A MAGNETIC SURVEY AT LES FORGES DU SAINT-MAURICE

Bruce Bevan

Museum Applied Science Center for Archaeology
The University Museum
University of Pennsylvania

7 October 1975

A Magnetic Survey at Les Forges du Saint-Maurice

Summary	1
Site Description	1
Survey Procedure	2
Interpretation Procedure	4
Interpretation Results	7
Aerial Photography	8
Conclusion	10
Acknowledgment	10
Appendix: Measurement Rate and Accuracy	11
References	11

SUMMARY

Over 300 magnetic anomalies were found in the seven acres of land surveyed with the cesium magnetometer; almost all of them are probably caused by buried iron and iron-containing slag from the old forges.

The approximate location of each anomaly is shown by the dots in Figure 1. The base map is the 1974 topographic map with the addition of the estimated position of roads and buildings as determined from the 1845 plan of J. P. Bureau (shown by dashed lines and hatching). There is little correlation between the clusters of anomalies and the estimated building locations.

Three intense and elongated anomalies fall roughly along the alignment marked by the dashed line of Figure 1. The two circled areas mark regions where immovable surface iron masks any possible anomalies from buried objects.

The pattern of magnetic anomalies is also shown in Slide 1, which differentiates the regions of high and low magnetic intensity. Intensely magnetic iron concentrations yield a dipole anomaly, a magnetic high and low paired in close proximity.

SITE DESCRIPTION

The site is on the west bank of the Saint-Maurice River, seven miles north of the river's junction with the St. Lawrence River at Trois-Rivieres. From 1730 to the middle of the 19th century Les Forges du Saint-Maurice was a major center for iron smelting and the production of iron implements. The iron ore was imported from the surrounding region and evidently none was natural to the area within the site itself.

Photo 1 and Slide 2 show the site and the small stream which once furnished water power for the industry there. The chimney in the foreground remains from the original lower forge; this is at area 3 in Figure 1. The base of the blast furnace is now under the geodesic dome; this is the area marked "8" in Figure 1. Area 6, the upper forge, is obscured by trees in these photos.

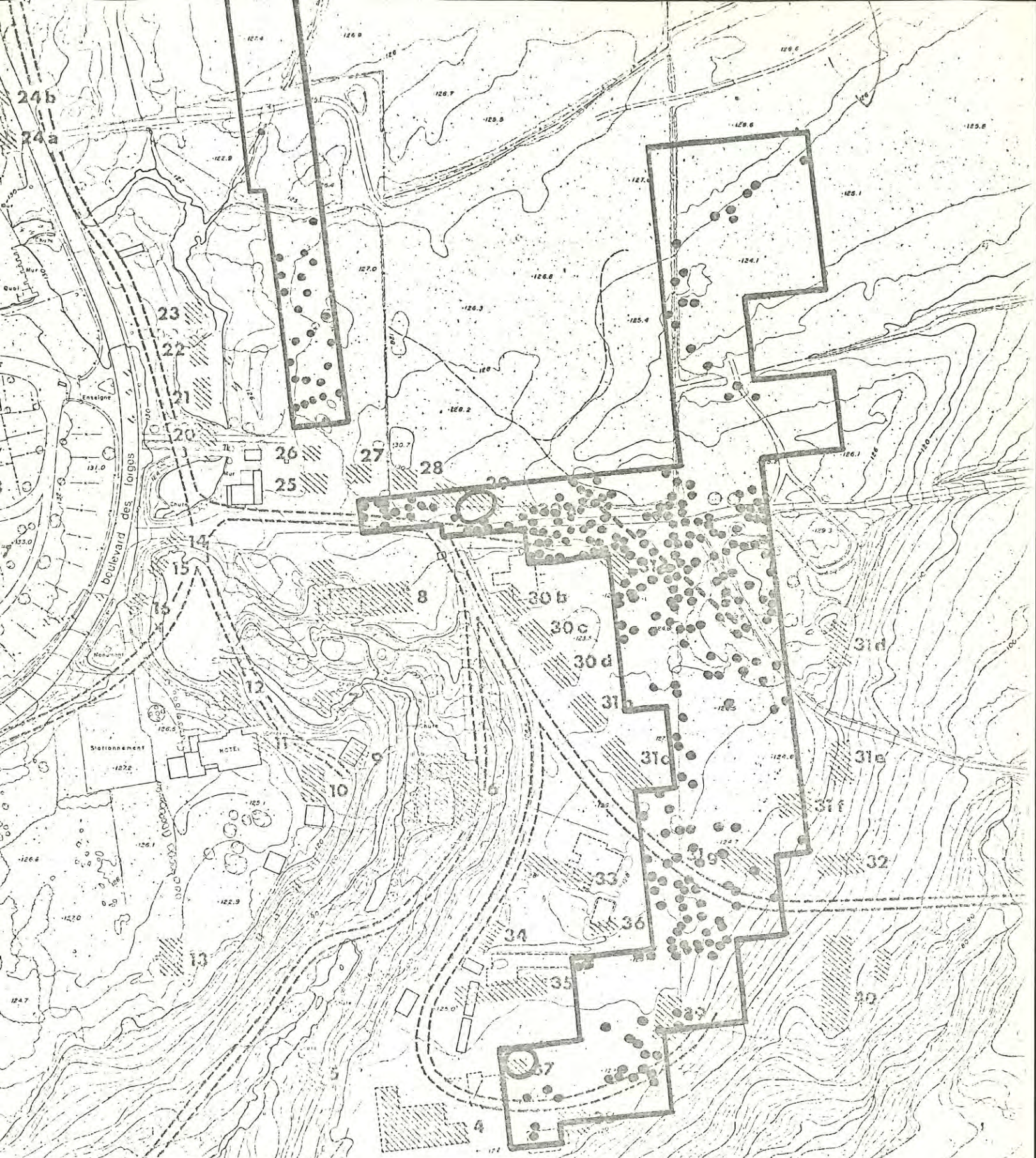


Figure 1: The approximate location of the magnetic anomalies



Photo 1: Les Forges du Saint-Maurice

The area of the survey was on flat-lying glacial sediments 100 feet above the river. Figure 2 and Photo 2 illustrate the terrain and the numbering of the survey grids. While most of the area surveyed was in weeds and grass 2-4 feet high, part was on mown turfgrass. There were only a few trees within the survey limits.

SURVEY PROCEDURE

Point-by-point measurements of the magnetic field were made and the intensity values were recorded as a square matrix of numbers. A contour map was drawn from these numbers in order to more clearly show the pattern of changes in the magnetic field. A buried magnetic object such as iron both distorts the earth's natural magnetic field and also generates a magnetic field of its own which is detectable from above the ground even though the change, or anomaly, is usually less than 1% of the earth's natural field. A general survey of magnetic prospecting is given by Jensen (1961).

Photo 3 and Slide 3 show the cesium magnetometer which was used for this survey. The cesium sensor, Varian Associates model 49-544, is mounted on a staff with the sensing element in the cylindrical housing and the associated amplifiers and temperature controllers in the rectangular box at the other end of the staff. A coaxial cable connects the sensor to the digital readout, Varian model 49-116. This apparatus converts the Larmor frequency (the Larmor constant is 3.5 hertz/gamma) into a number indicating the magnetic field intensity, in gammas, which is displayed on a liquid crystal indicator shown in Photo 4. A more complete description of this equipment is given by Ralph (1965) and Ralph and others (1968). The individual carrying the digital readout also carries a 28 volt, 6 ampere-hour nickel-cadmium battery which powers the magnetometer for almost an entire working day.

The magnetometer was not connected in difference mode (to correct for the diurnal shift) for three reasons: the average anomaly was large, greater than 100 gammas; the time of the survey was at a low in the eleven year magnetic storm cycle; and the high weeds would have made the cable connection to the fixed reference sensor difficult to control. Instead, uncorrected total magnetic intensity was recorded;

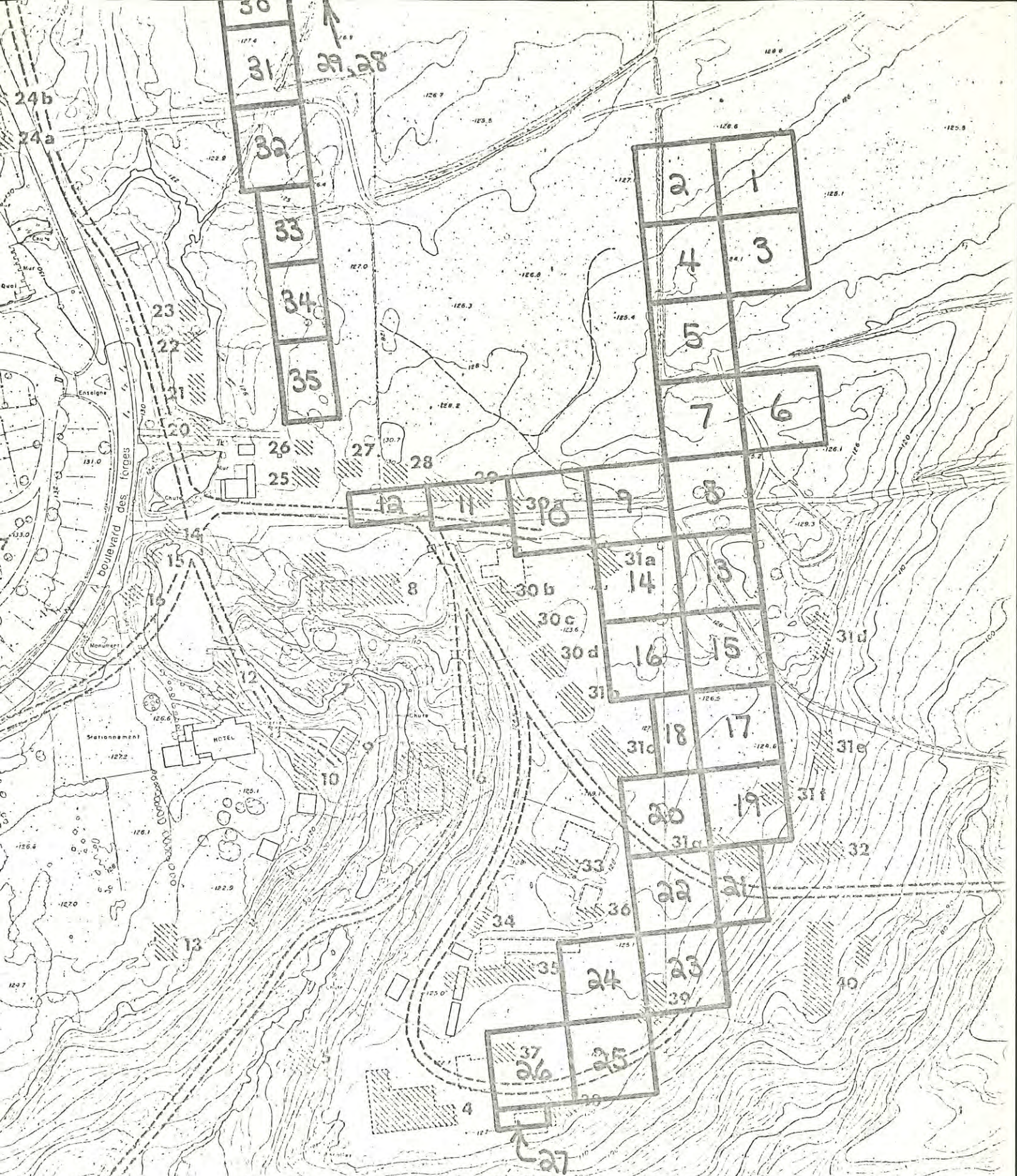


Figure 2: The grid numbering for the survey

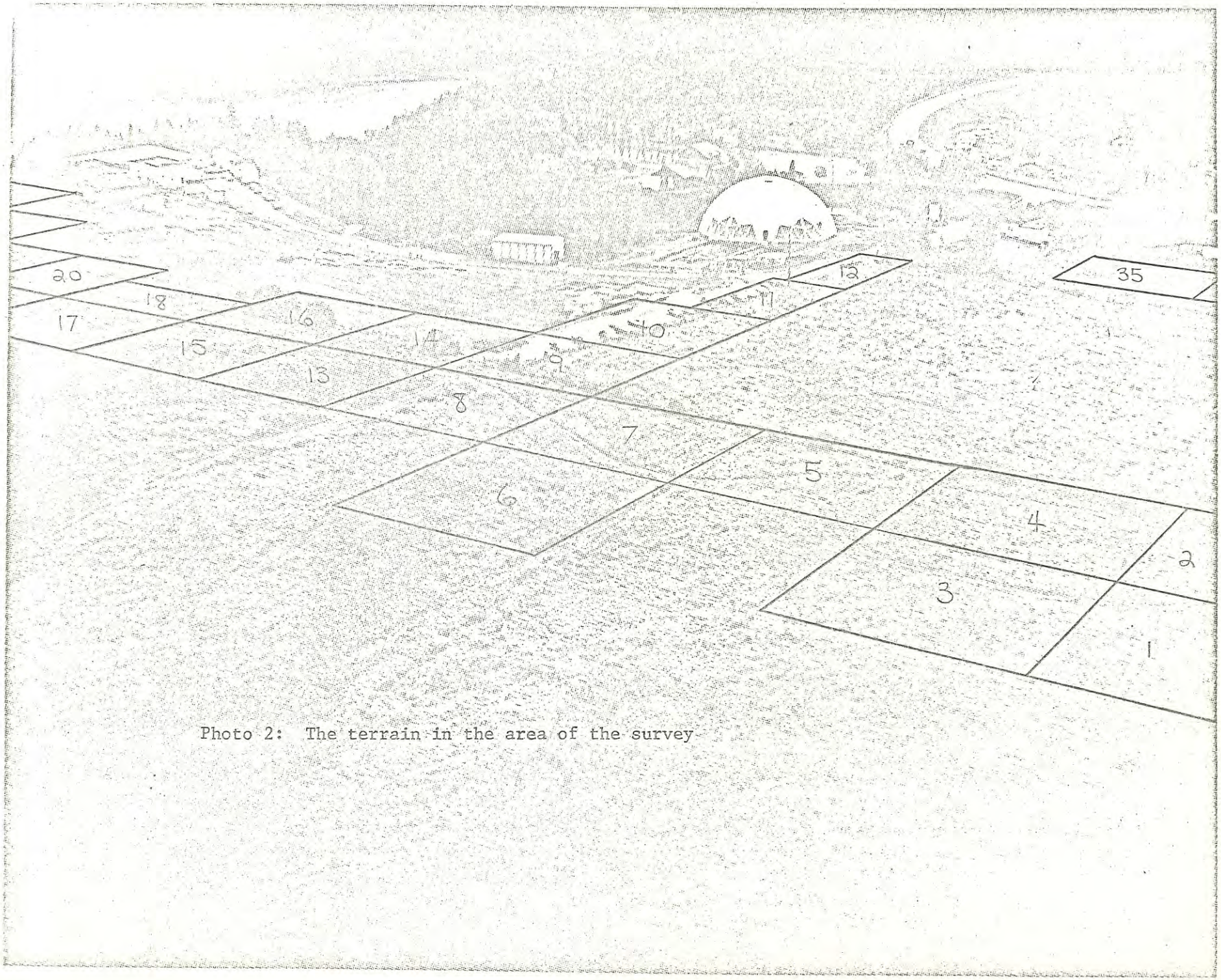


Photo 2: The terrain in the area of the survey

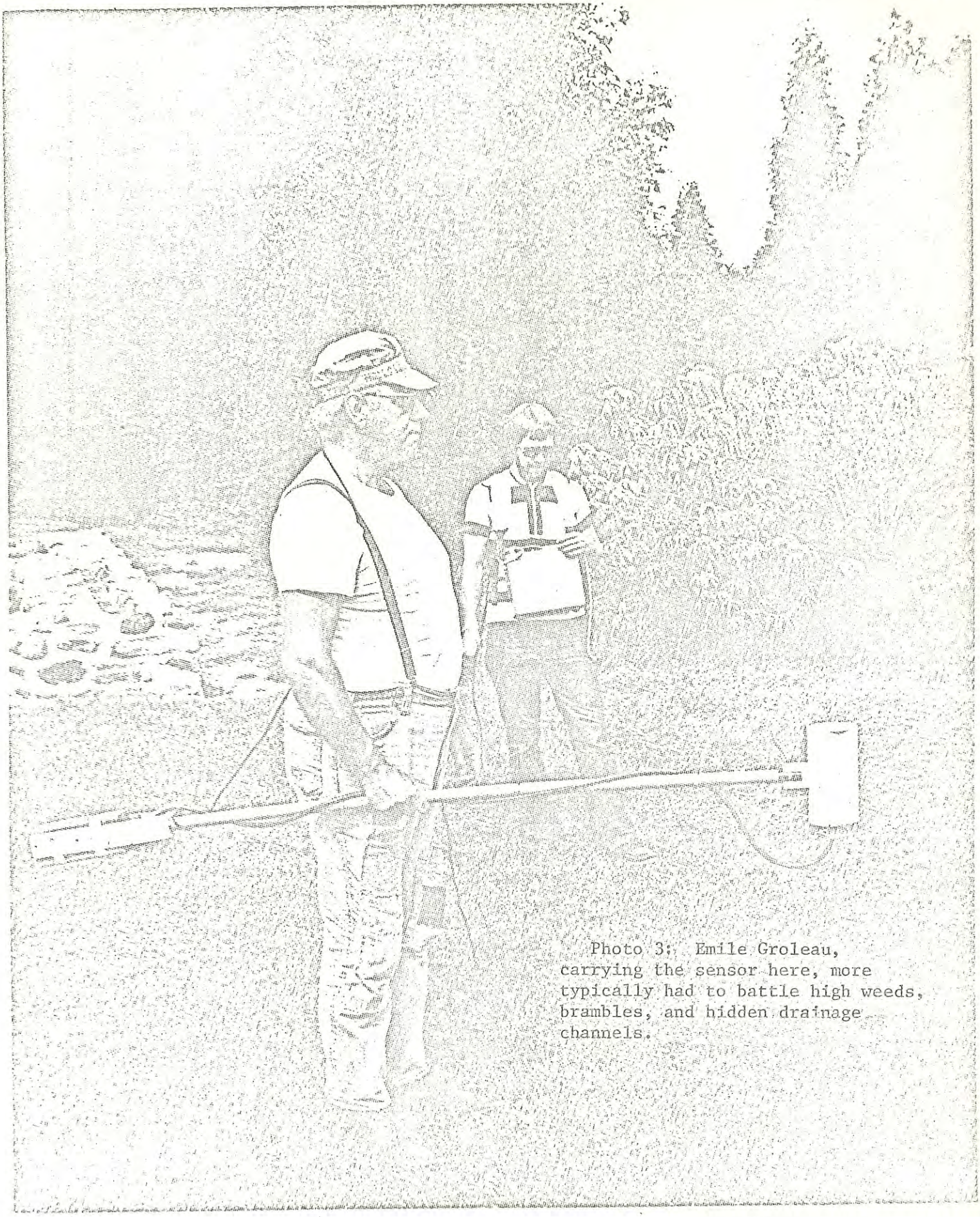


Photo 3; Emile Groleau, carrying the sensor here, more typically had to battle high weeds, brambles, and hidden drainage channels.

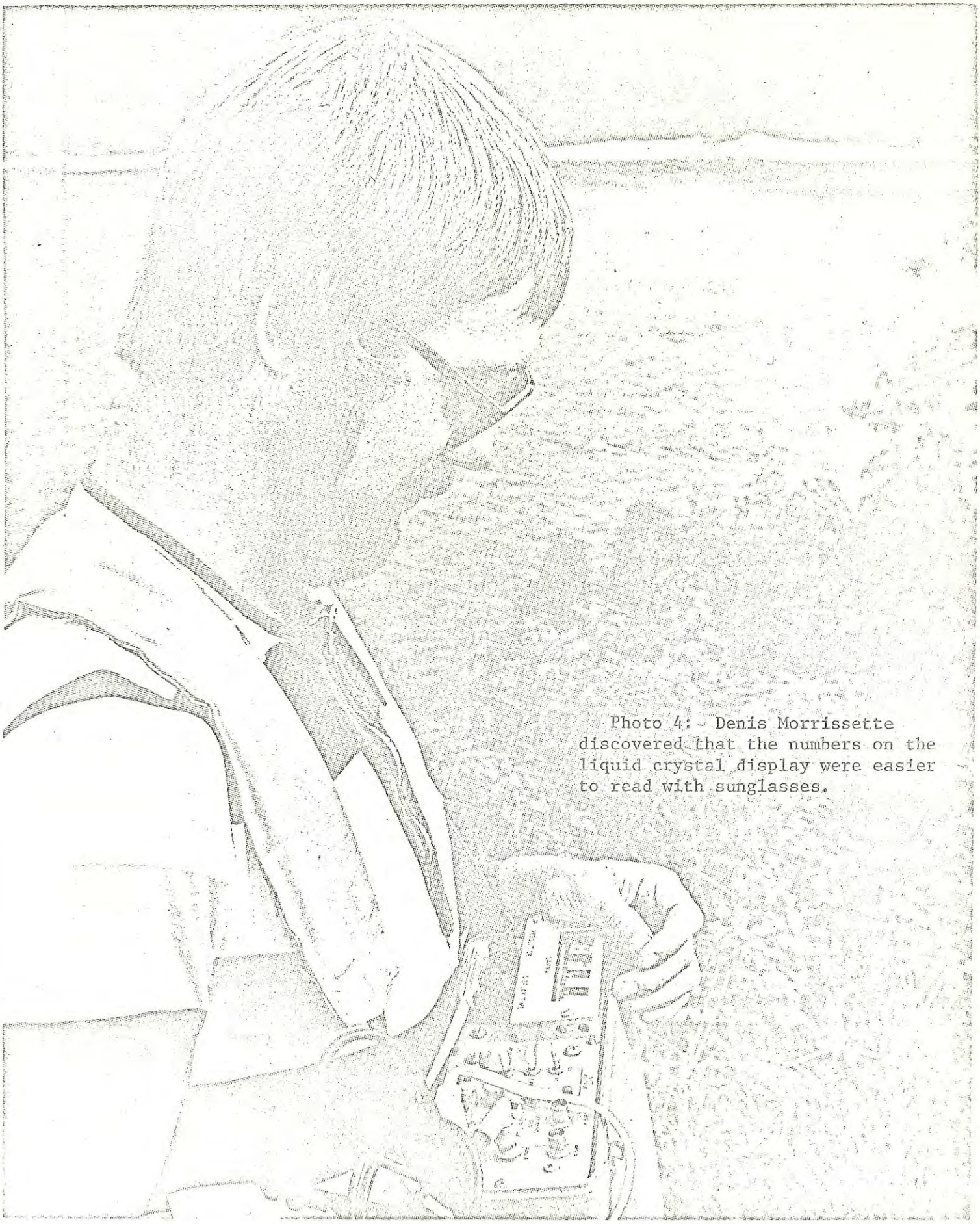


Photo 4: Denis Morrissette discovered that the numbers on the liquid crystal display were easier to read with sunglasses.

this yields an apparent discontinuity at the boundary between grids but no serious error within each grid.

This site is staked out in 100 foot squares and each magnetic grid is one of these squares or a part of it. A 100 foot cloth measuring tape was stretched out at opposite ends of each grid. A 100 foot cord, marked at a 5 foot interval with spray painted black and orange bands was extended perpendicular to the two tapes as a moving measurement line. A serpentine traverse pattern, first used by E. K. Ralph, kept walking to a minimum and speeded the survey. The traverse pattern is shown in Figure 3.

The measurement spacing was usually five feet, but sometimes ten. The positional accuracy at each measurement point is usually better than 1 foot. The date and time of doing each grid is given in Figure 4.

The survey areas were cleared of all surface iron which could conveniently be moved. Hundreds of feet of unused barbed wire were removed; since much of this was moderately brittle due to rust, probably some small broken fragments remained to cause very small anomalies. Other iron fencing and automobiles were temporarily removed for the survey. In several cases very intense magnetic gradients due to fairly large and shallow buried iron objects were found, these points are marked with an "X" on the magnetic grids.

The 35 grids are given on the following pages. Note that these figures are upside down relative to all of the other maps in the report. These are copies of the field notebook and the numbers have been kept in the original orientation for easier reading; for interpretation, however, the maps have been turned 180^{o} to coincide with the base map of the site. Note also that only part of the five digit number which indicates magnetic intensity is written on these maps. For example, in Grid 1, the number 58,181 is shortened to just "181" and 58,236 is shortened to "36"; that is, only changes from 58,200 gamma are recorded. These base values are also listed in Figure 4.

The contour lines on these grids have been drawn by approximate interpolation between the magnetic measurements. There was not enough space for all of the contour lines in a few of the very large anomalies.

Correction for time break in measurements (indicated by a line through grid)
Grid 2 and 5: equate column averages on each side of break
Grid 4: no correction, breaks < 1 hour
Grid 26: repeat edge line and equate averages

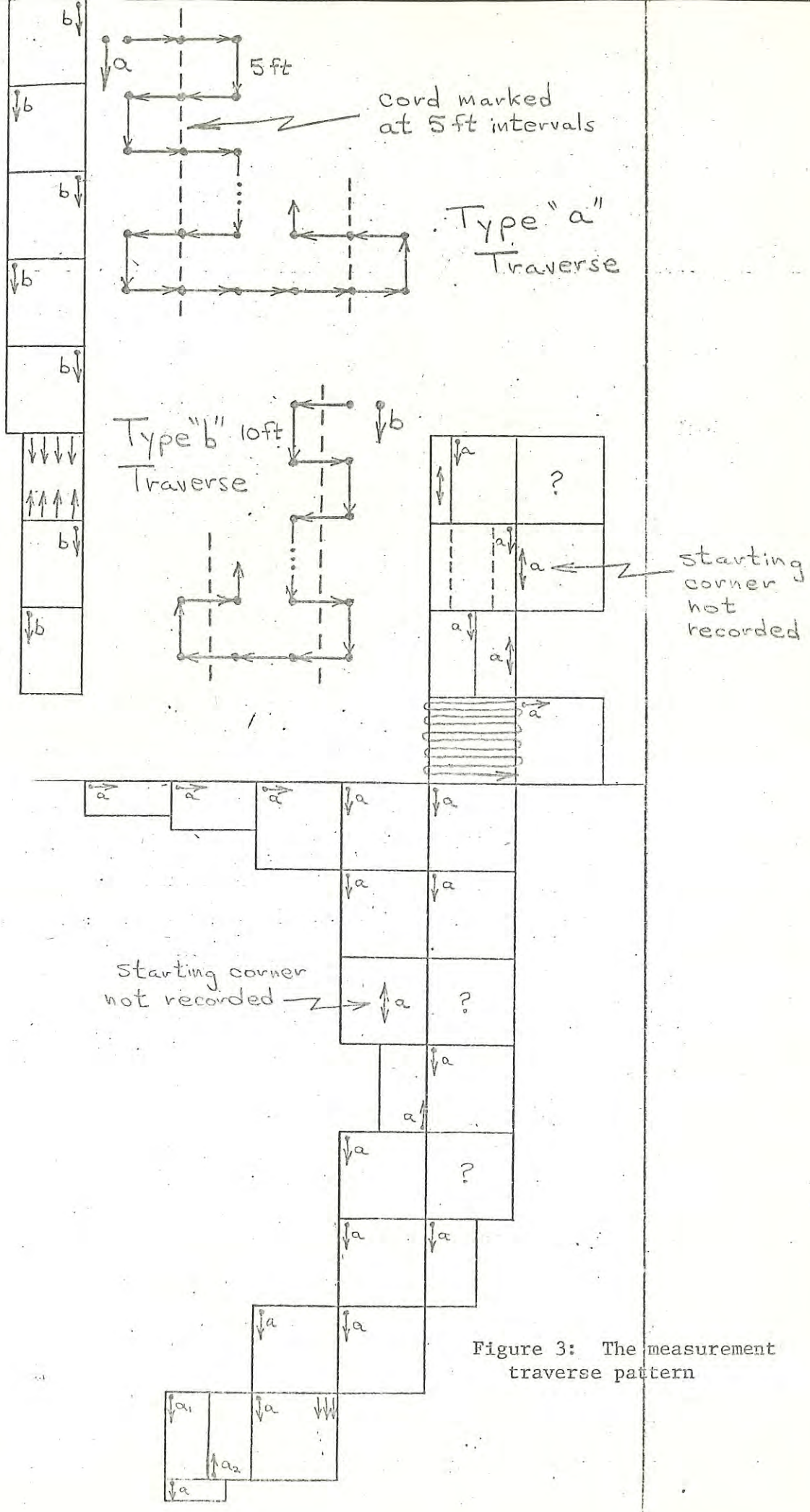


Figure 3: The measurement traverse pattern

Grid	Date	Time	Base Value
1	19	?	58,200
2	19/20	?/8:45-9:35	58,200
3	20	?	58,200
4	20	9:55- 1:10	58,100
5	20/21	?/8:10-9:06	58,200
6	29	8:45- 9:49	58,200
7	21	9:25- 9:56	58,200
8	28	4:10- 5:12	58,200
9	27	5:05- 5:58	58,300
10	27	8:32- 9:59	58,300
11	27	10:39-11:36	58,000
12	27	1:12- 1:48	58,200
13	27	3:42- 5:00	58,300
14	27	2:06- 3:14	58,200
15	21	?	58,300
16	21	?	58,300
17	22	1:10- 2:13	58,300
18	22	2:24- 2:58	58,300
19	22	?	58,300
20	25	2:00- 3:10	58,200
21	25	4:51- 5:33	58,000
22	25	3:45- 4:44	58,000
23	26	8:42-10:10	58,300
24	26	1:02- 2:10	58,300
25	26	10:45-11:50	58,300
26	26/29	3:30-4:53/10:11-10:35	58,300
27	29	11:09-11:23	58,300
28	28	9:05- 9:45	58,300
29	28	9:51-10:13	58,000
30	28	10:55-11:30	58,000
31	28	11:35-11:57	58,000
32	28	1:04- 1:24	58,000
33	28	1:39- 1:53	58,000
34	28	2:11- 2:40	58,000
35	28	3:40- 4:00	58,000

Figure 4: Notes for the magnetic grids

INTERPRETATION PROCEDURE

Slides 2 and 3 are examples of grid maps whose magnetic intensity contours have been color coded in order to show magnetic patterns better.

In this section, estimates of the position and depth of the source of each anomaly will be made; also, the weight of material causing each anomaly will be roughly estimated. It is first necessary to determine the magnetic properties of the material likely to cause the anomalies. Figure 5 tabulates the relative magnetic moments of eight samples from the site; these were measured by the method of Breiner (1973) in which the sample is rotated near the magnetic sensor and the maximum, minimum, and background values are recorded. The low density glass slag was non-magnetic. The iron samples had a remanent magnetization moment almost equal to the magnetic moment due to the induced field; therefore if the orientation of such a sample has its remanent magnetization vector antiparallel to the ambient field, the resultant moment can be small. More generally, this indicates that diverse anomaly orientations should be expected, which is found to be true.

The magnetic susceptibility of the iron samples was measured to be about one tenth of what it typically is for iron (although it can vary over a very wide range depending on the alloy). The variability and uncertainty in the magnetic moment to be expected in the survey area indicates that only an average value is suitable for this analysis. This has been chosen to be 45 gamma-ft^3/lb, but it is felt that this value might be too low by as much as a factor of ten. Even with this rough guess at the absolute magnetic properties to be expected, the interpretation of relative weights may be acceptably accurate.

The typical anomaly is less than 15 feet wide; with only an average of three numbers to define the shape of an anomaly, the accuracy of the interpretation is lowered due to the sensitivity to error in those few numbers. A discussion on the accuracy of this survey is given in an appendix.

Sample	Weight (ounces)	Specific Gravity	Magnetic Moment ($\frac{\text{gamma-ft}^3}{\text{lb}}$) Remanent, m_r	Induced, m_i	k
cast iron lump	0.40	5.9	15	21	0.13
cast iron lump	1.57	6.6	70	76	0.54
part of iron spike	5.99	6.1	25	43	0.28
glass-iron mixture	1.25	3.6	11	22	
frothy slag and iron	6.09	3.3	1.7	0.5	
green glass	6.50	2.6	less than 0.2		
black glass	3.48	2.7	less than 0.2		
frothy green glass	2.59	2.1	less than 0.2		

Figure 5: Magnetic properties of some samples from the site

Another uncertainty is the width of the source of each anomaly. A plateau on an anomaly can be a good clue, however, a guess is often all that is possible. When anomaly sources are close together their anomaly patterns overlap; the parameters for each single anomaly are then very difficult or impossible to isolate.

There are several general points to consider in the interpretation of the magnetic maps. The first point to check is if only a magnetic high or low is present or whether there is a related high and low forming a dipole. A deep, but not strong, source will tend to yield only a broad magnetic high (see the anomaly near the middle of Grid 1); while a shallow, diffuse source (such as a soil change) can give a high or only a low (the anomalies in Grid 17 might be examples of this). A source whose top is shallow and whose bottom is deep can also yield a monopole anomaly.

A second point to check is the horizontal gradient in magnetic intensity at the edge of the anomaly. Deep sources have low gradients (widely spaced contour lines) while nearby sources can have high gradients. For example an iron spike near the surface of the soil typically gives a single very high or low reading; the half dozen scattered points near the east corner of Grid 25 are examples.

Third, if a dipole anomaly is present, its orientation is important. Coherent magnetic sources which have been moved and which have a strong remanent magnetization (a part from a cast iron stove would be an example) can have a randomly oriented anomaly direction. However, an object magnetized in situ (such as a kiln or fireplace) or a cluster of random objects (such as a loose pile of iron-containing slag) must have its dipole anomaly oriented nearly parallel to the magnetic north-south line; furthermore, the magnetic low must be on the north side of the magnetic high. The large anomaly in Grid 5 is a typical example of a north-south oriented anomaly. Six of the well defined dipole anomalies have their anomaly axes pointed 150° east; the cause of this is not known.

A fourth point also applies to dipole anomalies; it is the ratio of the magnetic high to the magnetic low (both relative to an estimated uniform background). With a magnetic dip of 75°, this ratio should be about 3 if the remanent magnetization vector is either zero or aligned with the ambient field. Any other ratio is partial evidence

that the anomaly source has been moved from its place of magnetization.

The following maps have much of this analysis quantified for each of the anomalies. By following the procedure outlined in Figure 6, a close approximation to the depth and weight of the source of each anomaly is possible if the magnetic properties of the source can be more closely determined. Without these more accurate parameters, a simpler, more approximate, analysis will have the same resultant accuracy as the detailed procedure of Figure 6.

This simplified procedure has neglected the angle of polarization factor and has let the effective magnetic moment be constant at 45 gamma-ft^3/lb. Furthermore, source depth has been considered to be an integral multiple of the sensor height. Also, the width of each anomaly source has been guessed from the change in horizontal gradients at the edge of the anomaly.

Figure 6a: Procedure for Detailed Analysis

Estimate source width, S, along anomaly axis from plateau on magnetic high or distance from magnetic high to magnetic low

Measure width of magnetic high at half its peak amplitude along anomaly axis, H

Calculate depth, d, from $d = H - S - h$, $h = 2\frac{1}{2}$ ft

Measure declination, D, of anomaly axis relative to magnetic north

Select relative magnetic moment, m, to correct for noncollinearity of remanent and induced components from Figure 6b

Measure anomaly high peak, P, above ambient and low below ambient, V

Calculate high-low ratio, R, from $R = \frac{P}{V}$

Determine the correction, A, for the polarization difference from verticality with Figure 6c

Calculate source weight, W, from

$$W = \frac{P(d+h)^3}{2mA}$$

Estimate the position of the source center as $\frac{1}{3}$ to $\frac{1}{2}$ of the distance from the magnetic high to the background ambient along the anomaly axis

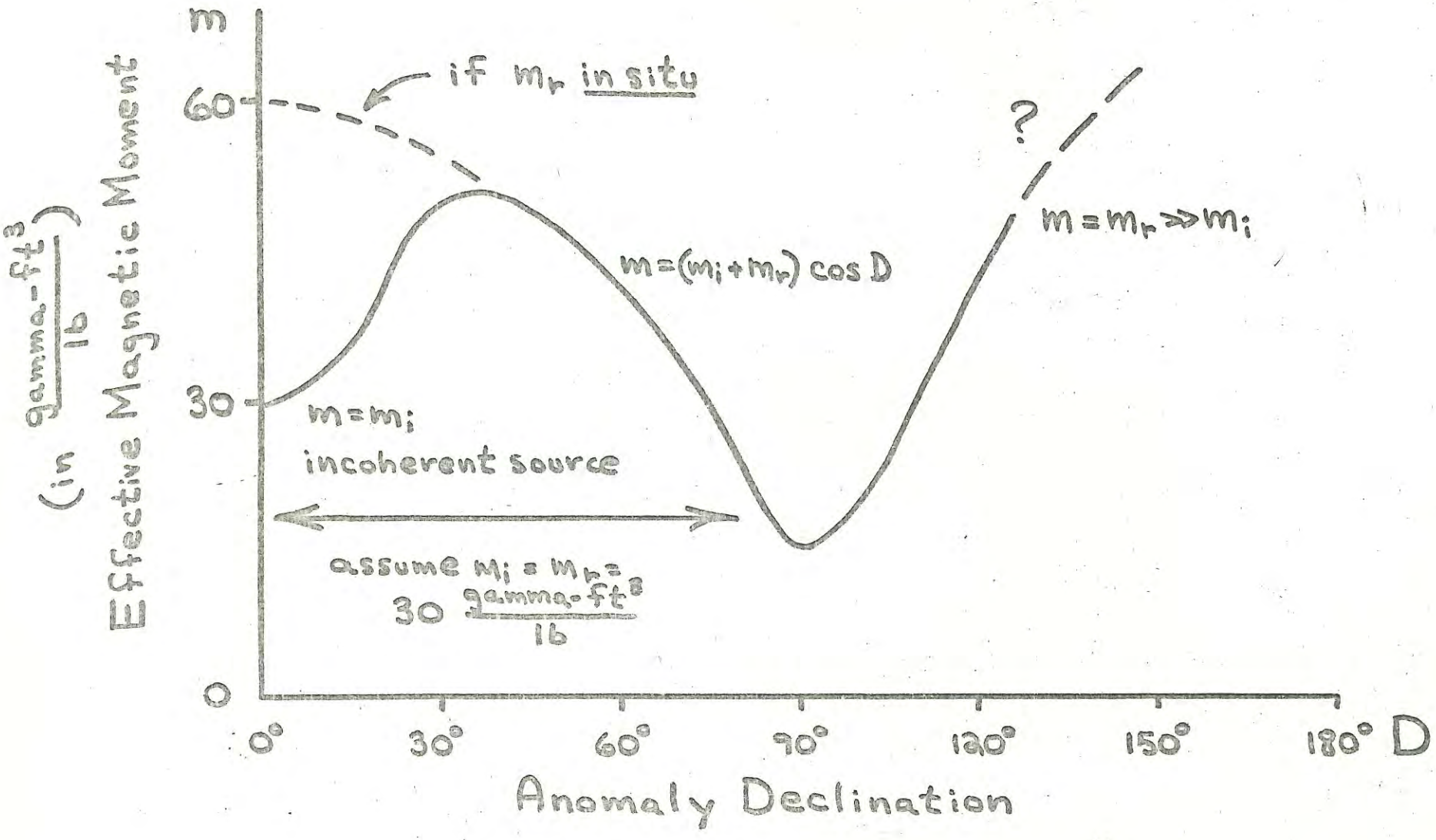


Figure 6b: Magnetic Moment Correction

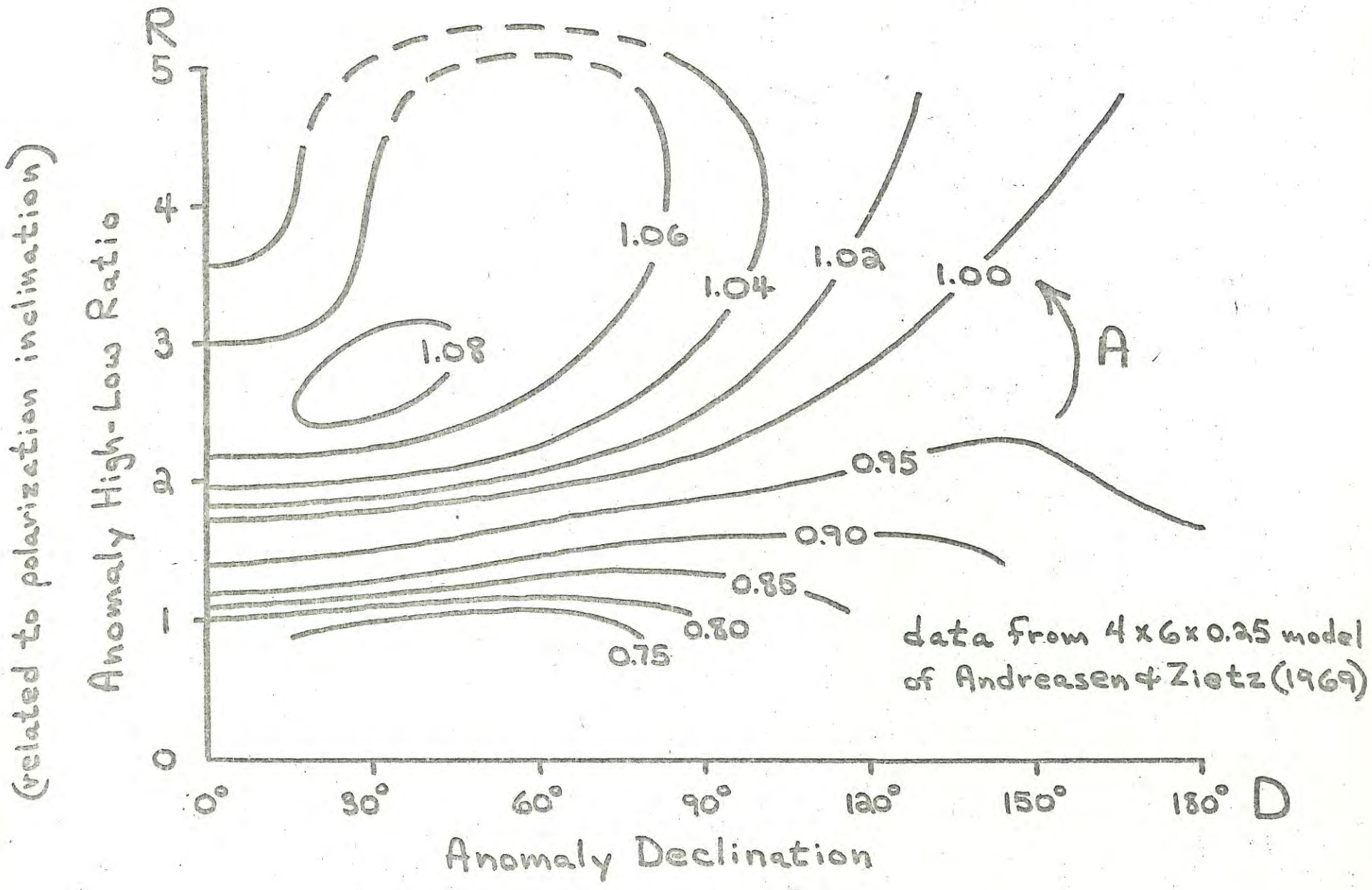


Figure 6c: Polarization Correction, A

INTERPRETATION RESULTS

Typical examples of the approximately five different types of anomalies are listed in Figure 7. The symbols designating these anomaly types have been used in the set of maps which have the interpretation results.

Some of the magnetic high anomalies tend to be clustered by closed contour lines (this is rarely true for the magnetic lows). Figure 8 shows the area of the set of magnetic maps where this clustering is most noticeable. These patterns must be treated cautiously because slight changes in the numbers can markedly change the patterns; however, possible linear clusters are apparent. The lineament in Grid 15 may be caused by a linear mound of earth or rubble.

The following maps give an estimate of the shape and location of the cause of each magnetic anomaly. The dot density is an indicator of how diffuse the source might be, however it is sometimes difficult to distinguish a shallow diffuse source from a deep concentrated one.

The numbers indicate an estimate of the weight and the depth below the surface of the soil of the iron which is assumed to cause each anomaly. The weight quantity is dependent on whether the average magnetic properties of the iron and slag samples which were measured are accurate and are typical of what is actually underground in these unexcavated areas. While it is suspected that these weights may be too high by as much as a factor of ten, the relative weights are more accurate.

Anomaly Type	Symbol	Anomaly Example Center	Grid
deep oriented dipole	D	2130N,1765E	5
shallow oriented dipole	S	1905N,1965E	10
random dipole	R	2110N,2165E	15
broad high	H	2180N,2220E	17
broad low	L	1680N,1030E	28

Figure 7: Types of anomalies

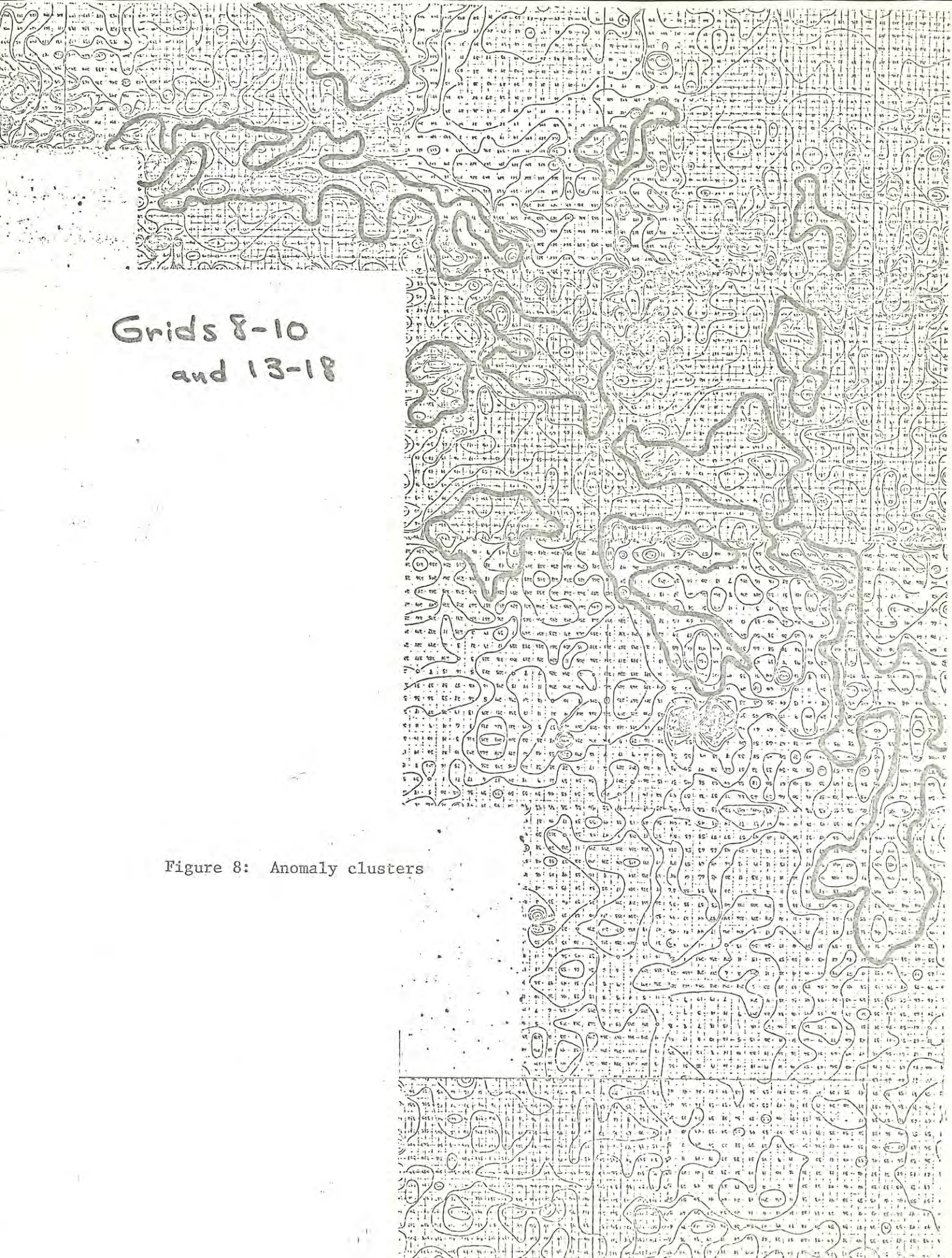


Figure 8: Anomaly clusters

AERIAL PHOTOGRAPHY

While the primary purpose of this trip was the magnetic survey, a number of aerial photos were taken as excavation records of the site as it was near the end of the field season. A helicopter was rented from Niagara Helicopter on August 21 and was used to take photos between 10:10 and 10:40 a.m. High, thin stratus clouds diffused the sunlight to allow good detail in the color photos. The flying heights were about 300, 500, and 1000 feet above the terrain. The right hand door of the cabin was removed and some near-vertical photos were possible by shooting between the pontoon and the body of the aircraft.

Several example photos are included with this report. Photos 2, 5, and 6 are oblique photos taken with a K-20 camera which has a 4 x 5 inch film format. Part of a 20 foot roll of Kodak Tri-X (TX 940) film was used on this assignment. It was developed for 3½ minutes in Kodak D-19 at 75°F in a rewind processor to yield a gamma of about 1.3. The lens focal length is 163 mm; the exposure was f/11 and $^{1}/_{500}$ second and no filter was used.

Photos 1, 7, and 8 were taken with a 35 mm camera having a 50 mm focal length lens. The film was Tri-X and the exposure was the same as for the K-20. The film gamma in this case is about one half of the above, for the film was developed in Kodak D-76.

Slides 5 through 9 were also taken with a 35 mm camera. The film was Kodachrome 25 and the exposure was f/4 and $^{1}/_{250}$ second. The camera's focal length was 45 mm.

In addition to the illustration photos shown with this report, some oblique stereo slides were taken by sequential exposure while moving around a scene in the helicopter. A time interval between photos of about ½ second yielded a stereo parallax of about 2° and an exaggerated depth portrayal which was suitable for showing shallow depths within excavations. These stereo photos are not included in this report; these photos and the negatives for all the photos have been sent to the excavation headquarters at Les Vieilles Forges (the originals of the magnetic maps have been left here at the University Museum).

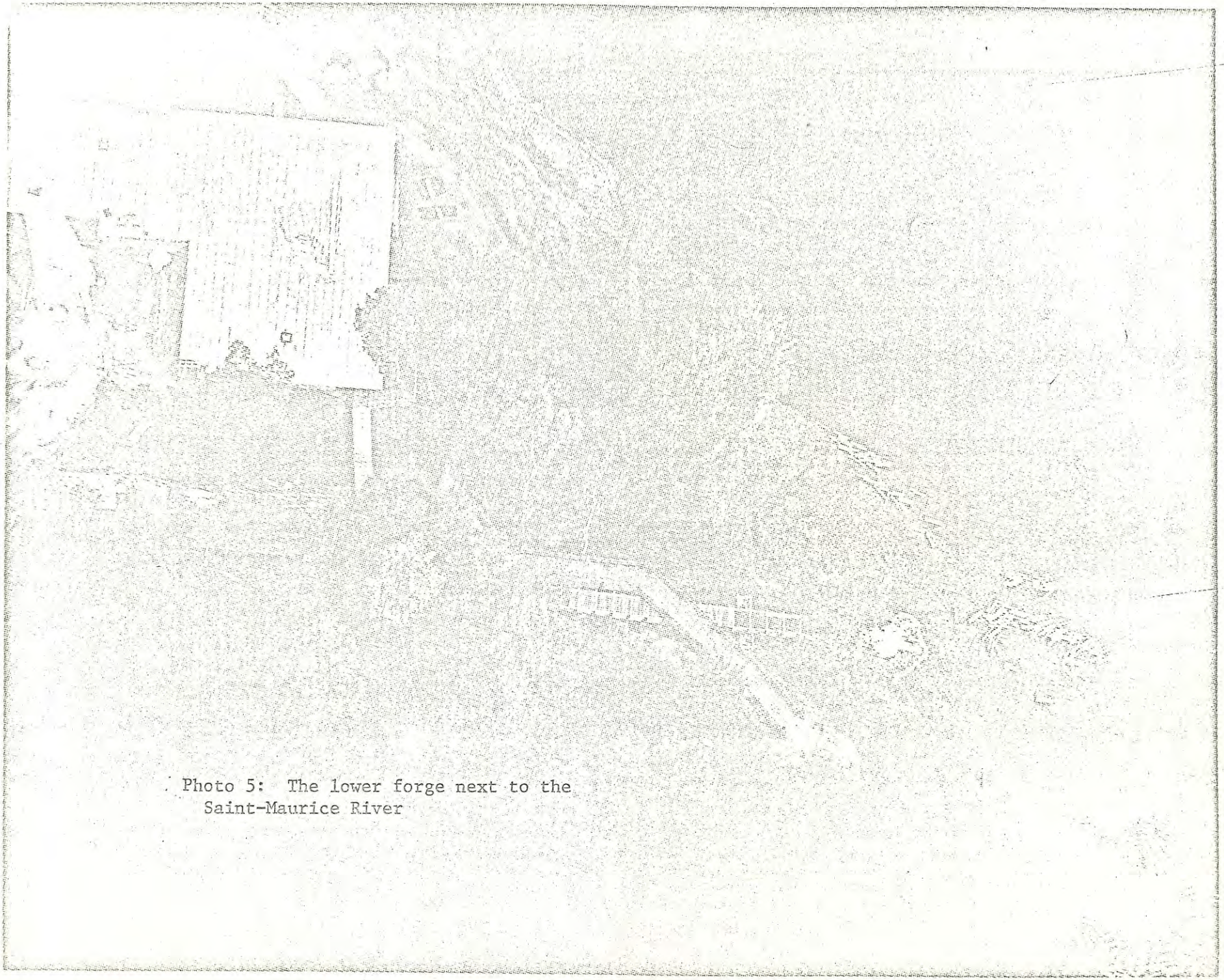


Photo 5: The lower forge next to the Saint-Maurice River

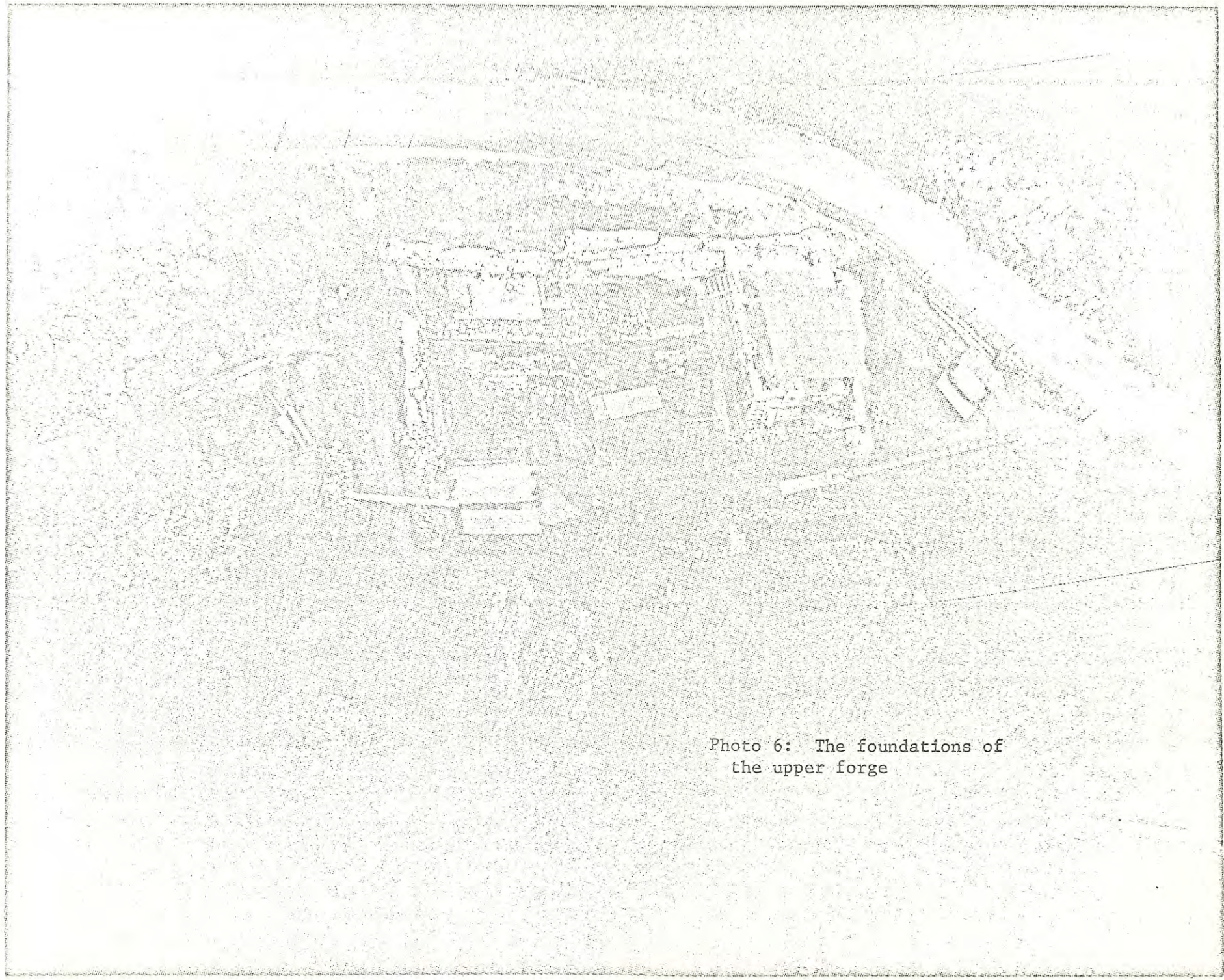


Photo 6: The foundations of the upper forge

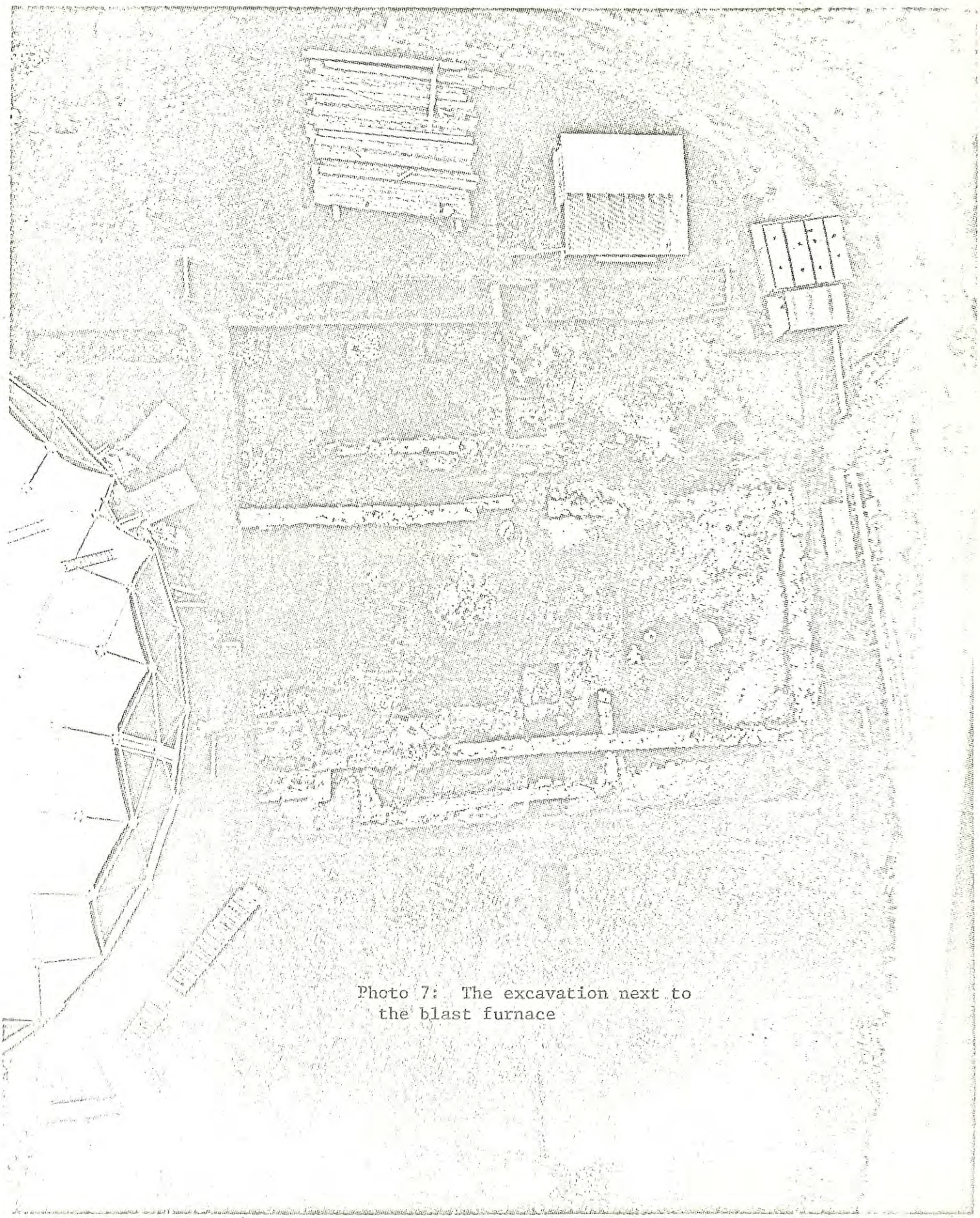


Photo 7: The excavation next to the blast furnace



Photo 8: House foundations being excavated

While these photos were taken for illustration rather than reconnaissance, they do show some patterns in the vegetation which might indicate something of buried remains. The high concentration of near-surface iron plus the possibility of other alloying minerals discarded in the area makes it possible that there might be changes in the growth of the plants or in the distribution of the different varieties. The rough location and shape of some of the many patterns which were visible are given in Figure 9. While most or all of these patterns may be of very recent origin (test pits, trails, and similar), they may also provide added evidence for underground features.

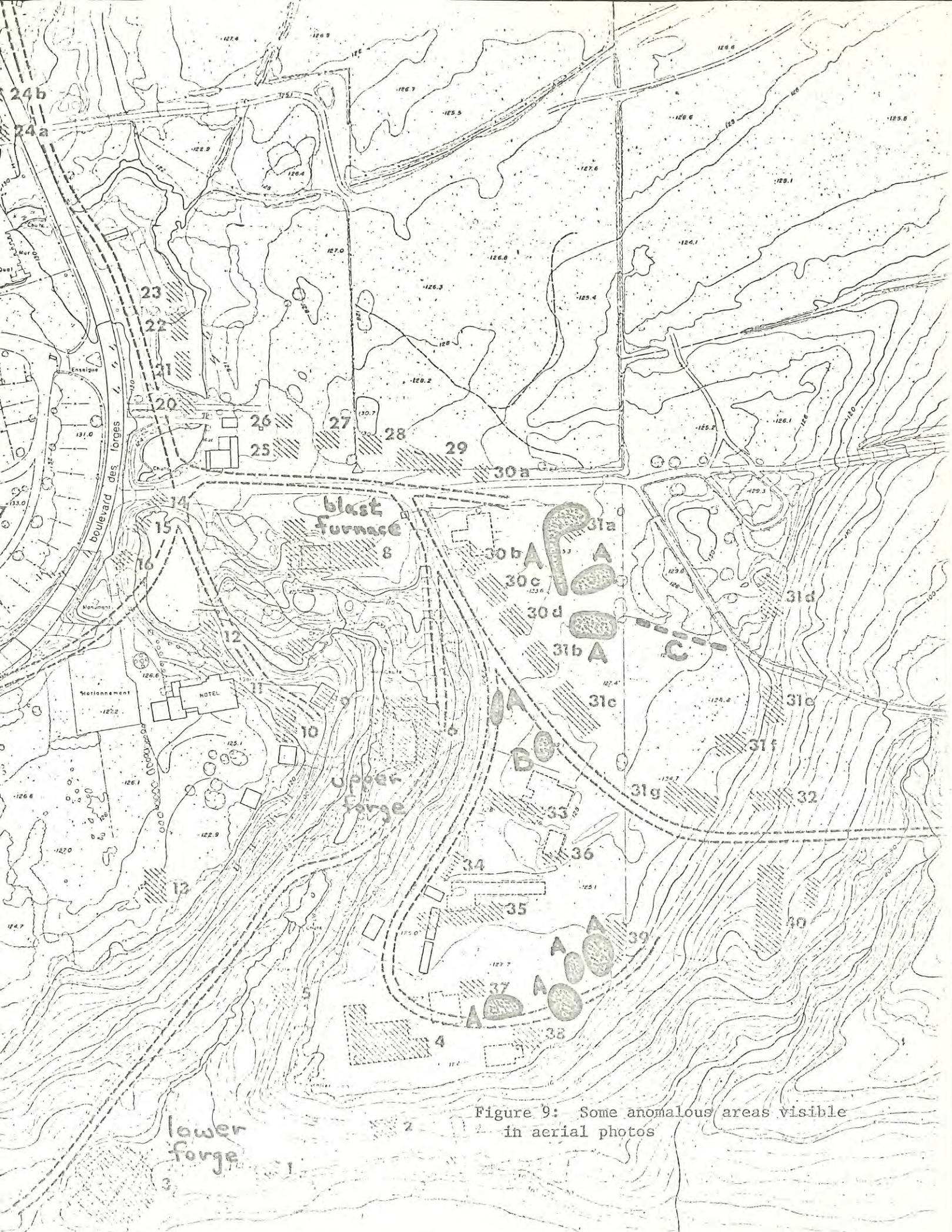


Figure 9: Some anomalous areas visible in aerial photos

CONCLUSION

Areas of magnetic disturbance, probably caused by buried concentrations of iron and slag, have been delimited. Many grids have been found to be almost devoid of magnetic anomalies: 2, 3, 6, 7, 17, 19, and 28 through 32.

While the archaeological significance of the many anomalies is not known, test excavation of some of them may allow extrapolation to other similar anomalies. Furthermore, it is possible that the areas with low amplitude magnetic anomalies may have some significance; small test pits will check this, too.

ACKNOWLEDGEMENT

My travel and living expenses for this survey were paid by Parks Canada. The helicopter rental and the crews needed for clearing the grids of iron wire, for surveying the 100 foot measurement stakes, and for helping with the magnetic measurements were furnished by the excavation at Les Vieilles Forges. My salary for the survey and its analysis and the expense for preparing this report and maintaining the magnetometers was supplied by NSF grant SOC-75-04203.

The idea for this survey originated with Pierre Nadon and John P. Wilson; Pierre also coordinated the on-site work. A. E. Wilson coordinated the planning which initiated this survey. Emile Groleau and Denis Morrissette were my co-workers in making the magnetic measurements.

APPENDIX: MEASUREMENT RATE AND ACCURACY

A total of 11,186 point magnetic measurements were made in about seven days of work. Also, the measurement rate was about one acre per day at a five foot measurement spacing. The electronic circuitry gives a new magnetic reading once every 1 1/2 seconds; however, in operation, about eight point measurements per minute were made. The difference between this rate and the daily rate primarily includes the time necessary to move the measuring tapes around the grid.

The accuracy of the measurements can be estimated from those lines at the common edge between a pair of grids which were measured twice. Figure 10 summarizes the analysis of six duplicated lines. The average of the differences between the pairs of numbers is almost entirely due to the diurnal shift; these numbers indicate that it might have been about 0.4 gamma/minute over a half hour period. The standard deviation of these pairs of differences is an indicator of measurement accuracy; it averages to be about 22 gamma, which is less than one contour interval. This inaccuracy is due primarily to three factors: diurnal shift over a short term, mispositioning the sensor on a magnetic gradient, and measurement slew due to the 1 1/2 second frequency measurement time. This inaccuracy is somewhat proportional to the magnetic gradient; areas of low magnetic gradient give higher accuracy.

REFERENCES

Andreasen, G.E., I. Zietz, 1969, Magnetic Fields for a 4X6 Prismatic Model, Geological Survey Professional Paper 666, U.S. Government Printing Office, Washington, D.C.

Breiner, S., 1973, Applications Manual for Portable Magnetometers, GeoMetrics, Sunnyvale, California.

Jensen, H., 1961, "The Airborne Magnetometer", Scientific American, vol. 204, no. 6, June, pp. 151-162.

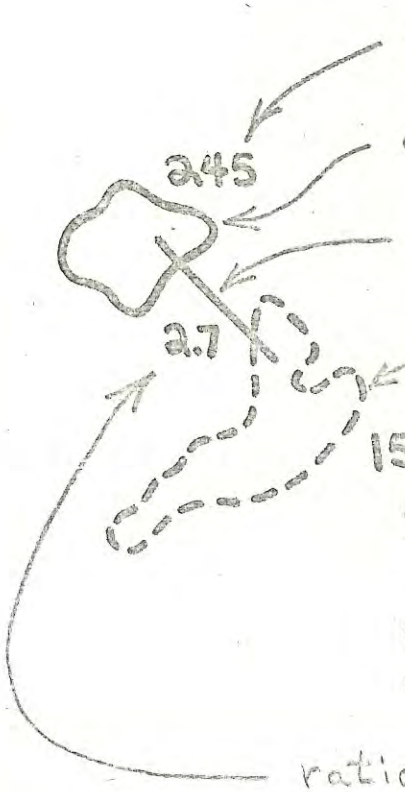
Ralph, E.K., 1965, "Comparison of a Proton and a Rubidium Magnetometer for Archaeological Prospecting", Archaeometry, vol. 7, pp. 20-27.

Ralph, E.K., F. Morrison, D.P. O'Brien, 1968, "Archaeological Surveying Utilizing a High-Sensitivity Difference Magnetometer", Geoexploration, vol. 6, pp. 109-122.

Edge	First Date	First Time	Second Date	Second Time	Average Difference	Standard Deviation	Average Gradient
8-9	28	4:10	27	5:50	+12	43	62
13-14	27	3:40	27	3:10	+9	18	58
17-18	22	1:55	22	2:30	-5	4	11
21-22	25	4:55	25	4:40	-13	37	51
23-24	26	8:45	26	2:05	-10	16	15
26 internal	26	5:00	29	10:10	+45	13	17

Figure 10: Repeatability analysis

Analysis Maps



peak magnetic high above background, in γ

contour around mid value between peak and background

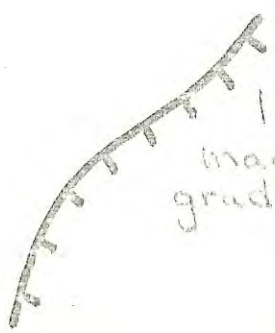
line connects peak high to valley low

contour around mid value between background and valley magnetic low

angle of valley low to peak high relative to magnetic north

ratio of peak high above background to valley low below background

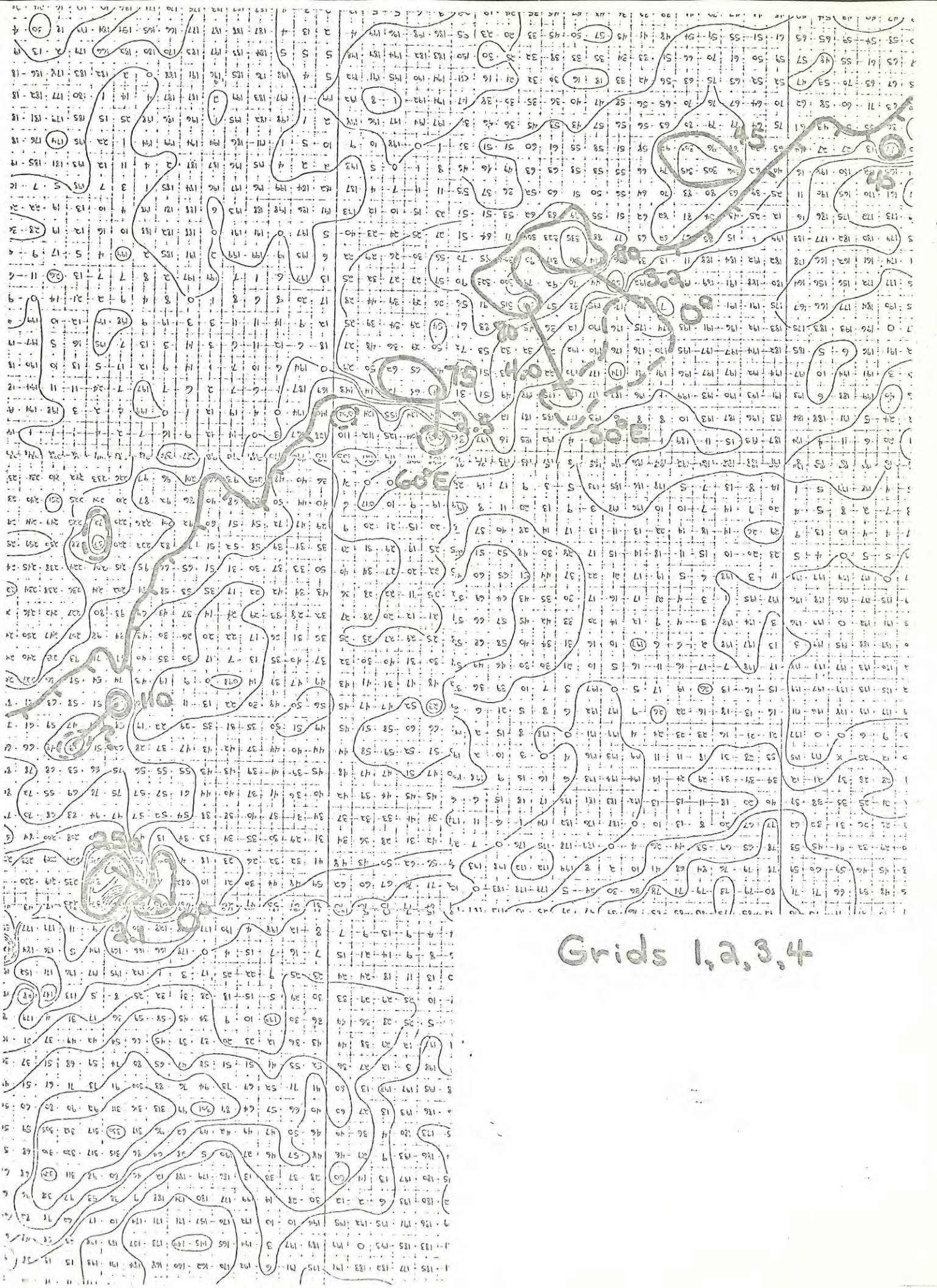
A question mark on line connecting anomaly high and low indicates that they may not have a common source; where no connecting lines are given, anomaly highs and lows cannot be paired.

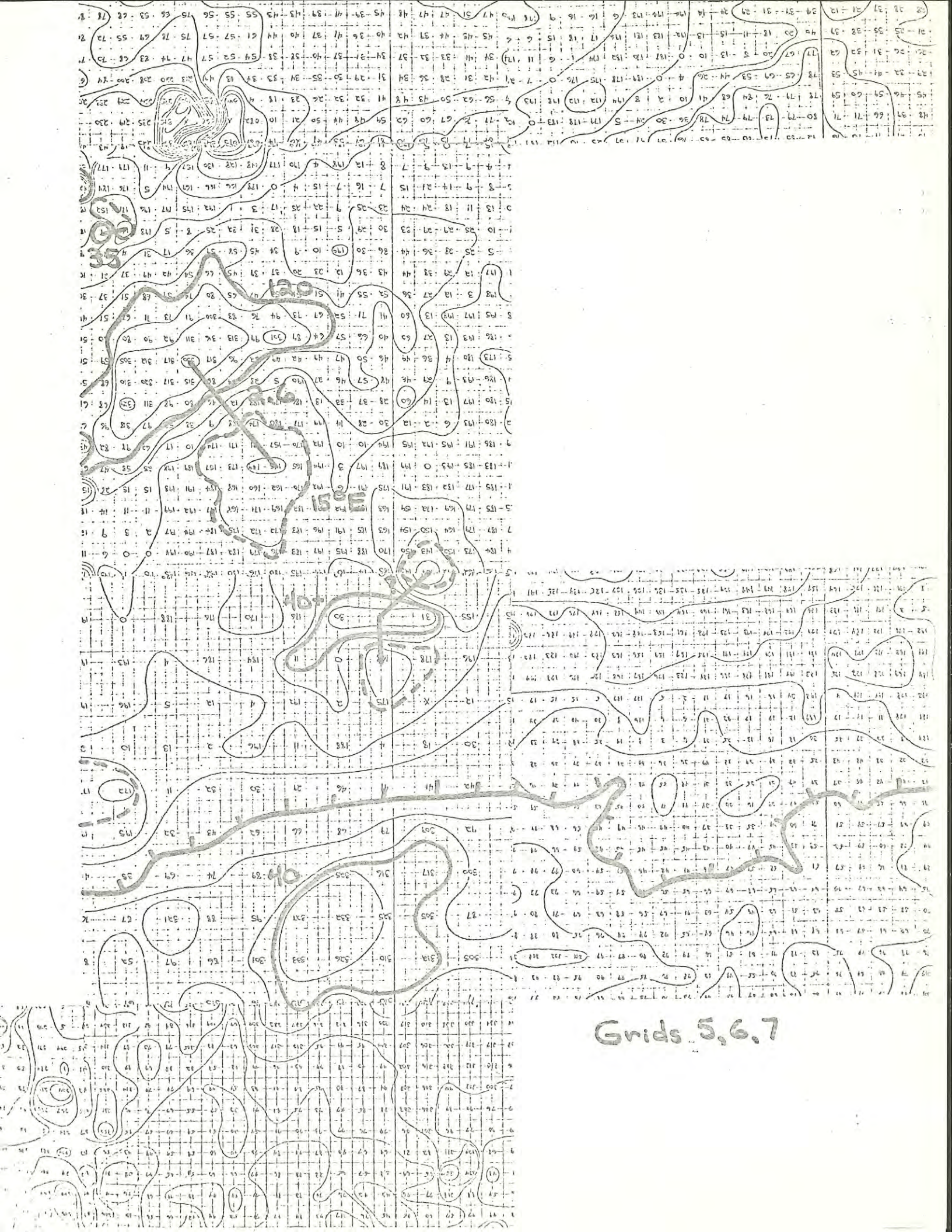


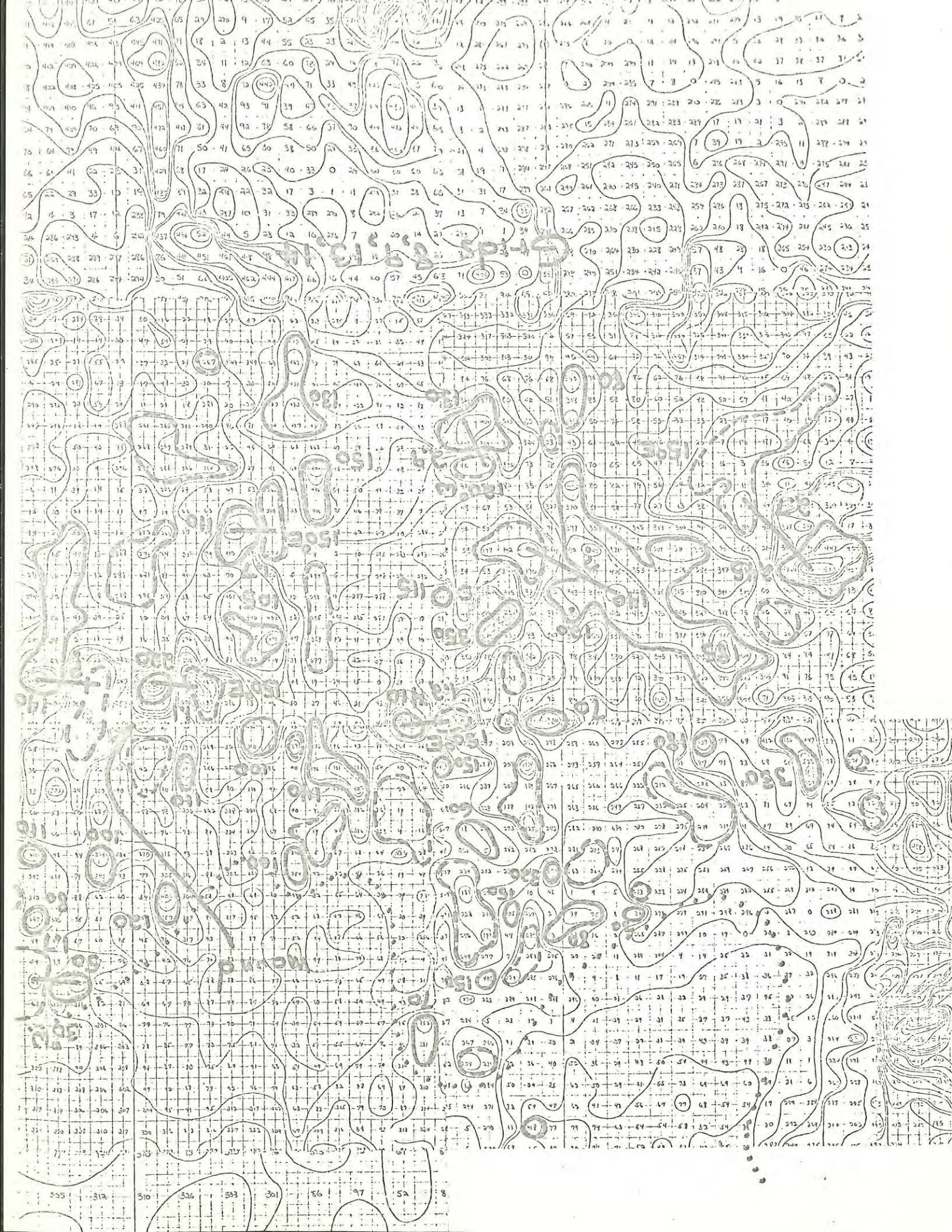
large area magnetic gradient

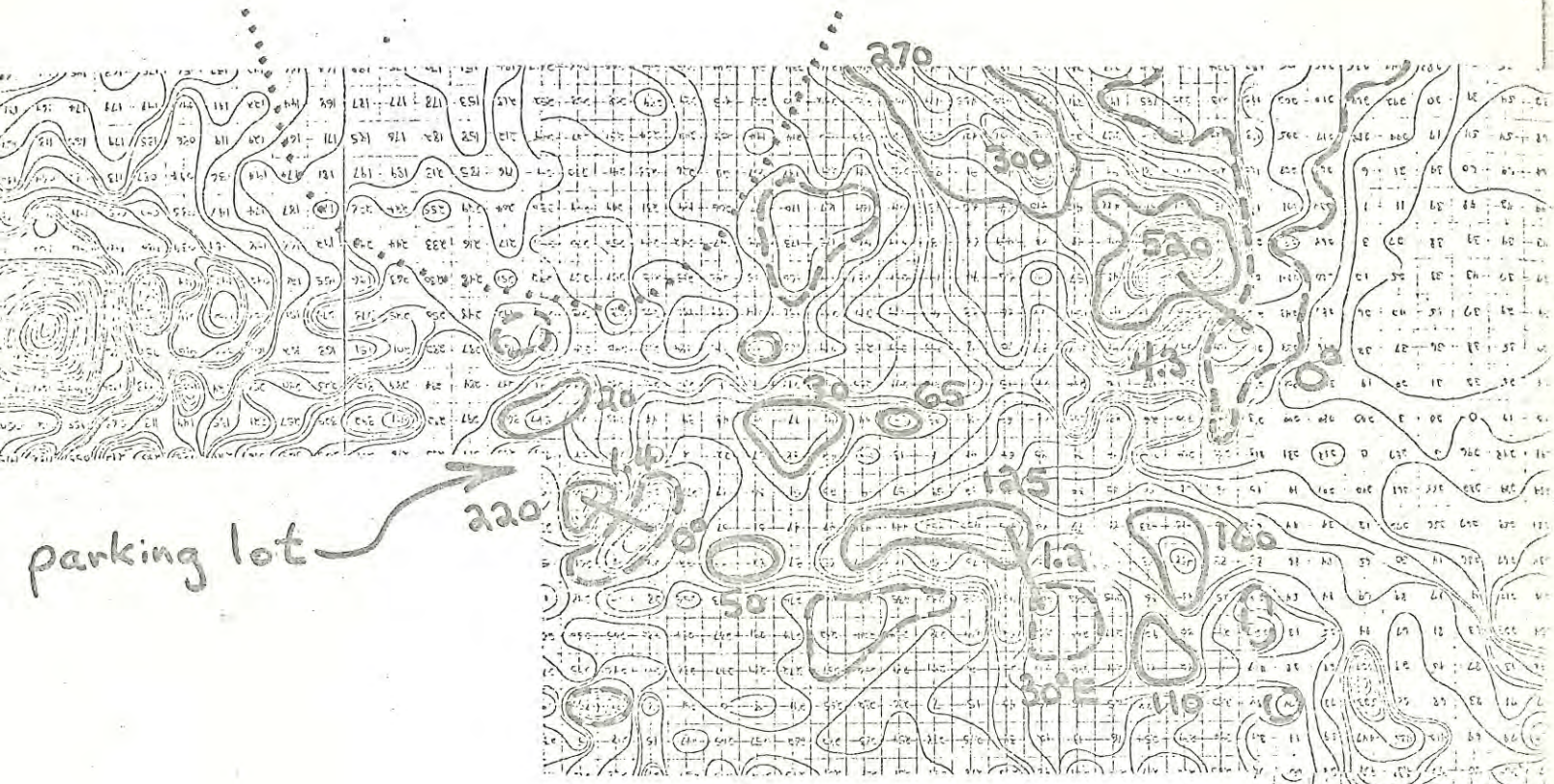


boundary between areas of high and low magnetic gradient

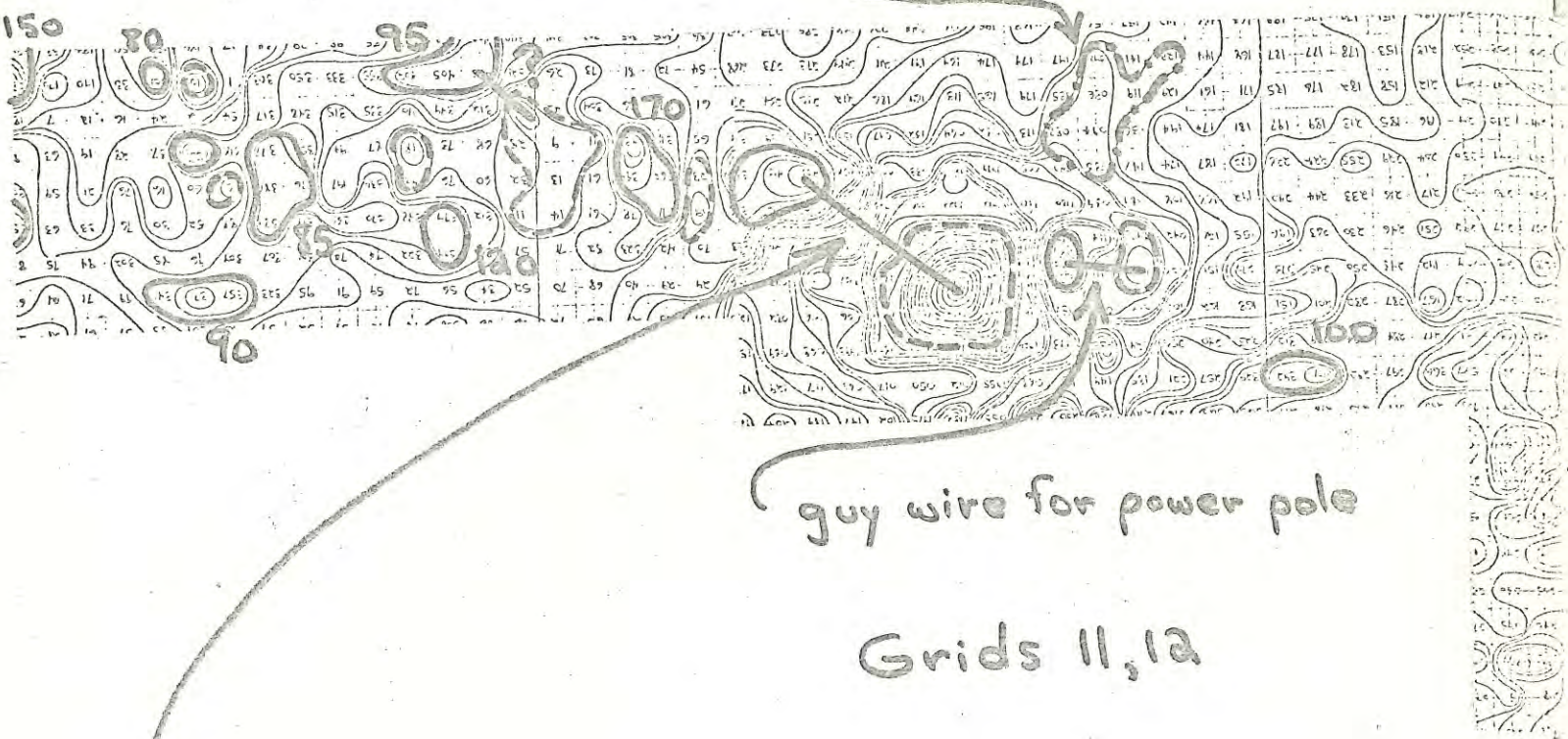

Grids 1,2,3,4


Grids 5,6,7

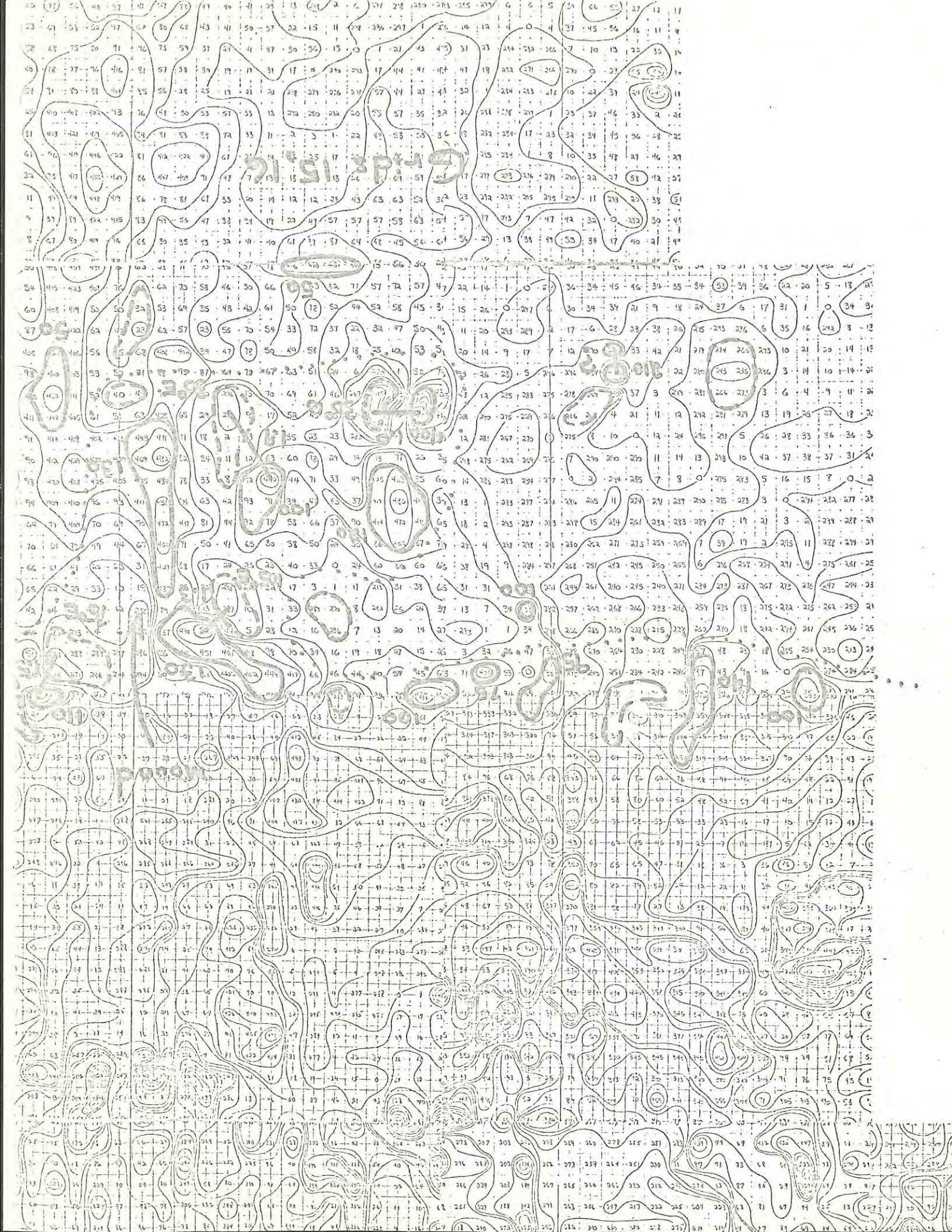


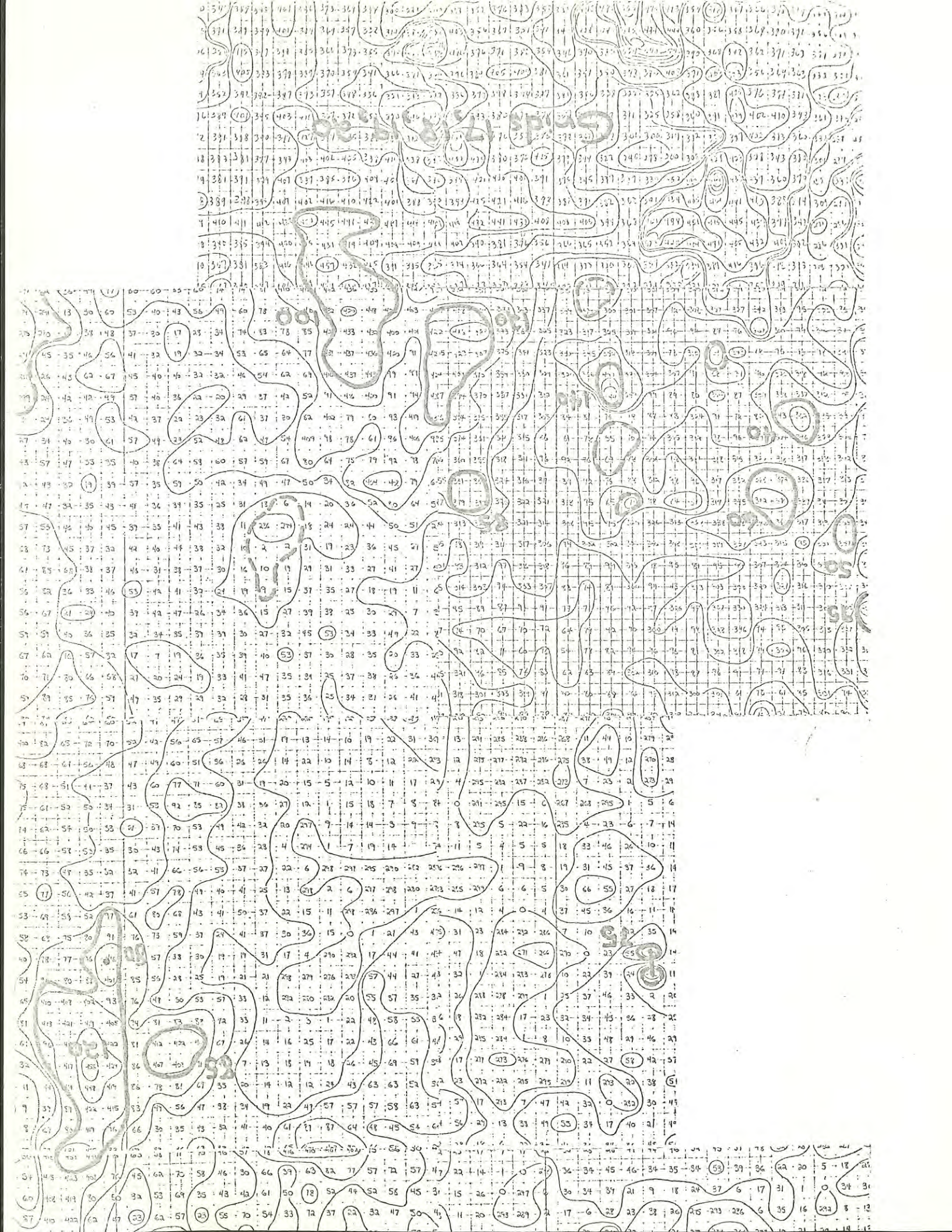


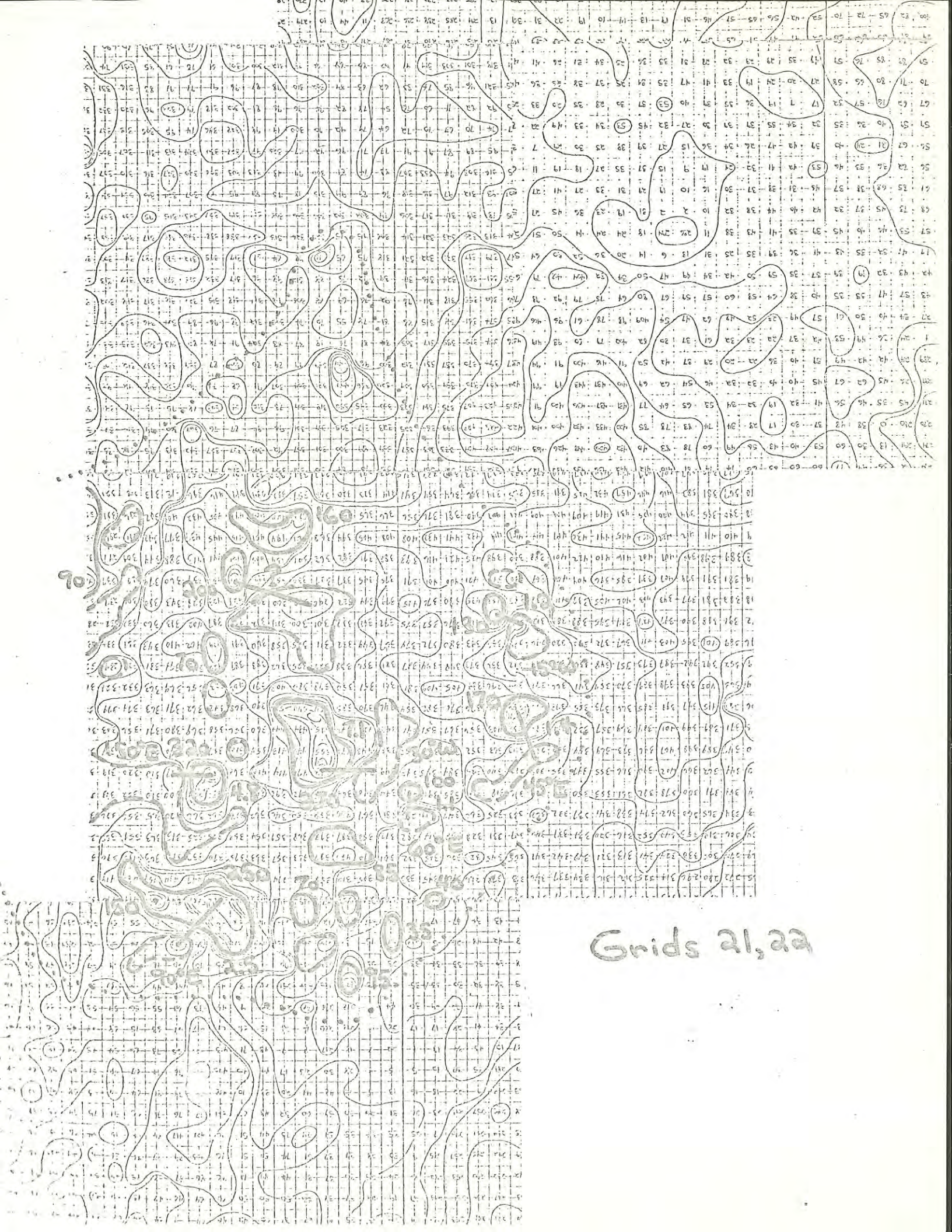
Grid 10

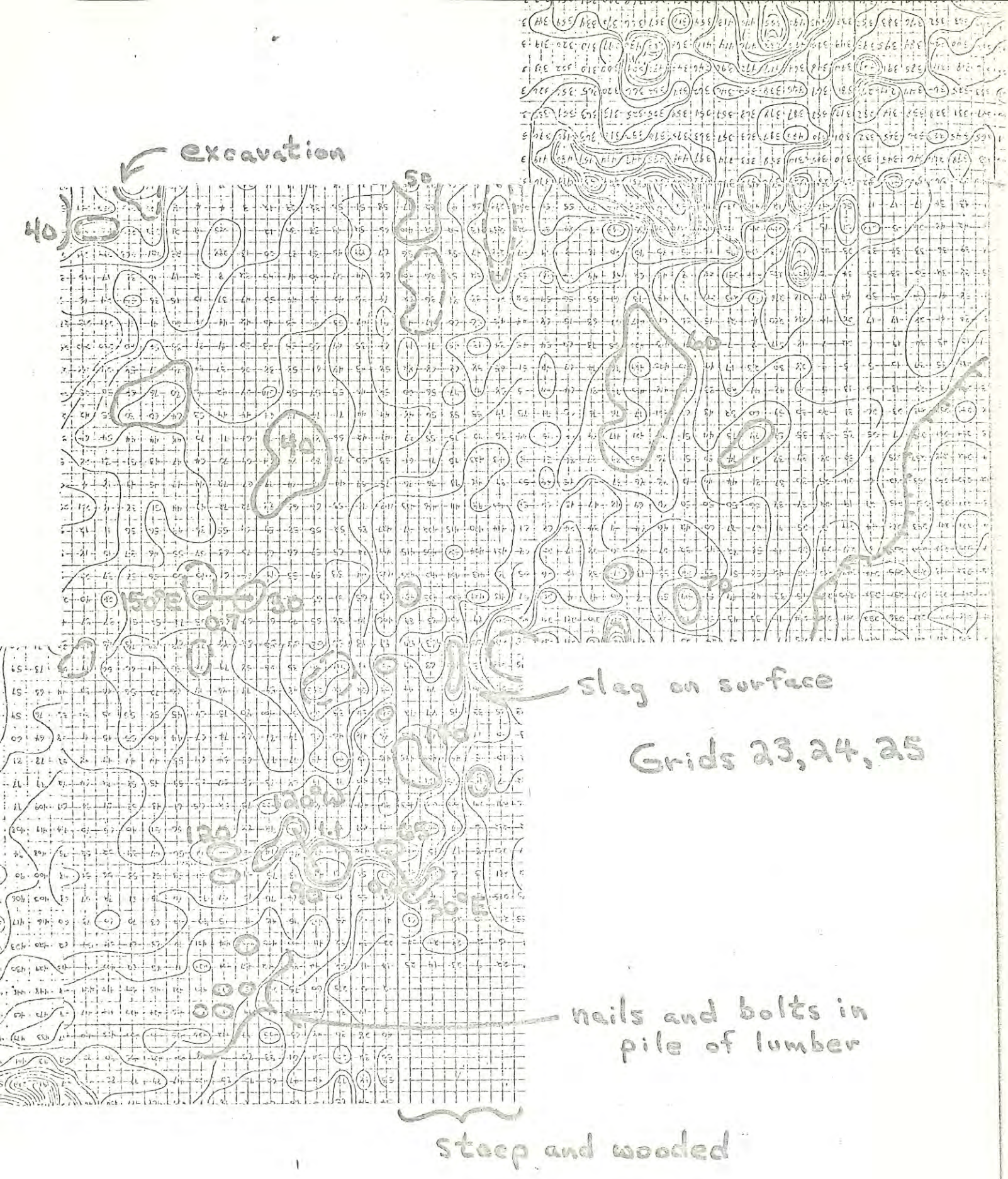

possible magnetic low anomaly on edge of intense low
guy wire for power pole
~25 ft. tall iron pipe alongside power pole (located at magnetic low)

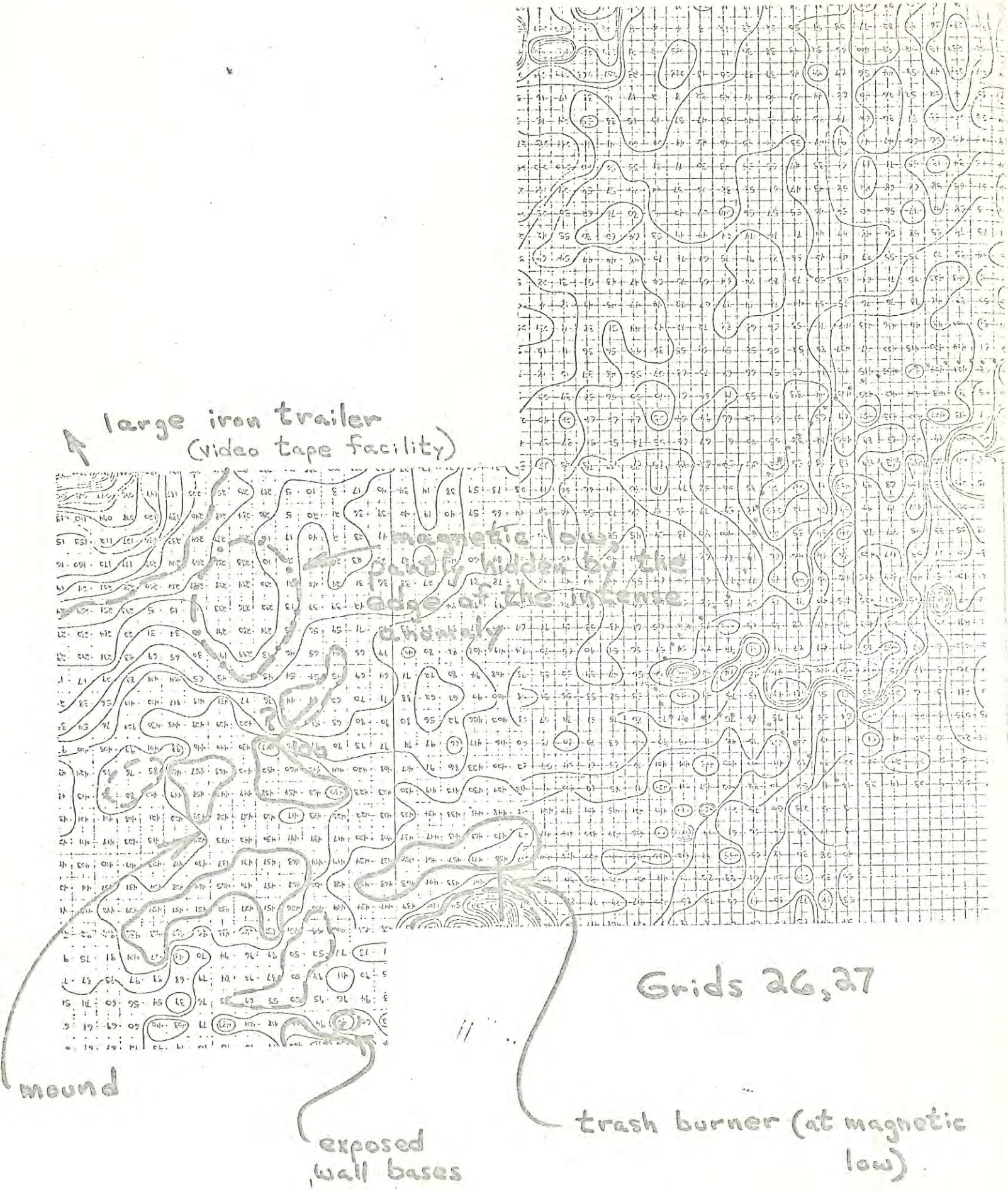
Grids 11, 12

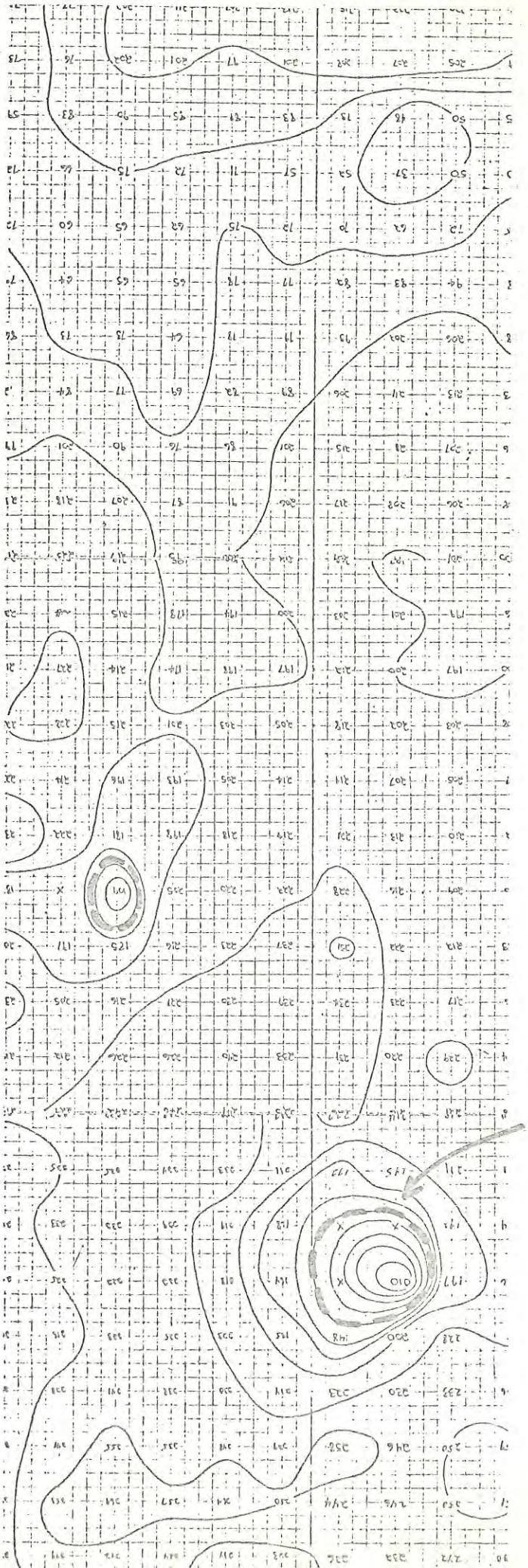





Grids 21,22


excavation
slag on surface
Grids 23,24,25
nails and bolts in pile of lumber
steep and wooded


large iron trailer
(video tape facility)
magnetic low partly hidden by the edge of the grid
Grids 26, 27
mound
exposed wall bases
trash burner (at magnetic low)



Grids 28, 29, 30

farm equipment: iron disc

Grids 31,32
iron
Culvert

drainage ditch
Grid 33


740
760
320
420
340
100
260
180
240
30
iron and slag are found on the surface in this area
Grids 34,35
mound here

Grid #1

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

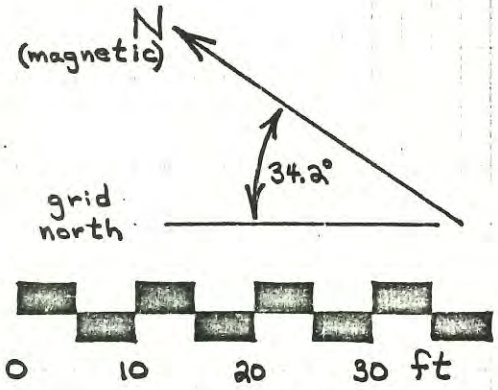
contour interval = 25 γ

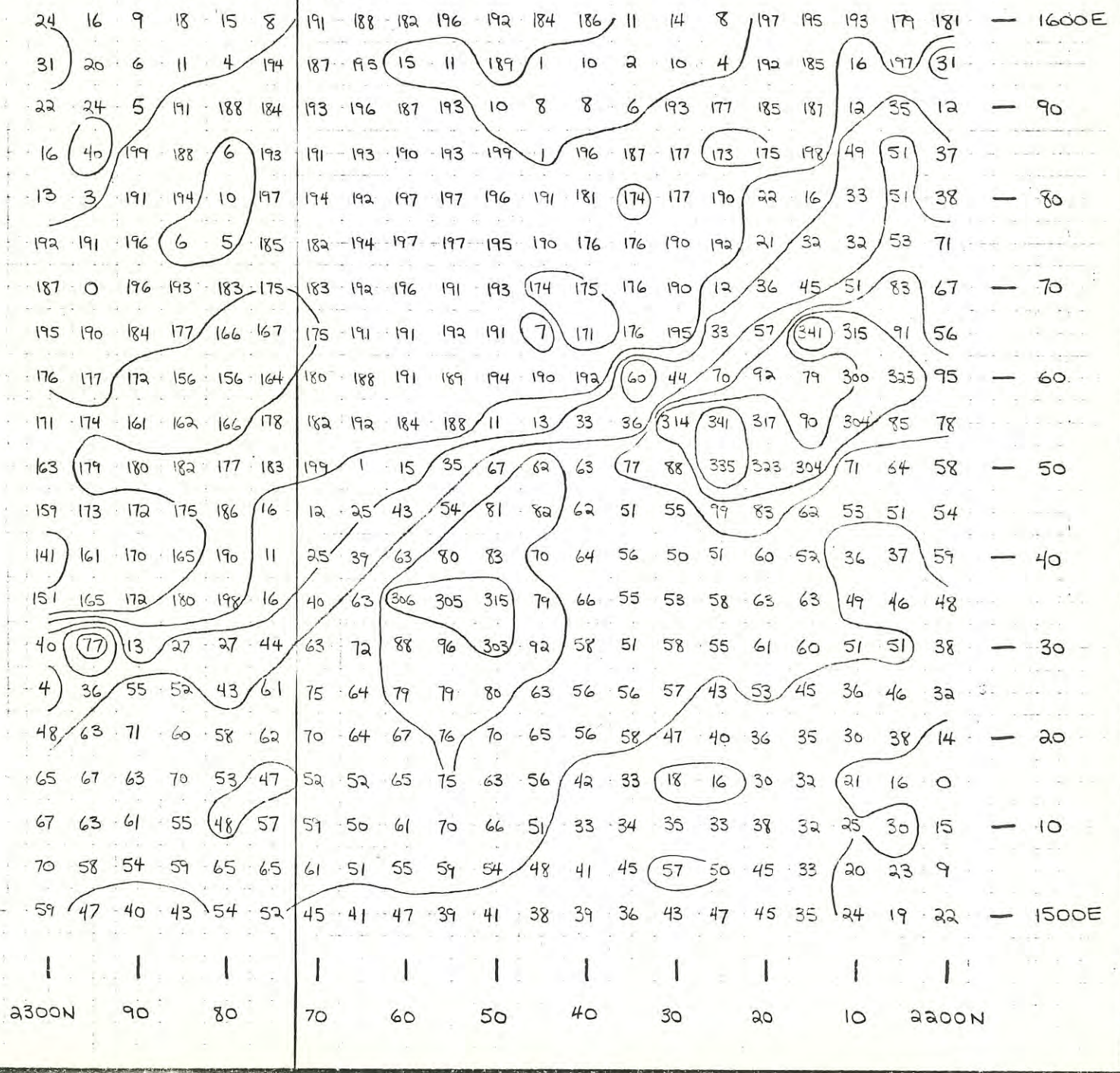
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #2

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

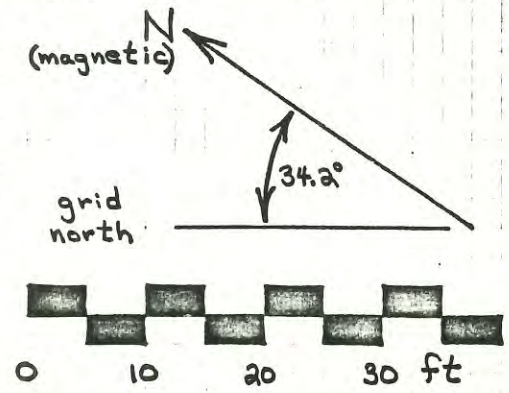
contour interval = 25 γ

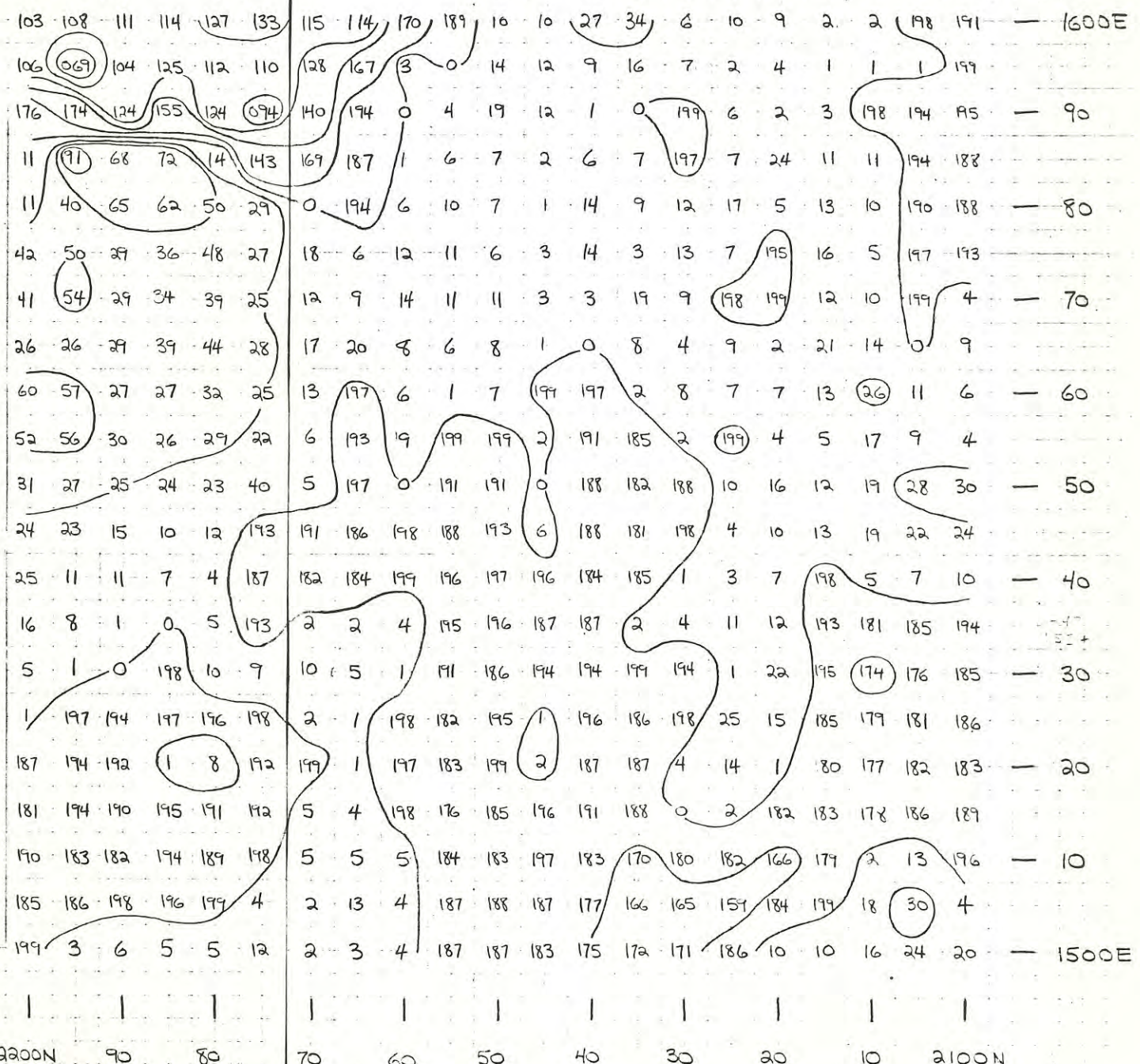
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #3

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

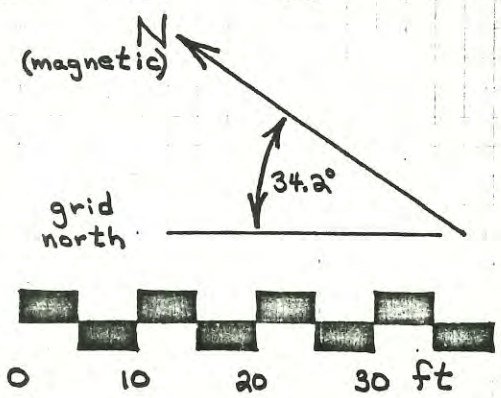
contour interval = 25 γ

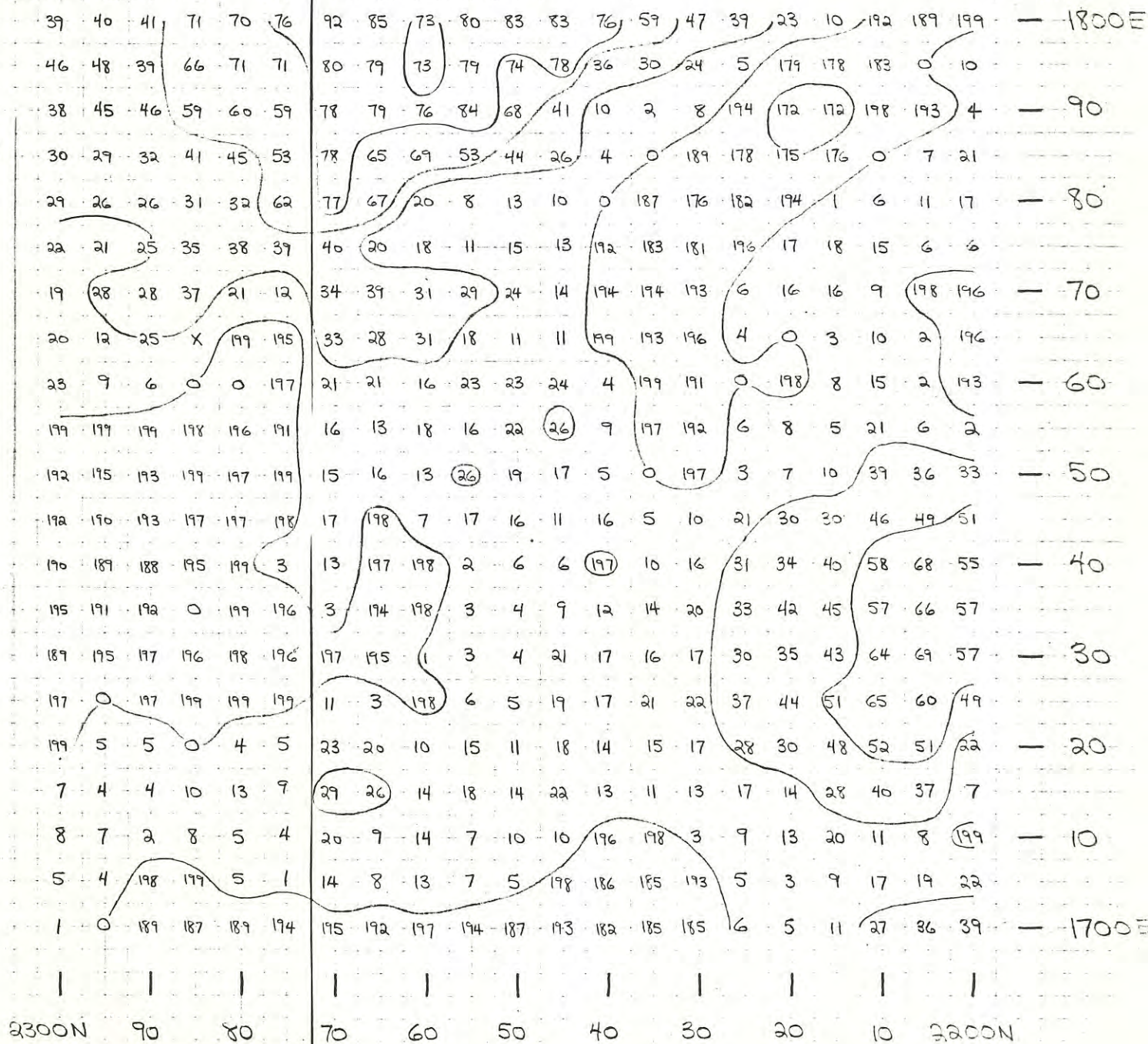
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





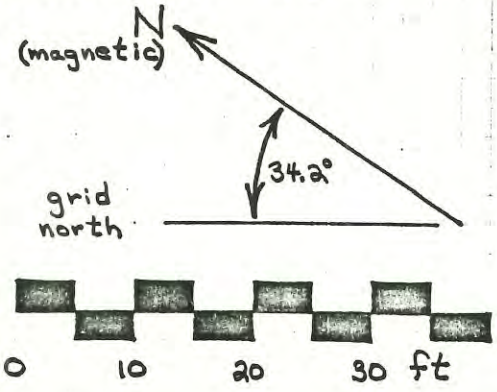
Grid #4

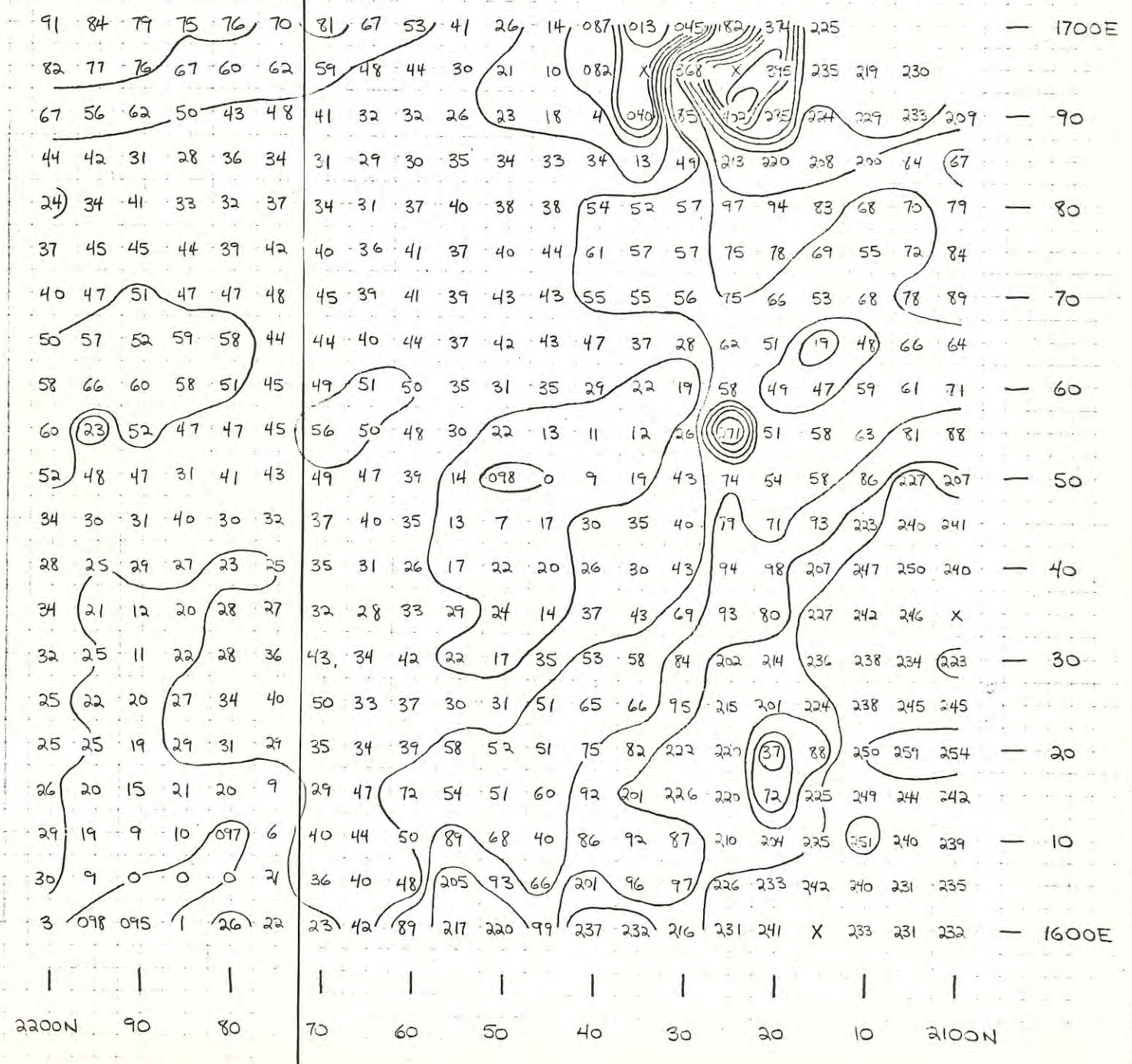
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





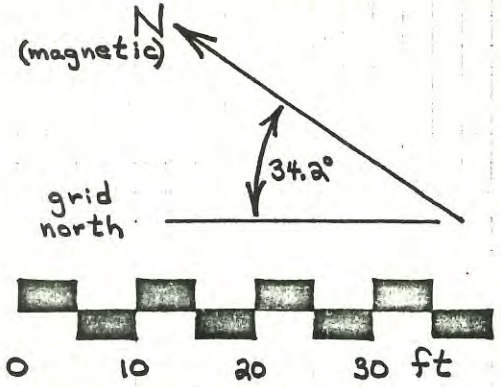
Grid #5

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W



180	176	162	142	104	143	185	14	10	194	195	180	176	180	192	186	195	195	1	193	78	— 1800E
184	184	173	152	143	150	170	188	195	197	183	176	179	182	187	190	194	0	0	6	11	
187	187	179	164	150	154	163	185	191	196	183	172	172	175	184	194	197	2	3	9	12	— 90
185	185	179	169	172	159	163	180	192	195	182	169	171	168	177	192	199	11	11	14	18	
181	185	177	182	183	191	175	191	6	192	170	162	160	168	184	191	193	15	15	28	157	— 80
181	183	185	193	0	199	189	197	3	194	165	145	149	173	157	189	198	25	58	47	63	
179	186	191	195	192	195	194	10	10	192	170	157	171	171	174	10	17	62	98	82	43	— 70
172	180	193	6	2	12	30	28	14	199	177	180	174	188	9	38	53	97	318	96	62	
175	180	197	13	14	60	28	37	33	13	186	179	188	12	46	80	98	311	321	68	61	— 60
174	186	193	9	29	46	48	57	46	27	190	5	28	64	86	315	317	320	310	68	51	
175	173	180	4	36	49	46	50	47	49	42	49	62	96	317	330	317	312	305	59	56	— 50
176	186	193	13	27	60	40	66	57	64	89	301	99	313	316	311	92	90	80	60	56	
188	195	197	198	13	60	41	71	52	67	73	94	76	83	300	91	73	71	67	51	48	— 40
4	198	3	12	27	36	52	55	41	51	51	58	47	65	80	74	59	68	51	37	30	
2	197	12	29	38	44	43	36	12	23	20	37	39	45	66	54	42	49	37	21	10	— 30
3	5	25	28	36	44	36	30	199	10	9	34	45	58	59	36	17	31	4	179	8	
9	10	25	29	29	33	30	29	5	15	18	28	31	32	25	8	5	193	147	48	181	— 20
10	13	11	18	24	24	23	25	9	22	25	17	3	1	192	195	197	196	171	152	189	
16	8	9	14	21	15	7	16	7	15	4	0	178	166	166	169	194	5	176	184	428	— 10
14	4	9	13	9	7	8	12	198	4	190	177	148	128	130	157	9	11	179	177	55	
28	15	7	0	5	199	11	196	181	183	169	175	123	052	1913	660	406	31	18	43	48	— 1700E
2200N		90		80		70		60		50		40		30		20		10		2100N

Grid #6

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

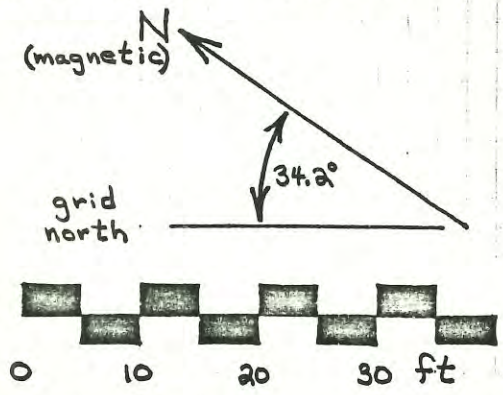
contour interval = 25 γ

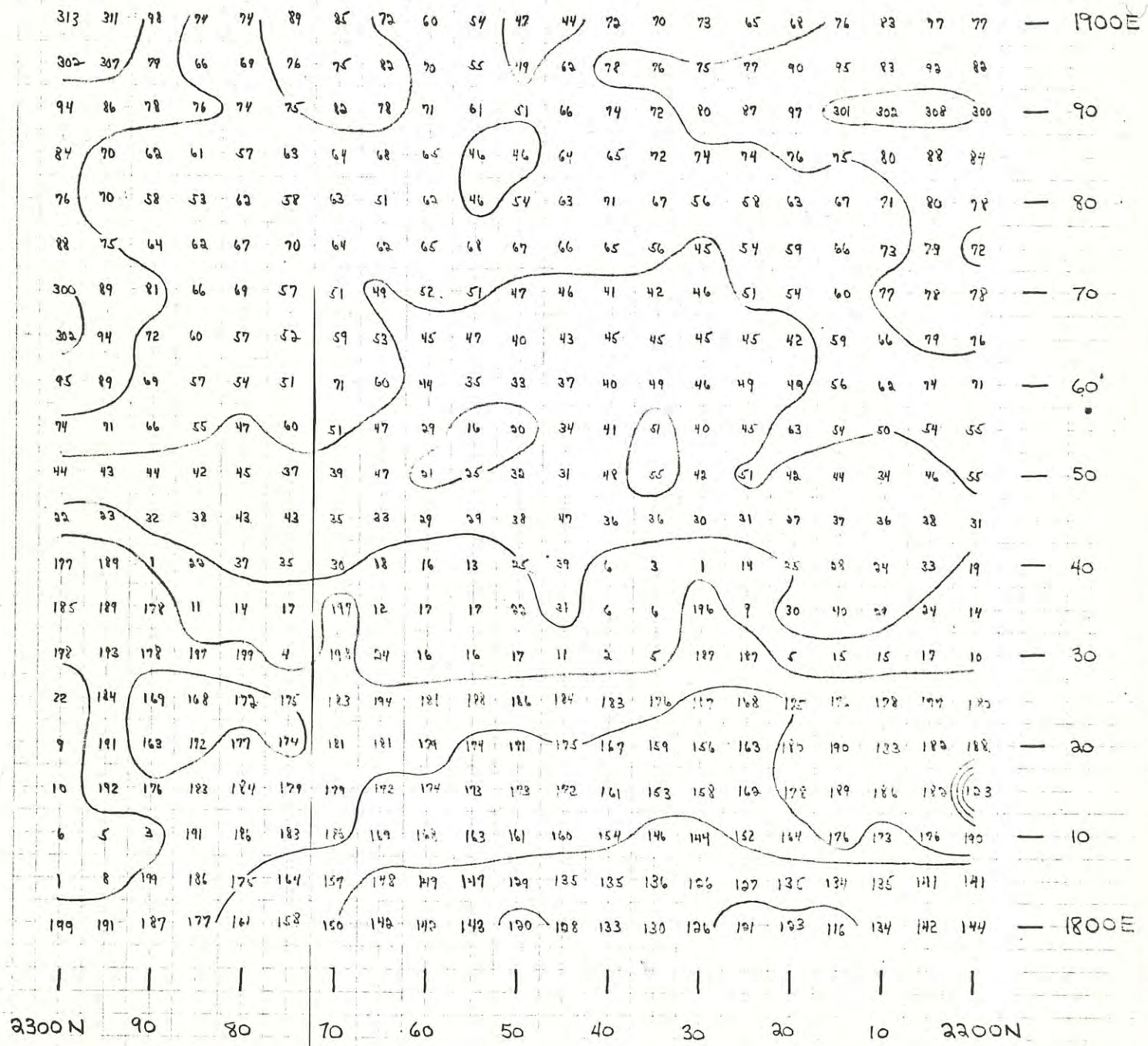
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





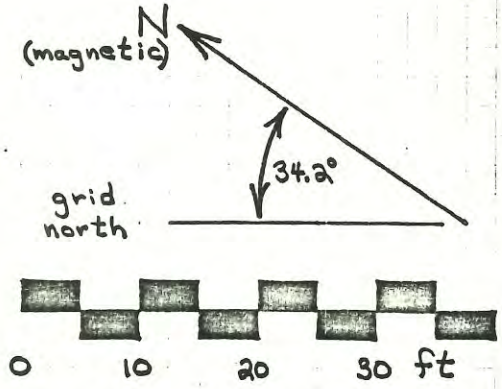
Grid #7

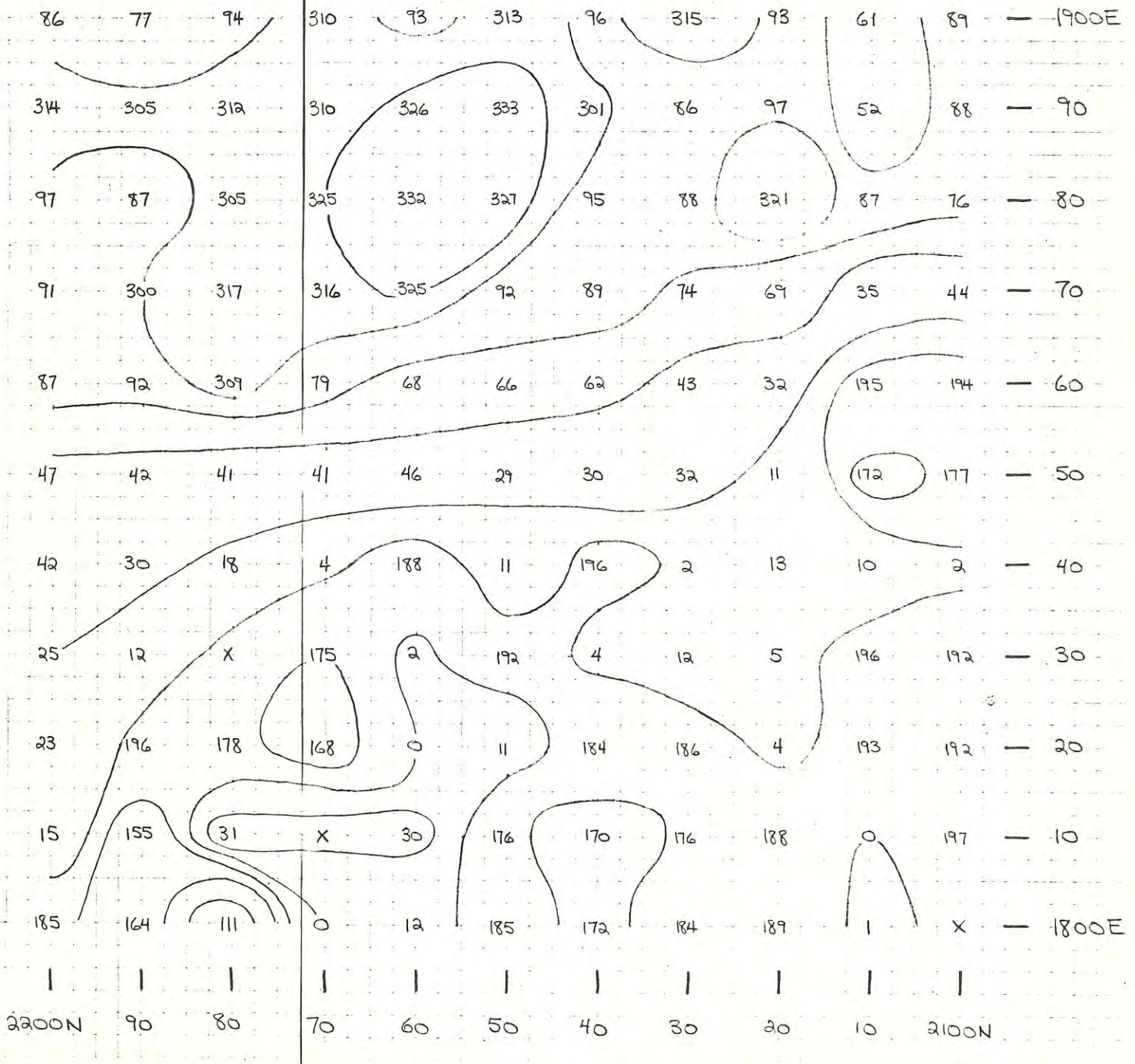
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





Grid #8

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

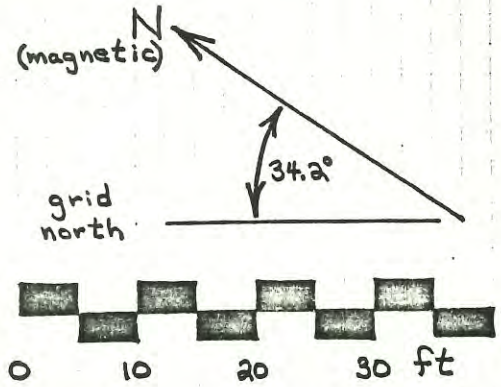
contour interval = 25 γ

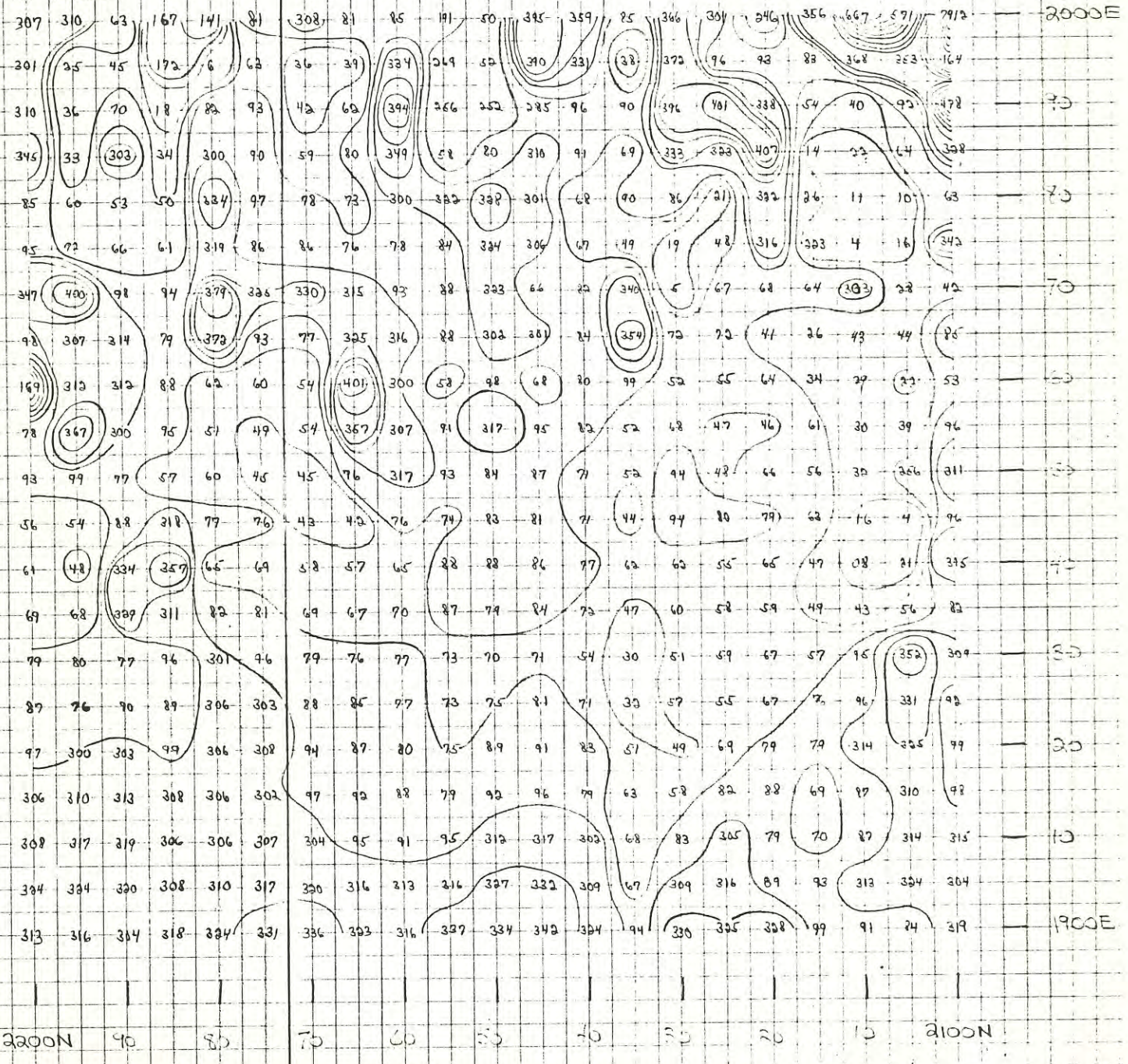
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #9

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

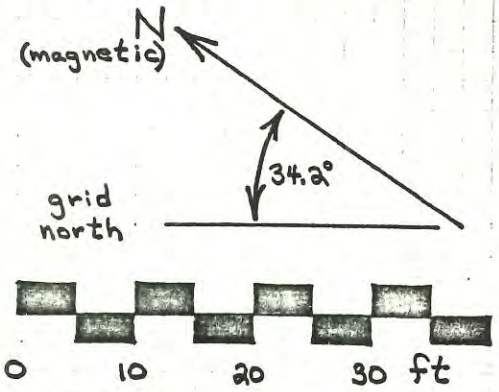
contour interval = 25 γ

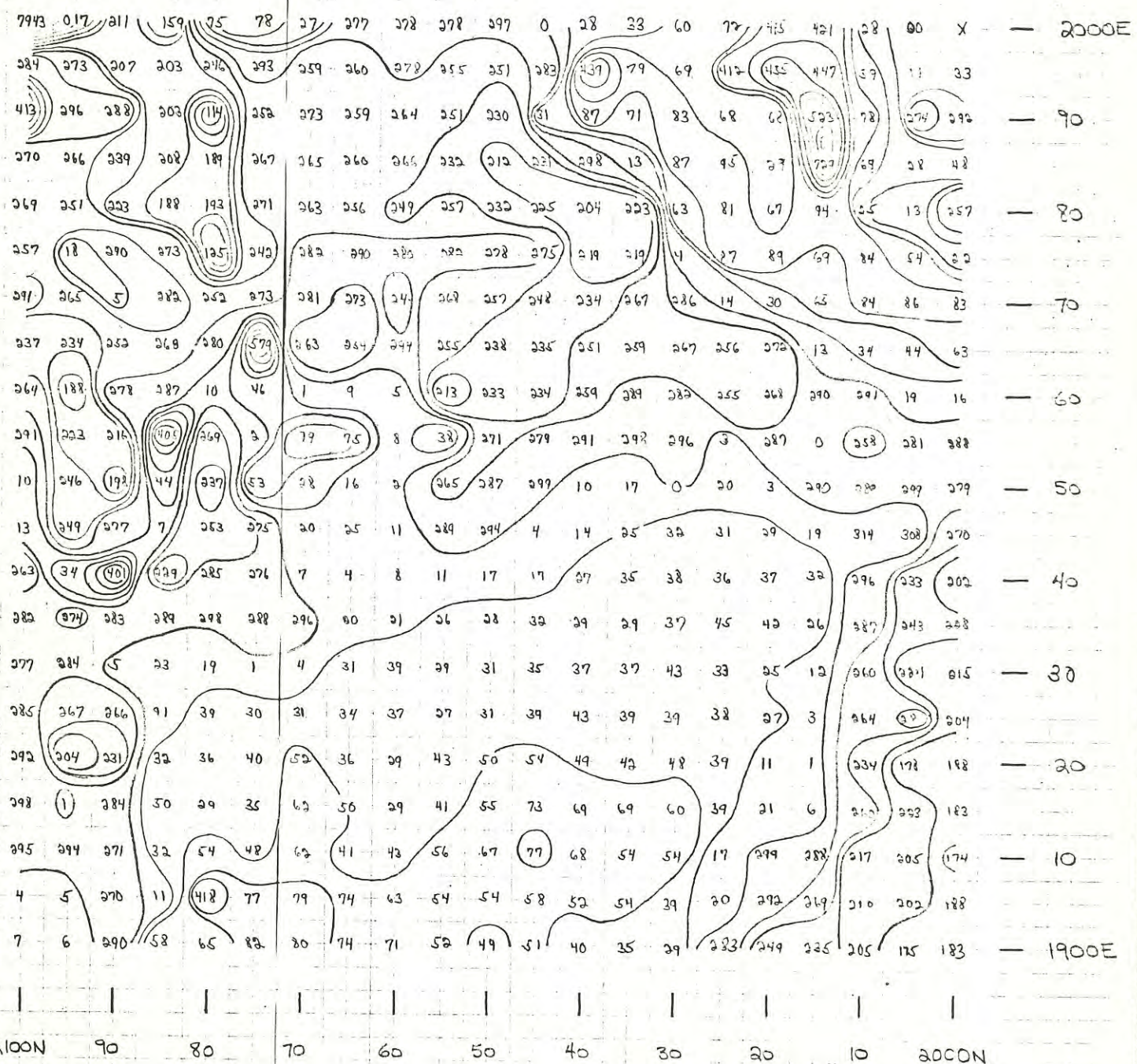
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #10

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

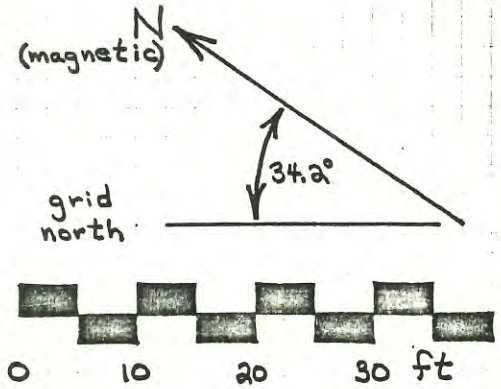
contour interval = 25 γ

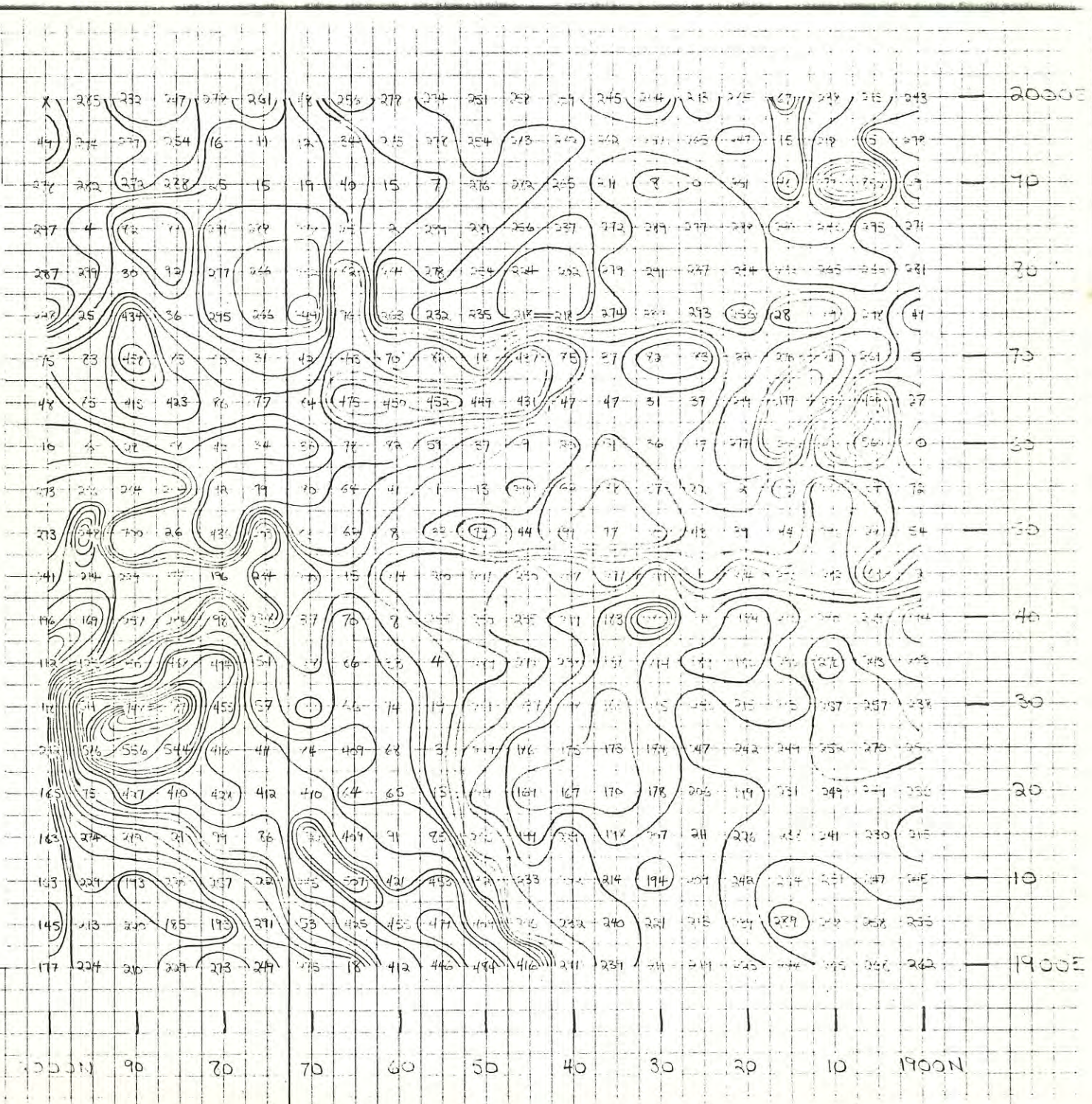
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #11

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

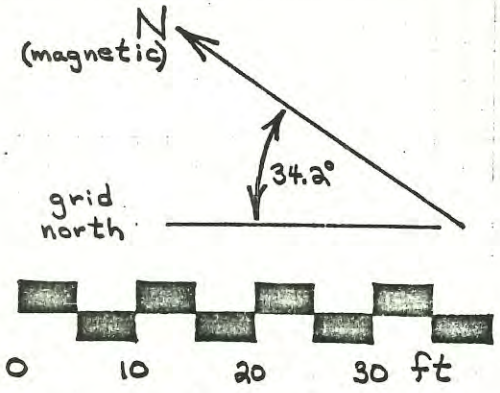
contour interval = 25 γ

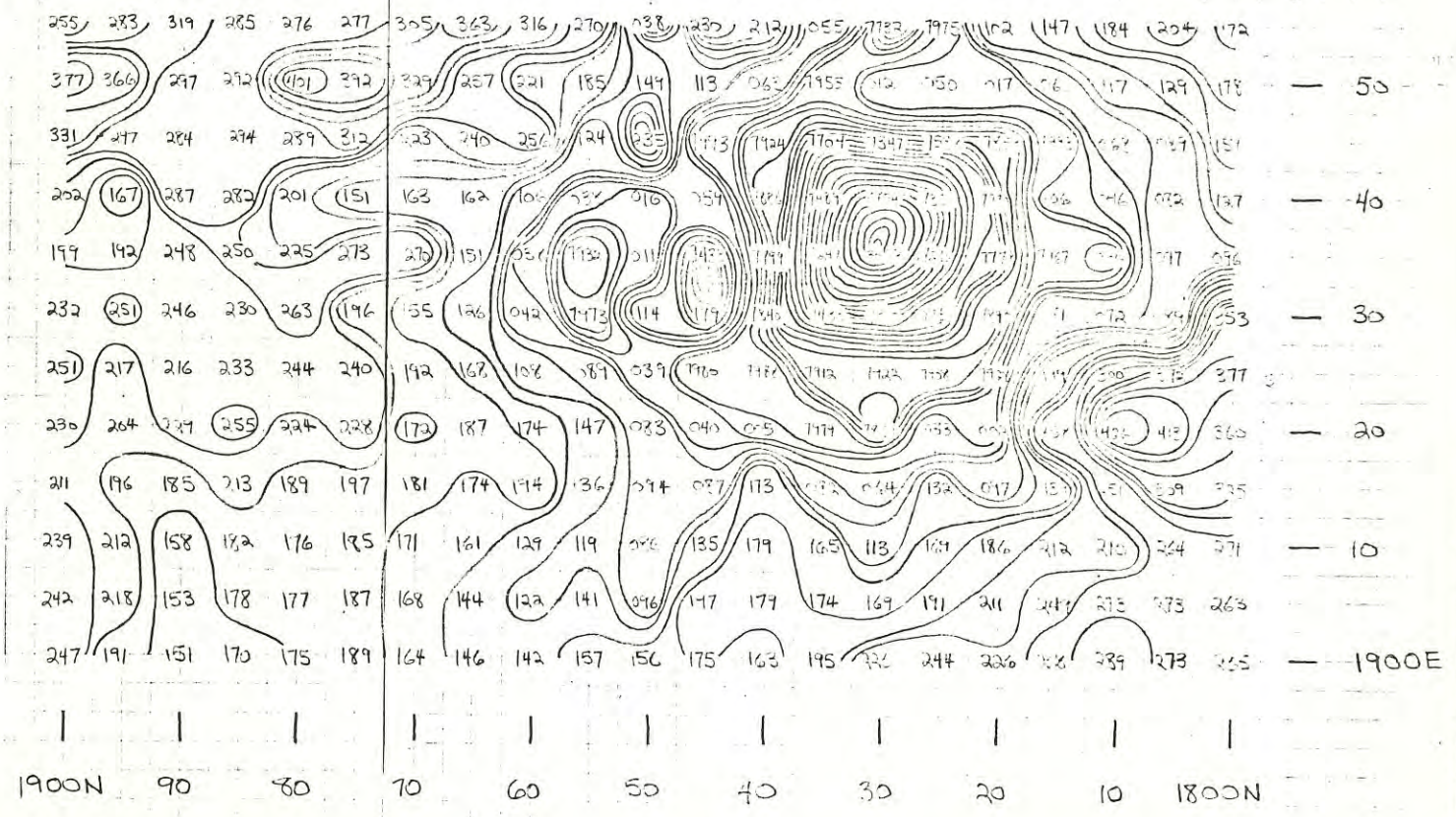
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





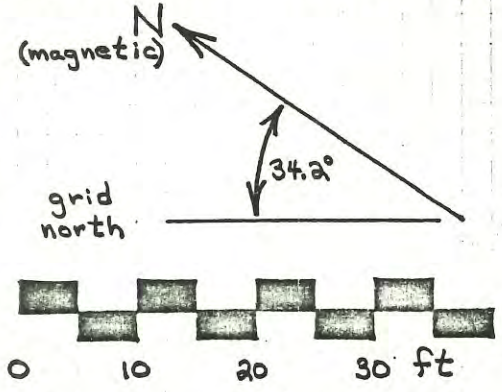
Grid #12

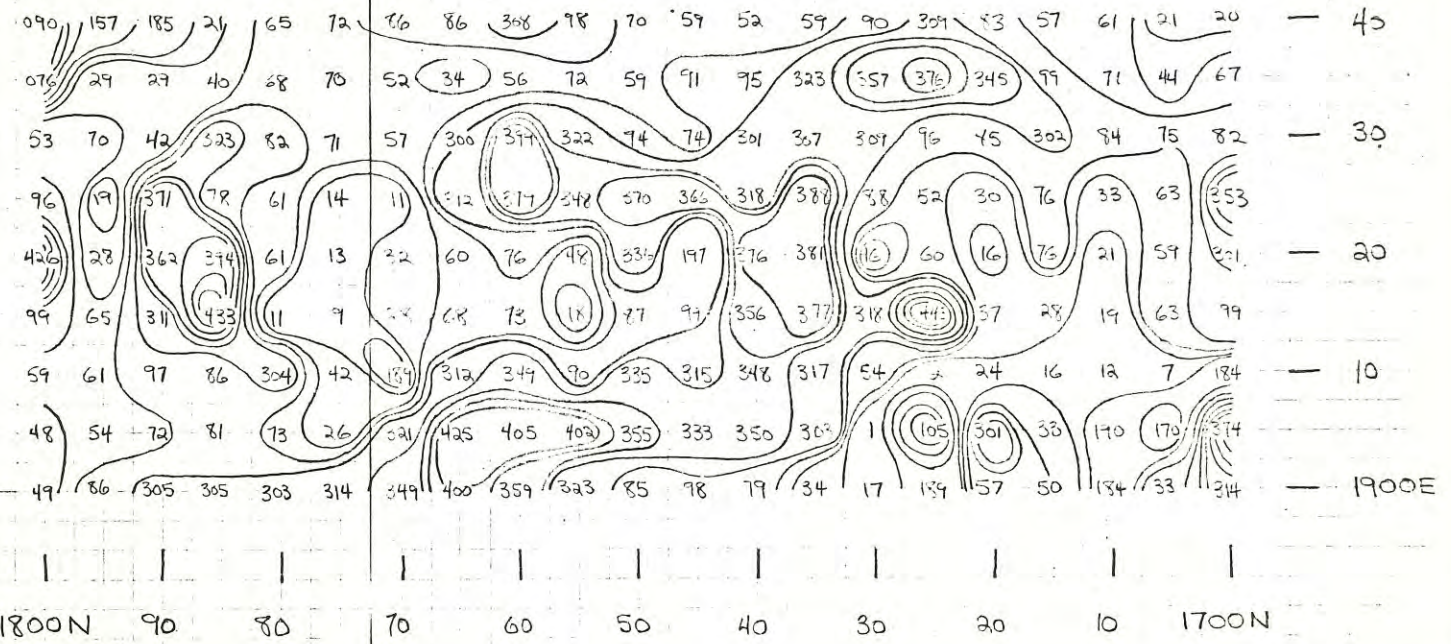
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





Grid #13

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

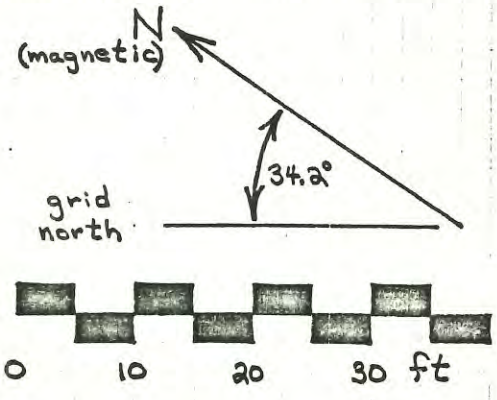
contour interval = 25 γ

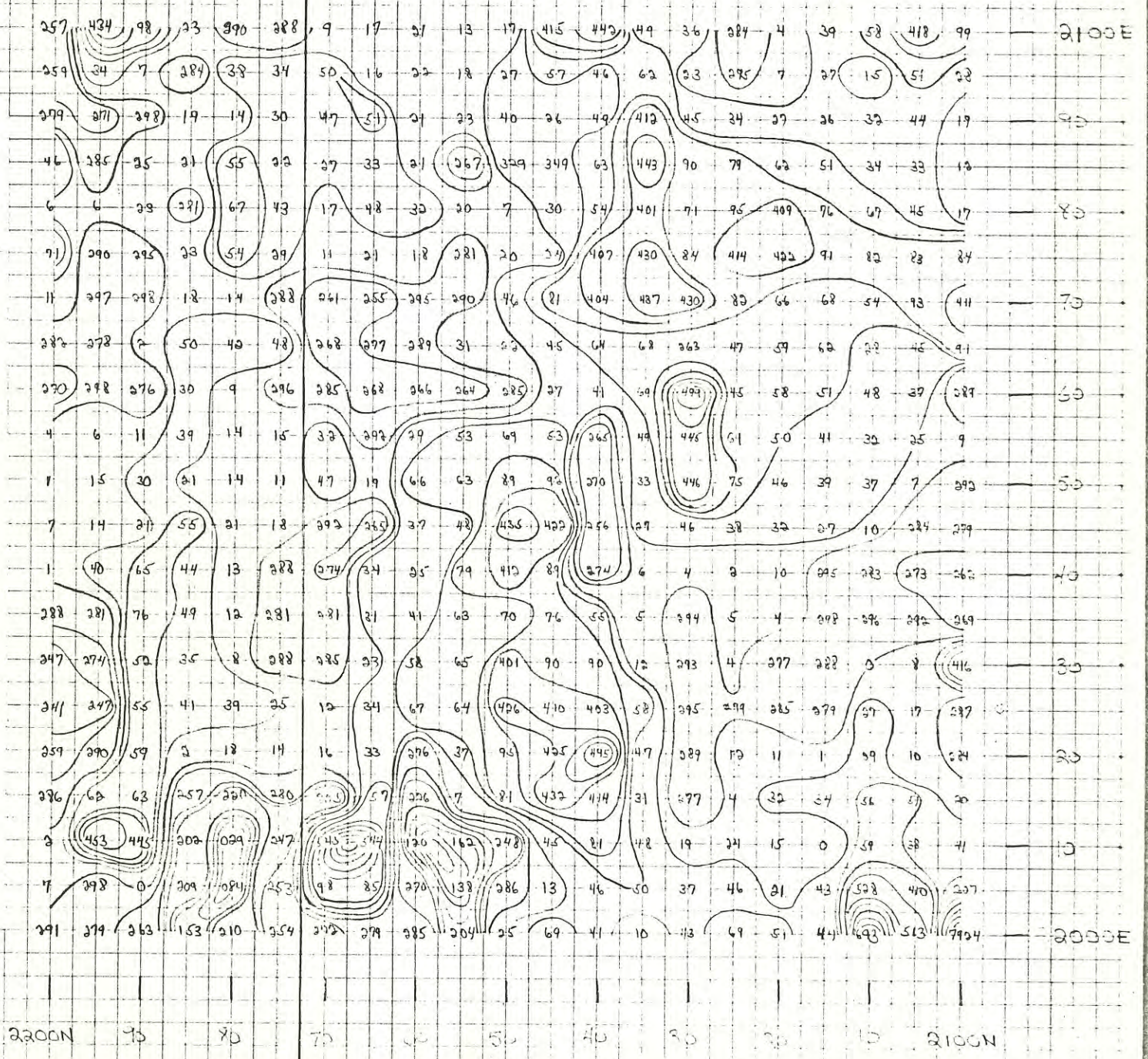
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #14

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

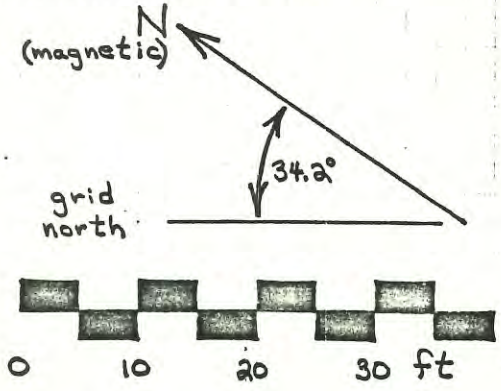
contour interval = 25 γ

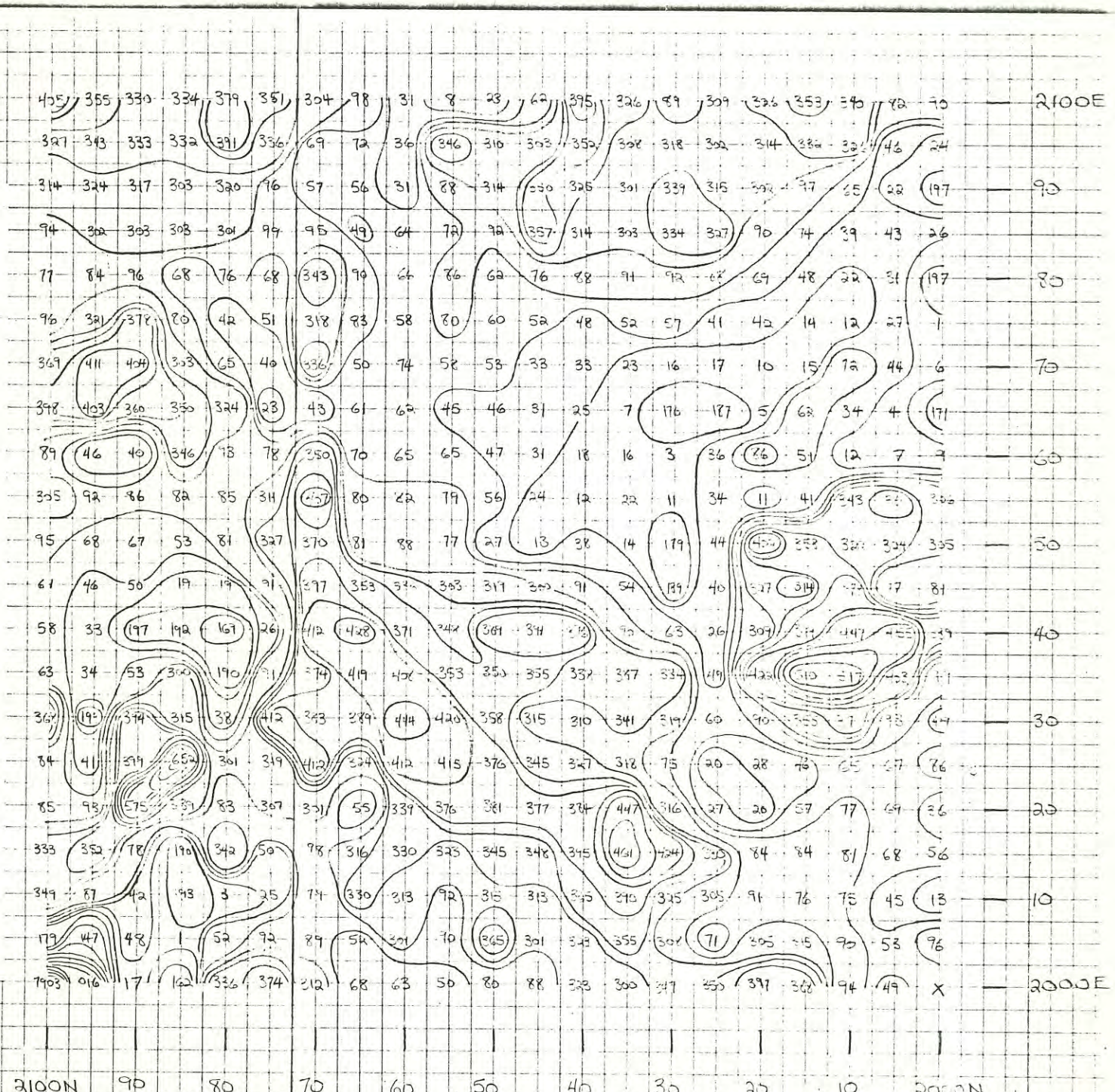
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #15

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

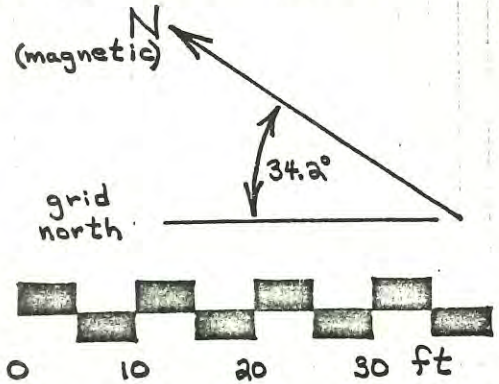
contour interval = 25 γ

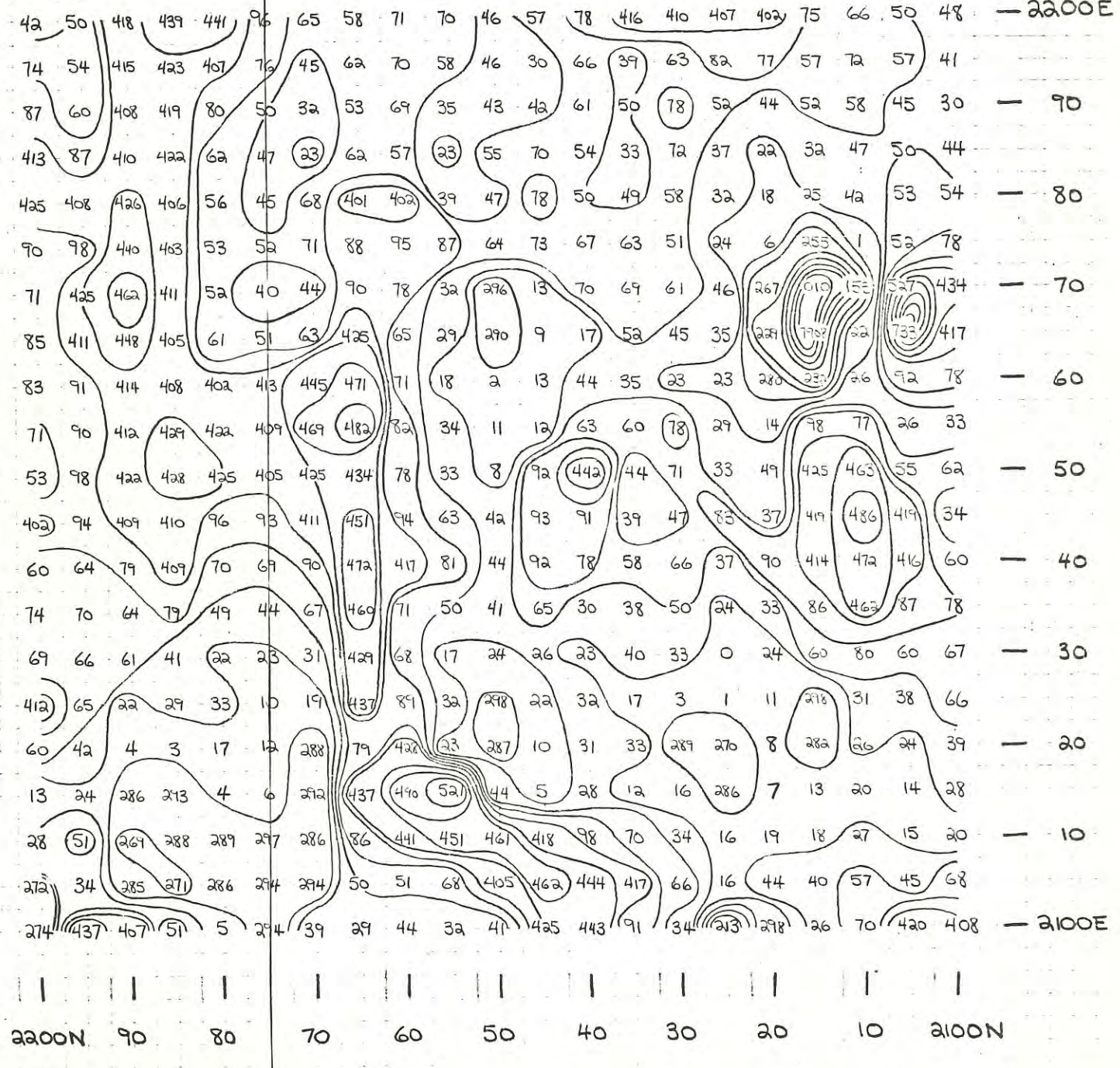
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





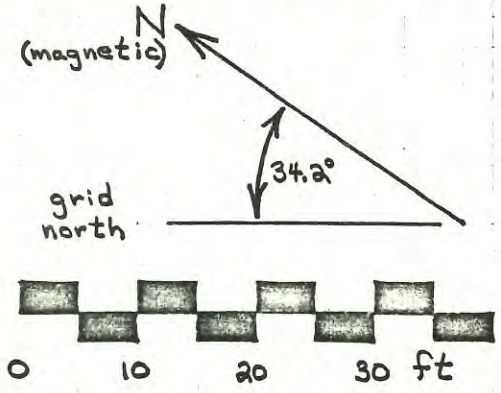
Grid #16

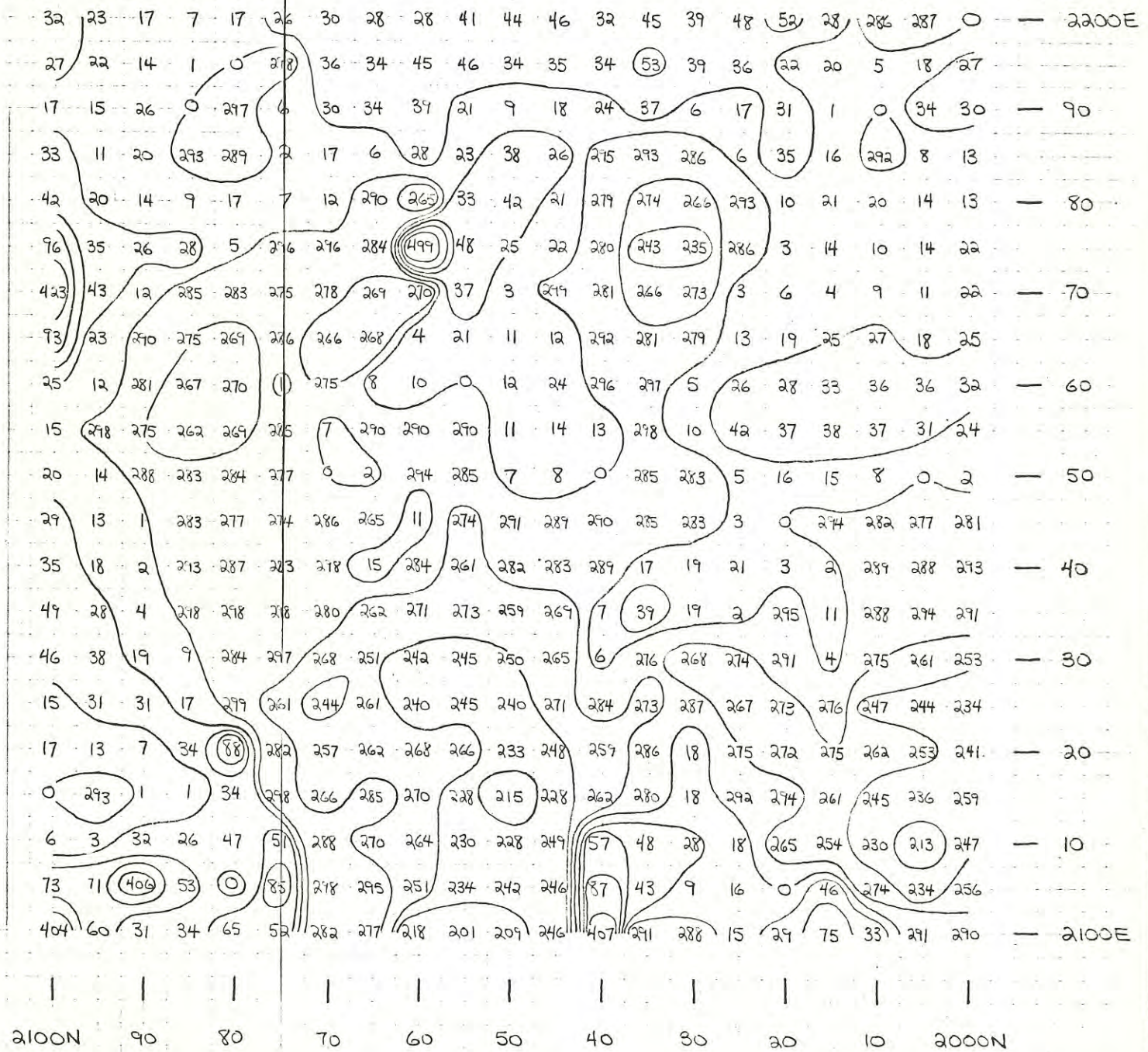
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





Grid #17

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

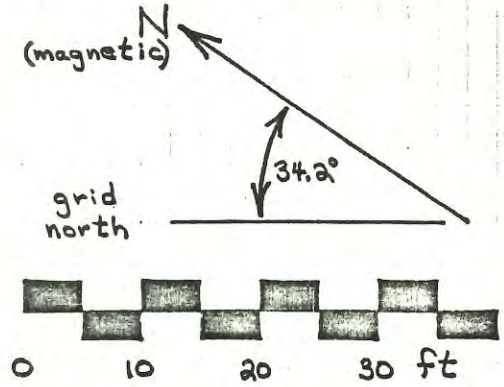
contour interval = 25 γ

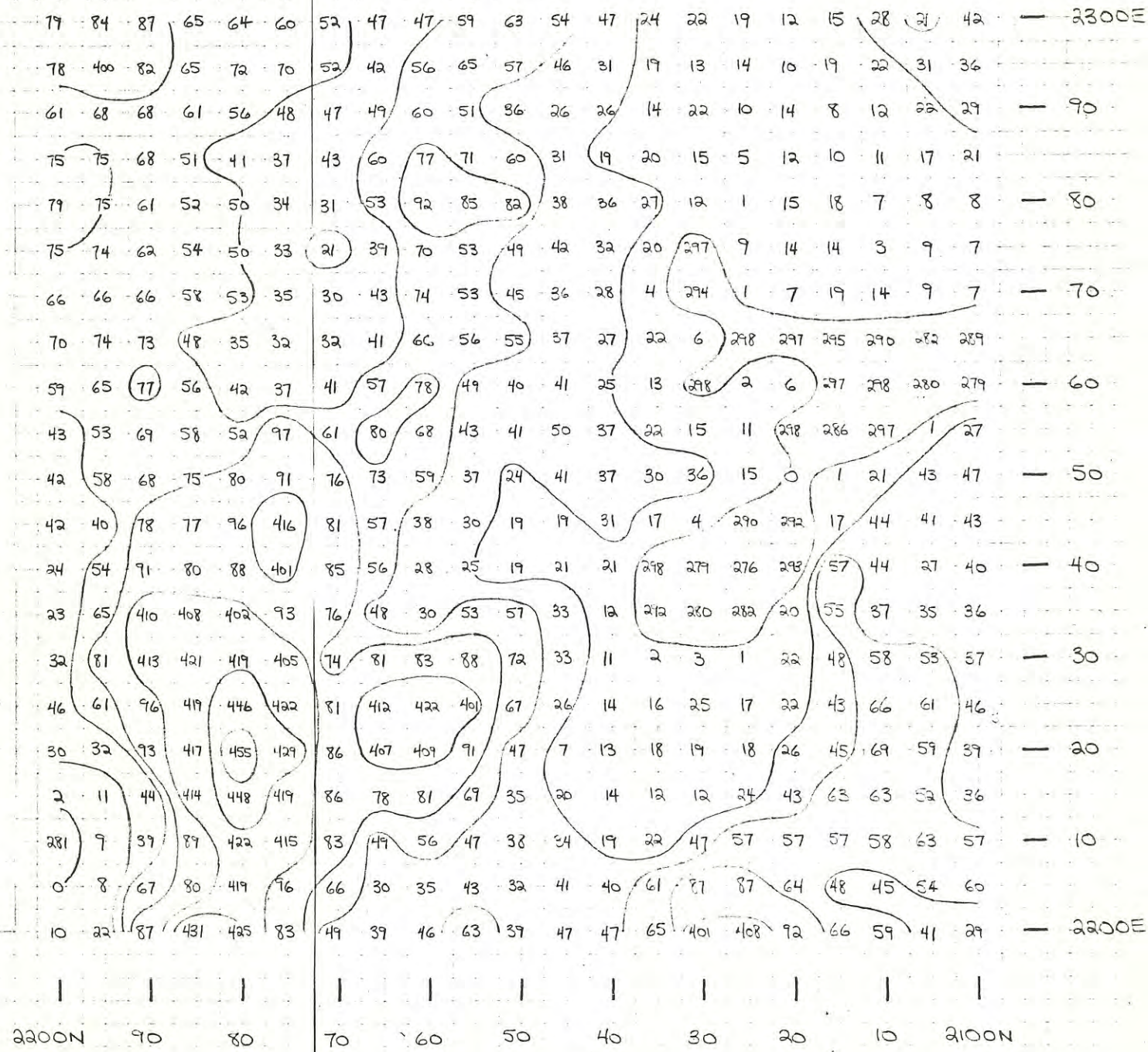
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





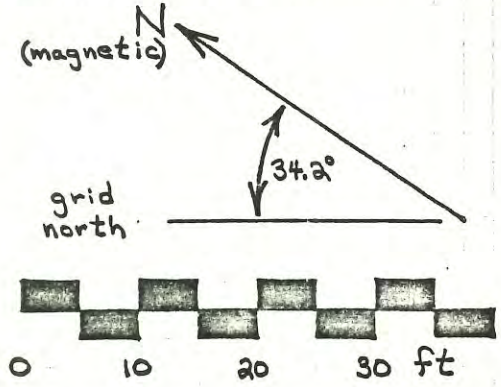
Grid #18

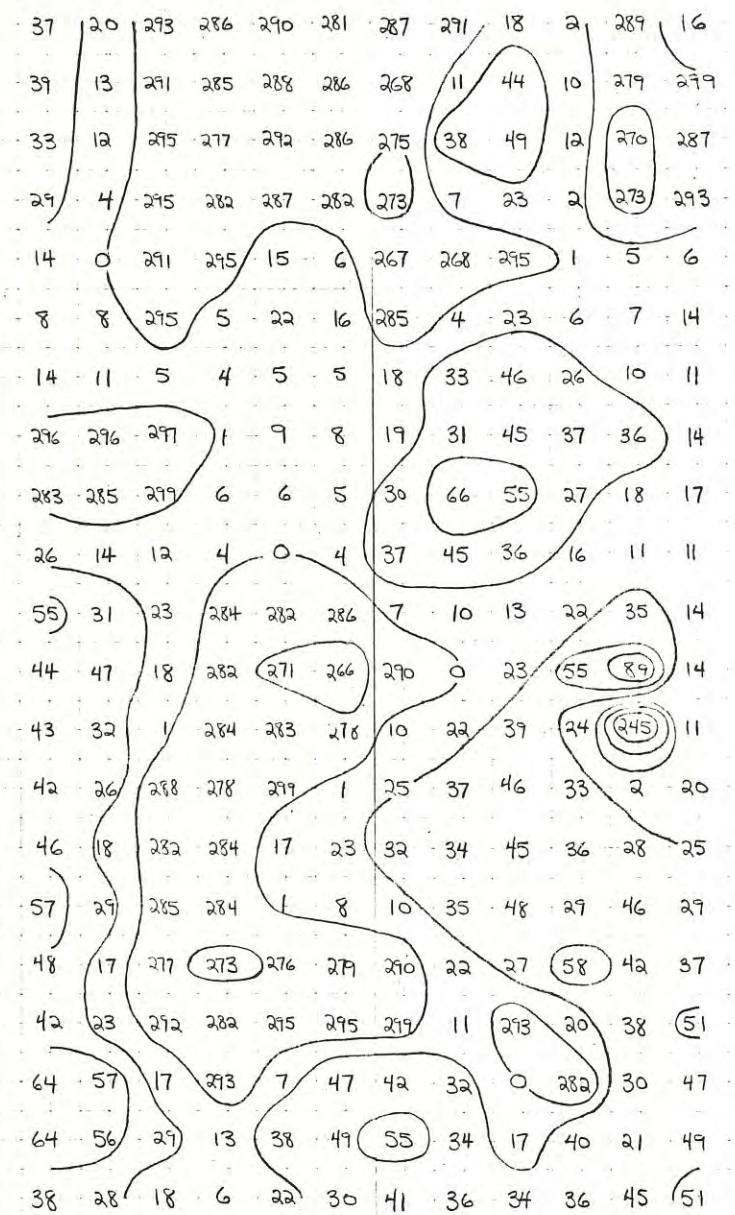
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25γ
sensor height = 2½ ft
average field = 58,200γ
inclination = 75°N
declination = 16°W





Grid #19

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

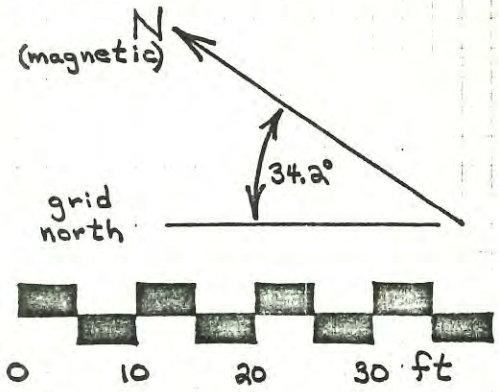
contour interval = 25 γ

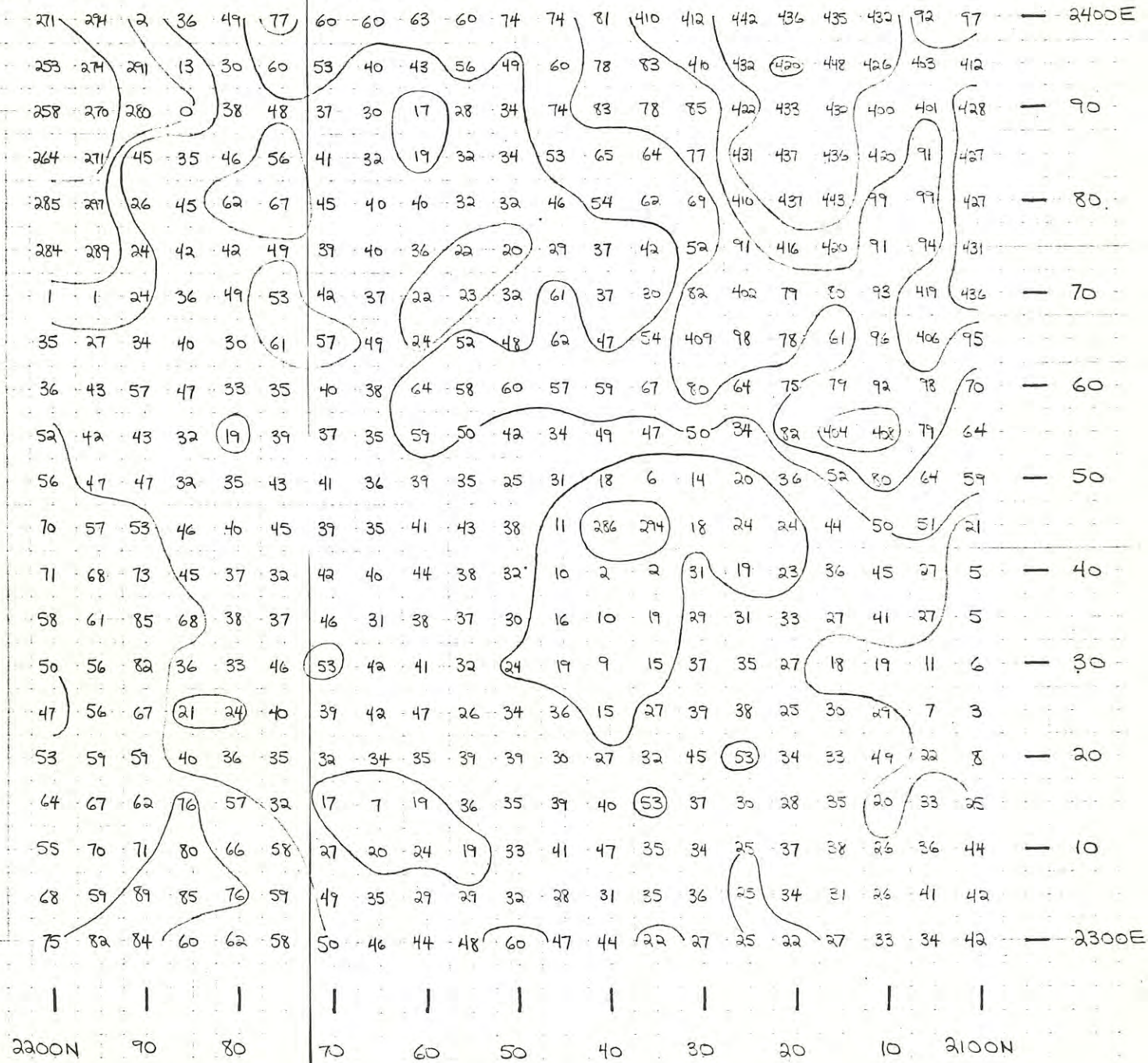
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #20

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

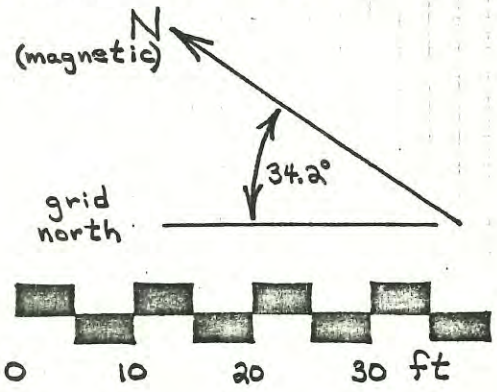
contour interval = 25 γ

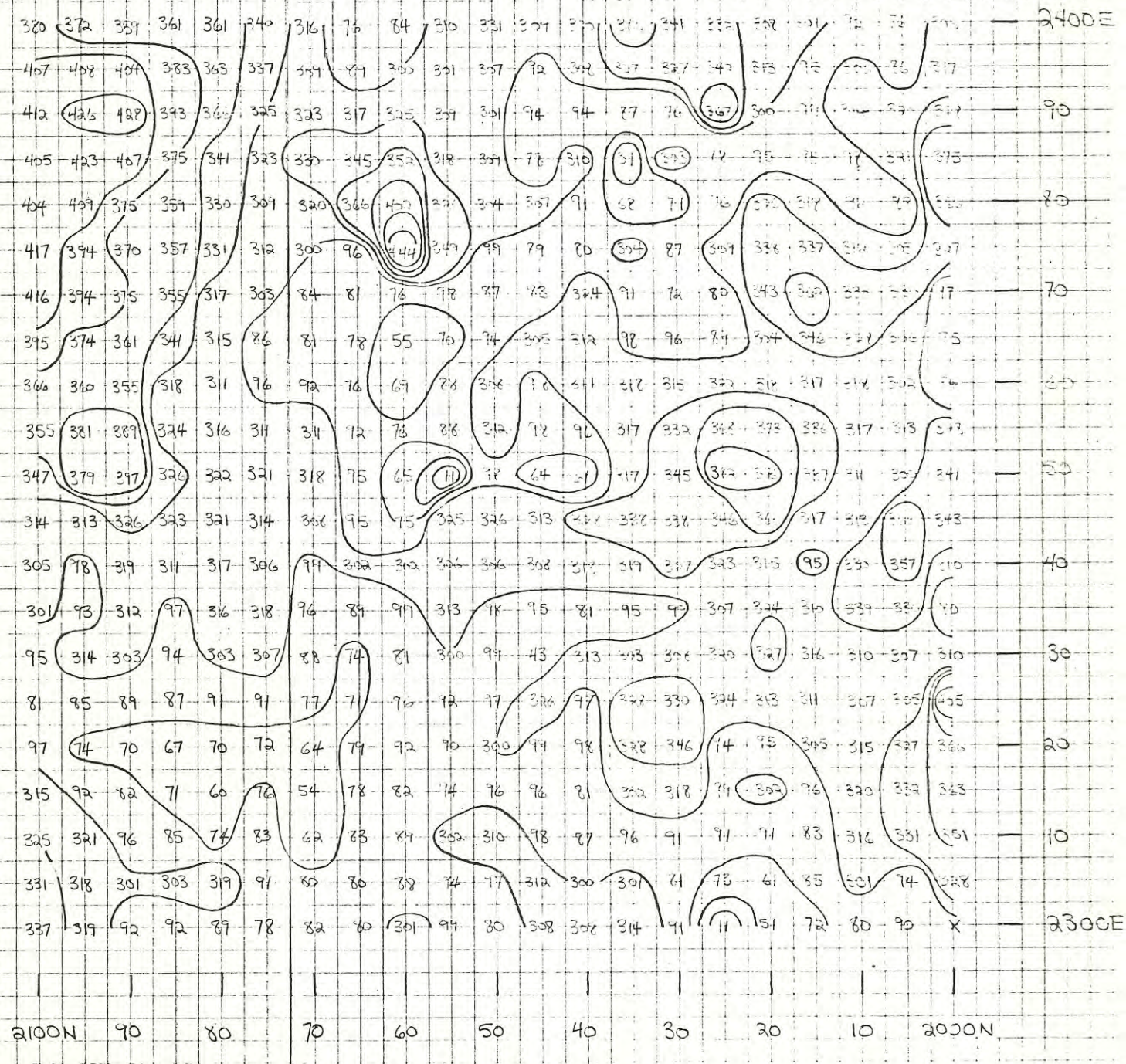
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





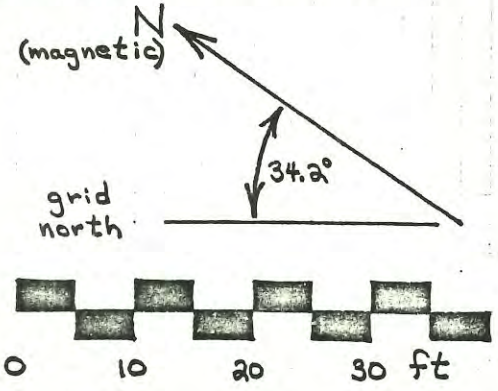
Grid #21

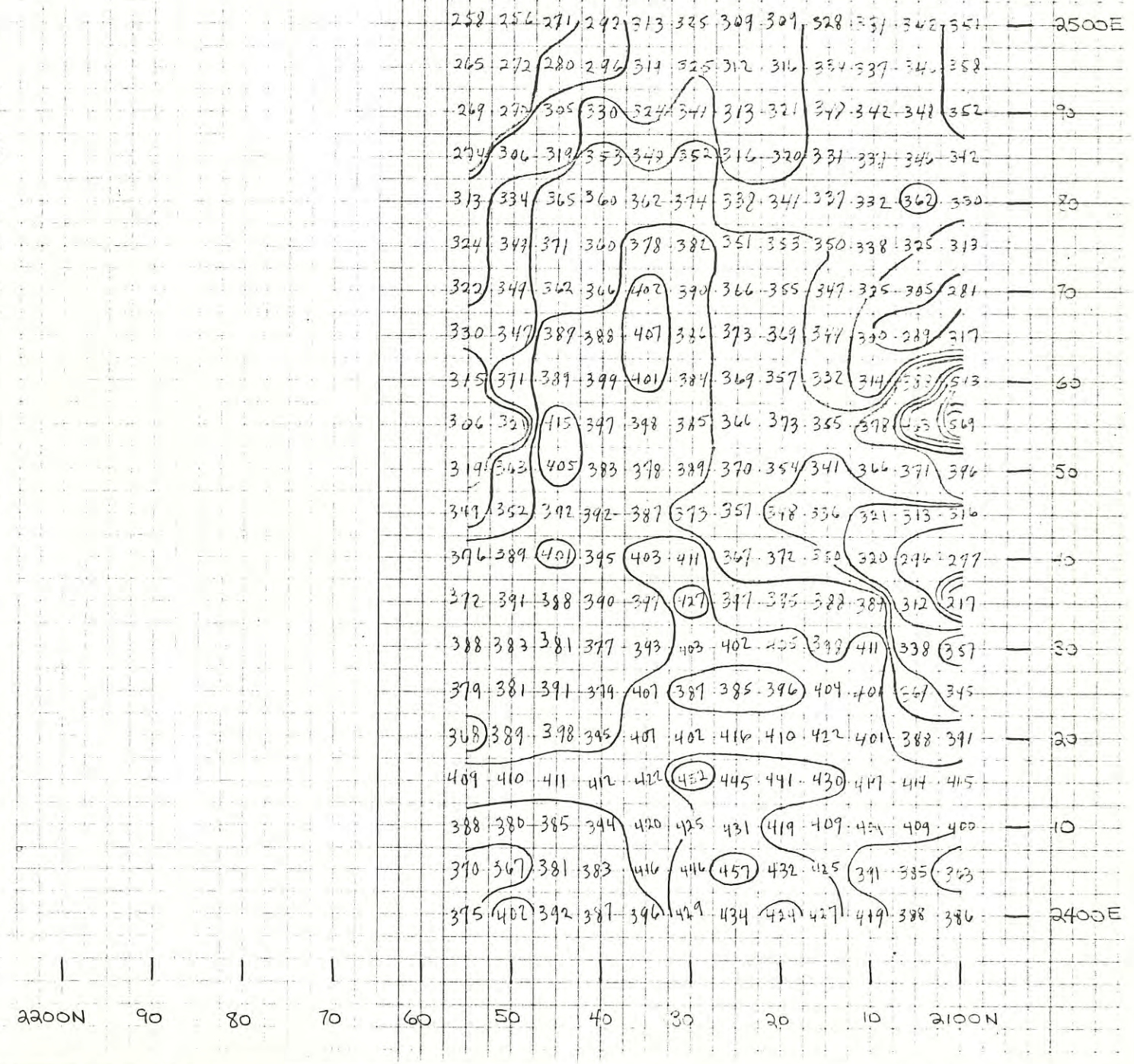
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





Grid #22

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

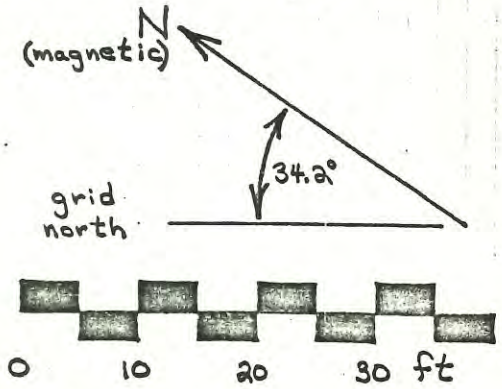
contour interval = 25 γ

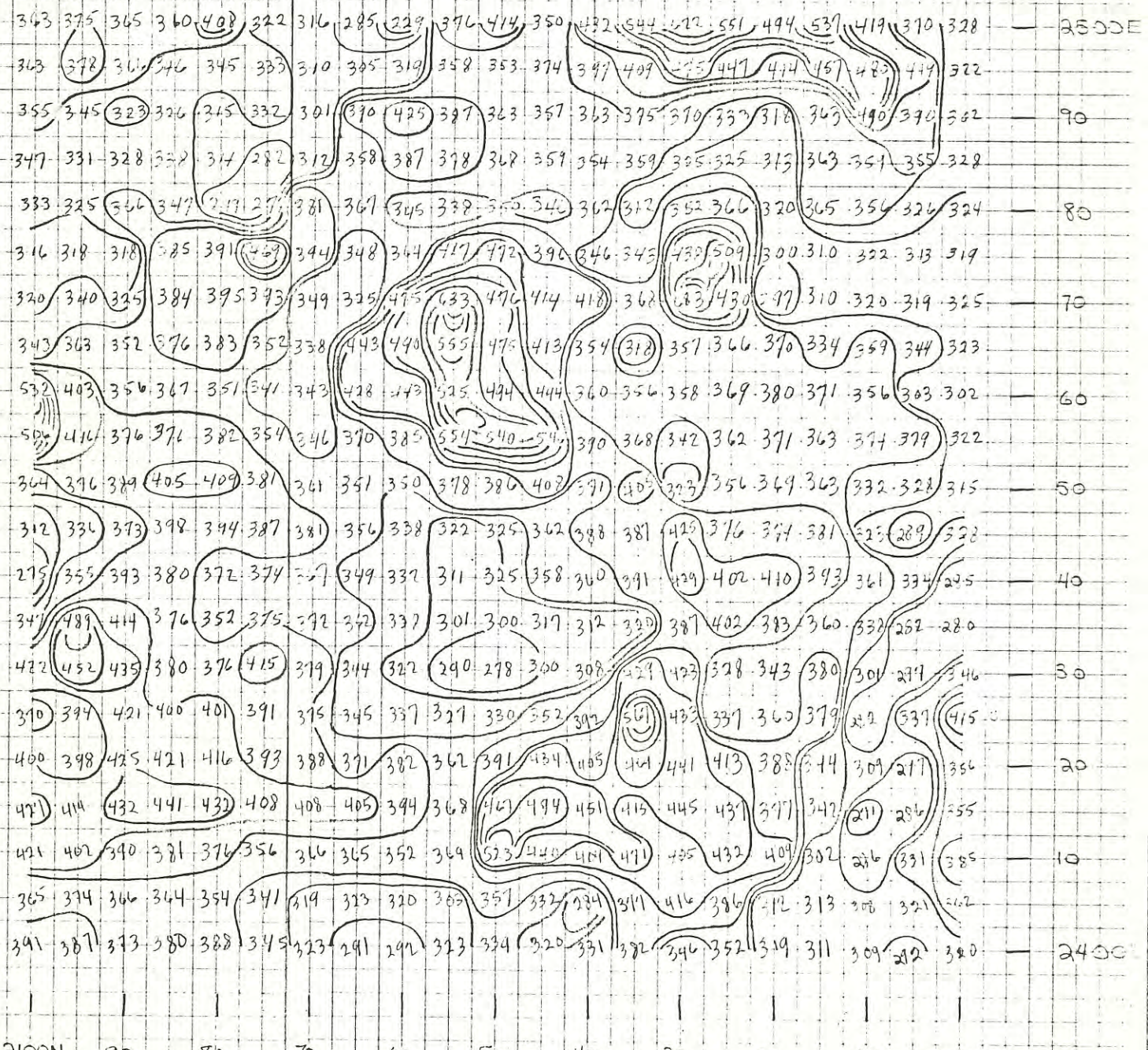
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #23

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

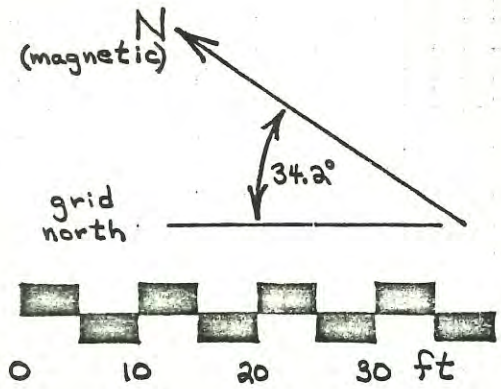
contour interval = 25 γ

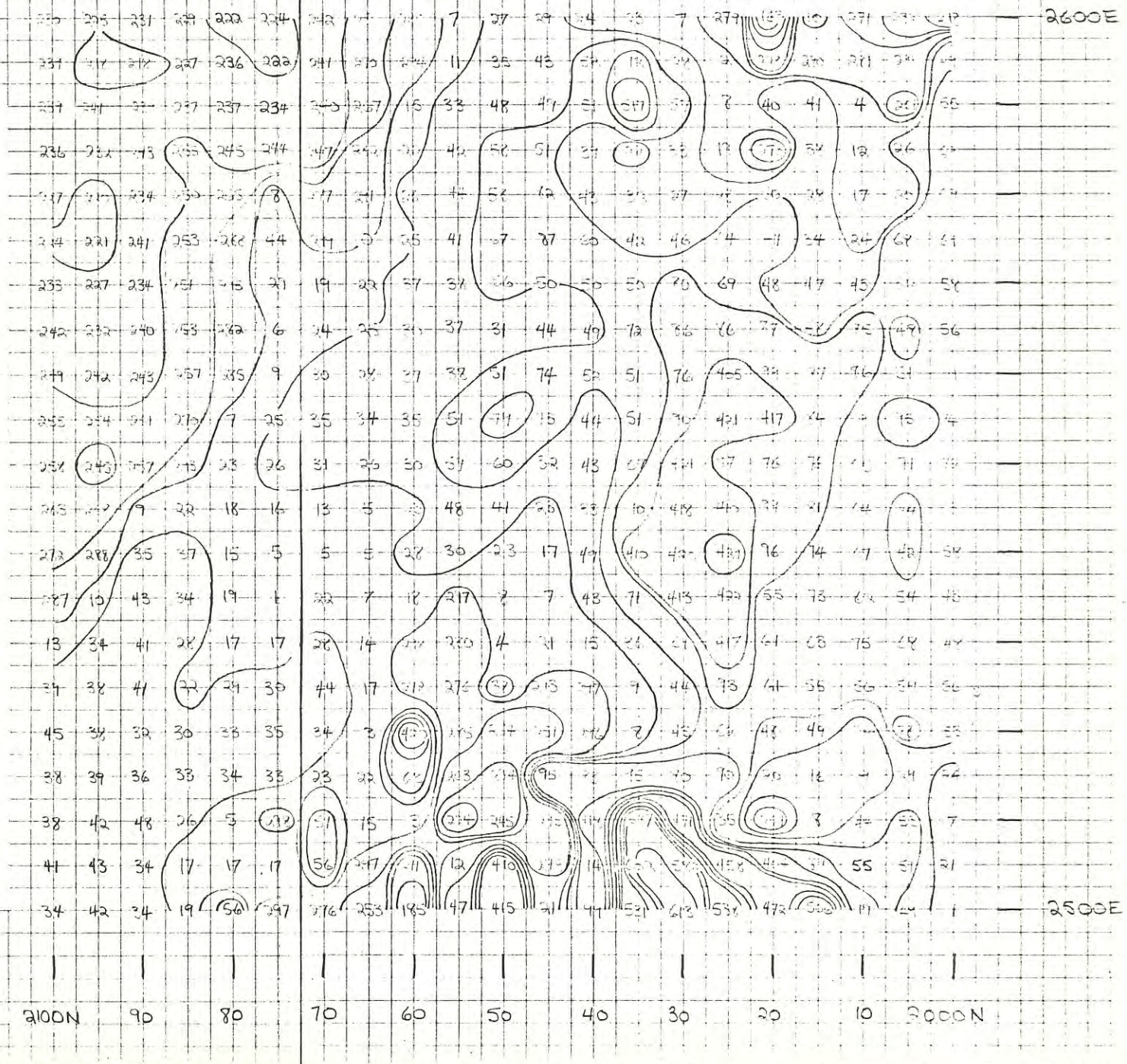
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #24

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

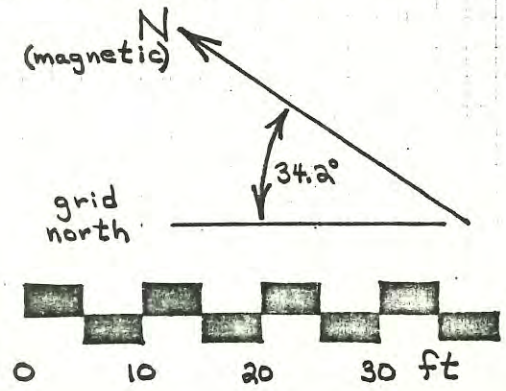
contour interval = 25 γ

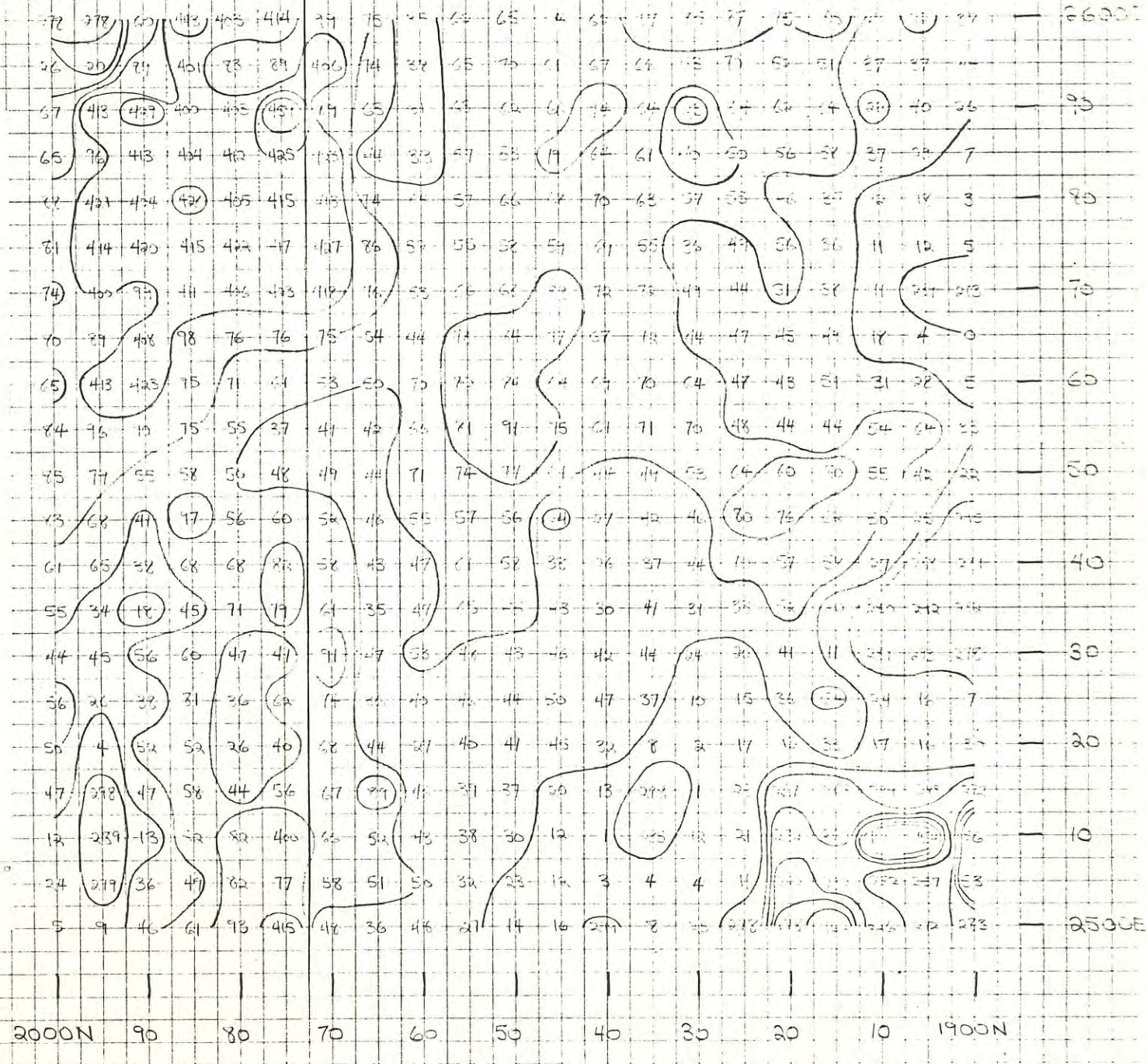
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #25

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

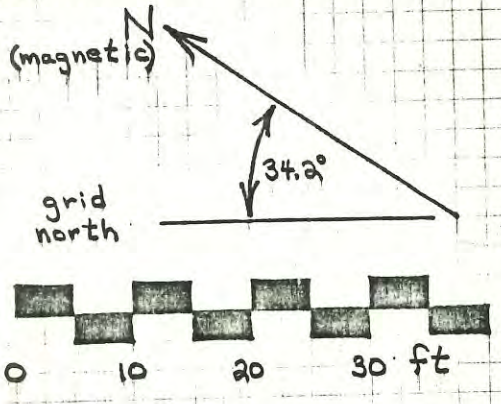
contour interval = 25 γ

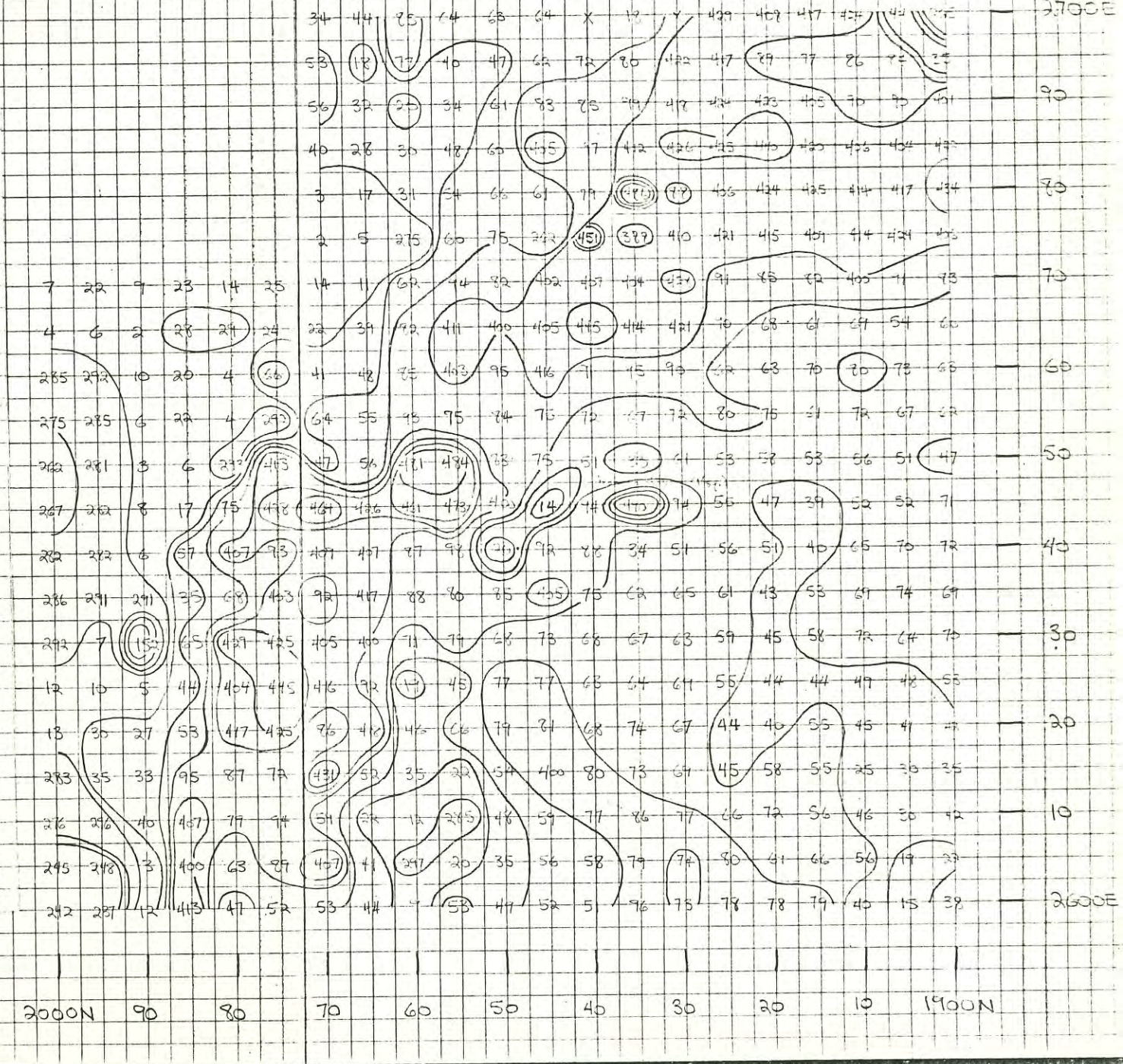
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





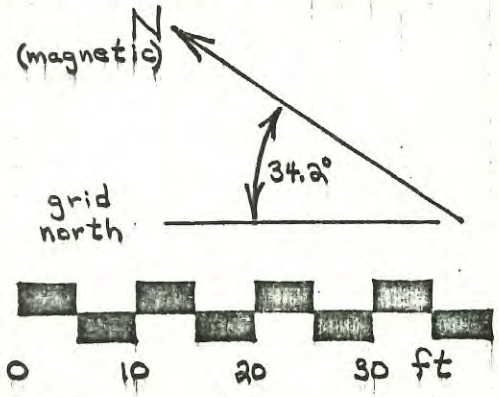
Grid #26

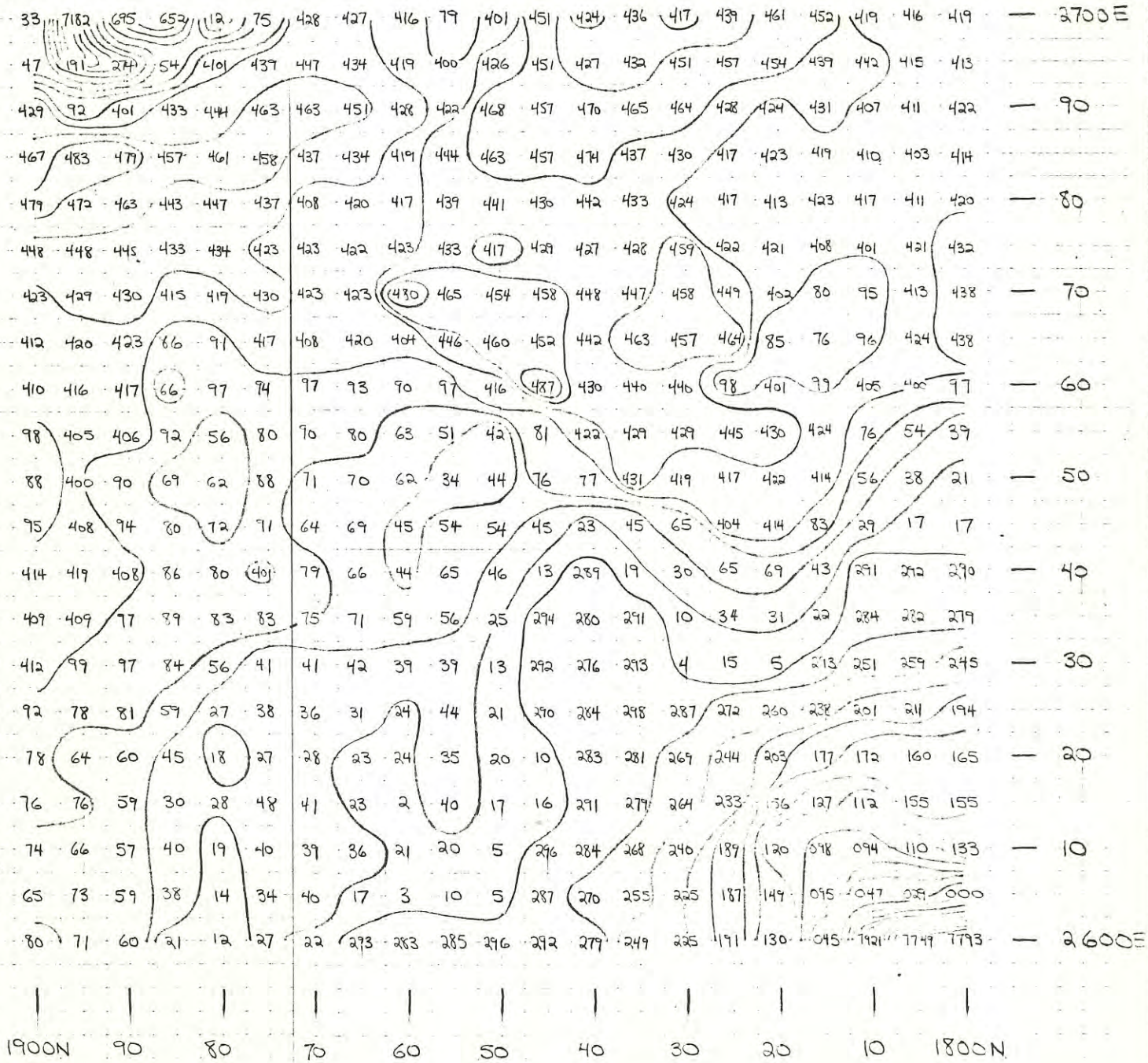
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25γ
sensor height = 2½ ft
average field = 58,200γ
inclination = 75°N
declination = 16°W





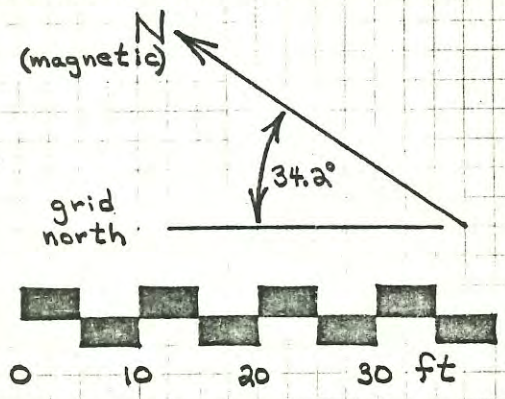
Grid #27

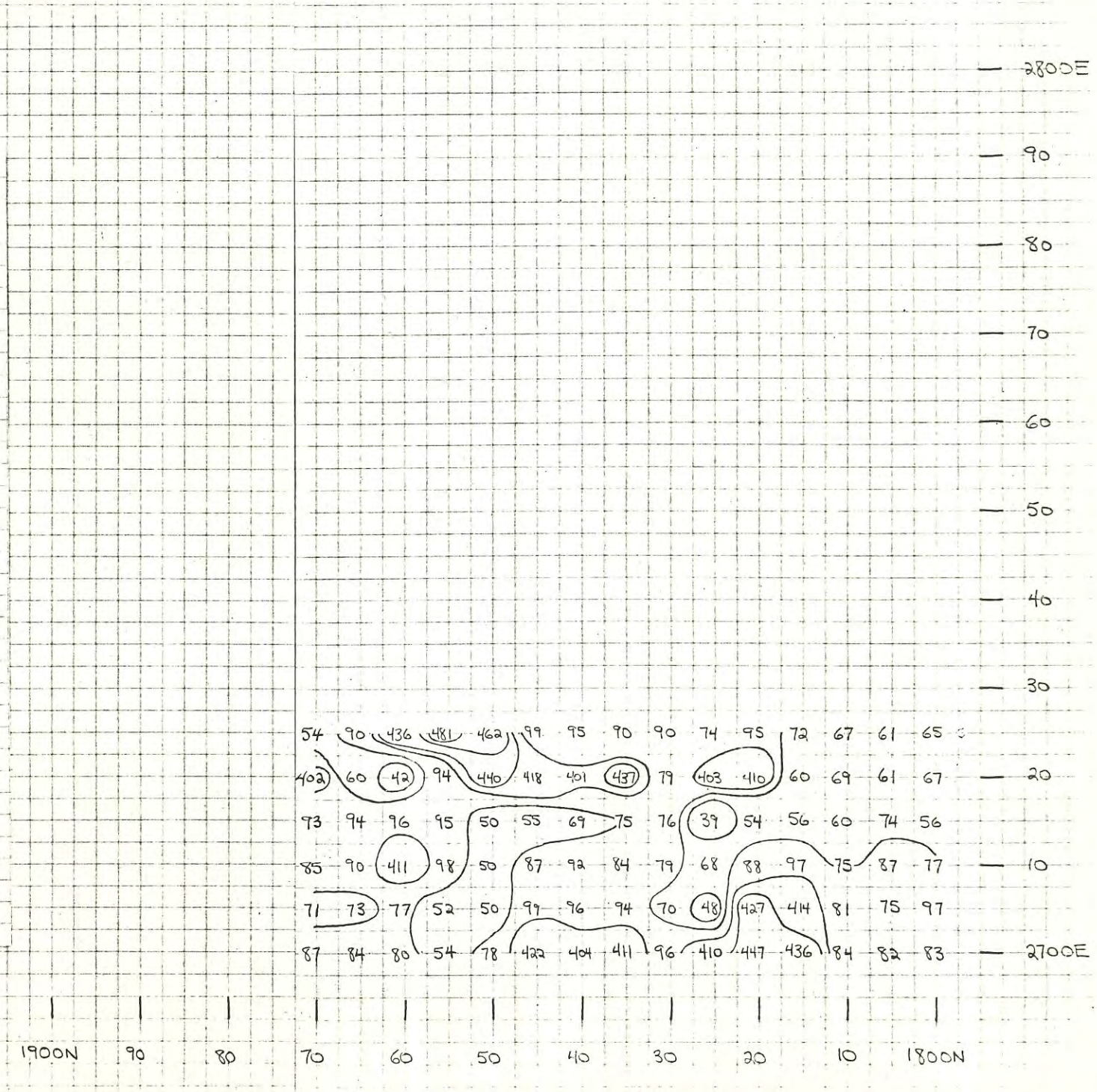
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





Grid #28

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

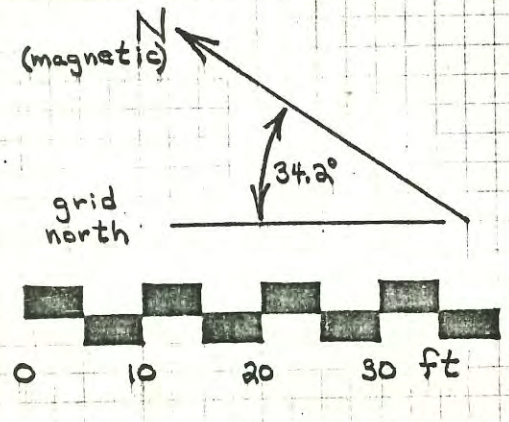
contour interval = 25 γ

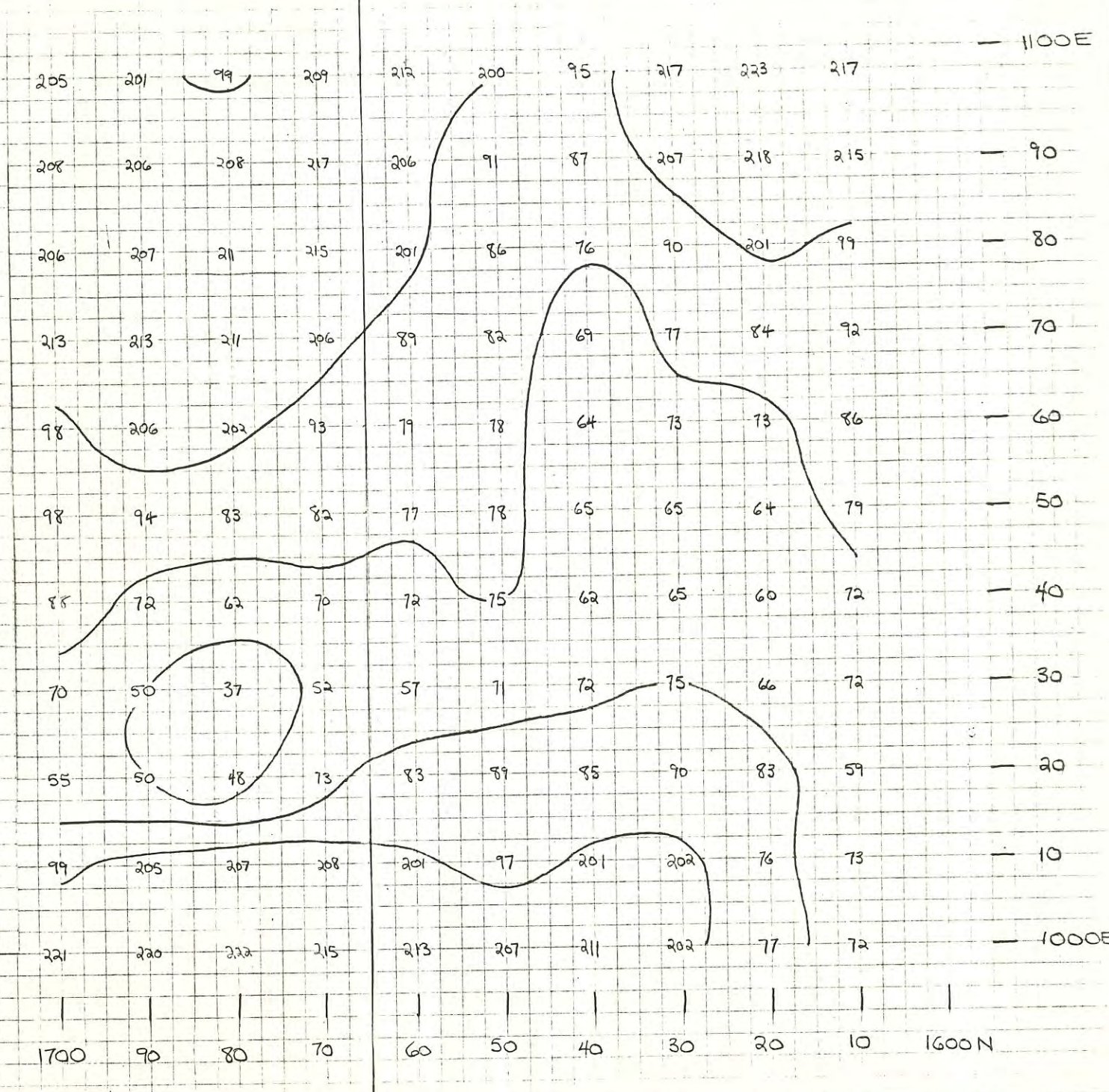
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





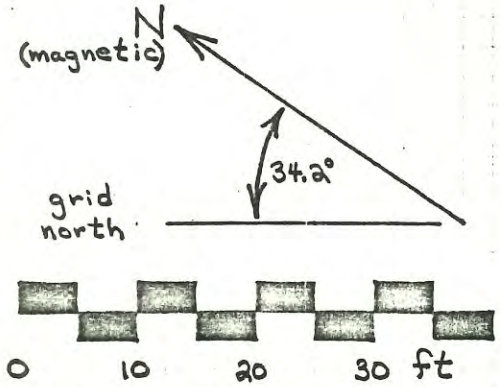
Grid #29

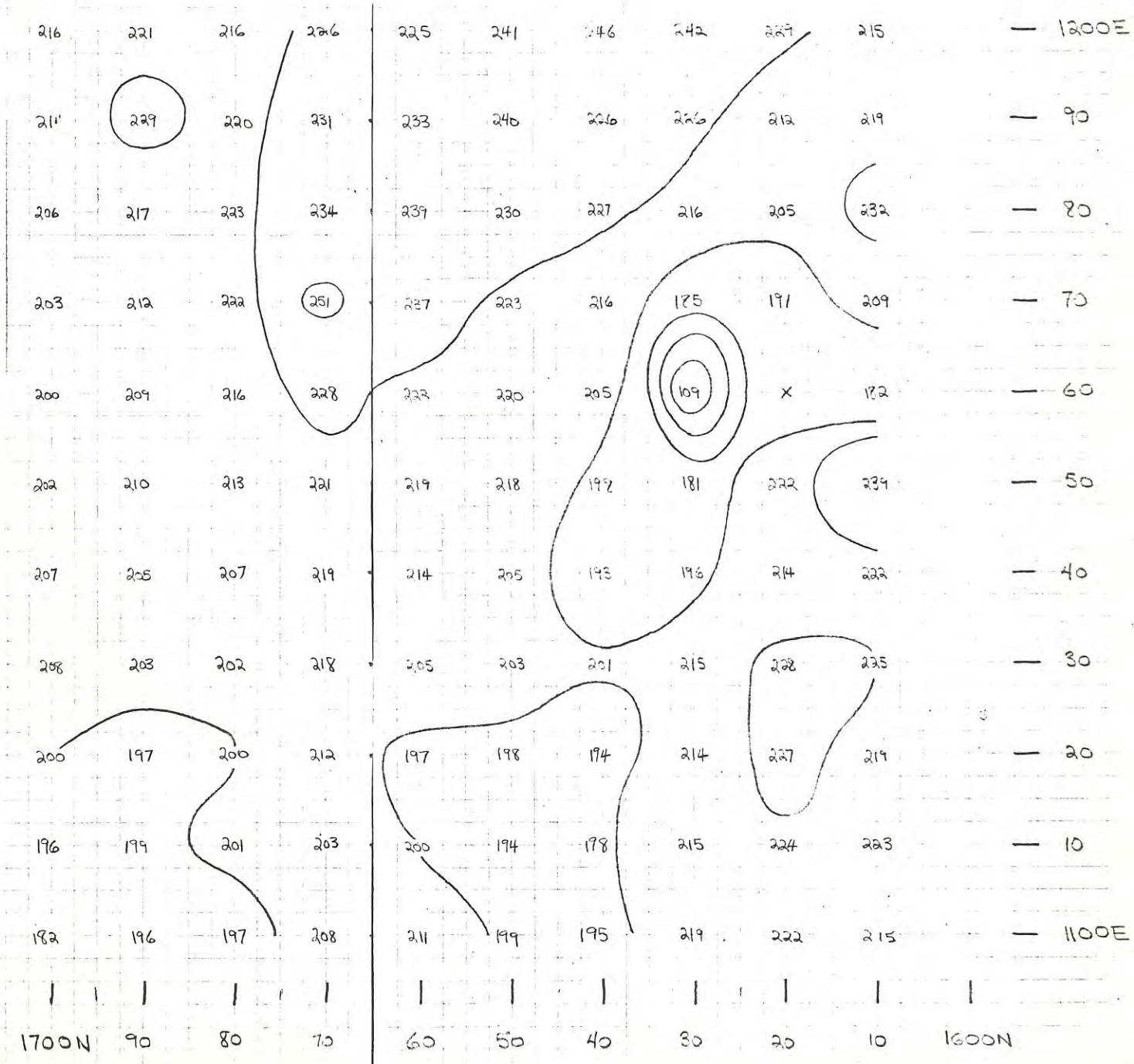
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





Grid #30

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

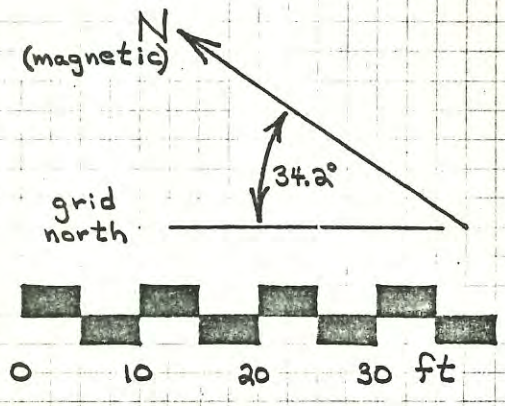
contour interval = 25 γ

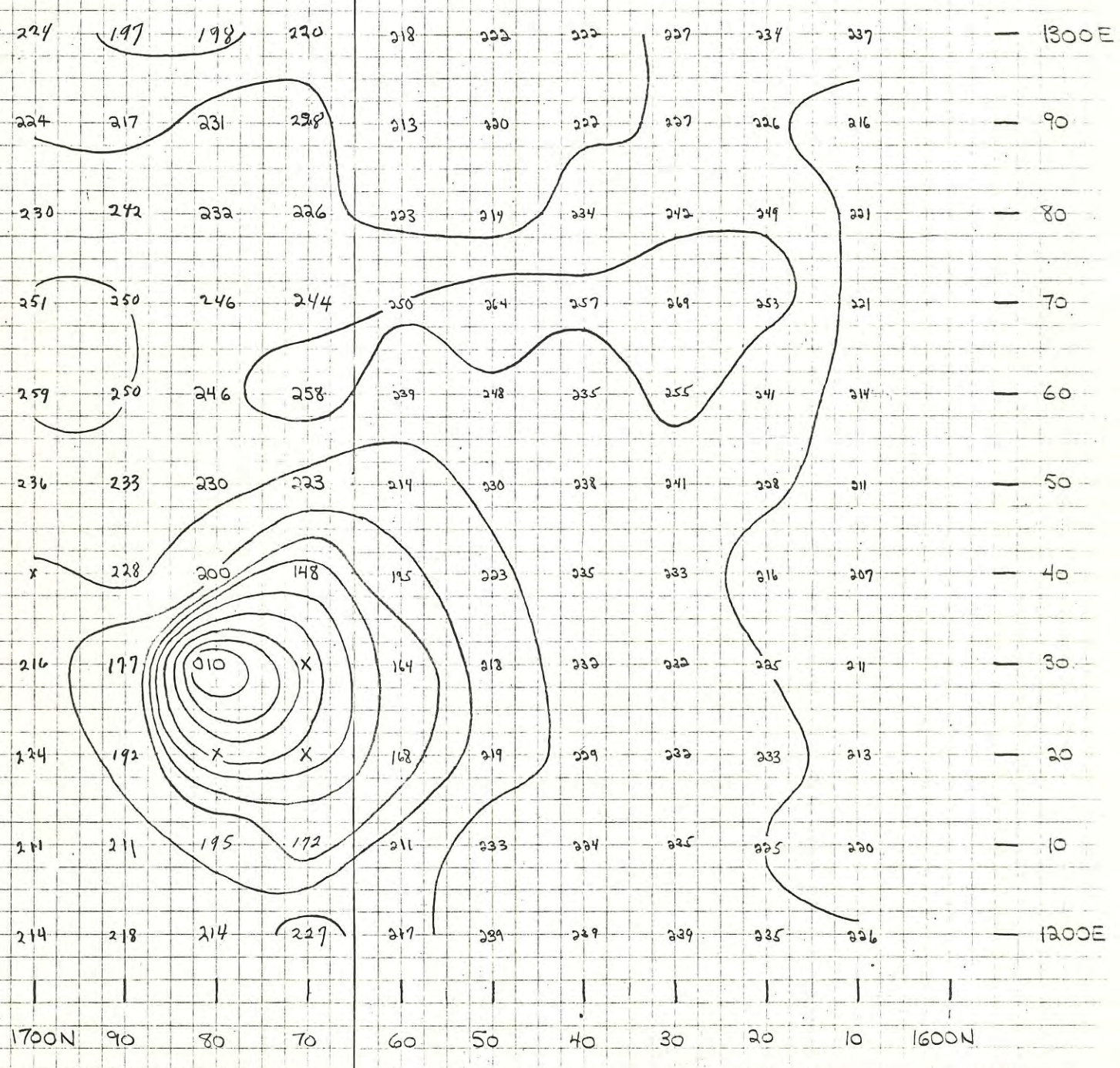
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





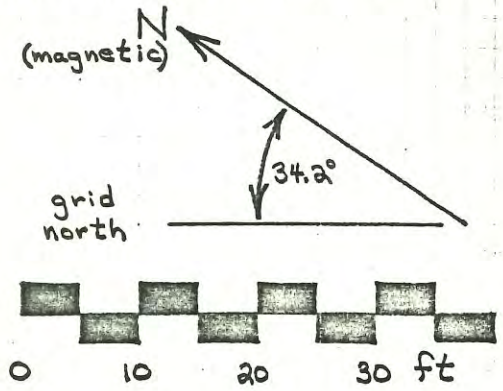
Grid #31

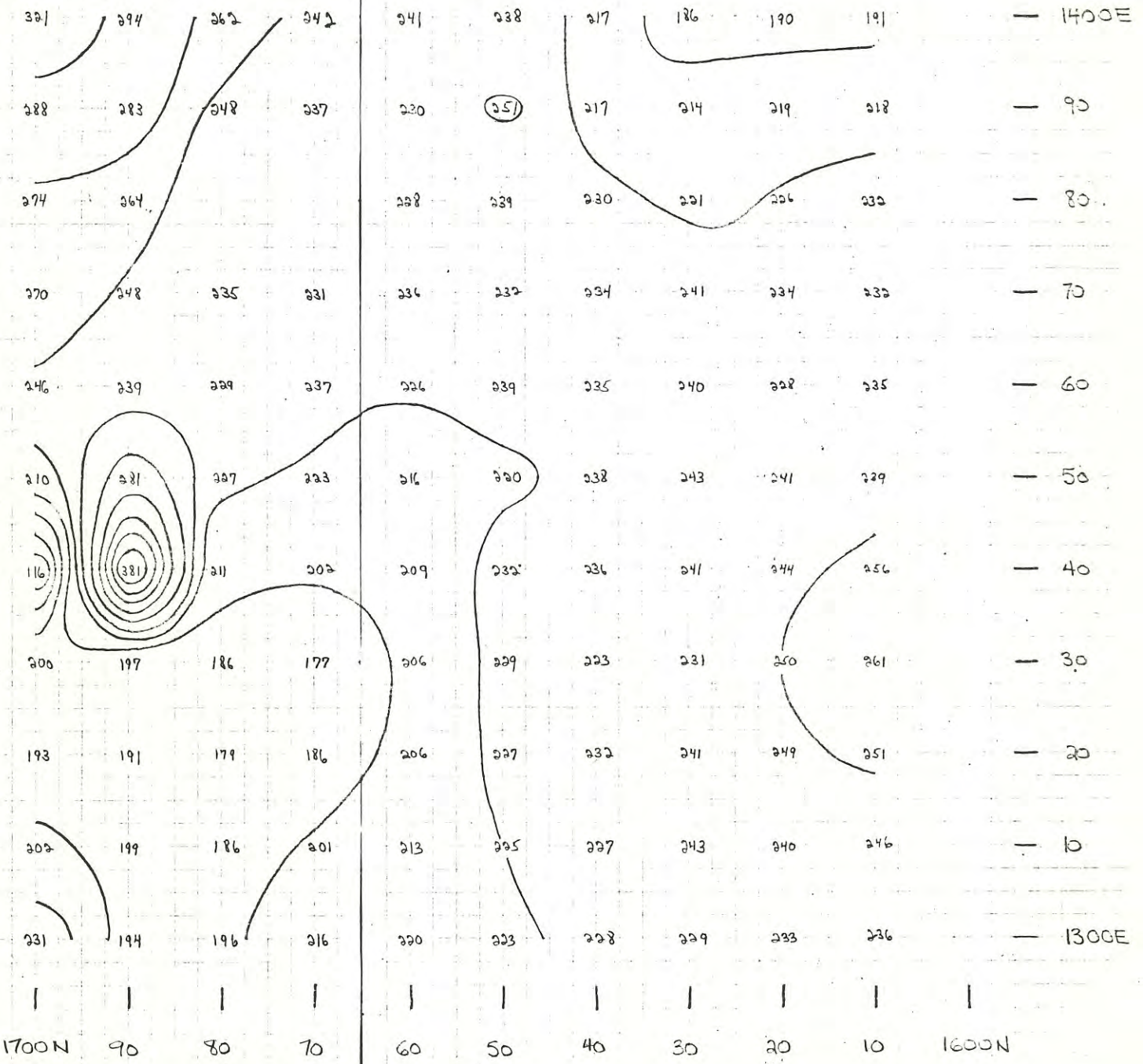
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





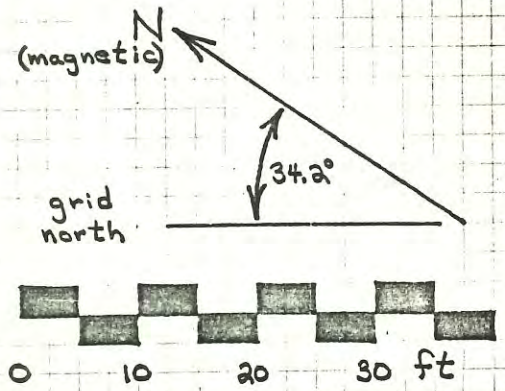
Grid #32

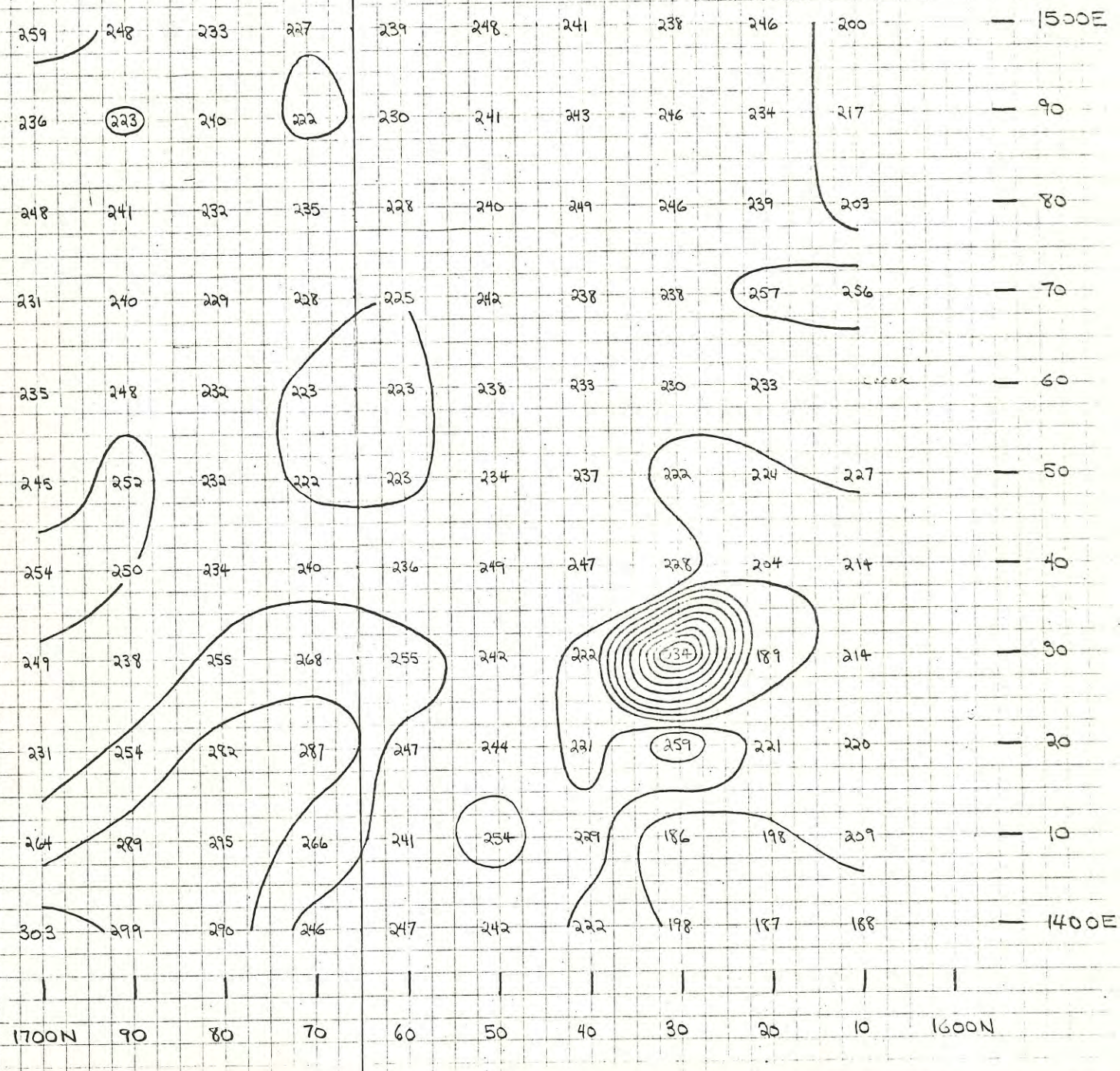
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





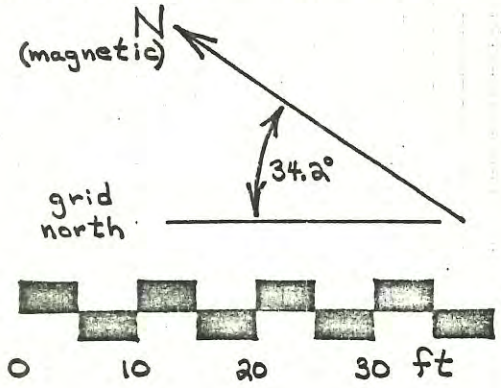
Grid #33

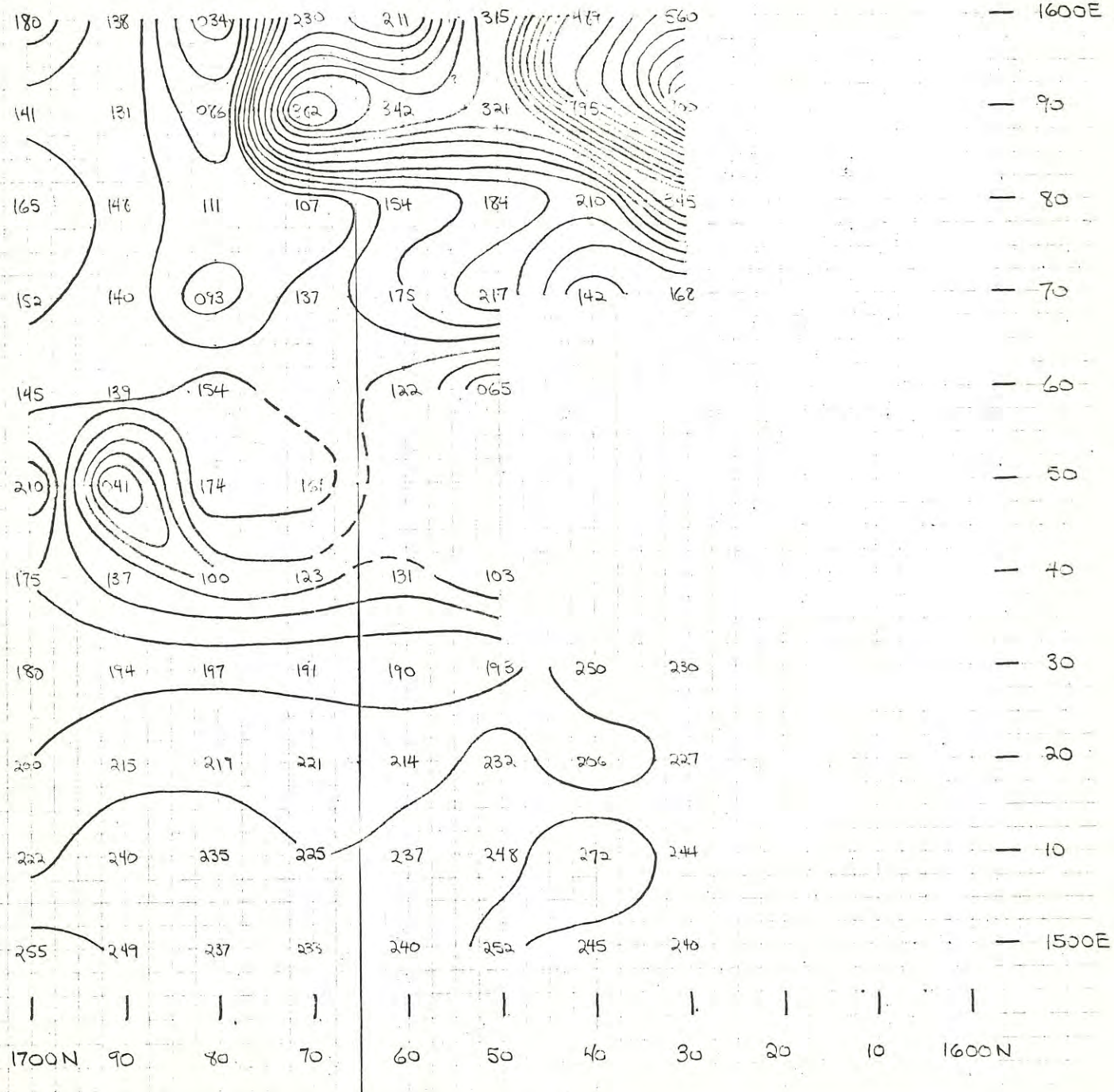
Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

contour interval = 25 γ
sensor height = 2½ ft
average field = 58,200 γ
inclination = 75°N
declination = 16°W





Grid #34

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

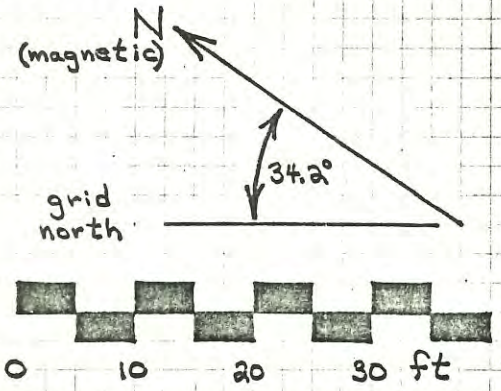
contour interval = 25 γ

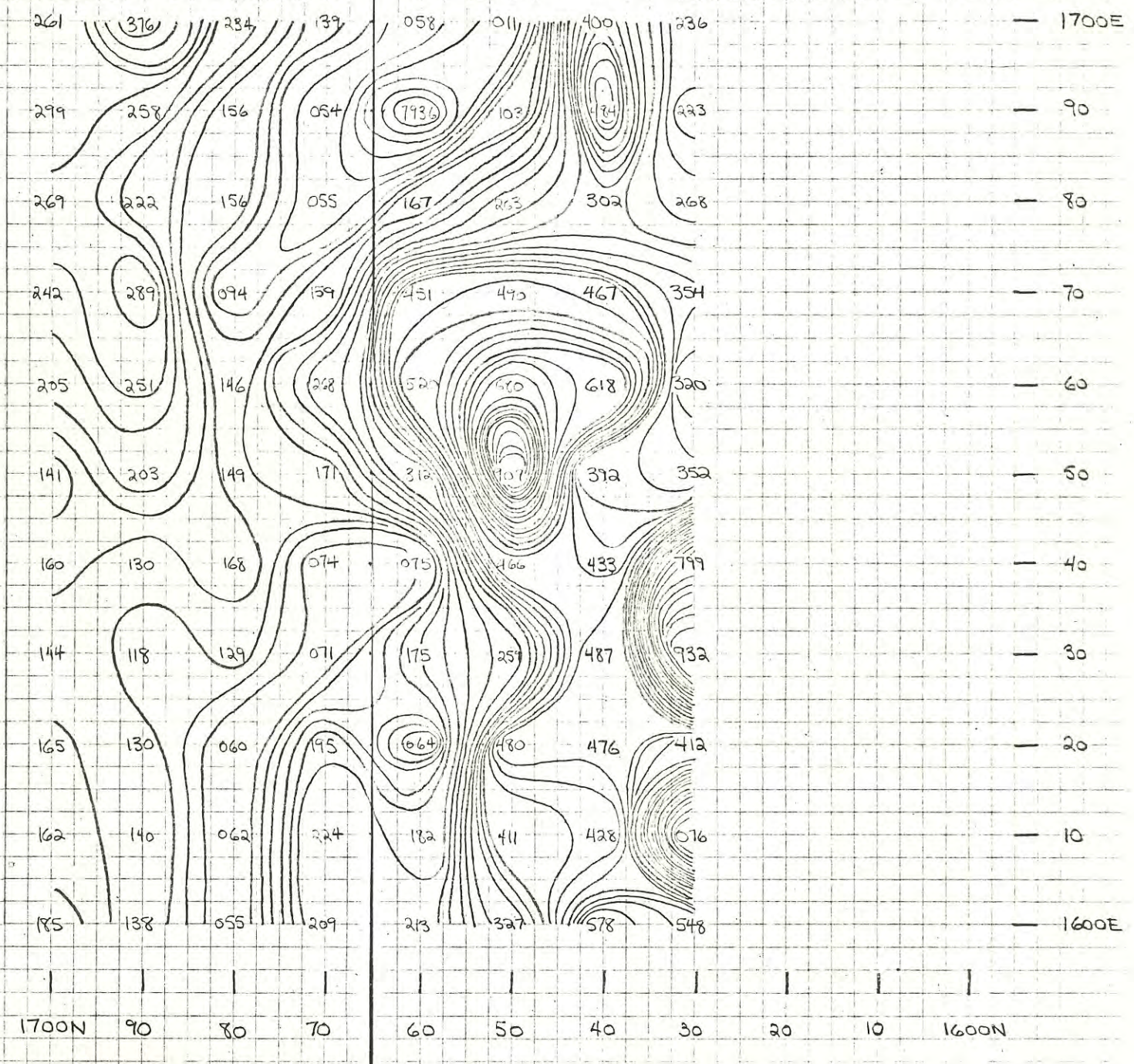
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

declination = 16°W





Grid #35

Magnetic Intensity Map

Les Forges du Saint-Maurice

August 1975

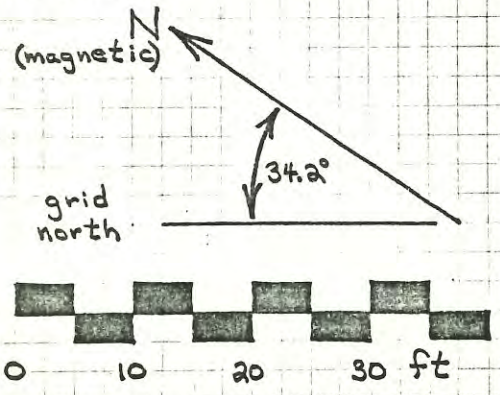
contour interval = 25 γ

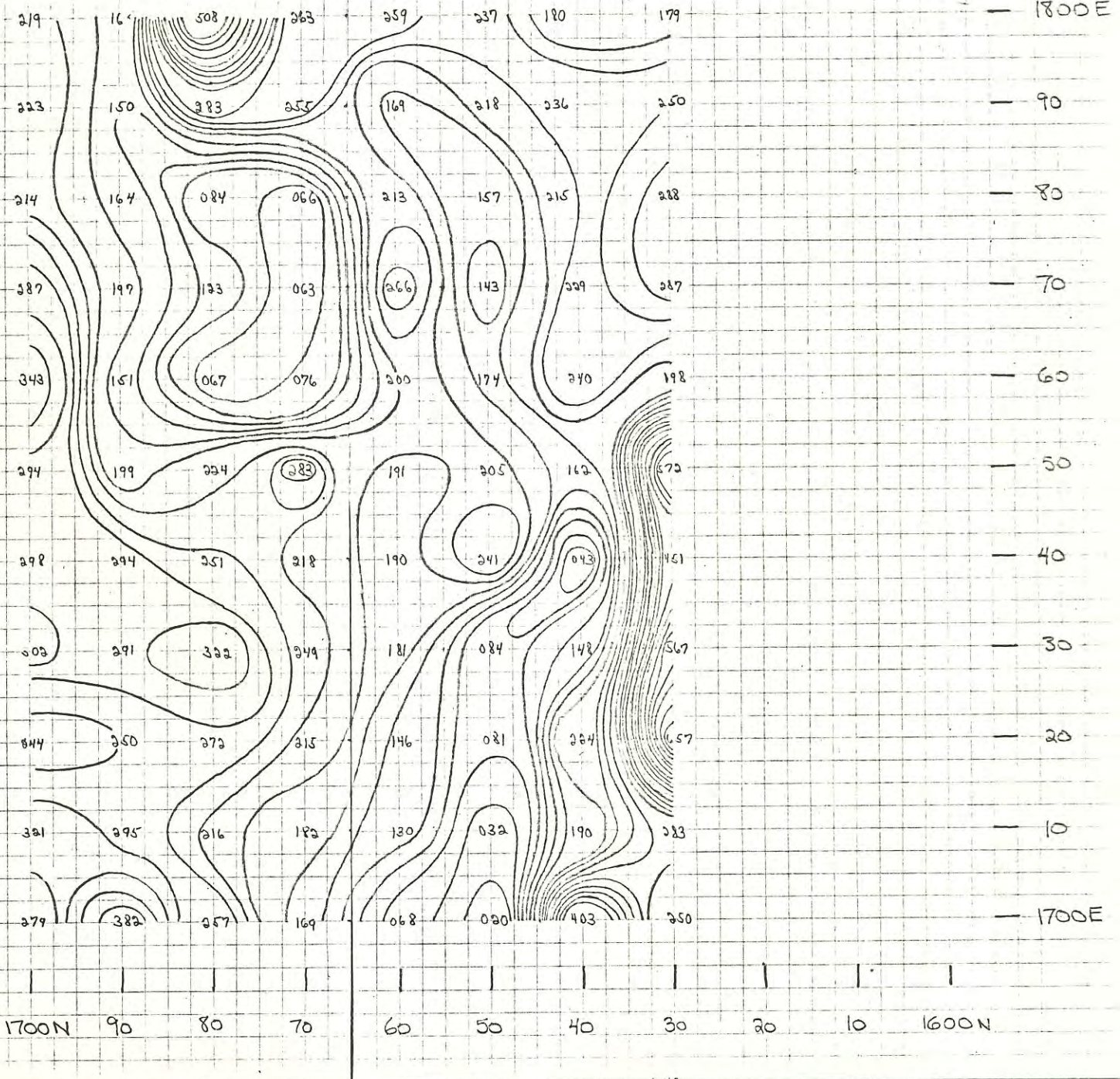
sensor height = 2½ ft

average field = 58,200 γ

inclination = 75°N

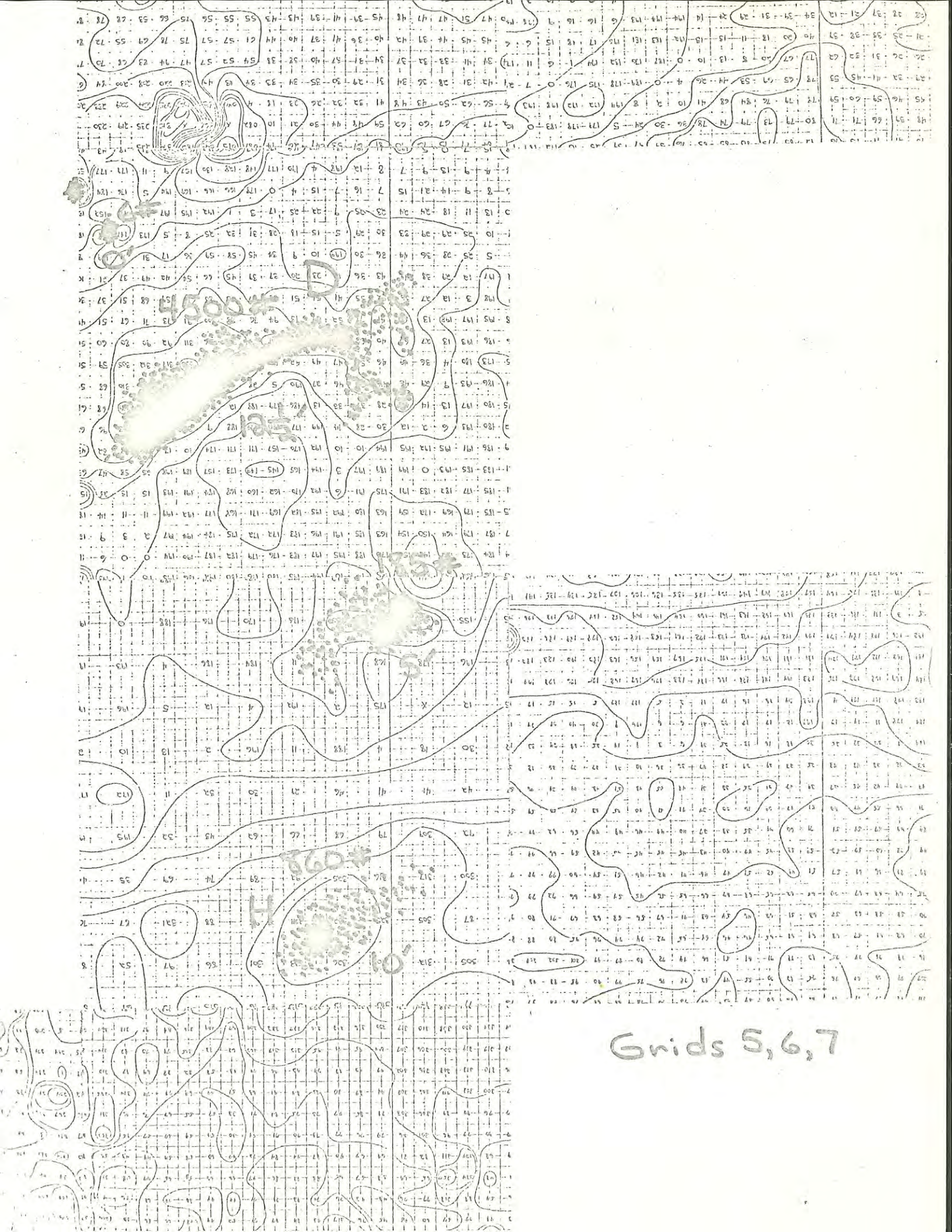
declination = 16°W

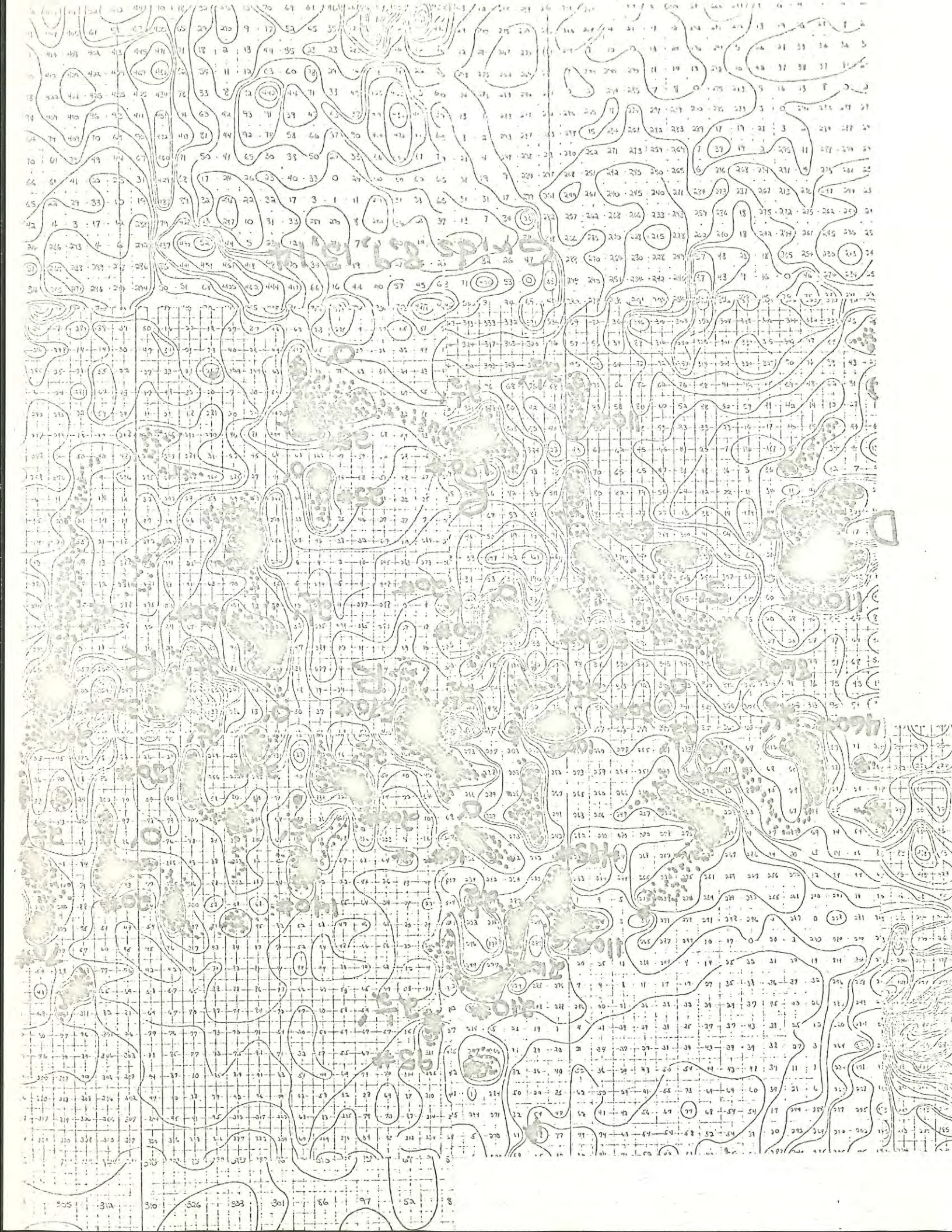




Magnetic Interpretation Maps

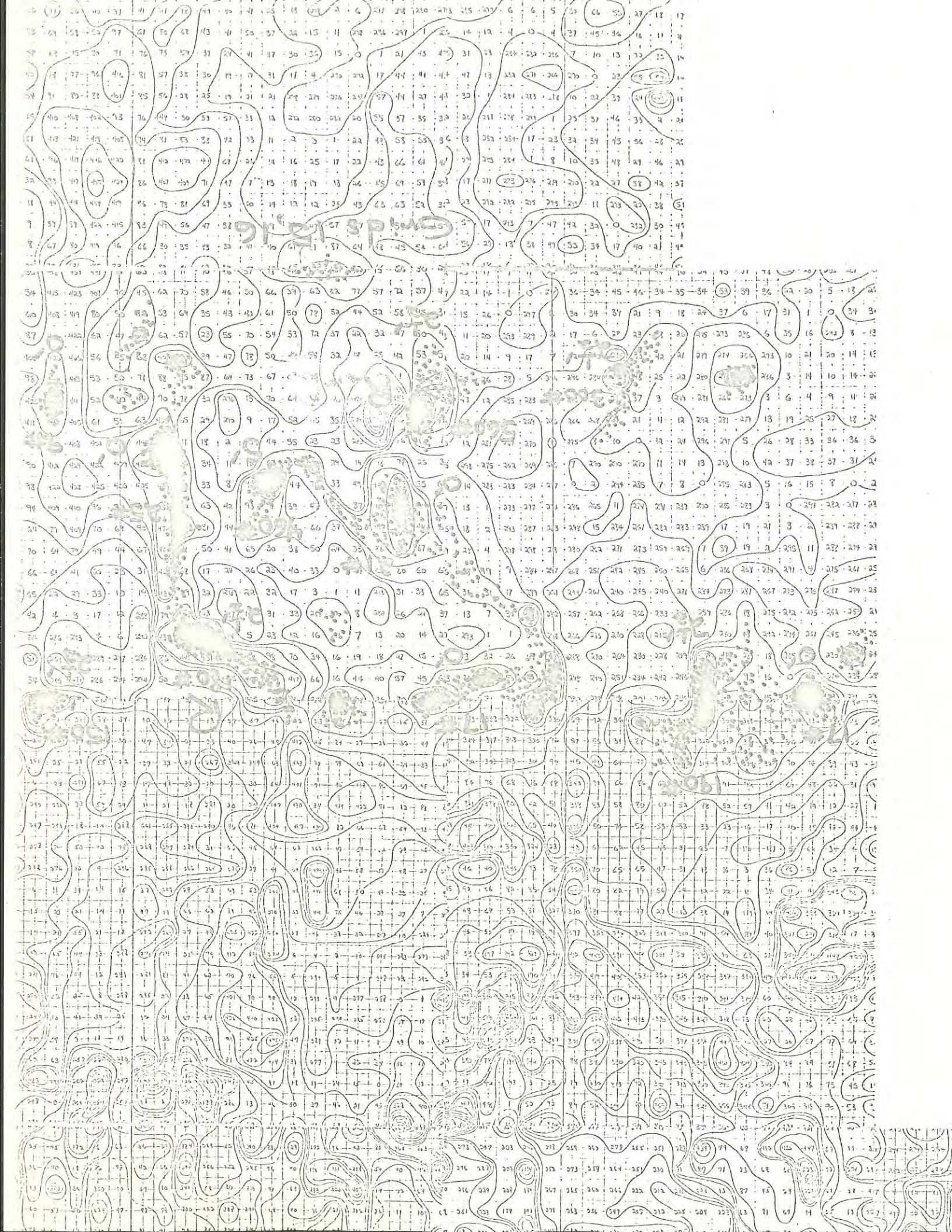
Grids 1,2,3,4

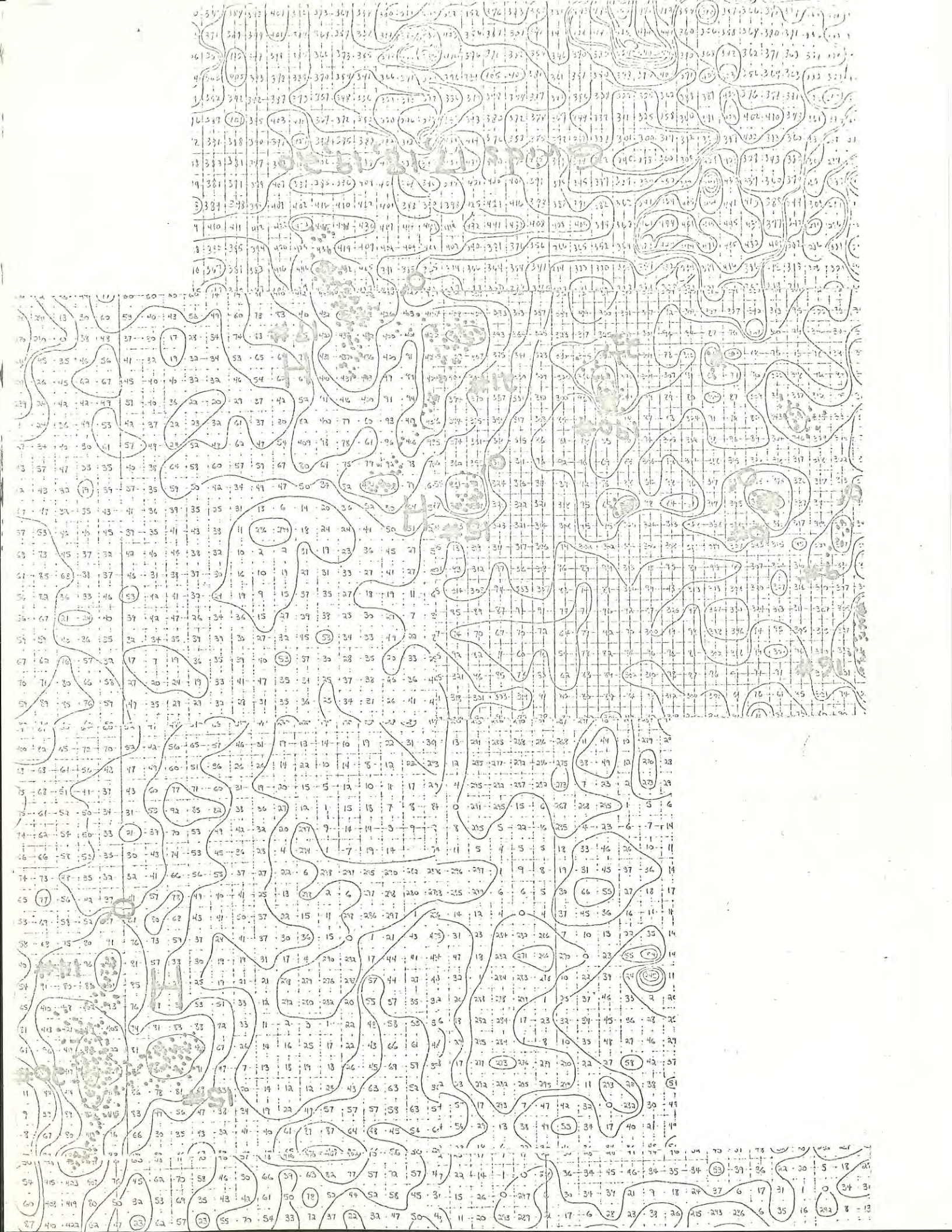

Grids 5,6,7



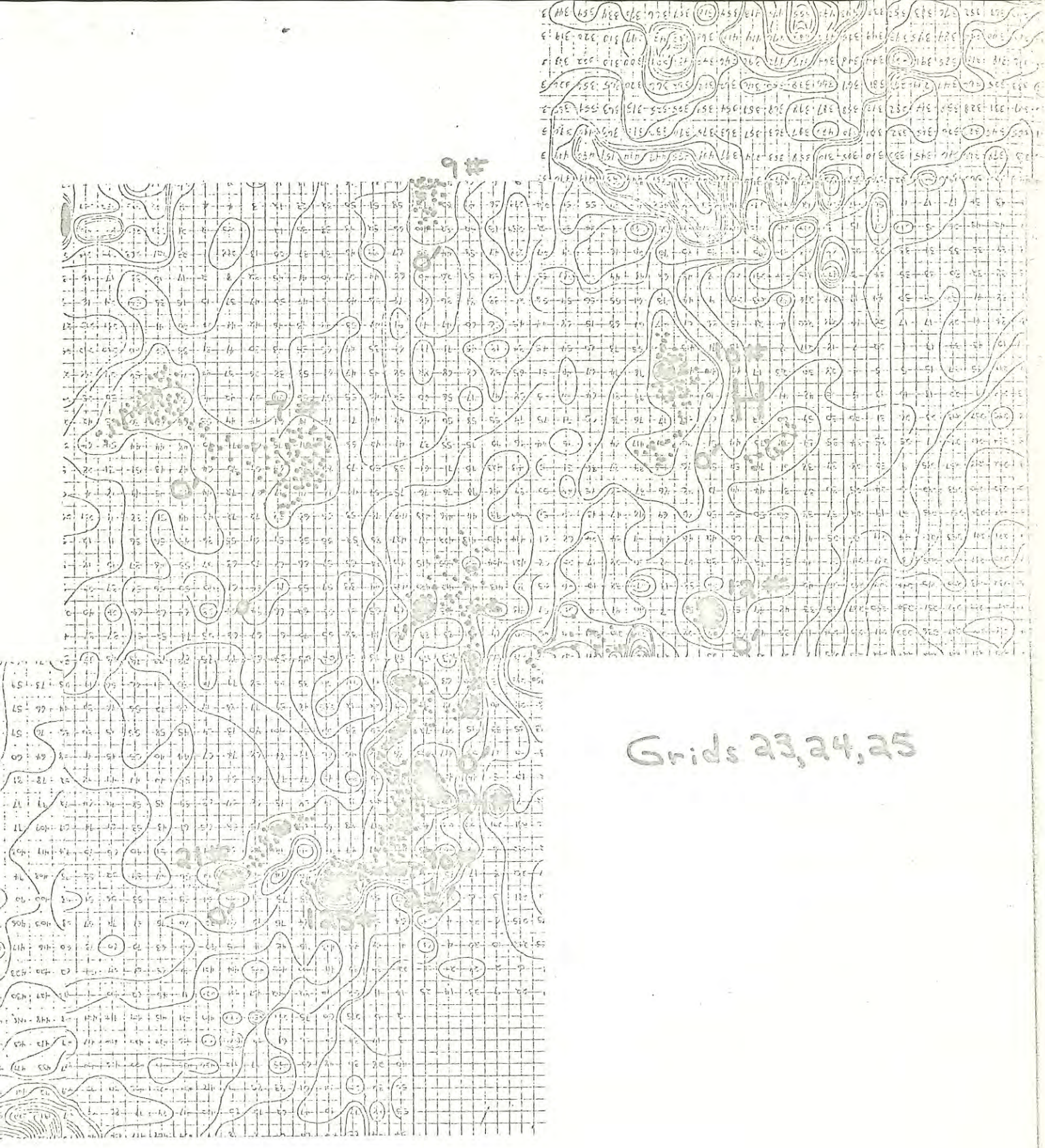

300ft
300ft
300ft
300ft
300ft
S 2½
Grid 10

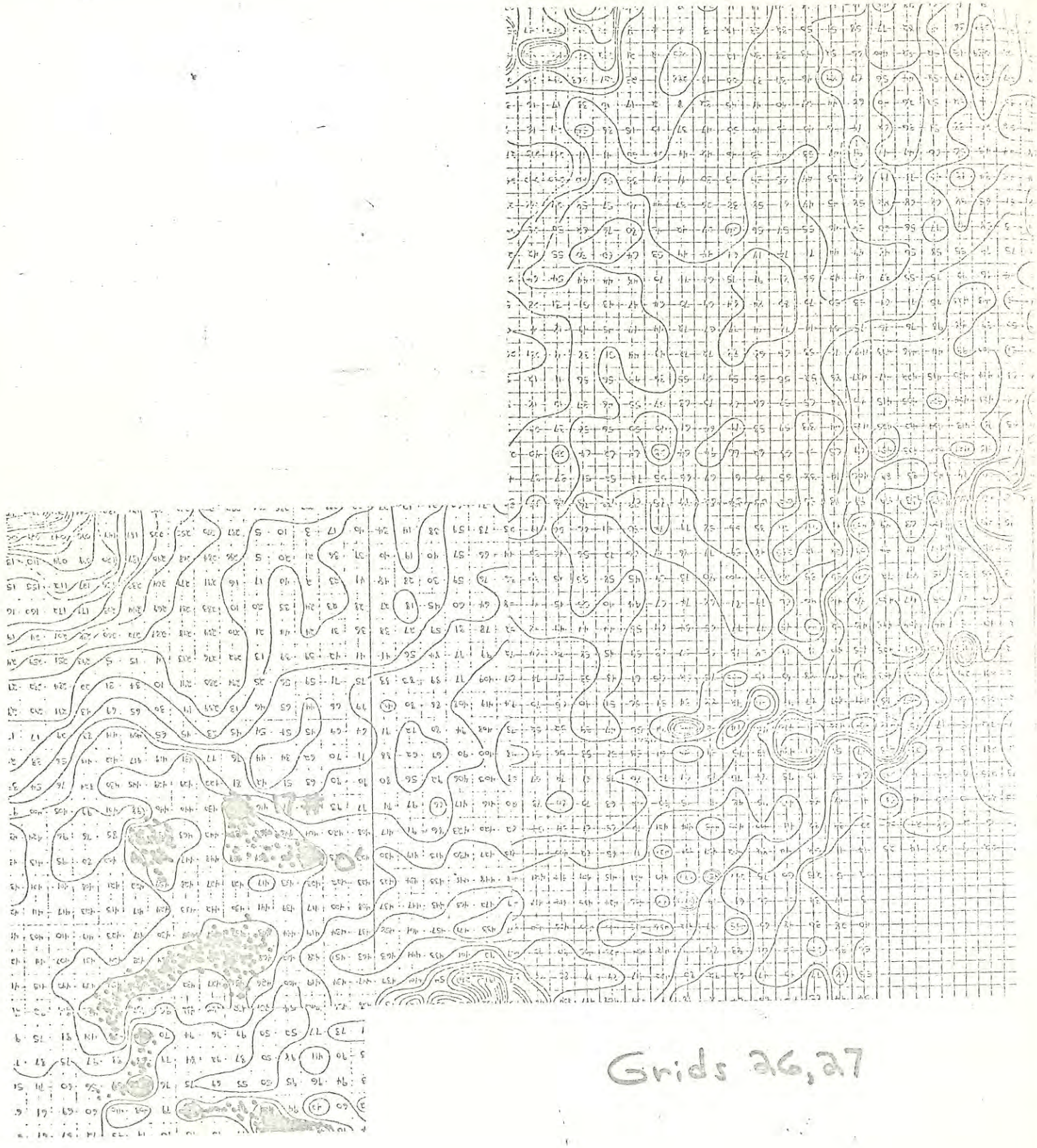
Grids 11, 12





Grids 21, 22


Grids 23,24,25

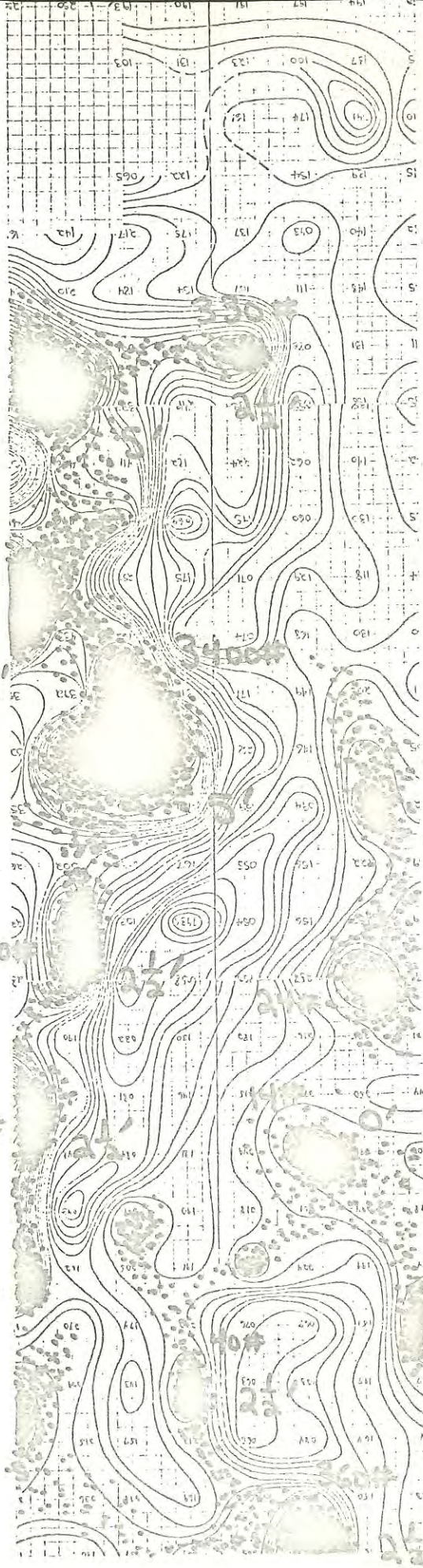


Grids 26,27

Grids 28,29,30

Grids 31,32

Grid 33


3400#
1050#
2½'
3400#
20#
Grids 34,35
0'
440#
0'
580#
470#
17#

Slide 5:

An overview of the site



Slide 1:

Summary magnetic map



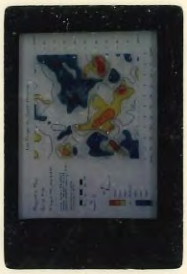
Slide 6:

An earlier excavation



Slide 2:

Grid 14



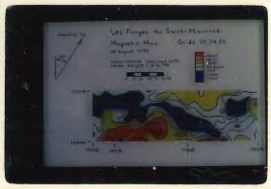
Slide 7:

The same excavation as Photo 8



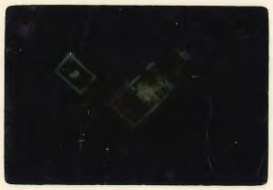
Slide 3:

Grids 33, 34, 35



Slide 8:

The previously-excavated foreman's house



Slide 9:

The lower forge



Slide 4:

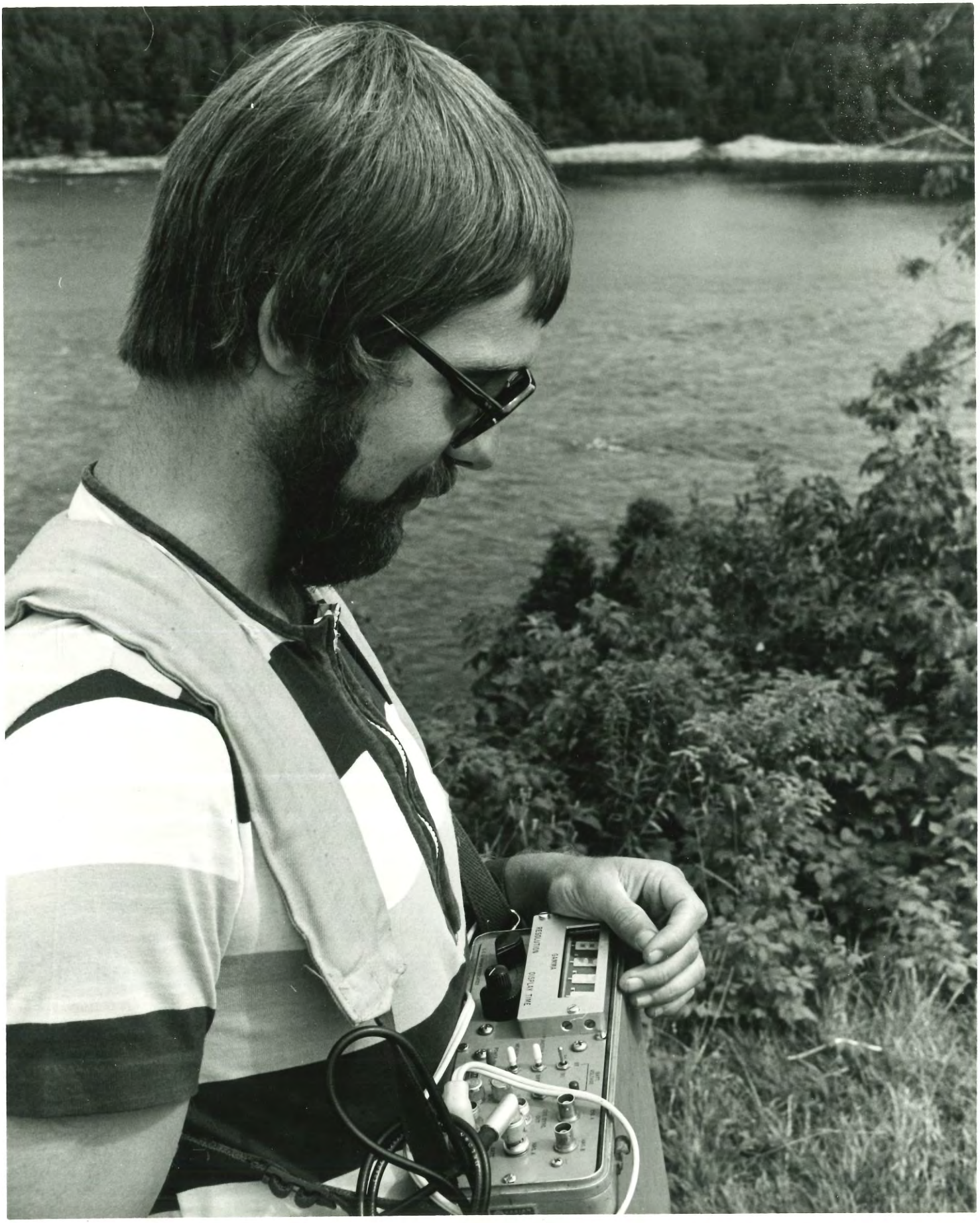
The magnetometer in Grid 14










RESOLUTION
SWEEP
DISPLAY TIME



