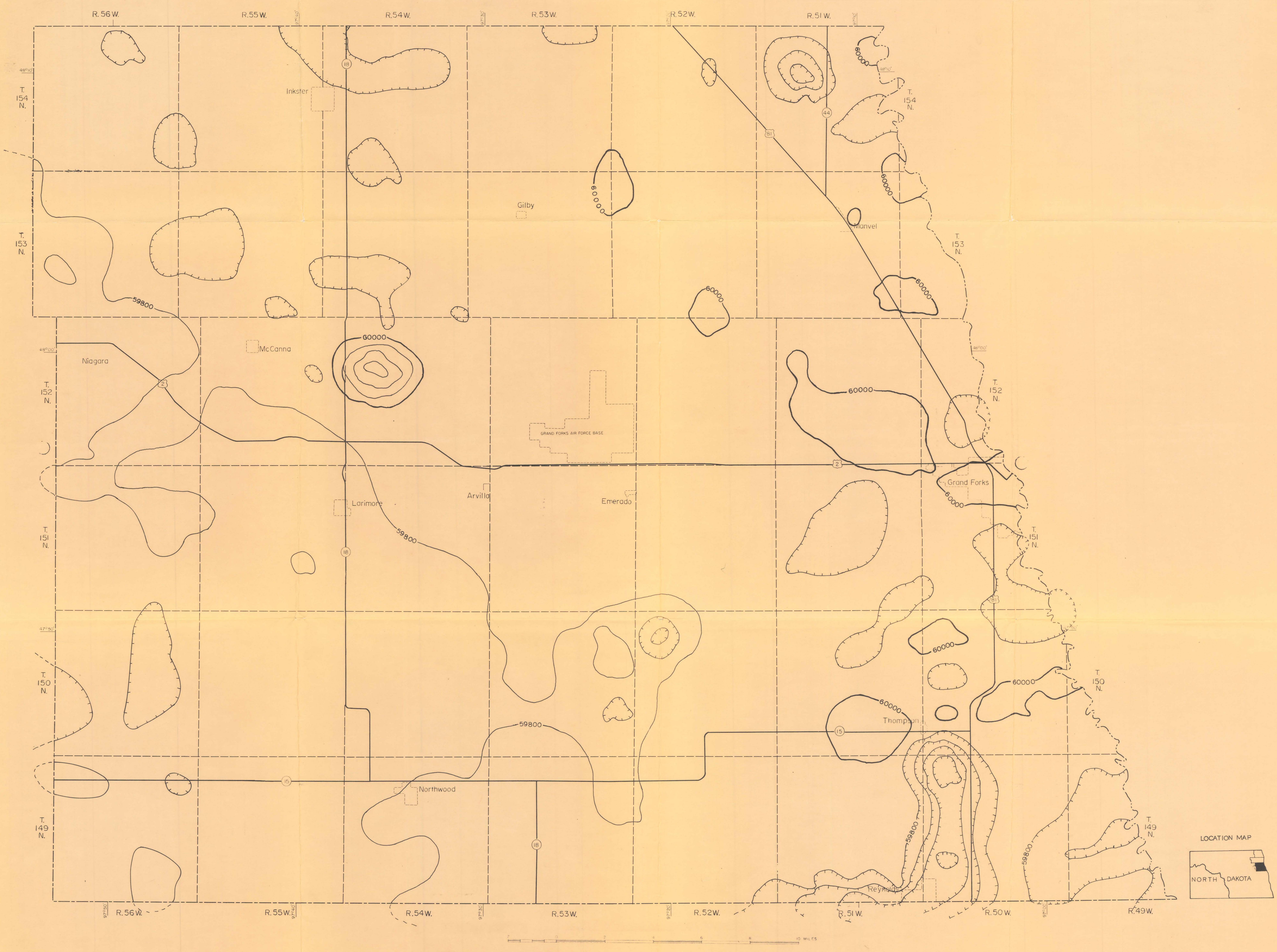


CONTOUR INTERVAL 200 nanoteslas (gammas)

GEOMAGNETIC MAP OF GRAND FORKS COUNTY, NORTH DAKOTA

PLATE 3

OKLAND, 1978



CONTOUR INTERVAL 200 nanotesias (gammas)

COMPUTER PRODUCED GEOMAGNETIC MAP OF PEMBINA COUNTY, NORTH DAKOTA

PLATE 4

OKLAND, 1978

1.543063 MINUTES FOR MAP

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

LEVEL	L	1	2	3	4	5	6	7	8	9	10	
MINIMUM	BELOW	59800.00	60000.00	60200.00	60400.00	60600.00	60800.00	61000.00	62000.00	63000.00	64000.00	ABOVE 65000.00
MAXIMUM	59800.00	60000.00	60200.00	60400.00	60600.00	60800.00	61000.00	62000.00	63000.00	64000.00	65000.00	
SYMBOLS	LLLLLLLLL	....1....	''''2''''	----3----	====4====	++++5++++	XXXX6XXXX	OOOO7OOOO	ΘΘΘΘ8ΘΘΘΘ	&&&&9&&&&	■■■■*■■■■	HHH

COMPUTER PRODUCED GEOMAGNETIC MAP
PEMBINA COUNTY, NORTH DAKOTA

PLATE 4
OKLAND, 1978

CONTOUR INTERVAL 200 AND 1000 NANOTESLAS(GAMMAS)

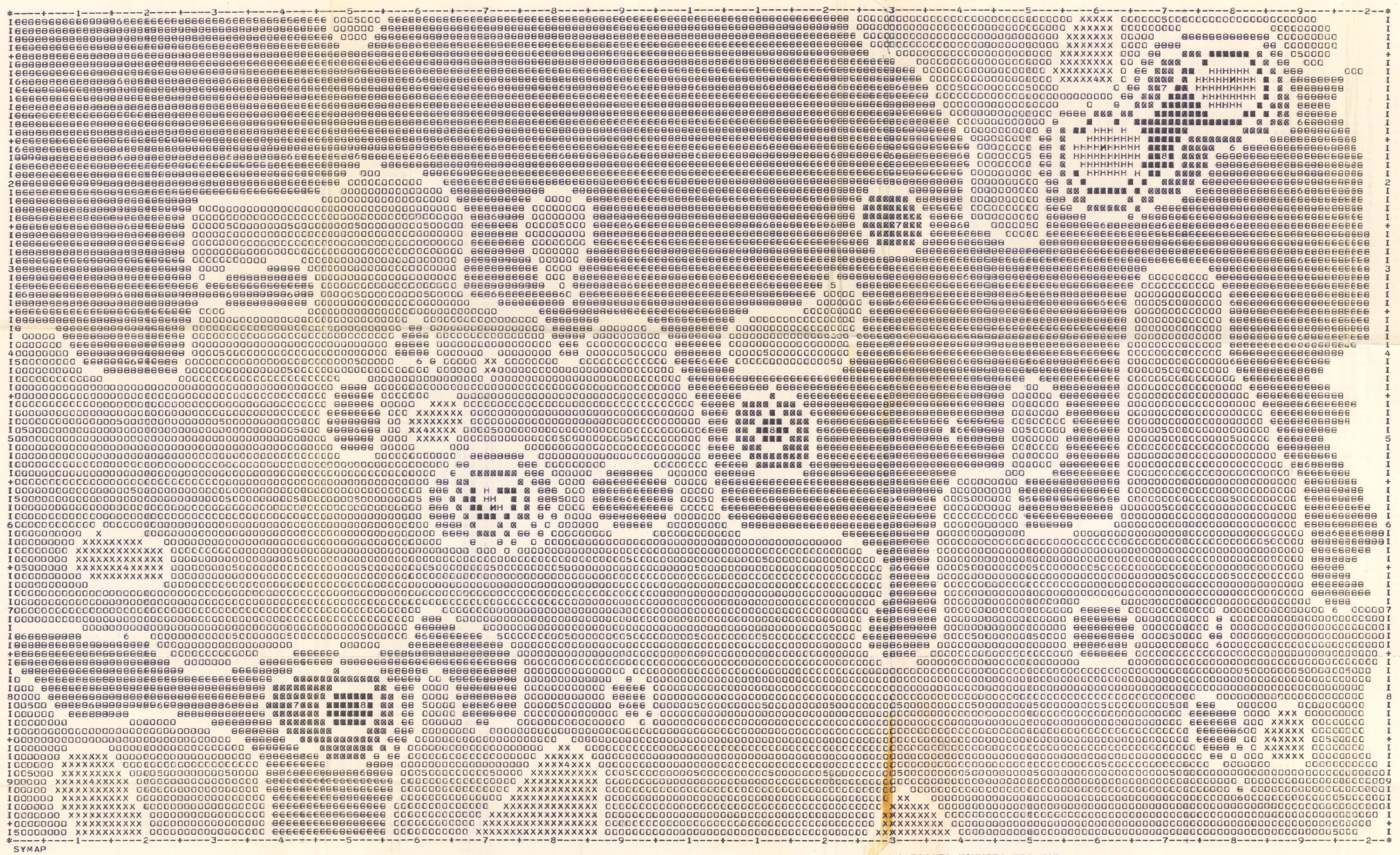
DATA VALUE EXTREMES ARE 59446.00 73456.00

TOTAL SUPERIMPOSED DATA POINTS IS 2. THESE OCCUR IN 1 LOCATIONS.

COMPUTER PRODUCED GEOMAGNETIC MAP OF WALSH COUNTY, NORTH DAKOTA

PLATE 5

OKLAND, 1978



SYMAP

1.316172 MINUTES FOR MAP

COMPUTER PRODUCED GEOMAGNETIC MAP — PLATE 5

WALSH COUNTY, NORTH DAKOTA — OKLAND, 1978

CONTOUR INTERVAL 200 NANOTESLAS(GAMMAS)

DATA VALUE EXTREMES ARE 59654.00 60952.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

									ABOVE
MINIMUM	59000.00	59200.00	59400.00	59600.00	59800.00	60000.00	60200.00	60400.00	60600.00
MAXIMUM	59200.00	59400.00	59600.00	59800.00	60000.00	60200.00	60400.00	60600.00	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50

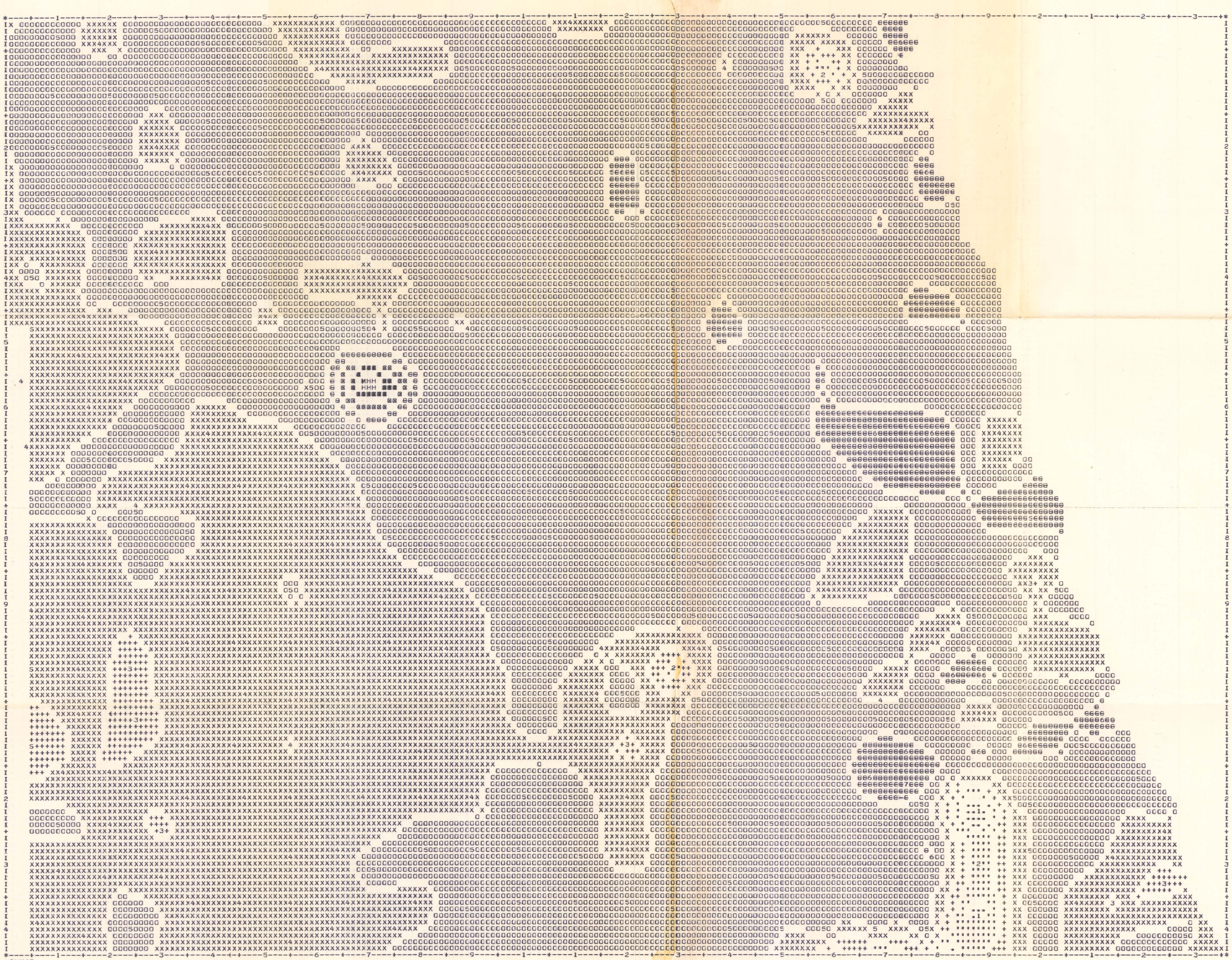
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	H
SYMBOLS	....1....	''''2''''	++++3++++	XXXX4XXXX	OOOO5OOOO	[illegible]	[illegible]	[illegible]	HHHHHHHHH

COMPUTER PRODUCED GEOMAGNETIC MAP OF GRAND FORKS COUNTY, NORTH DAKOTA

PLATE 6

OKLAND, 1978



SYMAP

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	BELOW	59000.00	59200.00	59400.00	59600.00	59800.00	60000.00	60200.00	60400.00	ABOVE 60600.00
MAXIMUM	59000.00	59200.00	59400.00	59600.00	59800.00	60000.00	60200.00	60400.00	60600.00	
LEVEL	L	1	2	3	4	5	6	7	8	H
SYMBOLS	LLLLLLLLL	....1....	''''2''''	++++3++++	XXXX4XXXX	OOOO5OOOO	66666	7	8	HHHHHHHHH

2.091234 MINUTES FOR MAP

COMPUTER PRODUCED GEOMAGNETIC MAP — PLATE 6

GRAND FORKS COUNTY, NORTH DAKOTA — OKLAND, 1978

CONTOUR INTERVAL 200 NANOTESLAS(GAMMAS)

DATA VALUE EXTREMES ARE 58977.00 60671.00

TOTAL SUPERIMPOSED DATA POINTS IS 8. THESE OCCUR IN 4 LOCATIONS.