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HON. WILSON D. PARASIUK
Minister

MALCOLM G. ANDERSON
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MINERAL RESOURCES DIVISION
IAN HAUGH
Assistant Deputy Minister

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INTERPRETATION OF AN AEROMAGNETIC SURVEY IN THE LYNN LAKE AREA, MANITOBA

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The study was carried out under contract by the Centre for Precambrian Studies, University of Manitoba.

by
D.H. Hall, T. Millar and K.H. Mok

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CHAPTER I — INTRODUCTION

This report relates to an aeromagnetic interpretation project, covering an area of 5 350 km² in NTS area 64C in the vicinity of Lynn Lake. Figure 1.1 indicates the outlines of the project area. The aeromagnetic surveys were implemented by Questor Surveys Limited in March, 1976 (Phase 1); and November and December, 1976 and March, 1977 (Phase 2). The interpretation, along with some associated ground surveys, was done by the Centre for Precambrian Studies, University of Manitoba, in the period July, 1977 to March, 1979.

BACKGROUND

The Project was a part of the Canada-Manitoba Subsidiary Agreement on Mineral Exploration and Development, under which costs were equally shared by the Governments of Manitoba and Canada. The overall objective of the Sub-Agreement was the improvement of the socio-economic conditions in Manitoba through development of the mineral industry. The general direction and supervision of projects under the Sub-Agreement was entrusted to a Management Committee, made up of a representative of the Department of Regional Economic Expansion of Canada, a representative of the Department of Energy, Mines and Resources of Canada, and two representatives of the Province of Manitoba.

Soon after the commencement of the Sub-Agreement it was decided that a high-quality regional airborne geophysical survey should be implemented in the Lynn Lake area, an area which historically had been a major producer of base metals, but where in the mid-seventies some of the ore bodies were nearing exhaustion. It was envisaged that the results of this regional survey would be released to the general public at the earliest possible date, so that the private sector would then carry on with the site-specific aspects of the exploration sequence.

In the latter part of 1975, the Province's Department of Mines, Resources and Environmental Management carefully reviewed the technical specifications of about half a dozen airborne geophysical systems which were commercially available on contract at that time. Several contractors accepted the Province's invitation to test-survey a small specified area, with a view to establishing the relative merits of the competing systems. On the basis of these test results, it was decided that for the type of survey desired in the Lynn Lake area, the most suitable was the electromagnetic/magnetic INPUT system of Questor Surveys Limited of Toronto.

Subsequently, this firm implemented the first phase of the survey (see Fig. 1.1) over an area of about 1 180 km² in March, 1976, the results of which were released simultaneously at several places in Manitoba on June 22, 1976. The balance of the area, phase 2, was surveyed in November and December, 1976 and March, 1977, and the results were released on June 8, 1977. It has been estimated that by September 1, 1977, as a result of these releases, 103 675 acres were acquired by exploration companies for detailed ground follow-up surveys and diamond drilling. This represented an acreage increase of about 150 percent over mineral dispositions in good standing in the area at the time of the first release.

It should be realized that the exploration companies largely staked on the basis of only the electromagnetic data resulting from the airborne survey. The complementary aeromagnetic data were generally not used, because by their very nature they are not amenable to rapid interpretation. However, they do contain a wealth of information which can be extracted by relatively lengthy interpretation procedures. For example, in the Lynn Lake area, gabbro plugs, granitic plutons and units within the volcanic sequences are features which would be expected to have an aeromagnetic expression, and further, all of them can be highly significant from the exploration point of view. Moreover, geological formations in overburden covered areas can often be precisely delineated by aeromagnetic interpretation. With this in view, the Magnetics Interpretation Group at the University of Manitoba, which is also affiliated with the University's Centre for Precambrian Studies, was approached by the Province to undertake a project for interpreting the aeromagnetic data derived from the Questor surveys in the Lynn Lake area. The results of their interpretation are presented in this report.

MAGNETICS INTERPRETATION GROUP

The Magnetics Interpretation Group at the University of Manitoba has, during its research program over the past 15 years, developed techniques and assembled computer programs directed especially towards certain aspects of aeromagnetic map interpretation. In addition methods for using magnetic properties measured at the surface to supply "ground truth" for the magnetic anomalies (whenever magnetic rock units outcrop or can be sampled by drilling) have been developed using the magnetic laboratory at the University. Among the applications of the computer techniques are the transformation of the map data so as to isolate and enhance features of interest, and the quantitative modelling of anomalies.

The interest of this group in the present interpretation lies in the application of these techniques to an exploration-oriented aeromagnetic survey. There are many aspects of the group's work which can be applied to exploration-oriented surveys. The emphasis and direction in the present work involves a strong research component, and overlap with services normally supplied by geophysical contractors is minimized.

An attempt was made to satisfy a number of aims, which were as follows: (1) to provide an edited digital data set which could be made available on open file; (2) to provide computer programs for display and manipulation of the data; (3) to interpret the data quantitatively; (4) to provide determinations of magnetic susceptibilities and remanent magnetization of rock units in the area covered by the survey; and (5) to provide a qualitative description of the aeromagnetic field in the survey area, especially with a view to correlating it with known geological features, and extending this information into overburden covered areas.

REGIONAL GEOLOGY AND EXPLORATION HISTORY OF THE LYNN LAKE AREA

The regional and economic geology of the Lynn Lake area, and its exploration history have been described by Allan (1950), Milligan (1960), Davies et al. (1962), Zwanzig (1974) and Gale et al. (1977).

The geophysical surveys relating to this report were implemented over a part of the Lynn Lake — Rusty Lake greenstone belt, which is an arcuate approximately east-west trending belt 150 km in length and 10 to 50 km in width. Figure 1.2 illustrates the regional geology. The oldest rocks belong to the Wasekwan Group, which consists of metavolcanic rocks, associated volcaniclastic material and minor sediment. Basic to intermediate volcanics and derived detritus constitute the dominant rock types. Acidic flows and volcaniclastics are abundant locally. Stable-trace-element geochemical data obtained from Wasekwan Group basalt and andesite in the Rusty Lake area (Steeves and Lamb, 1974) indicate that in this area these rocks have the characteristics of modern-day island arc tholeiitic magmas.

The Wasekwan Group is stratigraphically overlain by the Sickle Group metasandstones and metaconglomerates. Radiometric dates from the greenstone belt (Clark, 1980) indicate an Aphebian age of deposition.

There are about fifty known massive sulphide occurrences in

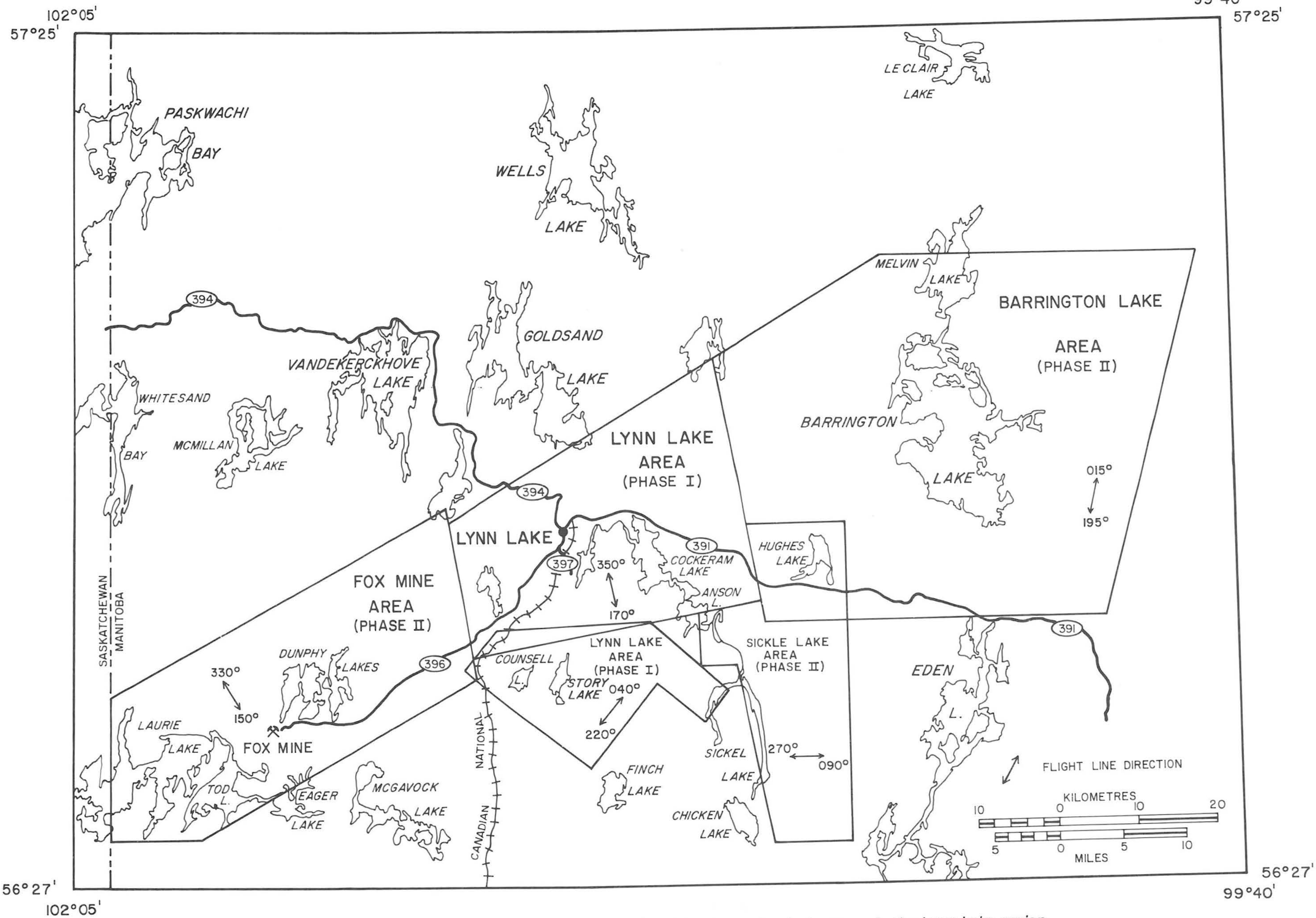


FIGURE 1.1 Areas covered by Phases I and II airborne INPUT geophysical surveys in the Lynn Lake region.

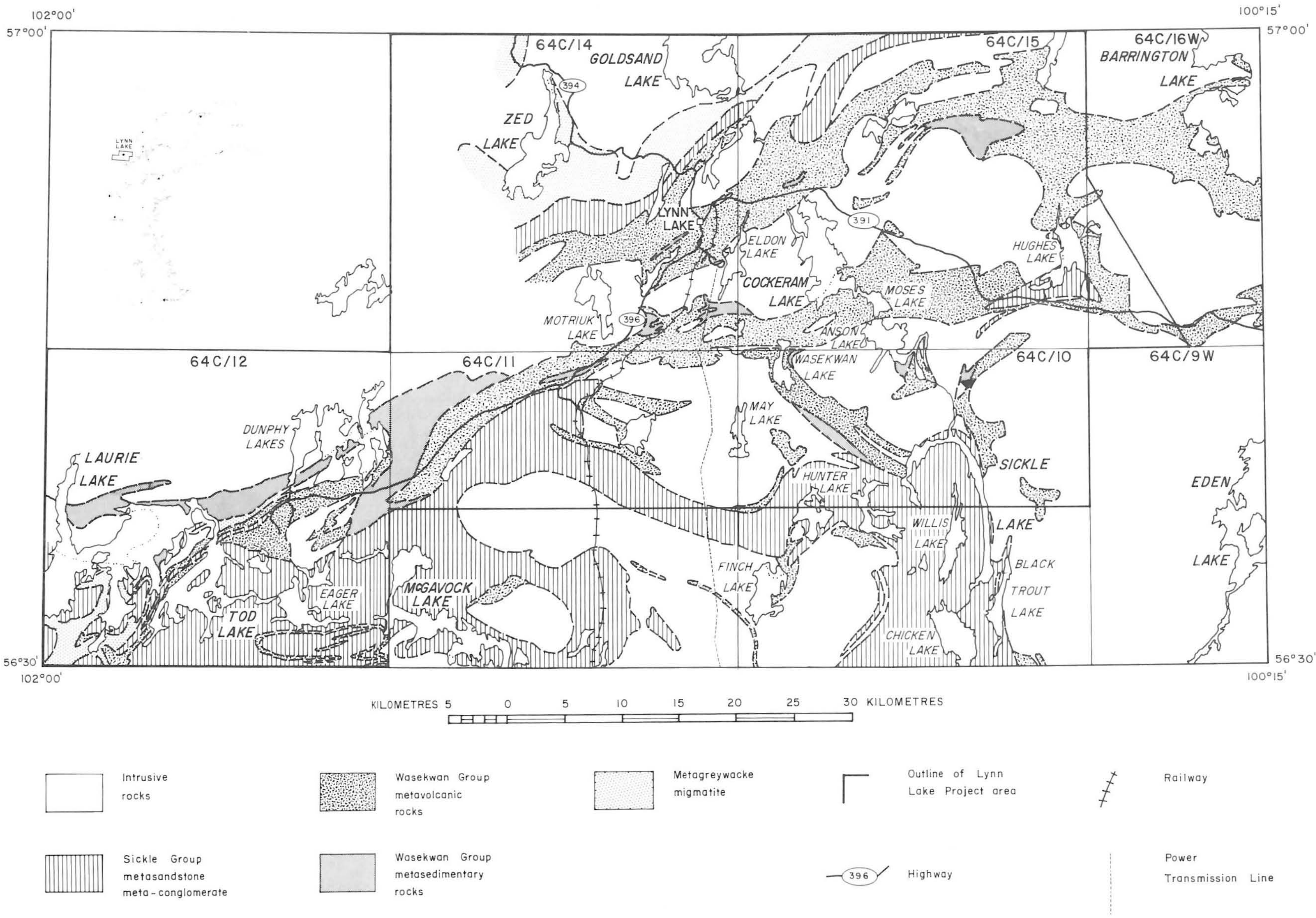


FIGURE 1.2 Regional geology of Lynn Lake area (from Gilbert, et al. 1980).

the Wasekwan Group. Nickel-copper mineralization is associated with gabbroNorite bodies intruded into the Wasekwan Group. Some prospecting took place in the nineteen-thirties; prospecting activity increased after the nickel-copper discoveries by Sherritt Gordon Mines in 1945. Ground magnetic, and to a lesser extent, ground electromagnetic surveys played a major role in the early development of the area. By 1950, eleven ore bodies with an aggregate of fourteen million tons of ore had been identified. By 1953 a mill was in operation and a rail link to Sherridon, about 230 km to the south, had been completed.

In the period 1953 to 1978, the production from the mines in the area had been 369 085 000 lbs. nickel, 805 357 000 lbs. copper and 601 076 000 lbs. zinc (Skinner, personal communication).

QUESTOR SURVEYS METHODS AND PROCEDURES

The INPUT electromagnetic/magnetic surveys were flown in two types of aircraft, a Britten-Norman Trislander for Phase 1, and a Shorts Skyvan for Phase 2. The nominal survey altitude was 130 m with the electromagnetic receiving coil and magnetic sensor at about 50 m above the surface. Flight line spacing was 200 m. The field crew consisted of a pilot, navigator, equipment operator, aircraft engineer and a geophysicist.

Base maps for the survey were uncontrolled mosaics constructed from 1" = ½ mile National Air Photo Library photographs. The mosaics were of scale 1:20 000 on stable transparent film. Flight path recovery was visual, involving comparison of the mosaic with prints from a 35 mm aerial camera. Fiducial points were marked at intervals of approximately 1.2 km on the flight lines.

The aircraft were equipped with a Mark VI INPUT airborne electromagnetic system, a Geometrics G-803 proton precession magnetometer, a 35 mm continuous strip camera, both analogue (Honeywell 2206) and digital (Geometrics G-704) recorders, a radar altimeter and a power-line monitor. The magnetometer measured the total magnetic field, and had a sensitivity of 1 nT (gamma) and a range of 20 000 to 100 000 nT.

Because of the high-intensity electromagnetic field generated by the electromagnetic transmitter, the magnetometer was operated on a time shared basis. Thus the magnetometer head was energized for 1.15 seconds, corresponding to the 'on' period of the EM transmitter, and the precession frequency was recorded and a read-out obtained during the following 0.15 seconds during which the EM transmitter was off. Thus a magnetic reading was taken every 1.3 seconds.

Questor Surveys presented the magnetic data as contours plotted on mosaics of scale 1:20 000, which were also photographically reduced to produce another set at scale 1:50 000. The flight records including a computer tape with the digital data were also available.

ACKNOWLEDGEMENTS

The authors acknowledge the assistance of a number of people at various stages of the project.

Mr. O.G. Stephenson supervised the initial stages of interpretation, the fieldwork, and reduction of data from that survey during the period July 1, 1977 to September, 1978.

Ms. C. Iverson acted as geophysical interpreter and party chief from July 1, 1977 to July 30, 1978.

Messrs. Kam-Hong Mok, Anthony Aming, and Jim Stacey made up the field crew, which operated during June, 1978.

Mr. R. Hines, Mr. R. Gordon, and Mr. A. Ghosh assisted at various stages of the project. Mr. M. Jackson assisted with geological aspects of the interpretation. Mrs. M. Gray typed the manuscript.

The staff of the Manitoba Mineral Resources Division cooperated in the loan of equipment and gave various forms of assistance prior to and during the fieldwork. The bulk of the Introduction has been provided by Dr. N.M. Soonawala. Much valuable assistance was given by the staff of Sherritt Gordon Mines Ltd. at Lynn Lake.

The magnetic interpretation group at the Centre for Precambrian Studies has consisted at various periods through the last 15 years of: Dr. A. Bukhari, Mr. D. Richards, Mr. C. Hasselfield, Mr. O. Stephenson, Ms. C. Iverson, Mr. T. Millar, Dr. R.L. Coles, Mr. Alan Tang (the last two as graduate students), all supervised by Dr. D.H. Hall.

CHAPTER II — DIGITAL DATA FILE

THE ORIGINAL DATA AND THE EDITED DATA SET

The original data supplied by Questor Surveys included tapes of digital data along flight lines. For an outside user the original tapes would be difficult to manipulate and it is recommended that anyone requiring digital data use edited tape LLM 001, which has been prepared by, and can be obtained from the Centre for Precambrian Studies. This tape contains an interpolated grid of data, consisting of magnetic values at a grid spacing of 200 m. Work with the edited data indicates that tape LLM 001 contains a digital data set which is usable for most interpretational purposes. The data may be retrieved for any specified profile or grid using the programs PROFILE (Appendix 1) and PRTPLOT (Appendix 2). Printouts of profiles along each row of data for the entire data set, plotted by PRTPLOT, are stored at the Centre for Precambrian Studies.

Modern techniques of interpretation of geophysical data rely heavily on data displays of types different from the conventional contour maps. These include 3-D displays, expanded and perspective views of selected anomalies, filtered maps, derivative and upward/downward continued maps, etc. Adequate digital data is essential for these techniques. Therefore, the development of a suitable file of digital data was considered an important part of this project.

PROCESSING OF DIGITAL DATA

The data obtained by Questor Surveys Limited in the Lynn Lake area is contained in a series of digital magnetic tapes in computer-compatible format. A series of computer programs was developed by the University for the treatment of these data so as to produce four data sets, one for each of the four blocks of the survey area, shown in Figure 1.1.

The purpose of these programs was to allow the reproduction of magnetic maps at any desired scale and in any format, and to facilitate computer modelling and quantitative analysis of individual anomalies.

The digital data supplied by Questor on magnetic tapes were of the following three types: a) data directly recorded from all the airborne systems and suitably multiplexed, b) aeromagnetic data which, because of the poor quality of their digital record, were hand digitized from the analogue records and then transferred to digital tapes and c) data that were strictly positional, i.e., a record of the X and Y coordinates and the corresponding fiducial numbers obtained by the process of flight path recovery.

The original set of magnetic tapes supplied by Questor were, for a number of reasons, not suitable for standard Fortran programs. To circumvent this, the following nine programs were employed to edit the data, the end results of which are recorded on Tape LLM 001 which is used as the input for all subsequent computer programs.

Program Mag 1, a special utility program written by Innovation Data Processing (FATAR), was used to 'clean up' as much as possible of the original data. The output of this program was a set of high density digital tapes containing usable data. About 99% of the original data were successfully retrieved by Mag 1.

Program Mag 2 demultiplexes the data, discarding the flight number, the six EM channels, the hydro monitor and the altimeter data. It was determined that the altitude correction could be safely ignored since the flight height was maintained quite close to the target height of 122 metres (46 metres for the magnetometer head).

Program Mag 3 resamples the magnetic values at each data point (approximate spacing of 160 metres).

Program Mag 4 combines the magnetic data at each data point with the corresponding horizontal position information. Output is in the form of magnetic profiles along flight lines.

Program Mag 5 interpolates the data along the flight lines to an equally spaced set of readings at an interval of 200 metres. This interval was chosen because it is the mean flight line spacing and is, therefore, the largest interval which will reproduce the data without aliasing or introducing spurious high frequency noise. The interpolation was performed using a 'natural' cubic spline algorithm, i.e. the first and second derivative values were not used in calculating the spline coefficients (Ahlbertg et al., 1967).

Program Mag 6 interpolates the data in a direction oblique to the flight lines (using the same cubic spline algorithm as in Mag 5), producing a map with equispaced points. The zones near the edges of the map for which no data exist, were padded with zeros to create a rectangular data set. The effects of this fictitious data and its treatment are discussed elsewhere.

Before being fed into Program Mag 4, the positional aspects of the digital data were treated by the following three programs:

Program XY1 reads the raw data from each map of a block on the input tape and translates and rotates the coordinating system and is able to reduce all maps to a common origin.

Program XY2 sorts all the values into increasing distances. This removes the effect of the S-pattern used in flying the survey.

Program XY3 combines all the maps in one block, eliminating tie lines and overlap. The output is then fed into MAG 4.

The final data set also includes the manually digitized magnetic data not available in the original data set. This data required a simple decimation and format change before it was inserted into the regular processing sequences as input to MAG 4.

DATA DISPLAYS

A display of the data for the four blocks is given in Figures 2.1, 2.2, 2.3 and 2.4 using program HIDE from the University of Manitoba's IMSL package.

From the edited digital data, the University of Manitoba Magnetic Interpretation Group's package of geophysical programs makes it possible to produce filtered, derivative, upward and downward continued maps contoured as desired for any area within the data set at any scale.

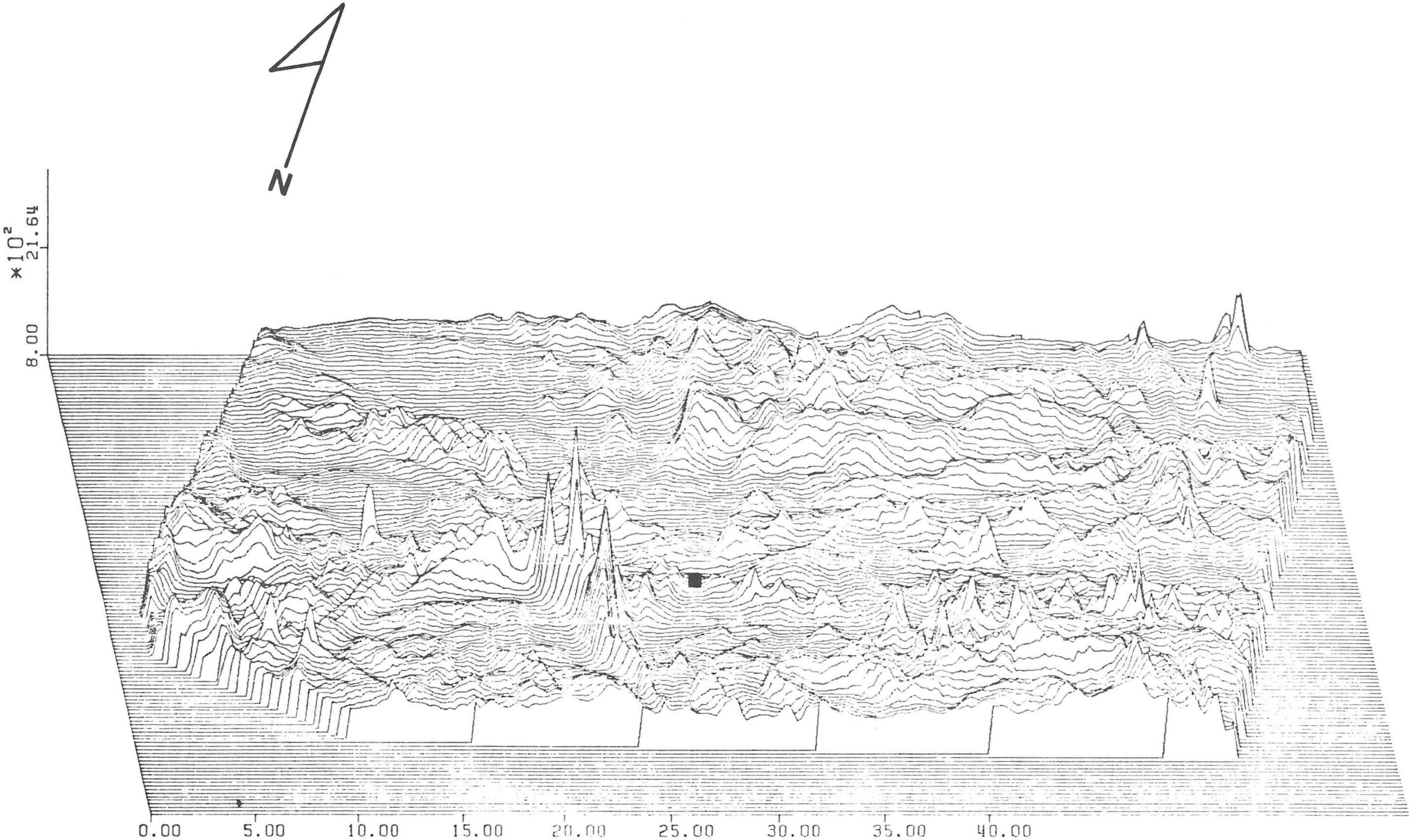


Figure 2.1 *Fox Lake Mine area. Units shown on the horizontal axis are kilometres. The vertical axis indicates nT above the 60 000 level. The origin of coordinates coincides with the southwest corner of map. Location of Fox Mine shown ■ (lat. 56°38'N, long. 101°36.4'W).*

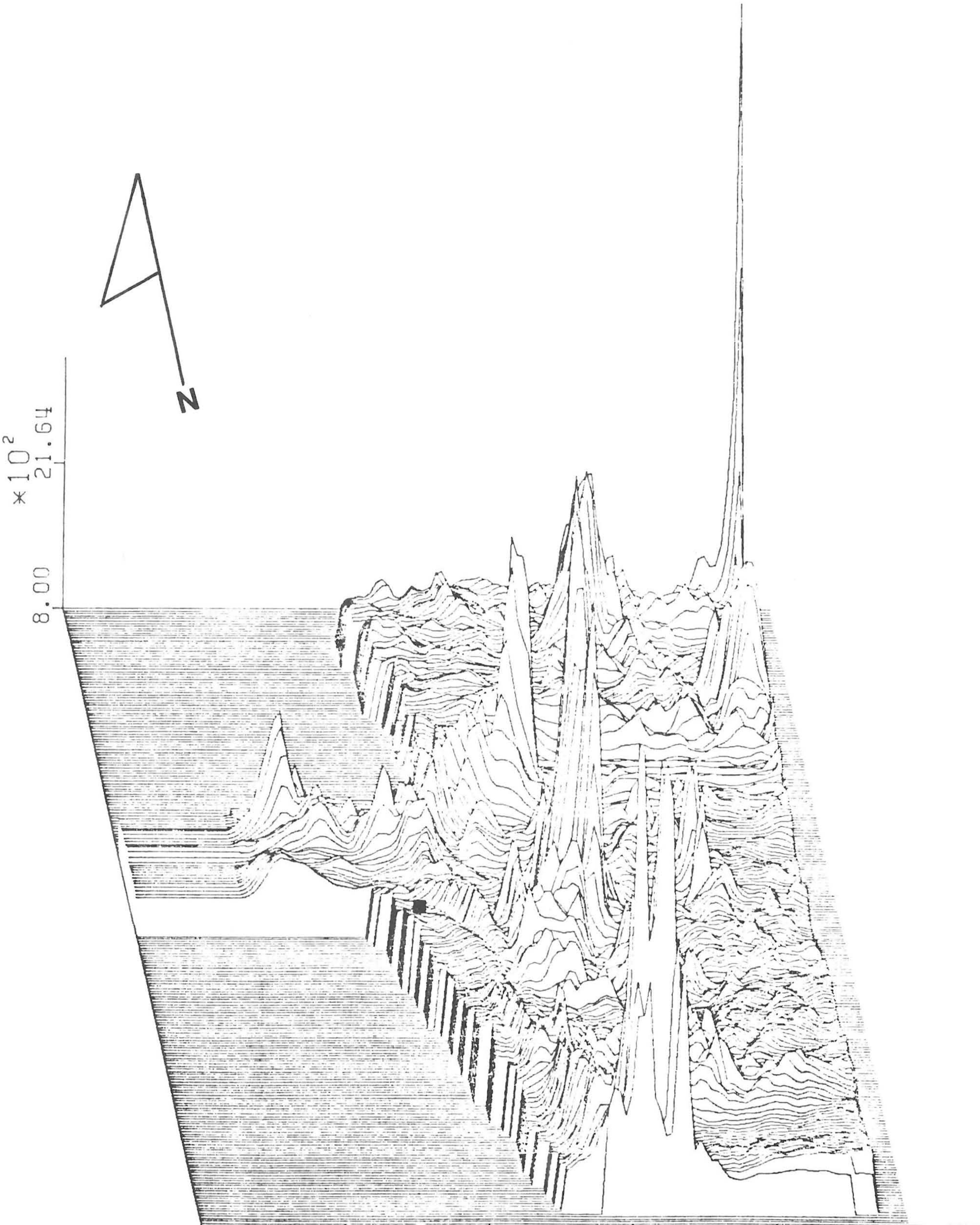


FIGURE 2.2 Sickle Lake area. Units shown on the horizontal axis are kilometres. The vertical axis indicates nT above the 60 000 level. The origin of coordinates coincides with the southwest corner of map. Location of northeast corner of Sickle Lake shown ■ (lat. 56°41'N, long. 100°41.3'W).

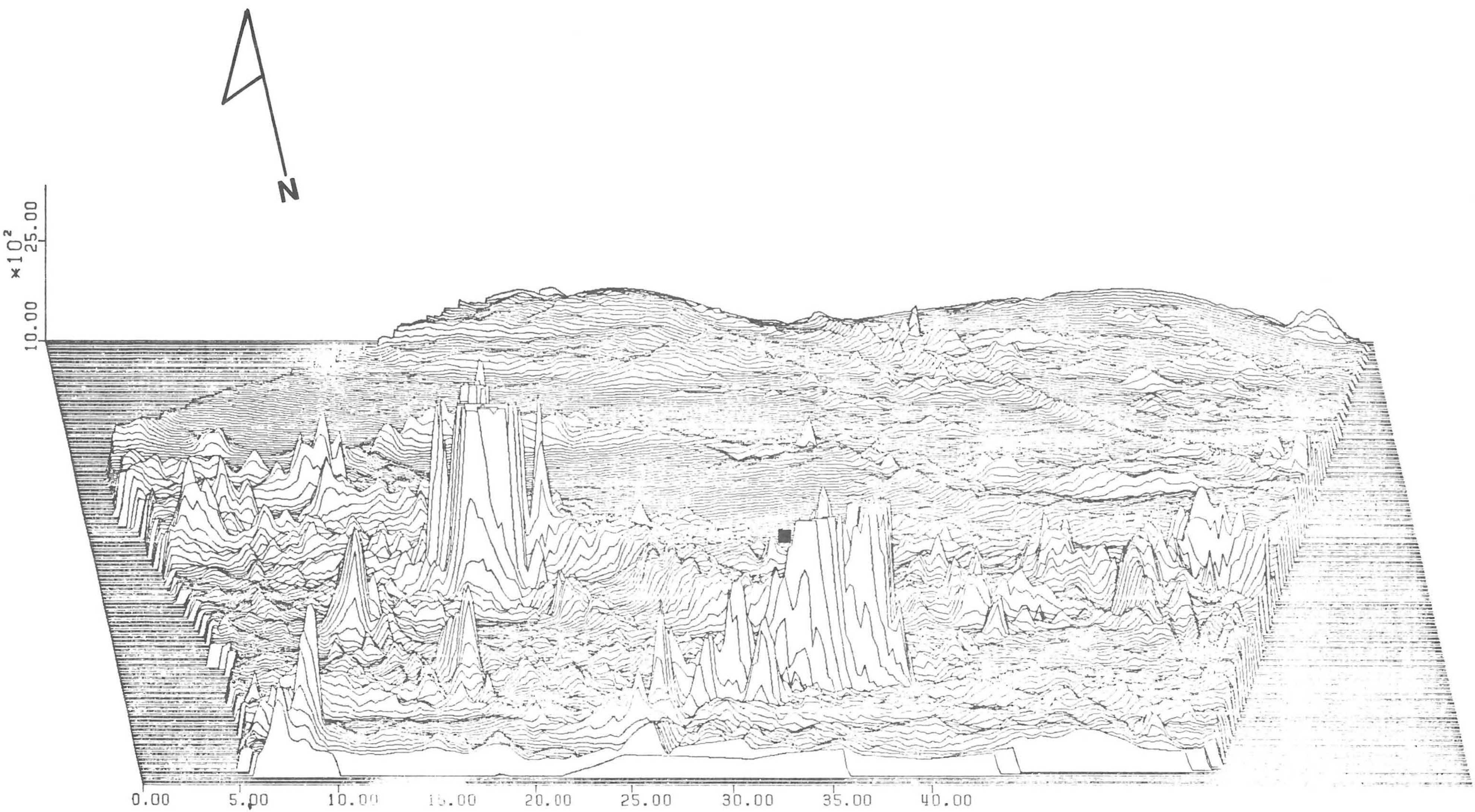


FIGURE 2.3 *Barrington Lake area. Units shown on the horizontal axis are kilometres. The vertical axis indicates nT above the 60 000 level. The origin of coordinates coincides with the southwest corner of map. Location of southeast corner of Barrington Lake shown ■ (lat. 56°52'N, long. 100°9.4'W).*

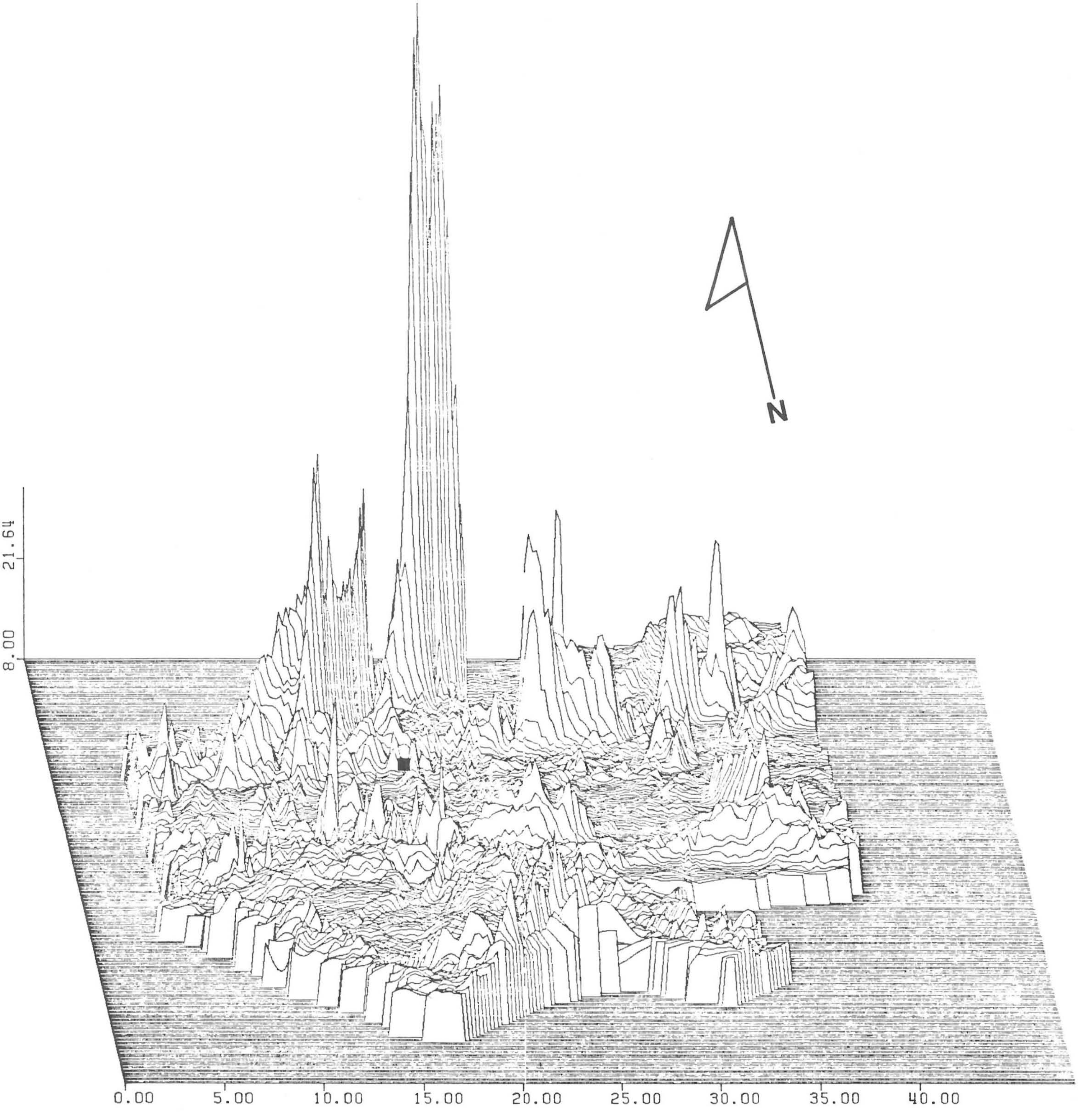


FIGURE 2.4 *Lynn Lake area. Units shown on the horizontal axis are kilometres. The vertical axis indicates nT above the 60 000 level. The origin of coordinates coincides with the southwest corner of map. Location of town of Lynn Lake shown ■ (lat. 56°51'N, long. 101°.03'W).*

CHAPTER III — GROUND SURVEYS OF MAGNETIC PROPERTIES

GENERAL CONSIDERATIONS

Information on the magnetic susceptibilities and remanent magnetization of rock units is an important part of the qualitative and quantitative interpretation of magnetic surveys. Both the magnetic susceptibility and the natural remanent magnetization (NRM) of rocks generate magnetic anomalies. The former is the easiest to determine, since measurements may be made with simple equipment on core or chip samples or on an outcrop surface or face, and no information on orientation of the samples is required. NRM measurements are more difficult, since oriented samples are needed, and measurement of the magnitude, direction and stability of NRM is required. By a careful choice of sites for oriented samples it is possible to make a useful combination of a large number of susceptibility determinations with a smaller number of NRM measurements. This procedure was adopted in the present study.

MEASUREMENT AND PRESENTATION OF SUSCEPTIBILITY VALUES

Susceptibility measurements were made in two ways:

(a) in situ with coil detectors placed on the outcrop. Two types of coil detector were used: a Kappameter Model KT3 (see Hall, 1977 for field technique), and a Sharpe Model SM-1 (see Hall, 1968 for technique);

(b) with a susceptibility bridge (Geophysical Specialities Co. Model MS 3) on core samples or chips.

Susceptibility values are plotted on a series of map sheets. The original plots at scale 1:50 000 are supplied as maps and Figures 3.1 to 3.7 are their page size reductions. These maps can easily be compared with the 1:50 000 scale geological sheets released by the Manitoba Department of Energy and Mines. Table 3.1 lists all the susceptibility values. In common with other cases where susceptibility values are mapped in Precambrian terranes, they show the following features:

(a) values are extremely variable but within particular rock units they group about a mean which is characteristic of that unit;

(b) there are no ranges of values which are characteristic of a particular rock type;

(c) rather, there are ranges characteristic of a particular rock unit, or group of rock units, i.e. of particular rock types in a given geological setting.

The following section illustrates these features of magnetic susceptibility throughout the area.

ANALYSIS OF SUSCEPTIBILITY MAPS

Table 3.2 lists rock units for which average susceptibility values have been determined. These results will be applied in the sections on qualitative and quantitative interpretation of anomalies. Generalizing broadly, the following four rock units were found to have the highest average susceptibilities:

(1) iron formation

(2) formations within Wasekwan and Sickle Group metasediments, particularly conglomerate units

(3) formations within Wasekwan Group metavolcanics (including iron formation)

(4) pre-Sickle gabbro

REMANENT MAGNETIZATION

The intensity of magnetization, I, of a rock unit is the primary parameter determining the strength of the associated magnetic field. This quantity is the vector sum of I_i the induced intensity of magnetization, which is parallel to the geomagnetic field (F), and I_r, remanent intensity of magnetization, which may lie in any direction depending on the magnetic characteristics and history of the rock unit. The induced intensity, I_i (equal to kF, where k is the magnetic susceptibility) is listed for some of the major rock types of the area in Tables 3.1 and 3.2. F is the magnitude of the ambient magnetic field.

MAGNITUDE AND DIRECTION OF I_r

These quantities can be determined for oriented samples, using a spinner magnetometer. In the present investigation, oriented core samples were taken in the field following procedures described by Coles (1973). Measurements were made with a Schonstedt Model SSM-1A spinner magnetometer. Values for the magnitudes and inclinations of I_r for the samples are given in Table 3.3. Several cores (A, B, C, etc.) were taken at each site (78200, 78201, 78202, etc.) and cut into slices (1, 2 etc.) resulting in samples of sizes suitable for the measuring system used. There are 57 such samples from nine different sites.

STABILITY OF REMANENT MAGNETIZATION

The stability of remanent magnetization varies considerably among various groups of rocks. A common method of measuring stability of remanent magnetization, involves measuring its response to demagnetization caused by an alternating magnetic field. The demagnetization process consists of applying an alternating field of a few hundred gauss to the specimen and then decreasing the field strength to zero over a period of a few minutes. Demagnetization is usually repeated, each step starting at a higher initial field than was used in the preceding step, in order to remove successively harder components of magnetization. In the present case, two successive demagnetizations were used (from the 200 and 400 gauss levels, respectively). The amount of magnetization remaining after each step is shown for some of the samples in Figures 3.8 to 3.11. These figures show various degrees of stability ranging from very unstable to very stable. The natural remanent magnetization (NRM) before demagnetization is normalized as 1.0 in these diagrams. The ratio of the amount of magnetization after demagnetization from 200 gauss, to the initial magnetization level, is defined as the stability index S_{200} (see Table 3.3). Remanent magnetization is considered very unstable for $S_{200} < 0.25$, and very stable for $S_{200} > 0.75$. Table 3.3 indicates that 10 cores out of 19 have average S_{200} indices in the "very unstable" range; there is only one core in the "very stable" range, and for the remainder, indices lie below 0.6. Thus, the overall tendency is towards unstable remanent magnetization.

SIGNIFICANCE OF UNSTABLE REMANENT MAGNETIZATION

Unstable remanent magnetization tends to be aligned nearly along the present-day direction of the earth's field, and moreover, the natural remanent magnetization can build up to significant amounts. Of the 16 cores whose inclinations are listed in Table 3.3, 12 have inclinations greater than 60°, thus indicating a tendency for the NRM to follow the geomagnetic field direction. When the NRM is parallel to the field direction, the vectors Ii and Ir are parallel, and the total intensity of magnetization is given by the scalar sum of the two. This presents a very simplified case for quantitative modelling of anomalies. These favourable circumstances, as anticipated by the results described above, should occur frequently in the study area. In such cases, the intensity of magnetization is given by a simple (scalar) sum:

$$I = kF + I_r \qquad \text{......(1)}$$

$$\text{Since} \quad I_r = QkF \qquad \text{......(2)}$$

where the Q-factor as defined in Table 3.4 is the ratio of the remanent to the induced intensity; k is the magnetic susceptibility; and

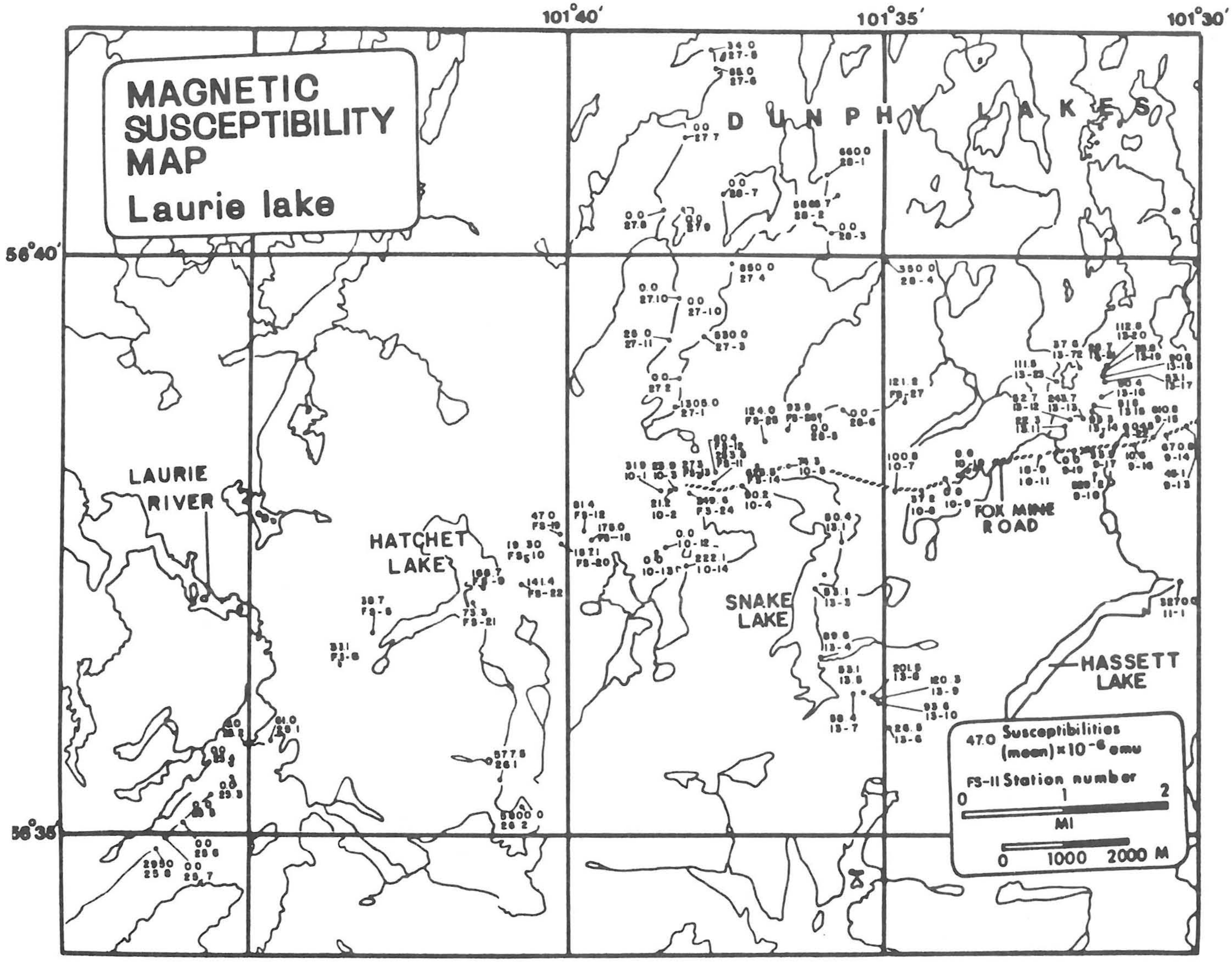


FIGURE 3.1 Magnetic Susceptibility map, Laurie Lake.

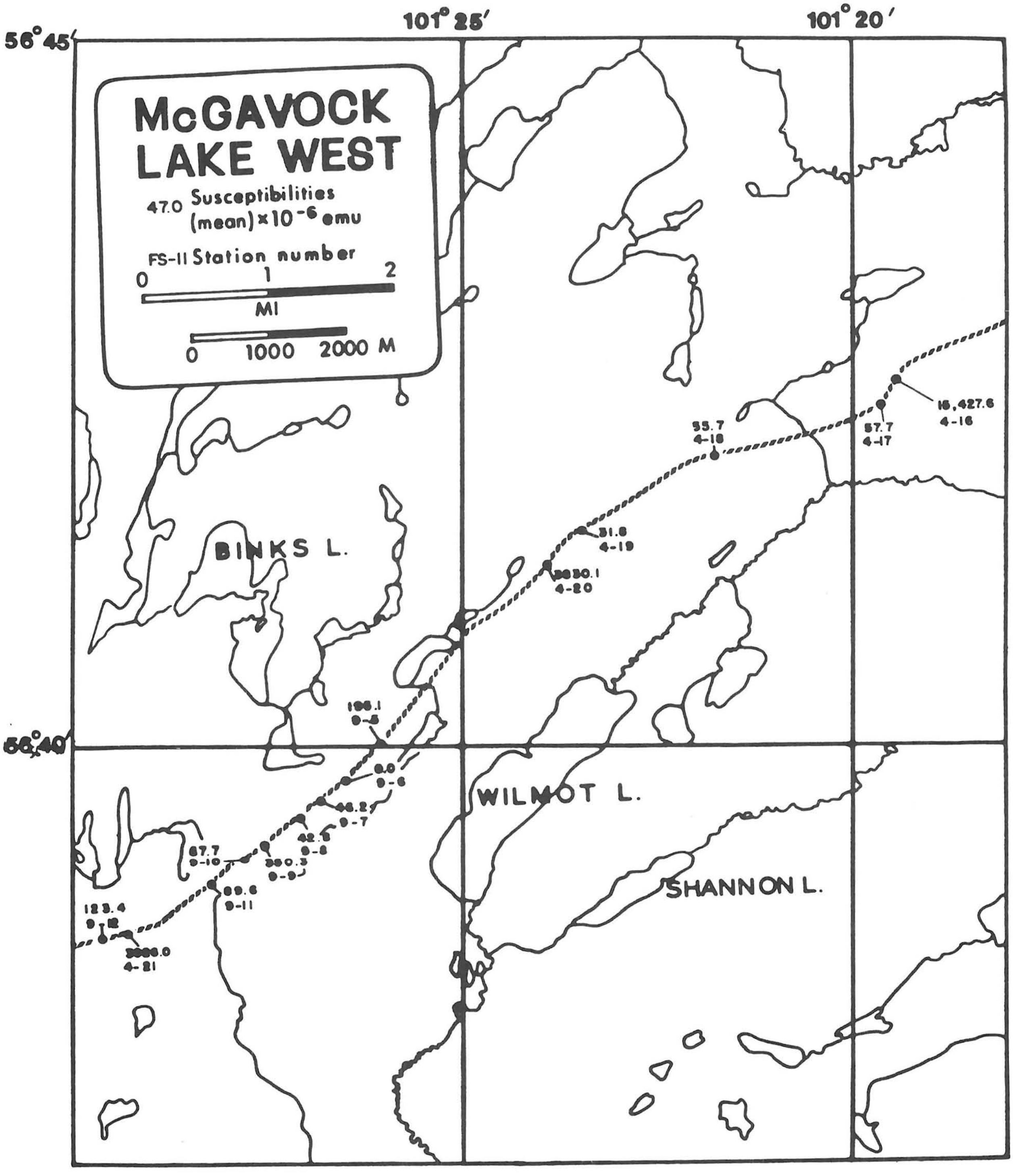


FIGURE 3.2 Magnetic Susceptibility map, McGavock Lake West.

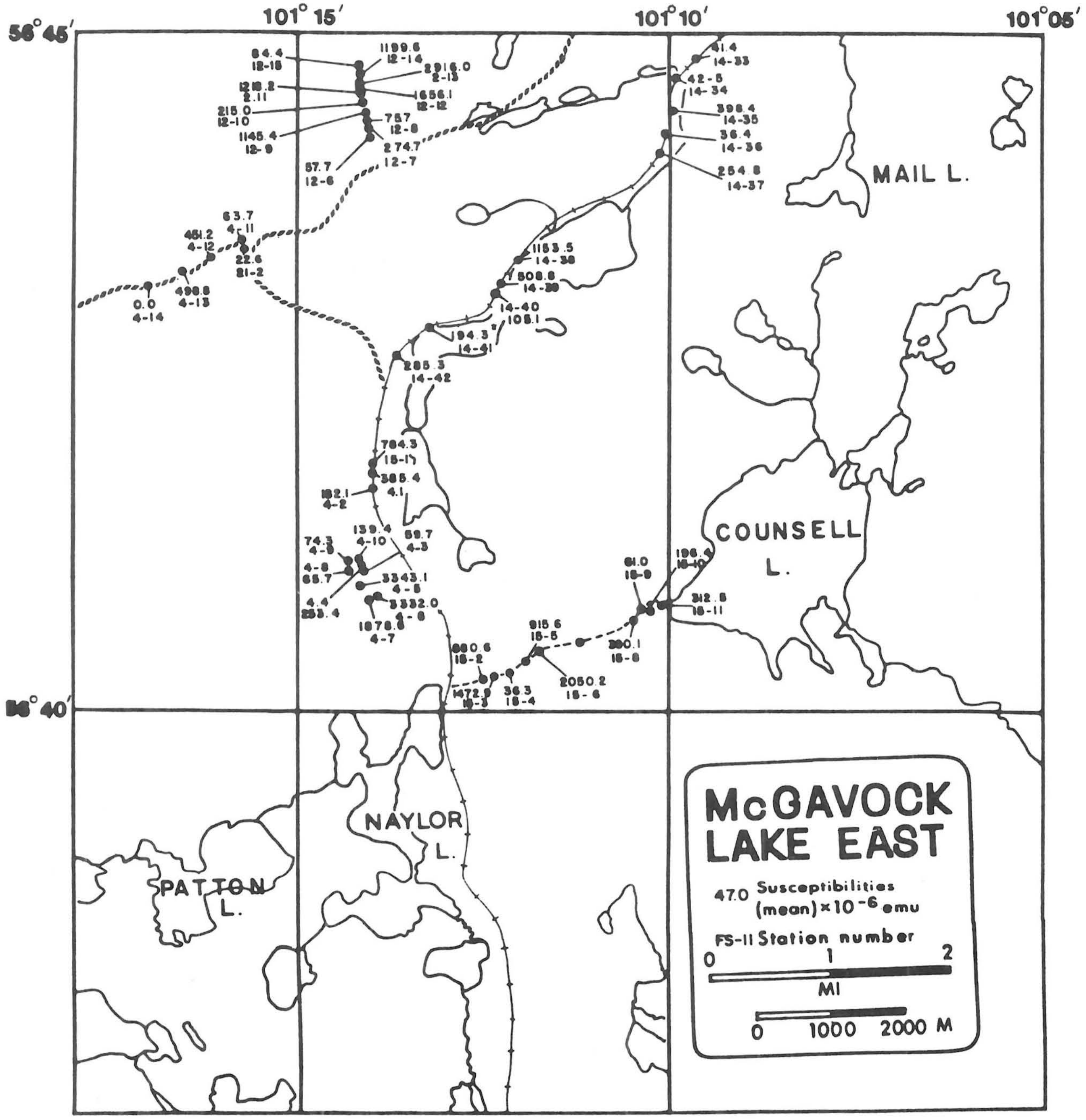


FIGURE 3.3 Magnetic Susceptibility map, McGavock Lake East.

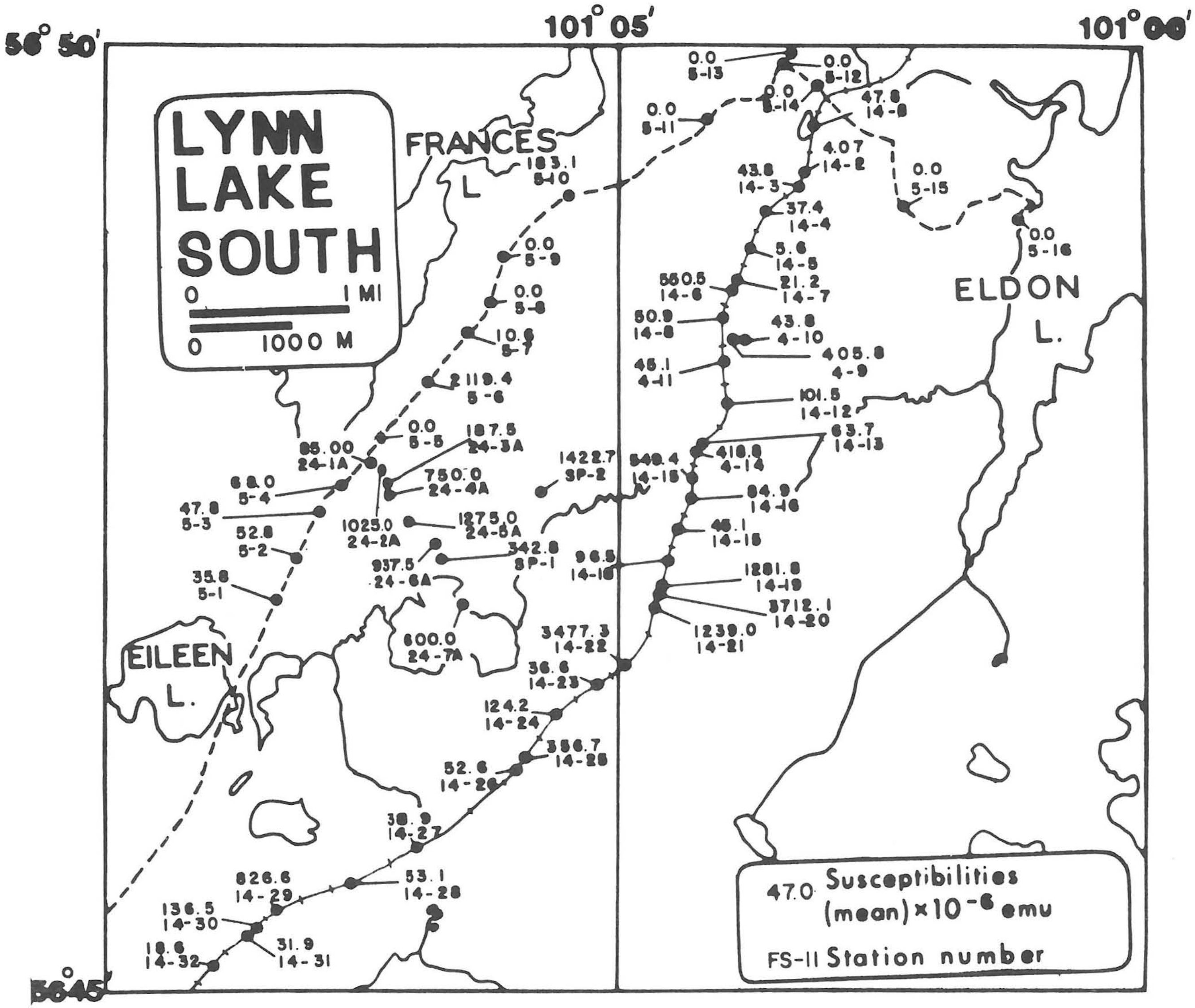


FIGURE 3.4 Magnetic Susceptibility map, Lynn Lake South.

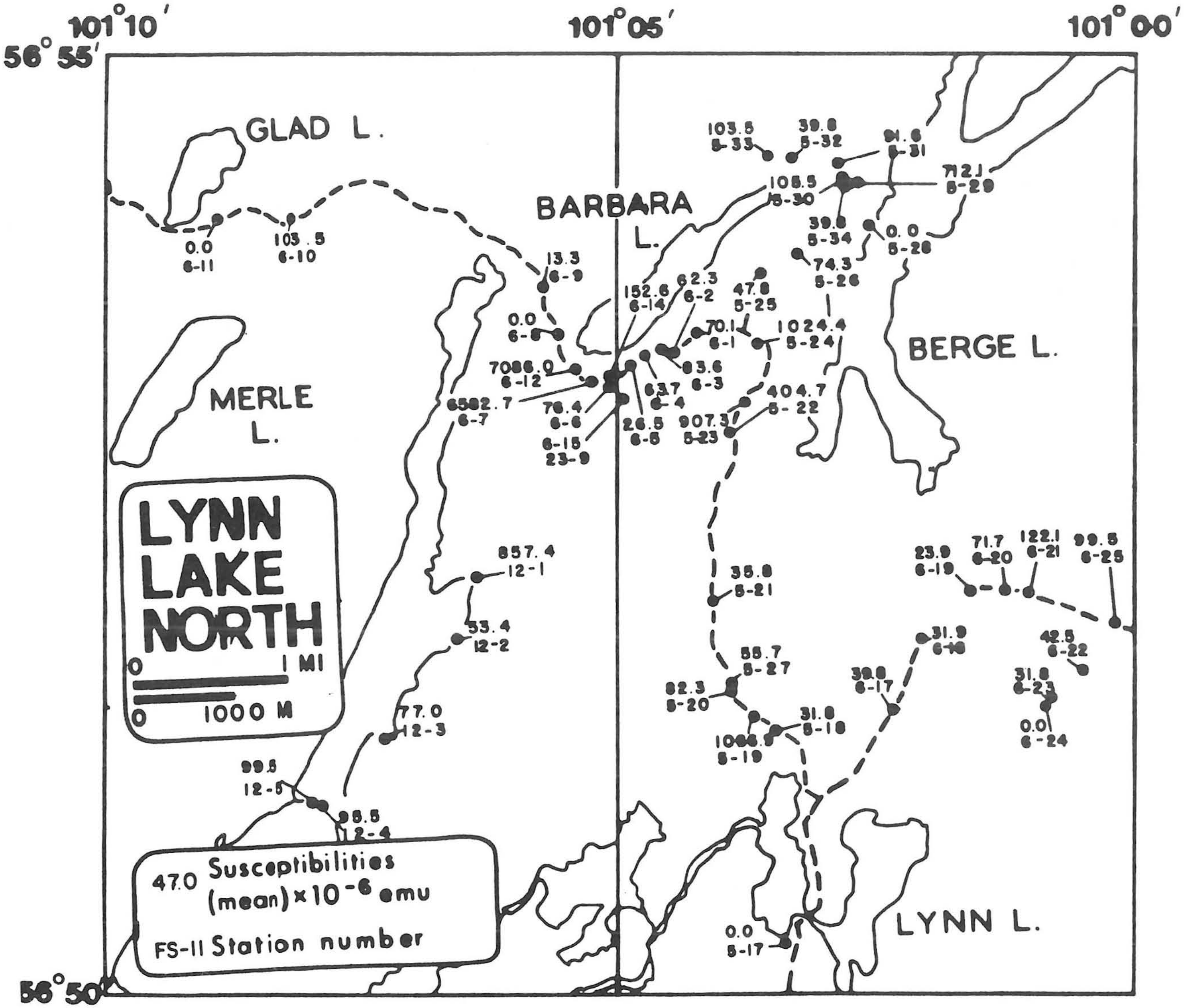


FIGURE 3.5 Magnetic Susceptibility map, Lynn Lake North.

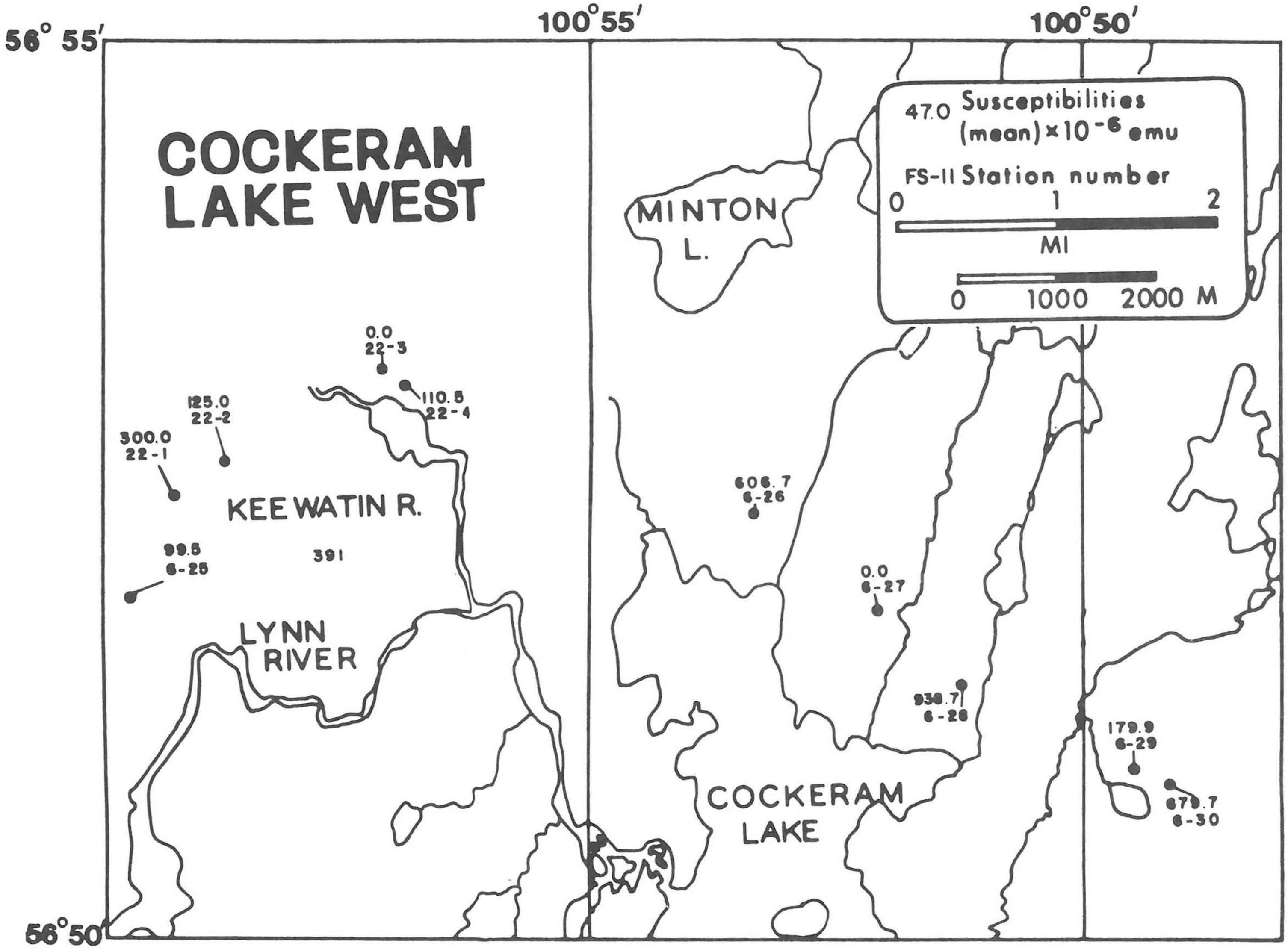


FIGURE 3.6 Magnetic Susceptibility map, Cockeram Lake West.

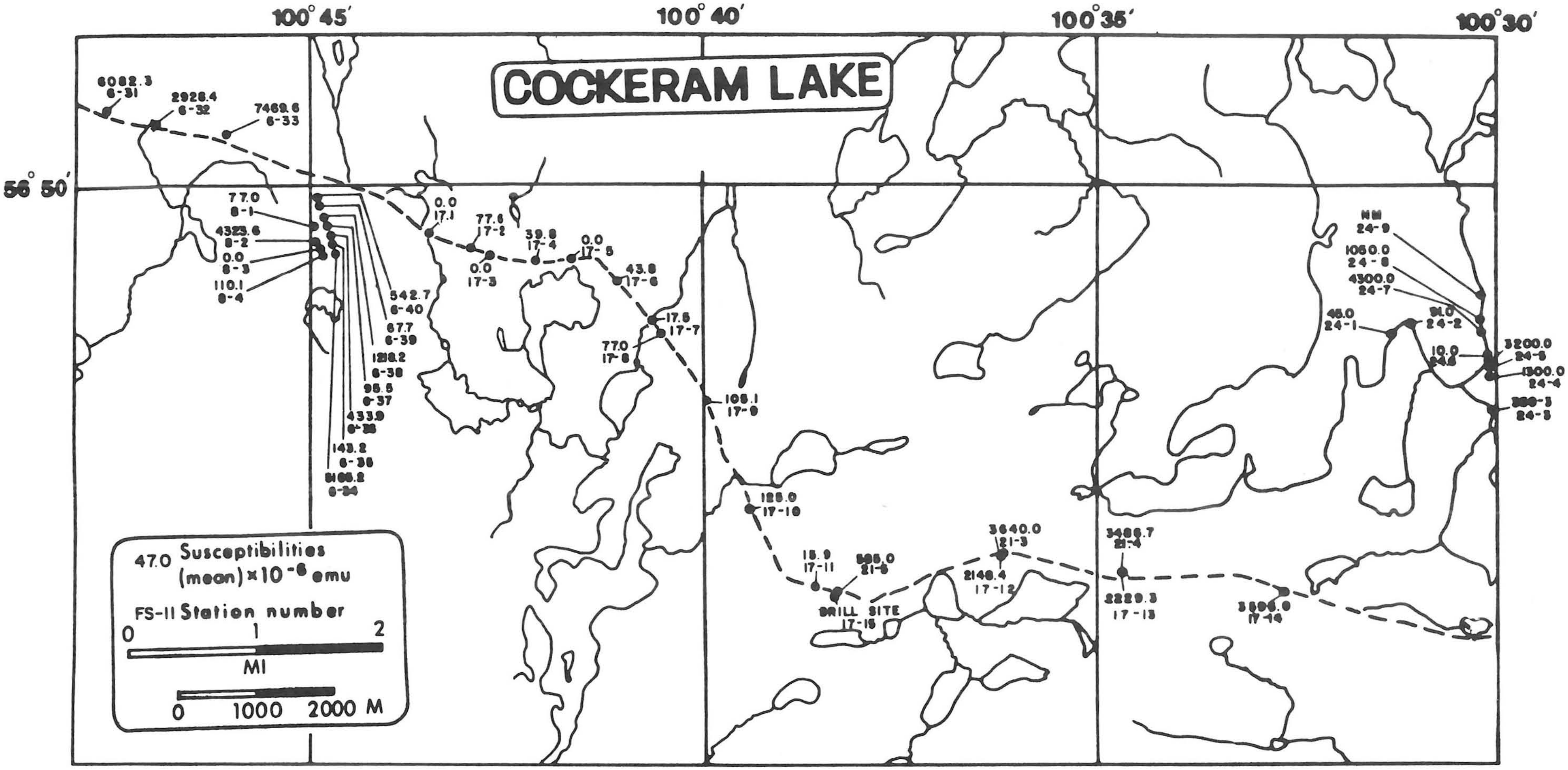


FIGURE 3.7 Magnetic Susceptibility map, Cockeram Lake.

F the strength of the geomagnetic field (averaging 0.615 gauss or 61 500 nT in the area); from equations (1) and (2).

$$I = kF(1 + Q). \qquad \ldots\ldots (3)$$

Example of calculation — Table 3.4 shows that core No. 78205A is from a metasedimentary or metavolcanic rock unit with $k = 4.42 \times 10^{-3}$ emu and $Q = 0.21$. If the NRM is parallel to the earth's field from equation (3), $I = 4.42 \times 0.615\ (1 + 0.21) \times 10^{-3} = 3.29 \times 10^{-3}$ emu. This is the value of the intensity of magnetization which should be used to calculate magnetic field levels generated by that rock unit.

In the absence of information about Ir for the whole area, a reasonable procedure for estimating the intensity of magnetization would be to use the susceptibilities along with the average Q-values for the area. The latter fall into two groups: the gabbro samples 78207, 78208 and 78209 for which average Q is 0.77; and the rest for which the average is 0.49.

Example of calculation — Sample No. 14-19 from a mafic volcanic rock unit has $k = 1.28 \times 10^{-3}$ emu. The average value of Q is 0.49, and assuming that NRM is parallel to the geomagnetic field:

$$I = 1.28 \times 0.615\ (1 + 0.49) \times 10^{-3} = 1.17 \times 10^{-3}\ emu.$$

This might be a reasonable value to employ in the calculation of the magnetic field arising from that rock unit.

REGIONAL SIGNIFICANCE OF Q-VALUES

Hall et al. (1979) published Q-values for several subprovinces of the Superior province and determined that the average was 1.25. In other measurements on 140 samples taken along Highway 391 (Thompson to Lynn Lake) the Q-values averaged 0.33. These were from the Kisseynew and Lynn Lake belts of the Churchill province. The average Q-value in the present study, for rocks other than gabbro, is 0.49 — again for the Churchill province. The explanation for lower values in the Churchill province as compared to the Superior province probably lies in the processes which generate soft or unstable components of magnetization, since NRM in most of the samples, Churchill as well as Superior, is quite unstable. It appears that soft magnetization is more easily emplaced in the latter.

POSSIBLE USE OF GABBRO BODIES FOR GEOCHRONOLOGY USING PALEOMAGNETIC METHODS

Of all the rock units for which NRM was measured, the gabbros possessed the most stable NRM. Also, the inclinations of their vectors were consistently away from the geomagnetic field direction; e.g. $I = 67°$ was the average for the 12 samples from sites 78207, 78208 and 78209. Thus, a strong oblique component of stable remanent magnetization is indicated, and the samples therefore may be suitable for paleomagnetic studies. The success of the method would depend on how well the structural histories of the gabbro bodies are known.

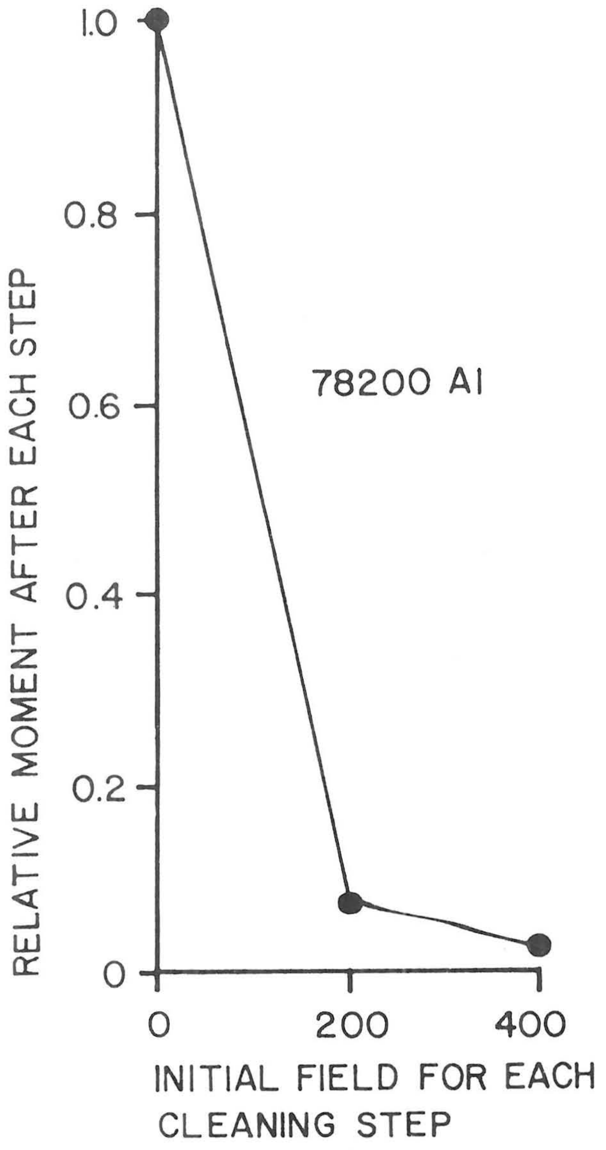


FIGURE 3.8 Relative magnetic moments of Sample 78200 A1.

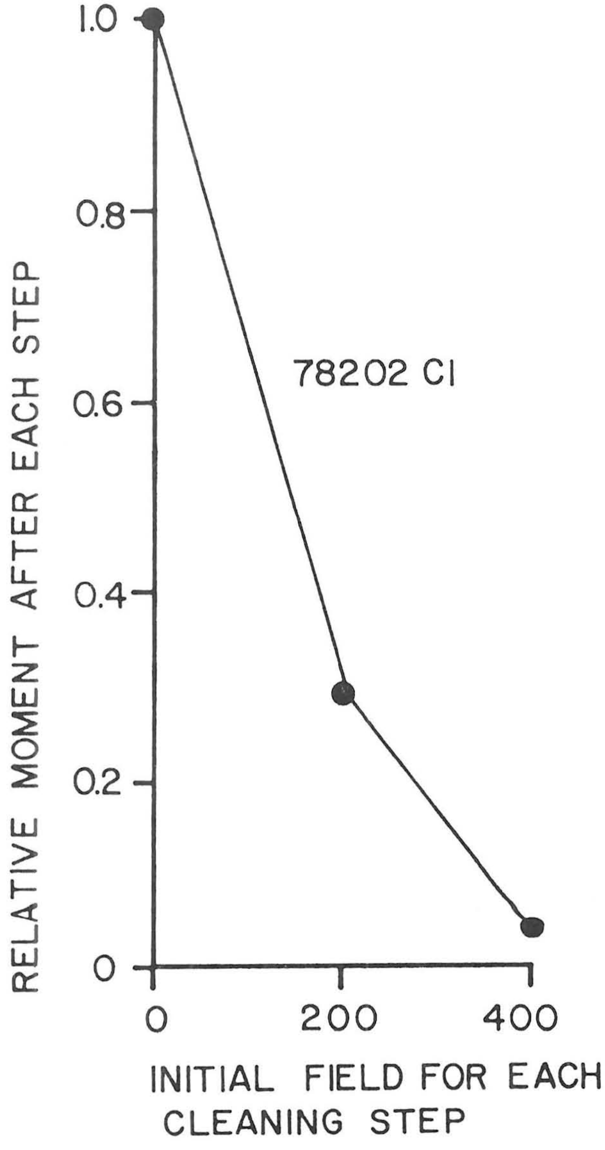


FIGURE 3.9 Relative magnetic moments of Sample 78202 C1.

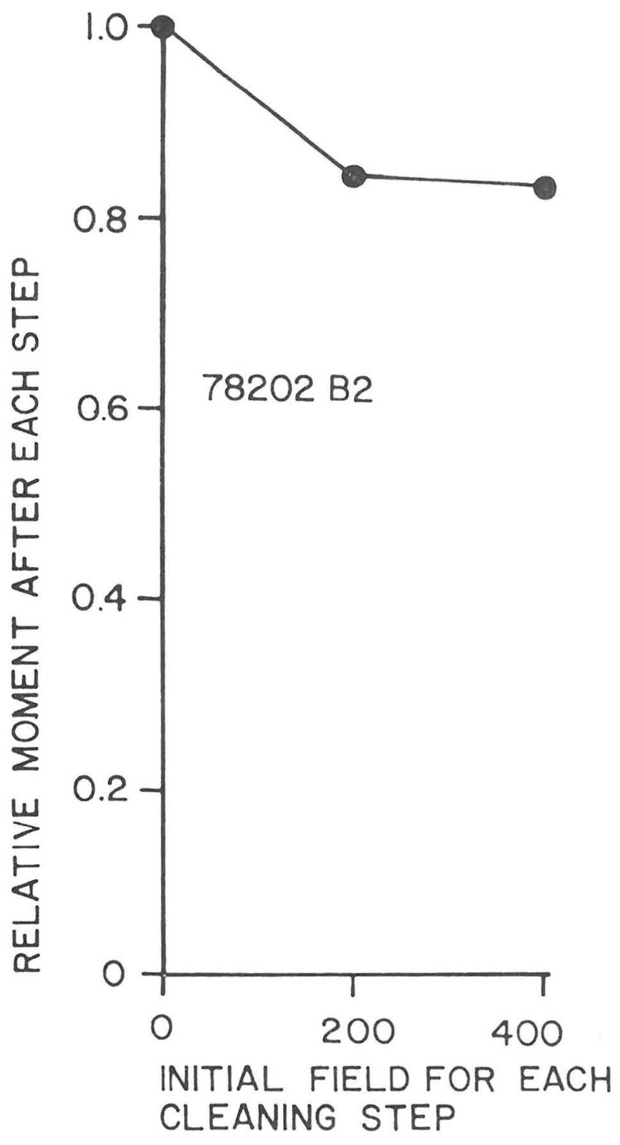


FIGURE 3.10 Relative magnetic moments of Sample 78202 B2.

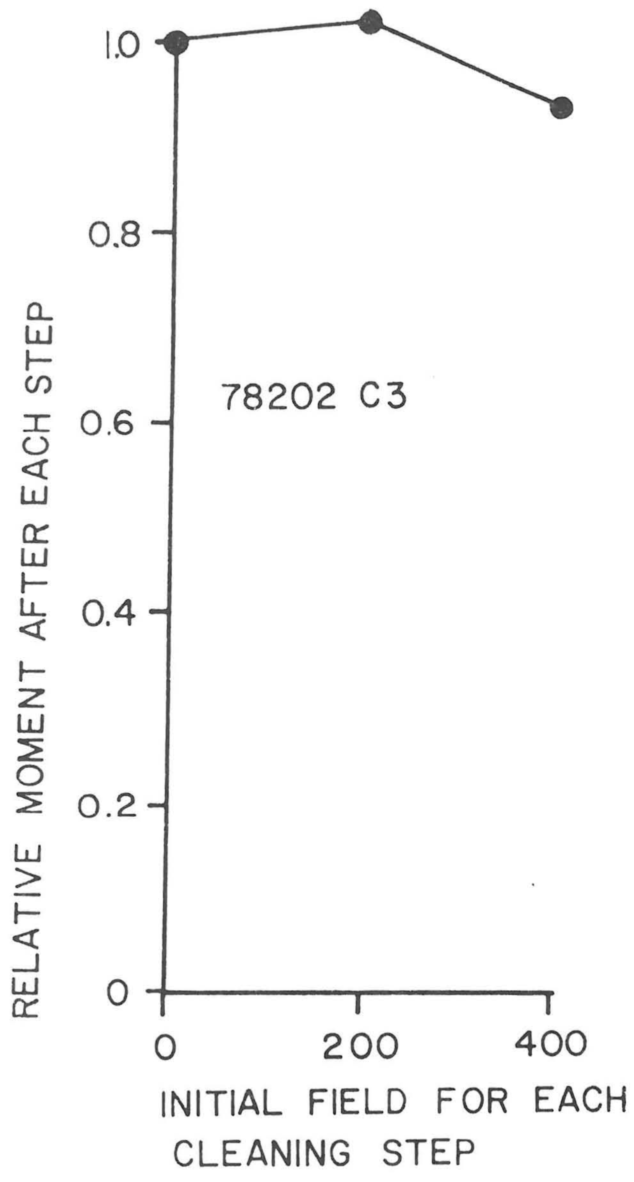


FIGURE 3.11 Relative magnetic moments of Sample 78202 C3.

TABLE 3.1 MAGNETIC SUSCEPTIBILITIES OF SAMPLES

Sample no.	Susc. x10⁶ (emu)	Lithology	Sample no.	Susc. x10⁶ (emu)	Lithology
		LYNN LAKE AREA			
5-1	35.8	gabbro	6-12	7086.0	Fe formation
5-2	52.8	gabbro	6-13		
5-3	47.8	q-f porphyry	6-14	152.6	mafic volcanic
5-4	68.0	q-f porphyry	6-15	23.9	mafic volcanic
5-5	0.0	q-f porphyry	6-16	91.6	mafic volcanic
5-6	2119.4	diorite-gabbro	6-17	39.8	maf.-fel. volcanic
5-7	10.6	q-f porphyry	6-18	31.9	congl.-greywacke
5-8	0.0	q-f porphyry	6-19	23.9	congl.-greywacke
5-9	0.0	q-f porphyry	6-20	71.7	congl.-greywacke
5-10	183.1	q-f porphyry	6-21	122.1	congl.-greywacke
5-11	0.0	q-f porphyry	6-22	42.5	mafic volcanic
5-12	0.0	q-f porphyry	6-23	31.8	mafic volcanic
5-13	0.0	q-f porphyry	6-24	0.0	felsic volcanic
5-14	0.0	q-f porphyry	6-25	99.5	maf.-fel. volcanic
5-15	0.0	q-f porphyry	12-1	857.4	iron formation
5-16	0.0	q-f porphyry	12-2	53.4	mafic volcanic
5-17	0.0	q-f porphyry	12-3	77.0	mafic volcanic
5-18	31.8	congl.-greywacke	12-4	95.5	mafic volcanic
5-19	1066.9	mafic volcanic	12-5	99.5	mafic volcanic
5-20	82.3	mafic volcanic	14-1	47.8	conglomerate
5-21	35.8	gran.-diorite	14-2	40.7	conglomerate
5-22	404.7	gran.-diorite	14-3	43.8	conglomerate
5-23	907.3	gran.-diorite	14-4	37.4	mafic volcanic
5-24	1024.4	mafic volcanic	14-5	5.6	granite
5-25	47.8	mafic volcanic	14-6	550.8	granite
5-26	74.3	mafic volcanic	14-7	21.2	granite
5-27	55.7	mafic volcanic	14-8	50.9	granite
5-28	0.0	granite	14-9	405.8	diorite-gabbro
5-29	712.1	mafic volcanic	14-10	43.8	diorite-gabbro
5-30	105.5	mafic volcanic	14-11	45.1	diorite-gabbro
5-31	91.6	mafic volcanic	14-12	101.5	diorite-gabbro
5-32	39.8	mafic volcanic	14-13	63.7	diorite-gabbro
5-33	103.5	congl.-greywacke	14-14	418.8	gabbro
5-34	39.8	mafic volcanic	14-15	549.4	gabbro
6-1	70.1	mafic volcanic	14-16	84.9	gabbro
6-2	62.3	mafic volcanic	14-17	45.1	gabbro
6-3	83.6	mafic volcanic	14-18	96.5	gabbro
6-4	63.7	mafic volcanic	14-19	1281.8	mafic volcanic
6-5	26.5	mafic volcanic	14-20	3712.1	mafic volcanic
6-6	76.4	mafic volcanic	14-21	1239.0	.mafic volcanic
6-7	6582.7	iron formation	14-22	3477.0	mafic volcanic
6-8	0.0	greywacke	14-23	36.6	mafic volcanic
6-9	13.3	greywacke	14-24	124.2	mafic volcanic
6-10	103.5	greywacke	14-25	356.7	mafic volcanic
6-11	0.0	ton.-gran.	14-26	52.6	mafic volcanic
14-27	38.9	mafic volcanic	24-1A	850.0	gabbro
14-28	53.1	mafic volcanic	24-2A	1025.0	gabbro
14-29	826.6	mafic volcanic	24-3A	187.5	gabbro
14-30	136.5	mafic volcanic	24-4A	750.0	gabbro
14-31	31.9	mafic volcanic	24-5A	1275.0	gabbro
14-32	18.6	mafic volcanic	24-6A	937.5	gabbro
			SP-1	342.8	gabbro

FOX LAKE AREA

4-16	15427.6	iron formation	10-12	0.0	inter. volcanic
4-17	57.7	inter. volcanic	10-13	0.0	inter. volcanic
4-18	55.7	congl.-greywacke	10-14	222.1	mafic volcanic
4-19	31.8	inter.-fel. volc.	11-1	3270.0	conglomerate
4-20	3830.1	iron formation	13-1	50.4	mafic volcanic
4-21	3926.0	iron formation	13-3	53.1	inter. volcanic
9-5	195.1	mafic volcanic	13-4	89.6	gabbro
9-6	0.0	mafic volcanic	13-5	53.1	inter. volcanic
9-7	46.2	mafic volcanic	13-6	26.5	inter. volcanic
9-8	42.8	mafic volcanic	13-7	58.4	inter. volcanic
9-9	350.3	mafic volcanic	13-8	201.5	inter. volcanic
9-10	67.7	mafic volcanic	13-9	120.3	inter. volcanic
9-11	89.6	mafic volcanic	13-10	93.6	inter. volcanic
9-12	123.4	mafic volcanic	13-11	22.3	inter. volcanic
9-13	45.1	greywacke	13-12	52.7	inter. volcanic
9-14	670.8	gabbro	13-13	243.7	gabbro
9-15	610.8	gabbro	13-14	93.3	inter. volcanic
9-16	10.6	greywacke	13-15	51.8	inter. volcanic
9-17	33.5	greywacke	13-16	50.4	inter. volcanic
9-18			13-17	53.1	inter. volcanic
9-19	0.0	greywacke	13-18	90.8	inter. volcanic
10-1	31.9	inter. volcanic	13-19	35.8	inter. volcanic
10-2	21.2	inter. volcanic	13-20	112.8	inter. volcanic
10-3	23.9	inter. volcanic	13-21	28.7	inter. volcanic
10-4	90.2	inter. volcanic	13-23	111.5	inter. volcanic
10-5	74.3	mafic volcanic	13-72	37.6	inter. volcanic
10-6			25-1	61.0	? — not mapped
10-7	100.8	mafic volcanic	25-2	0.0	? — not mapped
10-8	37.2	mafic volcanic	25-3	0.0	? — not mapped
10-9	0.0	mafic volcanic	25-4	0.0	? — not mapped
10-10	0.0	mafic volcanic	25-5	0.0	? — not mapped
10-11	15.9	mafic volcanic	25-6	0.0	? — not mapped
25-7	0.0	? — not mapped	28-5	0.0	diorite
25-8	2950.0	? — not mapped	28-6	0.0	diorite
26-1	577.5	conglomerate	FS-5	38.7	mafic volcanic
26-2	5800.0	conglomerate	FS-6	33.1	mafic volcanic
27-1	1305.0	? amphibolite ?	FS-9	168.7	mafic volcanic
27-2	0.0	? amphibolite ?	FS-10	19.3	greywacke
27-3	530.0	? amphibolite ?	FS-11	253.8	mafic volcanic
27-4	850.0	ton.-granodiorte	FS-12	80.4	mafic volcanic
27-5	34.0	ton.-granodiorite	FS-13	27.3	mafic volcanic
27-6	85.0	ton.-granodiorite	FS-14	625.5	mafic volcanic
27-7	0.0	ton.-granodiorite	FS-18	175.0	mafic volcanic
27-8	0.0	ton.-granodiorite	FS-19	47.0	mafic volcanic
27-9	0.0	ton.-granodiorite	FS-20	157.1	mafic volcanic
27-10	0.0	ton.-granodiorite	FS-21	75.3	mafic volcanic
27-11	25.0	? amphibolite ?	FS-22	141.4	mafic volcanic
28-1	660.0	ton.-granodiorite	FS-25	124.0	mafic volcanic
28-2	5866.7	ton.-granodiorite	F3-26	93.9	mafic volcanic
28-3	0.0	ton.-granodiorite	FS-27	121.2	mafic volcanic
28-4	350.0	amphibolite	F3-24	249.6	mafic volcanic

COCKERAM LAKE AREA

6-25	99.5	mafic volcanic	6-30	679.7	diorite/gabbro
6-26	606.7	ton.-gran.	22-1	300.0	mafic volcanic
6-27	0.0	ton.-gran.	22-2	125.0	mafic volcanic
6-28	938.7	diorite/gabbro	22-3	0.0	mafic volcanic
6-29	179.9	ton.-gran.	22-4	110.5	mafic volcanic

MCGAVOCK LAKE AREA

4-1	385.4	arkose	4-14	0.0	maf.-fel. volc.
4-2	182.1	arkose	12-6	57.7	maf.-fel. volc.
4-3	59.7	inter.-fel. volc.	12-7	274.7	maf.-fel. volc.
4-4	253.4	inter.-fel. volc.	12-8	75.7	maf.-fel. volc.
4-5	3343.1	inter.-fel. volc.	12-9	1145.4	maf.-fel. volc.
4-6	3332.0	inter.-fel. volc.	12-10	215.0	maf.-fel. volc.
4-7	1878.6	inter.-fel. volc.	12-11	1218.0	maf.-fel. volc.
4-8	65.7	inter.-fel. volc.	12-12	1656.1	maf.-fel. volc.
4-9	74.3	inter.-fel. volc.	12-13	2916.0	maf.-fel. volc.
4-10	139.4	inter.-fel. volc.	12-14	1199.6	maf.-fel. volc.
4-11	63.7	maf.-fel. volc.	12-15	84.4	maf.-fel. volc.
4-12	451.2	inter.-fel. volc.	14-33	41.4	ton.-granodiorite
4-13	498.8	inter.-fel. volc.	14-34	42.5	ton.-ganodiorite
14-35	398.4	ton.-granodiorite	15-3	1472.9	inter.-fel. volc.
14-36	36.4	ton.-granodiorite	15-4	36.3	inter.-fel. volc.
14-37	254.8	ton.-granodiorite	15-5	915.6	inter.-fel. volc.
14-38	1153.5	conglomerate	15-6	2050.2	inter.-fel. volc.
14-39	508.8	conglomerate	15-7		
14-40	105.1	conglomerate	15-8	390.1	inter.-fel. volc.
14-41	194.3	arkose	15-9	61.0	inter.-fel. volc.
14-42	285.3	arkose	15-10	196.4	? amphibolite ?
15-1	784.3	inter.-fel. volc.	15-11	312.5	? amphibolite ?
15-2	880.6	inter.-fel. volc.	21-2	22.6	felsic volcanic

TABLE 3.2 MAGNETIC SUSCEPTIBILITIES OF ROCK UNITS

Lithology	Rock unit	Location	Average susceptibility x 10^6 (emu)	Expression in magnetic anomalies
		Laurie lake susceptibility map		
	(Map 1977 L-1)			
metasedimentary[1] and metavolcanic rocks[1]	1, 2, 3, 4	these rocks form a belt along and adjacent to Hwy. 396 vicinity of Dunphy Lakes, Fox and Hatchet Lakes	$\bar{k}$ = 130 range: 0-670 these lie in a zone following the belt	no single anomaly trend follows the belt
gabbro[1]	7A	Hwy. 396, S of Dunphy Lake	$\bar{k}$ = 410 range: 11-670	—
conglomerate[2]	10B	McWhirter Lake, Tod Lake fault, Hassett Lake	$\bar{k}$ = 3150 range: 578-5800	—
metavolcanics[1]	3A	Snake Lake	$\bar{k}$ = 87 range: 27-201	weak anomaly trend
metasediments[2]	9	Tod Lake	$\bar{k}$ = 10 range: 0-61	—
		McGavock Lake West susceptibility map		
	(Maps 1977 L-1, L-3)	(all on Fox Mine road)		
basalt, breccia[1]	4	region of Wilmot Lake	$\bar{k}$ = 94 range: 0-350	—
gabbro[1]	3s	N. of Wilmot Lake; and western edge of map	3830 and 3926	good anomaly expression N. of Wilmot Lake
iron formation[1]	3r	eastern edge of map	15,430	anomaly expression but lower than expected
		McGavock Lake East susceptibility map		
	(Map 1977 L-3)			
metavolcanics[1] iron formation[1]	3	vicinity of Boiley and Naylor Lakes (Boiley Lake mineralized zone)	in an area with $k > 500$. $\bar{k}$ = 1495 range: 36-3332	well developed system of narrow sub-parallel anomalies
pebble conglomerate[2], arkose[2], greywacke[2]	19a, 20a	C.N. line, Pool Lake to Boiley Lake	$\bar{k}$ = 381 range: 60-1154	broad magnetic low
metavolcanics[1], metasediments[1]	3	northeast of Gemmel Lake	$\bar{k}$ = 894 range: 58-2916	corresponding anomaly peak

Lynn Lake South susceptibility map

	(Map 1977 L-4)			
metasediments[1], acid igneous rocks[3]	4, 15a, 15b	C.N. railroad, Lynn Lake-Muter Creek bridge	$\bar{k}$ = 131 range: 4-405	featureless magnetic low area
eastern side of Fraser Lake gabbro[3] and bordering units (diorite[3], quartz diorite[3] gabbro[3], basalt[1])	14, 15a, 5a	C.N. railroad, Muter Creek bridge to vicinity of Fraser Lake	$\bar{k}$ = 1320 range: 97-3477	prominent anomaly
metavolcanics[1] and metasediments[1]	3, 4	C.N. railroad, south of Fraser Lake	$\bar{k}$ = 168 range: 19-826	subparallel anomaly highs and lows
pre-Sickle intrusive rocks at western edge of the Fraser Lake gabbro[3]	14, 15a, 15b	Fox Mine Rd., Francis Lake to Eileen Lake	$\bar{k}$ = 50 range: 35-68	no prominent anomalies
quartz-feldspar porphyry[1], porphyritic rhyolite[1]	4j	Fox Mine Rd., vicinity of Francis Lake to West Lynn Lake	$\bar{k}$ = 26 range: 0-183	broad anomaly low

Lynn Lake North susceptibility map

	(Map 1977 L-4)			
metavolcanics[1] and metasediments[1]	3, 4, 5	Hwy. 396 north of Lynn Lake townsite; Hwy. 394 north to airport	$\bar{k}$ = 53 range: 0-122	—
granite[4], granodiorite[4]	24a	Hwy. 394, airport to vicinity of Burge Lake	$\bar{k}$ = 23 range: 0-56	—
metavolcanics[1]	6a	Ralph Lake-Barbara Lake-Burge Lake	$\bar{k}$ = 80 range: 26-106	—
metasediments[5]	21a	Hwy. 394	$\bar{k}$ = 38 range: 0-103	—

Cockeram Lake West susceptibility map

	(Map 1977 L-5)	(all on Hwy. 396)		
diorite[3], quartz diorite[3], isolated gabbro bodies	15c, d	vicinity of Cockeram Lake	$\bar{k}$ = 481 range: 0-938	subdued magnetic expression
metasediments[1]	3, 4	vicinity of Keewatin river	$\bar{k}$ = 127 range: 0-300	subdued magnetic expression

Cockeram Lake susceptibility map

	(Map 1977 L-5)			
conglomerate[1]	3k	east side of Hughes Lake	$\bar{k}$ = 2462 range: 1050-4300	pronounced anomaly "high"
metasediments[2]	20a	south shore, Hughes Lake	$\bar{k}$ = 124 range: 10-350	—
metavolcanics[1], metasediments[1]	2a	Hwy. 396, vicinity of Gan Lake	$\bar{k}$ = 2614 range: 585-3640	pronounced "high" lying to south
metavolcanics[1] and metasediments[1]	1, 5, 7	Hwy. 396, Pole-Norrie Lakes	$\bar{k}$ = 81 range: 16-125	no anomaly expression
acidic to intermediate intrusives[3]	15d, 16e	Hwy. 396, north of Norrie Lake	$\bar{k}$ = 26 range: 0-78	no anomaly expression
gabbro[3]	11	Hwy. 396, west of Norrie Lake, and south of highway	$\bar{k}$ = 2017 range: 0-7469	distinctive anomaly over the gabbro body

[3]Pre-Sickle Group intrusives; [4]intrusive in the Sickle Group; [5]age not determined

TABLE 3.3 REMANENT MAGNETIZATION OF SAMPLES

Sample no.		Intensity of magnetization x 10³ (emu)	Inclination of magnetization	Stability index	Lithology	Location
78200	A1	2.96	82°	0.10	Iron formation	Southwest edge of Barbara Lake
	A2	1.43	69	0.10		
	A3	1.12	43	0.08		
			average = 64°			
	B1	1.19	74°	0.17		
	B2	0.862	80	0.20		
	B3	0.313	81	0.18		
			average = 78°			
	C1	2.09	73°	0.10		
	C2	2.78	74	0.087		
	C3	1.66	65	0.11		
			average = 70°			
78201	A1	0.00031	33°	0.26	Intermediate to mafic composition of uncertain origin	Near sample site 4-16 between Fox Lake and Lynn Lake
	A2	0.00028	14	0.20		
	A3	0.00014	36	0.41		
			average = 27°			
	B1	0.0021	-50°	0.019		
	B2	0.013	2	0.059		
	B3	0.0025	2	0.51		
			average = ?			
	C1	0.249	47°	0.043		
	C2	0.046	48	0.063		
	C3	0.133	50	0.027		
			average = 48°			
78202	A1	0.509	83°	0.095	Intermediate to felsic composition volcanics	Near sample site 4-20 between Fox Lake and Lynn Lake
	A2	0.410	80	0.14		
	A3	0.744	80	0.072		
			average = 81°			
	B1	0.00011	20°	0.72	Mafic composition volcanics or intrusive	Near sample site 4-20 between Fox Lake and Lynn Lake
	B2	0.000092	43	0.94		
	B3	0.000070	62	1.29		
			average = 42°			
	C1	0.0045	80°	0.29		
	C2	0.00020	18	0.38		
	C3	0.000046	8	1.02		
			average = ?			
	D1	0.244	72°	0.118		
	D2	0.283	81	0.026		
	D3	0.707	76	0.042		
			average = 76°			
78203	A1	0.0034	53°	0.43	Fine grained, intermediate composition. Fragmental; from "Sickle conglomerate" unit	Near sample site 17-15 in Barrington Lake area
	A2	0.00058	19	2.18		
	A3	0.0074	-2	0.19		
			average = ?			
	B1	0.0023	65°	0.48		
	B2	0.0015	44	0.39		
			average = 54°			
78204	A1	0.258	55°	0.081	Intermediate to felsic composition. Fragmental (volcanic or sedimentary origin?)	Near sample site 17-12 in Barrington Lake area
78205	A1	0.723	70°	0.071	Intermediate to felsic composition. Fragmental (volcanic or sedimentary origin?)	Near sample site 17-13 in Barrington Lake area
	A2	0.530	81	0.077		
	A3	0.498	83	0.080		
			average = 78°			
78206	A1	0.497	80°	0.023	Mafic composition (volcanic or sedimentary origin?)	Near sample site 17-15 in Barrington Lake area
	A2	0.570	76	0.026		
	A3	0.482	85	0.043		
			average = 80°			

78207	A1	4.50		69°	0.56	Medium grained gabbro	South end of Frances Lake
	A2	4.93		68	0.62		
	A3	5.06		59	0.61		
			average =	65°			
	B1	8.84		72°	0.53		
	B2	8.04		85	0.61		
	B3	9.33		74	0.53		
			average =	77°			
78208	A1	0.269		63°	0.41	Gabbro	North of Fraser Lake
	A2	0.027		59	0.24		
	A3	0.293		65	0.44		
			average =	63°			
	B1	0.595		77°	0.33		
	B2	0.909		57	0.37		
	B3	0.747		61	0.44		
			average =	65°			
78209	A1	3.45		‡	0.07	Lithology uncertain	Location uncertain
	A2	5.66		‡	0.038		
	A3	4.19		‡	0.055		

‡ Values not available.

TABLE 3.4 Q-VALUES OF CORE SAMPLES

Sample no.	$I_r \times 10^3$ (emu)	$k \times 10^3$ (emu)	$kF \times 10^3$ (emu) (F = 0.615 gauss)	$Q = (I_r/kF)$
78200A	1.84	9.485	5.833	0.32
78200B	0.788	3.499	2.152	0.37
78200C	2.18	10.59	6.513	0.33
78201A	0.00024	0.07233	0.04448	0.01
78201B	0.0059	0.08548	0.05257	0.11
78201C	0.143	0.04603	0.02831	5.05
78202A	0.554	9.393	5.777	0.10
78202B	0.000091	0.05918	0.03640	0.00
78202C	0.0016	0.09863	0.06066	0.03
78202D	0.411	8.656	5.323	0.08
78203A	0.0038	0.02630	0.01617	0.24
78203B	0.0037	0.06575	0.04044	0.09
78204A	0.258	1.3479	0.8290	0.31
78205A	0.584	4.420	2.718	0.21
78206A	0.516	6.354	3.908	0.13
78207A	4.830	11.60	7.134	0.68
78207B	8.737	12.34	7.589	1.15
78208A	0.196	0.6641	0.4084	0.48
78208B	0.750	1.552	0.9545	0.79
78209A	4.43	9.485	5.833	0.76
				Av = 0.56

CHAPTER IV — QUANTITATIVE INTERPRETATION OF MAGNETIC ANOMALIES

SCOPE OF QUANTITATIVE INTERPRETATION

Magnetic interpretation methods have developed considerably over the past decade or so. Beside the traditional modelling of subsurface magnetic bodies, it is now also possible, within limits, to derive the distribution and other parameters of the intensity of magnetization. These new methods can be useful for exploration, e.g. in assigning priorities to target areas. For geological mapping, the delineation of conditions at depth is important. The quantitative work described in this section was aimed at this last application, and thus quantitative modelling of subsurface conditions is emphasized.

Quantitative modelling has proven itself as a method for providing subsurface information, given certain favourable circumstances. The most severe limitation is the fundamental nonuniqueness of potential field data. Models with a great variety of shapes and intensities of magnetization can be found to fit any given anomaly when no information beyond the anomaly map itself is available. If further information such as the configuration of the boundaries of the causative magnetic body (for example, depth to the top of the body) or its intensity of magnetization is available, the ambiguity can be greatly reduced or even removed.

PROCEDURE FOR QUANTITATIVE INTERPRETATION

Quantitative interpretation of anomalies may be approached in several ways. The traditional methods use the magnetic field values as the starting point for the interpretation procedure. This is referred to as interpretation in the space domain. Newer methods interpose a transformation of the data to the frequency domain and use the transformed data as the input to the interpretation process. For most purposes the space and frequency domain methods are equally effective, and either can be employed. Unless the data are of an absolutely top quality, it is probably safer to use space domain methods. This is the approach which was selected for the present survey.

All quantitative modelling is limited by the range of theoretical models available. At some stage in the procedure, the magnetic field about the various models has to be calculated by theoretical methods. This procedure limits the range of models availabale since calculations of this type become difficult and lengthy except for bodies with simple shapes such as blocks, sheets, polygonal prisms or simple polyhedra. However, using suitable combinations of these simple shapes, it is possible to arrive at a reasonable approximation of the shapes of real bodies.

Modelling is usually approached in two ways: by direct interactive methods, or by inverse methods.

In the case of the direct methods, an initial assumption is made about the shape, size, depth and intensity of magnetization of the body. The theoretical field about the body is calculated and compared with the anomaly being interpreted. The interpreter interacts by (usually relying on experience) making changes in the model parameters and proceeding to a second comparison of theoretical and measured fields. The process is repeated as often as necessary. In recent years, the introduction of cathode ray terminal systems, on line to computers, has made the direct approach attractive.

Interpretation by inverse methods involves an initial assumption of shape, followed by the use of an optimization algorithm to find the best fit between the dimensions and magnetization of the causative body or bodies and the field anomaly data. The whole series of calculations can be done on a computer without the intervention of an interpreter. The optimization works less smoothly when there is a large number of parameters. The Magnetic Interpretation Group at the University of Manitoba has developed a collection of inverse programs, and is doing research on developing them further. In the following sections are presented the results of such interpretations at four locations in the Lynn Lake area.

A quantitative study of anomalies over four gabbroic bodies (three known and one suggested) was undertaken. These anomalies where chosen partly because they are prominent magnetic anomalies, and partly because of their economic importance, considering the fact that the nickel-copper ore in the Lynn Lake mine is in such a body. The study was undertaken by Mok (1979) as an Honors Geophysics Project in the Geophysics Section, Department of Earth Sciences, University of Manitoba. The remaining sections (including figures) of the present section consist of extracts from his report on the project.

THE GEOLOGY OF PRE-SICKLE GABBRO BODIES

The pre-Sickle gabbro bodies are widely distributed within the district. They are found within a 13 km radius of Cockeram Lake and in the vicinities of Sickle Lake, Barrington Lake and Dunphy Lake. According to Manitoba Mineral Resources Division Preliminary Map 1978L1, these gabbroic bodies are divided into two distinct lithologic units. One is the gabbro, norite, diorite, pyroxenite and peridotite group while the other is the gabbro-diabase group. The Lynn Lake, Fraser Lake, Norrie Lake gabbro and a small gabbroic body near Ralph Lake belong to the first group; the rest of the gabbroic bodies fall into the second group. The Lynn Lake gabbro is associated with sulphide deposits which were mined from 1953 to 1975. The typical assemblage of sulphides was pyrrhotite-pentlandite-chalcopyrite. The ores were confined to a pre-Sickel gabbro-norite body. Therefore, a study of other similar gabbros should be of economic interest.

THE LYNN LAKE GABBRO

The Lynn Lake gabbro is located at the northeastern corner of the town of Lynn Lake and is a tabular layered intrusion 3 700 m long and 1 500 m wide. The original horizontal layering now stands close to vertical (Milligan, 1960; Fig. 2). Uralitized gabbroic rocks comprise the greater part of the intrusion, especially on the western side. Plagioclase is a prominent constituent in the eastern part. The known nickel-copper ore bodies lie along the western side of the intrusion. They can be explained as being segregations from a mafic magma (Emslie and Moore, 1961).

THE FRASER LAKE GABBRO

The Fraser Lake gabbro is located at the northeast corner of Fraser Lake and can be divided into a main body and a small southeast lobe. The main body is a truncated funnel-shaped mass (Hubert, 1978) approximately 4 000 m long and 2 100 m wide. It consists of norites, gabbro-norite, and anorthositic differentiates. The southeast lobe is 1 200 m in length and 760 m in width. The lithology is similar to that of the main body although slightly more mafic. The rocks of the Fraser Lake gabbro are similar to those in the eastern part of the Lynn Lake gabbro.

THE NORRIE LAKE GABBRO

The Norrie Lake gabbro is located about 1 km northeast of Norrie Lake. No details regarding its size, mineralogy or origin have been published. The outcrop boundary is roughly oval in shape. The major axis is about 4 500 m long and the minor axis is about 1 200 m. It is composed mainly of norite and gabbro.

A SUSPECTED MAFIC INTRUSION AT CHEPIL LAKE

A possible mafic intrusion is located at the northeast corner of Chepil Lake. The area, which has been studied in this report, is about 3 600 m in length and 2 700 m in width. The area over this suspected intrusive has been mapped as a mixture of volcanic flows, rhyolite and felsic rocks of the Wasekwan series (Milligan, 1960; Preliminary Map 1978L1). The area is covered by swamp. The interpretation given in a later section suggests an intrusion rising near to, but not reaching the surface.

RESULTS OF QUANTITATIVE INTERPRETATION

The interpretation was carried out using the inverse program "Prism" written by Coles (1973). This program finds the optimum parameters of a number of blocks for a given anomaly field. From the resulting configuration of blocks it is possible to estimate the parameters of the body.

The derived parameters include depth, lateral extent, direction and intensity of magnetization. As indicated in the section on ground surveys of magnetic properties, it is desirable to convert the latter to effective susceptibility, which is the intensity of magnetization divided by the geomagnetic field value.

The effective susceptibility k^1 is given by

$$k^1 = \frac{I}{F} \qquad \ldots\ldots(1)$$

Referring to equation (3) of the above section, for the case where NRM parallels the earth's field,

$$k^1 = k(1 + Q) \qquad \ldots\ldots(2)$$

Plan views and cross sections of optimum models for the four gabbro bodies referred to previously, are shown in Figures 4.2, 4.6, 4.10, and 4.14. Some selected profiles across the bodies are presented in Figures 4.3, 4.4, 4.7, 4.8, 4.11, 4.12, 4.15, and 4.16. The theoretically computed, and observed magnetic fields can be compared in Figures 4.1, 4.5, 4.12, and 4.13.

Some profiles reflect a fairly good match between the model and anomaly fields. For instance, the profile XY of Norrie Lake (Fig. 4.11) has a peak to peak correlation and the difference in amplitude between the peaks is only about 30 nT. However, there are differences in amplitude of as much as 60 to 100 nT at some other points along the profile. However, a comparison of individual profiles may yield a wrong impression of the degree of fit between the model and observed fields. The best-fit model should be the one with the least root-mean-square error, which is consistent with the physical quantities as well as geological evidence.

The root-mean-square errors in the results are in the range 10 to 15%. The magnetic anomaly profiles across the bodies are, in general, rather complicated and irregular. This reflects the complexity of the gabbro bodies. In some theoretically derived fields, the high-amplitude parts of the actual anomalies fail to appear, e.g. over the Norrie Lake gabbro (Fig. 4.9). This may be because the chosen digital interval at 487.68 m is too large for these cases.

THE LYNN LAKE GABBRO

A single prism was used in the first attempt at modelling the Lynn Lake gabbro. As shown in Figure 4.1, the magnetic anomalies over the Lynn Lake gabbro consist of three separate magnetic highs. The magnetic field profile XY also shows three peaks (Fig. 4.3). Clearly, a single prism-shaped body cannot explain three individual highs along a profile. So two prisms, adjacent to each other, were used. The magnetization was allowed to vary separately. The resultant model curve matches reasonably well with the field anomaly curve, but the amplitudes of the peaks are lower. This indicates that another block of magnetic material is required near the surface in the model. In the next trial, two more blocks were added on top of the original model, and one more small block was placed at the site corresponding to the highest magnetic field. The dimensions and intensities were allowed to vary until the best fit was achieved. The profiles (Figs. 4.3, 4.4) indicate a reasonably good fit to the anomaly curve. The average root-mean-square error is between 10 and 20 nT, but there are some exceptionally large errors. It is emphasized that the final result is not unique; several different models may all fit the observed data quite well. In this model (Fig. 4.2), the blocks represent the Lynn Lake gabbro which has been truncated and tilted to nearly vertical (Emslie and Moore, 1960). The results indicate that the intrusion is composed of several vertical blocks with different magnetizations and only parts of the intrusion are highly magnetic. These parts cover an area of 3 000 x 1 950 m and extend to a depth of about 3 000 m. As shown in Figure 4.2, a strip of material with high effective susceptibility (2 300 x 10^{-6} emu) is modelled near the surface at the eastern side. Blocks with smaller values of effective susceptibility are situated to the west of this strip, with the exception of a small block with very high effective susceptibility (8 000 x 10^{-6} emu). The subsurface magnetic zone is displaced to the west of the surface outcrop of the gabbro body. The polarization of the model is approximately parallel to the geomagnetic field. The main sulphide minerals of the Lynn Lake ores, both massive and disseminated, are pyrrhotite, pentlandite and chalcopyrite. Small amounts of magnetite, pyrite and marcasite are also present within the sulphide minerals. Among the sulphide minerals, pyrrhotite predominates in the Lynn Lake ores. Unlike the rest of the sulphide minerals, pyrrhotite has ferrimagnetic properties which are quite variable. The susceptibility of pyrrhotite is in the range 10^{-4} to 0.5 emu (Telford et al., 1976). The presence of magnetite and pyrrhotite is the reason for the high susceptibilities in the Lynn Lake gabbro. The sulphide ores are more or less located in the postulated strip with the high susceptibility, but the block with the highest susceptibility does not correspond to any sulphide ore body. This may be due to the presence in it of magnetite alone, which constitutes about 1 to 5% of the total amount of mineral assemblages of the pre-Sickle gabbro (Milligan, 1960). Even though it is a minor constituent, any uneven distribution of magnetite would cause the magnetic susceptibility to change dramatically. Since according to Dobrin (1976) gabbro with 2.4% magnetite has a susceptibility of 7 200 x 10^{-6} emu, it may be the main source of the local magnetic anomalies.

Distribution of magnetization — It should be remembered that intensities of magnetization derived from analysis of magnetic anomalies represent contrasts in intensity relative to that of the surrounding rock rather than absolute values. Thus the effective susceptibilities in Figure 4.2 show the excess in the amounts of magnetization carried by various portions of the body above that in the surrounding rock. A comparison of the plan view of the model with the outline of the gabbro body shows that only certain portions of the body are highly magnetic.

THE FRASER LAKE GABBRO

From the modelling, the Fraser Lake gabbro is a single intrusive dyke, about 4 500 m long, 3 300 m wide and 4 500 m deep. The magnetic anomaly pattern is not as complex as for the Lynn Lake gabbro (Fig. 4.5). Modelling attempts with one, two and three prisms have been made. Similar results are obtained from the two and three-prism models, except that the additional block located near the surface in the latter case produces a better correlation with the anomaly field, as shown in Figures 4.7 and 4.8. The approximately funnel-shaped body described by Hubert (1978) is reproduced quite well in the final model. The presence of layering and igneous lamination indicates that the Fraser Lake intrusion may be a tabular mass (Emslie and Moore, 1961). The body has a low effective susceptibility contrast in the top part (83 x 10^{-6} emu) and a high value (2 800 x 10^{-6} emu) in the bottom part. The polarization for the model lies approximately parallel to the geomagnetic field. The average susceptibility of the surface rocks from the Fraser Lake intrusion is 670 x 10^{-6} emu and that of the surrounding rocks averages 340 x 10^{-6} emu (Susceptibility Map "Lynn Lake South," Fig. 3.4). Since only a few values of Q have been measured in the area, we will assume the average value (0.5). The

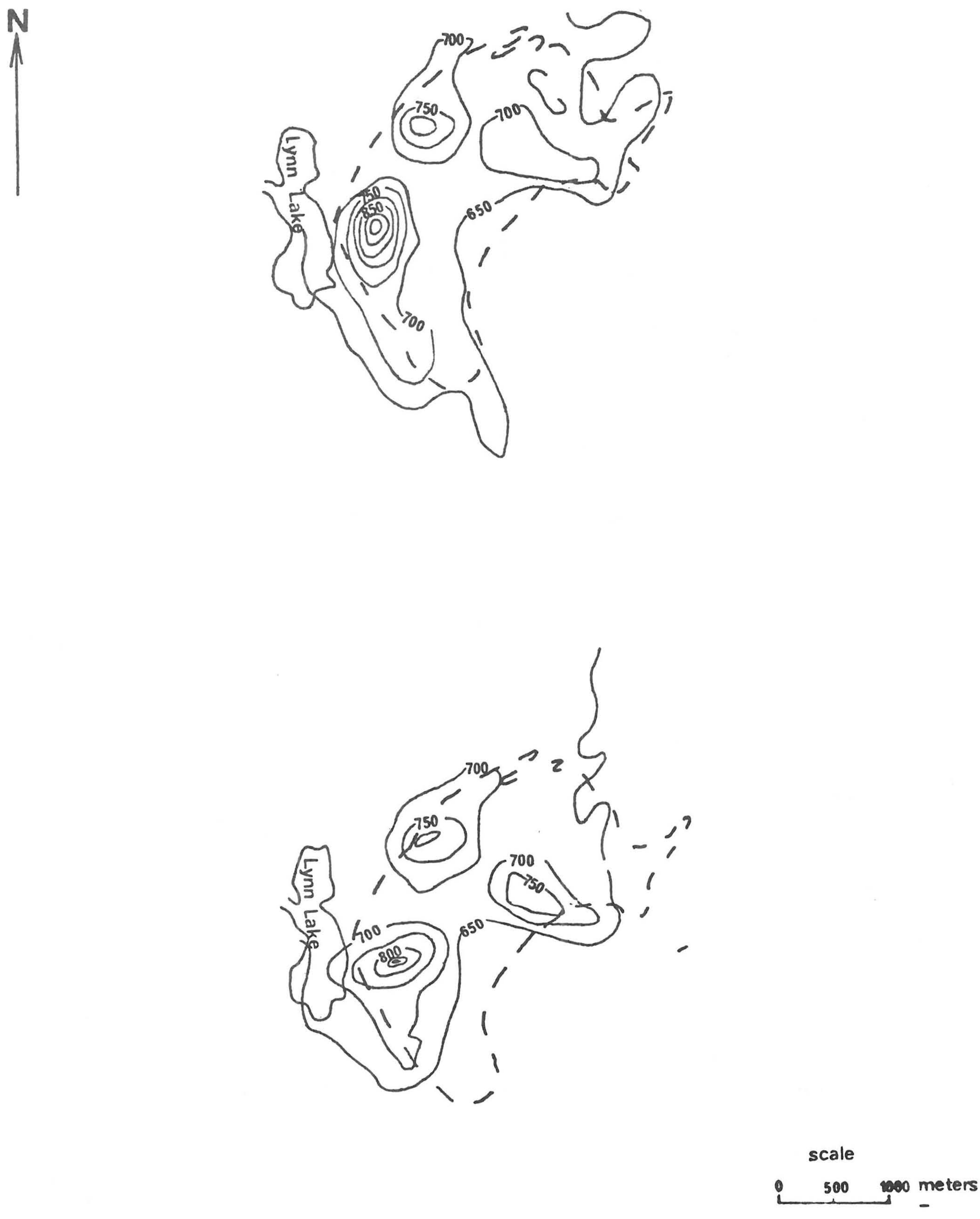


FIGURE 4.1 Magnetic anomalies over the Lynn Lake gabbro. The top diagram is the anomaly field, the bottom diagram is the model field, the dotted line is the outcrop boundary of the gabbro body, the values are the magnetic field in nT with a subtraction of 60 000 nT.

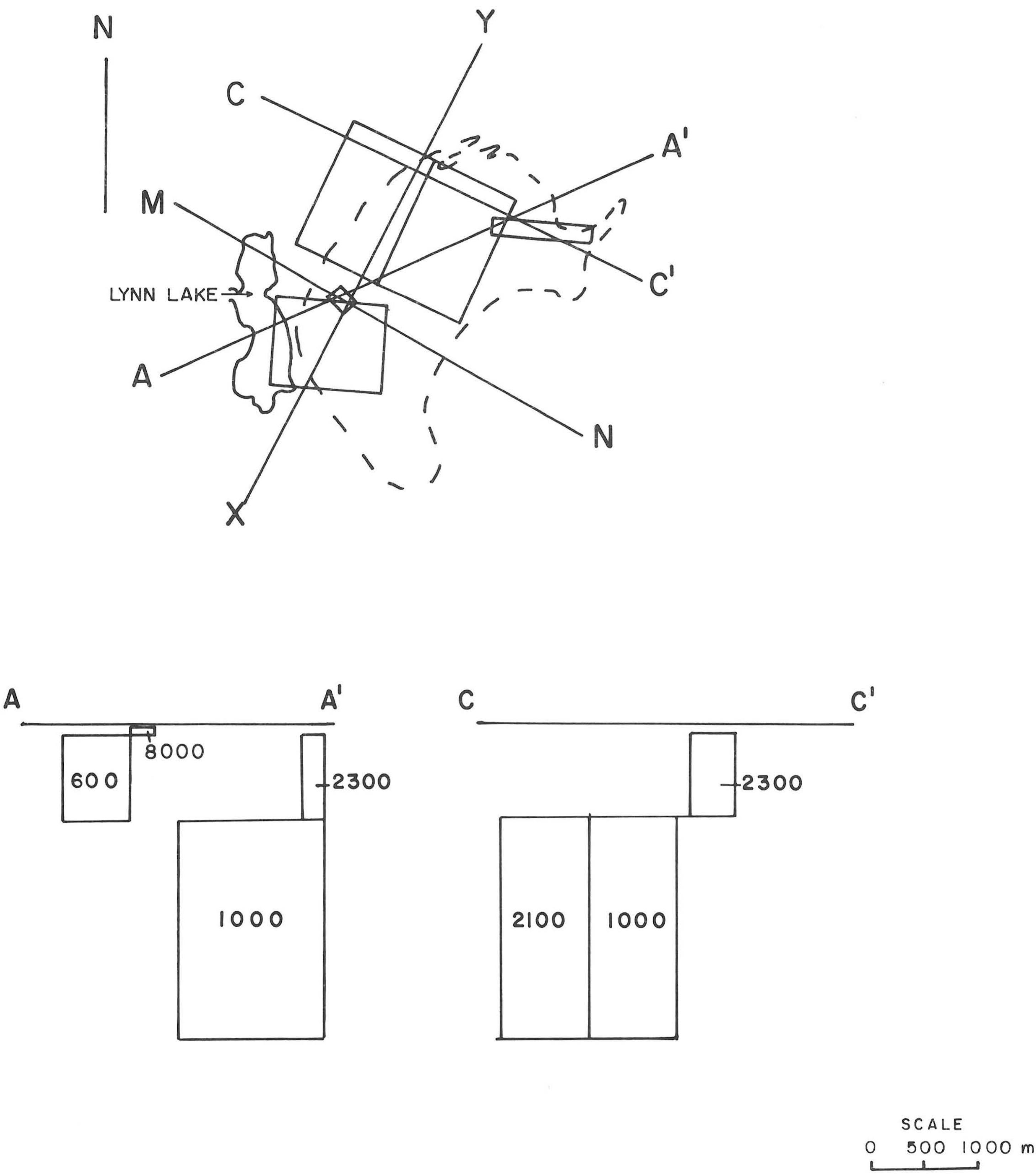


Figure 4.2 *Model of the Lynn Lake gabbro in plan view and in cross sections. The dotted line is the outcrop boundary of the gabbro body, the values are effective magnetic susceptibility (x 10^{-6} emu).*

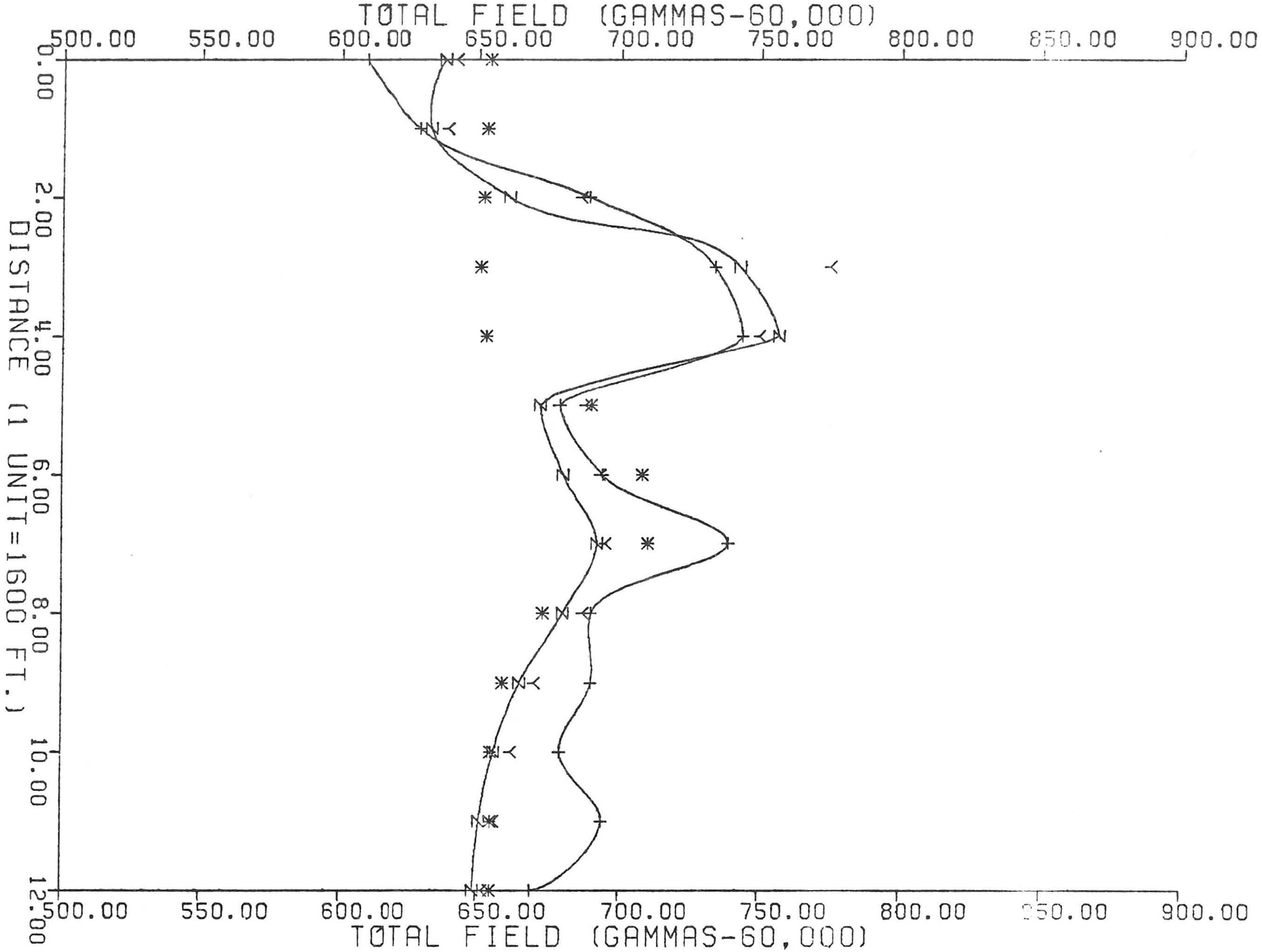


FIGURE 4.3 Magnetic Anomaly Profile across XY of Lynn Lake Gabbro. In text 'gammas' have been referred to as nT.
NOTE: '+' Anomaly Field; 'Z' Final Result; '*' One Prism; 'Y' Two Prisms.

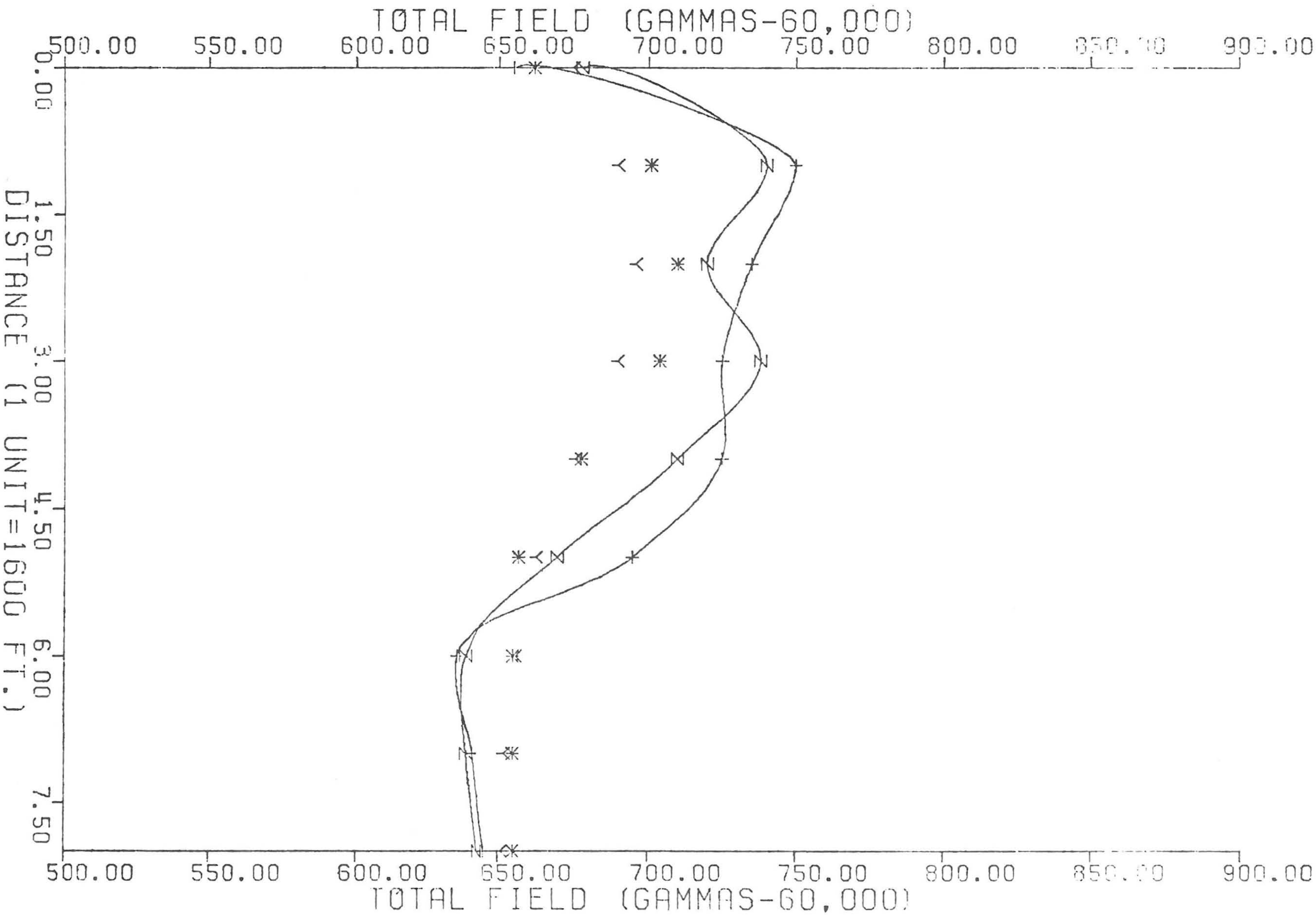


FIGURE 4.4 Magnetic Anomaly Profile across MN of Lynn Lake Gabbro. In text 'gammas' have been referred to as nT.
NOTE: '+' Anomaly Field; 'Z' Final Result; '' One Prism; 'Y' Two Prisms.*

TABLE 4.1 — The Configuration of the Lynn Lake Gabbro

# of prisms	Centre X	Centre Y	X length	Y length	Top	Base	Grid axis to block axis (°)	Polarization Decl. (°)	Polarization Incl. (°)	Polarization Int. (emu)
1	2.084	6.049	2.842	3.378	.4164	5.241	73.70	12.00	78.59	.000126
2	1.959	6.277	3.777	3.028	2.176	7.001	120.7	10.78	80.88	.000369
	2.000	3.000	2.000	2.000	.4164	2.191	0.0	11.50	83.58	.000369
5	1.000	6.277	2.000	3.028	2.191	7.001	-2.583	12.52	80.55	.001304
(final	1.698	3.107	2.038	2.647	.4164	2.191	-72.74	14.00	85.78	.000360
result)	4.181	7.253	3.135	.3535	.4164	2.191	20.17	12.05	83.91	.001466
	1.500	4.000	.5000	.5000	.1500	.4164	73.56	12.52	80.70	.004916
	3.000	6.277	2.000	3.028	2.191	7.001	-2.583	13.03	77.76	.000644

Declination of 'measured field' from true north 12.5°
Inclination of field 80.7°
Declination of x-axis 115.0°
Grid interval 1.0 by 1.0 unit
1 unit = 487.68 meters
The co-ordinates of the origin of the grid are (33.8, 37.1) w.r.t. the southwest corner of map 1 of aeromagnetic map '18005' (Questor Surveys)
RMS deviation 26.3

effective susceptibility contrast is then (670-340) (1 + 0.5) = 495 x 10^{-6} emu. There is therefore agreement in order of magnitude between the modelled and measured magnetic properties in the area. More detailed modelling may reduce the difference between the two still further. If the body originated by magmatic segregation (Emslie and Moore, 1961), the more basic rocks would be deposited at the bottom. If more magnetite was formed in these deeper rocks than in the shallower ones, susceptibility should increase with depth. Therefore, if the intrusive body has not been truncated or tilted, the magnetic susceptibility should be higher at the bottom, as is shown by the model in Figure 4.6.

THE NORRIE LAKE GABBRO (Figs. 4.9 to 4.12)

From the modelling, the Norrie Lake gabbro is an intrusive sill, about 4 900 m long, 600 m wide and 2 400 m in depth. The anomaly arises principally from the median portion of the body below 500 m, which is strongly magnetized. Two small magnetized pipes are shown to intrude near the surface. These two pipes correspond to two of the localized magnetic highs within the region (Fig. 4.9). The pipes have a lower contrast in effective magnetic susceptibility (399 x 10^{-6} and 999 x 10^{-6} emu) than the main body (2 900 x 10^{-6} emu). The polarization of the model lies approximately parallel to the geomagnetic field. The susceptibilities of surface samples (8-1 to 8-4 and 6-34 to 6-40) near the peak of the anomaly were measured and are shown on the Cockeram Lake susceptibility maps (Fig. 3.7). These average 1 109 x 10^{-6} emu. Adjacent to the anomaly (samples 17-1 to 17-10) are rocks of lower susceptibility averaging 49 x 10^{-6} emu. Using the same assumption about Q that was used for the Fraser Lake model (Q = 0.5 and the same for all rocks), the effective susceptibility contrast at the surface is about 1 500 x 10^{-6} emu. The model suggests values of 1 000 x 10^{-6} emu at the surface. This is an acceptable agreement. By the same reasoning as that used for the Fraser Lake gabbro, the greater magnetic susceptibility at the bottom may be due to a differentiation process.

CHEPIL LAKE (Figs. 4.13 to 4.16, Table 4.4)

Unlike the rest of the felsic volcanic rocks, the magnetic anomalies near the northeast corner of Chepil Lake have a circular pattern similar to those observed across the Fraser Lake, Lynn Lake and Norrie Lake gabbros, and further, these anomalies have very high magnetic fields (62 900 nT). For instance, the felsic volcanic rocks about 0.5 km to the northwest of Cockeram Lake and those about 1 km south of Hugo Lake have associated magnetic fields of about 60 000 nT which is 2 900 nT less than at Chepil Lake, and moreover, these have no distinct patterns. Therefore, a gabbroic intrusion is suspected near Chepil Lake, which can be modelled as follows. The derived model is a single subsurface intrusive dyke, with equal horizontal dimensions of about 2 000 m and a thickness of 3 660 m. The top surface of this configuration lies about 460 m below the ground. The susceptibility is fairly uniform except for the upper 3 000 m of the body. The magnetic susceptibility of the upper block increases in a southwesterly direction. This corresponds to the increase in amplitude of the anomaly curve (Fig. 4.15). The central portion of the upper block has the same susceptibility as the lower blocks, so these blocks may correspond to the same intrusive sequence. The blocks with different susceptibilities could have been formed by different intrusive sequences, with differing mineral contents. The area is covered by metavolcanic and metasedimentary rocks in which large susceptibility contrast between the postulated model and the surrounding felsic volcanic rocks can be explained by a subsurface gabbro body, which may be composed of two or three intrusive phases. The parameters of the model are listed in Table 4.4

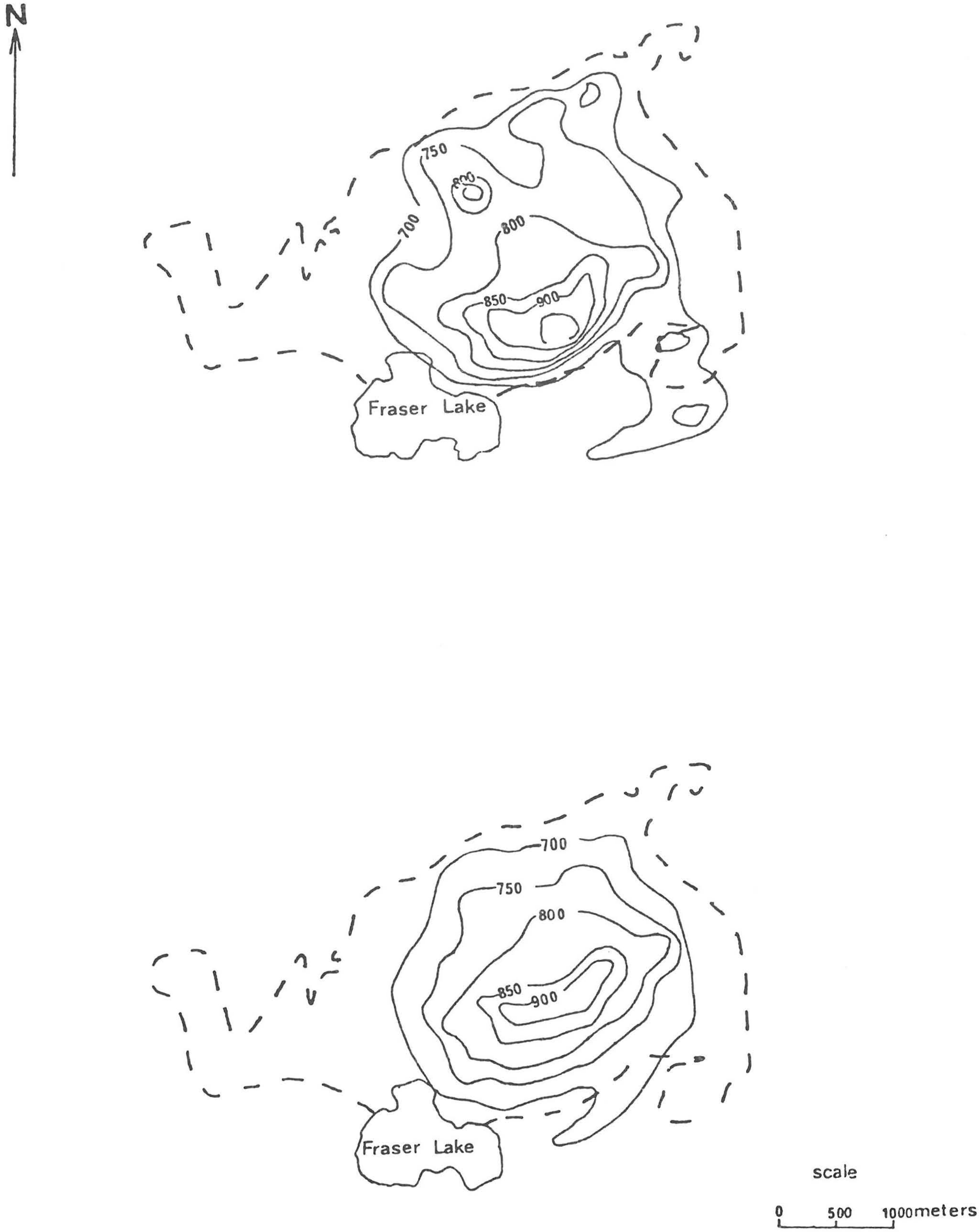


FIGURE 4.5 Magnetic anomalies over the Fraser Lake gabbro. The top diagram is the anomaly field, the bottom diagram is the model field, the dotted line is the outcrop of the gabbro body, the values are the magnetic field in nT with a subtraction of 60 000 nT.

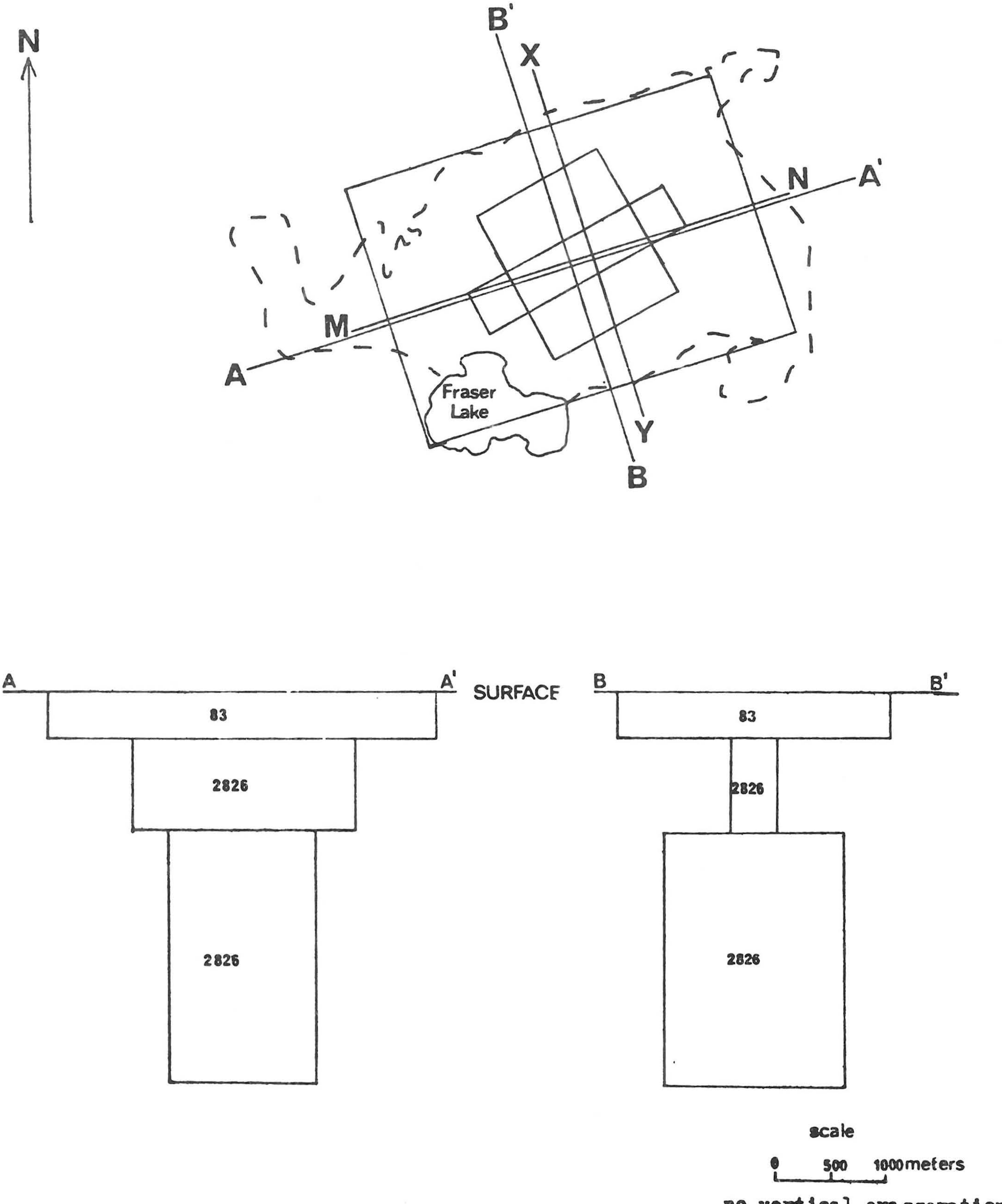


FIGURE 4.6 *Model of the Fraser Lake gabbro in plan view and in cross sections. The dotted line is the outcrop boundary of the gabbro body, the values are effective magnetic susceptibility ($x10^{-6}$ emu).*

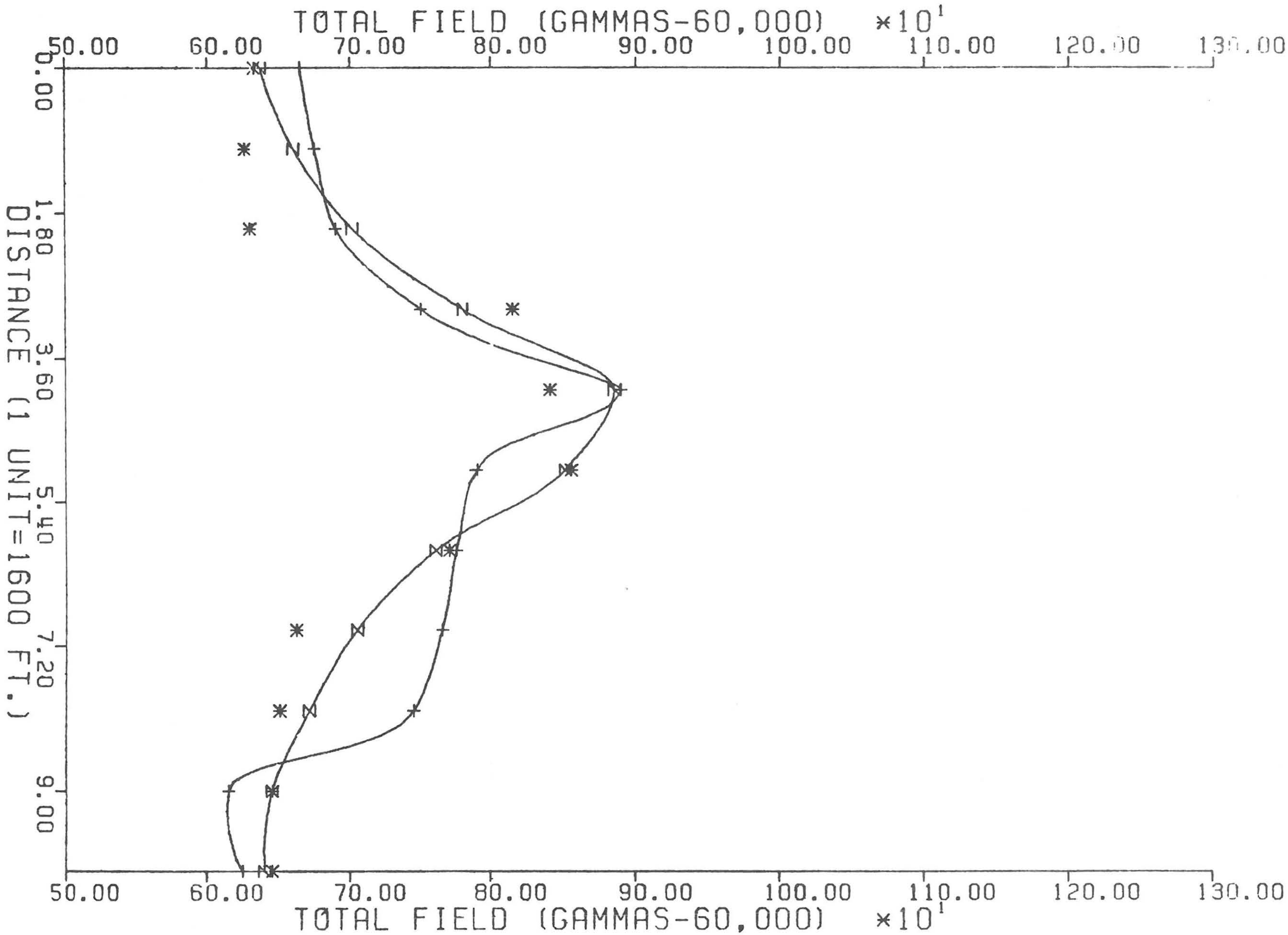


FIGURE 4.7 Magnetic Anomaly Profile across XY of Fraser Lake gabbro. Gammas are referred to as nT in text.

NOTE: '+' Anomaly Field; 'Z' Final Result; '' One Prism.*

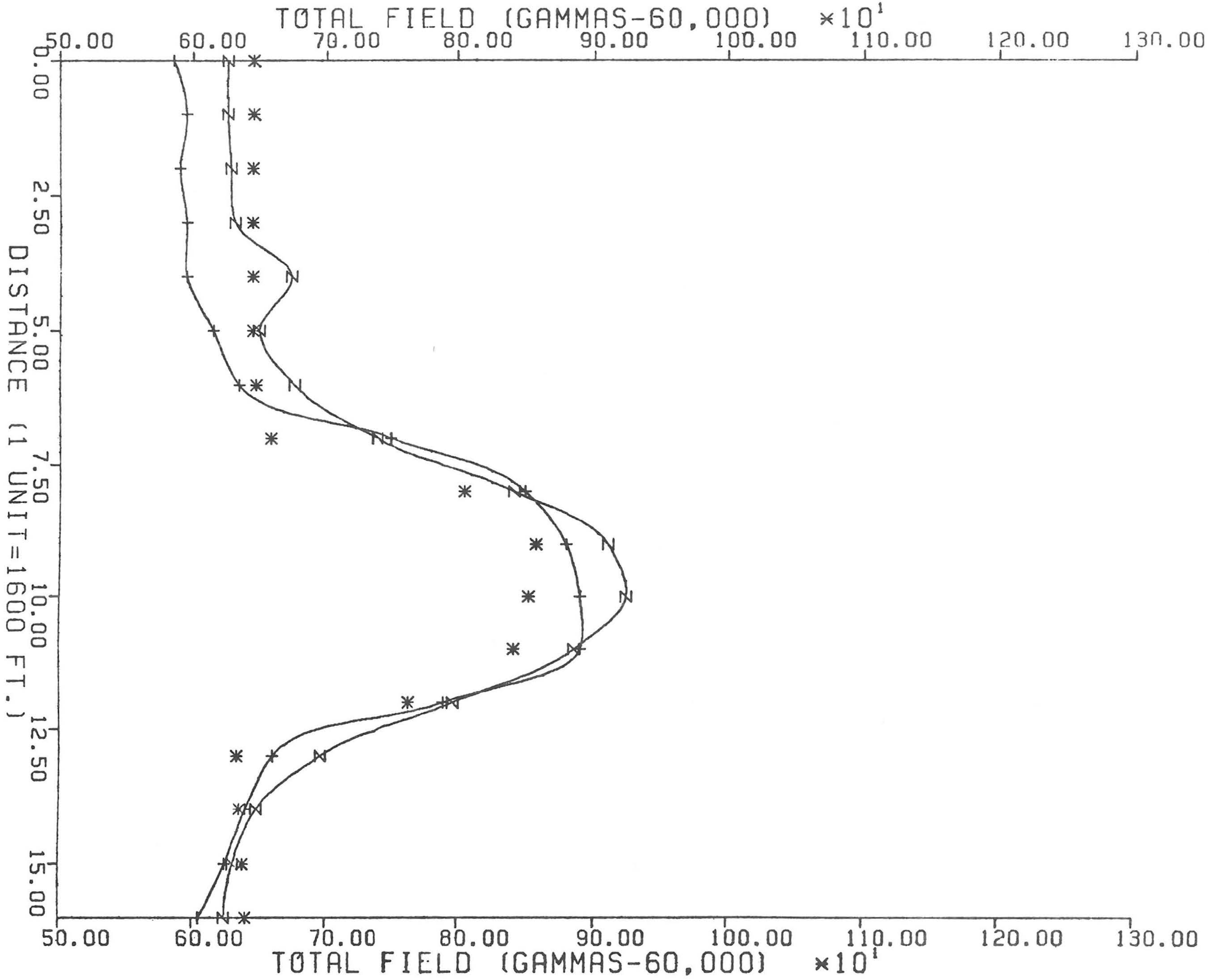


FIGURE 4.8 Magnetic Anomaly Profile across MN of Fraser Lake gabbro. Gammas are referred to as nT in text.
NOTE: '+' Anomaly Field; 'Z' Final Result; '' One Prism.*

TABLE 4.2 — The Configuration of the Fraser Lake Gabbro

# of prisms	Centre X	Centre Y	X length	Y length	Top	Base	Grid axis to block axis (°)	Polarization Decl. (°)	Polarization Incl. (°)	Polarization Int. (emu)
1	10.03	4.122	4.204	3.661	.1875	7.000	-.9480	9.58	97.09	.000396
3	10.00	4.000	8.582	6.053	.1750	1.314	-.4833	6.08	80.02	.000051
(final	9.999	3.902	4.900	1.014	1.314	3.000	12.37	11.53	83.66	.001713
result)	9.999	3.902	3.259	4.045	3.000	8.626	12.37	12.00	80.98	.001713

Declination of 'measured field' from true north 12.5°
Inclination of field 80.7°
Declination of x-axis 73.0°
Grid interval 1.0 by 1.0 unit
1 unit = 487.68 meters
The co-ordinates of the origin of the grid are (17.9, 23.5) w.r.t. the southwest corner of map 1 of aeromagnetic map '18005' (Questor Surveys)
RMS deviation 39.8

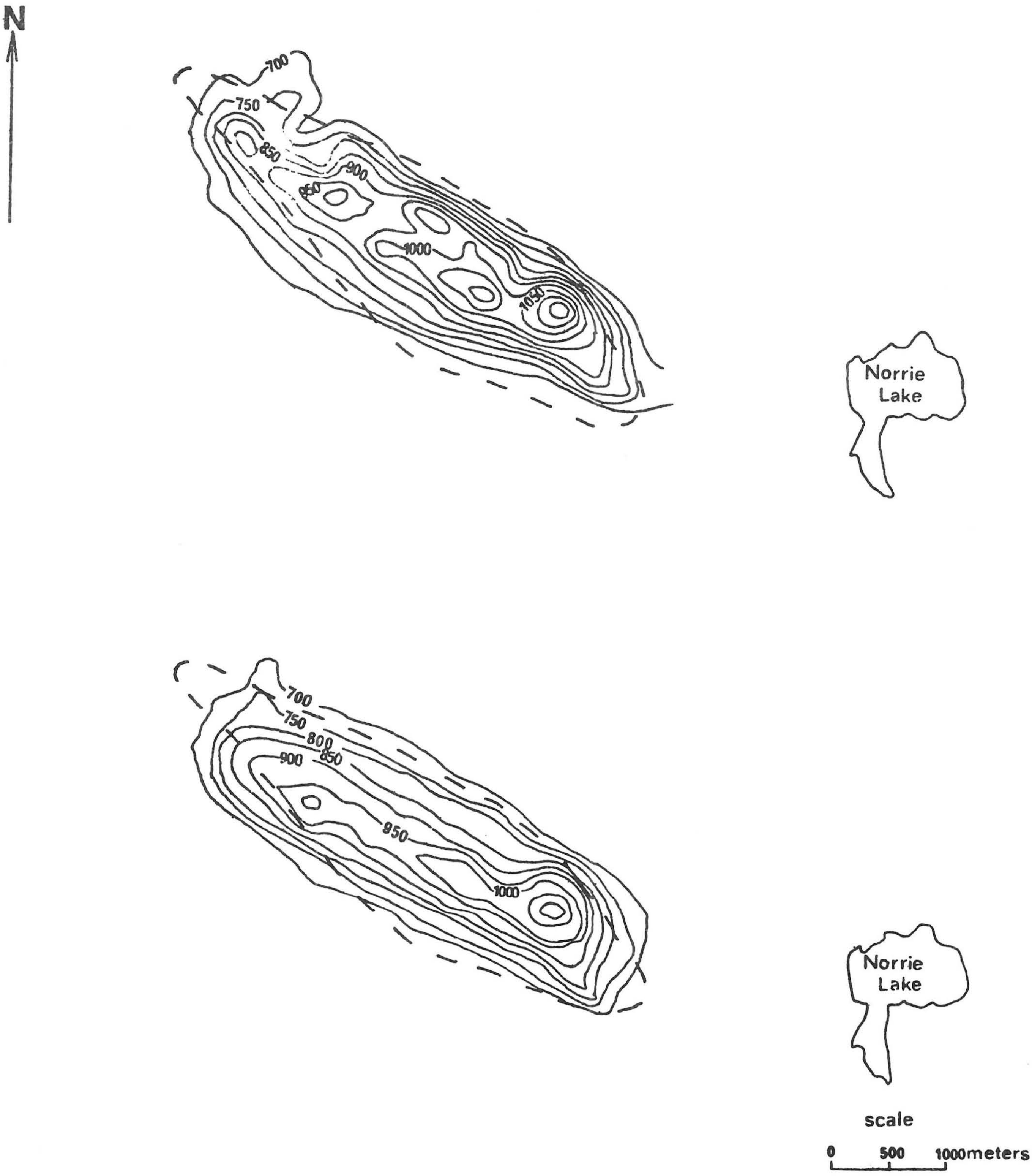


FIGURE 4.9 *Magnetic anomalies over the Norrie Lake gabbro. The top diagram is the anomaly field, the bottom diagram is the model field, the dotted line is the outcrop boundary of the body, the values are the magnetic field in nT with a subtraction of 60 000 nT.*

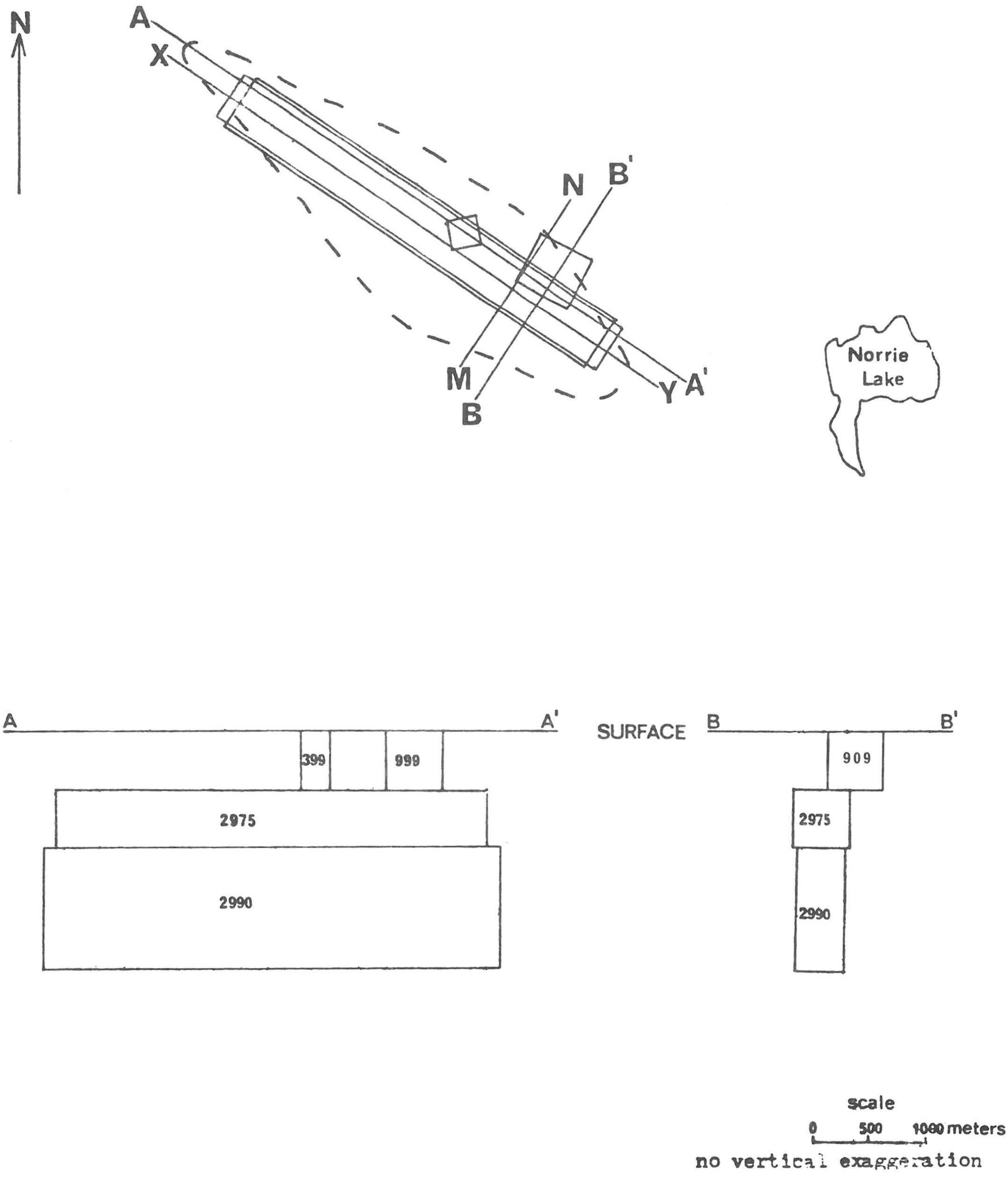


FIGURE 4.10 Model of the magnetic portion of the Norrie Lake gabbro in plan view and in cross sections. The dotted line is the outcrop boundary of the gabbro body, the values are effective magnetic susceptibility (x10⁻⁶ emu).

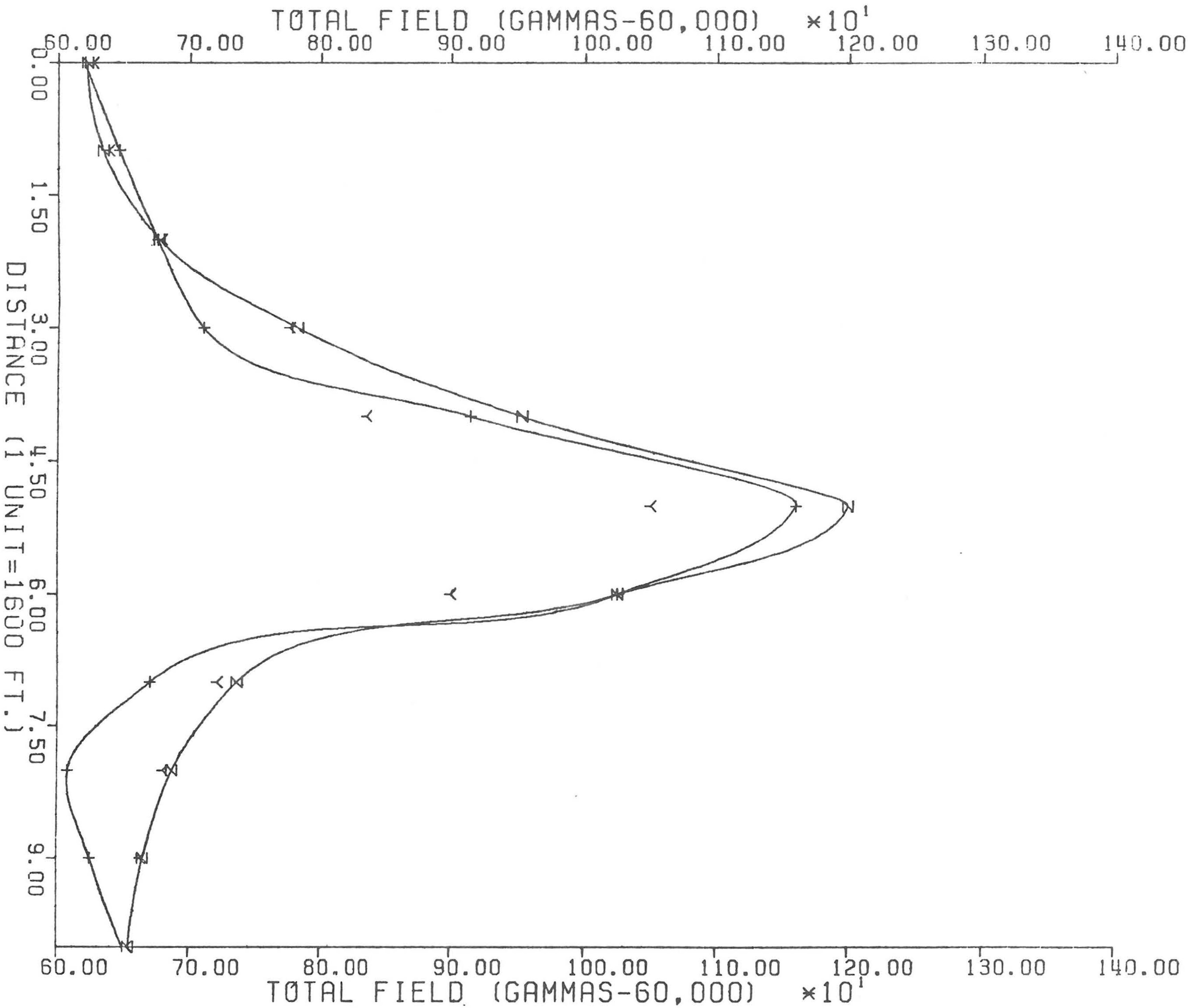


FIGURE 4.11 Magnetic Anomaly Profile across XY of Norrie Lake gabbro. In text gammas have been referred to as nT.

NOTE: '+' Anomaly Field; 'Z' Final Result; 'Y' Two Prisms.

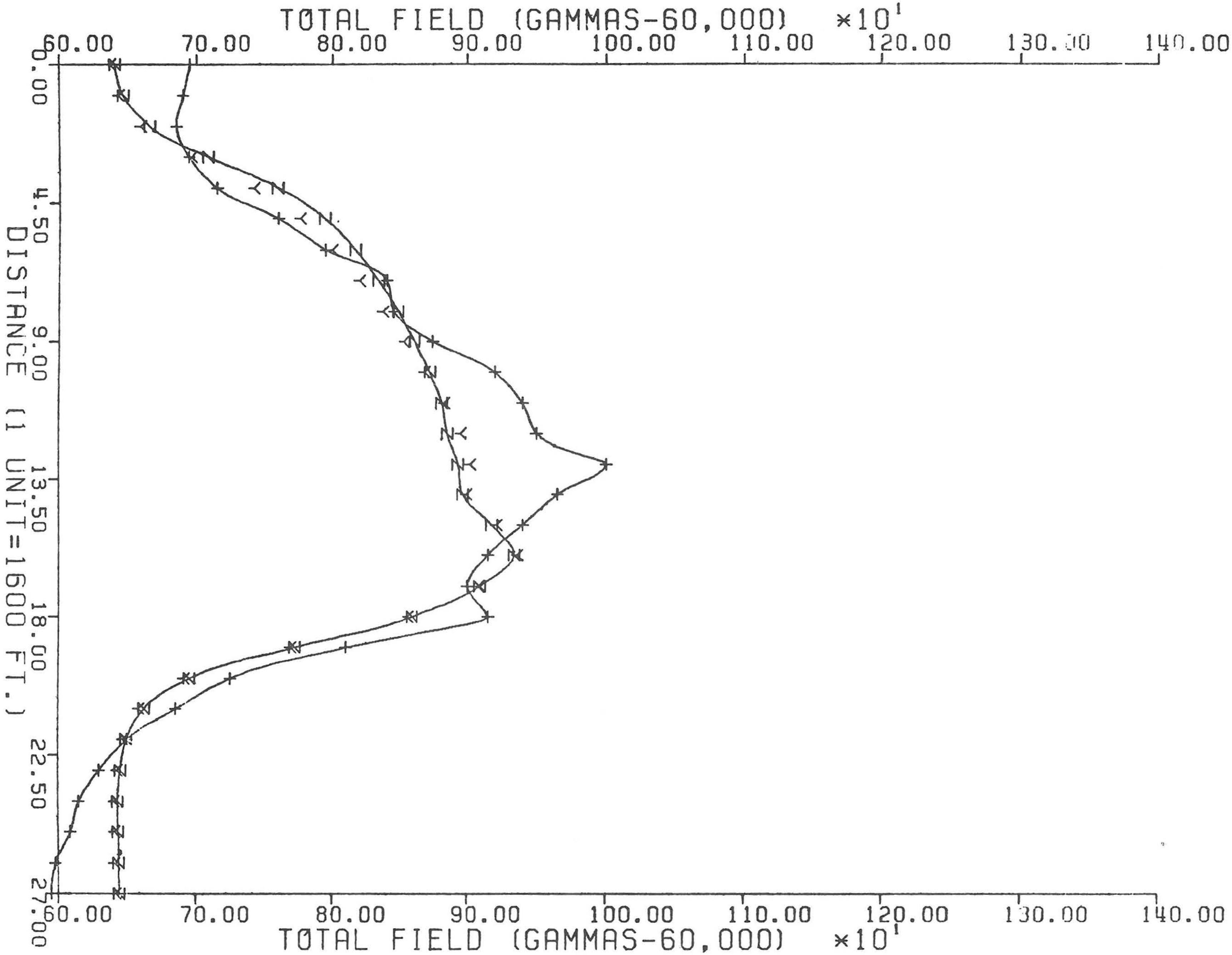


FIGURE 4.12 Magnetic Anomaly Profile across MN of Norrie Lake gabbro. In text gammas have been referred to as nT.

NOTE: '+' Anomaly Field; 'Z' Final Result; 'Y' Two Prisms.

TABLE 4.3 — The Configuration of the Norrie Lake Gabbro

# of prisms	Centre X	Centre Y	X length	Y length	Top	Base	Grid axis to block axis (°)	Polarization Decl. (°)	Polarization Incl. (°)	Polarization Int. (emu)
2	10.91	4.578	15.74	1.725	1.542	8.367	-5.877	12.00	80.50	.001831
	15.95	5.039	2.004	1.950	.1500	1.542	1.357	12.52	81.01	.000722
4	11.06	4.597	15.13	2.029	1.542	4.000	-4.833	12.52	80.70	.001826
(final	15.96	5.034	2.000	1.947	.1500	1.542	1.437	12.52	80.70	.000611
result)	12.50	5.000	.8000	.8000	.1500	1.542	-48.79	12.52	80.70	.000611
	10.91	4.578	15.74	1.725	4.000	8.367	-4.816	12.52	80.70	.001830

Declination of 'measured field' from true north 12.5°
Inclination of field 80.7°
Declination of x-axis 117.0°
Grid interval 1.0 by 1.0 unit
1 unit = 304.8 meters
The co-ordinates of the origin of the grid are (40.5, 39.5) w.r.t. the southwest corner of map 1 of aeromagnetic map '18005' (Questor Surveys)
RMS deviation 42.5

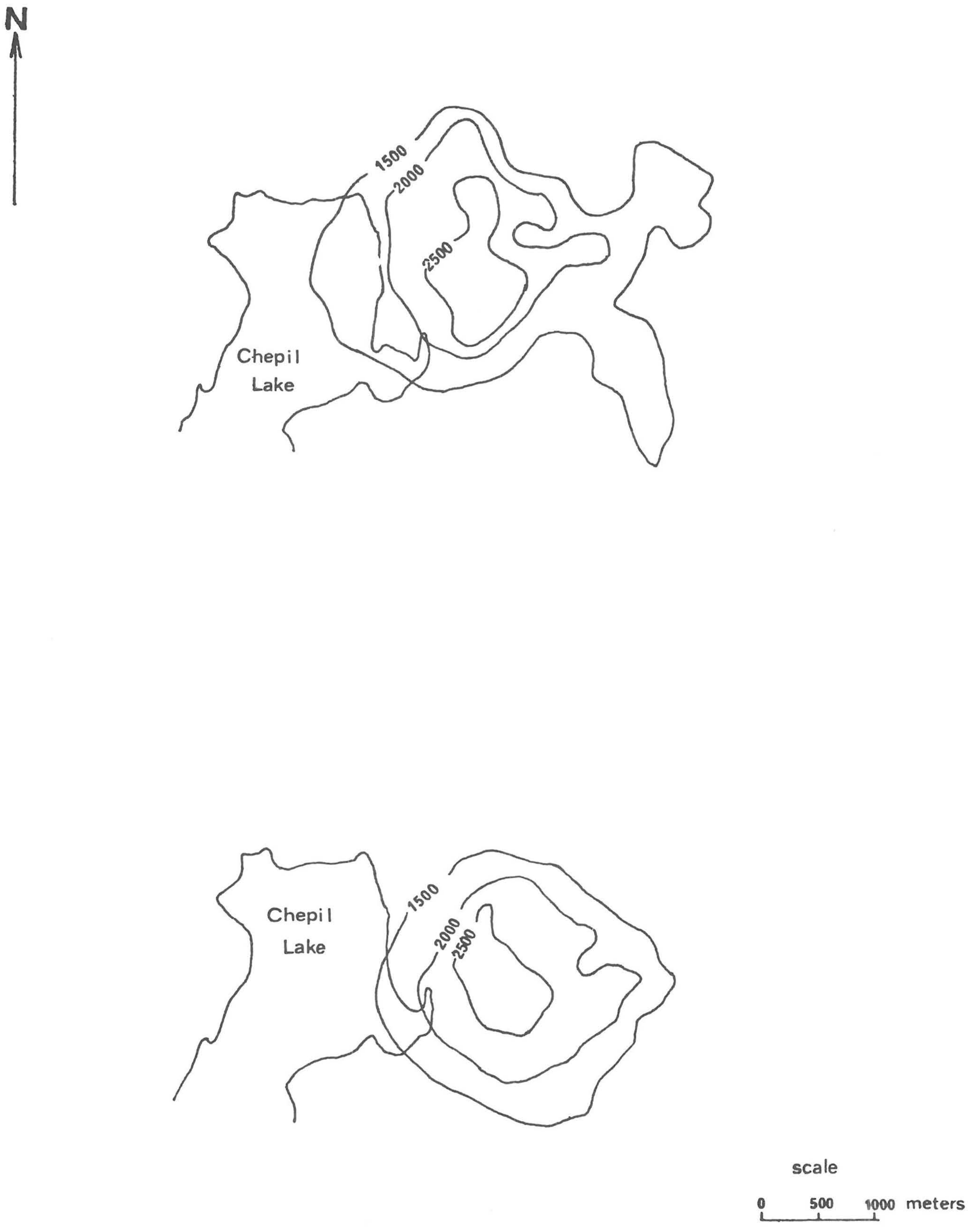


FIGURE 4.13 Magnetic anomalies near Chepil Lake. The top diagram is the anomaly field, the bottom diagram is the model field, the values are the magnetic field in nT with a subtraction of 60 000 nT.

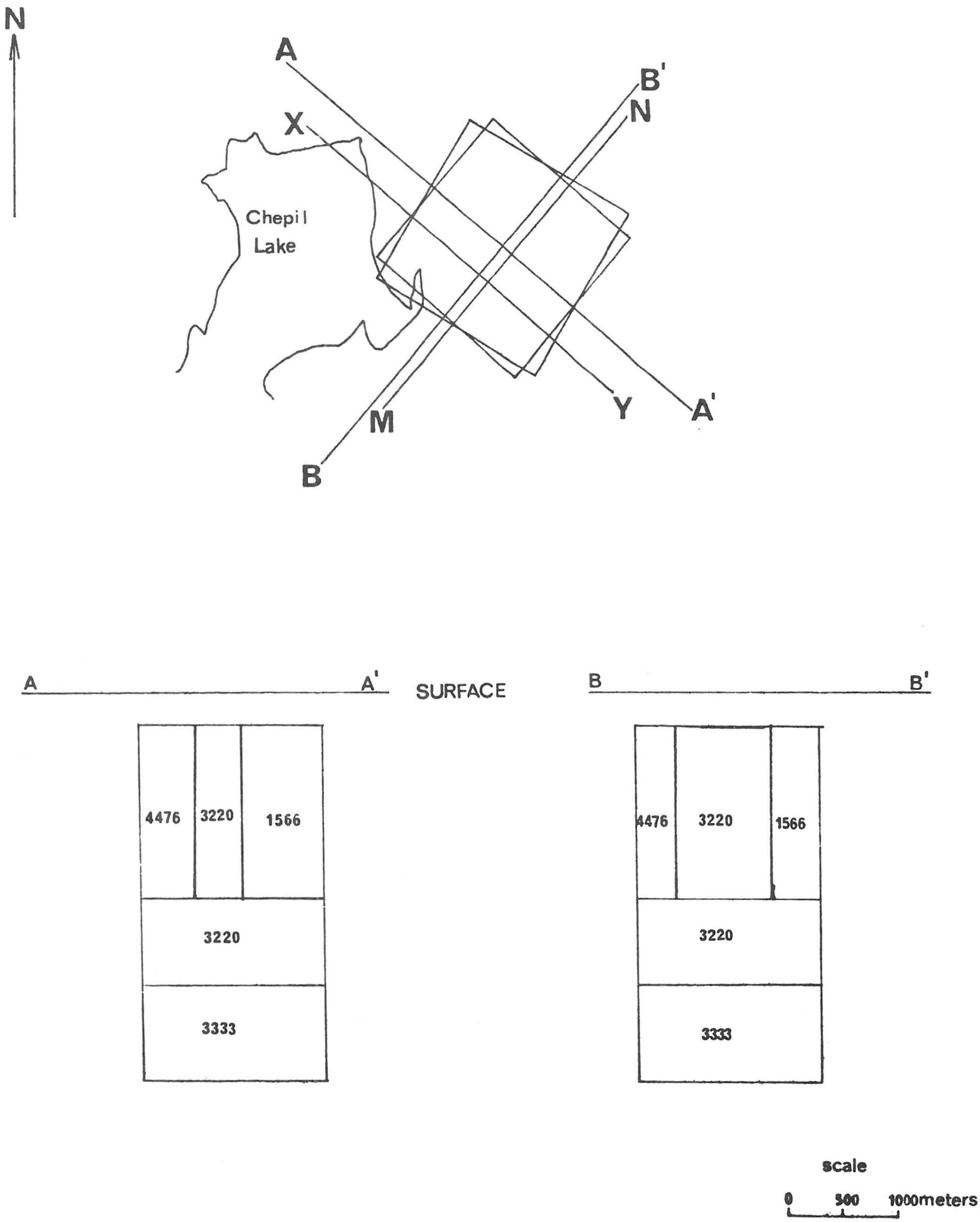


FIGURE 4.14 Model of the interpreted Chepil Lake gabbro in plan view and in cross sections. The values are effective magnetic susceptibility (x 10^{-6} emu).

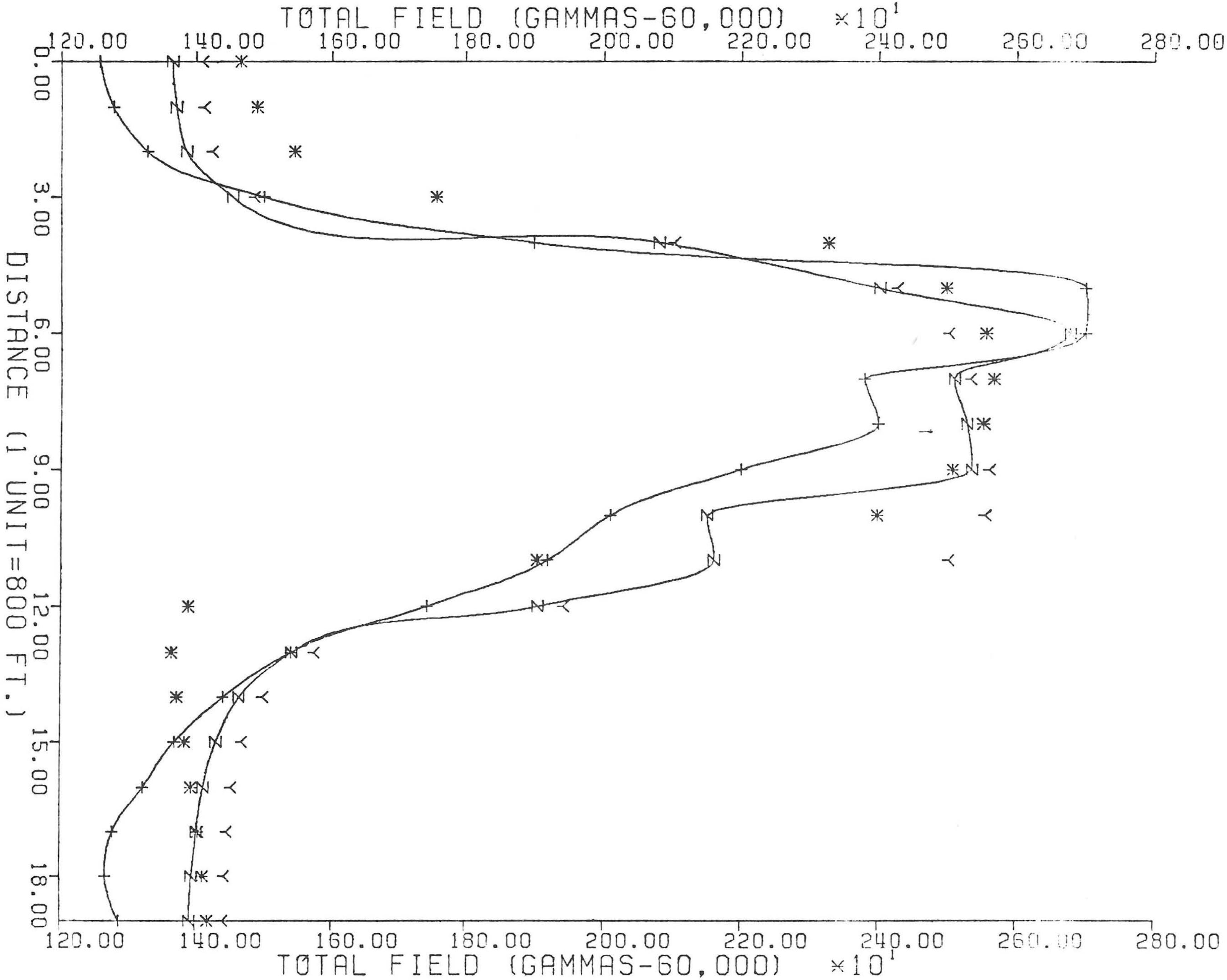


FIGURE 4.15 Magnetic Anomaly Profile across XY of interpreted Chepil Lake gabbro. Gammas are referred to as nT in text.
NOTE: '+' Anomaly Field; 'Z' Final Result; '' One Prism; 'Y' Two Prisms.*

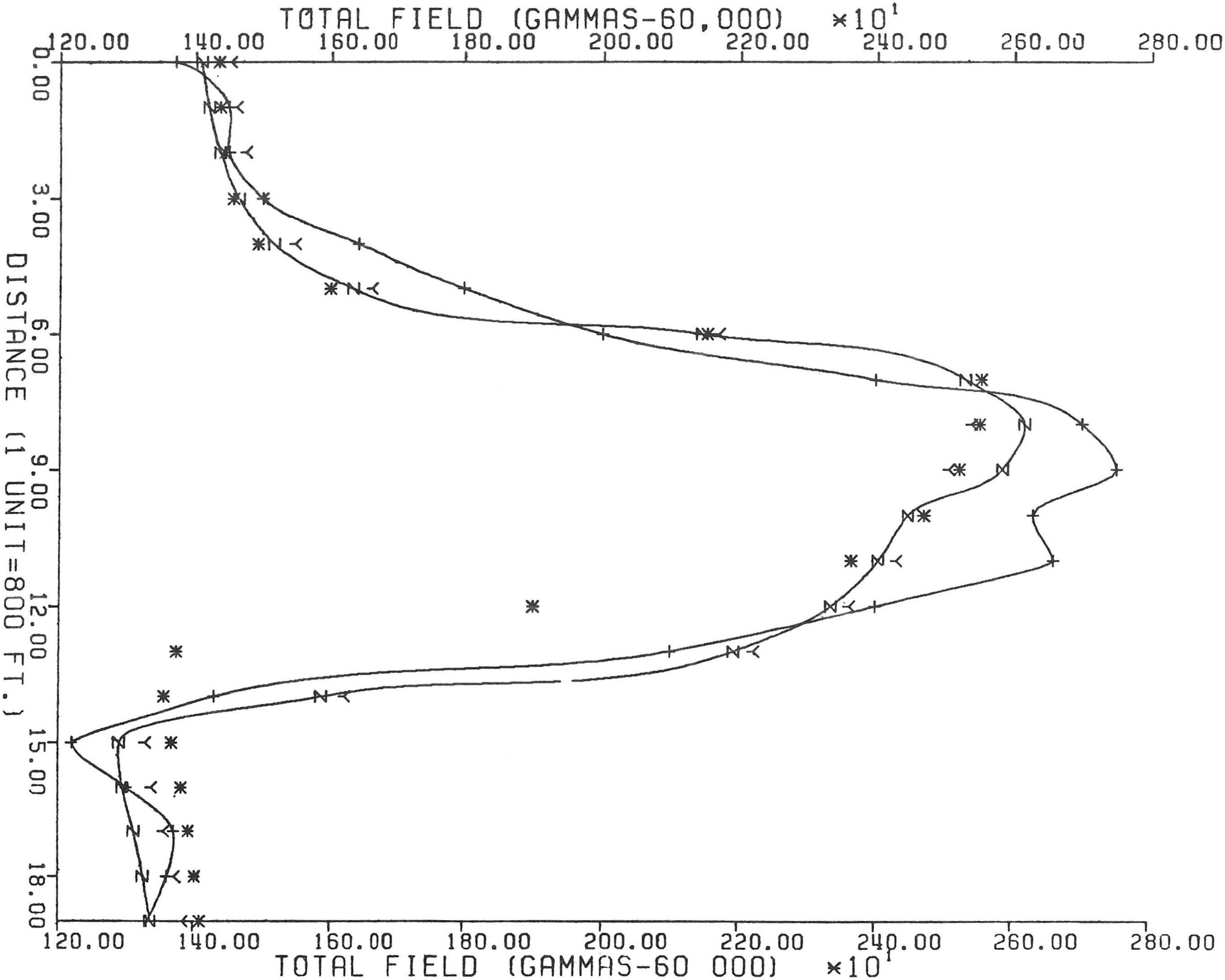


FIGURE 4.16 Magnetic Anomaly Profile across MN of interpreted Chepil Lake gabbro. Gammas are referred to as nT in text.
NOTE: '+' Anomaly Field; 'Z' Final Result; '' One Prism; 'Y' Two Prisms.*

TABLE 4.4 — The Configuration of the Interpreted Chepil Lake Gabbro

# of prisms	Centre X	Centre Y	X length	Y length	Top	Base	Grid axis to block axis (°)	Polarization Decl. (°)	Polarization Incl. (°)	Polarization Int. (emu)
1	9.148	7.663	5.990	7.636	.3750	10.00	11.77	10.02	80.77	.002139
2	10.00	7.700	7.894	8.069	.3750	8.000	-1.766	12.52	80.60	.001967
	10.00	7.760	7.935	8.228	8.000	12.00	315.8	12.39	81.09	.001967
5	7.250	5.150	2.500	2.520	2.074	8.000	-1.547	12.52	80.70	.002739
(final	12.25	9.95	3.500	3.509	2.704	8.000	-1.547	.12.52	80.70	.000957
result)	9.500	7.200	2.000	2.040	2.704	8.000	-1.547	12.52	80.70	.001969
	10.00	7.600	7.935	8.228	8.000	12.00	2.959	12.52	80.70	.001969
	10.00	7.600	7.900	8.228	12.00	16.00	-251.5	12.52	80.70	.001969

Declination of 'measured field' from true north 12.5°
Inclination of field 80.7°
Declination of x-axis −45.0°
Grid interval 1.0 by 1.0 unit
1 unit = 243.84 meters
The co-ordinates of the origin of the grid are (64.0, 42.0) w.r.t. the lower left corner of map 3 of aeromagnetic map '18036' (Questor Surveys)
RMS deviation 138.7

CHAPTER V — QUALITATIVE INTERPRETATION

PURPOSE OF THE INTERPRETATION

The correlation between geology and aeromagnetics in the survey area is investigated in this section. It has been shown in a previous section that many rock units in the area have distinct levels of effective susceptibility. It can be expected that these distinct levels of susceptibility are reflected in the levels of the associated magnetic fields. Further, the geometric configuration of the distribution of magnetization within a unit affects its magnetic signature. For example, concentration in equidimensional zones leads to a magnetic signature different from that for thin, elongated zones, or for a homogeneous distribution of magnetization. The survey area can be divided into distinct regions based on these signatures. The present section is devoted mainly to examining the degree of correlation between magnetic signatures and geology, and identifying some of the notable correlations.

THE GENERAL MAGNETIC FIELD

The general magnetic field may be best seen on the Geological Survey of Canada aeromagnetic maps 2373, 2374, 2377, 2378, 2381, 2382, 2385, 2386. The field is regionally high to the north and east of the Wasekwan belts. This area of above-average field extends from Dunphy-Zed Lakes and across the granitic terrain extending north to Carswell and Vandekerckhove Lakes. It also appears as a regional high on the Mountain Mineral Resources Division Map 75-3. Broad anomaly trends striking north-eastward lie within the regional high and may mark subunits within the granitic area.

Narrower trends lying over various units within the Wasekwan and Sickle belts give rise to a complex field over these belts and their associated plutonic bodies. Many of the units in these belts have a distinctive magnetic signature, which is evident particularly on the Questor 1:20 000 and 1:50 000 maps. In the following sections some of these magnetic-geology correlations are identified and display methods applied in illustrating them.

High closures of 1 000 nT or more above the regional fields occur over the following units: a Sickle Group conglomerate unit, iron formations, and some intrusive bodies, particularly gabbro.

DETAILED INTERPRETATION MAPS

The detailed interpretation maps are presented at the scale of 1:50 000. Their borders are keyed to the 1:50 000 sheets supplied with the Questor Survey and they have been given the same names: i.e.

The Fox Lake Mine Area
The Lynn Lake Area
The Sickle Lake Area
The Barrington Lake Area

The boundaries of the relevant geological maps at 1:50 000 scale issued by the Manitoba Mineral Resources Division to March, 1979 are shown on the maps. The susceptibility maps are also at the same scale. The 61 500 nT and 62 000 nT magnetic contours, taken from the Questor maps, are shown on the Detailed Interpretation maps. The contours are labelled by numbers which are equal to the value of field on the Quester sheets minus 60 000 nT, and in units of hundreds and gammas. Thus 61 500 on the Questor sheets becomes (61 500-60 000) ÷ 100 = 15 on the maps of this report. The major magnetic zones on the sheet are outlined in heavy line. These boundaries usually, but not always, coincide with geological boundaries. The zones are differentiated on the basis of magnetic character and level of magnetization. The differences among these factors can be seen on the maps. A brief indication of the lithology is given for each zone. A detailed analysis of these maps for the Fox Lake and Sickle Lake blocks follows, using examples chosen to illustrate in detail the information contained on the Detailed Interpretation maps.

FOX LAKE MINE AREA

Summary of zones — Table 5.1 summarizes the characteristics of prominent zones which can be distinguished on the Detailed Interpretation map of the Fox Lake mine area. For zones consisting mainly of rock units for which magnetic susceptibilities have been determined, values are quoted from Table 3.2. Following are some comments on the zones listed in Table 5.1:

Zone I. An extension of the magnetic survey south and east of Pyta and Conglomerate Lakes would aid in mapping the surface and subsurface configuration of the Sickle conglomerate member. It is an unusually distinct magnetic marker.

Zone II. Gabbro outcrop in the area is outlined by the 61 500 nT contour north of Wilmot Lake. Magnetics could be used in this zone to map gabbro bodies.

Zones V and VI. These zones are parts of trends evident on the Geological Survey of Canada aeromagnetic map series (1 mi = 1 in). A broad area of above-average field lies in the area extending from a point north of Dunphy Lake to a point south of Suttie Lake. This is over the southern part of a large granitic area, and may be a regional anomaly. Such an anomaly is seen on Map 75-3 (Manitoba Mineral Resources Division), lying over the granitic terrane between Dunphy Lake and Carswell-Vandekerckhove Lakes.

Profiles across prominent zones — A number of magnetic profiles across Fox Lake mine area were plotted from the digital data tape using the program PRTPLOT (Appendix 2).

An example of such a profile is shown in Figure 5.1. The top part of the diagram is the magnetic profile, with the vertical axis indicating the field strength in nT above the 60 000 nT level. Geological unit numbers and contacts are shown on the top-most line (level with the '1821' nT mark). These unit numbers have been taken from the relevant preliminary maps of the Manitoba Mineral Resources Division. The two lines immediately below the legend 'channels,' indicate the channel numbers, e.g., in Figure 5.1 channel numbers 1 to 97 are displayed. The five lines following 'contents' indicate the field strength associated with every channel, e.g., channel 13 has a field of (1 443.5 + 60 000 nT). The locations of the channels, in kilometres from the origin, are indicated in the five lines following 'low edge,' e.g., that edge of channel 75 which is closer to the origin, is 14.8 km away from it. The two bottom-most lines in the diagram give the positional and dimensional information, i.e. the coordinates of the end points of the profile, map and profile number, I and J dimensions, etc.

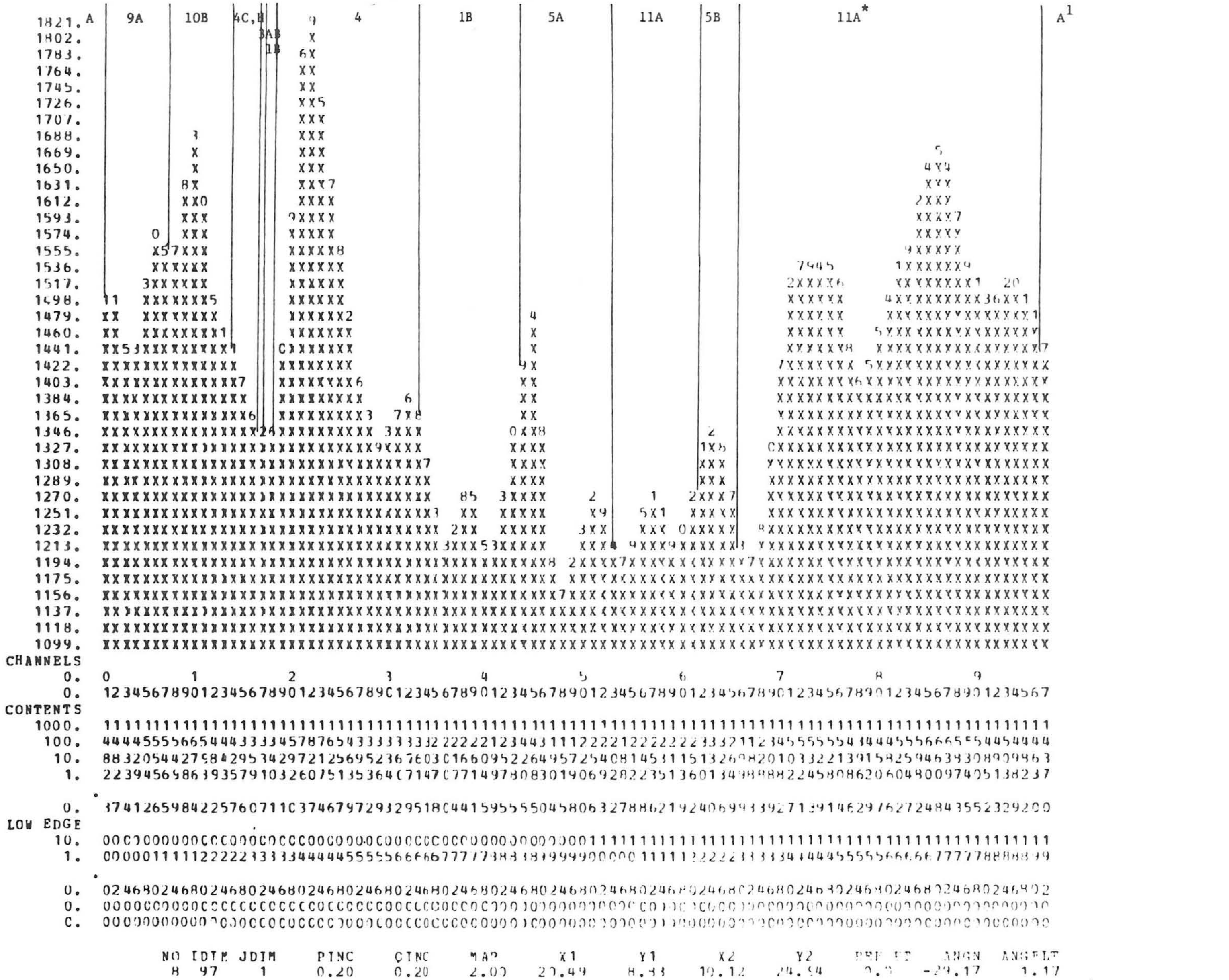
The first profile, AA[1] (Fig. 5.1) runs northwest through Wilmot and Irene Lakes. The second, BB[1] (Fig. 5.2) runs parallel to it and 4 km to the west. These profiles show a number of important features. First of these is the area of granitic intrustives (11A) which can be divided into two zones (V and VI, Table 5.1) of differing magnetic characteristics. This difference in field levels represents either different phases in the granitic intrusives, or a regional field generated by a large subsurface magnetic body. Notable on each profile is a small magnetic high over the layered amphibolite 5B. The profiles suggest that occurrences of this rock type, additional to those mapped on sheet 1977L-1, may be found in this area. The area of basic volcanics (5A), granitic intru-

TABLE 5.1 — Fox Lake Mine Area

Zone	Location	Magnetic character (average field, 61,500 nT)	Geology
I	Tod-McWhirter-Eager-Conglomerate-Shannon Lakes	narrow anomaly trends, ($<$1 km) rising from average levels to over 63,000	refer to Manitoba Mineral Resources Division Preliminary Maps Nos. 1976L-1, 1977 L-1, L-3. The anomaly trends are the expression of the Sickle Group conglomerate unit 10B*; $\bar{k}$ = 3.15 x 10^{-3} emu.
II	centred on Wilmot Lake	broad anomaly trends ($\sim$1 km) rising from average levels to over 63,000	basic volcanics[1] (unit 4) gabbro (7A), conglomerate[2] (10B), and iron formation. These have $\bar{k}$ = 0.130 x 10^{-3}, 0.410 x 10^{-3}, 3.15 x 10^{-3} emu, and up to 15 x 10^{-3} emu.
III	centred on Fox Lake	similar to zone 2	similar to zone 2; volcanics mostly units 2 and 4
IV	centred on Snake Lake	no prominent anomaly systems; field is below average levels	felsic volcanic rocks[1] (3A); gabbro[1] (7A), granitic rock (11A), for the volcanics $\bar{k}$ = 0.087 x 10^{-3} emu.
V	north of Dunphy Lakes	large area ($\sim$10 km across); of higher than average field	this lies over an area of granitic intrusives (11A, 11B); it may represent a distinct phase of the intrusive or be the high point in a regional field.
VI	passing through Dunphy Lakes	large area ($\sim$10 km across); of lower than average field	this lies over an area of granitic intrusives (11A, 11B); it may represent a distinct phase of the intrusive or be the high point in a regional field.

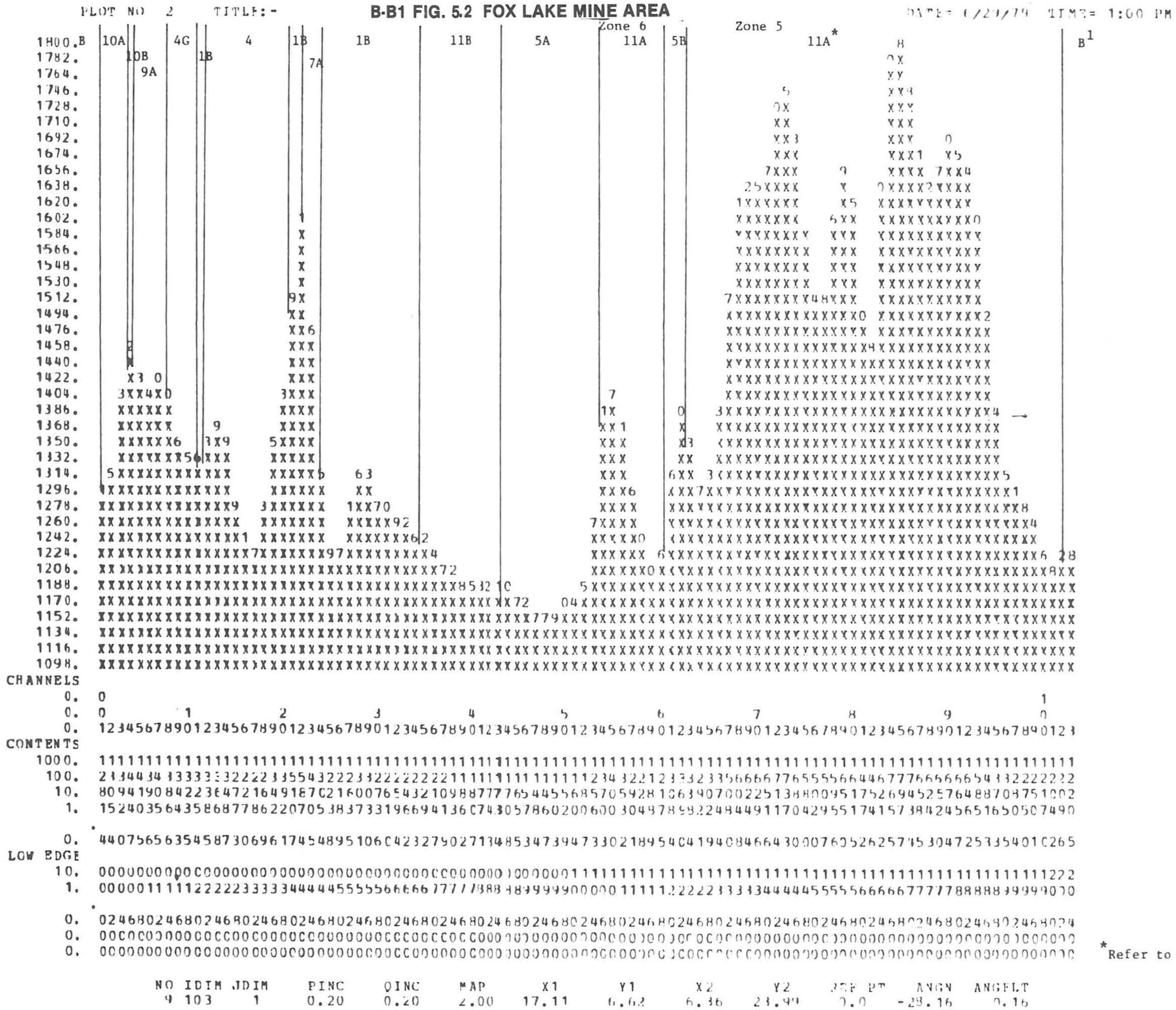
* for numbered units, see legend on Preliminary Map 1977L-1; [1] Wasekwan; [2] Sickle Group.

PLOT NO 1 TITLE:- **A-A1 FIG. 5.1 FOX LAKE MINE AREA**



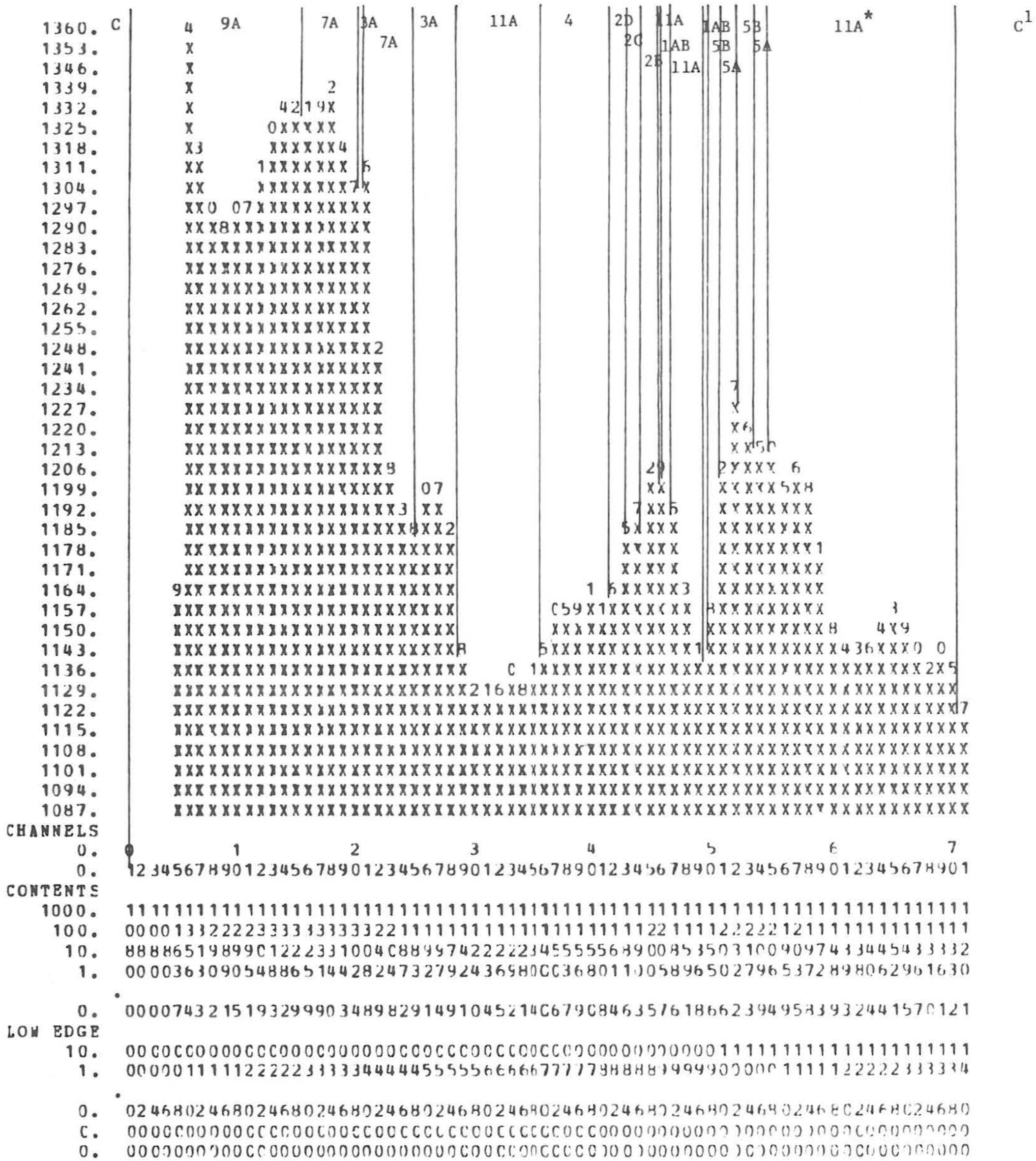
*Refer to Map 1977 L-1

B-B1 FIG. 5.2 FOX LAKE MINE AREA



*Refer to Map 1977 L-1

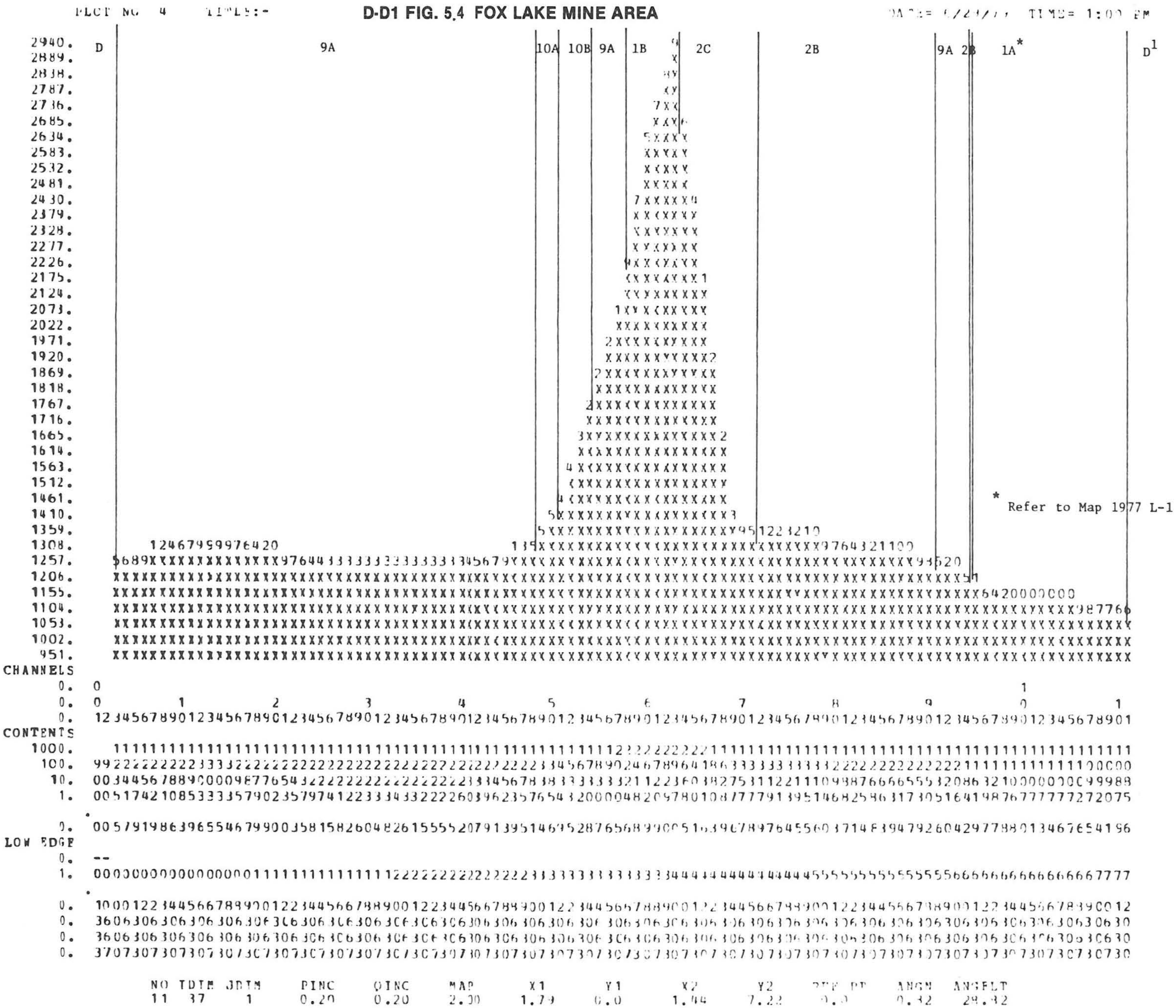
PLOT NO 3 TITLE:- **C-C1 FIG. 5.3 FOX LAKE MINE AREA** DATE= 6/29/79 TIME= 1:00 PM



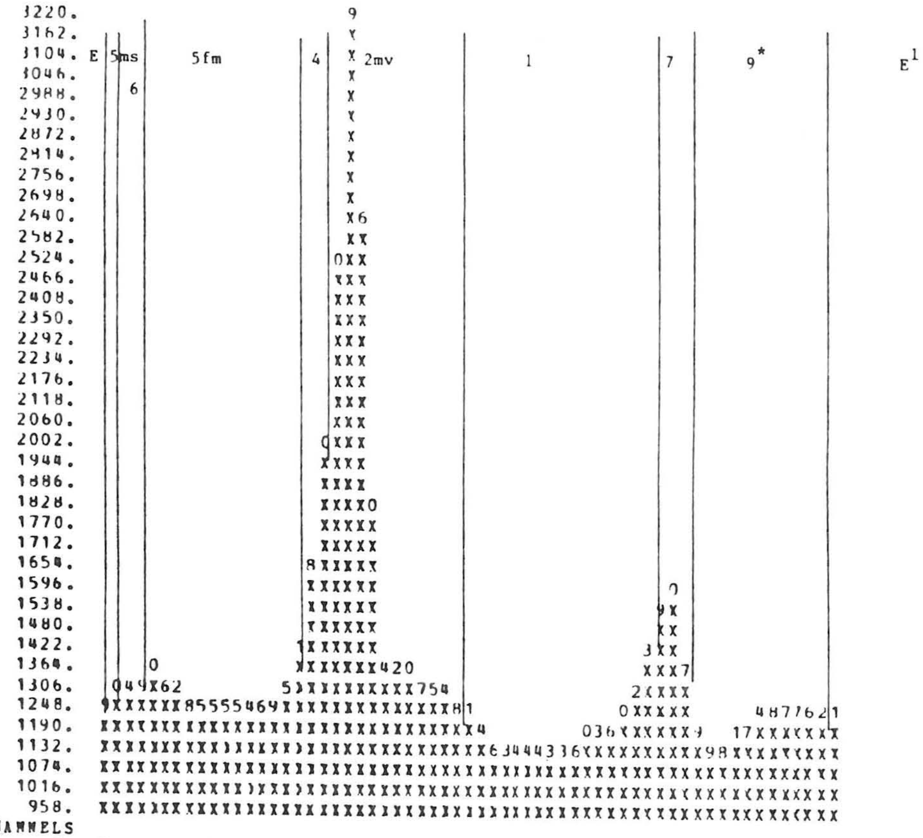
NO	IDIM	JDIM	FINC	QINC	MAP	X1	Y1	X2	Y2	[illegible] PT	ANGM	ANGFLT
10	71	1	0.20	0.20	2.00	7.61	-0.34	4.78	13.28	0.0	-8.14	19.86

*Refer to Map 1977 L-1

D-D1 FIG. 5.4 FOX LAKE MINE AREA



PLOT NO 5 TITLE:- **E-E1 FIG. 5.5 FOX LAKE MINE AREA** DATE= [illegible] TIME= 1:00 PM



* Refer to Map 1976 L-1

```
CHANNELS
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CONTENTS
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      1.  3160171630197741535948508802186217282412414226994058488407 66
      .
      0.  4423492937151453422641454495326636438270531958800639001527236
LOW EDGE
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      1.  0000011111222223333344444555556666677777388838999900000111112
      .
      0.  0246802468024680246802468024680246802468024680246802468024680
      0.  0000000000000000000000000000000000000000000000000000000000000
      0.  0000000000000000000000000000000000000000000000000000000000000
```

NO	IDIM	JDIM	PINC	QINC	MAP	X1	Y1	X2	Y2	REF PT	ANGN	ANGPLT
12	61	1	0.20	0.20	4.00	18.76	6.97	18.55	18.89	0.0	1.79	31.79

sion (11B), greywacke and siltstone (1B) all have low magnetic fields associated with them. Both profiles enter Zone 2, and show the characteristic field levels and the general character of this zone.

* Units are numbered according to the legend on Map 1977L-1 (Manitoba Mineral Resources Division).

Also shown are profiles CC' (Fig. 5.3) — Pyta Lake to Dunphy Lakes; DD' (Fig. 5.4) — McWhirter-Hatchet Lakes and EE' (Fig. 5.5) — along western border of Map 1977L-1 from 56°34' to 56°40'. The last two show the prominent contributions of iron formations and conglomerates to the magnetic field.

SICKLE LAKE AREA

The Sickle Lake sheet shows the magnetic zones and related Geology. Several gabbro intrusions are evident on this sheet, and the similarity of their magnetic character is readily apparent. The value of quantitative interpretation of such anomalies is shown in a previous section. The notations on the sheet indicate the magnetic and geological characteristics of the zones. These are further clarified by profiles plotted from the digital data using the program PRNPLOT. For example, AA' (Fig. 5.6) runs across Sickle and Durand Lakes. Field levels are low in a Sickle arkose unit, with a small anomaly over a Sickle conglomerate member. The field is low again over Wasekwan basalt and gabbro, but rises rapidly over a pre-Sickle gabbro intrusion at Durand Lake. Profile BB' (Fig. 5.7) runs northwest across a suspected gabbro body at Chepil Lake (Chapter IV). Wasekwan metavolcanic units similar to those at the anomaly peak, also occur near B but there they occupy an area of low magnetic field; thus the suggestion of a subsurface gabbro intrusion. The depth of its top has been interpreted in the preceeding chapter to be between 300 and 400 m.

The magnetic characteristics of metavolcanics and metasediments in the area are shown by a number of profiles. CC' (Fig. 5.8) and DD' (Fig. 5.9) cut across a belt of Wasekwan volcanic rocks and Sickle sediments. CC' runs east-west across Hughes Lake. The field is relatively low in the area of pre-Sickle intrusive rocks south of Chepil Lake, but rises markedly as the contact with Sickle Group arkose and greywacke is crossed. The field then drops off and becomes even lower as an area of Wasekwan metavolcanics is entered. DD' runs from Gap Lake to Kay Lake. The field begins at low levels (at D) over pre-Sickle intrusives, but rises rapidly as the Sickle group (a conglomerate and an arkosic member) is encountered. The field then drops rapidly to very low levels as an area of Wasekwan metavolcanics is crossed. The field then resumes moderate levels in the area of pre-Sickle intrusives. Fluctuations in the level mark various phases of the intrusive complex. EE' (Fig. 5.10) represents a profile running across an area of pre-Sickle intrusives with a belt of Wasekwan basalt and Wasekwan conglomerate running through it. The field rises to a peak over this belt. The peak lies near the contact and quantitative interpretation is required to decide which unit is generating the anomaly. Just to the northeast of the profile, a large anomaly peak is found over the Wasekwan basalt unit, while this same unit where crossed by AA' (Fig. 5.6) has very low field expression while a Sickle conglomerate unit has a distinct anomaly. This local variation of field within a particular belt may be important in further subdividing the lithology of the belt.

Profile FF' (Fig. 5.11) runs northeast from Dufresne Lake across an area designated as undifferentiated greenstone. This belt may be similar to the belt to the west of it. Both have high magnetic fields over them as is seen by comparing Figures 5.10 and 5.11. Profile GG' (Fig. 5.12) running east-west between Dufresne and Hanna Lakes, further confirms the nature of the latter belt; as the Wasekwan volcanics are crossed, the field rises by about 500 nT.

Profile HH' (Fig. 5.13) runs almost north-south across Sickle Lake. The field drops to a pronounced low over the lake. A negative anomaly of this magnitude (500 nT or more) is unlikely to be a topographic effect due to the lake. It may be due to a distinct member within the Sickle sediments, or even to reverse NRM in the Sickle conglomerate flanking the lake. The field recovers as an area of pre- and post-Sickle intrusives is entered.

BARRINGTON LAKE AND LYNN LAKE AREAS

The detailed maps for these areas give indications of magnetic zones and geology similar to those described in detail for the Fox and Sickle Lake areas.

GENERALIZED INTERPRETATION MAPS FROM MAGNETICS AND GEOLOGY

These maps have the same format, scale, and boundaries as the Detailed Interpretation maps. They have been generalized from these maps and indicate areas with characteristic magnetic field levels and geology. This information is included on the legends of the maps. These maps would be of value in more generalized assessment of the magnetic responses of the main geologic units.

FOX LAKE AREA

Relative highs — Zone I — This zone represents a linear trending "belt" of granitic gneisses and includes a slice of mafic volcanics to the east.

Zone II — This zone represents highly magnetic conglomerates. Relatively strong highs (up to 63 000 nT) occur in this very linear-trending trough. In the west it represents a highly folded sequence of coarse grained sandstone and conglomerate gneisses. In the east, where it is narrower and more linear, it probably reflects a conglomerate with high magnetic susceptibility. Magnetics correlate with traceable strata in outcrop, and can be used to trace the strata where outcrop is lacking.

Zone III — A stratigraphically traceable bed of iron formation or gabbroic lenses occurs here within largely mafic volcanics. The anomalies are numerous, small and rounded with a constant E-W strike, having readings of 61 500 to 61 700 nT.

Zone IV — In this zone, the higher readings represent magnetite-rich or sulphide-rich mafic volcanics, or gabbroic sills within the slice of dominantly mafic volcanics. This grades in the west to a very similar magnetic pattern but different geology (granitic gneisses).

Zone V — The magnetic pattern here is very complex, although not particularly high in amplitude. The magnetic contours vary from small, circular anomalies to very large, elongate patterns. Amplitudes are in the range of 61 000 to 62 000 nT. Geologically, the area encompasses two basic zones: 1 — mafic volcanics with local areas of conglomerate and/or iron formation giving the higher readings, and 2 — arkosic sandstones.

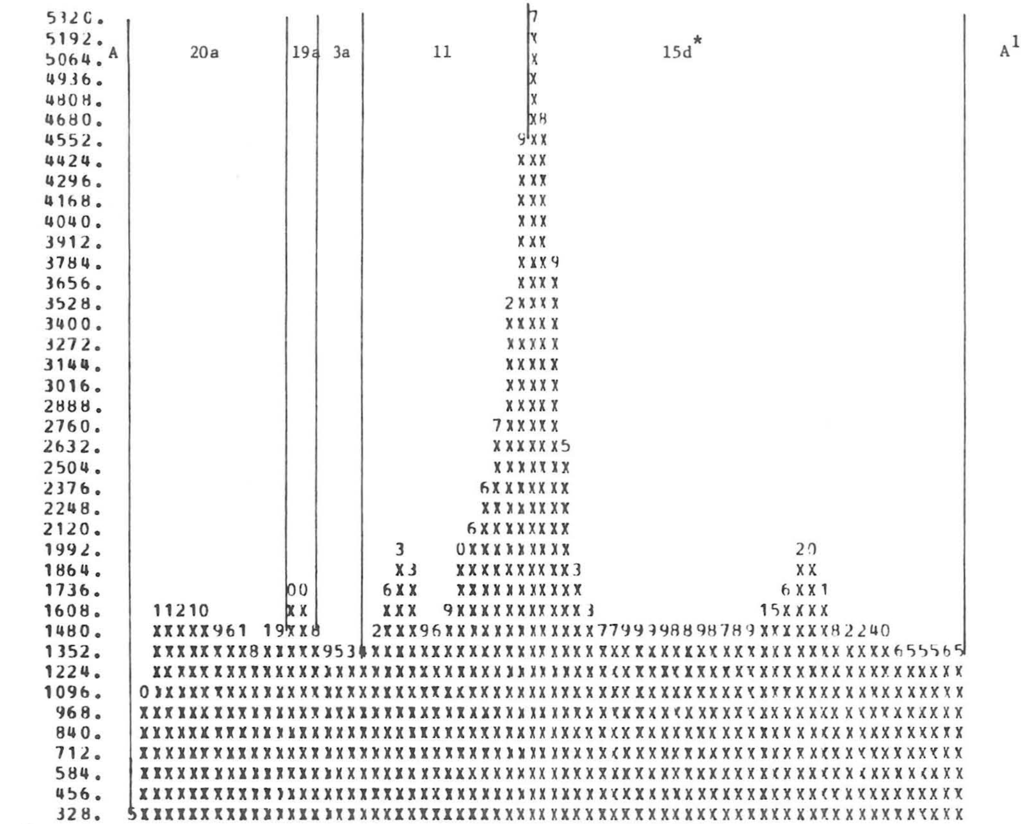
Zone VI — There is no geological information for this area. The magnetic pattern has a signature very similar to the slices of mafic volcanics and granitic gneisses.

Zone VII — This area is also magnetically complex. The contours are very large and elongate and encompass a very large area. They could possibly be caused by a large plug, with the smaller, circular highs representing more mafic intrusive rocks. It has all been mapped as dioritic intrusive but the magnetics suggest that more mafic rocks are involved as well, i.e. a composite intrusion.

Relative lows — Zone A — All readings are less than 61 000 nT. The area represents granitic rock.

Zone B — There are consistently low readings here but the geology is not as simple as in the case for Zone A. It includes granite, diorite, and greywacke sediments.

PLOT NO 1 TITLE:- **A-A1 FIG. 5.6 SICKLE LAKE AREA** DATE= 6/29/79 TIME=12:55 PM



*Refer to Map 1977 L-6

```
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   .
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```
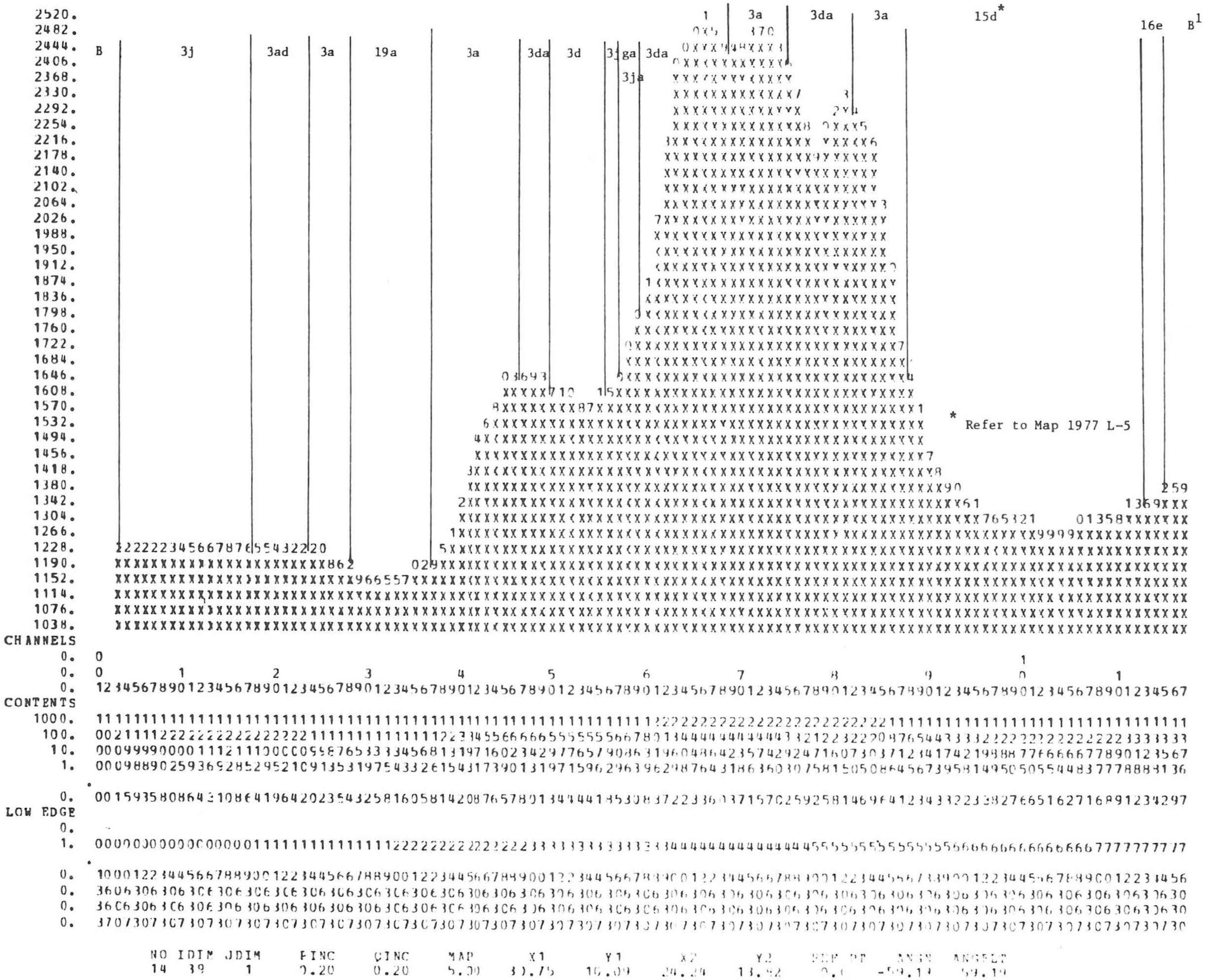
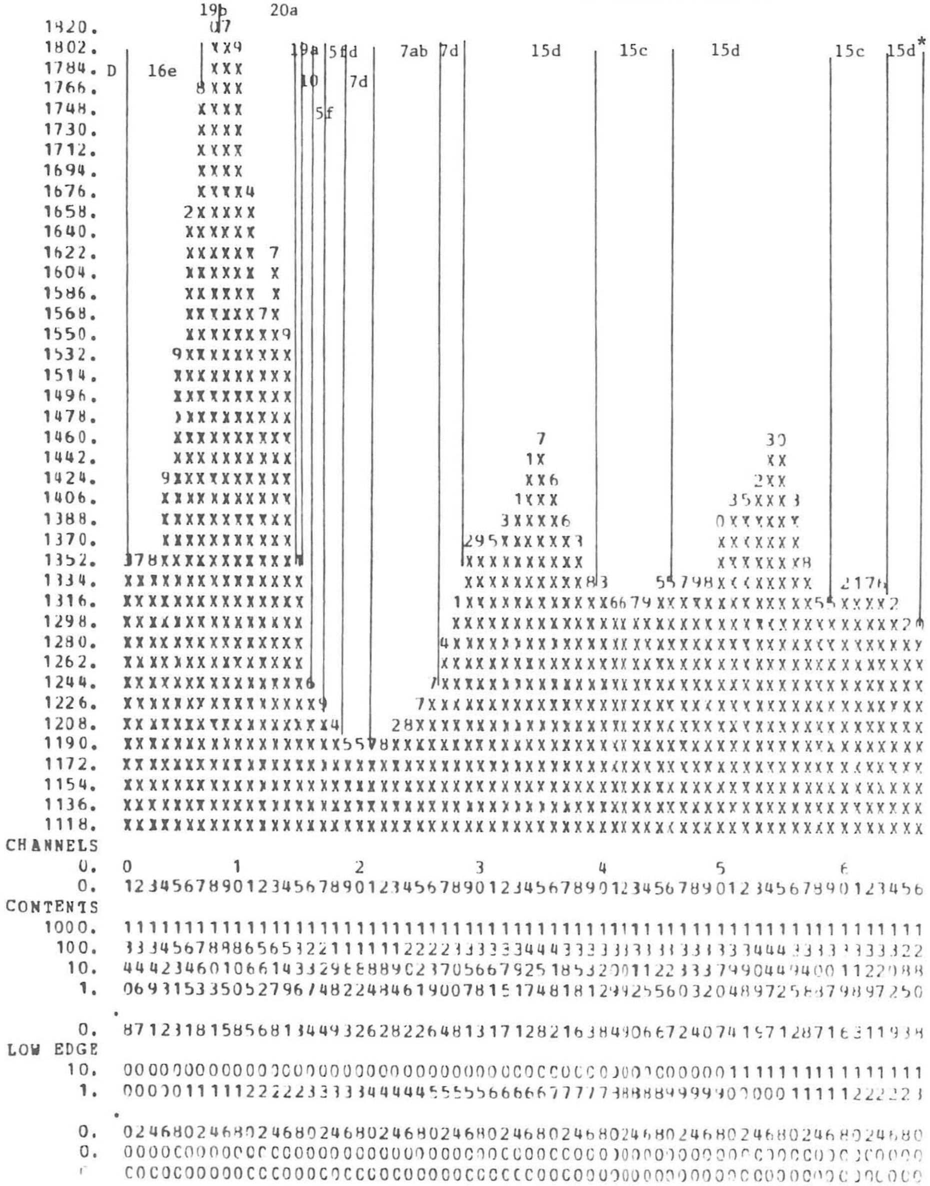

NO	IDIM	JDIM	PINC	QINC	MAP	X1	Y1	X2	Y2	REF PT	ANGN	ANGFLT
13	69	1	0.20	0.20	6.00	18.36	4.08	31.37	8.37	0.0	72.41	72.41

PLOT NO 2 TITLE:- **B-B1 FIG. 5.7 SICKLE LAKE AREA** DATE= 6/29/79 TIME=12:55 PM



NO	IDIM	JDIM	PINC	CINC	MAP	X1	Y1	X2	Y2	[illegible]	ANGN	ANGELT
15	30	1	0.20	0.20	5.00	25.12	7.53	30.75	3.43	[illegible]	31.92	31.92

PLOT NO 4 TITLE:- **D-D1 FIG. 5.9 SICKLE LAKE AREA** DATE= 6/29/79 TIME=12:55 PM



* Refer to Map 1977 L-5

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16	66	1	0.20	0.20	5.00	25.26	2.66	19.45	14.37	0.0	-25.39	25.39

PLOT NO 5   TITLE:-   **E-E1 FIG. 5.10 SICKLE LAKE AREA**


```
CHANNELS
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       NO IDIM JDIM    PINC    QINC    MAP     X1      Y1      X2      Y2    REF PT   ANGN   ANGFLT
       17  29    1     0.20    0.20    6.00   23.27   11.07   19.19   14.99   0.0   -45.48   45.48
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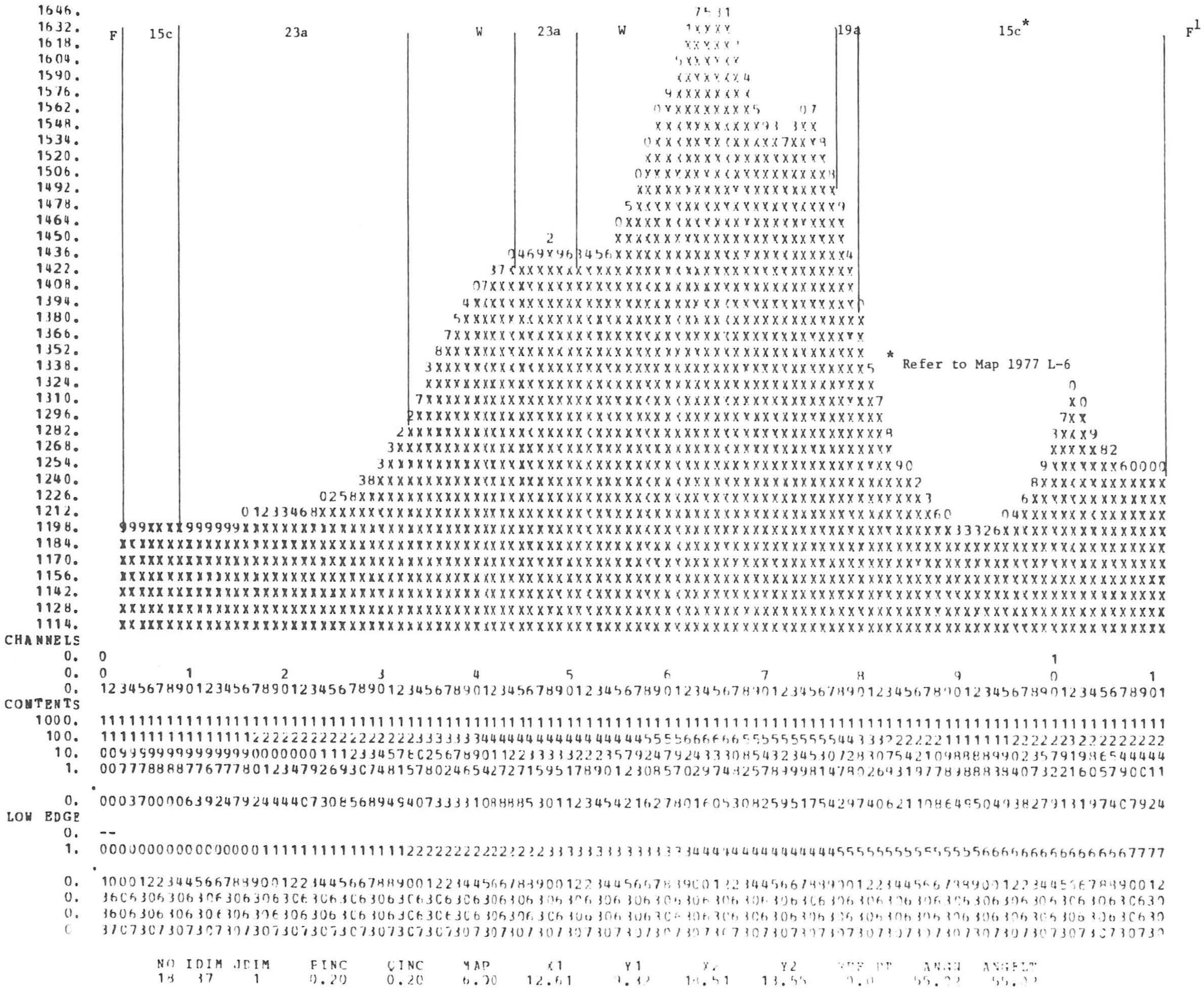
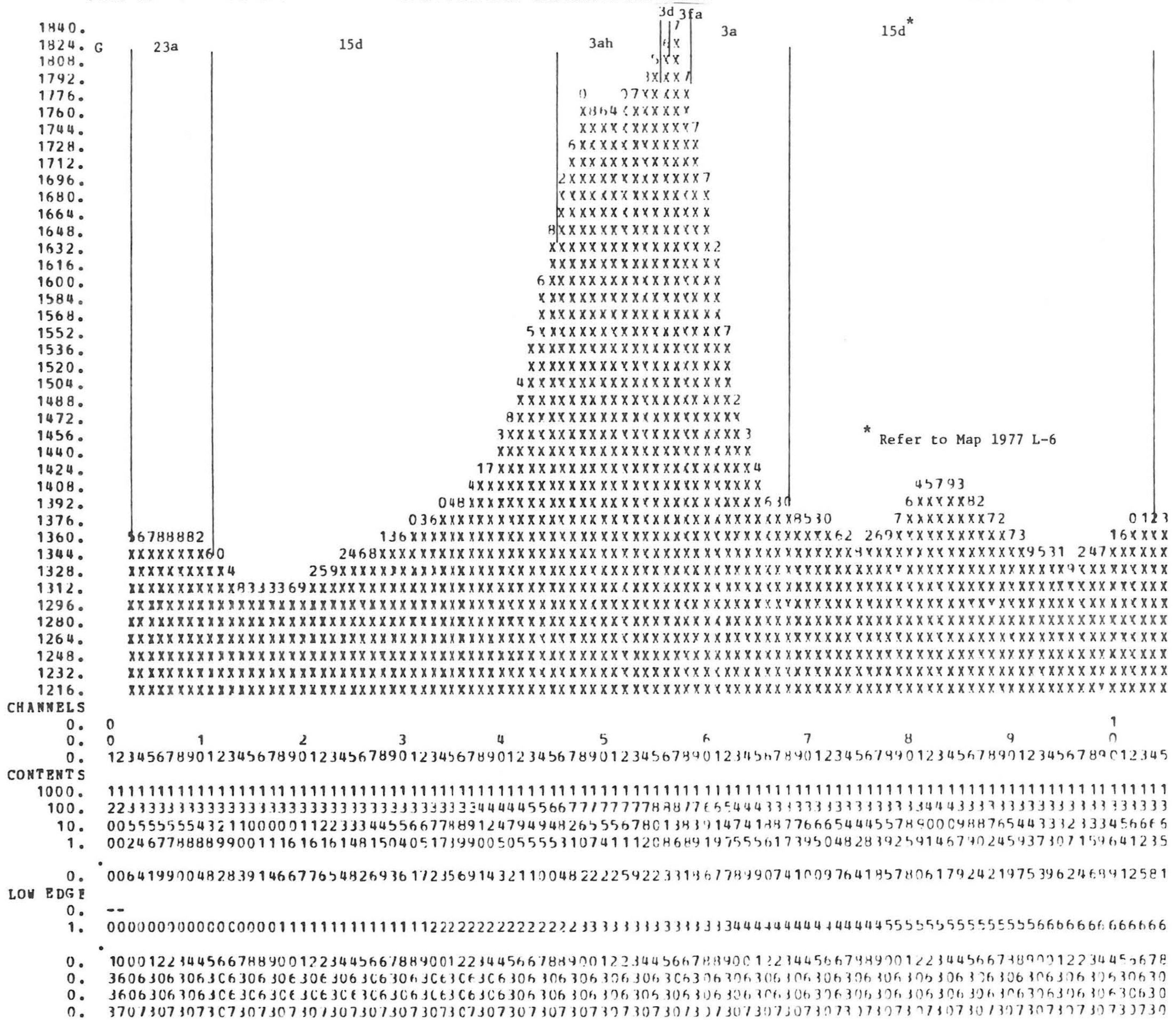
PLOT NO 6 TITLE:- **F-F1 FIG. 5.11 SICKLE LAKE AREA** DATE= 6/29/79 TIME=12:55 PM

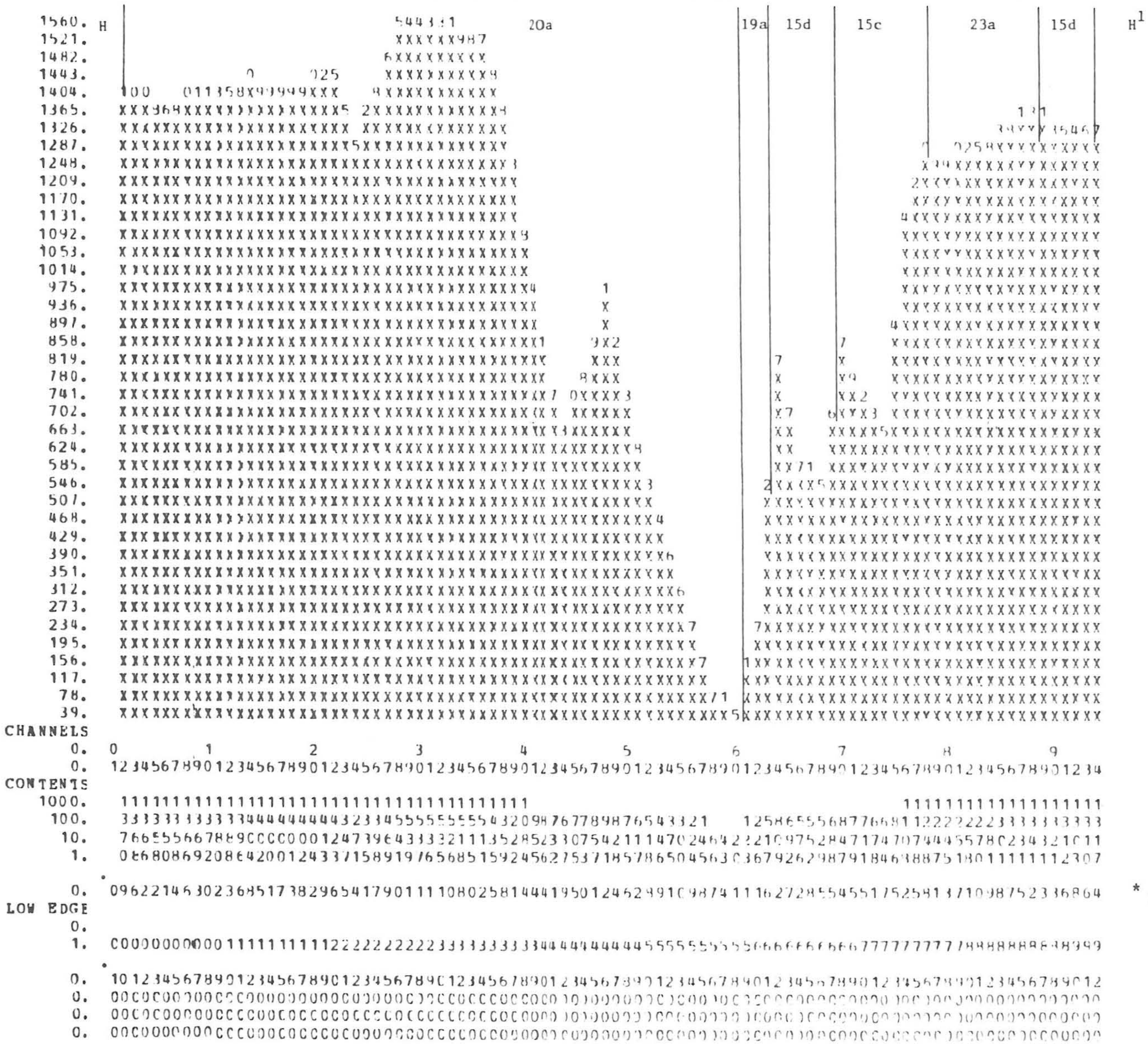


PLOT NO / TITLE:- **G-G1 FIG. 5.12 SICKLE LAKE AREA** DATE= 6/29/79 TIME=12:55 PM



NO	IDIM	JDIM	PINC	CINC	MAP	X1	Y1	X2	Y2	REF PT	ANGN	ANGFLT
19	35	1	0.20	0.20	6.00	16.24	9.27	22.96	9.38	0.0	89.73	89.73

PLOT NO 8 TITLE:- **H-H1 FIG. 5.13 SICKLE LAKE AREA** DATE= [illegible] TIME=12:55 PM



* Refer to Map 1977 L-6

NO	IDIM	JDIM	FINC	QINC	MAP	X1	Y1	X2	Y2	REF PT	ANGN	ANGELT
20	47	1	0.20	0.20	6.00	19.66	9.74	17.34	9.55	[illegible]	-15.53	[illegible]

Zone C — There is a very large, continuous area of low magnetics, corresponding geologically to sedimentary gneisses (calcareous and arkosic sandstones).

Zone D — Continuous, low magnetic readings prevail here in an area of quite complex geology. There are three different geological areas here, which are diverse in themselves. These are: 1 — dominantly mafic volcanics, 2 — felsic volcanics intruded by dioritic-granitic plugs, and 3 — greywacke-siltstone sediments.

LYNN LAKE AREA

Relative highs — Zone I — Moderate magnetic highs (60 800 to 61 500 nT) occur in this area where there is a lack of geological information. After comparison with Zones II and III, it may be speculated that it is part of a greenstone belt, with relative highs corresponding to gabbros or other mafic igneous rocks. However, the good strike trend and very thin, linear pattern also suggest that the magnetic pattern is reflecting magnetic conglomerate strata.

Zones II and III — There is a distinct pattern, shape and form of magnetic anomalies within these "belts" that geologically correspond well with blocks of dominantly mafic volcanic rocks that are intruded in places by gabbro (giving the higher readings and distinct magnetic anomalies). The magnetic contours are somewhat useful in tracing the boundaries of this belt of rock where there is a lack of outcrop, and help to locate fairly precisely, mafic igneous bodies.

Zones IV and VII — Extremely high linear magnetic anomalies (amplitudes up to 65 000 nT) with considerable strike length indicate iron formation. Geological mapping in places agrees with this. The magnetic anomalies help to trace the subsurface stratigraphy where outcrop is lacking. Zones IV and VII are probably part of the same formation, which has been structurally or stratigraphically offset.

Zone V — Magnetic patterns agree almost exactly with the mapped boundaries of these two gabbroic plugs. There is a similarity in magnetic character to that in Zones II and III.

Zone VI — This area contains mafic volcanics plus coarse grained sediments showing a slight though distinct magnetic contrast with the Zones VII and C adjacent to it. Very similar magnetic contours are found in Zones II and III, except that here there are no local highs representing mafic igneous intrusive rocks.

Relative lows — Zone A — A consistent, large area of moderate to low magnetic readings (less than 60 800 nT) represents a mass of similar lithology. There is no geological information for this area. The geophysical patterns most likely represent granitic rocks (possibly some sedimentary gneisses as well).

Zone B — This zone indicates magnetic trends very similar to those in Zone A, and it is known that the rocks are mainly granitic. Two slightly different areas within Zone B are: 1 — in the extreme southwest where there are some mafic volcanics not indicated by magnetics and, 2 — in the north where there are extreme lows (less than 60 500 nT) and mixed dioritic-granitic intrusive rocks.

Zone C — This zone is geologically more complex than A and B but the magnetics do not indicate this. This is probably because granite, granitic and sedimentary gneisses and greywacke-siltstone sediments all register similar, low magnetic readings (60 500 to 60 700 nT).

SICKLE LAKE AREA

Relative highs — Zone I — This zone is highly complex magnetically and geologically, but can be outlined quite well both to the north and south of Sickle Lake. A continuous "strip" of above average magnetic contours (above 61 500 nT) defines a related belt of rocks. This belt has been mapped in the Sickle Lake area as mafic to felsic volcanics and sediments. Some localized highs (62 000 to 63 500 nT) which define the trend and form of this belt even more strongly, could be iron formation, conglomeratic sedimentary beds, or gabbroic intrusions. Since the readings are not extremely high like those for iron formations, and since there are numerous, well-defined gabbroic intrusions in the Sickle Lake area, it is thought that these highs within this "belt" are mafic igneous rocks high in oxides and/or sulphides. As mentioned, the magnetic contour pattern is useful in tracing this very diverse belt of rocks from the Sickle Lake area towards the northeast and south-southeast where no mapping has been done, and where there is perhaps a poor exposure of surface rocks.

Zone II — This zone has been mapped in the Sickle Lake area as acid intrusive rocks (i.e. — same as Zone A). However, the abnormally high magnetics (61 500 to 62 500 nT — too high for granitic rocks in general), and the shape, size, form and trend of this zone suggest a gabbro plug. Compare with Zone III.

Zone III — Magnetic contours correspond very well with geological mapping and the contours indeed seem to pinpoint the boundaries of these gabbroic intrusions. The shape, size, pattern, trend and amplitudes of these anomalies are very characteristic of gabbros.

Relative lows — Zone A — Areas mapped as acid intrusives coincide with areas of continuous, non-patterned, low magnetic readings.

Zone B — The same pattern of magnetics as in Zone A is observed, but the rocks are now dominantly arkoses.

Zone C — No geological information is available for this area. The low, unpatterned magnetic signature of Zones A and B is seen here. The geological possibilities can be narrowed down to intermediate to acid intrusives, arkoses, and/or sedimentary gneisses.

BARRINGTON LAKE AREA

This area is very poorly understood because there is very little supporting geological information on which to base assumptions regarding the magnetic trends. The only features that can be identified are iron formations, and a few gabbroic intrusions.

Relative highs — Zone I — These areas are magnetically very complex — and there is poor geological data to help unravel these trends. Loosely, they are assumed to represent large slices of undifferentiated mafic to felsic greenstone volcanic belts with accompanying sediments and intrusions.

Zone II — There are the characteristic magnetic signatures for gabbroic intrusions. They are found within large areas of assumed granitic rocks of low magnetic amplitude (61 500 to 63 000 nT).

Zone III — This has the characteristic signature of iron formations: extremely high amplitudes (65 000 nT total magnetic field), and extreme linearity along the apparent strike of greenstones and sedimentary rocks.

Relative lows — Because of continuously low magnetic amplitudes with a lack of pattern, all are assumed to reflect mostly dioritic to granitic intrusive rocks.

GROUND SURVEYS

Numerous reports in the Mineral Resources Division's assessment files relating to ground magnetic surveys in the area were consulted. There were of value in planning the susceptibility surveys. However, since the Questor airborne maps invariably define anomalies just about as well, they were relied upon exclusively for the preparation of the maps for the present section.

CHAPTER VI — CONCLUSIONS AND RECOMMENDATIONS

1. Quantitative interpretation of several anomalies over pre-Sickle gabbros has made it possible to suggest their subsurface shapes, depth extent, and variations in magnetic properties, which suggest differentiation with depth. A suspected gabbro intrusion near Chepil Lake has been interpreted as having the depth to its top of 460 metres. A characteristic feature of pre-Sickle gabbro anomalies is the presence of smaller closures within the main anomaly. For the body at Norrie Lake, these smaller closures were interpreted as small pipes. The possibility of other similar occurrences could easily be followed up by quantitative work on other anomalies.

2. A Sickle Group conglomerate member was found to be an unusually distinct magnetic marker. Quantitative interpretation could be easily applied for mapping the subsurface form of this unit. It is an important stratigraphic marker, and further interpretation would be justified. An extension of the survey may be warranted as an aid to geological mapping.

3. Rock units in the area tend to have a significant component of remanent magnetization (Q_{AV} = 0.56 for the units sampled). The remanent magnetization (except for pre-Sickle gabbros) is usually unstable. This is a favourable circumstance for quantitative interpretation. Pre-Sickle gabbro bodies may be suitable for geochronology using paleomagnetic methods. None of the other units tested were suitable to the same degree. A paleomagnetic research program using these bodies should be developed.

4. The report, including maps, and program listings, and the edited data tapes, constitute a data-base which can be used for preparing specialized data displays or carrying out interpretations, e.g. filtering or upward/downward continuation.

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APPENDIX I — PROGRAM 'PROFILE'

ABSTRACT

Program PROFILE computes a grid or profile of data points using a natural cubic spline interpolation from a regular grid of known data values. The program also computes the transformation parameters for a series of different user maps.

INTRODUCTION

The program 'Profile' is the first in a series of computer programs designed to interpret aeromagnetic digital field data. The output from 'Profile' is used as the input for other interpretation programs. Due to the large quantity of field data to be analyzed, a 'mass production' philosophy has been applied in the design of the program.

The main functions of the program are as follows:

1. to obtain a set of profile and/or grid magnetic field data values which are to be stored sequentially on a disc data set. Also to be stored along with the data values is a set of parameters identifying the profile or grid which will be used in later programs;
2. to obtain a printed output defining the location of the grid or profile in a number of different co-ordinate frames (i.e. maps).

TRANSFORMATION CALCULATION

In order to obtain the profile and grid location information with respect to several different maps, transformation parameters (XO, YO, θ) are required. It was found most convenient to let the computer calculate these parameters from the co-ordinates (X11, Y11, X12, Y12) of the two points which define a straight line in a base map and the corresponding two points (X21, Y21, X22, Y22) which define the same straight line in a 'user' map. The base map is one to which all other maps can be referenced. All maps, 'base' and 'user,' should have the same scale.

The program reads in the two points from the base map and the corresponding points from the user map, calculates the required transformation parameters and stores them for later processing. If during the calculation the program finds a discrepancy in the length of the line, a correction is made to all four points such that the length becomes the same for both maps.

For the Lynn Lake aeromagnetic survey the base maps consist of the Questor 1:50 000 maps for the four areas covered. Examples of the transformation parameters for several geology maps for the Fox Lake mine area and the Sickle Lake area are shown in Tables 1 and 2.

TABLE 1 — Transformation parameters for Fox Lake mine area

Geology map	X Origin (km)	Y Origin (km)	Angle of rotation
1977 L-1	18.84908	7.29487	31.59451
1977 L-3	27.00702	-5.92759	31.46791
1976 L-1	0.62578	9.96933	30.88130

TABLE 2 — Transformation parameters for Sickle Lake area

Geology map	X Origin (km)	Y Origin (km)	Angle of rotation
1977 L-5	-9.64176	29.08359	1.00063
1977 L-6	-9.71025	14.92807	0.66328

NOTE: Columns X and Y list the coordinates of the origins for the geological maps, w.r.t. the origin of the corresponding Questor map of scale 1:50 000.

APPENDIX II

PROGRAM PRT PLOT

Program 'PRT PLOT' is used to display the profiles or grids obtained from program 'PROFILE.' The program assumes the data has been previously stored on a disk data file. An example of the input cards required to plot a set of profiles (A-A1 to C-C1) is shown below:

Data Card		Description
UNIT 8		Data stored on disk unit #8
PROFILE		profile plot requests to follow
A-AI	1 1080.0	Title, Profile #, Base value for Y-axis
B-B1	2 1080.0	Title, Profile #, Base value for Y-axis
C-C1	3 900.0	Title, Profile #, Base value for Y-axis
END		Terminates program.

```
REQUESTED OPTIONS: ,EB,,,,OBJ,,MAP,,GOSTMT,,,S,SIZE(256K),NAME(MAIN),OPT(0),LC(654),AD(NONE),FLAG(I),

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(54) SIZE(0256K) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT MAP NOFORMAT GOSTMT NOXREF NOALC NOANSF NOTERM IBM FLAG(I)

                C
                C
                C
                C     ****************************************************************
                C     *                                                              *
                C     *                      PROGRAM PRTPLOT                         *
                C     *                                                              *
                C     *               PLOTS ON THE LINE PRINTER                      *
                C     *               ONE DIM. PROFILE PLOTS                         *
                C     *                                                              *
                C     *          ALL DATA CARDS READ IN MUST BE PRECEEDED            *
                C     *          BY A HEADER CARD                                    *
                C     *                                                              *
                C     *          ALL GRID AND PROFILE DATA IS ASSUMED TO BE          *
                C     *          STORED SEQUENCIALLY AND READ FROM UNIT 'IR'         *
                C     *                                                              *
                C     *          CALLS SUBROUTINES  'LPPLOT'                         *
                C     *                                                              *
                C     ****************************************************************
                C
                C                          HEADER CARDS
                C
                C            KEY WORD            PROGRAM RESPONSE
                C            --------    --------------------------------------
                C                UNIT  - DEFINES UNIT NUMBER FIELD DATA IS READ
                C                        FROM. ALSO GIVES VALUE FOR UNIT
                C            CHANNELS  - DEFINES MAXIMUN CHANNEL NO FOR PLOTS
                C               LINES  - DEFINES MAXIMUN NO OF LINES FOR PLOT
                C             GRID     - A GRID OF DATA IS TO BE PLOTTED
                C             PROFILE  - A PROFILE OF DATA IS TO BE PLOTTED
                C               2DPLOT - TWO DIMENSIONAL PLOT REQUESTED
                C                NSPEC - FREQUENCY SPECTRUM REQUESTED
                C                NBASE - FIELD HISTOGRAM REQUESTED
                C
  ISN 0002            COMMON/CPLOT/ XTITLE(10),YTITLE(10),XMARGN,YMARGN,FACT,
                     1              XSTART,XASCAL,XALEN,YSTART,YASCAL,YALEN,
                     2              INTEQ,LINTYP,NINCH,ISAMP,SMOOTH,SAMEPL
                C
  ISN 0003            DIMENSION ATITLE(20),XGRID(400),YGRID(300),FGRID(120000)
  ISN 0004            DIMENSION WK(1000)
  ISN 0005            DIMENSION ANOMN(2)
  ISN 0006            DIMENSION R(122)
  ISN 0007            DIMENSION DATIME(7)
  ISN 0008            DOUBLE PRECISION NAME,NEND,NAMPPL,NAMSPL,NAMG,NAMP,NAMGP,NAMDAT
  ISN 0009            DOUBLE PRECISION NUNIT,NPEAK,NINVER,NSPEC,NBASE
  ISN 0010            LOGICAL SMOOTH,SAMEPL,PEAKS,INVERT,SPEC,BLEVEL
  ISN 0011            EQUIVALENCE(ANOMN(1),NAMDAT)
  ISN 0012            DATA NEND/'END     '/
  ISN 0013            DATA NUNIT/'UNIT    '/
  ISN 0014            DATA NAMPPL/'CHANNELS'/
  ISN 0015            DATA NAMSPL/'LINES   '/
  ISN 0016            DATA NAMG/'GRID    '/
  ISN 0017            DATA NAMP/'PROFILE '/
  ISN 0018            DATA NPEAK/'2DPLOT  '/
  ISN 0019            DATA NINVER/'INVERT  '/
  ISN 0020            DATA NSPEC/'FREQSPEC'/
  ISN 0021            DATA NBASE/'BASE    '/
  ISN 0022            DATA ATITLE(19)/'    '/
  ISN 0023            DATA ATITLE(20)/'    '/
  ISN 0024            DATA NLAST/0/
```

```
C                    DEFINITION OF VARIABLES
C
C          NAMDAT - HEADER WORD
C
C           ANOMN - NAME OF ANOMOLY REQUESTED
C              NO - NUMBER OF GRID OR PROFILE REQUESTED
C            BASE - BASE LEVEL TO BE SUBTRACTED FROM DATA
C           PORGN - DISTANCE OF ORIGIN FROM FIRST STATION
C           PDLOW - PLOTTING WILL START FROM NEAREST GRID
C                   POINT BELOW 'PDLOW'
C            PDUP - PLOTTING WILL END AT NEAREST GRID POINT
C                   AFTER 'PDUP'
C            SAMP - PLOTS ONLY EVERY OTHER 'SAMP' DATA POINTS
C
C
C                             DATA STORAGE
C
C            NAME - CONTAINS EITHER: 'GRID' OR 'PROFILE'
C          ATITLE - ANOMALY TITLE
C              NP - GRID OR PROFILE NUMBER
C            IDIM - X DIMENSION
C            JDIM - Y DIMENSION
C            PINC - X INCREMENT
C            QINC - Y INCREMENT
C             SET - MAP NO OF REFERENCE LINE
C             X,Y - CO ORDS OF REFERENCE LINE
C           REFPT - REFERENCE POINT ALONG PROFILE
C            ANGN - ANGLE PROFILE MAKES WITH GEOG. NORTH
C            ANGF - ANGLE PROFILE MAKES WITH FLIGHT LINES
C           FGRID - FIELD VALUES
C
C
C         1-8    9-80
C       |------|--------
C       | NAME | ATITLE
C       |______|_______
C
C       1-2    3-6    7-10    11-17   18-24  25-31  32-6  39-4  45-1  52-58
C       |----|------|-------|-------|-------|------|-----|-----|-----|----
C       | NP | IDIM | JDIM  | PINC  | QINC  | SET  | X1  | Y1  | X2  | Y2
C       |____|______|_______|_______|_______|______|_____|_____|_____|____
C
C         59-65   66-72  73-80
C       |-------|------|------
C       | REFPT | ANGN | ANGF
C       |_______|______|______
C
C                         1 - IDIM*JDIM (12 PER CARD)
C       |------------------------------------------------------------|
C       | ------------------------ FGRID ------------------------ |
C       |____________________________________________________________|
C
C
ISN 0025          IR=5
ISN 0026          NPLOT=0
ISN 0027          MAXCH=120
ISN 0028          MHIGH=40
ISN 0029          PEAKS=.FALSE.
ISN 0030          INVERT=.FALSE.
ISN 0031          SPEC=.FALSE.
ISN 0032          BLEVEL=.FALSE.
          C
ISN 0033          CALL $DATE(DATIME)
ISN 0034          WRITE(4,40) DATIME
ISN 0035          WRITE(4,41)
```

```
                 C
ISN 0036                WRITE(4,20)
                 C
                 C      READ HEADER CARD
                 C
ISN 0037           100  READ(5,10)  NAMDAT,NO,BASE,PORGN,PDLOWX,PDUPX,SAMPX,
                       1                                     PDLOWY,PDUPY,SAMPY
ISN 0038                IF(NAMDAT.EQ.NEND)  GO TO 8888
ISN 0040                IF(NAMDAT.EQ.NINVER)  GO TO 130
ISN 0042                IF(NAMDAT.EQ.NSPEC)  GO TO 134
ISN 0044                IF(NAMDAT.EQ.NBASE)  GO TO 136
ISN 0046                IF(NAMDAT.EQ.NAMP)  GO TO 140
ISN 0048                IF(NAMDAT.EQ.NAMG)  GO TO 140
ISN 0050                IF(NAMDAT.EQ.NPEAK)  GO TO 132
ISN 0052                PEAKS=.FALSE.
                 C
ISN 0053                IF(NAMDAT.NE.NUNIT)  GO TO 110
ISN 0055                WRITE(4,22)  NAMDAT,NO
ISN 0056                IR=NO
ISN 0057                GO TO 100
                 C
ISN 0058           110  IF(NAMDAT.NE.NAMPPL)  GO TO 120
ISN 0060                WRITE(4,31)  NAMDAT,NO
ISN 0061                MAXCH=NO
ISN 0062                IF(MAXCH.LE.0)  MAXCH=100
ISN 0064                GO TO 100
                 C
ISN 0065           120  IF(NAMDAT.NE.NAMSPL)  GO TO 160
ISN 0067                WRITE(4,32)  NAMDAT,NO
ISN 0068                MHIGH=NO
ISN 0069                IF(MHIGH.LE.0)  MHIGH=40
ISN 0071                GO TO 100
                 C
ISN 0072           130  INVERT=.TRUE.
ISN 0073                WRITE(4,21)  NAMDAT
ISN 0074                GO TO 100
                 C
ISN 0075           132  CONTINUE
ISN 0076                KEY=NO
ISN 0077                ALEV=BASE
ISN 0078                IF(BASE.LE.0.0)  ALEV=50.0
ISN 0080                PEAKS=.TRUE.
ISN 0081                GO TO 100
                 C
ISN 0082           134  CONTINUE
ISN 0083                SPEC=.TRUE.
ISN 0084                WRITE(4,21)  NAMDAT
ISN 0085                GO TO 100
                 C
ISN 0086           136  CONTINUE
ISN 0087                BLEVEL=.TRUE.
ISN 0088                SBL=BASE
ISN 0089                SBU=PORGN
ISN 0090                NBCH=PDLOWX
ISN 0091                IF(NBCH.LE.0)  NBCH=100
ISN 0093                IF(NBCH.GT.120)  NBCH=120
ISN 0095                WRITE(4,21)  NAMDAT
ISN 0096                GO TO 100
                 C
ISN 0097           140  CONTINUE
ISN 0098                WRITE(4,21)  NAMDAT
                 C
ISN 0099                NAMGP=NAMDAT
ISN 0100                READ(5,10)  NAMDAT,NO,BASE,PORGN,PDLOWX,PDUPX,SAMPX,
                       1                                     PDLOWY,PDUPY,SAMPY
```

```
ISN 0101          WRITE(4,30)
ISN 0102          WRITE(4,23) NAMGP
            C
ISN 0103      160 CONTINUE
ISN 0104          IF(SAMPX.LE.0.0) SAMPX=1.0
ISN 0106          IF(SAMPY.LE.0.0) SAMPY=1.0
ISN 0108          ISAMP=SAMPX
ISN 0109          JSAMP=SAMPY
ISN 0110          IF(PDLOWX.LE.0.0) PDLOWX=-9999.0
ISN 0112          IF(PDUPX.LE.0.0) PDUPX=9999.0
ISN 0114          IF(PDLOWY.LE.0.0) PDLOWY=-9999.0
ISN 0116          IF(PDUPY.LE.0.0) PDUPY=9999.0
ISN 0118          IF(ISAMP.LE.0) ISAMP=1
ISN 0120          IF(JSAMP.LE.0) JSAMP=1
            C
ISN 0122          WRITE(4,24) NAMDAT,NO,BASE,PORGN,PDLOWX,PDUPX,SAMPX,
                 1                                 PDLOWY,PDUPY,SAMPY
            C
ISN 0123          IF(NO.EQ.NLAST) GO TO 260
ISN 0125          IF(NO.GT.NLAST) GO TO 250
ISN 0127          IF(IR.EQ.5) GO TO 520
ISN 0129          REWIND IR
            C
            C
            C     READ IN PROFILE AND GRID DATA
            C
ISN 0130      250 READ(IR,12) NAME,(ATITLE(I),I=1,18)
ISN 0131          IF(NAME.EQ.NEND) GO TO 530
ISN 0133          READ(IR,14) NP,IDIM,JDIM,PINC,QINC,SET,X1,Y1,X2,Y2,REFPT,ANGN,ANGF
            C
ISN 0134          IF(JDIM.EQ.0) JDIM=1
ISN 0136          NDIM=IDIM*JDIM
ISN 0137          IF(INVERT) GO TO 255
ISN 0139          DO 252 J=1,JDIM
ISN 0140          N=(J-1)*IDIM
ISN 0141      252 READ(IR,16) (FGRID(N+I),I=1,IDIM)
ISN 0142          GO TO 260
            C
ISN 0143      255 READ(IR,16) ((FGRID(IDIM*J-I+1),I=1,IDIM),J=1,JDIM)
            C
ISN 0144      260 IF(ATITLE(1).NE.ANOMN(1)) GO TO 250
ISN 0146          IF(NAME.NE.NAMGP) GO TO 250
ISN 0148          IF(NP.NE.NO) GO TO 250
            C
ISN 0150          IF(NP.EQ.NLAST) BASE=0.0
ISN 0152          IF(NP.EQ.NLAST) PORGN=0.0
ISN 0154          NLAST=NO
            C
ISN 0155          N=0
ISN 0156          NN=0
ISN 0157          JJ=0
ISN 0158          JJJ=1
ISN 0159          JJJJ=0
ISN 0160          RMAX=-999999.0
ISN 0161          RMIN=999999.0
ISN 0162          DO 290 J=1,JDIM
ISN 0163          IF(JDIM.EQ.1) GO TO 270
            C
ISN 0165          DIS=(J-1)*QINC
ISN 0166          IF(DIS.LE.(PDLOWY-QINC)) GO TO 290
ISN 0168          IF(DIS.GT.PDUPY) GO TO 290
            C
ISN 0170          JJ=JJ+1
ISN 0171          IF(JJ.NE.JJJ) GO TO 290
```

```
ISN 0173            JJJ=JJJ+JSAMP
ISN 0174            JJJJ=JJJJ+1
ISN 0175            YGRID(JJJJ)=DIS
              C
ISN 0176        270 II=0
ISN 0177            III=1
ISN 0178            IIII=0
ISN 0179            DO 280 I=1,IDIM
ISN 0180            N=N+1
              C
ISN 0181            DIS=(I-1)*PINC
ISN 0182            IF(DIS.LE.(PDLOWX-PINC)) GO TO 280
ISN 0184            IF(DIS.GT.PDUPX) GO TO 280
              C
ISN 0186            II=II+1
ISN 0187            IF(II.NE.III) GO TO 280
ISN 0189            III=III+ISAMP
ISN 0190            IIII=IIII+1
ISN 0191            NN=NN+1
ISN 0192            XGRID(IIII)=DIS-PORGN
ISN 0193            IF(FGRID(N).GT.RMAX) RMAX=FGRID(N)
ISN 0195            IF(FGRID(N).LT.RMIN) RMIN=FGRID(N)
ISN 0197            FGRID(NN)=FGRID(N)
              C
ISN 0198        280 CONTINUE
ISN 0199        290 CONTINUE
              C
              C
              C     REDEFINE 'IDIM' AND 'JDIM'
              C
ISN 0200            IDIMN=IIII
ISN 0201            IF(IDIMN.LE.1) IDIMN=1
ISN 0203            JDIMN=JJJJ
ISN 0204            IF(JDIMN.LE.1) JDIMN=1
              C
ISN 0206            II=0
ISN 0207            IPLOT=0
              C
ISN 0208            IF(PEAKS) GO TO 500
ISN 0210            IF(BLEVEL) GO TO 600
ISN 0212        300 CONTINUE
              C
              C
ISN 0213            DO 305 I=1,122
ISN 0214        305 R(I)=0.0
              C
ISN 0215            NCH=IDIMN
ISN 0216            MTEST=NCH
              C
ISN 0217            DO 310 I=1,120
ISN 0218            MS=I
ISN 0219            MTEST=NCH*MS
ISN 0220            IF(MTEST.GT.MAXCH) GO TO 320
ISN 0222        310 CONTINUE
              C
ISN 0223        320 NCH=MTEST-NCH
ISN 0224            IF(MS.NE.1) MS=MS-1
ISN 0226            IF(NCH.EQ.0) NCH=MTEST
ISN 0228            IF(NCH.GT.MAXCH) NCH=MAXCH
              C
ISN 0230            MSS=MS-1
ISN 0231            DO 340 I=MS,NCH,MS
ISN 0232            II=II+1
ISN 0233            R(I+1)=FGRID(II)
ISN 0234            IF(II.EQ.1) GO TO 340
ISN 0236            IF(MS.EQ.1) GO TO 340
```

```
ISN 0238              FINC=(R(I+1)-R(I+1-MS))/MS
ISN 0239              DO 330 J=1,MSS
ISN 0240              III=I+1-MS+J
ISN 0241          330 R(III)=R(III-1)+FINC
ISN 0242          340 CONTINUE
                C
ISN 0243              NPLOT=NPLOT+1
ISN 0244              WRITE(6,25) NPLOT,(ATITLE(I),I=1,16),DATIME
ISN 0245              BIN=(XGRID(2)-XGRID(1))/MS
ISN 0246              SLL=XGRID(1)-BIN*(MS-1)
                C     DIS=0.25
                C     SC=0.0
                C     MAXIT=5
                C     CALL ICSMOU(XGRID,R(2),NCH,DIS,SC,MAXIT,WK,IER)
ISN 0247              CALL LPPLOT(NCH,SLL,BIN,R,BASE,MHIGH)
                C
ISN 0248              WRITE(6,26) NP,IDIM,JDIM,PINC,QINC,SET,X1,Y1,X2,Y2,REFPT,ANGN,ANGF
                C
ISN 0249              IF(NAME.EQ.NAMP) GO TO 100
                C
                C
ISN 0251          400 CONTINUE
                C
ISN 0252              IPLOT=IPLOT+1
ISN 0253              IF(IPLOT.GE.JDIMN) GO TO 100
ISN 0255              GO TO 300
                C
                C
ISN 0256          500 CONTINUE
                C
                C     PLOT PEAKS
                C
ISN 0257              IF(BASE.LE.0.0) BASE=RMIN
ISN 0259              BIN=(RMAX-BASE)/ALEV
ISN 0260              I=-IDIMN+1
ISN 0261              DO 510 J=1,JDIMN
ISN 0262              I=I+IDIMN
ISN 0263          510 CALL LDPLOT(KEY,FGRID(I),IDIMN,BASE,BIN)
ISN 0264              GO TO 100
                C
                C
ISN 0265          600 CONTINUE
                C
                C     HISTOGRAM ALL FIELD DATA
                C
ISN 0266              DO 605 I=1,122
ISN 0267          605 R(I)=0.0
                C
ISN 0268              BIN=(SBU-SBL)/NBCH
ISN 0269              NDIM=IDIMN*JDIMN
ISN 0270              DO 610 I=1,NDIM
ISN 0271              IBIN=(FGRID(I)-SBL)/BIN+2
ISN 0272              IF(IBIN.LT.2) IBIN=1
ISN 0274              IF(IBIN.GT.NBCH+1) IBIN=NBCH+2
ISN 0276          610 R(IBIN)=R(IBIN)+1.0
                C
ISN 0277              CALL LPPLOT(NBCH,SBL,BIN,R,0.0,MHIGH)
ISN 0278              GO TO 100
                C
ISN 0279          520 CONTINUE
                C
                C     COME HERE IF ERROR IN PLOT REQUEST
                C
ISN 0280              WRITE(4,51)
ISN 0281              GO TO 8888
```

```
ISN 0282        530 CONTINUE
              C
              C     COME HERE IF FIELD DATA CANNOT BE FOUND ON UNIT 'IR'
              C
ISN 0283            WRITE(4,53) IR
              C
ISN 0284       8888 CONTINUE
ISN 0285         25 FORMAT('1',8X,'PLOT NO',I3,4X,'TITLE:-  ',16A4,7A4/)
ISN 0286         27 FORMAT(' ',35X,'------------------------------------------'/)
ISN 0287         26 FORMAT('0',16X,'NO', 1X,'IDIM',1X,'JDIM', 4X,'PINC', 4X,'QINC',
                1            4X,'MAP', 6X,'X1', 6X,'Y1', 6X,'X2', 6X,'Y2', 4X,
                2            'REF PT',3X,'ANGN', 2X,'ANGFLT',/
                3      ' ',14X,2I4,1X,I4,1X,10F8.2/)
ISN 0288         28 FORMAT(' ',10X,10F10.2)
ISN 0289         29 FORMAT('0',50X,'FIELD DATA'/)
ISN 0290         30 FORMAT(' ',12X,'-----------------------------------------------------
                1----------------------------------------------')
ISN 0291         10 FORMAT(A8,I2,10F7.2)
ISN 0292         12 FORMAT(A8,18A4)
ISN 0293         14 FORMAT(I2,I4,I4,10F7.2)
ISN 0294         16 FORMAT(1X,12F6.0)
ISN 0295         20 FORMAT(' ',2X,'HEADER CARDS'/)
ISN 0296         21 FORMAT(' ',5X,A8,2X,I4)
ISN 0297         24 FORMAT(' ',10X,A8,2X,I4,4F10.2,F3.2,2X,F10.2,1X,2F10.2)
ISN 0298         22 FORMAT(' ',5X,A8,2X,'MAG. FIELD DATA READ FROM UNIT #',I2)
ISN 0299         31 FORMAT(' ',5X,A8,2X,'MAXIMUN CHANNEL NO. ',I2)
ISN 0300         32 FORMAT(' ',5X,A8,2X,'MAXIMUN HEIGHT OF PLOT= ',I2,' LINES')
ISN 0301         23 FORMAT(/' ',45X,A8,'REQUESTED'//' ',10X,'ANOMOLY'6X,'NO',4X,'BASE',
                16X,'ORIGIN',3X,'LOW X',4X,'UPPER X',3X,'XSAMP     ',1X,'LOW Y',4X,
                2       'UPPER Y',4X,'  YSAMP    '/)
ISN 0302         40 FORMAT(///' ',45X,'DEPT. OF EARTH SCIENCES, UNIV. OF MANITOBA',
                1              5X,7A4//)
ISN 0303         41 FORMAT(' ',56X,'PROGRAM **PRTPLOT**'/)
ISN 0304         51 FORMAT(' ',30X,'******** DATA REQUESTS NOT IN ORDER - TERMINATING
                1JOB ********')
ISN 0305         53 FORMAT(' ',30X,'******** CANNOT FIND FIELD DATA ON UNIT NO ',I2,
                1           '  TERMINATING JOB ********')
ISN 0306            STOP
ISN 0307            END
```

```
REQUESTED OPTIONS: ,EB,,,,OBJ,,MAP,,GOSTMT,,,S,SIZE(256K),NAME(MAIN),OPT(0),LC(654),AD(NONE),FLAG(I),

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(54) SIZE(0256K) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT MAP NOFORMAT GOSTMT NOXREF NOALC NOANSF NOTERM IBM FLAG(I)

  ISN 0002             SUBROUTINE LPPLOT(M,SLL,BIN,R,BASE,MHIGH)
                 C
                 C        ..........................................................
                 C        .                                                        .
                 C        .              PLOTS HBOOK TYPE HISTOGRAMS               .
                 C        .                  ON THE LINE PRINTER                   .
                 C        .                                                        .
                 C        .       THE CODING FOR THIS SUBROUTINE WAS OBTAINED      .
                 C        .       FROM THE ORIGINAL 'HBOOK' SUBROUTINE             .
                 C        .       C.E.R.N GENEVA. SWITZERLAND                      .
                 C        .                                                        .
                 C        ..........................................................
                 C
  ISN 0003             DIMENSION R(122),P(122),A(122),DGT(37)
  ISN 0004             DOUBLE PRECISION CHAN,CONT,EDGE
  ISN 0005             INTEGER F,O,Q
  ISN 0006             DATA DGT/'0','1','2','3','4','5','6','7','8','9','A','B','C','D',
                     1  'E','F','G','H','I','J','K','L','M','N','O','P','Q','R','S',
                     2 'T','U','V','W','X','Y','Z','*'/
  ISN 0007             DATA CHAN,CONT,EDGE/'CHANNELS','CONTENTS','LOW EDGE'/
  ISN 0008             DATA SCH/'-'/
  ISN 0009             DATA BLANK/' '/
                 C
                 C                       DEFINITION OF VARIABLE NAMES
                 C
                 C                    R - HISTOGRAM ARRAY
                 C                    M - NUMBER OF CHANNELS
                 C                  SLL - LOWER LIMIT OF HISTOGRAM VARIABLE
                 C                  BIN - BIN SIZE FOR HISTOGRAM
                 C                 BASE - BASE LEVEL TO BE SUBTRACTED FROM ORDINATE
                 C                MHIGH - MAXIMUN NO OF LINES USED FOR PLOT
                 C
                 C
  ISN 0010             MM=M+1
  ISN 0011         310 X=0.
  ISN 0012             P(1)=R(1)
  ISN 0013             P(M+2)=R(M+2)
  ISN 0014             H=0.
  ISN 0015             DO 320 I=2,MM
  ISN 0016             P(I)=R(I)-BASE
  ISN 0017             IF(P(I).LE.0.0) P(I)=0.0
  ISN 0019             X=AMAX1(X,ABS(P(I)))
  ISN 0020         320 H=H+P(I)
  ISN 0021             N=X+.5
  ISN 0022             O=(N-1)/MHIGH+1
  ISN 0023             Z=O
  ISN 0024             E=((N+O-1)/O)*O+1
  ISN 0025             RR=.1*Z
  ISN 0026             DO 350 I=1,N,O
  ISN 0027             X=E-I
  ISN 0028             CALL UBLANK(A,1,122)
  ISN 0029             DO 340 J=2,MM
  ISN 0030             K=34
  ISN 0031             D=P(J)-X
  ISN 0032             IF(D) 333,339,339
  ISN 0033         333 D=D+Z
  ISN 0034             IF(D) 340,340,336
  ISN 0035         336 K=D/RR+1
  ISN 0036         339 A(J-1)=DGT(K)
```

```
ISN 0037        340 CONTINUE
ISN 0038            X=X+BASE
ISN 0039        350 PRINT 2000,X,(A(IA),IA=1,MM)
              C
ISN 0040            X=0.0
ISN 0041            DO 354 J=2,MM
ISN 0042            P(J)=P(J)+BASE
ISN 0043        354 X=AMAX1(X,ABS(P(J)))
ISN 0044            N=X+.5
ISN 0045            Q=0
ISN 0046        355 PRINT 3000,CHAN
ISN 0047        356 K=100
ISN 0048            X=0.
ISN 0049            CALL UBLANK(A,1,122)
ISN 0050            IF(K.GT.M) GO TO 375
ISN 0052        360 N1=-1
ISN 0053            DO 370 I=1,M
ISN 0054            J=MOD((I-Q)/K,10)+1
ISN 0055            IF(J.NE.N1) A(I)=DGT(J)
ISN 0057        370 N1=J
ISN 0058            PRINT 2000,X,(A(IA),IA=1,MM)
ISN 0059        375 K=K/10
ISN 0060            IF(K.GT.0) GO TO 360
ISN 0062        376 PRINT 3000,CONT
ISN 0063            D=0.
ISN 0064            F=0.
ISN 0065        378 CALL UBLANK(A,1,M)
ISN 0066            X=N
ISN 0067            N=-1
ISN 0068            IF(X.GT.0.) N=ALOG10(X)
ISN 0070            IF(X.EQ.10.0) N=1
ISN 0072            X=10.**N
ISN 0073            Z=X/20000.
ISN 0074            DO 379 J=2,MM
ISN 0075            IF(P(J).GE.0.) GO TO 379
ISN 0077            A(J-1)=SCH
ISN 0078            P(J)=-P(J)
ISN 0079            O=0
ISN 0080        379 P(J)=P(J)+Z
ISN 0081            IF(O.EQ.0) PRINT 2000,O,(A(IA),IA=1,MM)
ISN 0083            DO 390 I=1,5
ISN 0084            DO 380 J=2,MM
ISN 0085            K=AMOD(P(J)/X,10.)
ISN 0086            AA=A(J-1)
ISN 0087            A(J-1)=DGT(K+1)
ISN 0088            IF(F.NE.0.) GO TO 380
ISN 0090            IF(N-I+2.EQ.0) GO TO 380
ISN 0092            IF(I.GT.1.AND.AA.NE.BLANK) GO TO 380
ISN 0094            IF(K.EQ.0) A(J-1)=BLANK
ISN 0096        380 CONTINUE
ISN 0097            IF(N-I+2.NE.0) GO TO 386
ISN 0099        385 PRINT 2500
ISN 0100            F=BIN
ISN 0101        386 CONTINUE
ISN 0102            PRINT 2000,X,(A(IA),IA=1,MM)
ISN 0103        390 X=X/10.
ISN 0104            IF(D.NE.0.) GO TO 398
ISN 0106            P(2)=SLL
ISN 0107            D=BIN
ISN 0108            DO 395 J=3,MM
ISN 0109        395 P(J)=P(J-1)+BIN
ISN 0110            X=AMAX1(ABS(P(2)),ABS(P(MM)))
ISN 0111            N=X
ISN 0112            PRINT 3000,EDGE
ISN 0113            GO TO 378
ISN 0114        398 CONTINUE
```

```
ISN 0115      2000 FORMAT(1H 1XF7.0,2X121A1)
ISN 0116      2500 FORMAT(1H 9X1H.)
ISN 0117      3000 FORMAT(1H A8)
ISN 0118           RETURN
ISN 0119           END
```

```
REQUESTED OPTIONS: ,EB,,,,OBJ,,MAP,,GOSTMT,,,S,SIZE(256K),NAME(MAIN),OPT(0),LC(654),AD(NONE),FLAG(I),

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(54)  SIZE(0256K)  AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT MAP NOFORMAT GOSTMT NOXREF NOALC NOANSF NOTERM IBM FLAG(I)

   ISN 0002                SUBROUTINE LDPLOT(KEY,R,N,BASE,BIN)
                   C
                   C          ..............................................................
                   C          .                                                            .
                   C          .                 ANALYSES AND PLOTS ON THE LINE             .
                   C          .                 PRINTER A NUMBER OF TWO DIMENSIONAL        .
                   C          .                 PLOTS                                      .
                   C          .                                                            .
                   C          ..............................................................
                   C
   ISN 0003                DIMENSION R(N)
   ISN 0004                DIMENSION A(120),IS(120),DGT(37),IMAX(120),IMIN(120)
   ISN 0005                DATA DGT/'0','1','2','3','4','5','6','7','8','9','A','B','C','D',
                          1 'E','F','G','H','I','J','K','L','M','N','O','P','Q','R','S',
                          2 'T','U','V','W','X','Y','Z','*'/
   ISN 0006                DATA BLANK/' '/
   ISN 0007                DATA APLUS/'+'/
   ISN 0008                DATA AMINUS/'-'/
                   C
                   C
                   C                         DEFINITION OF VARIABLES
                   C
                   C                   KEY - TYPE OF PLOT REQUESTED
                   C                     R - PROFILE ARRAY
                   C                     N - PROFILE DIMENSION
                   C                  BASE - BASE LEVEL FOR PROFILE
                   C                   BIN - BIN INTERVAL FOR PROFILE
                   C
                   C
   ISN 0009                IF(KEY.GT.1) CALL PPATN(R,N,IMAX,NMAX,IMIN,NMIN)
                   C
   ISN 0011                CALL UBLANK(A,1,120)
                   C
   ISN 0012                GO TO (1000,2000,3000,4000,5000,6000,7000,8000),KEY
                   C
                   C
   ISN 0013         1000 CONTINUE
                   C
                   C       PLOT ALL DATA POINTS
                   C
   ISN 0014                DO 140 I=1,N
   ISN 0015                IX=(R(I)-BASE)/BIN
   ISN 0016                IF(IX) 140,140,120
                   C
   ISN 0017          120 IF(IX.GT.37) IX=37
   ISN 0019                A(I)=DGT(IX)
                   C
   ISN 0020          140 CONTINUE
   ISN 0021                GO TO 9000
                   C
                   C
   ISN 0022         2000 CONTINUE
                   C
                   C       PLOT LOCAL MAXIMUMS
                   C
   ISN 0023                DO 240 I=1,NMAX
   ISN 0024                J=IMAX(I)
   ISN 0025                IX=(R(J)-BASE)/BIN
   ISN 0026                IF(IX) 240,240,220
```

```
ISN 0027         220 IF(IX.GT.37) IX=37
ISN 0029             A(J)=DGT(IX)
               C
ISN 0030         240 CONTINUE
ISN 0031             GO TO 9000
               C
               C
ISN 0032        3000 CONTINUE
               C
               C     PLOT LOCAL MINIMUMS
               C
ISN 0033             DO 340 I=1,NMIN
ISN 0034             J=IMIN(I)
ISN 0035             IX=(R(J)-BASE)/BIN
ISN 0036             IF(IX) 340,340,320
               C
ISN 0037         320 IF(IX.GT.37) IX=37
ISN 0039             A(J)=DGT(IX)
               C
ISN 0040         340 CONTINUE
ISN 0041             GO TO 9000
               C
               C
ISN 0042        4000 CONTINUE
               C
               C     PLOT BOTH LOCAL MINIMUMS AND MAXIMUMS
               C
ISN 0043             DO 440 I=1,NMAX
ISN 0044             J=IMAX(I)
ISN 0045         440 A(J)=APLUS
               C
ISN 0046             DO 480 I=1,NMIN
ISN 0047             J=IMIN(I)
ISN 0048         480 A(J)=AMINUS
               C
ISN 0049             GO TO 9000
               C
               C
ISN 0050        5000 CONTINUE
               C
               C     PLOT DISTANCE BETWEEN SUCCESIVE MINIMUMS
               C
ISN 0051             JJ=1
ISN 0052             DO 540 I=1,NMAX
ISN 0053             J=IMAX(I)
ISN 0054             IF(I.EQ.1) GO TO 520
ISN 0056             IF(I.EQ.NMAX) GO TO 530
               C
ISN 0058         510 JJ=JJ+1
ISN 0059             IX=IMIN(JJ)-IMIN(JJ-1)
ISN 0060         515 IF(IX.GT.37) IX=37
ISN 0062             IF(IX.LT.1) IX=1
ISN 0064             A(J)=DGT(IX)
ISN 0065             GO TO 540
               C
ISN 0066         520 IF(IMIN(1).LT.IMAX(1)) GO TO 510
ISN 0068             IX=2*(IMIN(1)-IMAX(1))
ISN 0069             GO TO 515
               C
ISN 0070         530 IF(IMIN(NMIN).GT.IMAX(NMAX)) GO TO 510
ISN 0072             IX=2*(IMAX(NMAX)-IMIN(NMIN))
ISN 0073             GO TO 515
               C
ISN 0074         540 CONTINUE
```

```
ISN 0075      6000 CONTINUE
ISN 0076      7000 CONTINUE
ISN 0077      8000 CONTINUE
             C
             C
ISN 0078      9000 CONTINUE
             C
             C      PLOT ON LINE PRINTER
             C
ISN 0079            WRITE(6,20) (A(I),I=1,N)
ISN 0080        20 FORMAT(' ',120A1)
ISN 0081            RETURN
ISN 0082            END
```

```
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REQUESTED OPTIONS: ,FB,,,,OBJ,,MAP,,GOSTMT,,,S,SIZE(256K),NAME(MAIN),OPT(0),LC(654),AD(NONE),FLAG(I),

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(54) SIZE(0256K) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT MAP NOFORMAT GOSTMT NOXREF NOALC NOANSF NOTERM IBM FLAG(I)

  ISN 0002             SUBROUTINE PPATN(R,N,IMAX,NMAX,IMIN,NMIN)
                 C
                 C        ...............................................................
                 C        .                                                             .
                 C        .          SCANS THE ARRAY 'R' FOR LOCAL MINIMUMS AND         .
                 C        .          MAXIMUMS.                                          .
                 C        .                                                             .
                 C        . ............................................................
                 C
  ISN 0003             DIMENSION R(N),IMAX(N),IMIN(N),IS(120)
                 C
                 C                    DEFINITION OF VARIABLES
                 C
                 C                  R - ARRAY OF DATA
                 C                  N - DIMENSION OF 'R'
                 C               IMAX - CONTAINS ADDRESSES OF LOCAL MAXIMA
                 C               IMIN - CONTAINS ADDRESSES OF LOCAL MINIMA
                 C               NMAX - NUMBER OF MAXIMUMS
                 C               NMIN - NUMBER OF MINIMUMS
                 C
                 C
  ISN 0004             NN=N-1
  ISN 0005             IS(1)=0
  ISN 0006             IF(R(1).LT.R(2)) IS(1)=1
                 C
  ISN 0008             DO 100 I=2,NN
  ISN 0009             IS(I)=0
  ISN 0010             IF(R(I).LT.R(I+1)) IS(I)=1
  ISN 0012             IF(R(I).EQ.R(I+1)) IS(I)=IS(I+1)
  ISN 0014         100 CONTINUE
                 C
  ISN 0015             IS(N)=0
  ISN 0016             IF(IS(N).GT.IS(N-1)) IS(N)=1
  ISN 0018             IF(IS(N).EQ.IS(N-1)) IS(N)=IS(N-1)
                 C
                 C
  ISN 0020             NMIN=0
  ISN 0021             NMAX=0
  ISN 0022             DO 230 I=1,NN
  ISN 0023             IF(IS(I)-IS(I+1)) 210,230,220
                 C
  ISN 0024         210 NMIN=NMIN+1
  ISN 0025             IMIN(NMIN)=I+1
  ISN 0026             GO TO 230
                 C
  ISN 0027         220 NMAX=NMAX+1
  ISN 0028             IMAX(NMAX)=I+1
                 C
  ISN 0029         230 CONTINUE
                 C
                 C
  ISN 0030             RETURN
  ISN 0031             END
```

APPENDIX III
INPUT DATA CARDS

GENERAL DESCRIPTION OF INPUT DATA CARDS

Three classifications of input data cards can be identified:-

1. initialization
2. raw aeromagnetic field data
3. profile and/or grid requests

The above classifications are identified with the use of header cards which contain a key word in cols. 1-8. In some cases (#2 and 3) additional information in the form of a title is also supplied.

Immediately following the header cards are the input data cards containing the input information to be read in.

Initialization header cards

Header card	Program response
TRANS	Transformation information to follow
ANGLES	Base map information to follow
NPOINT	Interpolation information to follow

If the header cards 'ANGLES' and 'NPOINT' and their corresponding input information are omitted, default values will be used.

Raw field data header cards

Header card	Program response
GRID BLOCK	Raw field data in the form of a 2 dim. regular grid to follow.

Where ' ' symbolizes a blank

(Note:- The second identifier 'BLOC' is needed in order for the program to distinguish between the raw data grid and the requested grids.)

Request header cards

Header card	Program response
PROFILE TITLE	Profile request information to follow
GRID TITLE	Grid request information to follow

End header card

Header card	Program response
END	Program terminates

TRANSFORMATION INFORMATION

Header card:- **TRANS**

Data set	Card #	Column	Format	Name	Description
1	1	1- 2	I2	NO	not used
REPEAT		3-10	A8	MAPN	name of map (output only)
FOR		11-17	F7.2	SET	map number ($\neq$ 1.0)
EACH		18-24	F7.2	X11	X1 for base map
MAP		25-31	F7.2	Y11	Y1 for base map
(must be		32-38	F7.2	X12	X2 for base map
followed		39-45	F7.2	Y12	Y2 for base map
by 'END'		46-52	F7.2	X21	X1 for user map
card)		53-59	F7.2	Y21	Y1 for user map
		60-66	F7.2	X22	X2 for user map
		67-73	F7.2	Y22	Y2 for user map
2	1	3-10	A8	END	END CARD ('END' in cols. 3, 4, 5)

NOTE:- Reference to a particular map is later made through its map number 'SET.' Map number '1' is reserved for reference to the block and therefore should not be used in the above.

OPTION:- The transformation parameters (XO, YO, Θ) may be specified by substituting X11 $\rightarrow$ XO, Y11 $\rightarrow$ YO and X12 $\rightarrow$ Θ and making (Y12-Y22) = 0.0.

Header card:- **ANGLES**

Data set	Card #	Column	Format	Name	Description
1	1	1- 2	I2	1BLOCK	block number
		3-10	8X	DUMMY	not used
		11-17	F7.2	ANGN	Angle Y-axis of base map makes with geographic north
		18-24	F7.2	ANGFLT	Angle Y-axis of base map makes with flight lines

NOTE:- All angles are defined: positive — clockwise
negative — anti-clockwise

Header card:- **NPOINT**

Data set	Card #	Column	Format	Name	Description
1	1	1-2	I2	NPOINT	specifies how many rows and columns of data block are to be used in spline interpolation

NOTE:- Default value of 'NPOINT' is '5' if 'NPOINT' = 2 linear (4-way) interpolation is performed.

FIELD DATA

Header card:- **GRID** in cols. 1-4
BLOCK in cols. 9-13

Data set	Card #	Column	Format	Name	Description
1	1	1- 2	I2	NO	block no.
		3- 6	I4	IDIM	X-dimension
		7-10	I4	JDIM	Y-dimension
		11-17	F7.2	GRIDX	X-increment
		18-24	F7.2	GRIDY	Y-increment
		25-31	F7.2	SET	map no. (usually = 1.0)
		32-38	F7.2	XO	X-orgn of block in base map
		39-45	F7.2	YO	Y-orgn of block in base map
		46-52	F7.2	ANG	angle of rotation of X-axis of block relative to X-axis of base map (positive — clockwise, negative — anti-clockwise)
2	1 to last	1-60	12F6.0	FGRID	field values (12 per card)

GRID REQUEST CARDS

Header card:- **GRID** in cols. 1-4
TITLE in cols. 9-80

Data set	Card #	Column	Format	Name	Description
1	1	1- 2	I2	NO	grid number
		3-10	8X	DUMMY	not used
		11-17	F7.2	PINC	increment required for X-direction
		18-24	F7.2	QINC	increment required for Y-direction
		25-31	F7.2	SET	map no.
		32-38	F7.2	X1	X1 co-ord (in map 'SET'), for point one
		39-45	F7.2	Y1	Y1 co-ord (in map 'SET'), for point one
		46-52	F7.2	X2	X2 co-ord (in map 'SET'), for point two
		53-59	F7.2	Y2	Y2 co-ord (in map 'SET'), for point two
		60-66	F7.2	CENT	reference point along line (X1, Y1), (X2, Y2) [optional]
		67-73	F7.2	GLENTH	length of grid in Y-direction

NOTE:- Repeat header card ('GRID' + TITLE) and DATSET 1 for each grid requested.

NOTE:- The line (X1, Y1), (X2, Y2) defines X-axis.

PROFILE REQUEST CARDS

Header card:- **PROFILE** in cols. 1-7
TITLE in cols. 9-80

Data set	Card #	Column	Format	Name	Description
1	1	1- 2	I2	NO	profile no.
		3-10	8X	DUMMY	not used
		11-17	F7.2	PINC	required profile increment
		18-24	F7.2	QINC	not used
		25-31	F7.2	SET	map no.
		32-38	F7.2	X1	defines starting (X1, Y1)
		39-45	F7.2	Y1	and stopping (X2, Y2) positions
		46-52	F7.2	X2	of profile
		53-59	F7.2	Y2	
		60-66	F7.2	CENT	reference point along profile

NOTE:- Repeat header card + data set #1 for each profile requested.

Header card:- **END**

No data cards to follow:- terminates run.

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REQUESTED OPTIONS: ,FB,,,,OBJ,,MAP,,GOSTMT,,,S,SIZE(256K),NAME(MAIN),OPT(0),LC(654),AD(NONE),FLAG(I),

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(54) SIZE(0256K) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT MAP NOFORMAT GOSTMT NOXREF NOALC NOANSF NOTERM IBM FLAG(I)

                C
                C          ..............................................................
                C          .                                                            .
                C          .                      PROGRAM PROFILE                       .
                C          .                                                            .
                C          .          COMPUTES THE FIELD VALUES ALONG A SPECIFIED       .
                C          .          PROFILE FROM A CUBIC SPLINE INTERPOLATION         .
                C          .          OF THE MEASURED DATA                              .
                C          .                                                            .
                C          .          THE PROFILE MAY BE SPECIFIED IN ANY ONE           .
                C          .          OF A NUMBER OF DIFFERENT CO-ORD FRAMES            .
                C          .                                                            .
                C          ..............................................................
                C
  ISN 0002            DIMENSION XGRID(400),YGRID(300),FGRID(120000)
  ISN 0003            DIMENSION ANGN(8),ANGFLT(8)
  ISN 0004            DIMENSION FP(500)
  ISN 0005            DIMENSION TITLE(20)
  ISN 0006            DIMENSION BUF(12)
  ISN 0007            DIMENSION DATIME(7)
                C
  ISN 0008            DOUBLE PRECISION NAME,NREF,NEND,NAMG,NAMP,NDUM,NANGLE,NPOIN
  ISN 0009            DOUBLE PRECISION XINC,YINC,XGINC,YGINC,PLENTH,XLIMD,XOD,YLIMD,YOD,
                     1                PIND,QIND,XPD,YPD
  ISN 0010            DATA ANGN/28.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0/
  ISN 0011            DATA ANGFLT/0.00,0.0,0.0,0.0,0.0,0.0,0.0,0.0/
  ISN 0012            DATA CON/0.0174533/
  ISN 0013            DATA NREF/'TRANS   '/
  ISN 0014            DATA NEND/'END     '/
  ISN 0015            DATA NAMG/'GRID    '/
  ISN 0016            DATA NAMP/'PROFILE '/
  ISN 0017            DATA BLOCK/'BLOC'/
  ISN 0018            DATA NANGLE/'ANGLES  '/
  ISN 0019            DATA NPOIN/'NPOINT  '/
  ISN 0020            DATA NPDIM/500/
  ISN 0021            DATA ITIMR/0/
  ISN 0022            DATA ITIME/0/
  ISN 0023            DATA NSET/0/
                C
                C                         DEFINITION OF VARIABLES
                C
                C                ANGN - ANGLE Y-AXIS OF BASE FRAME MAKES WITH THE
                C                       GEOGRAPHIC NORTH (POSITIVE CLOCKWISE)
                C              ANGFLT - ANGLE Y-AXIS OF BASE FRAME MAKES WITH THE
                C                       FLIGHT LINES (POSITIVE CLOCKWISE)
                C     NOTE:- THE BASE FRAME IS THE FRAME TO WHICH ALL OTHER
                C            CO-ORD FRAMES CAN BE TRANSFORMED TOO
                C
                C               XGRID - X CO-ORDS OF GRID POINTS
                C               YGRID - Y CO-ORDS OF GRID POINTS
                C               FGRID - FIELD VALUES OF GRID POINTS
                C              IBLOCK - BLOCK NUMBER
                C                IDIM - DIMENSION OF 'XGRID'
                C                JDIM - DIMENSION OF 'YGRID'
                C                GRID - GRID SPACING
                C                 XOB - X-ORIGIN OF BLOCK W.R.T BASE FRAME
                C                 YOB - Y-ORIGIN OF BLOCK W.R.T BASE FRAME
                C                ANGB - ANGLE OF ROTATION OF BLOCK W.R.T. BASE FRAME
                C               POINT - NUMBER OF ROWS (AND COLUMNS) TO USE FOR
                C                       INTERPOLATION
```

```
             C                   NO - PROFILE NUMBER
             C                 NAME - ANOMOLY NAME
             C                  SET - MAP NUMBER
             C                X1,Y1 - CO-ORDS OF ORIGIN OF PROFILE IN MAP 'SET'
             C                X2,Y2 - CO-ORDS OF REFERENCE POINT FOR PROFILE
             C                 PINC - INCREMENT ALONG PROFILE
             C
             C                   AP - NUMBER OF STATIONS FOR PROFILE
             C               ANGLEN - ANGLE PROFILE MAKES WITH GEOG. NORTH
             C               ANGLEF - ANGLE PROFILE MAKES WITH FLIGHT LINES
             C                   FP - FIELD VALUES ALONG PROFILE
ISN 0024           CALL $DATE(DATIME)
ISN 0025           WRITE(6,40) DATIME
ISN 0026           WRITE(6,41)
             C
             C
ISN 0027       100 CONTINUE
ISN 0028           IBUF=1
             C     READ HEADER CARD
             C
             C
ISN 0029           READ(5,10) NAME,(TITLE(I),I=1,18)
ISN 0030           IF(NAME.EQ.NEND) GO TO 1000
ISN 0032           IF(NAME.NE.NAMG) GO TO 120
ISN 0034           IF(TITLE(1).NE.BLOCK) GO TO 120
ISN 0036           IF(ITIMR.GT.0) GO TO 150
             C
             C     READ IN DATA BLOCK FROM CARDS
             C
ISN 0038           ITIMR=10
ISN 0039           READ(5,21) IBLOCK,IDIM,JDIM,GRIDX,GRIDY,SET,X1,Y1,X2,Y2,CENT,
                  1           ANGLEN,ANGLEF
ISN 0040           IF(GRIDX.LE.0.0) GRIDX=0.2
ISN 0042           IF(GRIDY.LE.0.0) GRIDY=0.2
             C
             C     INITIALIZE 'TRANS' SUBROUTINE FOR TRANSFORMATION FROM BASE
             C     FRAME TO BLOCK FRAME
             C
ISN 0044           ISET=1
ISN 0045           IROT=0
ISN 0046           CALL TRANS(IROT,ISET,X1,Y1,X2,Y2,XOP,YOP,XLIMP,YLIMP)
             C
ISN 0047           NDIM=IDIM*JDIM
ISN 0048           JJ=-IDIM
ISN 0049           DO 110 J=1,JDIM
ISN 0050           JJ=JJ+IDIM
ISN 0051       110 READ(5,11) (FGRID(I+JJ),I=1,IDIM)
ISN 0052           GO TO 100
             C
             C
ISN 0053       120 IF(ITIMR.GT.0) GO TO 130
             C
             C     READ IN DATA BLOCK FROM UNIT NO '4'
             C
ISN 0055           ITIMR=10
ISN 0056           READ(4,10) NDUM
ISN 0057           READ(4,21) IBLOCK,IDIM,JDIM,GRIDX,GRIDY,SET,X1,Y1,X2,Y2,CENT,
                  1           ANGLEN,ANGLEF
ISN 0058           IF(GRIDX.LE.0.0) GRIDX=0.2
ISN 0060           IF(GRIDY.LE.0.0) GRIDY=0.2
             C
ISN 0062           NDIM=IDIM*JDIM
ISN 0063           READ(4,11) (FGRID(I),I=1,NDIM)
             C
```

```
ISN 0064          130 CONTINUE
                C
ISN 0065              IF(NAME.NE.NREF) GO TO 140
                C
                C
                C     INITIALIZE SUBROUTINE 'TRANS'
                C     RETURN WITN 'NSET' EQUAL TO TOTAL NUMBER OF MAPS
                C
ISN 0067              NSET=0
ISN 0068              IROT=0
ISN 0069              CALL TRANS(IROT,NSET,XB1,YB1,XB2,YB2,X21,Y21,X22,Y22)
ISN 0070              GO TO 100
                C
                C
ISN 0071          140 IF(NAME.NE.NANGLE) GO TO 145
                C
                C     DEFINE ANGLES OF GEOG NORTH AND FLIGHT LINES
                C
ISN 0073              READ(5,16) IBLOCK,A1,A2
ISN 0074              IF(A1.GT.0.0) ANGN(IBLOCK)=A1
ISN 0076              IF(A2.GT.0.0) ANGFLT(IBLOCK)=A2
ISN 0078              GO TO 100
                C
                C
ISN 0079          145 IF(NAME.NE.NPOIN) GO TO 150
                C
                C     DEFINE NUMBER OF POINTS USED IN SPLINE INTERPOIATION
                C
ISN 0081              READ(5,16) NPOINT
ISN 0082              IF(NPOINT.LE.0) NPOINT=5
ISN 0084              GO TO 100
                C
                C
ISN 0085          150 CONTINUE
                C
                C     READ IN PROFILE SPECIFICATION
                C
ISN 0086              READ(5,16) NO,PINC,QINC,SET,X1,Y1,X2,Y2,CENT,GLENTH
ISN 0087              JSET=SET
ISN 0088              IF(QINC.LE.0.0) QINC=0.2
ISN 0090              IF(JSET.NE.1) GO TO 155
ISN 0092              XB1=X1
ISN 0093              YB1=Y1
ISN 0094              XB2=X2
ISN 0095              YB2=Y2
ISN 0096              GO TO 156
                C
ISN 0097          155 CONTINUE
                C     TRANSFORM TO BASE FRAME
                C
ISN 0098              IROT=-1
ISN 0099              ISET=JSET
ISN 0100              IF(ISET.LE.0) ISET=1
ISN 0102              CALL TRANS(IROT,ISET,XB1,YB1,XB2,YB2,X1,Y1,X2,Y2)
                C
ISN 0103          156 IF(JSET.NE.0) GO TO 157
ISN 0105              XOP=X1
ISN 0106              YOP=Y1
ISN 0107              XLIMP=X2
ISN 0108              YLIMP=Y2
ISN 0109              GO TO 158
                C
ISN 0110          157 CONTINUE
                C
                C     TRANSFORM TO BLOCK FRAME
                C
```

```
ISN 0111            ISET=1
ISN 0112            IROT=1
ISN 0113            CALL TRANS(IROT,ISET,XB1,YB1,XB2,YB2,XOP,YOP,XLIMP,YLIMP)
              C
ISN 0114        158 CONTINUE
              C
              C     FIND ANGLE OF PROFILE RELATIVE TO GEOGRAPHIC NORTH
              C
ISN 0115            X=XB2-XB1
ISN 0116            Y=YB2-YB1
ISN 0117            ANGLEN=ATAN2(X,Y)/CON-ANGN(IBLOCK)
ISN 0118            IF(ANGLEN.LT.180.0) ANGLEN=ANGLEN+360.0
ISN 0120            IF(ANGLEN.GT.180.0) ANGLEN=ANGLEN-360.0
              C
              C
              C     FIND ANGLE OF PROFILE WITH DIRECTION OF FLIGHT LINES
              C     (ALWAYS POSITIVE (0-90) DEG.)
              C
ISN 0122            ANGLEF=ATAN2(X,Y)/CON-ANGFLT(IBLOCK)
ISN 0123            ANGLEF=ABS(ANGLEF)
ISN 0124            IF(ANGLEF.GT.90.0) ANGLEF=180.0-ANGLEF
              C
              C
              C     PRINT OUT PROFILE INFORMATION
              C
ISN 0126            IF(ITIME.EQ.0) WRITE(6,32) DATIME
ISN 0128            ITIME=ITIME+1
ISN 0129            WRITE(6,25)
ISN 0130            WRITE(6,24) (TITLE(I),I=1,18)
              C
ISN 0131            IF(NAME.EQ.NAMP) WRITE(6,26) NO,PINC,ANGLEN,ANGLEF,CENT
ISN 0133            IF(NAME.EQ.NAMG) WRITE(6,27) NO,PINC,ANGLEN,ANGLEF,CENT,
                   1                             QINC,GLENTH
ISN 0135            WRITE(6,23)
              C
              C     PRINT BLOCK CO-ORDS OF PROFILE
              C
ISN 0136            ISET=0
ISN 0137            WRITE(6,30) ISET,XOP,YOP,XLIMP,YLIMP
              C
              C
              C     PRINT BASE CO-ORDS OF PROFILE
              C
ISN 0138            ISET=1
ISN 0139            WRITE(6,30) ISET,XB1,YB1,XB2,YB2
              C
ISN 0140            IF(NSET.LE.1) GO TO 180
              C
              C     PRINT CO-ORDS IN REMAINING MAP FRAMES
              C
ISN 0142            IROT=1
ISN 0143            DO 170 ISET=2,NSET
ISN 0144            CALL TRANS(IROT,ISET,XB1,YB1,XB2,YB2,X21,Y21,X22,Y22)
ISN 0145            WRITE(6,30) ISET,X21,Y21,X22,Y22
ISN 0146        170 CONTINUE
              C
ISN 0147        180 CONTINUE
              C
              C
              C     SET UP 'XGRID' AND 'YGRID'
              C
ISN 0148            XGINC=GRIDX
ISN 0149            DO 200 I=1,IDIM
ISN 0150            XINC=(I-1)*XGINC
ISN 0151        200 XGRID(I)=XINC
```

```
ISN 0152              YGINC=GRIDY
ISN 0153              DO 210 J=1,JDIM
ISN 0154              YINC=(J-1)*YGINC
ISN 0155          210 YGRID(J)=YINC
            C
            C
            C         FIND INCREMENTS IN X AND Y
            C
ISN 0156              XOD=XOP
ISN 0157              XLIMD=XLIMP
ISN 0158              YOD=YOP
ISN 0159              YLIMD=YLIMP
ISN 0160              PIND=PINC
ISN 0161              QIND=QINC
            C
ISN 0162              PLENTH=DSQRT((XLIMD-XOD)**2+(YLIMD-YOD)**2)
ISN 0163              XINC=PIND*(XLIMD-XOD)/PLENTH
ISN 0164              YINC=PIND*(YLIMD-YOD)/PLENTH
ISN 0165              IC=1
ISN 0166              XGINC=QIND*(YLIMD-YOD)/PLENTH
ISN 0167              YGINC=QIND*(XLIMD-XOD)/PLENTH
ISN 0168              PLENTP=PLENTH
ISN 0169              NP=PLENTP/PINC+1.5
ISN 0170              NQ=QLENTH/QINC+1.5
ISN 0171              ITG=0
            C
ISN 0172          250 IP=0
ISN 0173              XPD=XOD
ISN 0174              YPD=YOD
ISN 0175              GO TO 320
            C
ISN 0176          300 CONTINUE
ISN 0177              IF(IP.GE.NPDIM) GO TO 400
ISN 0179              IF(IP.GE.NP) GO TO 400
            C
ISN 0181              XPD=XPD+XINC
ISN 0182              YPD=YPD+YINC
ISN 0183          320 IP=IP+1
ISN 0184              XP=XPD
ISN 0185              YP=YPD
            C
            C         FIND FIELD VALUES ALONG PROFILE
            C
            C
ISN 0186              CALL INTER(XGRID,YGRID,FGRID,IDIM,JDIM,XP,YP,FP(IP),NPOINT)
ISN 0187              GO TO 300
            C
            C
ISN 0188          400 CONTINUE
            C
            C         ----------------- OUTPUT --------------------
            C
            C
            C
            C
ISN 0189              IF(ITG.GT.0) GO TO 410
ISN 0191              ND=NP*NQ
ISN 0192              WRITE(6,28) ND
ISN 0193              WRITE(8,20) NAME,(TITLE(I),I=1,18)
ISN 0194              WRITE(8,21) ND,NP,NQ,PINC,QINC,SET,X1,Y1,X2,Y2,CENT,ANGLEN,ANGLEF
            C
ISN 0195          410 ITG=ITG+1
            C
ISN 0196              IP=0
```

```
ISN 0197        415 NBUF=0
ISN 0198            DO 420 I=IBUF,12
ISN 0199            IP=IP+1
ISN 0200            IF(IP.GT.NP) GO TO 430
ISN 0202            NBUF=NBUF+1
ISN 0203        420 BUF(I)=FP(IP)
              C
              C     WRITE(6,29)  (BUF(I),I=1,12)
ISN 0204            WRITE(8,22)  (BUF(I),I=1,12)
ISN 0205            IBUF=1
ISN 0206            GO TO 415
              C
ISN 0207        430 IBUF=NBUF+1
ISN 0208            IF(NBUF.EQ.0) GO TO 435
ISN 0210            IF(NAME.EQ.NAMP) WRITE(6,29)  (BUF(I),I=1,NBUF)
ISN 0212            IF(NAME.EQ.NAMP) WRITE(8,22)  (BUF(I),I=1,NBUF)
ISN 0214        435 IF(NAME.EQ.NAMP) GO TO 100
              C
              C     LOOP OVER GRID
              C
ISN 0216            IF(NBUF.EQ.0) GO TO 440
ISN 0218            IF(IC.GE.NQ) WRITE(6,29) (BUF(I),I=1,NBUF)
ISN 0220            IF(IC.GE.NQ) WRITE(8,22) (BUF(I),I=1,NBUF)
ISN 0222        440 IF(IC.GE.NQ) GO TO 100
ISN 0224            XOD=XOD-XGINC
ISN 0225            YOD=YOD+YGINC
ISN 0226            IC=IC+1
ISN 0227            GO TO 250
              C
ISN 0228       1000 CONTINUE
              C
ISN 0229         10 FORMAT(A8,18A4)
ISN 0230         11 FORMAT(12F6.0)
ISN 0231         14 FORMAT(I2,I4,I4,10F7.2)
ISN 0232         16 FORMAT(I2,8X,10F7.2)
ISN 0233         20 FORMAT(A8,18A4)
ISN 0234         21 FORMAT(I2,2I4,10F7.2)
ISN 0235         22 FORMAT(12F6.0)
ISN 0236         23 FORMAT('0',19X,'MAP NO',10X,'X1',8X,'Y1',8X,'X2',8X,'Y2'/)
ISN 0237         24 FORMAT(//' ',40X,'TITLE:-  ',18A4//)
ISN 0238         25 FORMAT(' ',2X,'-----------------------------------------------------------
                  1-------------------------------------------------------------
                  2---'/)
ISN 0239         26 FORMAT(' ',5X,'PROFILE NO',5X,'PINC',5X,'ANGLE NORTH',5X,
                  1              'ANGLE FLT',5X,'REF. DIST',//
                  2       ' ',8X,I2,9X,F5.2,7X,F7.2,8X,F7.2,7X,F7.2/)
ISN 0240         27 FORMAT(' ',5X,'   GRID NO',5X,'PINC',5X,'ANGLE NORTH',5X,
                  1              'ANGLE FLT',5X,'REF. DIST',5X,'QINC',5X,'GLENTH'//
                  2       ' ',8X,I2,9X,F5.2,7X,F7.2,8X,F7.2,7X,F7.2,5X,F5.2,4X,F7.2/)
ISN 0241         30 FORMAT(' ',21X,I2,7X,4F10.5)
ISN 0242         28 FORMAT('0',50X,'----- FIELD DATA -----',//
                  1       ' ',3X,I4,' STATIONS'/)
ISN 0243         29 FORMAT(' ',2X,12F10.2)
ISN 0244         32 FORMAT('1',////' ',50X,'**** INTERPOLATED DATA ****',10X,7A4//)
ISN 0245         40 FORMAT(///' ',45X,'DEPT. OF EARTH SCIENCES, UNIV. OF MANITOBA',
                  1              5X,7A4//)
ISN 0246         41 FORMAT(' ',56X,'PROGRAM **PROFILE**'/)
ISN 0247         99 FORMAT('1')
ISN 0248            STOP
ISN 0249            END
```

```
REQUESTED OPTIONS: ,EP,,,,OBJ,,MAP,,GOSTMT,,,S,SIZE(256K),NAME(MAIN),OPT(0),LC(654),AD(NONE),FLAG(I),

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(54) SIZE(0256K) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT MAP NOFORMAT GOSTMT NOXREF NOALC NOANSF NOTERM IBM FLAG(I)

   ISN 0002            SUBROUTINE TRANS(IROT,ISET,X11,Y11,X12,Y12,X21,Y21,X22,Y22)
                 C
                 C     .............................................................
                 C     .                                                           .
                 C     .         TRANSLATE AND ROTATE FROM CO-ORD FRAME 1          .
                 C     .            TO CO-ORD FRAME 2. (OR VICE VERSA)             .
                 C     .                                                           .
                 C     .    FIRST CALL - INITIALIZES SUBROUTINE. THE CO-ORDS       .
                 C     .      IROT=0     OF TWO POINTS IN EACH FRAME WHICH         .
                 C     .                 DEFINE THE SAME STRAIGHT LINE ARE         .
                 C     .                 USED TO SET UP THE MATRIX ELEMENTS        .
                 C     .     ISET EQ 0 - READ CO-ORDS OF LINE FROM CARDS           .
                 C     .     ISET NE 0 - INITIALIZE FROM CALLING PROGRAM           .
                 C     .                                                           .
                 C     .   SECOND CALL - PERFORMS THE CONVERSION                   .
                 C     .      IROT=1   - CALL TO 'TRANS' WILL CONVERT TWO          .
                 C     .                 POINTS FROM FRAME 1 TO FRAME 2            .
                 C     .     IROT=-1   - CALL TO 'TRANS' WILL CONVERT TWO          .
                 C     .                 POINTS FROM FRAME 2 TO FRAME 1            .
                 C     .    ENTRY CALL - CONVERTS ONE POINT ONLY                   .
                 C     .        F1TOF2 - CONVERTS FROM FRAME 1 TO FRAME 2          .
                 C     .        F2TOF1 - CONVERTS FROM FRAME 2 TO FRAME 1          .
                 C     .                                                           .
                 C     .         50 DIFFERENT SETS OF FRAMES ARE ALLOWED           .
                 C     .                                                           .
                 C     .         THE ANGLE OF ROTATION IS DEFINED POSITIVE         .
                 C     .         FOR CLOCKWISE ROTATIONS AND NEGATIVE FOR          .
                 C     .         ANTI-CLOCKWISE ROTATIONS                          .
                 C     .                                                           .
                 C     .............................................................
                 C
   ISN 0003            DIMENSION XORGN(50),YORGN(50),COSANG(50),SINANG(50)
   ISN 0004            DIMENSION MAPNAM(50)
   ISN 0005            DOUBLE PRECISION MAPNAM,MAPN,NEND
   ISN 0006            DATA XORGN/50*0.0/
   ISN 0007            DATA YORGN/50*0.0/
   ISN 0008            DATA COSANG/50*1.0/
   ISN 0009            DATA SINANG/50*0.0/
   ISN 0010            DATA NEND/'END     '/
   ISN 0011            DATA ITIME/0/
   ISN 0012            DATA CON/0.0174533/
                 C
                 C                      DEFINITION OF VARIABLES
                 C
                 C              IROT - IF '0' - INITIALIZE SUBROUTINE
                 C                     IF '1' - CONVERT FROM FRAME 1 TO FRAME 2
                 C                     IF'-1' - CONVERT FROM FRAME 2 TO FRAME 1
                 C              ISET - DETERMINES THE SET OF FRAMES
                 C                     ALSO USED AS FLAG DURING INITIALIZATION
                 C                X1 - REFERS TO X CO-ORDS IN FRAME 1
                 C                     (X11 REFERS TO POINT 1, X12 TO POINT 2)
                 C                Y1 - REFERS TO Y CO-ORDS IN FRAME 1
                 C                X2 - REFERS TO X CO-ORDS IN FRAME 2
                 C                Y2 - REFERS TO Y CO-ORDS IN FRAME 2
                 C
                 C
   ISN 0013            IF(IROT) 300,100,200
                 C
   ISN 0014        100 CONTINUE
                 C
```

```
ISN 0015            IF(ISET.NE.0) GO TO 120
               C
               C    READ FROM CARDS CO-ORDS OF STRAIGHT LINE COMMON TO BOTH FRAMES
               C    TERMINATE WITH 'END'
               C
ISN 0017         110 CONTINUE
ISN 0018            READ(5,10) NO,MAPN,SET,X11,Y11,X12,Y12,X21,Y21,X22,Y22
ISN 0019            IF(MAPN.EQ.NEND) GO TO 140
ISN 0021            ISET=SET
ISN 0022            MAPNAM(ISET)=MAPN
               C
               C    PRINT CO-ORDS OF LINE ON PRINTER
               C
ISN 0023            IF(ITIME.EQ.0) WRITE(6,20)
ISN 0025            IF(ITIME.EQ.0) WRITE(6,21)
ISN 0027            ITIME=ITIME+1
               C
ISN 0028            WRITE(6,22) MAPNAM(ISET),ISET,X11,Y11,X12,Y12,X21,Y21,X22,Y22
               C
               C
ISN 0029         120 CONTINUE
               C
               C    CHECK IF DATA IS CONVERSION CONSTANTS OR CO-ORD INFO
               C
ISN 0030            IF(X21.EQ.0.AND.X22.EQ.0) GO TO 150
               C
               C    SET UP CONVERSION CONSTANTS
               C
ISN 0032            R1=SQRT((X12-X11)**2+(Y12-Y11)**2)
ISN 0033            R2=SQRT((X22-X21)**2+(Y22-Y21)**2)
ISN 0034            R=(R1+R2)/2.0
ISN 0035            RSQ=R*R
               C
               C    CHECK IF 'R1' EQUALS 'R2'
               C
ISN 0036            IF(R1.EQ.R2) GO TO 130
               C
               C
               C    REDEFINE POINTS SUCH THAT 'R1' EQUALS 'R2'
               C    KEEP THE ANGLES 'R1' AND 'R2' MAKE WITH THE X-AXIS THE SAME
               C
ISN 0038            COSTH=(X22-X21)/R2
ISN 0039            SINTH=(Y22-Y21)/R2
ISN 0040            X22=X21+(R2+.5*(R-R2))*COSTH
ISN 0041            Y22=Y21+(R2+.5*(R-R2))*SINTH
ISN 0042            X21=X22-R*COSTH
ISN 0043            Y21=Y22-R*SINTH
               C
ISN 0044            COSTH=(X12-X11)/R1
ISN 0045            SINTH=(Y12-Y11)/R1
ISN 0046            X12=X11+(R1+.5*(R-R1))*COSTH
ISN 0047            Y12=Y11+(R1+.5*(R-R1))*SINTH
ISN 0048            X11=X12-R*COSTH
ISN 0049            Y11=Y12-R*SINTH
               C
ISN 0050            WRITE(6,23)
ISN 0051            WRITE(6,22) MAPNAM(ISET),ISET,X11,Y11,X12,Y12,X21,Y21,X22,Y22
               C
               C
ISN 0052         130 COSANG(ISET)=((X22-X21)*(X12-X11)+(Y22-Y21)*(Y12-Y11))/RSQ
ISN 0053            SINANG(ISET)=((Y22-Y21)*(X12-X11)-(X22-X21)*(Y12-Y11))/RSQ
               C
ISN 0054            XORGN(ISET)=X11-(X21*COSANG(ISET)+Y21*SINANG(ISET))
ISN 0055            YORGN(ISET)=Y11-(Y21*COSANG(ISET)-X21*SINANG(ISET))
```

```
ISN 0056          IF(ITIME.GT.0) GO TO 110
ISN 0058          RETURN
            C
            C
ISN 0059      140 CONTINUE
            C
            C     PRINT OUT TRANSFORMATION PARAMETERS
            C
ISN 0060          WRITE(6,24)
ISN 0061          DO 145 I=1,ISET
ISN 0062          ANG=ATAN2(SINANG(I),COSANG(I))/CON
ISN 0063      145 WRITE(6,26) MAPNAM(I),I,XORGN(I),YORGN(I),ANG
ISN 0064          RETURN
            C
            C
ISN 0065      150 CONTINUE
            C
            C     COME HERE IF CONVERSION CONSTANTS SUPPLIED DIRECTLY
            C
ISN 0066          XORGN(ISET)=X11
ISN 0067          YORGN(ISET)=Y11
ISN 0068          ANG=X12*CON
ISN 0069          COSANG(ISET)=COS(ANG)
ISN 0070          SINANG(ISET)=SIN(ANG)
ISN 0071          RETURN
            C
            C
ISN 0072      200 CONTINUE
            C
            C     TRANSLATE AND ROTATE FROM FRAME1 TO FRAME 2
            C
ISN 0073          X=X12-XORGN(ISET)
ISN 0074          Y=Y12-YORGN(ISET)
ISN 0075          X22=X*COSANG(ISET)-Y*SINANG(ISET)
ISN 0076          Y22=X*SINANG(ISET)+Y*COSANG(ISET)
            C
ISN 0077          ENTRY F1TOF2(ISET,X11,Y11,X21,Y21)
            C
ISN 0078          X=X11-XORGN(ISET)
ISN 0079          Y=Y11-YORGN(ISET)
ISN 0080          X21=X*COSANG(ISET)-Y*SINANG(ISET)
ISN 0081          Y21=X*SINANG(ISET)+Y*COSANG(ISET)
ISN 0082          RETURN
            C
            C
ISN 0083      300 CONTINUE
            C
            C     ROTATE AND TRANSLATE FROM FRAME 2 TO FRAME 1
            C
ISN 0084          X12=X22*COSANG(ISET)+Y22*SINANG(ISET)+XORGN(ISET)
ISN 0085          Y12=Y22*COSANG(ISET)-X22*SINANG(ISET)+YORGN(ISET)
            C
ISN 0086          ENTRY F2TOF1(ISET,X11,Y11,X21,Y21)
            C
ISN 0087          X11=X21*COSANG(ISET)+Y21*SINANG(ISET)+XORGN(ISET)
ISN 0088          Y11=Y21*COSANG(ISET)-X21*SINANG(ISET)+YORGN(ISET)
            C
ISN 0089       10 FORMAT(I2,A8,9F7.2)
ISN 0090       20 FORMAT(' ',  ///' ',  8X,'REFERENCE LINE CO-ORDINATES'//)
ISN 0091       21 FORMAT(' ',33X,'-------------- BASE MAP -------------',
                1          8X,'---------------- MAP ----------------'//
                2       ' ',6X,'MAP NAME',5X,'MAP NO',11X,'X1',8X,'Y1',8X,'X2',8X,
                2          'Y2',13X,'X1',8X,'Y1', 8X,'X2',8X,'Y2'/)
ISN 0092       22 FORMAT(' ',8X,A8,5X,I2,7X,4F10.5,5X,4F10.5)
ISN 0093       23 FORMAT(    ' ',50X,'***** REDEFINING REFERENCE LINE *****'/)
ISN 0094       24 FORMAT(///'0', 8X,'TRANSFORMATION PARAMETERS'//
```

```
                 2         ' ',6X,'MAP NAME',5X,'MAP NO',11X,'X-ORIGIN',8X,'Y-ORIGIN',
                 1            8X,'ANGLE OF ROTATION'/)
ISN 0095        26 FORMAT(' ',8X,A8,5X,I2,11X,F10.5,6X,F10.5,10X,F10.5)
ISN 0096           RETURN
ISN 0097           END
```

```
REQUESTED OPTIONS: ,EB,,,,OBJ,,MAP,,GOSTMT,,,S,SIZE(256K),NAME(MAIN),OPT(0),LC(654),AD(NONE),FLAG(I),

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(54) SIZE(0256K) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT MAP NOFORMAT GOSTMT NOXREF NOALC NOANSF NOTERM IBM FLAG(I)

  ISN 0002              SUBROUTINE INTER(XGRID,YGRID,FGRID,IDIM,JDIM,PX,PY,FP,NPOINT)
                 C
                 C        ...............................................................
                 C        .                                                             .
                 C        .            TWO DIMENSIONAL SPLINE INTERPOLATION             .
                 C        .                USING NATURAL BICUBIC SPLINES                .
                 C        .                                                             .
                 C        .          CALCULATES THE FUNCTION VALUE FOR A POINT          .
                 C        .          (XP,YP) LYING WITHIN A TWO DIMENSIONAL             .
                 C        .          GRID (XGRID,YGRID) OF KNOWN VALUES                 .
                 C        .                                                             .
                 C        . NOTE 1- IF 'NPOINT'=2, A LINEAR INTERPOLATION IS            .
                 C        .          PERFORMED                                          .
                 C        .       2- 'NPOINT' CANNOT BE GREATER THAN 400                .
                 C        .          (DIMENSION LIMITATION)                             .
                 C        .                                                             .
                 C        ...............................................................
                 C
  ISN 0003              DIMENSION XGRID(IDIM),YGRID(JDIM),FGRID(IDIM,JDIM)
  ISN 0004              DIMENSION BPAR(4),C(400,3)
  ISN 0005              DIMENSION XROW(400),YCOL(400),FROW(400),FCOL(400)
  ISN 0006              DIMENSION FROWP(400),FCOLP(400)
                 C
  ISN 0007              EQUIVALENCE(XROW(1),YCOL(1)),(FROW(1),FCOL(1)),(FROWP(1),FCOLP(1))
  ISN 0008              DATA BPAR/0.0,0.0,0.0,0.0/
  ISN 0009              DATA NPXY/0/
                 C
                 C
                 C                     DEFINITION OF VARIABLES
                 C
                 C        INPUT:-
                 C                XGRID - X CO-ORD OF GRID POINTS
                 C                YGRID - Y CO-ORD OF GRID POINTS
                 C                FGRID - FUNCTION VALUES OF GRID POINTS
                 C                 IDIM - DIMENSION OF 'XGRID'
                 C                 JDIM - DIMENSION OF 'YGRID'
                 C
                 C                   XP - X CO-ORD OF INTERPOLATED POINT
                 C                   YP - Y CO-ORD OF INTERPOLATED POINT
                 C               NPOINT - NUMBER OF GRID POINTS SURROUNDING POINT
                 C                        (XP,YP) TO BE USED FOR SPLINE INTERPOLATION
                 C
                 C       OUTPUT:-
                 C                   FP - INTERPOLATED FUNCTION VALUE AT POINT (XP,YP)
                 C
                 C          FOR THE FUTURE (NOT YET IMPLIMENTED)
                 C
                 C                 NPXY - SET TO '0' IF 'NPOINT' IS THE SAME FOR
                 C                        BOTH X AND Y DIRECTIONS
                 C
                 C
                 C
  ISN 0010              XP=PX
  ISN 0011              YP=PY
                 C
                 C        CHECK INPUT QUANTITIES
                 C
```

```
ISN 0012          IF(XP.LT.XGRID(1)) GO TO 8888
ISN 0014          IF(XP.GT.XGRID(IDIM)) GO TO 8888
ISN 0016          IF(YP.LT.YGRID(1)) GO TO 8888
ISN 0018          IF(YP.GT.YGRID(JDIM)) GO TO 8888
ISN 0020          IF(NPOINT.LE.1) NPOINT=2
ISN 0022          IF(NPOINT.GT.IDIM) NPOINT=IDIM
ISN 0024          IF(NPOINT.GT.JDIM) NPOINT=JDIM
            C
            C
            C     SET PARAMETERS USED FOR SPLINE SUBROUTINES
            C
            C
ISN 0026          IC=NPOINT-1
ISN 0027          M=1
            C
            C
            C     FIND THE GRID LOCATION FOR THE POINT (XP,YP)
            C
ISN 0028          I=0
ISN 0029          J=0
            C
ISN 0030      100 I=I+1
ISN 0031          IF(XP.GE.XGRID(I).AND.XP.LT.XGRID(I+1)) GO TO 120
ISN 0033          GO TO 100
            C
ISN 0034      120 J=J+1
ISN 0035          IF(YP.GE.YGRID(J).AND.YP.LT.YGRID(J+1)) GO TO 150
ISN 0037          GO TO 120
            C
ISN 0038      150 CONTINUE
            C
            C
            C     INITIALIZE INDICES FOR SURROUNDING ROWS AND COLUMNS
            C
ISN 0039          NUP=NPOINT/2
ISN 0040          NLOW=NUP-1
            C
ISN 0041          ITEST=(NPOINT/2)*2
ISN 0042          IF(ITEST.NE.NPOINT) NLOW=NUP
            C
ISN 0044          IS=I-NLOW
ISN 0045          IE=I+NUP
ISN 0046          IF(IS.GE.1) GO TO 160
ISN 0048          IS=1
ISN 0049          IE=NPOINT
ISN 0050          GO TO 180
            C
ISN 0051      160 IF(IE.LE.IDIM) GO TO 180
ISN 0053          IS=IDIM-NPOINT+1
ISN 0054          IE=IDIM
            C
ISN 0055      180 JS=J-NLOW
ISN 0056          JE=J+NUP
ISN 0057          IF(JS.GE.1) GO TO 190
ISN 0059          JS=1
ISN 0060          JE=NPOINT
ISN 0061          GO TO 200
            C
ISN 0062      190 IF(JE.LE.JDIM) GO TO 200
ISN 0064          JS=JDIM-NPOINT+1
ISN 0065          JE=JDIM
            C
            C
ISN 0066      200 CONTINUE
            C
            C     INTERPOLATE ALONG X-DIRECTION FOR 'NPOINT' ROWS SURROUNDING
            C     POINT, AND FOR 'NPOINT' POINTS WITHIN EACH ROW
            C
```

```
ISN 0067          DO 205 II=IS,IE
ISN 0068      205 XROW(II-IS+1)=XGRID(II)
            C
ISN 0069          DO 220 JJ=JS,JE
            C
ISN 0070          DO 210 II=IS,IE
ISN 0071          FROWS=FGRID(II,JJ)
ISN 0072          IF(ABS(XP-XGRID(II)).LT.0.00001) GO TO 220
ISN 0074      210 FROW(II-IS+1)=FGRID(II,JJ)
            C
ISN 0075          CALL ICSICU(XROW,FROW,NPOINT,BPAR,C,IC,IER)
ISN 0076          CALL ICSEVU(XROW,FROW,NPOINT,C,IC,XP,FROWS,M,IER)
            C
ISN 0077      220 FROWP(JJ-JS+1)=FROWS
            C
ISN 0078          DO 230 JJ=JS,JE
ISN 0079          F1=FROWP(JJ-JS+1)
ISN 0080          IF(ABS(YP-YGRID(JJ)).LT.0.00001) GO TO 300
ISN 0082      230 YCOL(JJ-JS+1)=YGRID(JJ)
            C
ISN 0083          CALL ICSICU(YCOL,FROWP,NPOINT,BPAR,C,IC,IER)
ISN 0084          CALL ICSEVU(YCOL,FROWP,NPOINT,C,IC,YP,F1,M,IER)
            C
ISN 0085      300 CONTINUE
ISN 0086          IF(NPXY.EQ.0) GO TO 500
            C
            C ----------------------------------------------------------------
            C
            C      ***********  NOT USED IN THIS VERSION  ***********
            C                   MAY NEVER BE NEEDED ??
            C
            C
            C      INTERPOLATE ALONG Y-DIRECTION FOR 'NPOINT' COLUMNS
            C      SURROUNDING POINT, AND FOR 'NPOINT' POINTS WITHIN EACH COLUMN
            C
ISN 0088          DO 320 II=IS,IE
            C
ISN 0089          DO 310 JJ=JS,JE
ISN 0090          FCOLS=FGRID(II,JJ)
ISN 0091          IF(YP.EQ.YGRID(JJ)) GO TO 320
ISN 0093      310 FCOL(JJ-JS+1)=FGRID(II,JJ)
            C
ISN 0094          CALL ICSICU(YCOL,FCOL,NPOINT,BPAR,C,IC,IER)
ISN 0095          CALL ICSEVU(YCOL,FCOL,NPOINT,C,IC,YP,FCOLS,M,IER)
            C
ISN 0096      320 FCOLP(II-IS+1)=FCOLS
            C
ISN 0097          DO 330 II=IS,IE
ISN 0098          F2=FCOLP(II-IS+1)
ISN 0099          IF(XP.EQ.XGRID(II)) GO TO 400
ISN 0101      330 XROW(II-IS+1)=XGRID(II)
            C
ISN 0102          CALL ICSICU(XROW,FCOLP,NPOINT,BPAR,C,IC,IER)
ISN 0103          CALL ICSEVU(XROW,FCOLP,NPOINT,C,IC,XP,F2,M,IER)
            C
            C
ISN 0104      400 CONTINUE
            C
            C     AVERAGE 'F1' AND 'F2'
            C
ISN 0105          FP=(F1+F2)/2.0
            C
ISN 0106          RETURN
            C
            C ----------------------------------------------------------------
            C
```

```
ISN 0107        500 CONTINUE
              C
              C     COME HERE IF 'NPOINT' IS SAME FOR X AND Y DIRECTIONS
              C
ISN 0108            FP=F1
              C
ISN 0109            RETURN
              C
              C
ISN 0110       8888 FP=0.0
ISN 0111            RETURN
ISN 0112         20 FORMAT(///' ',30X,'******* XP OUT OF RANGE = ',F10.5,'*******'/)
ISN 0113         22 FORMAT(///' ',30X,'******* YP OUT OF RANGE = ',F10.5,'*******'/)
ISN 0114            END
```

DEPT. OF EARTH SCIENCES, UNIV. OF MANITOBA DATE=12/09/81 TIME=11:11 AM

PROGRAM **PROFILE**

REFERENCE LINE CO-ORDINATES

MAP NAME	MAP NO	BASE MAP X1	BASE MAP Y1	BASE MAP X2	BASE MAP Y2	MAP X1	MAP Y1	MAP X2	MAP Y2
1977 L-1	2	23.19000	11.00000	43.44000	13.56000	1.98000	5.61000	17.44000	18.03999
***** REDEFINING REFERENCE LINE *****									
1977 L-1	2	23.33235	11.01800	43.29764	13.54200	1.86818	5.52008	17.55182	18.12988
1977 L-3	3	34.98000	1.91000	52.48000	3.47000	2.74000	10.87000	16.78999	21.28999
***** REDEFINING REFERENCE LINE *****									
1977 L-3	3	34.99921	1.91171	52.46077	3.46829	2.72451	10.85850	16.80548	21.30147
1976 L-1	4	20.64999	9.15000	22.28000	19.77000	17.62000	9.54000	13.54000	19.56000
***** REDEFINING REFERENCE LINE *****									
1976 L-1	4	20.64716	9.13160	22.28281	19.78839	17.61298	9.55724	13.54702	19.54276

TRANSFORMATION PARAMETERS

MAP NAME	MAP NO	X-ORIGIN	Y-ORIGIN	ANGLE OF ROTATION
	1	0.0	0.0	0.0
1977 L-1	2	18.84908	7.29487	31.59451
1977 L-3	3	27.00702	-5.92759	31.46791
1976 L-1	4	0.62578	9.96933	30.88130

**** INTERPOLATED DATA **** DATE=12/09/81 TIME=11:11 AM

TITLE:- A-A1 FIG. 6.1 FOX LAKE MINE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
8	0.20	-29.17	1.17	0.0

MAP NO	X1	Y1	X2	Y2
0	40.92802	4.08125	40.53522	23.23624
1	40.92802	4.08125	40.53522	23.23624
2	20.48993	8.82997	10.11998	24.93993
3	6.64884	15.80391	-3.68550	31.93672
4	37.61078	15.63224	27.44215	31.87004

----- FIELD DATA -----

97 STATIONS

1482.25	1482.72	1433.38	1429.10	1504.17	1555.61	1546.53	1549.93	1628.84	1676.43	1593.21	1489.25
1443.49	1425.67	1397.56	1359.01	1331.69	1340.07	1423.06	1591.96	1776.25	1820.65	1717.41	1625.62
1551.69	1463.85	1395.72	1353.16	1325.89	1334.30	1360.18	1377.95	1361.54	1304.09	1237.85	1200.03
1217.36	1267.41	1261.15	1204.53	1199.85	1257.47	1328.47	1420.52	1468.46	1343.04	1190.40	1151.49
1179.77	1219.99	1256.58	1249.26	1202.19	1188.66	1212.80	1242.79	1253.59	1235.17	1211.10	1213.94
1256.20	1310.40	1331.03	1323.56	1264.94	1199.93	1188.29	1228.27	1308.92	1418.23	1502.66	1532.12
1534.35	1525.93	1528.10	1510.40	1438.57	1396.17	1412.86	1450.66	1486.63	1520.25	1554.73	1598.21
1640.35	1660.82	1639.41	1587.26	1534.49	1500.52	1485.24	1491.33	1503.20	1498.88	1482.24	1462.95
1437.02											

TITLE:- B-B1 FIG. 6.2 FOX LAKE MINE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
9	0.20	-28.16	0.16	0.0

MAP NO	X1	Y1	X2	Y2
0	36.89120	3.96963	36.83482	24.39693
1	36.89120	3.96963	36.83482	24.39693
2	17.10995	6.61998	6.35999	23.98991
3	3.26398	13.60140	-7.44758	30.99503
4	34.20355	13.46449	23.67062	30.96692

----- FIELD DATA -----

103 STATIONS

1281.44	1305.35	1392.02	1444.68	1410.55	1393.58	1405.49	1386.60	1344.33	1323.52	1325.36	1338.47
1366.81	1348.68	1277.29	1227.05	1218.64	1266.90	1342.57	1392.12	1510.74	1587.38	1470.48	1305.44

1223.81	1218.88	1263.50	1307.13	1303.03	1273.58	1260.97	1259.44	1246.22	1236.29	1229.18	1214.69
1201.87	1193.01	1186.19	1180.72	1177.09	1174.32	1173.36	1170.75	1165.52	1157.32	1148.38	1146.74
1150.35	1152.94	1160.40	1180.70	1256.25	1370.26	1399.99	1353.20	1290.13	1224.78	1188.94	1217.51
1308.38	1368.98	1338.40	1292.08	1302.93	1374.39	1508.04	1604.81	1624.37	1629.59	1651.64	1711.43
1737.30	1680.03	1584.02	1502.01	1509.72	1595.65	1654.96	1611.49	1477.17	1454.57	1621.20	1765.51
1797.67	1743.40	1658.51	1624.32	1651.97	1674.41	1665.74	1646.24	1585.52	1481.26	1376.30	1305.51
1280.44	1274.99	1250.12	1216.98	1204.19	1209.60	1220.49					

TITLE:- C-C1 FIG. 6.3 FOX LAKE MINE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
10	0.20	-8.14	19.86	0.0

MAP NO	X1	Y1	X2	Y2
0	25.15295	3.01836	29.87801	16.10219
1	25.15295	3.01836	29.87801	16.10219
2	7.60997	-0.34000	4.77999	13.27996
3	-6.25136	6.66242	-9.05125	20.28857
4	24.61766	6.62330	21.95743	20.27745

----- FIELD DATA -----

71 STATIONS

0.0	0.0	0.0	0.0	1163.66	1356.43	1313.32	1290.20	1289.13	1290.53	1295.08	1304.87
1318.28	1328.19	1326.91	1325.90	1331.94	1334.04	1314.34	1302.44	1308.78	1242.94	1204.83	1187.19
1183.91	1192.05	1197.42	1179.92	1142.14	1123.99	1123.42	1126.49	1129.17	1128.10	1130.37	1139.98
1150.57	1153.71	1156.89	1157.99	1150.80	1161.41	1181.62	1190.32	1200.48	1205.66	1188.59	1159.12
1136.83	1155.59	1200.64	1232.17	1217.28	1209.86	1206.39	1195.91	1203.53	1197.80	1172.30	1148.87
1139.27	1138.24	1140.36	1146.36	1152.14	1149.49	1136.68	1131.02	1136.12	1133.19	1120.05	

TITLE:- D-D1 FIG. 6.4 FOX LAKE MINE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
11	0.20	0.82	28.82	0.0

MAP NO	X1	Y1	X2	Y2
0	20.37375	6.35708	23.85822	12.69027
1	20.37375	6.35708	23.85822	12.69027
2	1.78999	-0.00000	1.43999	7.21998
3	-12.07058	7.01528	-12.40462	14.23602
4	18.80235	7.03572	18.54225	14.25951

----- FIELD DATA -----

37 STATIONS

1235.54	1254.09	1280.63	1303.60	1303.37	1279.94	1252.96	1229.81	1221.81	1222.97	1224.25	1222.46
1222.52	1233.66	1252.31	1287.12	1434.85	1730.81	2030.47	2612.90	2936.98	2131.56	1377.65	1317.85
1323.42	1311.55	1288.73	1268.82	1261.41	1250.22	1206.38	1139.66	1106.82	1107.30	1107.66	1092.39
1085.59											

TITLE:- E-E1 FIG. 6.5 FOX LAKE MINE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
12	0.20	3.79	31.79	0.0

MAP NO	X1	Y1	X2	Y2
0	20.30362	6.32243	26.58476	16.45502
1	20.30362	6.32243	26.58476	16.45502
2	1.74841	-0.06626	1.79003	11.85515
3	-12.11231	6.94911	-12.04434	18.87039
4	18.75996	6.96999	18.94997	18.88995

----- FIELD DATA -----

61 STATIONS

1243.41	1251.39	1276.23	1300.25	1311.43	1287.91	1261.17	1236.85	1223.28	1220.68	1221.10	1219.46
1217.14	1227.43	1244.46	1281.28	1375.36	1643.16	1949.25	2469.60	3214.40	2618.07	1775.42	1330.49
1320.38	1308.40	1288.87	1280.49	1272.31	1241.16	1198.58	1156.60	1112.34	1091.61	1097.42	1102.30
1098.82	1092.25	1094.71	1110.99	1132.53	1154.35	1171.15	1194.93	1262.46	1382.78	1536.75	1539.03
1348.96	1184.55	1130.28	1125.86	1137.97	1173.97	1218.14	1238.52	1234.18	1230.74	1227.25	1206.35
1196.61											

DEPT. OF EARTH SCIENCES, UNIV. OF MANITOBA DATE=12/09/81 TIME=11:14 AM

PROGRAM **PROFILE**

REFERENCE LINE CO-ORDINATES

MAP NAME	MAP NO	BASE MAP X1	BASE MAP Y1	BASE MAP X2	BASE MAP Y2	MAP X1	MAP Y1	MAP X2	MAP Y2
1977 L-5	5	7.16000	30.27000	20.50000	44.87000	16.77000	1.47000	29.87000	16.32001
***** REDEFINING REFERENCE LINE *****									
1977 L-5	5	7.15565	30.26524	20.50432	44.87473	16.77423	1.47481	29.86572	16.31517
1977 L-6	6	7.86000	15.14000	17.38000	27.46001	17.53999	0.38000	26.97000	12.88000
***** REDEFINING REFERENCE LINE *****									
1977 L-6	6	7.84647	15.12250	17.39351	27.47749	17.55330	0.39765	26.95668	12.86234

TRANSFORMATION PARAMETERS

MAP NAME	MAP NO	X-ORIGIN	Y-ORIGIN	ANGLE OF ROTATION
	1	0.0	0.0	0.0
ANGLES	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
1977 L-5	5	-9.64176	29.08359	1.00063
1977 L-6	6	-9.71025	14.92807	0.66328

**** INTERPOLATED DATA ****   DATE=12/09/81 TIME=11:14 AM

TITLE:- A-A1 FIG. 6.6 SICKLE LAKE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
13	0.20	72.41	72.41	0.0

MAP NO	X1	Y1	X2	Y2
0	8.69574	18.79526	21.75452	22.93436
1	8.69574	18.79526	21.75452	22.93436
2	8.69574	18.79526	21.75452	22.93436
3	8.69574	18.79526	21.75452	22.93436
4	8.69574	18.79526	21.75452	22.93436
5	18.51436	-9.96653	31.49886	-5.60001
6	18.35999	4.08000	31.36996	8.36999

----- FIELD DATA -----

69 STATIONS

271.38	969.99	1497.00	1503.61	1508.09	1500.05	1492.17	1473.48	1435.36	1376.68	1328.46	1364.85
1473.89	1611.52	1616.59	1463.73	1343.83	1290.94	1269.89	1281.60	1384.82	1693.02	1914.50	1783.22
1479.58	1432.30	1607.57	1864.74	2069.37	2331.44	2732.37	3436.33	4548.56	5284.91	4659.77	3779.07
2580.37	1774.96	1519.62	1451.25	1450.30	1472.40	1470.94	1472.18	1471.77	1455.67	1459.08	1469.05
1465.06	1446.55	1455.41	1479.91	1500.31	1548.40	1695.54	1893.22	1866.87	1626.94	1463.71	1379.29
1384.80	1404.47	1359.00	1302.22	1291.71	1293.30	1299.71	1300.83	1300.50			

TITLE:- B-B1 FIG. 6.7 SICKLE LAKE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
14	0.20	-59.19	59.19	0.0

MAP NO	X1	Y1	X2	Y2
0	21.27974	38.63504	14.83589	42.47816
1	21.27974	38.63504	14.83589	42.47816
2	21.27974	38.63504	14.83589	42.47816
3	21.27974	38.63504	14.83589	42.47816
4	21.27974	38.63504	14.83589	42.47816
5	30.74997	10.08999	24.23999	13.82000
6	30.71346	24.06410	24.22554	27.83238

----- FIELD DATA -----

39 STATIONS

1200.13	1198.31	1202.03	1213.37	1222.01	1212.39	1202.61	1199.00	1175.54	1139.21	1134.10	1162.46

1235.40	1471.77	1609.49	1643.05	1577.36	1559.45	1609.50	1839.78	2369.18	2486.33	2421.34	2473.47
2393.16	2175.22	2305.05	2200.94	1714.11	1447.36	1345.23	1294.26	1280.69	1265.55	1264.22	1277.61
1308.11	1338.39	1376.66									

TITLE:- C-C1 FIG. 6.8 SICKLE LAKE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
15	0.20	81.92	81.92	0.0

MAP NO	X1	Y1	X2	Y2
0	15.60589	36.17375	21.25075	36.97530
1	15.60589	36.17375	21.25075	36.97530
2	15.60589	36.17375	21.25075	36.97530
3	15.60589	36.17375	21.25075	36.97530
4	15.60589	36.17375	21.25075	36.97530
5	25.11998	7.52999	30.74997	8.42999
6	25.06848	21.53731	30.70367	22.40413

----- FIELD DATA -----

30 STATIONS

1361.60	1301.50	1285.05	1286.49	1281.39	1287.25	1277.83	1264.88	1259.34	1263.36	1279.93	1307.91
1346.19	1372.51	1426.01	1505.57	1574.51	1581.61	1554.94	1553.45	1575.36	1543.98	1507.83	1440.72
1364.49	1364.59	1361.48	1355.13	1338.19	1327.41						

TITLE:- D-D1 FIG. 6.9 SICKLE LAKE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
16	0.20	-25.39	25.39	0.0

MAP NO	X1	Y1	X2	Y2
0	15.66084	31.30205	10.05623	43.11172
1	15.66084	31.30205	10.05623	43.11172
2	15.66084	31.30205	10.05623	43.11172
3	15.66084	31.30205	10.05623	43.11172
4	15.66084	31.30205	10.05623	43.11172
5	25.25999	2.65999	19.45000	14.37000
6	25.17982	16.66656	19.43887	28.41057

----- FIELD DATA -----

66 STATIONS

1340.79	1346.67	1349.09	1423.21	1531.26	1645.09	1763.85	1803.07	1815.53	1800.82	1665.54	1562.58
1617.78	1549.11	1336.34	1237.36	1224.41	1198.87	1182.34	1182.25	1184.58	1188.19	1194.83	1206.18
1221.25	1239.65	1270.45	1300.81	1357.07	1368.34	1361.11	1375.73	1391.10	1427.16	1454.81	1418.21
1381.14	1358.62	1331.34	1322.78	1309.44	1309.91	1312.01	1315.63	1325.63	1326.65	1330.19	1333.38
1332.00	1370.66	1394.44	1398.06	1409.88	1447.67	1442.05	1395.22	1348.80	1308.67	1307.12	1319.56
1318.27	1329.13	1327.07	1302.89	1285.33	1280.77						

TITLE:- E-E1 FIG. 6.10 SICKLE LAKE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
17	0.20	-45.48	45.48	0.0

MAP NO	X1	Y1	X2	Y2
0	13.68634	25.72795	9.65199	29.69492
1	13.68634	25.72795	9.65199	29.69492
2	13.68634	25.72795	9.65199	29.69492
3	13.68634	25.72795	9.65199	29.69492
4	13.68634	25.72795	9.65199	29.69492
5	23.38313	-2.94774	19.28012	0.94817
6	23.26999	11.07000	19.19000	14.99000

----- FIELD DATA -----

29 STATIONS

1445.78	1406.08	1344.81	1309.22	1274.40	1255.48	1268.07	1298.02	1334.35	1371.28	1466.62	1657.43
1883.65	1765.42	1446.35	1260.55	1223.26	1262.70	1296.02	1302.29	1277.02	1264.56	1280.19	1285.91
1244.44	1272.64	1251.15	1210.57	1165.61							

TITLE:- F-F1 FIG. 6.11 SICKLE LAKE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
18	0.20	55.02	55.02	0.0

MAP NO	X1	Y1	X2	Y2
0	3.00680	24.10147	8.95535	28.26288
1	3.00680	24.10147	8.95535	28.26288
2	3.00680	24.10147	8.95535	28.26288
3	3.00680	24.10147	8.95535	28.26288
4	3.00680	24.10147	8.95535	28.26288
5	12.73363	-4.76047	18.60860	-0.49582
6	12.61000	9.32000	18.50998	13.54999

----- FIELD DATA -----

37 STATIONS

1197.01	1198.00	1198.00	1196.86	1197.67	1201.36	1204.39	1212.26	1223.46	1244.86	1285.44	1350.34
1386.28	1412.78	1427.80	1438.99	1427.20	1430.45	1493.11	1575.73	1642.12	1634.49	1555.81	1529.92
1558.73	1477.18	1332.35	1253.22	1215.98	1189.37	1188.01	1204.32	1253.68	1311.28	1265.65	1240.66
1241.41											

TITLE:- G-G1 FIG. 6.12 SICKLE LAKE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
19	0.20	89.73	89.73	0.0

MAP NO	X1	Y1	X2	Y2
0	6.63596	24.00945	13.35680	24.04164
1	6.63596	24.00945	13.35680	24.04164
2	6.63596	24.00945	13.35680	24.04164
3	6.63596	24.00945	13.35680	24.04164
4	6.63596	24.00945	13.35680	24.04164
5	16.36383	-4.78911	23.08308	-4.63955
6	16.23997	9.26999	22.95999	9.37999

----- FIELD DATA -----

35 STATIONS

1352.63	1357.92	1358.01	1329.21	1300.89	1301.60	1316.68	1331.45	1341.56	1354.63	1371.20	1389.62
1420.39	1495.08	1644.99	1760.21	1751.21	1782.18	1836.27	1691.60	1475.84	1386.05	1373.07	1360.87
1342.44	1359.48	1398.99	1406.72	1380.41	1355.90	1337.29	1327.17	1339.78	1361.17	1365.11	

TITLE:- H-H1 FIG. 6.13 SICKLE LAKE AREA

PROFILE NO	PINC	ANGLE NORTH	ANGLE FLT	REF. DIST
20	0.20	-15.90	15.90	0.0

MAP NO	X1	Y1	X2	Y2
0	9.95699	15.44043	7.43915	24.28017
1	9.95699	15.44043	7.43915	24.28017
2	9.95699	15.44043	7.43915	24.28017
3	9.95699	15.44043	7.43915	24.28017
4	9.95699	15.44043	7.43915	24.28017
5	19.83400	-13.29882	17.16217	-4.50440
6	19.65997	0.74000	17.03998	9.54999

----- FIELD DATA -----

47 STATIONS

1370.90	1366.24	1350.14	1366.61	1372.02	1388.28	1404.83	1400.10	1401.33	1404.19	1423.57	1271.37
1398.72	1540.97	1537.10	1535.15	1518.81	1511.25	1359.76	1084.44	826.39	637.88	773.02	941.15
715.63	518.79	375.10	224.90	66.69	20.15	226.14	809.18	576.22	529.52	847.37	711.50
644.73	1108.19	1248.84	1245.29	1258.11	1281.94	1321.68	1341.19	1321.34	1303.79	1317.38	