National Uranium Resource Evaluation

AERIAL GAMMA RAY AND MAGNETIC SURVEY
MANITOWOC AND TRAVERSE CITY QUADRANGLES
WISCONSIN AND MICHIGAN

FINAL REPORT

EG&G GEOMETRICS
Sunnyvale, California 94086

July 1981

PREPARED FOR U.S. DEPARTMENT OF ENERGY
Grand Junction Office, Colorado

This report is a result of work performed by EG&G geoMetrics through a Bendix Field Engineering Corporation Subcontract, as part of the National Uranium Resource Evaluation. NURE is a program of the U.S. Department of Energy's Grand Junction, Colorado, Office to acquire and compile geologic and other information with which to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the United States.

AERIAL GAMMA RAY AND MAGNETIC SURVEY
MANITOWOC AND TRAVERSE CITY QUADRANGLES
WISCONSIN AND MICHIGAN

FINAL REPORT

Prepared by
EG&G geoMetrics
Sunnyvale, California

July 1981

Prepared for the U.S. Department of Energy
Grand Junction Office, Colorado
Under Contract No. DE-AC13-76GJ01664
and Bendix Field Engineering Corporation
Subcontract No. 80-479-L

ABSTRACT

The combined quadrangles of Manitowoc and Traverse City include an approximate land area of 8,800 square miles and an additional water surface area of 4,800 square miles in Michigan and Wisconsin. A thick sequence of Paleozoic sediments overlie the crystalline basement forming the northwestern quadrant of the Michigan Basin. The sediments thin toward the west to approximately 500 feet in Wisconsin. A pervasive layer of Wisconsinan Stage (Pleistocene) glacial drift and glacial lake sediments cover the entire land surface.

A search of available literature revealed no known uranium deposits.

A total of nine (9) uranium anomalies were detected and are discussed briefly in this report. Radiometric data appears to reflect differences in saturated versus unsaturated ground conditions rather than differences between map units. None of the anomalies were considered significant and all appear to be related to cultural features.

Magnetic data appears to be in general agreement with the structural interpretation of the area. Broad wavelength magnetic contours correspond to the deeply buried basement rocks in the east with increasing complexity in magnetic data occuring toward the west where basement rocks are closer to the surface.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

General

The Manitowoc and Traverse City quadrangles include a land area of 8,800 square miles and an additional water surface area of 4,800 square miles. Both quadrangles encompass most of the northern part of the lower Michigan peninsula. In addition, the Manitowoc quadrangle contains a broad expanse of Lake Michigan and part of northeastern Wisconsin (see Figure 1).

The geologic base maps used in this report were complied at a scale of 1:250,000 by Amuedo and Ivey, Consulting Geologists (Traverse City, 1980) and Fremont Geologic Consultants (Manitowoc, 1980). Published sources of geologic data for the base maps include reports by the Michigan Geological Survey, Geological Society of America and U.S. Geological Survey dating from 1915 and later. Additional data was extracted from published and manuscript maps at scales of 1:220,000 and larger. Geologic unit descriptions in this report conform to those of the base map legends which are found in Appendix C. Supplementary geologic information came from Cohee and others (1962), Flint (1959, 1971) and Weller (1975). Cultural and physiographic information was taken from the 1:250,000 scale topographic quadrangles.

Radiometric and magnetic data for both Manitowoc and Traverse City quadrangles were acquired in May and June 1981 and processed in July of the same year. A detailed summary of data acquisition, processing, interpretation, and presentation methods can be found in Appendix A. A flight line summary report for the Manitowoc and Traverse City quadrangles is contained in Appendix B. It should be noted that although Appendices C, D, E, and H are presented as separate quadrangles, the interpretation report, statistics, data tapes and microfiche are processed and presented as one area.

Physiography

The Manitowoc and Traverse City quadrangles lie within a broad glaciated plain which is situated near the northern boundary of the Midwestern Physiographic Province. Landforms produced by the most recent stage of glaciation characterize the region and include such features as moraines, drumlins, glacial outwash valleys, and dissected landscape that resulted from erosion of glacial till. A deranged drainage pattern, typical of glaciated regions, is developed throughout the area within Michigan and to a les ser extent in Wisconsin. Here numerous glacially formed lakes are scattered among swampy lowlands and stream courses.

In both Michigan and Wisconsin marshlands occupy considerable area within low-lying outwash and moraine deposits. A regional topographic summit in Michigan produces a drainage system that radiates to the east, south, and west. The two principle rivers, the Manistee and AuSable Rivers, drain central Michigan in opposite directions, flowing into Lake Michigan and Lake Huron respectively. The smaller Muskegon River flows out of the region toward the south (see Figures 3a and 3b). In Wisconsin the course of present day streams reflects the influence of ancient glacially controlled drainage patterns.

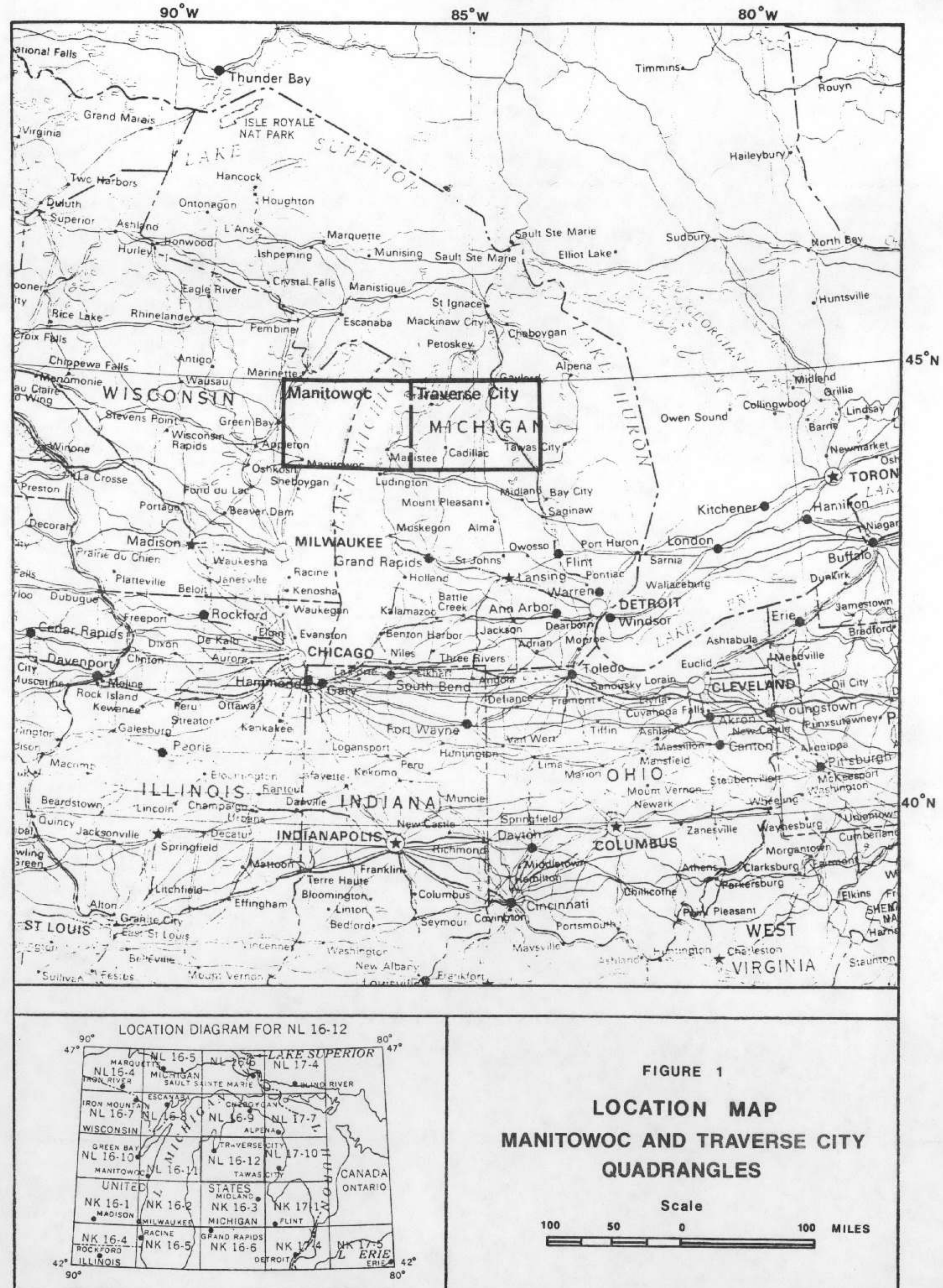


FIGURE 1

LOCATION MAP
MANITOWOC AND TRAVERSE CITY QUADRANGLES

Scale

100 50 0 100 MILES

Four streams cross the entire width of the Door Peninsula occupying channnels that are larger than would otherwise be expected from such short courses. They empty toward the southeast into Lake Michigan. Green Bay separates the Door Peninsula from the mainland to the west.

The topography in both Michigan and Wisconsin displays some variability with areas of relatively flat surfaces included among areas where stream erosion has caused up to 300 feet of local relief. The lowest elevation is the mean level of Lake Michigan which is 580 feet. The highest point is 1,725 feet at the Cadillac Lookout tower 8 miles south-southeast of the town of Cadillac, Michigan. Total elevation difference over the entire region is 1,145 feet.

In Michigan, land application is primarily rural although numerous small population centers, a military reservation and oil and gas fields are present throughout the area. Wisconsin has a somewhat more developed primary and secondary road network and also contains the city of Green Bay (87,800 pop.). Railroads serve only the larger communities in both states.

GEOLOGY

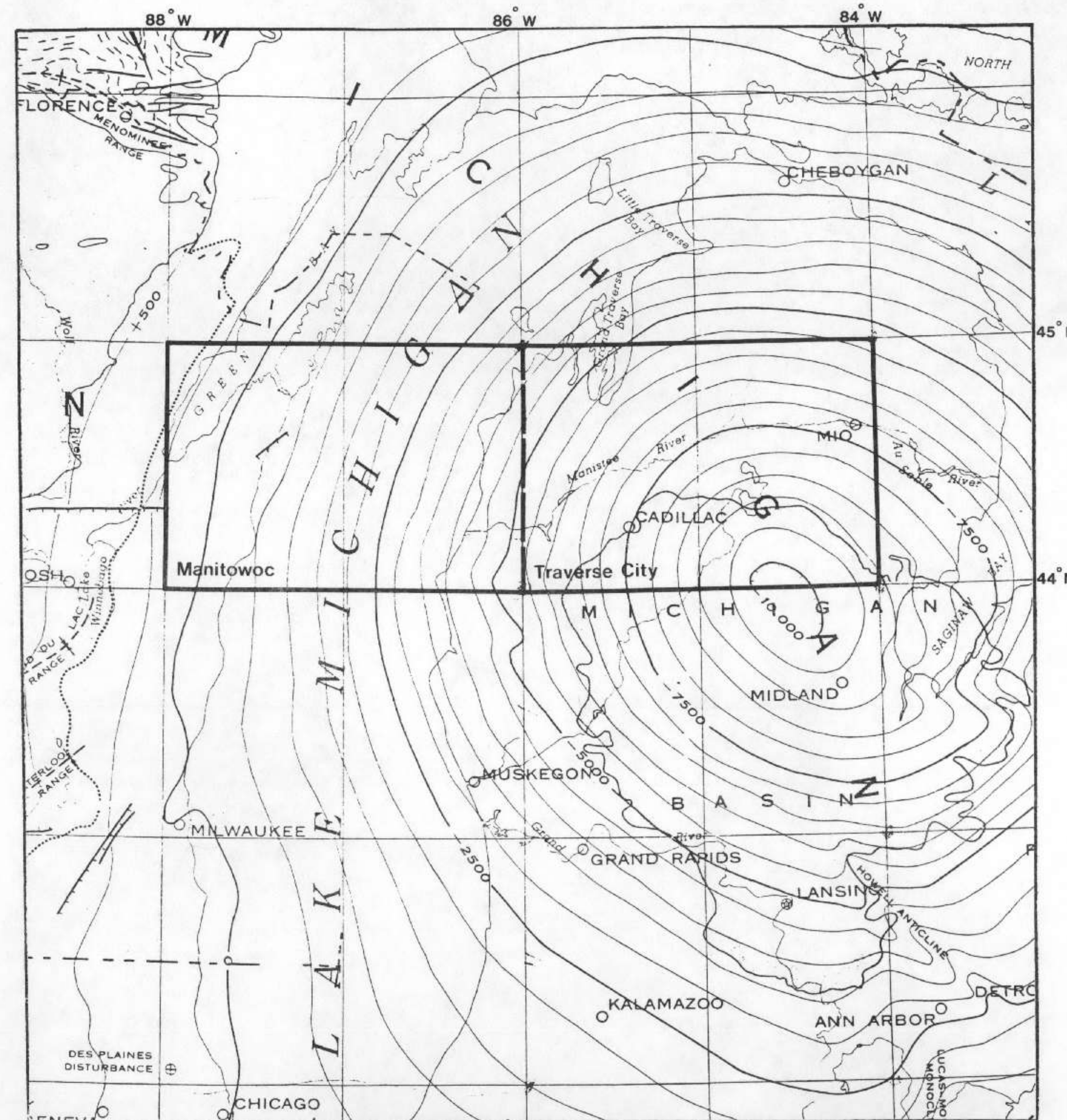
Structure

The basement rocks below the Manitowoc and Traverse City quadrangles are influenced by a regional downwarping called the Michigan Basin which contains more than 10,000 feet of Paleozoic sediments (see Figure 2). The quadrangles overlie the north and western sectors of the Michigan Basin where a total relief of 10,500 feet in the basement surface occurs between the east and west map boundaries. Sedimentary strata reach a maximum thickness of 11,000 feet below the southeast corner of the Traverse City quadrangle and thins to approximately 500 feet under Green Bay. The basement surface displays a constant dip eastward with no faults or folds, and no faults are indicated on the geologic base maps for these quadrangles.

Surface Geology

A mantle of Pleistocene sediments spreads across the entire land surface of the Manitowoc and Traverse City quadrangles. These deposits consist of a combination of glacial, periglacial, and post-glacial material. Bedrock units do not reach through this cover and therefore no exposures older than Pleistocene are shown on the base map.

A variety of glacial depostis from the Wisconsinan Stage cover Michigan in a mosaic of outwash sediments, till plains, glacial ponded water deposits and lake plain sediments. Flat-lying outwash and spillway sediments occupy many of the modern valleys and lake basins. The direction of outwash flow at the time of deglaciation was toward the south and west, approximating today's drainage conditions. Outwash sediments account for 30 percent of all glacial material in Michigan. A number of major lateral moraines and prominate end moraines lie between the outwash deposits. The area occupied by all moraine deposits comprises 55 percent of all glacial material while glacial ponded water depostis and lake plains sediments constitute the remaining 15 percent.



After
USGS and AAPG
Tectonic Map of the United States
by
Cohee and others (1962)

FIGURE 2

TECTONIC STRUCTURE MAP
MANITOWOC AND TRAVERSE CITY QUADRANGLES

Scale 1:2,500,000

25 0 25 50 75 MILES

Ground moraines typically form flat land surfaces that are often interrupted by hummocky topography produced by end moraines. Both ground and end moraines are composed of till which contains an unsorted, unstratified mixture of clay, silt, sand, and gravel. Outwash and lake sediments form nearly flat surfaces and contain stratified sediments including clay, silt, sand and gravel.

Uranium

According to available literature, there are no known Uranium deposits in the Manitowoc and Traverse City quadrangles (Butler and others, 1962, Schnabel, 1955).

INTERPRETATION OF GEOPHYSICAL DATA

Radiometric Data

A total of 9 groups of uranium (Bi214) samples meet the minimum statistical requirements set forth in the data interpretation section of Appendix A. These are displayed, along with all other anomalous samples and pertinent data, on Figures 3 and 3a. The anomalies are summarized in a table in Appendix G. The potassium, uranium, thorium, and ratio pseudo-contour maps, which reflect radiometric responses for each quadrangle, are found in Appendix H. Discussion of the abundances of potassium, uranium, and thorium are in terms of apparent equivalent percent and apparent equivalent ppm. These equivalent units are drived from scaling of counts per second by the sensitivities calculated for the detection system and as such cannot be taken as directly determined geochemical values.

Values for potassium, uranium, and thorium are low throughout the survey area, as are the respective values in survey areas to the north and south. The unusually low values are due, in part, to the excessive surface moisture represented by marshes and broad low valleys where saturation of the ground tends to suppress the emission of gamma rays into the atmosphere. Radiometric values are significantly lower in Michigan due to this phenomenon. Areas of higher standing ground are often responsible for a greater number of anomalous samples as illustrated by the drainage divide between the Manistee and Betsie Rivers in the west center of the Traverse City quadrangle (see Appendix H and the Uranium Anomaly Map, Figure 3a). The greater number of anomalous samples here are not restricted to any single map unit. In addition, these same units in lower lying areas contain no highly anomalous samples. The average value for uranium considering all map units throughout the area is .95 ppmeU. Potassium and thorium areawide average values are .81 percent and 2.01 ppmeTh respectively.

Statistical analysis shows map unit Qde (drumlins and eskers) has the highest mean value for the three sampled elements. Potassium has a mean value of 1.45 percent while uranium and thorium have mean values of 1.22 ppmeU and 3.71 ppmeTh respectively. This map unit occurs over a limited area in Wisconsin, and represents only a small number of data points however (see Appendix H).

Map unit Qwn (glacial water-laid moraine) has the second highest mean value for uranium, 1.19 ppmeU, although it too represents only a small proportion of the survey area in Michigan. The highest measured peak values for potassium and thorium are located over map unit Ol (glacial lake deposits). These are 2.36 percent potassium and 7.46 ppmeTh respectively. The map unit Qma (marsh deposits) in Wisconsin is responsible for the highest measured peak value for uranium of 2.72 ppmeU.

Most of the map units show either a slight bimodal tendency or a skewing toward higher values in all three radiometric elements (see Appendix F). The area west of Lake Michigan produces generally higher overall values and is partially responsible for this skewing. An additional reason for the skewing stems from the masking of anomalous samples due to the relative amount of moisture within a given map unit as mentioned above . This is especially true in Michigan.

Of the nine uranium anomalies identified in the two quadrangles and appearing in Figures 3 and 3a, four occur over map unit QGM (glacial ground moraine). The anomalies follow no discernable trend and are widely scattered throughout the southern part of the area. Peak values for these anomalies range from 1.2 ppmeU to 2.4 ppmeU. Specific anomalies appear to result entirly from cultural influences (such as the effect of roads, railroads, pipelines, etc.) and locally unsaturated areas that tend to enhance uranium values.

Magnetic Data

The pseudo-contour map of the magnetic data appears in Appendix H.

The general aspect of the pseudo-contour map confirms the structural interpretation for the basement in this area. The relatively flat magnetic terrain reflects the great thickness of the sedimentary column in Michigan, where low residual magnetic values are broadly distributed and are only occassionally interrupted by smaller magnetic features. In Wisconsin where the basement is close to the surface, magnetic values are larger. A poorly defined east-west strike is evident in the pseudo-contours. The shorter wavelength magnetic features superimposed on the regional background may be due to structures within the magnetic basement or folds which bring basement rocks closer to the surface.

MANITOWOC

mt

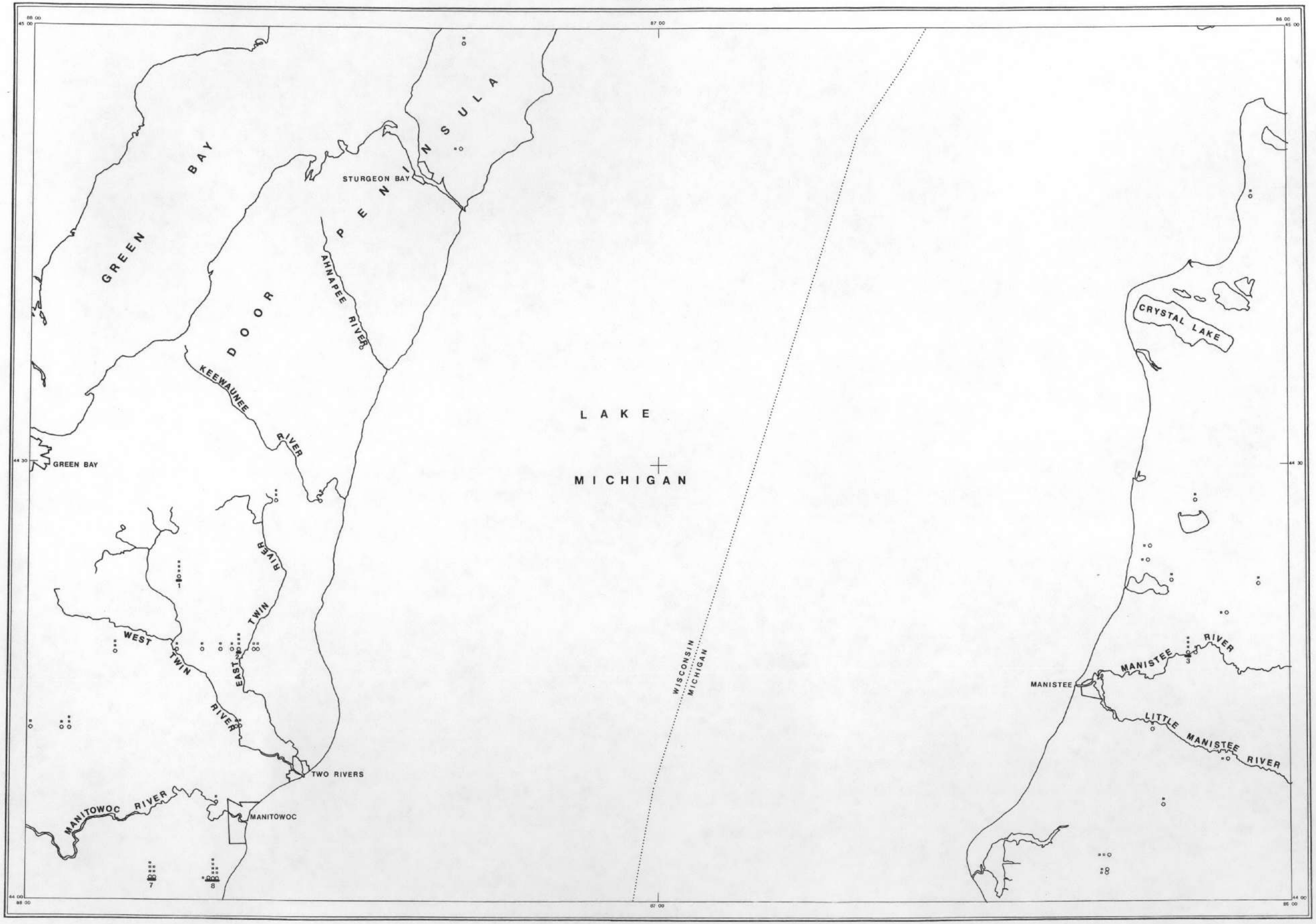
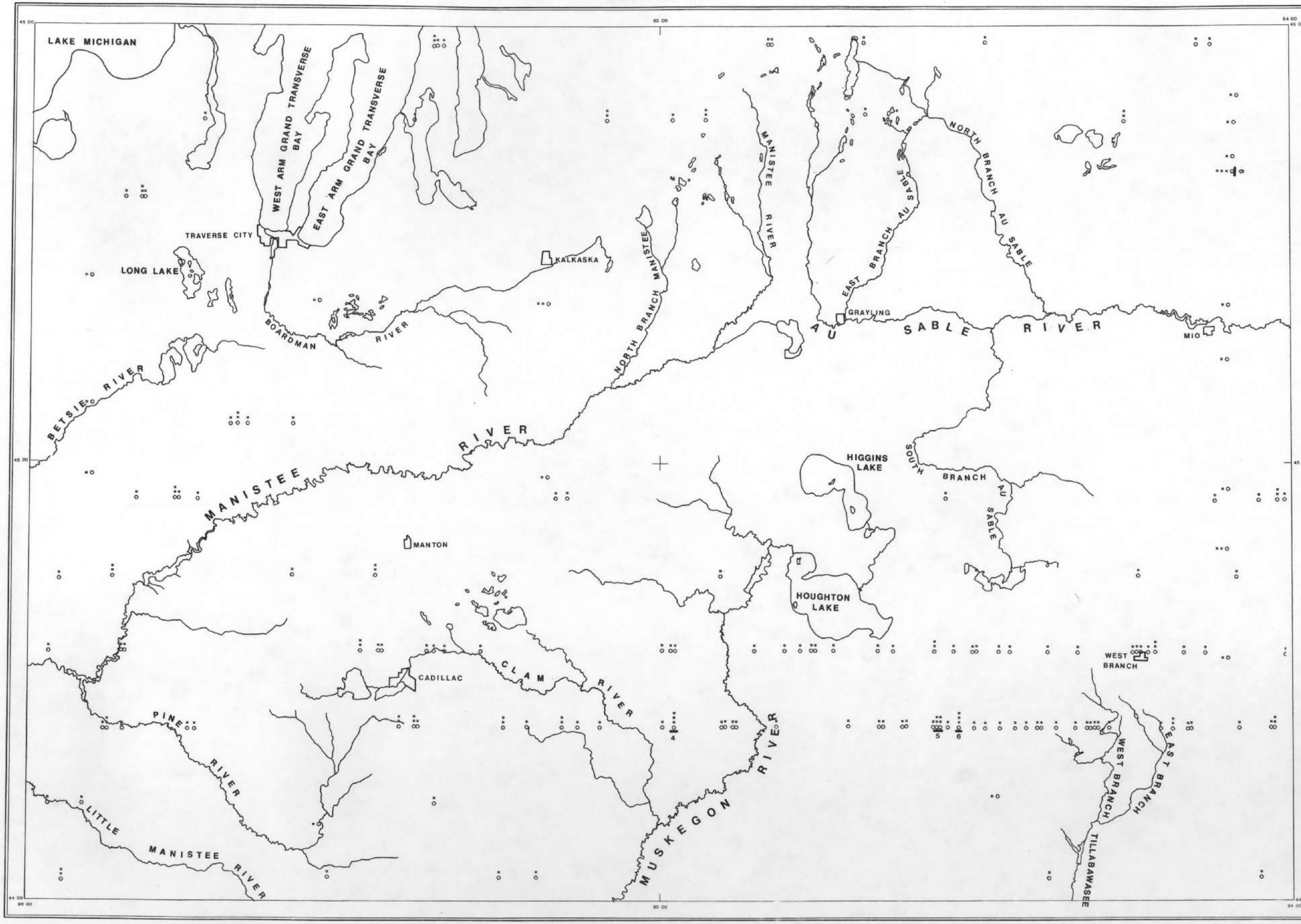


Figure 3 - Uranium Anomaly/Interpretation Map - Manitowoc Quadrangle

TRAVERSE CITY



URANIUM ANOMALY/ INTERPRETATION MAP

TRAVERSE CITY QUADRANGLE

U.S. DEPARTMENT OF ENERGY

APPROXIMATE SCALE 1:500,000

EXPLANATION

□ - CITY OR TOWN

- URANIUM SAMPLE MEETING FOLLOWING CRITERIA:
  - (1) 1.0 ≤ U ≤ ∞
  - (2) -1.0 ≤ T ≤ ∞
  - (3) 1.0 ≤ U/T ≤ ∞

IN STANDARD DEVIATION UNITS.
EACH SQUARE REPRESENTS 1 STANDARD DEVIATION.

- URANIUM ANOMALY:

A SINGLE SAMPLE OF 3 OR MORE STANDARD DEVIATIONS OR GROUP OF ADJOINING SAMPLES WHICH TOGETHER TOTAL 4 OR MORE STANDARD DEVIATIONS, 4.0 ≤ sum ≤ ∞, WITH AT LEAST ONE SAMPLE OF 2 OR MORE STANDARD DEVIATIONS.

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

Figure 3a - Uranium Anomaly/Interpretation Map - Traverse City Quadrangle

BIBLIOGRAPHY

Amuedo and Ivey, Consulting Geologists, 1980, Geology of the Traverse City Quadrangle: scale 1:250,000.

Butler, A.P., Jr., Finch, W.I., and Twenhofel, E.S., 1962, Epigenetic Uranium Deposits in the United States: U.S. Geological Survey Mineral Resources Map MR-21, scale 1:3,000,000.

Cohee, G.V., and others, 1962, Tectonic Map of the United States: U.S. Geological Survey and American Association of Petroleum Geologists, scale 1:2,500,000.

Flint, R.F., 1959, Glacial Map of the United States East of the Rocky Mountains: America, scale 1:1,750,000.

Flint, R.F., 1971, Glacial and Quaternary Geology: New York, Wiley & Sons, Inc., 892p.

Fremont Geologic Consultants, 1980, Geology of the Manitowoc Quadrangle: scale 1:250,000.

Schnabel, R.W., 1955, The Uranium Deposits of the United States: U.S. Geological Survey Mineral Resources Appraisals Map MR2, scale 1:5,000,000.

Weller, J.M., 1975, United States - Midwestern Region: in the Encyclopedia of World Regional Geology, Part I 1975: R.W. Fairbridge, ed.. Stroudsburg, Pa., Dowden, Hutchinson & Ross, 704 p.

APPENDIX A – Data Acquisition, Processing, and Interpretation Methods

INTRODUCTION

General

Under the U.S. Department of Energy's (DoE), National Uranium Resource Evaluation (NURE) Program, geoMetrics, Inc., conducted a high sensitivity airborne radiometric and magnetic survey. The data collection and processing were conducted under requirements set forth in Bendix Field Engineering Corporation specification 1200-C, dated February, 1979. The objectives of the (DoE)/NURE program, of which this project is a small part, may be summarized as follows:

> "To develop and compile geologic and other information with which to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the United States." (DoE)

As an integral part of the DoE/NURE Program, the National Airborne Radiometric Program is designed to provide cost effective, semiquantitative reconnaissance radio element distribution information to aid in the assessment of regional distribution of uraniferous materials within the United States.

All Airborne data collected by geoMetrics during the course of this project were done so utilizing a Beechcraft B65 Queen Air Airplane (U.S. Registry No. N9AG) and a Rockwell Aero Commander (Registry No. N1213B). Both aircraft used 3584 cubic inches of NaI crystal and a high sensitivity proton magnetometer (0.25 gamma).

Each report contains a detailed geologic summary, interpretation report, reduced scale copies of all maps and profiles, histograms, and statistical tables for each quadrangle contained within the project. In addition, each report contains an appendix detailing the survey description, specifications, data collection and processing methods, and interpretation methods.

All data processing, statistical analyses, and interpretation were performed at the geoMetrics computer facility, Sunnyvale, California. After processing, the corrected data were statistically evaluated to define those areas which were radiometrically anomalous relative to other areas within each computer map unit. Standard deviation maps and radiometric and magnetic profile data were first evaluated individually and then integrated into a final interpretation map for each NTMS quadrangle.

Corrected profiles of all radiometric variables (total count, potassium, uranium, thorium, uranium/thorium, uranium/potassium, and thorium /potassium, ratios), magnetic data, radar altimeter data, barometric altimeter data, air temperature, and airborne bismuth contributions are presented as profiles in this report. Single record and averaged data are presented on microfiche in report. These data are given at 1.0 second sample intervals, corrected for Compton Scatter, referenced to 400 foot mean terrain clearance as Standard Temperature and Pressure and corrected for atmospheric bismuth. Digital magnetic tapes are available containing raw spectral data, single record data, magnetic data, and statistical analysis results.

OPERATIONS

PRODUCTION SUMMARY

The production summary presented below describes the general procedures involved in gathering data for the entire project. The detailed daily production summary in Appendix B describes a portion of the total project.

Prior to the start of the survey operations, the airplanes were calibrated at the DoE test pads and Dynamic Test Range (the Queen Air in April 1980, and the Aero Commander in October 1980). Requirements for system calibrations are listed in the 1250-A specifications from BFEC.

Throughout the course of the overall project, the average ground speed maintained by the Queen Air was 140 mph. The Aero Commander averaged 150 mph.

Nearly 100% of the data collected were within the specification limits of 200-700 feet. Several deviations over short distances were required to meet military regulations, FAA safety requirements, and to ensure that livestock were not endangered due to low flying aircraft. A sample altitude statistical distribution is shown in Figure I.

DATA COLLECTION PROCEDURES

Operating Parameters/Sampling Procedures

This survey was conducted using data collection parameters summarized below:

1. Data sampling was performed by a time-base system using 1.0 second sample intervals. All sensor data with analog output were digitally sampled at each scan based upon the clock timing rate of 1.0 seconds. The data so collected are the instantaneous values of the altimeter, temperature, pressure, and magnetometer parameters determined at the time of the data scan, but represent a count time of 1.0 seconds for the gamma ray spectrometer data.

2. The airplanes' objective ground speeds, mentioned previously, were not exceeded unless dictated by safety.

3. The airplane's downward looking crystal volume was 3,072 cubic inches providing an objective V/V (crystal volume in cubic inches divided by ground speed in miles per hour) of 22.0 at 140 m.p.h.

4. The upward looking crystal volume was 512 cubic inches.

FIGURE I

Typical Radar Altimeter Statistical Summary Histogram for Single Flight Line

Navigation/Flight Path Recovery

For all of the quadrangles, profiles were flown east-west at 6 mile (9.6 km) spacing. North-south tie lines were flown at 18 mile (28.8 km) spacing.

Navigation was accomplished using visual navigation techniques. Flight lines were drawn on 1:250,000 quadrangles and the pilot/navigator utilized these maps to provide visual navigation features.

Simultaneously, a 35 mm tracking camera was used to record actual flight position. This camera's fiducial numbering system was directly synchronized to the digital recording system such that a one-to-one correlation between position and data could be made. Upon completion of a data collection flight, the 35 mm film was processed and actual flight path positions located on the appropriate scale map sheets.

Infield System Calibration

Due to the complex nature of both the system and the required data interpretation, much emphasis was placed on infield calibration of the data collection system. The objective of this calibration was to ensure continuous high quality of the data collected. The daily calibration procedures used are summarized below:

A. Pre Flight

1. Use cesium sources (same positioning on crystals every day), peak each Photomultiplier tube/crystal using the digital split-window detector of the GR-800. Then using thallium sources, repeat the tuning of the individual crystals.

2. Run full cesium spectrum on analog recorder for both down and up looking crystals. Calculate the cesium resolution (see sample in Figure II). Run spectrum out past the K40 peak on down crystals for evaluation of system tuning.

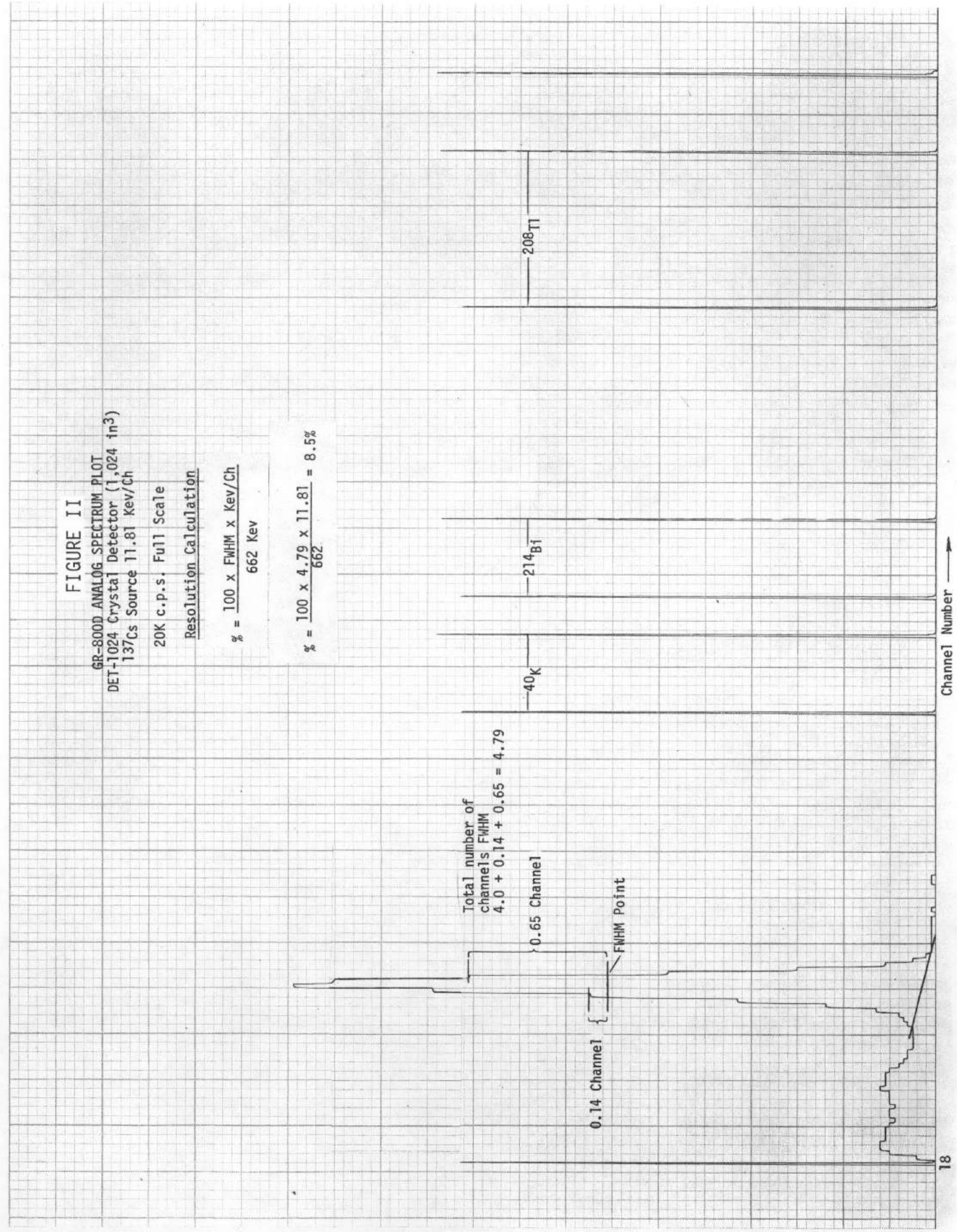
3. Finally run a full thorium analog spectrum of the down crystals and check for centering of K40 and Tl208 peaks in spectrum.

4. Repeat 1-3 until system is within contract specifications.

B. During Flight

1. Fly test line at survey altitude (400 ft), for approximately five miles, prior to production data collection (record both analog and digital).

2. Prior to production data collection, the above data are evaluated to ensure ±20% limits on total count compared to average of all test flights from that base of operations.



DATA COLLECTION SYSTEM

AIRCRAFT

Two aircraft were used for this survey: (1) a Beechcraft Queen Air - Model 65 (U.S. Reg. No. N9AG), and (2) a Rockwell Aero Commander 680F (U.S. Reg. No. N1213B). Both these aircraft, being medium size with twin engines, possess overall performance and safety features which make them ideal for low level, fixed-wing airborne geophysical surveys in areas of up to moderately high topographic relief. They can carry adequate payloads at low constant airspeeds, while maintaining economy and a wide envelope of safety. Performance data for the two craft in their present survey configuration are given below.

	QUEEN AIR	AERO COMMANDER
Maximum Aircraft Gross Weight	7,700 lbs.	8,500 lbs.
Aircraft Empty (dry)	4,640 lbs.	5,200 lbs.
Max. useful load including fuel	3,060 lbs.	3,300 lbs.
Geophysical Package	1,110 lbs.	1,110 lbs.
Navigation Equipment	125 lbs.	125 lbs.
Fuel Tanks Full	1,380 lbs.	1,338 lbs.
Pilot & Electronics Operator	350 lbs.	350 lbs.
Total	2,965 lbs.	2,923 lbs.
Min. Control Speed at G.W. (IAS)	95 mph	NG
Safe Single Eng. Speed @ G.W. (IAS)	105 mph	NG
Rate of Climb 2 engines @ gross (FPM)	1,300	1,500
Rate of climb 1 engine @ gross (FPM)	210	250
Avgas consumption (ga/hr) at 75% power	36	38
Endurance (75% power)	6 hrs/6 mins.	5 hrs/30 mins.
Range (75% power - 45 min. reserve)	1,200 miles	1,100 miles
Cruise Configuration stalling speed at gross weight (IAS)		
0° bank	80 mph	80 mph
45° bank	95 mph	NG

3. During production data collection, monitor radon analog data for unusual increases. Visually correlate these with temperature and barometric pressure.

4. Upon completion of production data collection, refly test line at survey altitude (400 ft). Record both analog and digital.

C. Post Flight

1. Verify test line total count within 20% of average for all test lines at that base of operations.

2. Using cesium sources (same position as pre-flight), run full cesium spectrum for both down and up crystals (allow it to record through the K40 peak in the down crystals). Repeat the procedure using thallium sources and examine the T1208 window.

3. Calculate the resolution of down and up crystal pack.

4. Determine shift, if any, in T1208 peak position.

Field Digital Data Verification

At the completion of each flight, the raw digital data tapes were checked for data quality and completeness on geoMetrics' G-725. The G-725 system is a totally portable mini computer (and peripherals) consisting of; an Interdata 516, two 9 track tape drives, a CRT, a line printer, and two floppy discs. Any digital problems encountered were immediately evaluated by the electronics operator and data man, thus assuring optimum data quality. In addition, histogram information for each measured variable was generated. Thus a summary display of altitude, etc., is available for immediate evaluation.

Electronics

The major components of the airborne data collection system are summarized below (shown schematically in Figure III):

1. Gamma Ray Spectrometer, geoMetrics GR-800, utilizing a dual 256 channel capability to provide spectral data in the 0.4 to 3.0 MeV range for both the downward looking and the upward looking crystal packages and coverage in the 3.0 to 6.0 MeV range for cosmic background.

2. Crystal Detector, geoMetrics Model DET-3072/512R consisting of 3072 cubic inches in the downward looking configuration and 512 cubic inches appropriately shielded in an upward looking configuration.

3. A geoMetrics Digital Data Acquisition System, Model G-714 with "read-after-write" data verification, recording the following on magnetic tape:

   a. 512 channels of gamma ray spectrometer data

   b. Total magnetic intensity

   c. Fiducial number from data system/camera

   d. Manually inserted information, i.e. date, survey area, and flight line number

   e. Altitude from radar altimeter and barometric altimeter (by analog-to-digital conversion)

   f. Time in days, hours, minutes and seconds

   g. Outside air temperature

4. Magnetometer, geoMetrics Airborne Model G-803, capable of 0.125 gamma sensitivity, but operated at 0.25 gamma sensitivity.

5. Radar Altimeter, Bonzer Model Mark 10 with recording output and display operating over an altitude range of 0 to 2,500 feet.

6. Rosemont Barometric Altimeter with recording output and display.

7. Recording Thermometer for monitoring outside air temperature.

8. Tracking Camera. Automax 35 mm framing camera with wide angle lens and 10 character fiducial/line number display to provide flight path recovery data.

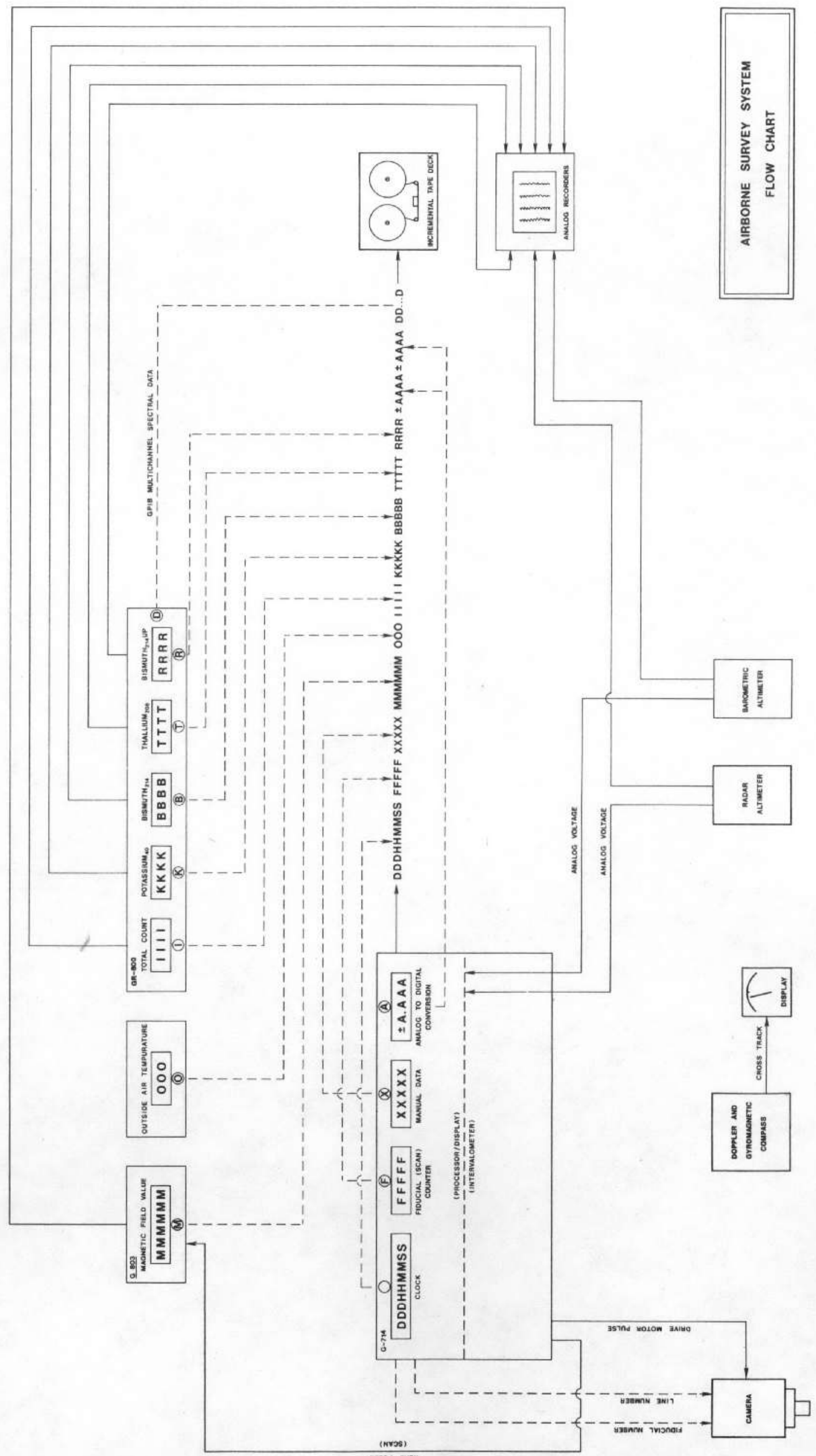


FIGURE III

9. Analog Recorder geoMetrics (MARS 6)to record the following data:

   a. Bi214 using a window about the 1.76 MeV peak from the downward looking system.

   b. Bi air background from the upward looking system.

   c. Magnetometer

   d. Radar Altitude

   e. Total count for downward looking system (0.4 to 3.0 MeV)

   f. Barometric Altitude

   g. Time markers

10. HP 7155 single channel analog recorder during pre and post flight calibrations, this recorder is used to plot a full analog spectra for both the down and up crystal systems via the GR-800. Thus, a hard copy record of the data used for resolution, drift, etc., checks are available at all times. This approach provides instant verification of system parameters (refer to Figure II).

SYSTEM CALIBRATION

AIRCRAFT AND COSMIC BACKGROUND

Full spectral data are collected at five (5) altitudes over water (14,000 feet, 12,000 feet; 10,000 feet; 8,000 feet and 6,000 feet) in an area where the existence of no airborne Bi214 can be assured (off shore over the Pacific Ocean). This results in separate spectra as shown schematically in Figure 10. We define S(12,000) to be the spectra at 12,000 feet from 0.4 MeV to 3.0 MeV with S(8,000) the same spectra at a lower altitude (8,000) and $C_i(h)$ the total count between 3.0 and 6.0 MeV at respective altitudes.[1] Since the aircraft background is constant, the difference between any two altitudes separated sufficiently - typically, 2,000 feet - yields the cosmic spectral curve shape as shown schematically in Figure VI. Thus

$$S(12{,}000) - S(8{,}000) = \Delta S$$

and

$$\Sigma C_{12}(h_i) - \Sigma C_8(h_i) = \Delta C$$

This cosmic spectral curve is scaled back to 12,000 feet as follows:

$$\frac{C_{12}(h_i)}{\Delta C} \times \Delta S = \Delta C\ (12{,}000)$$ the Cosmic Spectrum (shape and magnitude at 12,000 feet)

The aircraft background is derived as follows:

$$S(12{,}000) - C(12{,}000) = \text{A/C Background}$$

Since data were collected at five altitudes, this procedure was repeated for each combination of altitudes and results averaged. Typical aircraft and cosmic spectra are shown in Figures V, AND VI respectively.

SYSTEM CONSTANTS

System constants were determined by occupation of the DoE Walker Field Test Pads. (See Ward, 1978, and Stromswold, 1978, for complete descriptions of the building and monitoring of the pads). The five test pads contained varying concentrations of K, U, and T as presented by BFEC:

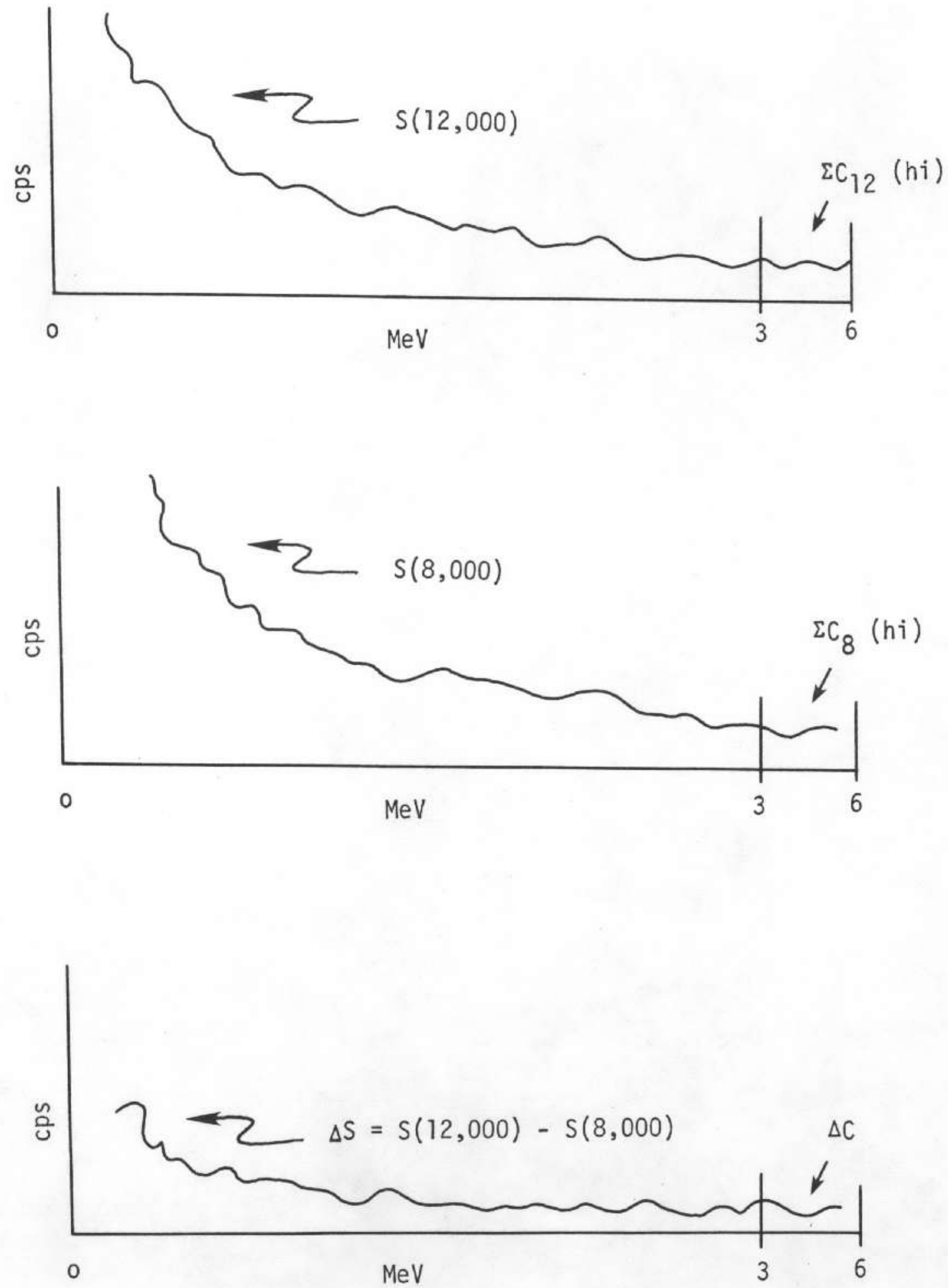


FIGURE IV - Multiple altitude spectra schematic

PAD	K	U	T
Matrix	1.45%	2.19 ppm	6.26 ppm
K	5.14%	5.09 ppm	8.48 ppm
U	2.03%	30.29 ppm	9.19 ppm
T	2.01%	5.14 ppm	45.33 ppm
Mixed	4.11%	20.39 ppm	17.52 ppm

Since the measurements were taken over a relatively short time period (a few hours), it was assumed that the matrix pad measurements contain not only the effects of the matrix pad itself, but also aircraft background (which is a constant), cosmic background (constant over the time period of interest), and all other local background (e.g. BiAir, etc.) effects. (The matrix pad is constructed with only the basic concrete mix without the additional elemental minerals). Thus, by subtracting the matrix pad count rates from the count rates in the four pads, we have eliminated aircraft and cosmic background and BiAir effects for the four pads. The pad concentrations are then modified in a similar fashion by the subtraction of the matrix pad concentrations. The differential concentrations in the pads are given in the table below.

PAD	K	U	T
K-Matrix	3.7%	2.9 ppm	2.2 ppm
U-Matrix	0.6%	28.5 ppm	2.9 ppm
T-Matrix	0.6%	3.0 ppm	39.0 ppm
Mixed-Matrix	2.7%	18.8 ppm	11.3 ppm

Considering the above, we can define a functional relationship between the differential concentrations and the residual count rates which will provide a method of determining the calibration constants for the spectrometer system. These calibration constants are the six (6) stripping coefficients which account for the interactions occuring between the elemental channels in the system (Compton scatter coefficients, etc.).

On the basis of an ideal situation, one would anticipate that some of these interactions should be negligible. This is not totally the case, since we are dealing with a system which has less than infinite resolving power (i.e. the energies are smeared to some extent).

```
DERIVED AIRCRAFT BACKGROUND SPECTRUM FROM PACIFIC OCEAN DATA

DOWNWARD-LOOKING CRYSTAL SPECTRUM FOR LINE AC BGD, DATED 072577

TC (0-6 MEV)  184.07 TC (0.4-3.0 MEV)  141.17 COSMIC (3-6 MEV)     0.00
U (1.12 MEV)     9.91 K (1.46 MEV)   14.54 U (1.76 MEV)     4.36 T (2.62 MEV)     4.29

CH    0 (0.000 MEV)    0.000 CPS *
CH    1 (0.012 MEV)    0.000 CPS *
CH    2 (0.024 MEV)    0.000 CPS *
CH    3 (0.035 MEV)    0.000 CPS *
CH    4 (0.047 MEV)    0.000 CPS *
CH    5 (0.059 MEV)    0.000 CPS *
CH    6 (0.071 MEV)    0.000 CPS *
CH    7 (0.083 MEV)    0.000 CPS *
CH    8 (0.095 MEV)    0.000 CPS *
CH    9 (0.106 MEV)    0.000 CPS *
CH   10 (0.118 MEV)    0.000 CPS *
CH   11 (0.130 MEV)    0.000 CPS *
CH   12 (0.142 MEV)    0.000 CPS *
CH   13 (0.154 MEV)    0.000 CPS *
CH   14 (0.165 MEV)    0.000 CPS *
CH   15 (0.177 MEV)    0.000 CPS *
CH   16 (0.189 MEV)    0.000 CPS *
CH   17 (0.201 MEV)    0.000 CPS *
CH   18 (0.213 MEV)   -0.025 CPS *
CH   19 (0.225 MEV)   -0.020 CPS *
CH   20 (0.236 MEV)    0.080 CPS *
CH   21 (0.248 MEV)    1.401 CPS *****
CH   22 (0.260 MEV)    3.792 CPS ************
CH   23 (0.272 MEV)    4.280 CPS **************
CH   24 (0.284 MEV)    4.334 CPS **************
CH   25 (0.295 MEV)    3.748 CPS ************
CH   26 (0.307 MEV)    3.897 CPS *************
CH   27 (0.319 MEV)    3.818 CPS ************
CH   28 (0.331 MEV)    4.236 CPS **************
CH   29 (0.343 MEV)    3.433 CPS ***********
CH   30 (0.355 MEV)    2.996 CPS **********
CH   31 (0.366 MEV)    2.559 CPS *********
CH   32 (0.378 MEV)    2.269 CPS ********
CH   33 (0.390 MEV)    2.102 CPS *******
CH   34 (0.402 MEV)    2.081 CPS ******* TOTAL COUNT
CH   35 (0.414 MEV)    2.121 CPS *******
CH   36 (0.426 MEV)    2.114 CPS *******
CH   37 (0.437 MEV)    1.976 CPS *******
CH   38 (0.449 MEV)    2.290 CPS ********
CH   39 (0.461 MEV)    2.188 CPS ********
CH   40 (0.473 MEV)    2.226 CPS ********
CH   41 (0.485 MEV)    1.983 CPS *******
CH   42 (0.496 MEV)    2.165 CPS *******
CH   43 (0.508 MEV)    2.158 CPS *******
CH   44 (0.520 MEV)    2.267 CPS ********
CH   45 (0.532 MEV)    2.217 CPS ********
CH   46 (0.544 MEV)    1.997 CPS *******
CH   47 (0.556 MEV)    2.447 CPS ********
CH   48 (0.567 MEV)    2.540 CPS *********
CH   49 (0.579 MEV)    2.586 CPS *********
CH   50 (0.591 MEV)    2.708 CPS *********
CH   51 (0.603 MEV)    2.481 CPS ********
CH   52 (0.615 MEV)    2.372 CPS ********
CH   53 (0.626 MEV)    1.866 CPS *******
CH   54 (0.638 MEV)    1.682 CPS ******
CH   55 (0.650 MEV)    1.661 CPS ******
CH   56 (0.662 MEV)    1.480 CPS *****
CH   57 (0.674 MEV)    1.474 CPS *****
CH   58 (0.686 MEV)    1.447 CPS *****
CH   59 (0.697 MEV)    1.431 CPS *****
CH   60 (0.709 MEV)    1.476 CPS *****
CH   61 (0.721 MEV)    1.453 CPS *****
CH   62 (0.733 MEV)    1.467 CPS *****
CH   63 (0.745 MEV)    1.579 CPS ******
CH   64 (0.756 MEV)    1.497 CPS *****
CH   65 (0.768 MEV)    1.548 CPS ******
CH   66 (0.780 MEV)    1.421 CPS *****
CH   67 (0.792 MEV)    1.282 CPS *****
CH   68 (0.804 MEV)    1.155 CPS ****
CH   69 (0.816 MEV)    1.246 CPS *****
CH   70 (0.827 MEV)    1.245 CPS *****
CH   71 (0.839 MEV)    1.161 CPS ****
CH   72 (0.851 MEV)    1.253 CPS *****
CH   73 (0.863 MEV)    1.231 CPS *****
CH   74 (0.875 MEV)    1.425 CPS *****
CH   75 (0.887 MEV)    1.452 CPS *****
CH   76 (0.898 MEV)    1.543 CPS ******
CH   77 (0.910 MEV)    1.444 CPS *****
CH   78 (0.922 MEV)    1.364 CPS *****
CH   79 (0.934 MEV)    1.289 CPS *****
CH   80 (0.946 MEV)    1.150 CPS ****
CH   81 (0.957 MEV)    1.144 CPS ****
CH   82 (0.969 MEV)    1.085 CPS ****
CH   83 (0.981 MEV)    1.061 CPS ****
CH   84 (0.993 MEV)    0.941 CPS ****
CH   85 (1.005 MEV)    0.919 CPS ****
CH   86 (1.017 MEV)    0.822 CPS ***
CH   87 (1.028 MEV)    0.816 CPS ***
CH   88 (1.040 MEV)    0.853 CPS ****
CH   89 (1.052 MEV)    0.901 CPS **** BISMUTH 214
CH   90 (1.064 MEV)    0.822 CPS ***
CH   91 (1.076 MEV)    0.867 CPS ****
CH   92 (1.087 MEV)    0.968 CPS ****
CH   93 (1.099 MEV)    0.851 CPS ****
CH   94 (1.111 MEV)    0.905 CPS ****
CH   95 (1.123 MEV)    0.847 CPS ****
CH   96 (1.135 MEV)    0.861 CPS ****
CH   97 (1.147 MEV)    0.800 CPS ***
CH   98 (1.158 MEV)    0.727 CPS ***
CH   99 (1.170 MEV)    0.751 CPS ***
CH  100 (1.182 MEV)    0.607 CPS *** BISMUTH 214
CH  101 (1.194 MEV)    0.663 CPS ***
CH  102 (1.206 MEV)    0.657 CPS ***
CH  103 (1.217 MEV)    0.633 CPS ***
CH  104 (1.229 MEV)    0.719 CPS ***
CH  105 (1.241 MEV)    0.671 CPS ***
CH  106 (1.253 MEV)    0.475 CPS **
CH  107 (1.265 MEV)    0.601 CPS ***
CH  108 (1.277 MEV)    0.661 CPS ***
CH  109 (1.288 MEV)    0.669 CPS ***
CH  110 (1.300 MEV)    0.606 CPS ***
CH  111 (1.312 MEV)    0.630 CPS ***
CH  112 (1.324 MEV)    0.652 CPS ***
CH  113 (1.336 MEV)    0.644 CPS ***
CH  114 (1.347 MEV)    0.652 CPS ***
CH  115 (1.359 MEV)    0.791 CPS ***
CH  116 (1.371 MEV)    0.787 CPS *** POTASSIUM 40
CH  117 (1.383 MEV)    0.834 CPS ****
CH  118 (1.395 MEV)    0.984 CPS ****
CH  119 (1.407 MEV)    1.072 CPS ****
CH  120 (1.418 MEV)    1.124 CPS ****
CH  121 (1.430 MEV)    1.088 CPS ****
CH  122 (1.442 MEV)    1.210 CPS *****
CH  123 (1.454 MEV)    1.231 CPS *****
CH  124 (1.466 MEV)    1.207 CPS *****
CH  125 (1.477 MEV)    0.995 CPS ****
CH  126 (1.489 MEV)    0.967 CPS ****
CH  127 (1.501 MEV)    0.624 CPS ***
CH  128 (1.513 MEV)    0.635 CPS ***
CH  129 (1.525 MEV)    0.512 CPS ***
CH  130 (1.537 MEV)    0.488 CPS **
CH  131 (1.548 MEV)    0.409 CPS **
CH  132 (1.560 MEV)    0.369 CPS ** POTASSIUM 40
CH  133 (1.572 MEV)    0.339 CPS **
CH  134 (1.584 MEV)    0.438 CPS **
CH  135 (1.596 MEV)    0.310 CPS **
CH  136 (1.608 MEV)    0.259 CPS **
CH  137 (1.619 MEV)    0.250 CPS **
CH  138 (1.631 MEV)    0.353 CPS **
CH  139 (1.643 MEV)    0.323 CPS **
CH  140 (1.655 MEV)    0.332 CPS **
CH  141 (1.667 MEV)    0.326 CPS ** BISMUTH 214
CH  142 (1.678 MEV)    0.267 CPS **
CH  143 (1.690 MEV)    0.275 CPS **
CH  144 (1.702 MEV)    0.245 CPS **
CH  145 (1.714 MEV)    0.347 CPS **
CH  146 (1.726 MEV)    0.352 CPS **
CH  147 (1.738 MEV)    0.293 CPS **
CH  148 (1.749 MEV)    0.359 CPS **
CH  149 (1.761 MEV)    0.270 CPS **
CH  150 (1.773 MEV)    0.334 CPS **
CH  151 (1.785 MEV)    0.245 CPS **
CH  152 (1.797 MEV)    0.255 CPS **
CH  153 (1.808 MEV)    0.174 CPS **
CH  154 (1.820 MEV)    0.228 CPS **
CH  155 (1.832 MEV)    0.188 CPS **
CH  156 (1.844 MEV)    0.115 CPS *
CH  157 (1.856 MEV)    0.084 CPS * BISMUTH 214
CH  158 (1.868 MEV)    0.147 CPS *
CH  159 (1.879 MEV)    0.147 CPS *
CH  160 (1.891 MEV)    0.139 CPS *
CH  161 (1.903 MEV)    0.109 CPS *
CH  162 (1.915 MEV)    0.091 CPS *
CH  163 (1.927 MEV)    0.151 CPS *
CH  164 (1.938 MEV)    0.088 CPS *
CH  165 (1.950 MEV)    0.136 CPS *
CH  166 (1.962 MEV)    0.157 CPS *
CH  167 (1.974 MEV)    0.119 CPS *
CH  168 (1.986 MEV)    0.109 CPS *
CH  169 (1.998 MEV)    0.113 CPS *
CH  170 (2.009 MEV)    0.106 CPS *
CH  171 (2.021 MEV)    0.147 CPS *
CH  172 (2.033 MEV)    0.137 CPS *
CH  173 (2.045 MEV)    0.171 CPS **
CH  174 (2.057 MEV)    0.154 CPS *
CH  175 (2.068 MEV)    0.108 CPS *
CH  176 (2.080 MEV)    0.162 CPS *
CH  177 (2.092 MEV)    0.104 CPS *
CH  178 (2.104 MEV)    0.138 CPS *
CH  179 (2.116 MEV)    0.137 CPS *
CH  180 (2.128 MEV)    0.119 CPS *
CH  181 (2.139 MEV)    0.169 CPS **
CH  182 (2.151 MEV)    0.148 CPS *
CH  183 (2.163 MEV)    0.101 CPS *
CH  184 (2.175 MEV)    0.114 CPS *
CH  185 (2.187 MEV)    0.088 CPS *
CH  186 (2.199 MEV)    0.101 CPS *
CH  187 (2.210 MEV)    0.085 CPS *
CH  188 (2.222 MEV)    0.130 CPS *
CH  189 (2.234 MEV)    0.117 CPS *
CH  190 (2.246 MEV)    0.113 CPS *
CH  191 (2.258 MEV)    0.116 CPS *
CH  192 (2.269 MEV)    0.088 CPS *
CH  193 (2.281 MEV)    0.097 CPS *
CH  194 (2.293 MEV)    0.095 CPS *
CH  195 (2.305 MEV)    0.087 CPS *
CH  196 (2.317 MEV)    0.059 CPS *
CH  197 (2.329 MEV)    0.015 CPS *
CH  198 (2.340 MEV)    0.041 CPS *
CH  199 (2.352 MEV)    0.070 CPS *
CH  200 (2.364 MEV)    0.087 CPS *
CH  201 (2.376 MEV)    0.085 CPS *
CH  202 (2.388 MEV)    0.084 CPS *
CH  203 (2.399 MEV)    0.064 CPS *
CH  204 (2.411 MEV)    0.123 CPS * THALLIUM 208
CH  205 (2.423 MEV)    0.076 CPS *
CH  206 (2.435 MEV)    0.116 CPS *
CH  207 (2.447 MEV)    0.147 CPS *
CH  208 (2.459 MEV)    0.108 CPS *
CH  209 (2.470 MEV)    0.120 CPS *
CH  210 (2.482 MEV)    0.092 CPS *
CH  211 (2.494 MEV)    0.127 CPS *
CH  212 (2.506 MEV)    0.169 CPS **
CH  213 (2.518 MEV)    0.206 CPS **
CH  214 (2.529 MEV)    0.262 CPS **
CH  215 (2.541 MEV)    0.184 CPS **
CH  216 (2.553 MEV)    0.206 CPS **
CH  217 (2.565 MEV)    0.195 CPS **
CH  218 (2.577 MEV)    0.173 CPS **
CH  219 (2.589 MEV)    0.201 CPS **
CH  220 (2.600 MEV)    0.329 CPS **
CH  221 (2.612 MEV)    0.232 CPS **
CH  222 (2.624 MEV)    0.187 CPS **
CH  223 (2.636 MEV)    0.171 CPS **
CH  224 (2.648 MEV)    0.177 CPS **
CH  225 (2.660 MEV)    0.089 CPS *
CH  226 (2.671 MEV)    0.122 CPS *
CH  227 (2.683 MEV)    0.124 CPS *
CH  228 (2.695 MEV)    0.131 CPS *
CH  229 (2.707 MEV)    0.090 CPS *
CH  230 (2.719 MEV)    0.027 CPS *
CH  231 (2.730 MEV)    0.012 CPS *
CH  232 (2.742 MEV)   -0.026 CPS *
CH  233 (2.754 MEV)   -0.024 CPS *
CH  234 (2.766 MEV)    0.038 CPS *
CH  235 (2.778 MEV)    0.003 CPS *
CH  236 (2.790 MEV)    0.060 CPS *
CH  237 (2.801 MEV)    0.038 CPS * THALLIUM 208
CH  238 (2.813 MEV)    0.023 CPS *
CH  239 (2.825 MEV)    0.008 CPS *
CH  240 (2.837 MEV)    0.078 CPS *
CH  241 (2.849 MEV)    0.027 CPS *
CH  242 (2.860 MEV)    0.047 CPS *
CH  243 (2.872 MEV)    0.039 CPS *
CH  244 (2.884 MEV)    0.084 CPS *
CH  245 (2.896 MEV)    0.025 CPS *
CH  246 (2.908 MEV)    0.025 CPS *
CH  247 (2.920 MEV)   -0.015 CPS *
CH  248 (2.931 MEV)    0.037 CPS *
CH  249 (2.943 MEV)   -0.005 CPS *
CH  250 (2.955 MEV)    0.042 CPS *
CH  251 (2.967 MEV)    0.002 CPS *
CH  252 (2.979 MEV)   -0.018 CPS *
CH  253 (2.990 MEV)    0.031 CPS *
CH  254 (3.002 MEV)   -0.106 CPS * TOTAL COUNT
CH  255 (3.014 MEV)    0.000 CPS *
```

AIRCRAFT BACKGROUND
ROTARY WING AIRCRAFT
DOWNWARD LOOKING CRYSTAL
2048 CUBIC INCHES
DATE: 25 JULY 1977

FIGURE V

DERIVED COSMIC SPECTRUM FROM PACIFIC OCEAN DATA

DOWNWARD-LOOKING CRYSTAL SPECTRUM FOR LINE COSMIC, DATED 072577

TC (0-6 MEV) 5275.09 TC (0.4-3.0 MEV) 3245.27 COSMIC (3-6 MEV) 1000.00
U (1.12 MEV) 165.91 K (1.46 MEV) 181.83 U (1.76 MEV) 157.56 T (2.62 MEV) 213.66

COSMIC SPECTRUM
ROTARY WING AIRCRAFT
DOWNWARD LOOKING CRYSTAL
2048 CUBIC INCHES
DATE: 25 JULY 1977

CH	MEV	CPS	
0	0.000	0.000	
1	0.012	0.000	
2	0.024	0.000	
3	0.035	0.000	
4	0.047	0.000	
5	0.059	0.000	
6	0.071	0.000	
7	0.083	0.000	
8	0.095	0.000	
9	0.106	0.000	
10	0.118	0.000	
11	0.130	0.000	
12	0.142	0.000	
13	0.154	0.000	
14	0.165	0.000	
15	0.177	0.000	
16	0.189	0.000	
17	0.201	0.000	
18	0.213	1.091	
19	0.225	1.313	
20	0.236	2.226	
21	0.248	26.345	
22	0.260	89.243	
23	0.272	100.516	
24	0.284	103.036	
25	0.295	94.423	
26	0.307	88.893	
27	0.319	85.032	
28	0.331	80.528	
29	0.343	78.271	
30	0.355	72.498	
31	0.366	74.934	
32	0.378	65.560	
33	0.390	65.966	
34	0.402	63.189	TOTAL COUNT
35	0.414	62.880	
36	0.426	64.078	
37	0.437	67.602	
38	0.449	69.116	
39	0.461	76.972	
40	0.473	84.879	
41	0.485	96.049	
42	0.496	94.167	
43	0.508	86.706	
44	0.520	68.016	
45	0.532	48.444	
46	0.544	40.965	
47	0.556	30.512	
48	0.567	33.160	
49	0.579	31.892	
50	0.591	25.907	
51	0.603	30.781	
52	0.615	27.055	
53	0.626	27.982	
54	0.638	25.776	
55	0.650	22.988	
56	0.662	27.787	
57	0.674	25.274	
58	0.686	25.240	
59	0.697	23.489	
60	0.709	24.769	
61	0.721	22.350	
62	0.733	22.242	
63	0.745	22.424	
64	0.756	22.234	
65	0.768	20.332	
66	0.780	18.821	
67	0.792	20.493	
68	0.804	19.339	
69	0.816	19.021	
70	0.827	17.949	
71	0.839	20.235	
72	0.851	17.491	
73	0.863	18.370	
74	0.875	16.244	
75	0.887	16.331	
76	0.898	17.519	
77	0.910	16.689	
78	0.922	17.150	
79	0.934	19.230	
80	0.946	17.111	
81	0.957	16.248	
82	0.969	14.954	
83	0.981	17.324	
84	0.993	16.276	
85	1.005	14.813	
86	1.017	15.703	
87	1.028	13.767	
88	1.040	16.414	
89	1.052	13.642	BISMUTH 214
90	1.064	13.624	
91	1.076	13.517	
92	1.087	13.700	
93	1.099	14.633	
94	1.111	14.303	
95	1.123	13.766	
96	1.135	14.949	
97	1.147	13.503	
98	1.158	13.481	
99	1.170	13.189	
100	1.182	13.602	BISMUTH 214
101	1.194	12.965	
102	1.206	12.538	
103	1.217	14.001	
104	1.229	11.346	
105	1.241	11.113	
106	1.253	13.669	
107	1.265	11.910	
108	1.277	12.345	
109	1.288	10.736	
110	1.300	11.444	
111	1.312	11.433	
112	1.324	11.927	
113	1.336	11.846	
114	1.347	11.896	
115	1.359	11.470	
116	1.371	11.864	POTASSIUM 40
117	1.383	10.286	
118	1.395	12.084	
119	1.407	9.642	
120	1.418	11.778	
121	1.430	12.635	
122	1.442	10.601	
123	1.454	9.140	
124	1.466	11.144	
125	1.477	10.766	
126	1.489	9.250	
127	1.501	11.961	
128	1.513	10.296	
129	1.525	10.900	
130	1.537	9.022	
131	1.548	10.311	
132	1.560	10.151	POTASSIUM 40
133	1.572	9.361	
134	1.584	8.753	
135	1.596	11.176	
136	1.608	10.130	
137	1.619	10.551	
138	1.631	9.204	
139	1.643	9.159	
140	1.655	8.738	
141	1.667	8.679	BISMUTH 214
142	1.678	10.154	
143	1.690	9.743	
144	1.702	9.453	
145	1.714	9.418	
146	1.726	8.425	
147	1.738	9.263	
148	1.749	9.653	
149	1.761	9.412	
150	1.773	9.019	
151	1.785	9.329	
152	1.797	10.232	
153	1.808	9.686	
154	1.820	7.911	
155	1.832	8.104	
156	1.844	9.602	
157	1.856	9.473	BISMUTH 214
158	1.868	8.568	
159	1.879	8.105	
160	1.891	8.014	
161	1.903	8.365	
162	1.915	8.759	
163	1.927	6.994	
164	1.938	8.477	
165	1.950	8.144	
166	1.962	7.798	
167	1.974	8.214	
168	1.986	9.240	
169	1.998	7.945	
170	2.009	7.615	
171	2.021	6.816	
172	2.033	8.408	
173	2.045	7.196	
174	2.057	7.231	
175	2.068	7.473	
176	2.080	9.062	
177	2.092	8.116	
178	2.104	8.235	
179	2.116	7.653	
180	2.128	8.338	
181	2.139	7.237	
182	2.151	7.528	
183	2.163	8.039	
184	2.175	8.536	
185	2.187	8.888	
186	2.199	7.485	
187	2.210	8.211	
188	2.222	8.233	
189	2.234	8.055	
190	2.246	7.825	
191	2.258	7.062	
192	2.269	8.435	
193	2.281	7.440	
194	2.293	7.686	
195	2.305	7.110	
196	2.317	7.329	
197	2.329	7.890	
198	2.340	7.771	
199	2.352	7.147	
200	2.364	6.729	
201	2.376	6.264	
202	2.388	6.318	
203	2.399	7.050	
204	2.411	6.506	THALLIUM 208
205	2.423	6.486	
206	2.435	6.589	
207	2.447	7.033	
208	2.459	6.515	
209	2.470	6.852	
210	2.482	6.871	
211	2.494	6.573	
212	2.506	6.417	
213	2.518	5.845	
214	2.529	6.127	
215	2.541	6.355	
216	2.553	6.964	
217	2.565	6.820	
218	2.577	6.670	
219	2.589	6.808	
220	2.600	5.940	
221	2.612	6.177	
222	2.624	6.176	
223	2.636	6.109	
224	2.648	6.347	
225	2.660	7.049	
226	2.671	5.757	
227	2.683	5.645	
228	2.695	5.229	
229	2.707	5.415	
230	2.719	6.190	
231	2.730	6.092	
232	2.742	6.466	
233	2.754	7.032	
234	2.766	5.533	
235	2.778	6.309	
236	2.790	5.559	
237	2.801	5.206	THALLIUM 208
238	2.813	6.045	
239	2.825	5.257	
240	2.837	5.640	
241	2.849	5.835	
242	2.860	5.348	
243	2.872	4.804	
244	2.884	4.742	
245	2.896	5.304	
246	2.908	5.248	
247	2.920	6.036	
248	2.931	5.711	
249	2.943	5.513	
250	2.955	5.010	
251	2.967	5.579	
252	2.979	6.256	
253	2.990	5.207	
254	3.002	9.302	TOTAL COUNT
255	3.014	1000.000	

FIGURE VI

Thus, energy peaks within a spectrum of a given element are Gaussian shaped rather than pure line spectra. Additionally, we are dealing with finite spectral windows, multiple peaked spectra, and pulse pileup; all tend to couple each window's response to the other.

Keeping in mind that we are dealing with the count rates corresponding to the concentrations presented in the last table, we define the following:

KC_i = uncorrected system count rate for the K channel

UC_i = uncorrected system count rate for the U channel

TC_i = uncorrected system count rate for the T channel

K_i = the percent differential concentration of potassium

U_i = ppm differential concentration of uranium

T_i = ppm differential concentration of thorium

where "i" refers to the ith pad.

We also define the following:

ζ_{kk} = sensitivity of KC_i to concentrations of K_i

ζ_{ku} = sensitivity of KC_i to concentrations of U_i

ζ_{kt} = sensitivity of KC_i to concentrations of T_i

ζ_{uk} = sensitivity of UC_i to concentrations of K_i

ζ_{uu} = sensitivity of UC_i to concentrations of U_i

ζ_{ut} = sensitivity of UC_i to concentrations of T_i

ζ_{tk} = sensitivity of TC_i to concentrations of K_i

ζ_{tu} = sensitivity of TC_i to concentrations of U_i

ζ_{tt} = sensitivity of TC_i to concentrations of T_i

Using the above definitions, we now construct the functional relationship by means of the following nine (9) equations in sets of three (3) per pad.

<u>K pad</u>

$$KC_k = \zeta_{kk}K + \zeta_{ku}U + \zeta_{kt}T$$
$$UC_k = \zeta_{uk}K + \zeta_{uu}U + \zeta_{ut}T$$
$$TC_k = \zeta_{tk}K + \zeta_{tu}U + \zeta_{tt}T$$

<u>U pad</u>

$$KC_u = \zeta_{kk}K + \zeta_{ku}U + \zeta_{kt}T$$
$$UC_u = \zeta_{uk}K + \zeta_{uu}U + \zeta_{ut}T$$
$$TC_u = \zeta_{tk}K + \zeta_{tu}U + \zeta_{tt}T$$

<u>T pad</u>

$$KC_t = \zeta_{kk}K + \zeta_{ku}U + \zeta_{kt}T$$
$$UC_t = \zeta_{uk}K + \zeta_{uu}U + \zeta_{ut}T$$
$$TC_t = \zeta_{tk}K + \zeta_{tu}U + \zeta_{tt}T$$

Separating these equation into consistent groups, we get for the uncorrected count rates in the K channel

(K pad) $KC_k = \zeta_{kk}K_k + \zeta_{ku}U_k + \zeta_{kt}T_k$

(U pad) $KC_u = \zeta_{kk}K_u + \zeta_{ku}U_u + \zeta_{kt}T_u$

(T pad) $KC_t = \zeta_{kk}K_t + \zeta_{ku}U_t + \zeta_{kt}T_t$

The equations can be expressed in matrix notation

$$\begin{bmatrix} KC_k \\ KC_u \\ KC_t \end{bmatrix} = \begin{bmatrix} K_k & U_k & T_k \\ K_u & U_u & T_u \\ K_t & U_t & T_t \end{bmatrix} \cdot \begin{bmatrix} \zeta_{kk} \\ \zeta_{ku} \\ \zeta_{kt} \end{bmatrix}$$

Where the k, u and t subscripts represent the K, U and T pads.

In a similar manner we can write two other matrix equations for UC_i and TC_i respectively.

$$\begin{bmatrix} UC_k \\ UC_u \\ UC_t \end{bmatrix} = \begin{bmatrix} K_k & U_k & T_k \\ K_u & U_u & T_u \\ K_t & U_t & T_t \end{bmatrix} \cdot \begin{bmatrix} \zeta_{uk} \\ \zeta_{uu} \\ \zeta_{ut} \end{bmatrix}$$

$$\begin{bmatrix} TC_k \\ TC_u \\ TC_t \end{bmatrix} = \begin{bmatrix} K_k & U_k & T_k \\ K_u & U_u & T_u \\ K_t & U_t & T_t \end{bmatrix} \cdot \begin{bmatrix} \zeta_{tk} \\ \zeta_{tu} \\ \zeta_{tt} \end{bmatrix}$$

Collecting the above, these equations can be expressed in matrix form as

$$\begin{bmatrix} KC_k & UC_k & TC_k \\ KC_u & UC_u & TC_u \\ KC_t & UC_t & TC_t \end{bmatrix} = \begin{bmatrix} K_t & U_k & T_k \\ K_u & U_u & T_u \\ K_t & U_t & T_t \end{bmatrix} \cdot \begin{bmatrix} \zeta_{kk} & \zeta_{uk} & \zeta_{tk} \\ \zeta_{ku} & \zeta_{uu} & \zeta_{tu} \\ \zeta_{kt} & \zeta_{ut} & \zeta_{tt} \end{bmatrix}$$

or

$$\bar{A} = \bar{B} \cdot \bar{\zeta}$$

where $\bar{A}$ is the residual count rate matrix, $\bar{B}$ is the matrix of the known differential concentrations and $\bar{\zeta}$ the sensitivity matrix.

Rearranging the above equations we have

$$\bar{B} = \bar{A} \cdot \bar{\zeta}^{-1}$$

We now define

$$\bar{\zeta}^{-1} = \bar{\Delta}$$

Eliminating $\bar{\zeta}$, we get

$$\bar{B} = \bar{A} \cdot \bar{\Delta}$$

We can now solve for $\bar{\Delta}$ by matrix inversion.

Therefore, the differential concentrations in the mixed pad can be derived from the k,u,t pads to check the computed $\bar{\Delta}$.

$$\begin{bmatrix} K_m \\ U_m \\ T_m \end{bmatrix} = \begin{bmatrix} \Delta_{kk} & \Delta_{ku} & \Delta_{kt} \\ \Delta_{uk} & \Delta_{uu} & \Delta_{ut} \\ \Delta_{tk} & \Delta_{tu} & \Delta_{tt} \end{bmatrix} \cdot \begin{bmatrix} KC_m \\ UC_m \\ TC_m \end{bmatrix}$$

where the subscript m refers to the mixed pad. Expanding this in algebraic form we obtain the following set of equations:

$$K_m = \Delta_{kk}\left(KC_m + \frac{\Delta_{ku}}{\Delta_{kk}} UC_m + \frac{\Delta_{kt}}{\Delta_{kk}} TC_m\right)$$

$$U_m = \Delta_{uu}\left(UC_m + \frac{\Delta_{ut}}{\Delta_{kk}} TC_m + \frac{\Delta_{uk}}{\Delta_{uu}} KC_m\right)$$

$$T_m = \Delta_{tt}\left(TC_m + \frac{\Delta_{tu}}{\Delta_{tt}} UC_m + \frac{\Delta_{tk}}{\Delta_{tt}} KC^m\right)$$

The terms in parentheses in the above 3 equations are the "corrected stripped count rates" for the system, and the stripping coefficients are as follows:

$S_{ku} = \frac{\Delta_{ku}}{\Delta_{kk}}$ (effect of uranium on potassium)

$S_{kt} = \frac{\Delta_{kt}}{\Delta_{kk}}$ (effect of thorium on potassium)

$S_{ut} = \frac{\Delta_{ut}}{\Delta_{uu}}$ (effect of thorium on uranium)

$S_{uk} = \frac{\Delta_{uk}}{\Delta_{uu}}$ (effect of potassium on uranium)

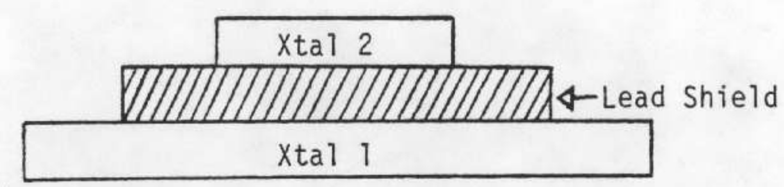
$S_{tu} = \frac{\Delta_{tu}}{\Delta_{tt}}$ (effect of uranium on thorium)

$S_{tk} = \frac{\Delta_{tk}}{\Delta_{tt}}$ (effect of potassium on thorium)

These stripping coefficients are defined in terms of S_{ij} in order to eliminate confusion with α, β, and γ, which are sometimes defined slightly differently.

ATMOSPHERIC RADON CORRECTION

Consider the crystal configuration shown below:



Let 1 and 2 designate the down and up crystal respectively. The down crystal sees radiation rates of I_1 composed of the air signal I_a and the ground signal I_g plus aircraft and cosmic background.

Therefore $$I_1 = I_g + I_a + A_1 + C_1$$

Similarly, the up crystal sees the air signal and ground signal (both somewhat attenuated) plus an aircraft and cosmic background.

Therefore $$I_2 = \ell I_g + mI_a + A_2 + C_2$$

Where m is the response to the air signal and is the % of the ground signal getting through to the up detector.

Using the test pad data, the factor can be determined. Consider the two previous equations. When we subtract the matrix pad data from the K, U, and T pad data, we have essentially set A_1, A_2, C_1, and C_2 and I_a equal to zero.

Therefore $$I_1 = I_g$$

$$I_2 = \ell I_g$$

$$= \left(\frac{I_2}{I_1}\right)$$

Instead of using the count rates we can use the resultant sensitivities $1/\Delta_{uu}$ to determine ℓ for the elemental channel U.

$$= \frac{1/\Delta_{uu}\ (up)}{1/\Delta_{uu}\ (down)}$$

It should be noted that due to "shine around" (since the shielding is not an infinite plane, the upward looking crystal responds to the surrounding terrain) on the test pads, as altitude increases, should decrease, thus $\ell = f(h)$.

Only the factor m remains to be determined. This unfortunately cannot be determined from test pad data. It can however be determined by flying over water (e.g. use of the Lake Mead over-water data).

Consider the equations for I_1 and I_2 again

$$I_1 = I_g + I_a + A_1 + C_1$$

$$I_2 = \ell I_g + mI_a + A_2 + C_2$$

Over water $I_g = 0$

We have A_1, A_2, C_1, and C_2 defined.

Removing the aircraft and cosmic background from the over water data and we are left with

$$I_1 = I_a$$

$$I_2 = mI_a$$

Since m is the shielding factor response to the air signal, we should have an air signal to "shield". Thus m is best determined if there is radon present.

Both up and down counting rates are corrected for aircraft and cosmic background and so we can solve the following two equations for I_a.

$$I_1 = I_g + I_a$$

$$I_2 = \ell I_g + mI_a$$

$$mI_a = I_2 - \ell I_g$$

but $$I_g = I_1 - I_a$$

then $$I_a\ (m-\ell) = I_2 - \ell I_1$$

or $$I_a = \frac{I_2 - \ell I_1}{m - \ell} = \text{Bi Air}$$

and I_a is then the Bi Air contribution from the surrounding air. This is then subtracted from the down looking U count resulting in corrected data.

DATA PROCESSING

DATA PREPARATION

The following sections summarize the techniques used for reduction and processing of the airborne data collected by geoMetrics.

Field Tape Verification and Edit

The field data tapes containing the airborne data are read on a computer to verify the recording and data quality. Data recovery is essentially 100% from the field tapes. During this phase, statistics are generated summarizing all the variables recorded for each flight line. Simultaneously, the spectral peaks are evaluated for shifts using a centroid calculation and the particular window's peak channel. The data are also checked for correct scan lengths and proper justification of data fields within each scan and and live time calculations are made. During this process, the desired window data fields are extracted from each spectrum and rewritten as a reformatted copy tape. (Portions of this operation were performed in the field using the G-725 field computer system.)

The reformatted raw data for each flight line (with aborted or unnecessary flight line data edited out) are then checked for consistency, data spikes, gradients, etc. Every correction suggested by the computer is evaluated by the data processing personnel prior to implementation. Upon completion of the phase, the data on the output tape are "clean" and ready for subsequent correction of the radiometrics and tieing of the magnetics.

Flight Line Location

A single frame 35 mm camera is used for obtaining position recovery information. The photo locations are spotted or transferred to a suitable base map and are digitized. The fiducial numbers of the spotted points along each line are entered during the digitying process. A computer program is used to check the consistency of these data using calculated intersections from tie line to tie line and from traverse to traverse. This program allows easy detection of entry errors as well as potential flight path recovery errors.

A computer program then calculates the map location for each intersection and the beginning and end of each line based on the fiducial numbers and the control line/tie grid. A computer plot is made of these locations to check against the field plot and correct editing information. These flight lines are then overlain on the geologic base map and each map unit is digitized such that each sample falls within a single unit. This resulting location information is then merged with the geophysicial data using the fiducial numbers as common reference.

RADIOMETRIC DATA REDUCTION

Reduction of the raw window data was carried out utilizing system calibration constants as derived from high altitude over water flights, Lake Mead Dynamic Test Range, and the Walker Field Test Pads. The data reduction sequence used is summarized in Figure VII. Processing of the data was performed using the window energies given below:

Total count - 0.4 to 3.0 MeV

K - 1.37 to 1.57 MeV

U - 1.66 to 1.87 MeV (downward looking system)

U_{up} - 1.04 to 1.21 MeV and 1.65 to 2.42 MeV (upward looking system)

T - 2.41 to 2.81 MeV

Cosmic - 3 to 6 MeV (downward and upward looking system)

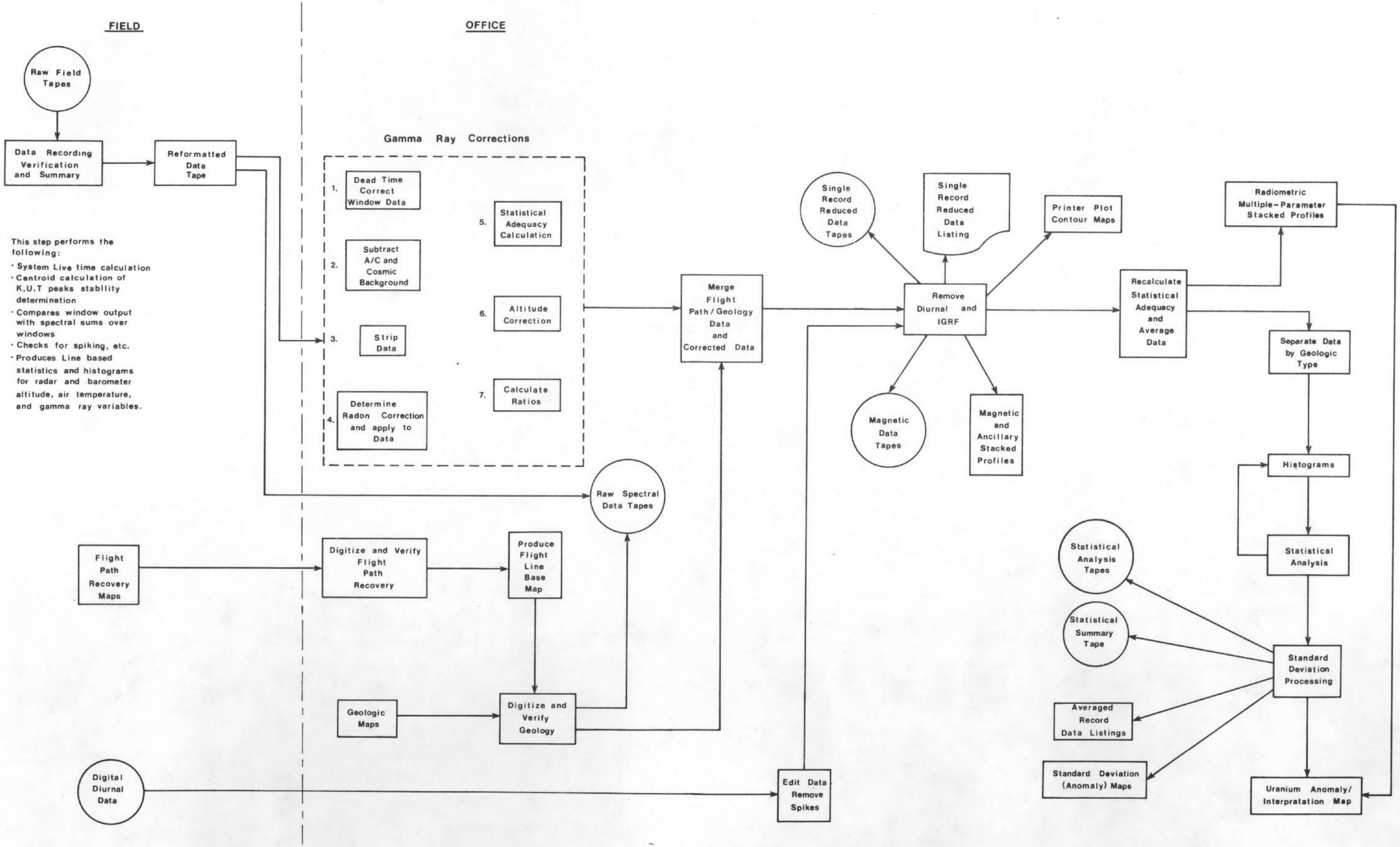
Aircraft and Cosmic background for the Queen Air/Aero Commander over these windows are as follows:

	QUEEN AIR		AERO COMMANDER	
	Aircraft	Cosmic*	Aircraft	Cosmic*
TC (cps)	152.04	2.3833	220.37	2.3915
K (cps)	16.06	0.1322	18.82	0.1334
U_{dn}(cps)	6.50	0.1098	10.85	0.1082
U_{up}(cps)	3.17	0.5540	5.35	0.5915
T (cps)	3.42	0.1503	4.35	0.1513

*Cosmic background values are in cps per 1.0 cps in the 3-6 MeV window.

DATA PROCESSING FLOW DIAGRAM

FIGURE VII



Compton corrections to the down data were made using the following constants:

Sij	QUEEN AIR	AERO COMMANDER
S_{ku}	0.8437	0.8717
S_{kt}	0.1584	0.1408
S_{ut}	0.2703	0.2877
S_{uk}	0.0	0.0
S_{tu}	0.05614	0.09453
S_{tk}	0.0	0.0

The ij subscripts represent the influence of the j^{th} window on the i^{th} window.

All parameters except for S_{ut} are considered constants. S_{ut} was considered an altitude dependent paramenter utilizing the following expression (after Grasty, 1975).

$S_{ut} = S_{ut_o} + 0.0076h$, where h is the altitude in hundreds of feet.

Altitude attenuation coefficients used are defined as follows:

ALTITUDE ATTENUATION COEFFICIENTS

	QUEEN AIR	AERO COMMANDER
TC (per foot)	0.002011	0.001688
K (per foot)	0.002740	0.002800
U (per foot)	0.002479	0.002536
T (per foot)	0.002048	0.002102

All radiometric data presented in the strip charts have been normalized to 400 feet mean terrain clearance at STP using the expression:

$$\exp - u_i \frac{273.15}{760} \times \frac{P}{T} (h - 400)$$

where h is the height in feet, $_i$ is the appropriate altitude attenuation coefficient, P is in mm of Hg, and T is in degrees Kelvin. In cases where the altitude exceeds 1,000 feet, the correction coefficients were limited to the 1,000 foot value.

Bi Air calculations are made using the following expressions:

$$Bi_{Air} = \frac{U_{up} - (R_{us} + \frac{C'uk}{C'uu} R_{ks} + \frac{C'ut}{C'uu} R_{ts})\ell}{m - \ell}$$

Where U_{up} = count rate from upward detectors

ℓ = crystal coupling constant

m = crystal geometric factor

C'_{uk}, C'_{ut}, C'_{uu}, = stripping coefficients relating down data to up data

R_{us} = stripped uranium count rate - down system

R_{ks} = stripped potassium count rate - down system

R_{ts} = stripped thorium count rate - down system

The numerical values for the constants ℓ, m, C'_{uk}, and C'_{uu} are given below:

	QUEEN AIR	AERO COMMANDER
ℓ	0.1101	0.0890
m	0.596	0.445
C'_{uk}	0.00947	0.00964
C'_{uu}	0.07136	0.08562
C'_{ut}	0.04636	0.05644
$\mu\ell$	-0.000032	-0.00019
μm	-0.000192	-0.000112

$\mu\ell$ & μm are altitude dependent as follows:

$$\ell = \ell - \mu\ell \times h, \text{ where h is in feet}$$

$$m = m - \mu m \times h, \text{ where h is in feet}$$

These Bi Air data are filtered and the filtered results are then removed on a point by point basis from the corrected uranium window data.

The window data are then evaluated for statistical adequacy prior to altitude correction to ensure they are significant within the context of the anticipated errors in count statistics.

Statistical Adequacy Test

The statistical adequacy test is made to determine whether the corrected data sample is sufficiently greater than the "noise" to represent the "signal" of interest.

We can define three separate criteria for detection thresholds (ref. Currie, Analytical Chemistry, Volume 40, No. 3, March 1968) of which only one is directly applicable to our case; this is the "critical level". This is the level at which the decision is made that a signal is "detected". We thus define this critical level as that level at which the data are statistically adequate.

Setting the actual levels in counts per second, "a priori " for each elemental window is difficult at best since the full effect of all parameters affecting the counts is not known to a sufficient degree of certainty. If the corrections to the data are a significant portion of the count rate, most of the error (exclusive of systematic errors due to electronics, etc.) in the corrected data can be ascribed to random errors within the applied corrections. The corrections are basically the results of counting radioactive decay products (gamma rays) and are therefore assumed to follow the classical Poisson distribution. The following assumptions concerning these corrections are:

1. In the best case, the error in each correction is additive.

2. The sum of these corrections also follows a Poisson distribution.

3. The uncertainty in the correction itself is equal to the square root of the correction applied.

4. This uncertainty is directly reflected in the corrected single record count rate.

With these assumptions in mind, the criterion for determining the statistical adequacy of a given data sample is defined as follows:

> "If a corrected single record data sample exceeds 1.5 times the square root of the summed correction applied to that data sample, then that data sample is statistically adequate."

Since any calculation using statistically inadequate data (such as ratios) is also inadequate, the adequacy of each element of the single sample record data is tested prior to the calculation. This is done during the course of the processing by retaining all corrections applied to each data sample and determining its adequacy as explained above.

Not only are the results of this statistical adequacy test used to insure that calculated ratios will be meaningful but they are also utilized to determine the optimum interval over which the data should be averaged (e.g. 5 seconds or 7 seconds, etc.) to improve the overall data statistical adequacy In the case of this project, the resulting averaging sample interval was 7 seconds.

Conversion to Equivalent ppm and Percent

At this point the data are single record corrected samples in units of counts per second. These data are then converted to equivalent ppm (parts per million) uranium, thorium and percent potassium. The conversion factors are the sensitivities derived from the Lake Mead Dynamic Test Range data at 400 feet mean terrain clearance.

Radioelement	Equivalent Percent/ppm	Queen Air Counts/Second	Aero Commander Counts/Second
K	1%K	91.5	96.3
U	1 ppmeu	10.4	9.2
T	1 ppmeT	6.4	6.7

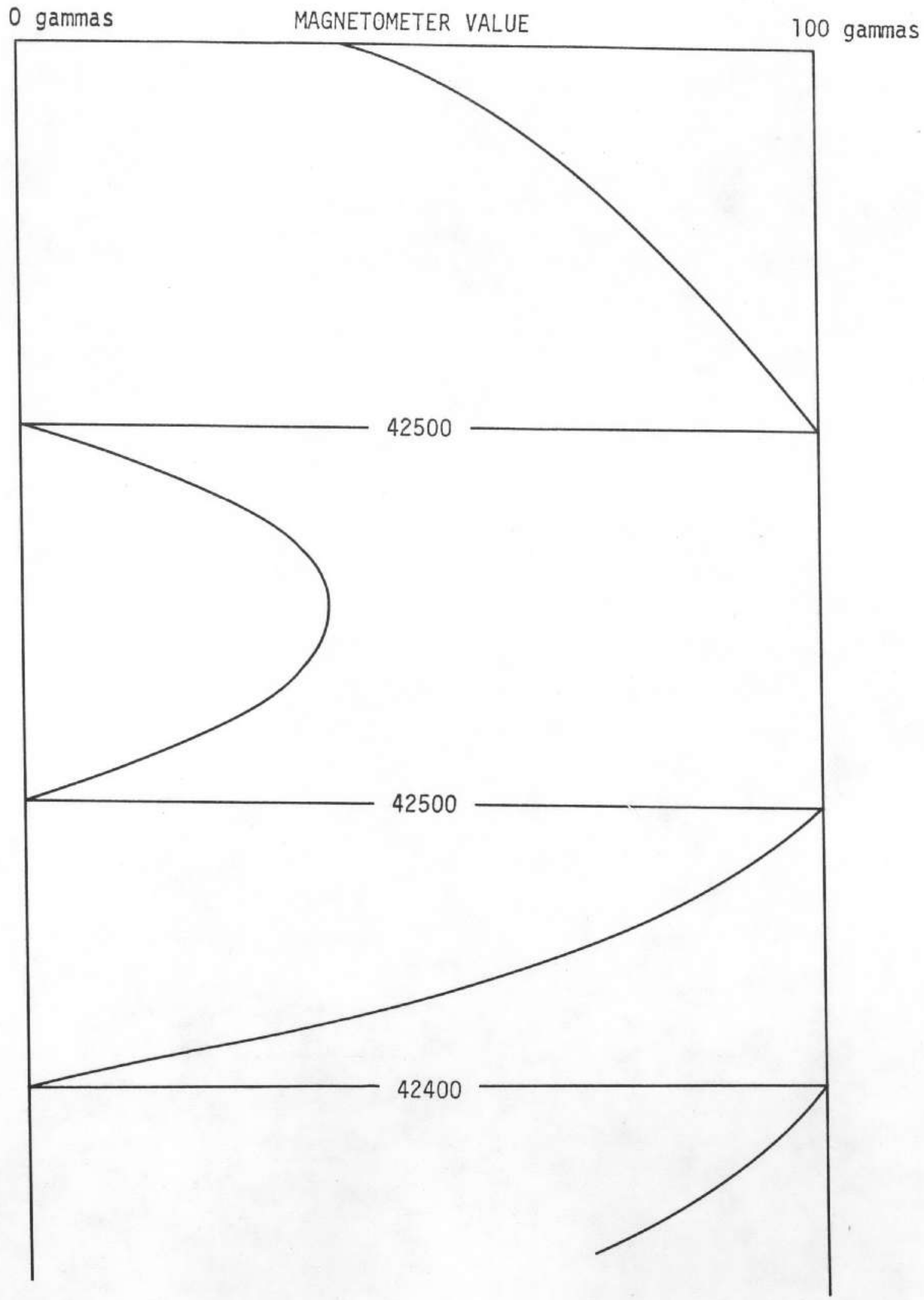


FIGURE VIII Plotter Step Value Labeling

FLIGHT PATH MAPS

For each of the NTMS quadrangle sheets covered by this survey, a flight path position map is available at a scale of 1:250,000. The actual flight path has been superimposed on the geologic quadrangle maps. Flight lines and tie lines are annotated along with fiducial numbers of located positions. Reduced scale (1:500,000) copies of these can be found in this report.

STANDARD DEVIATION MAPS

Gamma ray standard deviation maps have been prepared for each NTMS quadrangle included in this survey. The six maps generated represent the following parameters: percent potassium, equivalent ppm uranium, equivalent ppm thorium, and eU/eT, eU/%K and eT/%K ratios. The data contained in each map represent only those data which are considered statistically adequate. This automatically excludes all data collected over water or data which falls outside of altitude specifications (i.e. altitude greater than 700 and less than 200 feet). The symbolism of each of the six maps is identical. The center of each circle represents the central averaged sample since the data had been averaged over a 7 second interval. The small boxes adjacent to each of the circles represents one standard deviation from the mean for that specific data sample. In order to determine whether the data shown are represented by positive or negative standard deviations, consider each map with north pointing away from the viewer. For east/west lines (traverse lines) positive standard deviations lie above or to the north of the traverse line with negative standard deviation below or to the south. On the north/south lines (tie lines) positive standard deviations are to the left of the viewer (west) with negative standard deviations to the right (east).

These maps were generated at a scale of 1:250,000 for each NTMS sheet and in addition, are presented in each report at a reduced scale of approximately 1:500,000.

HISTOGRAMS

Computer generated histograms, showing the equivalent ppm and percent distributions for the three gamma ray emitters and their ratios measured and calculated as a function of computer map unit are presented in this report (See Figure IX). Information contained on these histograms includes the standard deviation as calculated about the arithmetic mean (or median), and the total number of samples from which the statistics were derived.

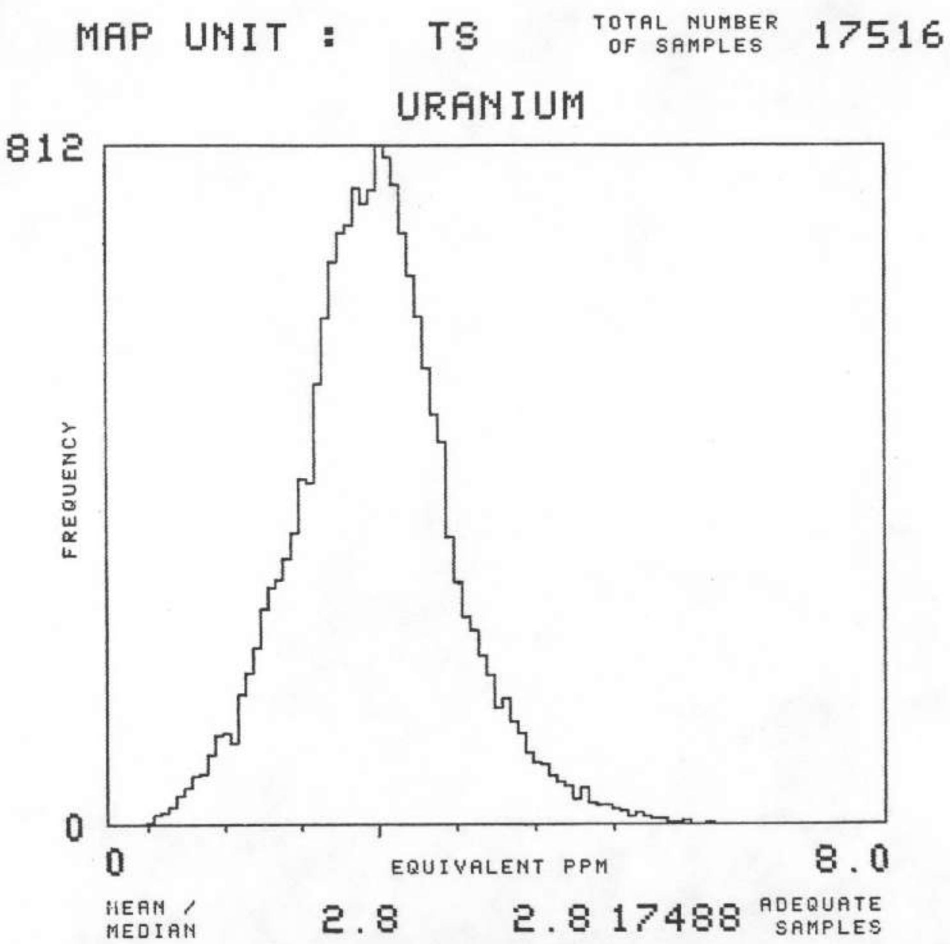


FIGURE IX Sample Computer Map Unit Histogram

DATA LISTINGS

Single record reduced and averaged record (statistical analysis) data listings have been prepared on microfiche. The microfiche are contained in each report. Each of the single record and averaged record data listings are presented for the data contained in a single quadrangle. The data contained in the single record data listings are summarized below:

1. Fiducial number

2. System/Quality (SAKUT) - The first digit identifies the system used to collect the sample. The remaining digits define the results of statistical adequacy testing for altitude, potassium, uranium, and thorium. A value of 0 indicated that the data are statistically adequate. A value of 1 indicates that the data are statistically inadequate. All data collected in excess of 700 feet and less than 200 feet are considered statistically inadequate.

3. Time - time presented in hours, minutes, and seconds

4. Altitude - altitude presented in feet above terrain

5. LAT/LONG - Latitude and Longitude presented in terms of decimal degrees

6. Magnetic field expressed in residual gammas

7. Geology - code representing geologic units

8. %K, eU, eT - percent potassium, equivalent ppm of uranium and thorium

9. eU/eTH, eU/%K, eTH/%K - calculated ratios of the three parameters

10. Total count - corrected total count data (0.4 to 3.0 MeV)

11. COS - downward looking cosmic count rate in the 3-6 MeV channel

12. Uair - atmospheric Bi-214 equivalent ppm

13. Temperature - outside air temperature in degrees centigrade

14. Press - barometric pressure in mm of mercury

The averaged record (statistical analysis) data listings are summarized below:

1. Fiducial number

2. System/Quality (SAKUT) - The first digit identifies the system used to collect the sample. The remaining digits define the results of statistical adequacy testing for altitude, potassium, uranium, and thorium. A value of 0 indicated that the data are statistically adequate. A value of 1 indicates that the data are statistically inadequate. All data collected in excess of 700 feet and less than 200 feet are considered statistically inadequate.

3. LAT/LONG - Latitude and longitude presented in terms of decimal degrees

4. Magnetic field expressed in residual gammas

5. Geology - code representing geologic formations

6. %K, eU, eT - percent potassium, equivalent ppm of uranium and thorium data and the number of ($\pm$) standard deviations from the mean

7. eU/eTH, eU/%K, eTh/%K - calculated ratios of the three parameters, and the number of ($\pm$) standard deviations from the mean

8. Total count - corrected total count data (0.4 to 3.0 MeV)

9. COS - downward looking cosmic count rate in the 3-6 MeV channel

10. Uair - atmospheric Bi-214 in equivalent ppm

DATA TAPES

Data tape files have been generated for each of the 1:250,000 NTMS quadrangle sheets. The tapes are IBM compatible and recorded on 9 track EBCDIC at 800 bpi. Five separate types of data tapes are presented: raw spectral data tapes, single record reduced data tapes, statistical analysis tapes, magnetic data tapes and a statistical analysis summary tape. Detailed descriptions of the data tape formats follow this discussion.

DATA INTERPRETATION METHODS

General

The stated objective of the NURE Program is the evaluation of the uranium potential of the United States. In support of this goal, high sensitivity airborne radiometric and magnetic surveys have been implemented to obtain reconnaissance information pertaining to regional distribution of uraniferous materials. Within this context, data interpretation has been oriented toward regional detection and description of anomalously high concentrations of uranium.

By far the most significant natural sources of gamma radiation in the geologic environment are the radioactive decay series of potassium 40 (K40), thorium 232 (Th232) and uranium 238 (U238) of which 0.7% is uranium 235. Potassium 40 is the largest contributor to natural radioactivity, accounting for nearly 98%, as it is the most abundant gamma ray emitter-.012% of all potassium in nature. (Refer to GSA Memoir 97 for abundances of uranium, thorium, and potassium).

Potassium 40 is directly identified by the airborne spectrometer from a single clear peak at 1.46 mev (million electron volts) in its gamma ray spectrum. However, thorium 232 and uranium 238 do not have any clear, distinct peaks at sufficiently high energies to allow direct detection from airborne systems. Instead, daughter products which do have distinct peaks are measured as representing the abundance of the parent element. For thorium 232, the daughter nuclide thallium 208 (T1208) has a distinct peak at 2.62 meV while uranium 238 has a daughter, bismuth 214 (Bi214) possessing a clear peak at 1.76 meV (see Figure 7 for a composite decay series spectrum). Consequently the fundamental assumption implicit to airborne uranium and thorium measurements is that the measured daughter products are in radioactive equilibrium - the number of atoms of disintegrating daughter nuclides are equal to the number being formed (see Adams and Gasparini, 1970).

An airborne gamma ray measurement is the sum of photons counted during a specified time interval from a multitude of gamma ray sources which include the three geologic emitters that are being sought plus other interfering sources. These others include, but are not limited to higher energy cosmic rays, aircraft and instruments, contributions from overlapping decay series and airborne radon 222. (See Burson, 1974 and McSharry, 1973 for a more complete discussion of airborne radiometric measurements, and Radiometric Data Reduction in this volume for a complete description of data correction procedures).

When correlating ground data (geochemical, geological, etc.) with the corrected data derived from raw airborne measurements, the interpreter must remember what an individual airborne gamma ray sample physically measures. First, the terrestrial component of the gamma radiation measured by the airborne detector emanated primarily from the upper 18 inches of material on the earth's surface (Gregory and

Horwood, 1963). The airborne measurement cannot "see" any deeper into the underlying rock material and is essentially a measurement of the soil's or exposed (weathered) rock's radioactivity. Secondly, since each airborne sample is an accumulation of gamma rays measured on a moving platform over a fixed period of time, the individual sample represents a large areal extent of surficial material. For this survey, with specifications of 400 feet mean terrain clearance and an average ground speed of 140 miles per hour, a one second sample corresponds to an oval approximately 750 feet long by 600 feet wide (assuming an infinite, uniformly distributed source). Accordingly, averaged samples represent tremendous volumes of surficial materials.

Methodology

As described previously, the gamma ray data were located by computer map units, histograms were produced and statistical analyses performed. The basic unit for interpretation then is the averaged sample and its attendant deviations about a particular map unit's mean.

The uranium anomaly/interpretation map displays each individual averaged sample that meets the following criteria:

1. The averaged uranium sample must be greater than or equal to 1 standard deviation above its map unit mean.

2. The sample must have a U/T ratio greater than or equal to 1 standard deviation above its unit mean.

3. Each U/T ratio defined in (2) must have a corresponding thorium value lying at least greater than minus one (-1) standard deviation below the mean. If the thorium sample is less than one standard deviation below the mean, the U/T ratio is considered questionable.

All the possible anomalies displayed on the map are then examined for clusters, trends, and comparisons with all other available data.

Minimum requirements in the subsequent interpretation discussions of each quadrangle for anomalies listed in the uranium anomaly summary are defined as follows:

> Two (2) consecutive averaged U samples lying two or more standard deviations above the mean or three (3) consecutive averaged U samples, two of which are one (1) or more standard deviations and the third of which is two (2) or more standard deviations above the mean.

Statistical anomalies which meet the above criteria can result from several factors or circumstances including: (1) true concentration of uraniferous minerals, (2) differential surface cover (soils and/or vegetation) within a lithologic unit, (3) local weather conditions such as rain and snow, (4) extreme facies variation within a mapped unit, and (5) differential weathering of rocks within mapped units. Obviously an averaged sample which lies on the boundary between two map units is not truly reflecting either one, but is rather an average of both. Thus, for two markedly different units, such a sample would be anomalous relative to one of the units and not be a true indication of radioactive differences within the unit.

The percent potassium, equivalent ppm thorium and uranium, the three ratios and residual magnetic data were plotted as separate pseudo-contour maps and overlain on the geologic base map and standard deviation maps. Regional trends of each variable and average valves could thus be easily and quickly determined and compared with the associated geological, magnetic, and statistical trends. Only the long wavelengths within each variable would show any line-to-line continuity on the pseudo-contour maps and thus, only regional trends will appear.

Each quadrangle's stacked profiles were also overlain on the corresponding geologic and standard deviation maps and anomaly map to further delineate trends and to allow a more detailed analysis of individual anomalies. Since the interpretation was concentrated on detection of anomalous uranium, subtle trends present in the potassium and thorium channels and ratios were only examined in a cursory manner. Even during such a brief examination of the profiles, it was evident that the spectrometer system was highly sensitive to changes in surface materials even in areas of low counting rates such as glacial drift. Thus radiometrics have a real potential for performing general surficial mapping "geochemical analysis" on a geologic unit (or soils) basis in addition to merely radioactive mineral "anomaly hunting".

TAPE FORMATS

SINGLE RECORD REDUCED DATA TAPE

REFERENCE: Paragraphs 4.7.6 and 6.1.6, BFEC 1200-C

The Single Record Tape is an unlabeled, nine track, 800 BPI, NRZI. All data are recorded as EBCDIC characters. Each tape contains but one file of format, header, data, and trailer records for no more than one quadrangle. The tape is divided into 6900-character blocks containing the following information.

Block 1 - Format Data

This block contains 6768 characters in 94 consecutive lines of 72 characters containing the following literal description.

02 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)

SINGLE RECORD REDUCED DATA TAPE

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

ITEM	FORMAT	DESCRIPTION
1.	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
2.	A20	NAME OF SUBCONTRACTOR
3.	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
4.	I1	NUMBER OF AERIAL SYSTEMS USED TO COLLECT DATA FOR THIS QUADRANGLE
5.	I1	AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
6.	A20	AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR FIRST SYSTEM
7.	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE IN CPS PER PERCENT K
8.	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE IN CPS PER PPM EQUIVALENT U
9.	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE IN CPS PER PPM EQUIVALENT TH
13	I3	NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST AERIAL SYSTEM
14	I3	NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST AERIAL SYSTEM
15-24	(SAME)	REPEAT OF ITEMS 5-14 FOR SECOND AERIAL SYSTEM
*	*	*
*	*	*
*	*	*
85-94	(SAME)	REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
95	I3	NUMBER OF FLIGHT LINES ON THIS TAPE
96	I4	FIRST FLIGHT LINE NUMBER ON THIS TAPE
97	I6	FIRST RECORD NUMBER OF FIRST FLIGHT LINE
98	I3	JULIAN DATE (DAY OF YEAR) FIRST FLIGHT-LINE DATA WAS COLLECTED
99-101	I4,I6,I3	REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS TAPE
*	*	*
*	*	*
*	*	*
390-392	I4,I6,I3	REPEAT OF ITEMS 96-98 FOR 99th FLIGHT LINE ON THIS TAPE

FORMAT FOR SINGLE RECORD REDUCED DATA RECORD (THIRD THRU LAST BLOCK)

ITEM	FORMAT	DESCRIPTION
1	I1	AERIAL SYSTEM IDENTIFICATION CODE
2	I4	FLIGHT LINE NUMBER
3	I6	RECORD IDENTIFICATION NUMBER
4	I6	GMT TIME OF DAY (HHMMSS)
5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
8	F7.1	RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE IN GAMMAS
9	A8	SURFACE GEOLOGIC MAP UNIT CODE
10	I4	QUALITY FLAG CODES
11	F6.1	APPARENT CONCENTRATION OF TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
12	F4.1	UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL PLACE IN PERCENT K
13	F6.1	APPARENT CONCENTRATION OF TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
14	F4.1	UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
15	F6.1	APPARENT CONCENTRATION OF TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
16	F4.1	UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH

ITEM	FORMAT	DESCRIPTION
17	F6.1	URANIUM-TO-THORIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
18	F6.1	URANIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
19	F5.1	THORIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
20	F8.1	GROSS GAMMA (0.4-3.0 MEV) COUNT RATE TO ONE DECIMAL PLACE IN COUNTS PER SECOND
21	F6.1	UNCERTAINTY IN GROSS GAMMA COUNT RATE TO ONE DECIMAL PLACE IN COUNTS PER SECOND
22	F5.1	ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
23	F4.1	UNCERTAINTY IN ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
24	F4.1	OUTSIDE AIR TEMPERATURE TO ONE DECIMAL PLACE IN DEGREES CELSIUS
25	F5.1	OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG

This description serves to identify the format of data on subsequent blocks on the tape. The remaining 132 characters on this block are blanks.

Block 2 - Single Record Reduced Identification Data

The second block contains the identifier information for the data contained in subsequent blocks. The identification information is written according to the format description in the first half of the first block. The remaining 4978 characters on this block are blanks.

Block 3 - Single Record Reduced Data

These blocks contain data written according to the format description in the second half of the first block. There will be 50 logical records per physical block. As of August 1979, the method for determining uncertainties specified in the data blocks remains undefined, and those values are filled with 9's under format control.

STATISTICAL ANALYSIS TAPE

REFERENCE: Paragraphs 4.7.7 and 6.1.6, BFEC 1200-C

The statistical analysis data tape is an unlabeled, nine track, 800 BPI, NRZI. All data is recorded as EBCDIC characters. The block length is 8000 characters long. Each tape contains one file of data for no more than one quadrangle.

Block 1 - Format Description Data

The first physical block on this tape contains a format description for data on subsequent blocks. The first 7560 characters on this block contains 105 lines of 72 characters exactly as written below:

03 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)

STATISTICAL ANALYSIS DATA TAPE

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

ITEM	FORMAT	DESCRIPTION
1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
2	A20	NAME OF SUBCONTRACTOR
3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
4	I1	NUMBER OF AERIAL SYSTEMS USED TO COLLECT DATA FOR THIS QUADRANGLE
5	I1	AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
6	A20	AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR FIRST SYSTEM
7	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE IN CPS PER PERCENT K
8	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE IN CPS PER PPM EQUIVALENT U
9	F6.1	NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE IN CPS PER PPM EQUIVALENT TH
10	I6	BLANK FIELD (99999)
11	F6.3	4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL PLACES IN SECONDS FOR FIRST SYSTEM
12	F6.3	2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL PLACES IN SECONDS FOR FIRST SYSTEM
13	I3	NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST AERIAL SYSTEM
14	I3	NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST AERIAL SYSTEM

ITEM	FORMAT	DESCRIPTION
15-24	(SAME)	REPEAT OF ITEMS 5-14 FOR SECOND AERIAL SYSTEM
*	*	*
*	*	*
*	*	*
85-94	(SAME)	REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
95	I3	NUMBER OF FLIGHT LINES ON THIS TAPE
96	I4	FIRST FLIGHT LINE NUMBER ON THIS TAPE
97	I6	FIRST RECORD NUMBER OF FIRST FLIGHT LINE
98	I3	JULIAN DATE (DAY OF YEAR) FIRST FLIGHT-LINE DATA WAS COLLECTED
99-101	I4,I6,I3	REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS TAPE
*	*	*
*	*	*
*	*	*
390-392	I4,I6,I3	REPEAT OF ITEMS 96-98 FOR 99th FLIGHT LINE ON THIS TAPE

FORMAT FOR STATISTICAL ANALYSIS DATA RECORD (THIRD THRU LAST BLOCK)

ITEM	FORMAT	DESCRIPTION
1	I1	AERIAL SYSTEM IDENTIFICATION CODE
2	I4	FLIGHT LINE NUMBER
3	I6	RECORD IDENTIFICATION NUMBER
4	I6	GMT TIME OF DAY (HHMMSS)
5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
8	F7.1	RESIDUAL (IGRF Removed) MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE IN GAMMAS
9	A8	SURFACE GEOLOGIC MAP UNIT CODE
10	I4	QUALITY FLAG CODES
11	F6.1	APPARENT CONCENTRATION OF TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE IN PERCENT K
12	F4.1	UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL PLACE IN PERCENT K
13	F5.1	POTASSIUM STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
14	F6.1	AVERAGED CONCENTRATION OF TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
15	F4.1	UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
16	F5.1	URANIUM STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
17	F6.1	AVERAGED CONCENTRATION OF TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
18	F4.1	UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
19	F5.1	THORIUM STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRIACALLY SIGNED.
20	F8.1	GROSS GAMMA (0.4-3.0 MEV) COUNT RATE TO ONE DECIMAL PLACE IN COUNTS PER SECOND
21	F6.1	UNCERTAINTY IN GROSS GAMMA COUNT RATE TO ONE DECIMAL PLACE IN COUNTS PER SECOND
22	F5.1	ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
23	F4.1	UNCERTAINTY IN ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DEICMAL PLACE IN PPM EQUIVALENT U
24	F4.1	AVERAGED URANIUM-TO-THORIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
25	F5.1	URANIUM-TO-THORIUM RATIO STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
26	F6.1	AVERAGED URANIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
27	F5.1	THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
D8	F6.1	AVERÁGED THORIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
29	F5.1	THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED

The remaining 440 characters in this block are blanks.

Block 2 - Statistical Analysis Identification Data

The second block contains the identifier information for the data contained in subsequent blocks according to the format specification in the first part of Block 1. The final 6078 characters on this block are blanks.

Block 3 - Statistical Analysis Data

The third and subsequent blocks contain statistical analysis data in the format specified by the second part of the Block 1. Fifty logical records are allowed per block. The method for determining uncertainty values shown, as of August 1979, remains undefined. These values are filled with 9's under format control.

MAGNETIC DATA TAPE

REFERENCE: Paragraphs 4.7.8 and 6.1.6, BFEC 1200-C

The Magentic Data Tape is an unlabeled, nine track, 800 BPI, NRZI. All data are recorded as EBCDIC characters. Each tape contains data for no more than one quadrangle and are divided into 8000-character blocks as described below.

Block 1 - Tape Format Description

The first block contains 3384 characters of format information in exactly the following format:

04 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)

MAGNETIC DATA TAPE

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

ITEM	FORMAT	DESCRIPTION
1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
2	A20	NAME OF SUBCONTRACTOR
3	I4	APPROXIMATE DATE OF SURVEY (MONTH., YEAR
4	I3	NUMBER OF FLIGHT LINES ON THIS TAPE
5	I4	FIRST FLIGHT LINE ON THIS TAPE
6	I6	FIRST RECORD NUMBER OF FIRST FLIGHT LINE
7	I3	JULIAN DATE (DAY OF YEAR) FIRST FLIGHT-LINE DATA WAS COLLECTED
8	F8.4	LATITUDE OF GROUND BASE STATION TO FOUR DECIMAL PLACES IN DEGREES FOR FIRST FLIGHT LINE
9	F8.4	LONGITUDE OF GROUND BASE STATION TO FOUR DECIMAL PLACES IN DEGREES FOR FIRST FLIGHT LINE
10-14	(SAME)	REPEAT OF ITEMS 5-9 FOR SECOND FLIGHT LINE ON THIS TAPE
*	*	*
*	*	*
*	*	*
495-499	(SAME)	REPEAT OF ITEMS 5-9 FOR 99th FLIGHT LINE ON THIS TAPE

FORMAT FOR MAGNETIC DATA RECORD (THIRD THRU LAST BLOCK)

ITEM	FORMAT	DESCRIPTION
1	I1	AERIAL SYSTEM IDENTIFICATION CODE
2	I4	FLIGHT LINE NUMBER
3	I6	RECORD IDENTIFICATION NUMBER
4	I6	GMT TIME OF DAY (HHMMSS)
5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
8	F5.1	OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
9	A8	SURFACE GEOLOGIC MAP UNIT CODE
10	F7.1	TOTAL MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE IN GAMMAS
11	F7.1	RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE IN GAMMAS
12	F7.1	DIURNAL MAGNETIC INTENSITY VARIATION TO ONE DECIMAL PLACE IN GAMMAS
13	F7.1	MAGNETIC DEPTH-TO-BASEMENT TO ONE DECIMAL PLACE IN METERS (IF REQUIRED)

The remaining 4616 characters in this block are blanks.

Block 2 - Magnetic Tape Identification Data

This block contains information about the data in subsequent blocks organized according to the format specification in the first half of Block 1.

Block 3 - Magnetic Data

This block and subsequent block contains magnetic data for the quadrangle organized according to the format specifications in the second half of Block 1. There will be 100 logical records per physical block.

STATISTIC ANALYSIS SUMMARY TAPE

REFERENCE: Paragraphs 4.7.9, BFEC 1200-C

The statistical analysis summary tape is an unlabeled, nine track, 800 BPI, NRZI. All data is recorded as EBCDIC characters. The block length is 700 characters long. Each tape contains one file of data for no more than one quadrangle.

Block 1 - Format Description Data

The first physical block on this tape contains a format description for data on subsequent blocks. The first 4320 characters on this block contains 60 lines of 72 characters exactly as written below:

05 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODE)

STATISTICAL ANALYSIS SUMMARY TAPE (OR FILE)

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

ITEM	FORMAT	DESCRIPTION
1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
2	A20	NAME OF SUBCONTRACTOR
3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
4	I6	NUMBER OF GEOLOGIC MAP UNITS USED FOR THIS QUADRANGLE

FORMAT FOR STATISTICAL ANALYSIS SUMMARY DATA RECORD (THIRD THRU LAST BLOCK)

ITEM	FORMAT	DESCRIPTION
1	A8	SURFACE GEOLOGIC MAP UNIT IDENTIFYING CODE
2	I6	TOTAL RECORDS FOR GEOLOGIC MAP UNIT
3	I6	NUMBER OF POTASSIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
4	F6.1	POTASSIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN PERCENT K
5	F6.1	POTASSIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PERCENT K
6	A3	POTASSIUM CONCENTRATION DISTRIBUTION CODE
7	I6	NUMBER OF URANIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
8	F6.1	URANIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
9	F6.1	URANIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
10	A3	URANIUM CONCENTRATION DISTRIBUTION CODE
11	I6	NUMBER OF THORIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
12	F6.1	THORIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
13	F6.1	THORIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
14	A3	THORIUM CONCENTRATION DISTRIBUTION CODE
15	I6	NUMBER OF URANIUM-TO-THORIUM RATIO RECORDS COMPUTED FOR GEOLOGIC UNIT
16	F6.1	URANIUM-TO-THORIUM RATIO MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT U PER PPM EQUIVALENT TH
17	F6.1	URANIUM-TO-THORIUM RATIO STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVA-LENT TH
18	A3	URANIUM-TO-THORIUM RATIO DISTRIBUTION CODE
19	I6	NUMBER OF URANIUM-TO-POTASSIUM RATIO RECORDS COMPUTED FOR GEOLOGIC UNIT
20	F6.1	URANIUM -TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
21	F6.1	URANIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT
22	A3	URANIUM-TO-POTASSIUM RATIO DISTRIBUTION
23	I6	NUMBER OF THORIUM-TO-POTASSIUM RATIO RECORDS COMPUTED FOR GEOLOGIC UNIT
24	F6.1	THORIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
25	F6.1	THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
26	A3	THORIUM-TO-POTASSIUM RATIO DISTRIBUTION CODE

The remaining 2680 characters on this block shall be blanks.

Block 2 - Statistical Analysis Identification Data

The second block contains the identifier information for the data contained in subsequent blocks according to the format specification in the first part of Block 1. The final 6930 characters on this block are blanks.

Block 3 - Statistical Analysis Summary Data

The third and subsequent blocks contain statistical analysis data in the format specified by the second part of the Block 1. Fifty logical records are allowed per block.

BIBLIOGRAPHY

Adams, J. A. S., and Gasparini, P., 1970, Gamma-Ray Spectrometry of Rocks; Elsevier Publishing Co.

Burson, Z. G., 1974, Airborne Surveys of Terrestrial Gamma Radiation in Environmental Research; IEEE Trans. Nucl. Sci., NS-21, No. 1, p. 558-571.

Currie, L. A., 1968, Limits for Qualitative Detection and Quantitative Determination; Analytical Chemistry, Vol. 40, No. 3, p. 586-593.

Grasty, R. L., Uranium Measurement by Airborne Gamma-Ray Spectrometry; Geophysics, Vol. 40, No. 3, June 1975, p. 503-519.

Gregory, A. F., and Horwood, J. L., 1963, A Spectrometric Study of the Attenuation in Air of Gamma Rays from Mineral Resources; U.S. Atomic Energy Commission Report CEX-60-3, Washington, D.C.

McSharry, P. J. and Emerson, D. W., The Collection and Processing of Gamma Ray Spectrometer Data; 2nd International Conference on Geophysics of the Earth and Oceans, Sydney, Australia, January 1973.

APPENDIX B - Flight Summary

APPENDIX B

DAILY PRODUCTION SUMMARY

QUEEN AIR N9AG

MAY, JUNE, 1981

May	25-27	Base Mobilization
	28	337 line miles, Racine, Detroit, Grand Rapids
	29	Weather - nil production
	30	756 line miles, Milwaukee, Midland, Flint
	31	547 " " Racine, Grand Rapid, Detroit
June	1	791 " " Racine, Grand Rapids, Detroit
	2-3	Weather - nil production
	4	696 line miles, Racine, Grand Rapids, Detroit
	5	645 " " Milwaukee, Midland, Flint
	6	467 " " " " "
	7	471 " " Manitowoc, Racine, Milwaukee
	8	Weather - nil production
	9	417 line miles, Manitowoc, Milwaukee, Midland, Grand Rapids
	10	661 " " Flint, Milwaukee, Midland
	11	652 " " Flint, Milwaukee, midland
	12	751 " " Manitowoc, Racine, Traverse, Tawas City
	13-14	Weather - nil production
	15	766 line miles, Midland, Manitowoc, Traverse, Tawas City
	16	744.4 " " " " " " "

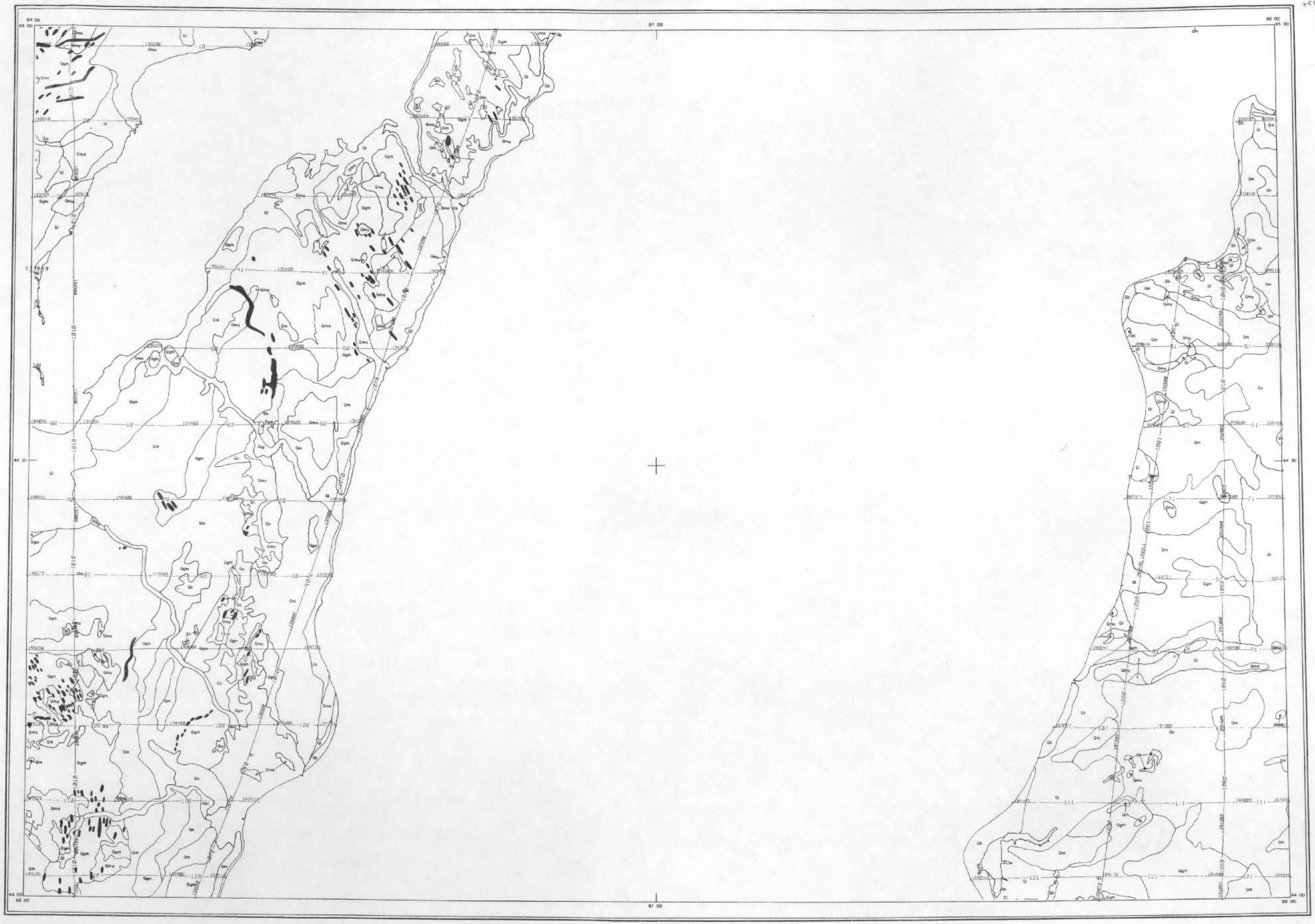
Total miles for the above periods = 8701.4 line miles

Total miles for the included quadrangles:

Racine	419.2
Grand Rapids	1,637.4
Detroit	833.7
Milwaukee	489.2
Midland	1,617.0
Flint	1,001.2
Manitowoc	628.5
Traverse City	1,588.6
Tawas City	486.6

APPENDIX C - Flight Path and Geologic Map

MANITOWOC



SCALE 1:500,000

MILES — KILOMETRES

FIDUCIAL NUMBER — 123400 — 053-0 — 133820 — LINE NUMBER

FLIGHT LINE SPACING .... 6.0 MILE(S)
FLIGHT ALTITUDE .... 400 FEET AMT
FLOWN AND COMPILED 1980–1981

SURVEY AND COMPILATION BY:

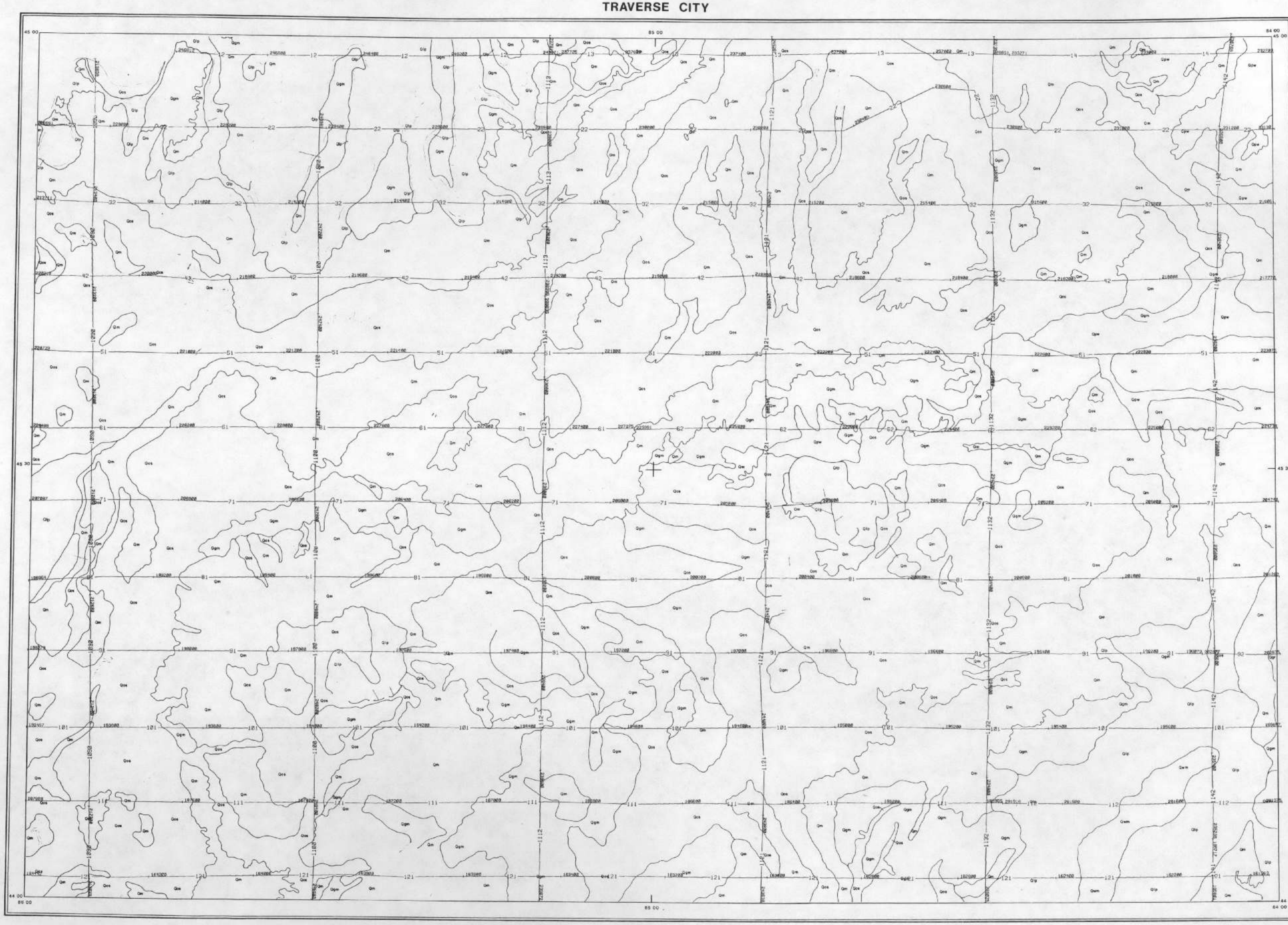
EG&G GEOMETRICS

FLIGHT PATH RECOVERY

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

TRAVERSE CITY



SCALE 1:500,000

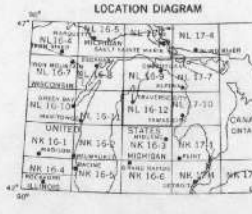
MILES 0 5 10 15 MILES

KILOMETRES 0 5 10 15 20 25 30 KILOMETRES

FIDUCIAL NUMBER — 122400 — 053-0 — 123600 — LINE NUMBER

FLIGHT LINE SPACING .... 6.0 MILE(S)
FLIGHT ALTITUDE .... 400 FEET AMT
FLOWN AND COMPILED 1980–1981

LOCATION DIAGRAM



FLIGHT PATH RECOVERY

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

MANITOWOC QUADRANGLE
GEOLOGIC MAP EXPLANATION
(Martel Laboratories, 1981)

Cenozoic — Quaternary — Pleistocene & Holocene

Qal	**Alluvium**
Qb	**Beach deposits** *Pleistocene & Recent beaches & dunes.*
Qma	**Marsh deposits** *Muck, peat, & silt.*
Qm	**Moraines** *Unconsolidated, unsorted deposits. Includes lateral & end moraines.*
Qgm	**Ground moraines** *Till plains.*
Ql	**Lake deposits** *Near-shore sand & off-shore clay deposits. Locally includes alluvium.*
Qo	**Outwash** *Meltwater deposits. Includes glacial channel deposits &, locally, alluvium.*
//	**Drumlins & eskers**

TRAVERSE CITY QUADRANGLE
GEOLOGIC MAP EXPLANATION
(Martel Laboratories, 1981)

CENOZOIC — QUATERNARY — PLEISTOCENE

Qm

Glacial Moraine

Glacial sediments and sediments related to glaciation, beds and lenses of till, gravel, sand, silt and clay with numerous boulders and cobbles.

Qgm

Glacial Ground Moraine

Smooth-surfaced glacial till forming relatively flat land, exept where it thinly caps broad, rolling hills near the glacial margin. Unsorted and unstratified mixture of clay, silt, sand, and coarser fragments laid down under an ice sheet during a stage of retreat.

Qwm

Glacial Water-Laid Moraine

Near shore deposits of moderately well to poorly sorted sand, gravel and coarse cobbles laid down along the margins of major glacial lakes.

Qpw

Glacial Ponded Water Deposits

Silt, sand, and clay, commonly laminated, deposited in isolated interglacial lakes

Qlp

Glacial Lake Plains

Lake bottom sediments of major glacial lakes, composed of silt and clay, commonly laminated, in places covered by marl and peat.

Qos

Glacial Outwash and Spillways

Chiefly sand and gravel laid down by water issuing from glacial moraines. Forms gently undulating to nearly flat surfaces.

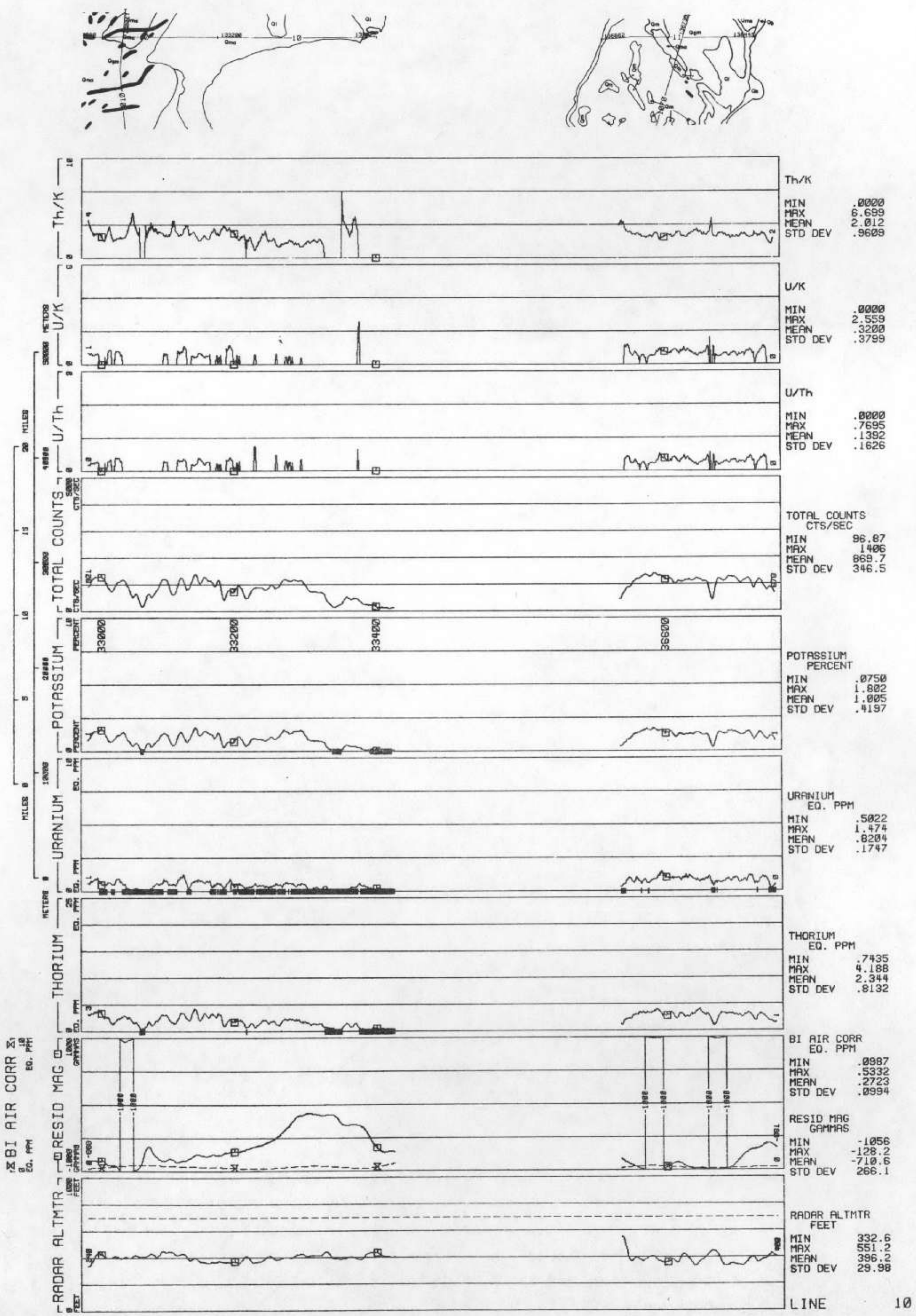
SYMBOLS

Formation Contact

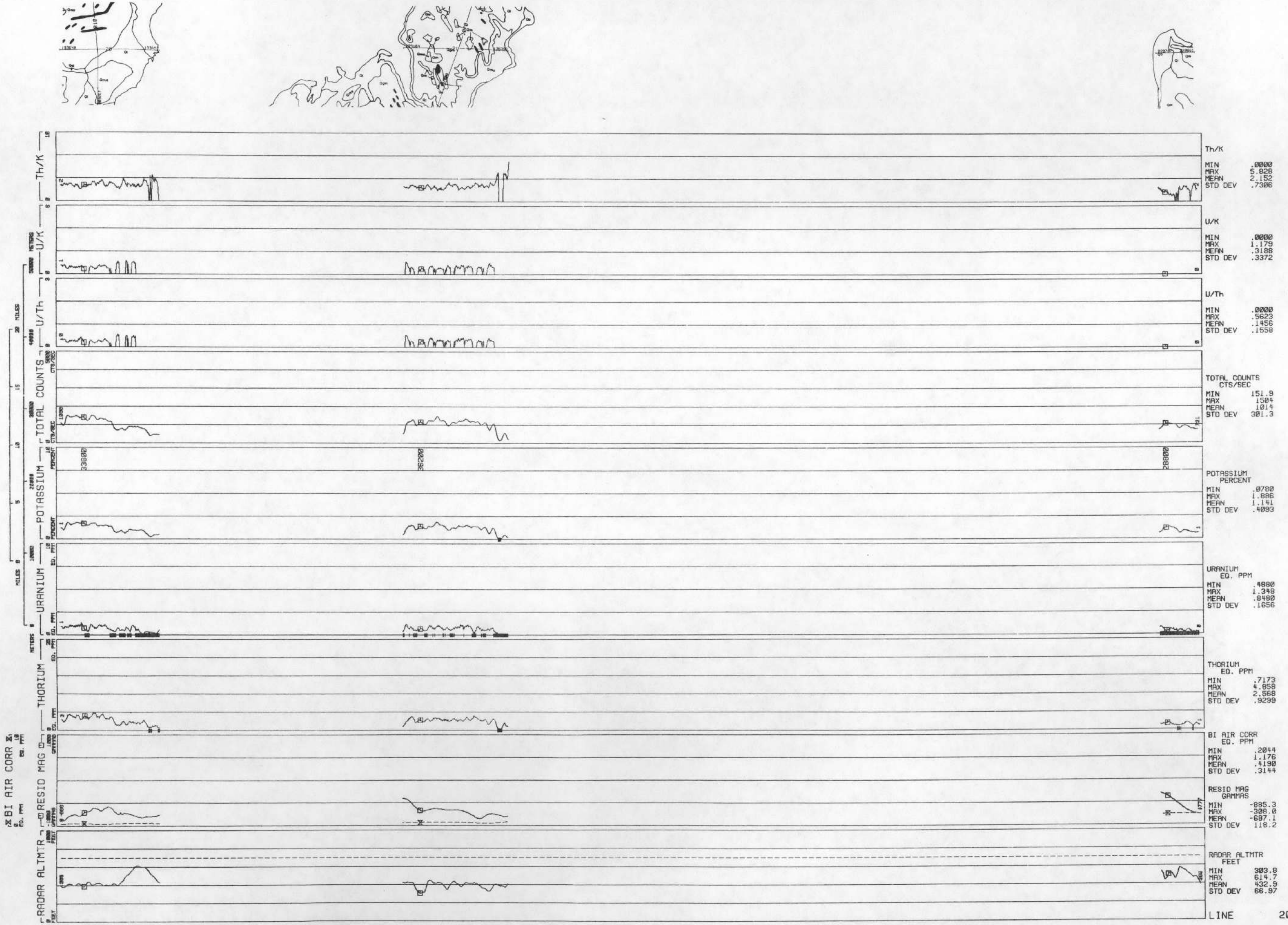
APPENDIX D - Profiles

D1 mt

LINE 10
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158

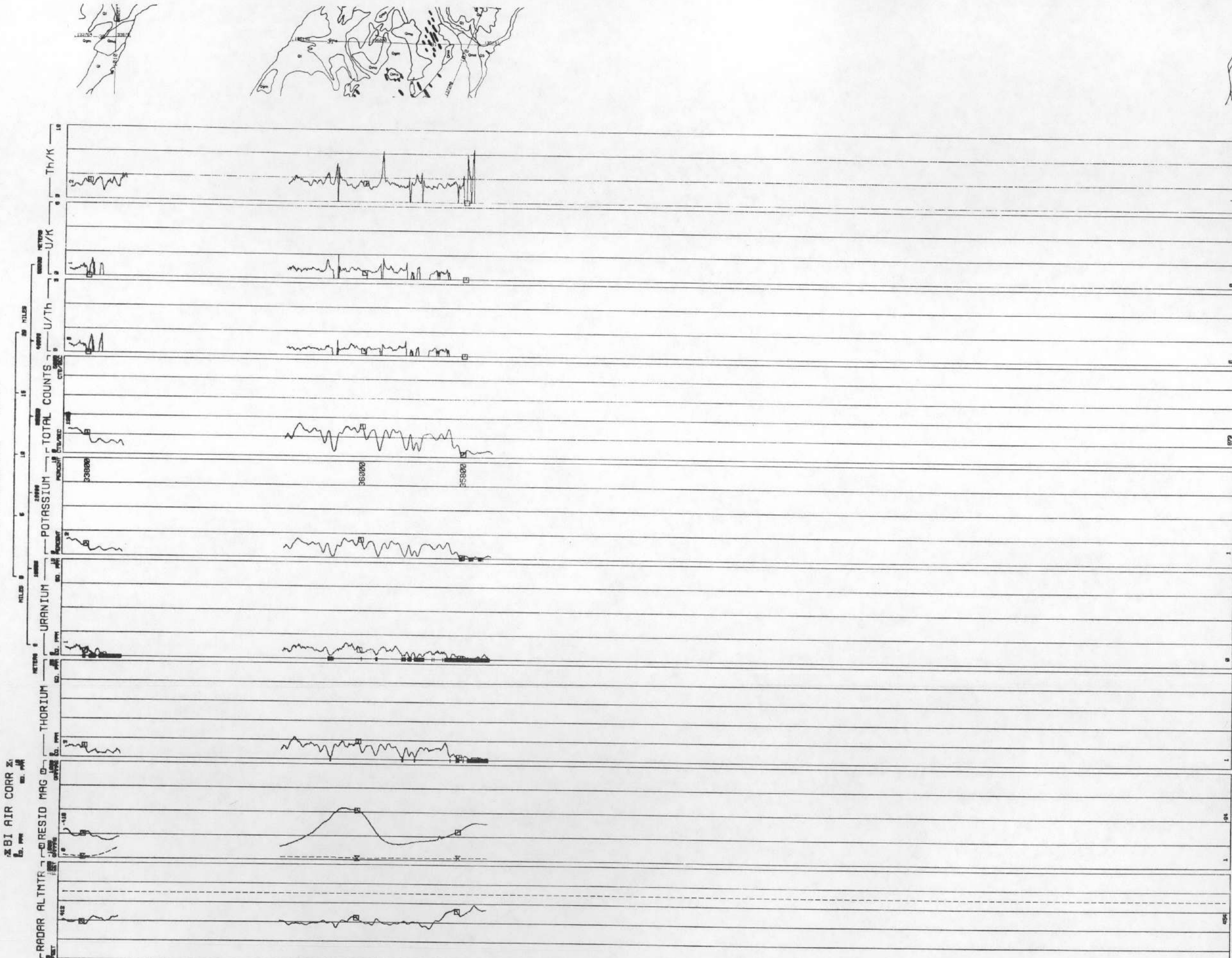


LINE 20
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158



D3 mt

LINE 30
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158

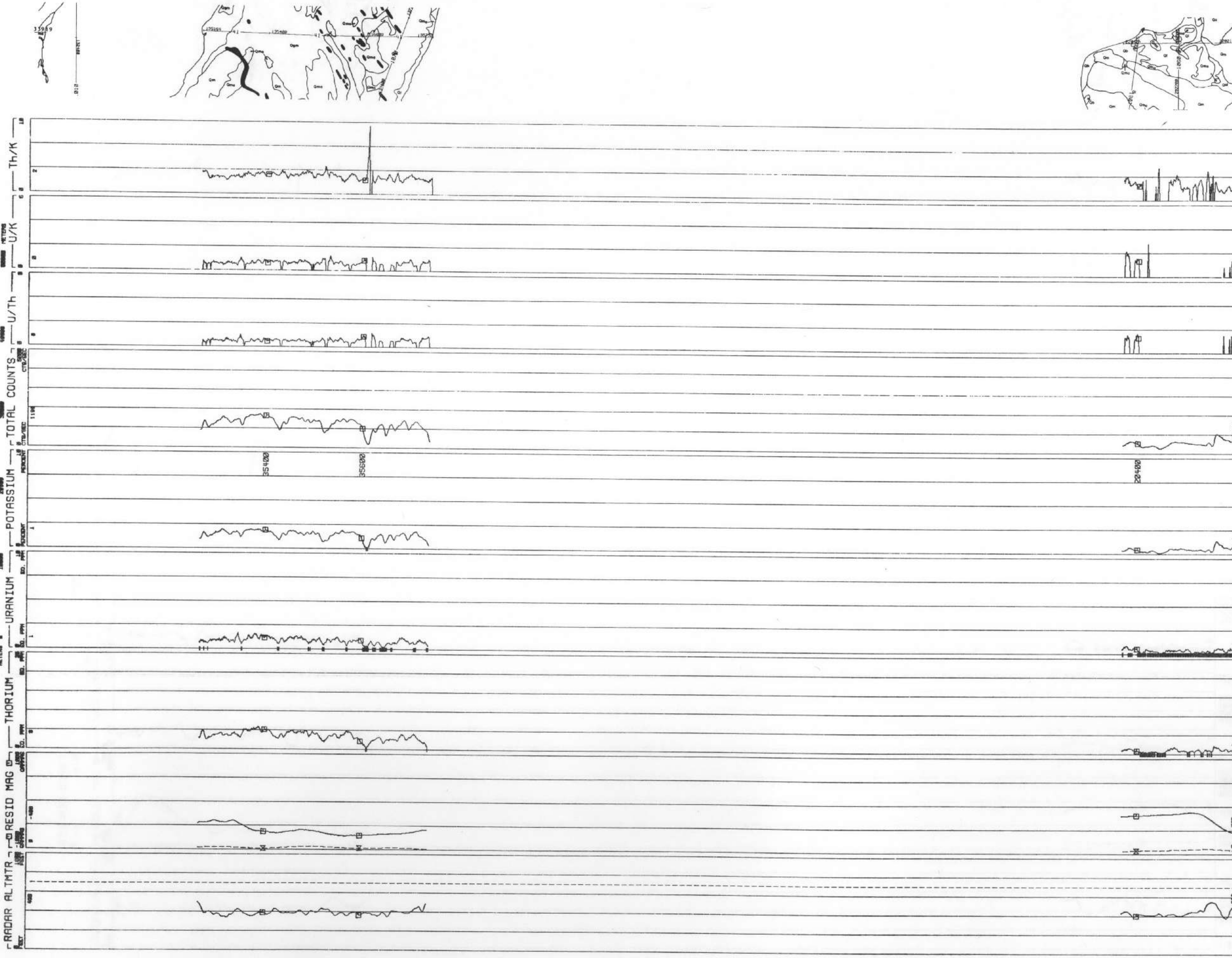


Th/K	
MIN	.0000
MAX	7.355
MEAN	2.299
STD DEV	1.096
U/K	
MIN	.0000
MAX	1.949
MEAN	.4358
STD DEV	.4006
U/Th	
MIN	.0000
MAX	.7730
MEAN	.1798
STD DEV	.1663
TOTAL COUNTS CTS/SEC	
MIN	114.0
MAX	1693
MEAN	915.3
STD DEV	409.0
POTASSIUM PERCENT	
MIN	.1136
MAX	1.968
MEAN	1.015
STD DEV	.5127
URANIUM EQ. PPM	
MIN	.4979
MAX	1.630
MEAN	.9219
STD DEV	.2343
THORIUM EQ. PPM	
MIN	.7198
MAX	5.794
MEAN	2.655
STD DEV	1.120
BI AIR CORR EQ. PPM	
MIN	.1600
MAX	1.115
MEAN	.2573
STD DEV	.1502
RESID MAG GAMMAS	
MIN	-730.7
MAX	84.93
MEAN	-427.7
STD DEV	224.9
RADAR ALTMTR FEET	
MIN	338.2
MAX	583.8
MEAN	420.5
STD DEV	52.48

LINE 30

D4 mt

LINE 40
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158



Th/K
MIN .0000
MAX 9.445
MEAN 2.196
STD DEV .9197

U/K
MIN .0000
MAX 2.746
MEAN .4263
STD DEV .3869

U/Th
MIN .0000
MAX .8193
MEAN .1778
STD DEV .1627

TOTAL COUNTS CTS/SEC
MIN 192.8
MAX 1719
MEAN 1047
STD DEV 414.2

POTASSIUM PERCENT
MIN .0843
MAX 1.958
MEAN 1.148
STD DEV .5459

URANIUM EQ. PPM
MIN .5466
MAX 1.641
MEAN .9317
STD DEV .2256

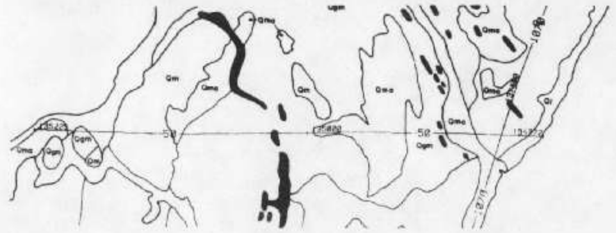
THORIUM EQ. PPM
MIN .6995
MAX 5.813
MEAN 2.956
STD DEV 1.361

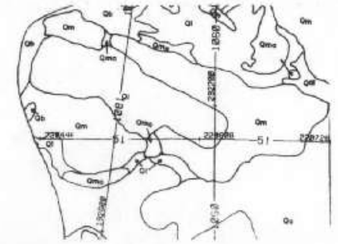
BI AIR CORR EQ. PPM
MIN .0533
MAX .5375
MEAN .2671
STD DEV .1304

RESID MAG GAMMAS
MIN -717.3
MAX -122.9
MEAN -489.3
STD DEV 201.6

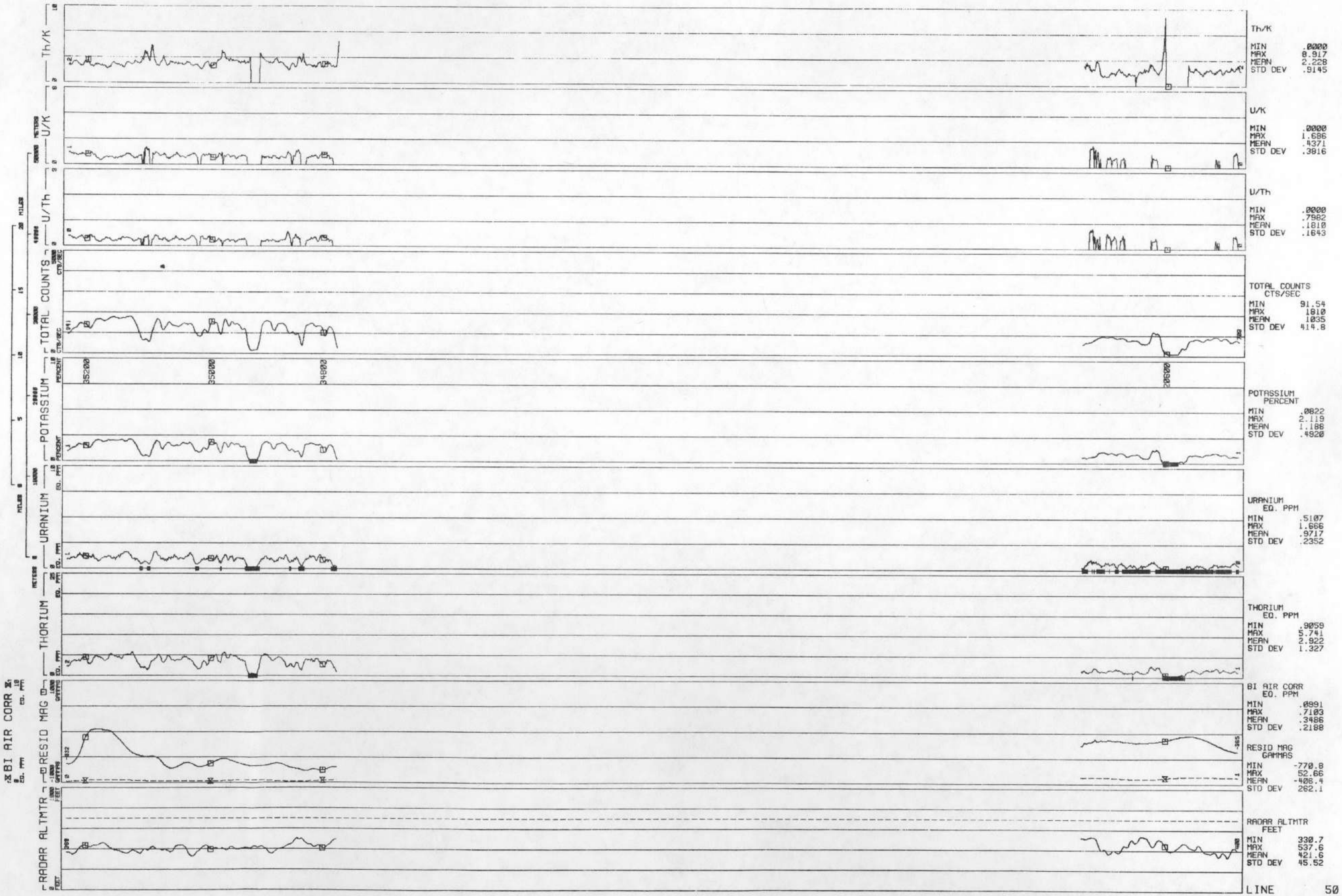
RADAR ALTMTR FEET
MIN 340.1
MAX 552.5
MEAN 407.3
STD DEV 39.63

LINE 40

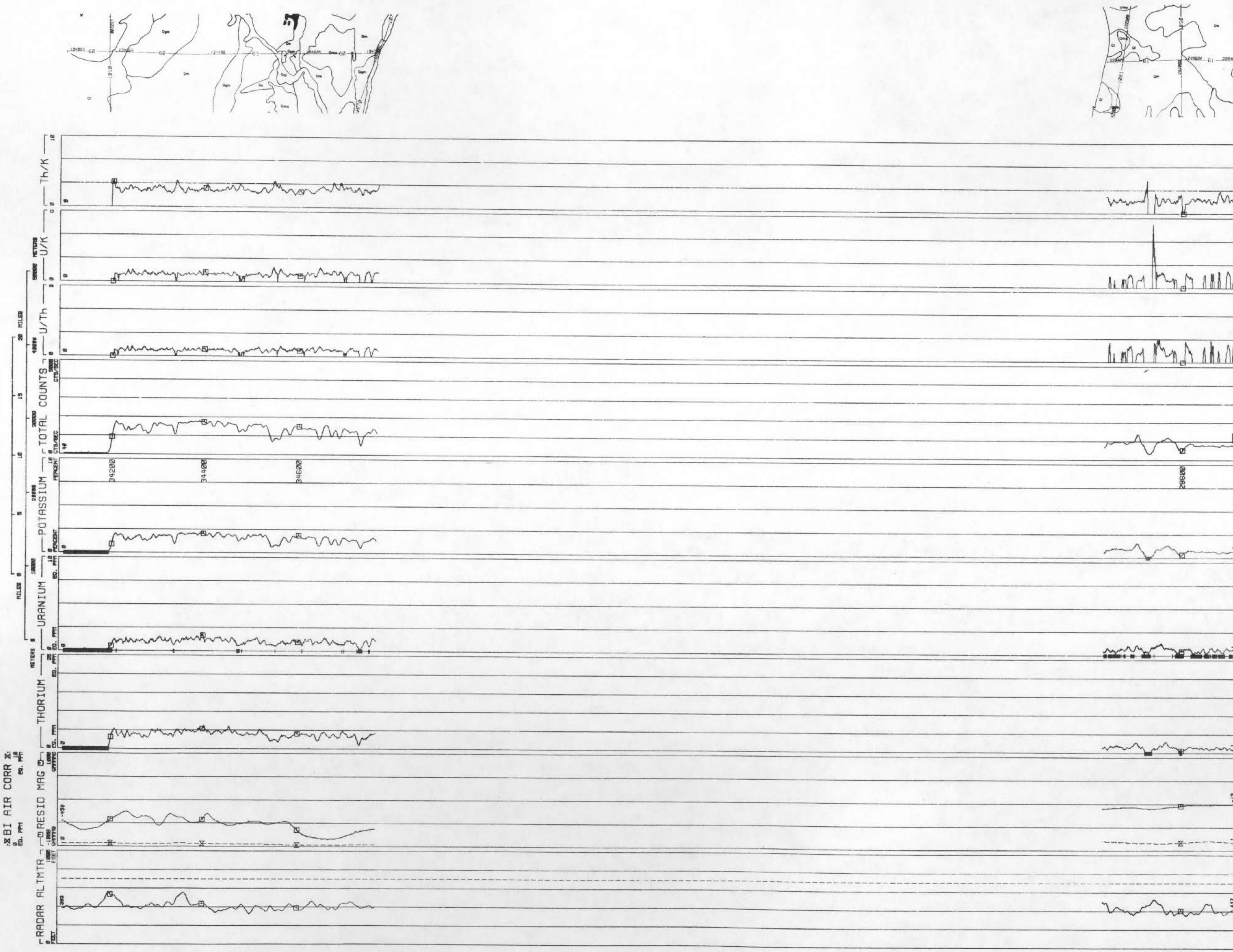




LINE 50
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158

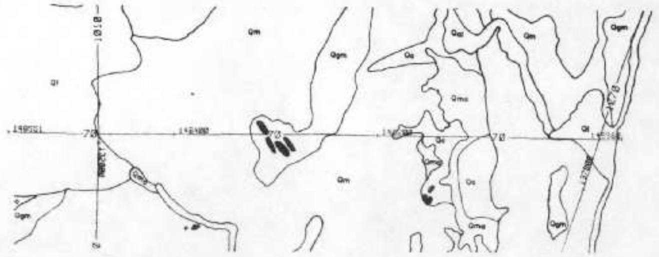


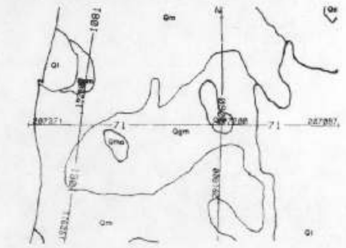
LINE 60
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158



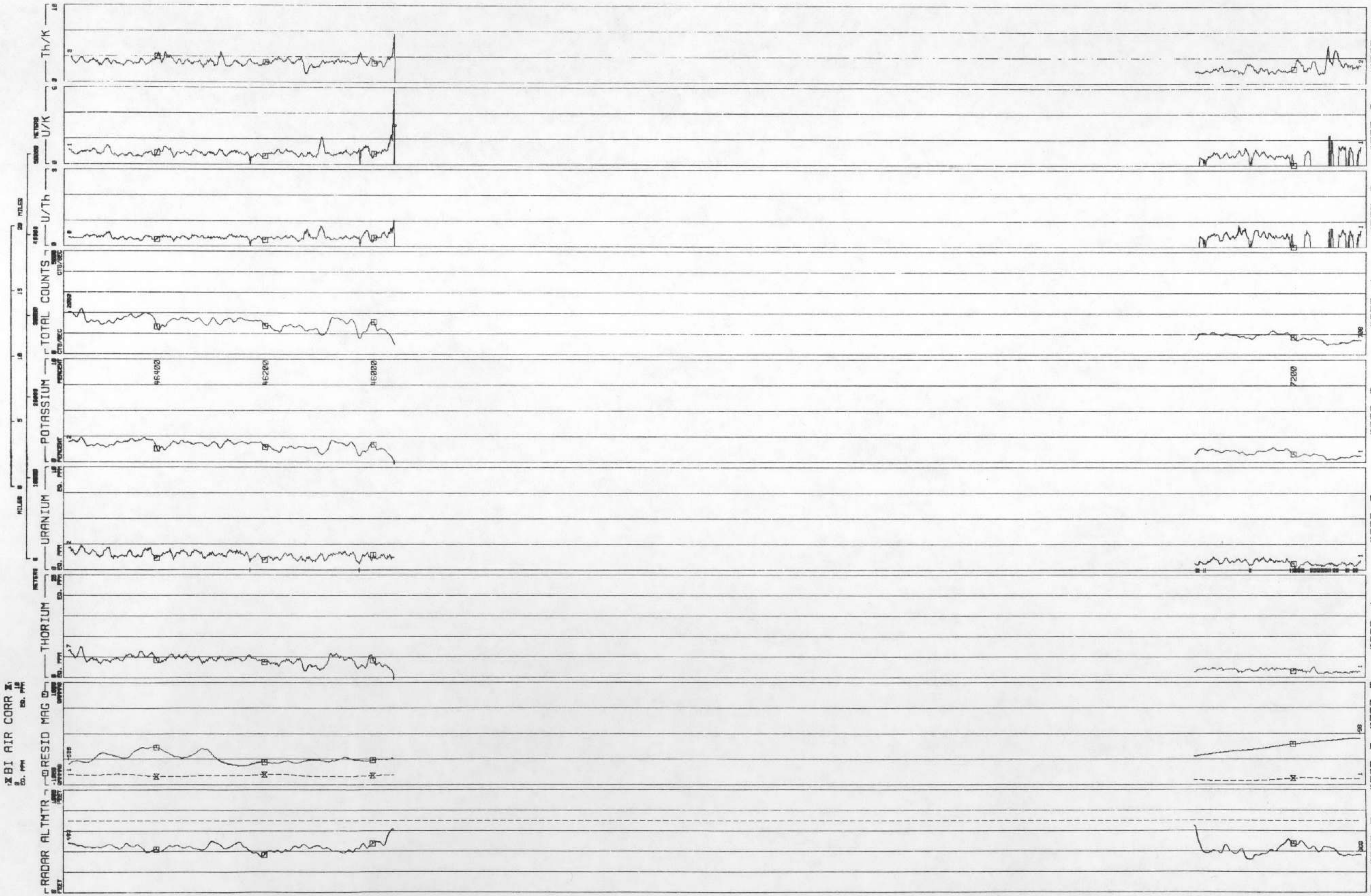
Th/K	MIN	.0000
	MAX	4.637
	MEAN	2.027
	STD DEV	.8954
U/K	MIN	.0000
	MAX	5.443
	MEAN	.5145
	STD DEV	.4462
U/Th	MIN	.0000
	MAX	.9818
	MEAN	.2212
	STD DEV	.1893
TOTAL COUNTS CTS/SEC	MIN	36.52
	MAX	1769
	MEAN	1088
	STD DEV	488.1
POTASSIUM PERCENT	MIN	.1111
	MAX	2.146
	MEAN	1.315
	STD DEV	.5062
URANIUM EQ. PPM	MIN	.5377
	MAX	1.738
	MEAN	.9996
	STD DEV	.2329
THORIUM EQ. PPM	MIN	.7355
	MAX	6.285
	MEAN	3.154
	STD DEV	1.343
BI AIR CORR EQ. PPM	MIN	.1292
	MAX	.9881
	MEAN	.4352
	STD DEV	.2941
RESID MAG GAMMAS	MIN	-846.3
	MAX	-10.98
	MEAN	-391.2
	STD DEV	256.5
RADAR ALTMTR FEET	MIN	327.3
	MAX	555.1
	MEAN	413.8
	STD DEV	43.11

LINE 60





LINE 70
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160



LINE 70

D8 mt


LINE 80
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160
Th/K
MIN .0000
MAX 4.705
MEAN 2.546
STD DEV .5867
U/K
MIN .0000
MAX 2.402
MEAN .8356
STD DEV .3717
U/Th
MIN .0000
MAX 1.213
MEAN .3383
STD DEV .1770
TOTAL COUNTS CTS/SEC
MIN 526.3
MAX 1928
MEAN 1343
STD DEV 374.0
45400
45600
45800
88800
POTASSIUM PERCENT
MIN .3198
MAX 2.120
MEAN 1.410
STD DEV .4513
URANIUM EQ. PPM
MIN .5463
MAX 2.409
MEAN 1.310
STD DEV .4218
THORIUM EQ. PPM
MIN .6978
MAX 6.723
MEAN 3.683
STD DEV 1.540
BI AIR CORR EQ. PPM
MIN .4757
MAX 1.181
MEAN .8344
STD DEV .1520
RESID MAG GAMMAS
MIN -644.4
MAX -230.5
MEAN -515.7
STD DEV 86.57
RADAR ALTMTR FEET
MIN 327.8
MAX 529.0
MEAN 411.5
STD DEV 39.94
LINE 80

D9 mt


LINE 90
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81180
Th/K
MIN .0000
MAX 7.487
MEAN 2.563
STD DEV .7580
U/K
MIN .0000
MAX 7.830
MEAN 1.049
STD DEV .6847
U/Th
MIN .0000
MAX 1.280
MEAN .3899
STD DEV .2127
TOTAL COUNTS CTS/SEC
MIN 334.0
MAX 2045
MEAN 1148
STD DEV 387.3
45200
45000
44800
38800
38400
POTASSIUM PERCENT
MIN .1047
MAX 2.237
MEAN 1.151
STD DEV .4940
URANIUM EQ. PPM
MIN .5701
MAX 2.367
MEAN 1.230
STD DEV .3897
THORIUM EQ. PPM
MIN .7210
MAX 6.884
MEAN 3.016
STD DEV 1.490
BI AIR CORR EQ. PPM
MIN .5035
MAX 1.494
MEAN .8367
STD DEV .1761
RESID MAG GAMMAS
MIN -751.5
MAX -64.09
MEAN -398.3
STD DEV 186.8
RADAR ALTMTR FEET
MIN 338.9
MAX 474.7
MEAN 404.8
STD DEV 25.09
LINE 90

LINE 100
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160

Th/K
MIN .0000
MAX 8.635
MEAN 2.517
STD DEV .7732

U/K
MIN .0000
MAX 2.395
MEAN .7257
STD DEV .5360

U/Th
MIN .0000
MAX 1.086
MEAN .2892
STD DEV .2360

TOTAL COUNTS CTS/SEC
MIN 246.8
MAX 1945
MEAN 1106
STD DEV 394.3

POTASSIUM PERCENT
MIN .0928
MAX 2.192
MEAN 1.064
STD DEV .5092

URANIUM EQ. PPM
MIN .5899
MAX 2.128
MEAN 1.160
STD DEV .3430

THORIUM EQ. PPM
MIN .7083
MAX 6.968
MEAN 2.816
STD DEV 1.619

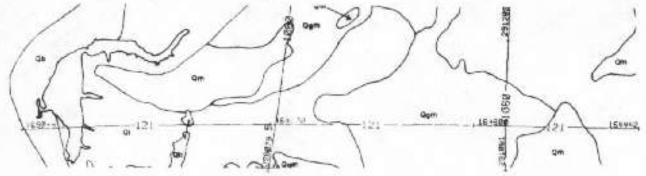
BI AIR CORR EQ. PPM
MIN .7994
MAX 1.260
MEAN .9936
STD DEV .1085

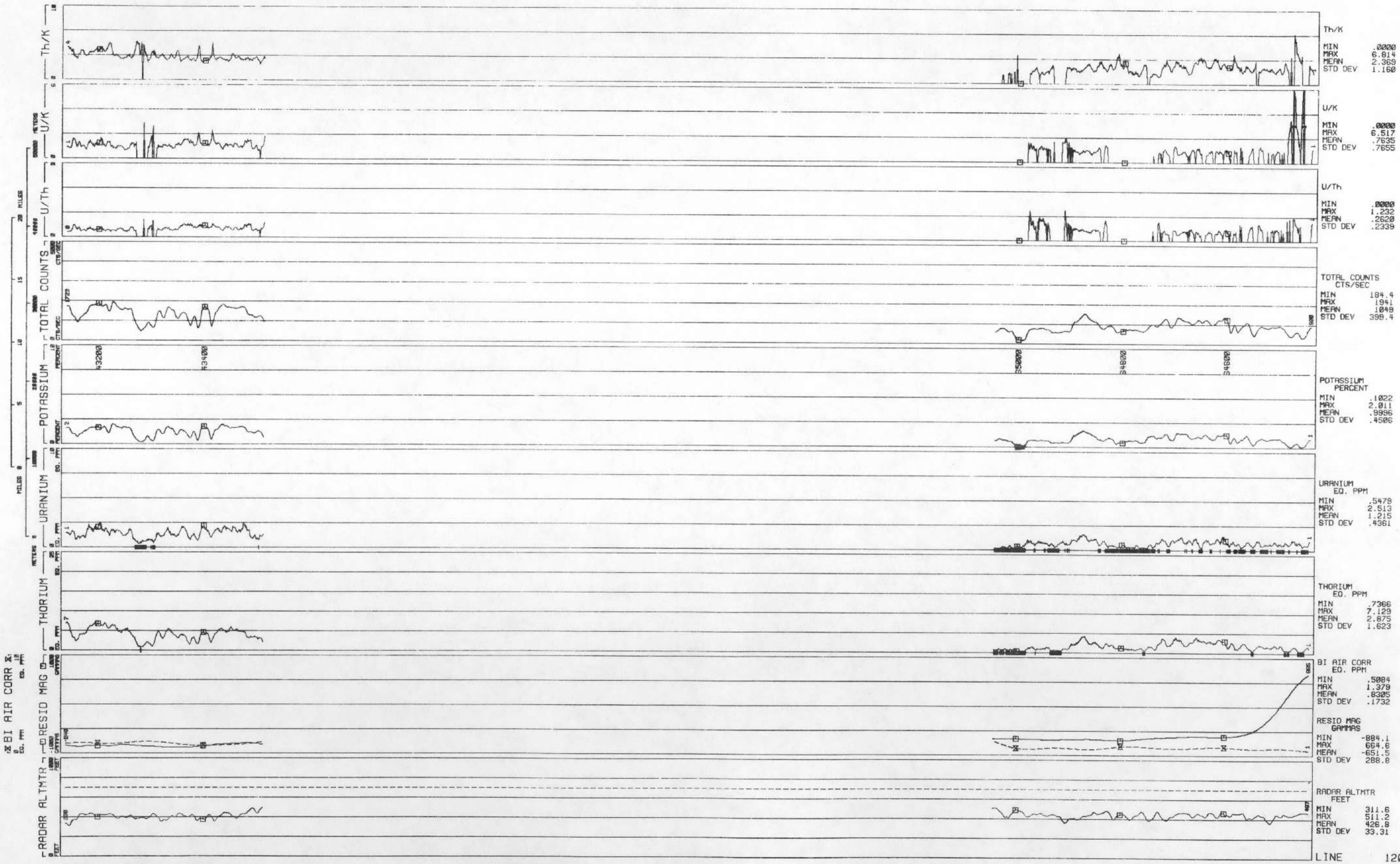
RESID MAG GAMMAS
MIN -899.0
MAX 165.9
MEAN -437.8
STD DEV 305.2

RADAR ALTMTR FEET
MIN 342.1
MAX 515.5
MEAN 408.3
STD DEV 32.12

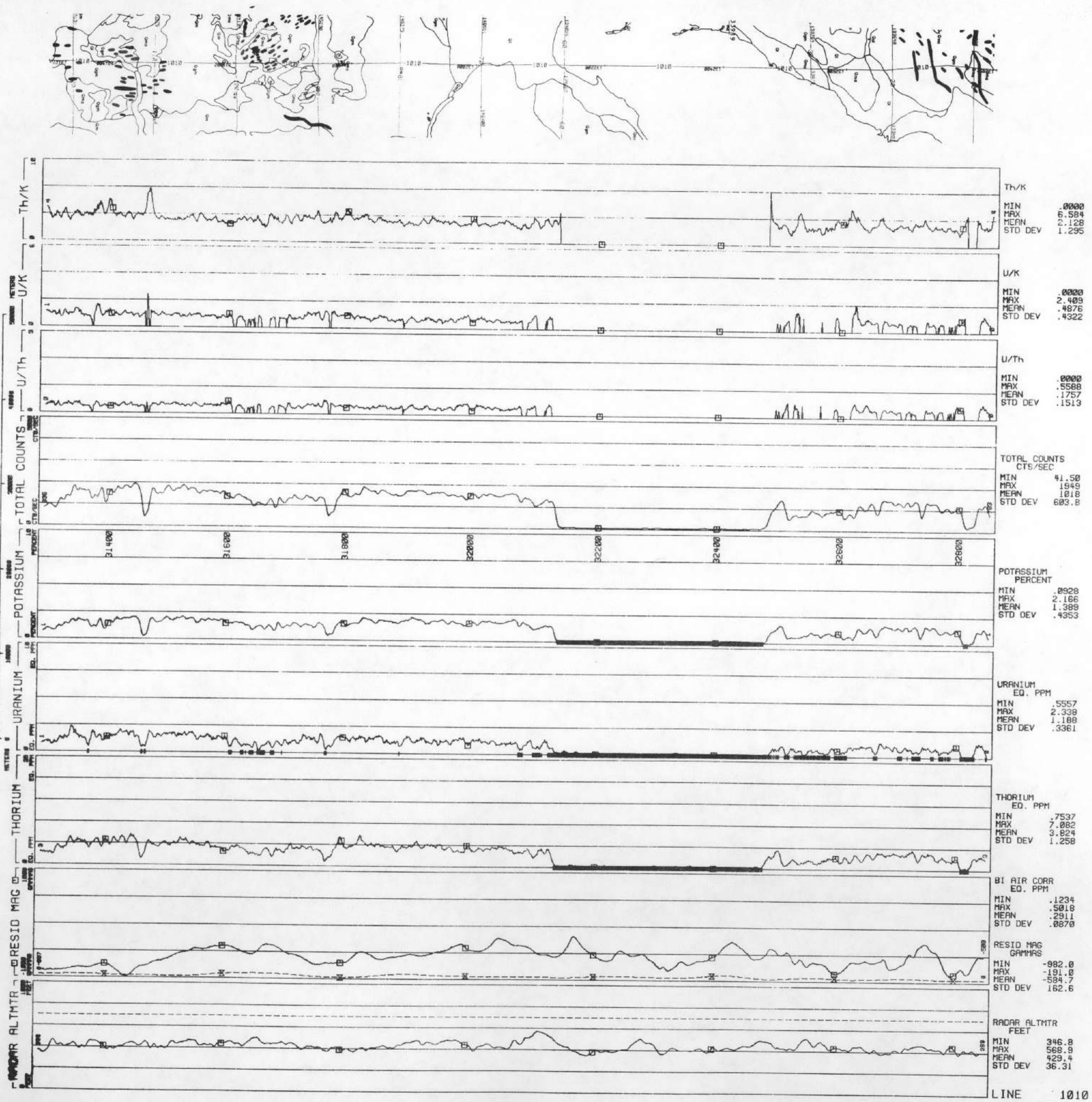
LINE 100


LINE 110
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160
Th/K
MIN .0000
MAX 12.01
MEAN 2.475
STD DEV 1.497
U/K
MIN .0000
MAX 8.745
MEAN .6305
STD DEV .9007
U/Th
MIN .0000
MAX 1.294
MEAN .2109
STD DEV .2359
TOTAL COUNTS CTS/SEC
MIN 403.5
MAX 2001
MEAN 1046
STD DEV 399.1
POTASSIUM PERCENT
MIN .1035
MAX 2.127
MEAN 1.009
STD DEV .4793
URANIUM EQ. PPM
MIN .5602
MAX 2.728
MEAN 1.292
STD DEV .4588
THORIUM EQ. PPM
MIN .6904
MAX 7.184
MEAN 2.627
STD DEV 1.668
BI AIR CORR EQ. PPM
MIN .5754
MAX 1.253
MEAN .9037
STD DEV .1805
RESID MAG GAMMAS
MIN -977.6
MAX -224.6
MEAN -618.9
STD DEV 254.8
RADAR ALTMTR FEET
MIN 304.3
MAX 828.0
MEAN 437.7
STD DEV 82.68
43800
43600
38400
38200
38000
LINE 110

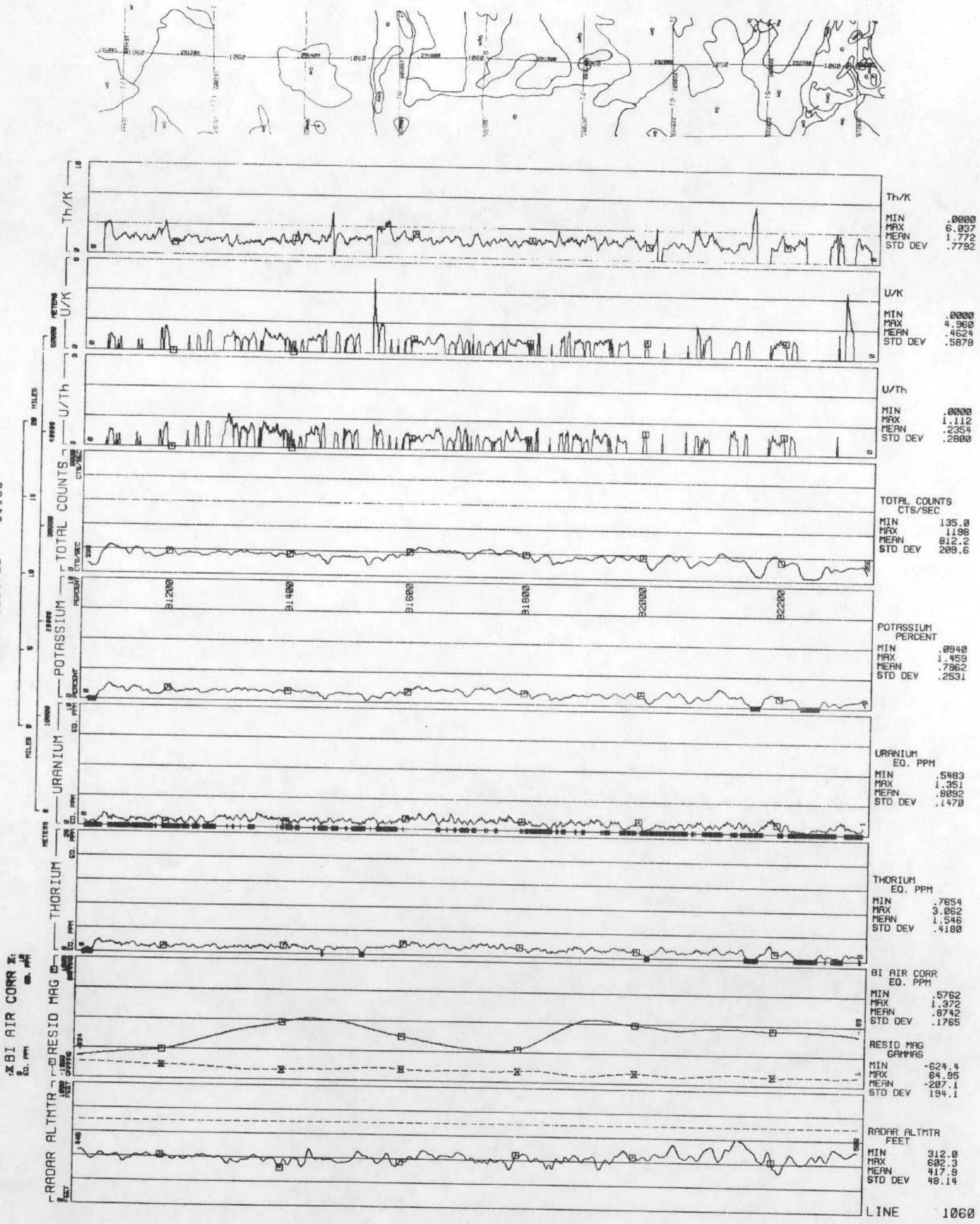



LINE 120
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160
Th/K
MIN .0000
MAX 6.814
MEAN 2.369
STD DEV 1.160
U/K
MIN .0000
MAX 6.517
MEAN .7635
STD DEV .7655
U/Th
MIN .0000
MAX 1.232
MEAN .2620
STD DEV .2339
TOTAL COUNTS CTS/SEC
MIN 184.4
MAX 1941
MEAN 1049
STD DEV 398.4
POTASSIUM PERCENT
MIN .1022
MAX 2.011
MEAN .9996
STD DEV .4506
URANIUM EQ. PPM
MIN .5479
MAX 2.513
MEAN 1.215
STD DEV .4361
THORIUM EQ. PPM
MIN .7366
MAX 7.129
MEAN 2.875
STD DEV 1.623
BI AIR CORR EQ. PPM
MIN .5084
MAX 1.379
MEAN .8305
STD DEV .1732
RESID MAG GAMMAS
MIN -884.1
MAX 664.6
MEAN -651.5
STD DEV 288.8
RADAR ALTMTR FEET
MIN 311.6
MAX 511.2
MEAN 426.8
STD DEV 33.31
LINE 120

LINE 1010
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158

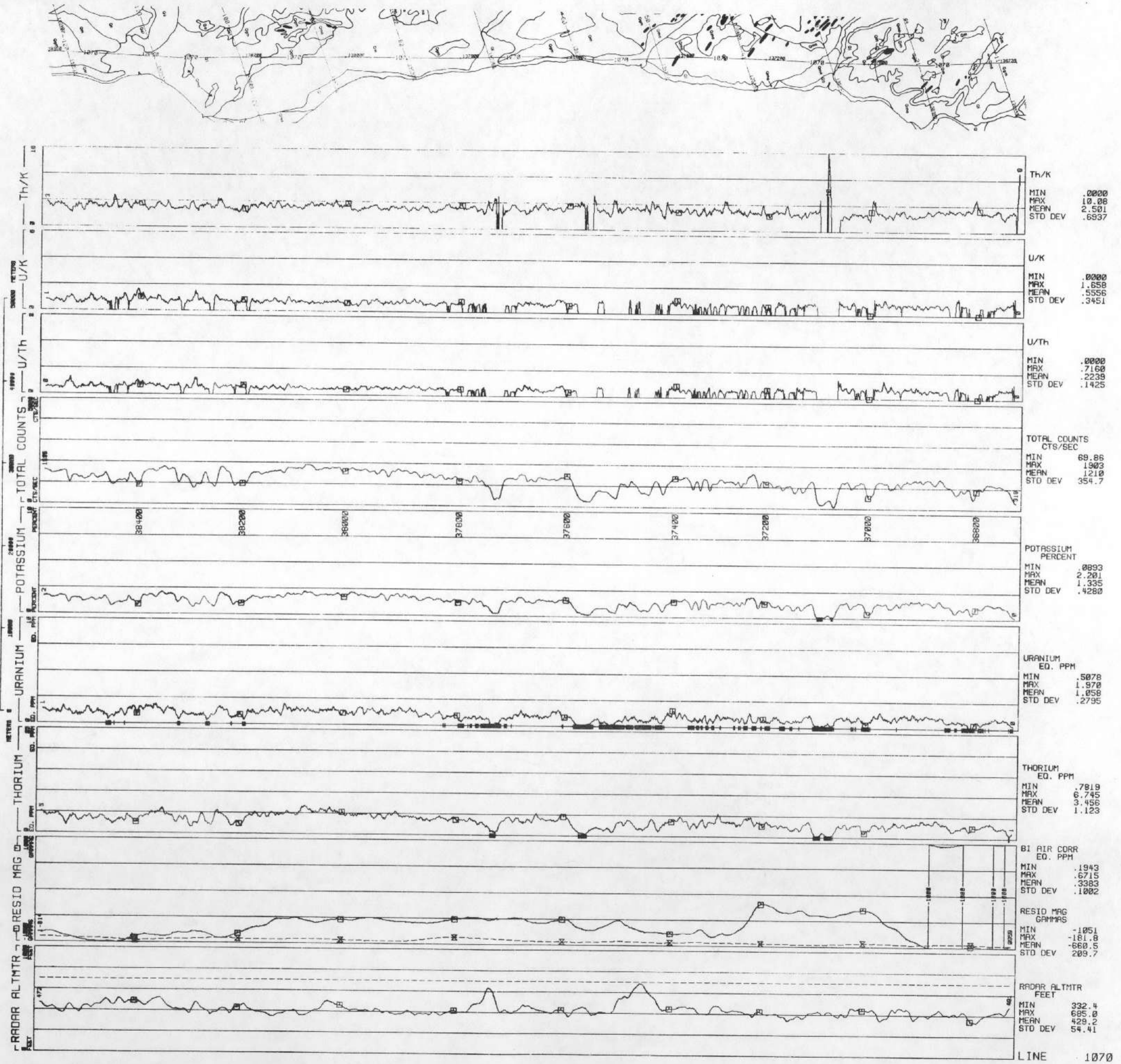


LINE 1060
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81163

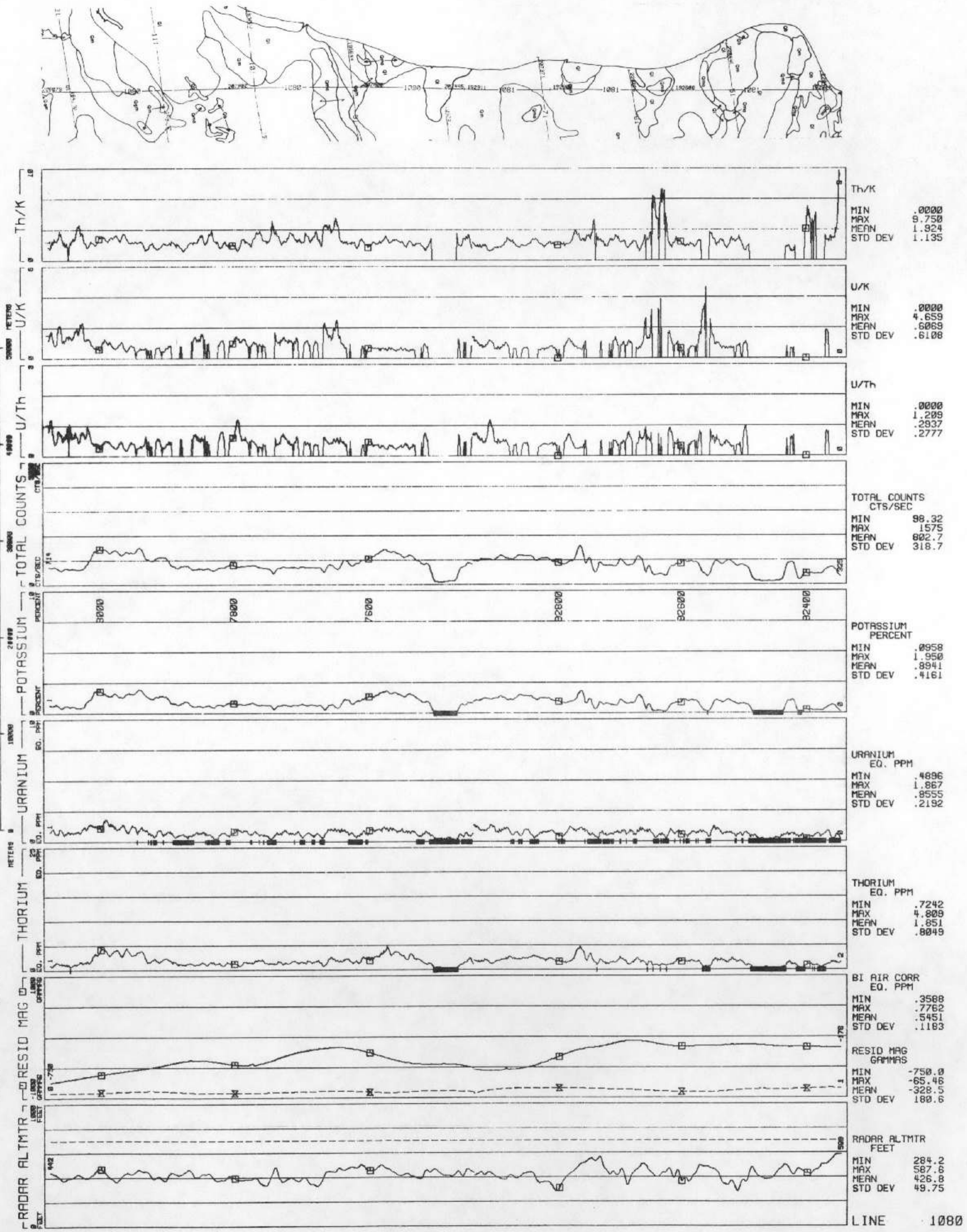


D15 mt

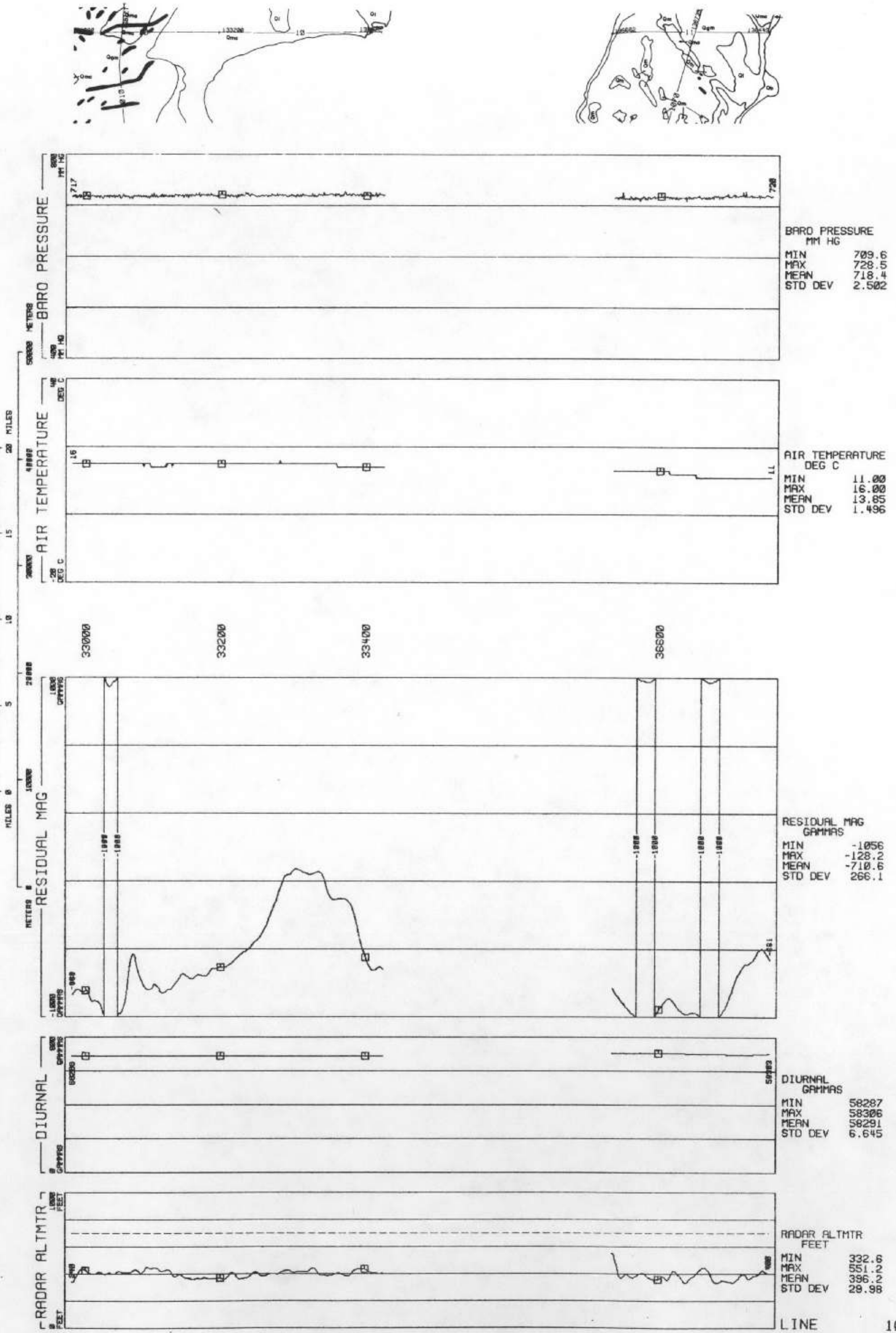
LINE 1070
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158



LINE 1080
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81163



LINE 10
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158



LINE 20
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158

BARO PRESSURE MM HG
MIN 706.4
MAX 725.8
MEAN 717.0
STD DEV 3.108

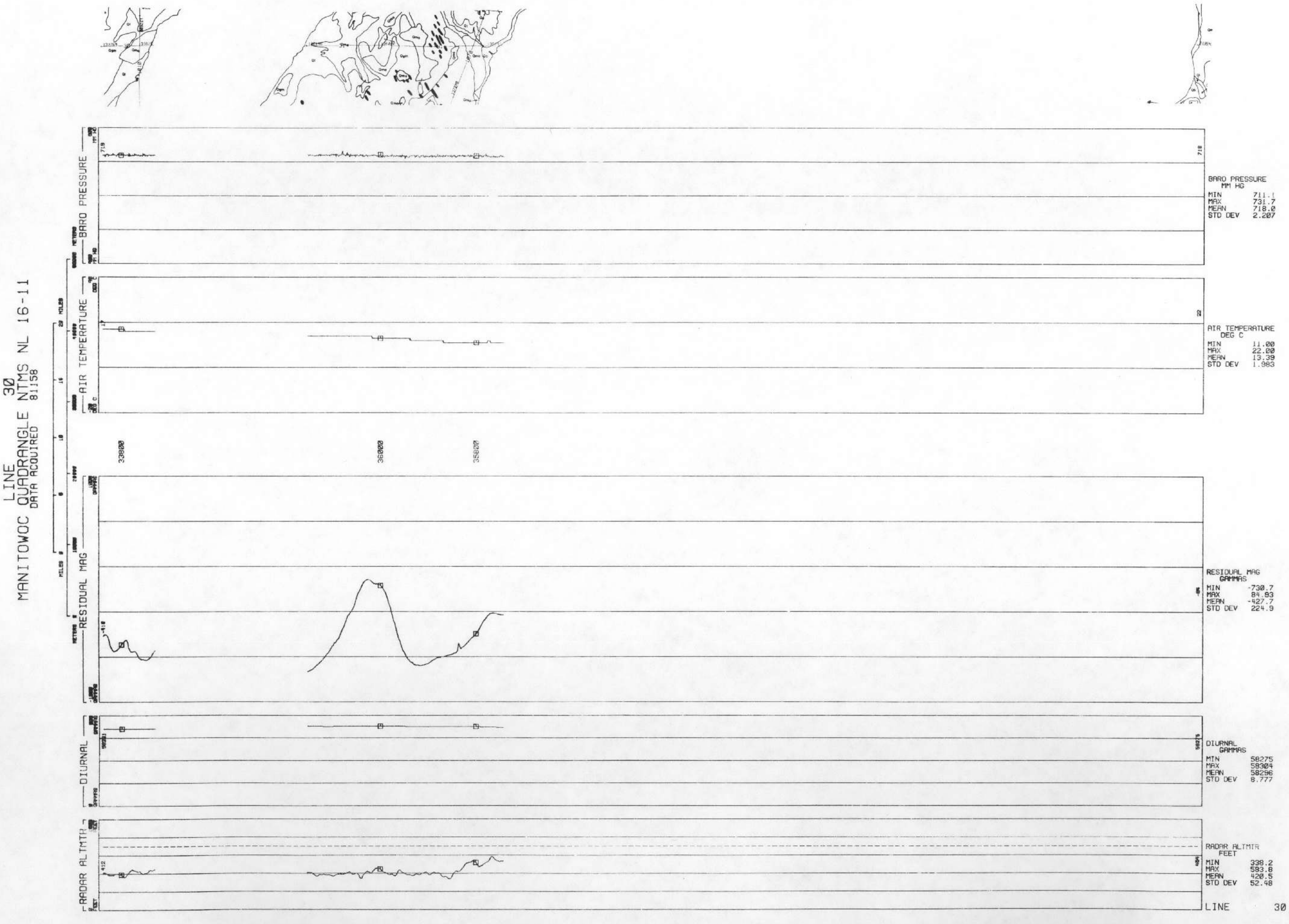
AIR TEMPERATURE DEG C
MIN 11.00
MAX 19.00
MEAN 14.22
STD DEV 2.398

RESIDUAL MAG GAMMAS
MIN -885.3
MAX -308.0
MEAN -687.1
STD DEV 118.2

DIURNAL GAMMAS
MIN 58283
MAX 58318
MEAN 58297
STD DEV 13.64

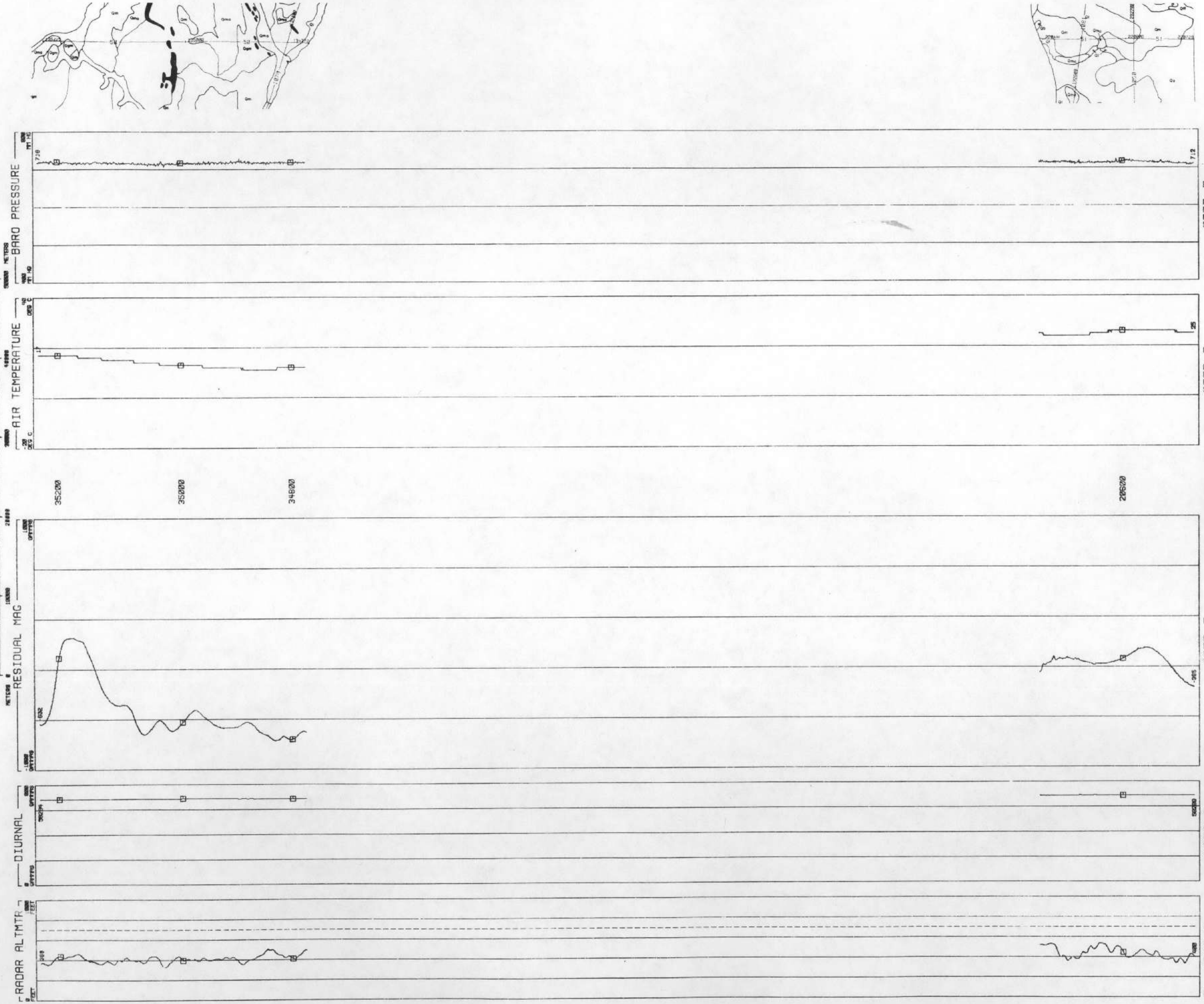
RADAR ALTMTR FEET
MIN 303.8
MAX 614.7
MEAN 432.9
STD DEV 66.97

LINE 20


LINE 30
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
33800
36000
35800
BARO PRESSURE MM HG
MIN 711.1
MAX 731.7
MEAN 718.0
STD DEV 2.207
AIR TEMPERATURE DEG C
MIN 11.00
MAX 22.00
MEAN 13.39
STD DEV 1.983
RESIDUAL MAG GAMMAS
MIN -730.7
MAX 84.83
MEAN -427.7
STD DEV 224.9
DIURNAL GAMMAS
MIN 58275
MAX 58304
MEAN 58296
STD DEV 8.777
RADAR ALTMTR FEET
MIN 338.2
MAX 583.8
MEAN 420.5
STD DEV 52.48
LINE 30


LINE 40
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
35400
35600
28400
BARO PRESSURE MM HG
MIN 709.3
MAX 728.0
MEAN 716.9
STD DEV 2.378
AIR TEMPERATURE DEG C
MIN 11.00
MAX 26.00
MEAN 17.14
STD DEV 5.992
RESIDUAL MAG GAMMAS
MIN -717.3
MAX -122.8
MEAN -489.3
STD DEV 201.6
DIURNAL GAMMAS
MIN 58281
MAX 58313
MEAN 58297
STD DEV 9.571
RADAR ALTMTR FEET
MIN 340.1
MAX 552.5
MEAN 407.3
STD DEV 39.63
LINE 40

LINE 50
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158



BARO PRESSURE
MM HG
MIN 706.6
MAX 728.5
MEAN 715.6
STD DEV 2.747

AIR TEMPERATURE
DEG C
MIN 11.00
MAX 26.00
MEAN 17.93
STD DEV 5.880

RESIDUAL MAG
GAMMAS
MIN -770.8
MAX 52.66
MEAN -406.4
STD DEV 262.1

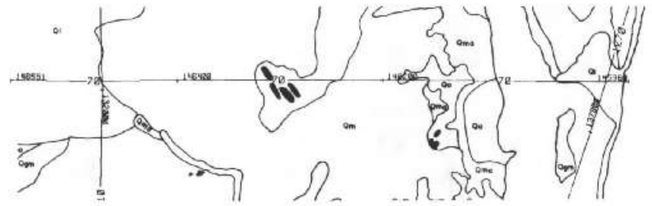
DIURNAL
GAMMAS
MIN 58283
MAX 58290
MEAN 58285
STD DEV 2.864

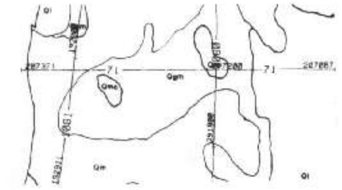
RADAR ALTMTR
FEET
MIN 330.7
MAX 537.6
MEAN 421.6
STD DEV 45.52

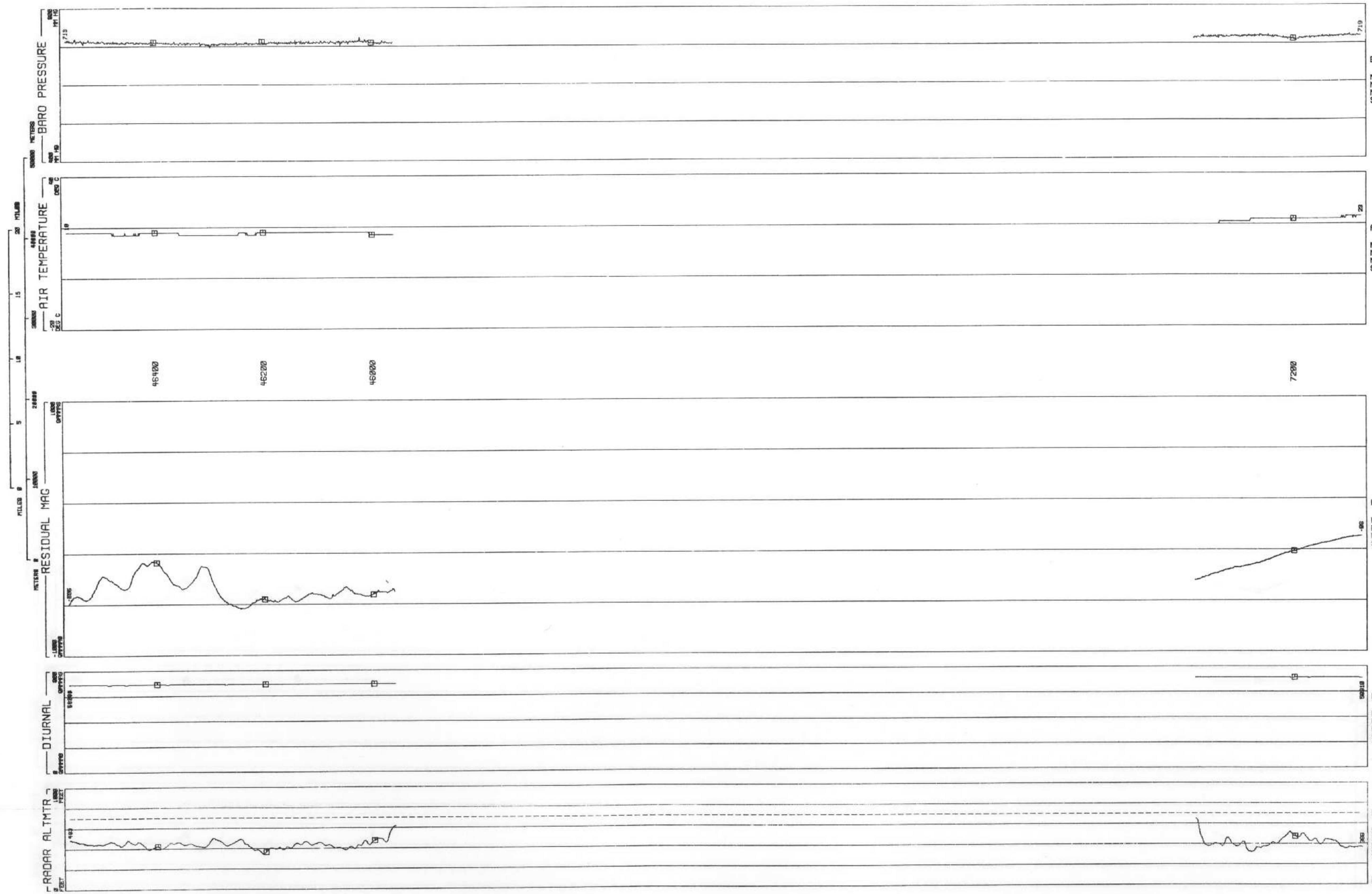
LINE 50


LINE 60
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
34200
34400
34600
28600
BARO PRESSURE MM HG
MIN 705.3
MAX 727.2
MEAN 715.4
STD DEV 2.884
AIR TEMPERATURE DEG C
MIN 12.00
MAX 18.00
MEAN 16.70
STD DEV 1.964
RESIDUAL MAG GAMMAS
MIN -846.3
MAX -10.98
MEAN -391.2
STD DEV 256.5
DIURNAL GAMMAS
MIN 58282
MAX 58293
MEAN 58284
STD DEV 4.357
RADAR ALTMTR FEET
MIN 327.3
MAX 555.1
MEAN 413.8
STD DEV 43.11
LINE 60

LINE 70
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160







BARO PRESSURE
MM HG
MIN 698.0
MAX 723.1
MEAN 711.5
STD DEV 4.491

AIR TEMPERATURE
DEG C
MIN 17.00
MAX 23.00
MEAN 18.92
STD DEV 1.960

RESIDUAL MAG
GAMMAS
MIN -631.4
MAX -96.07
MEAN -410.2
STD DEV 145.3

DIURNAL
GAMMAS
MIN 58289
MAX 58313
MEAN 58294
STD DEV 9.929

RADAR ALTMTR
FEET
MIN 320.9
MAX 651.1
MEAN 431.5
STD DEV 45.57

LINE 70

LINE 80
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160

LINE 90
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160

BARO PRESSURE
MM HG
MIN 698.8
MAX 731.5
MEAN 713.8
STD DEV 5.866

AIR TEMPERATURE
DEG C
MIN 17.00
MAX 22.00
MEAN 18.78
STD DEV 2.134

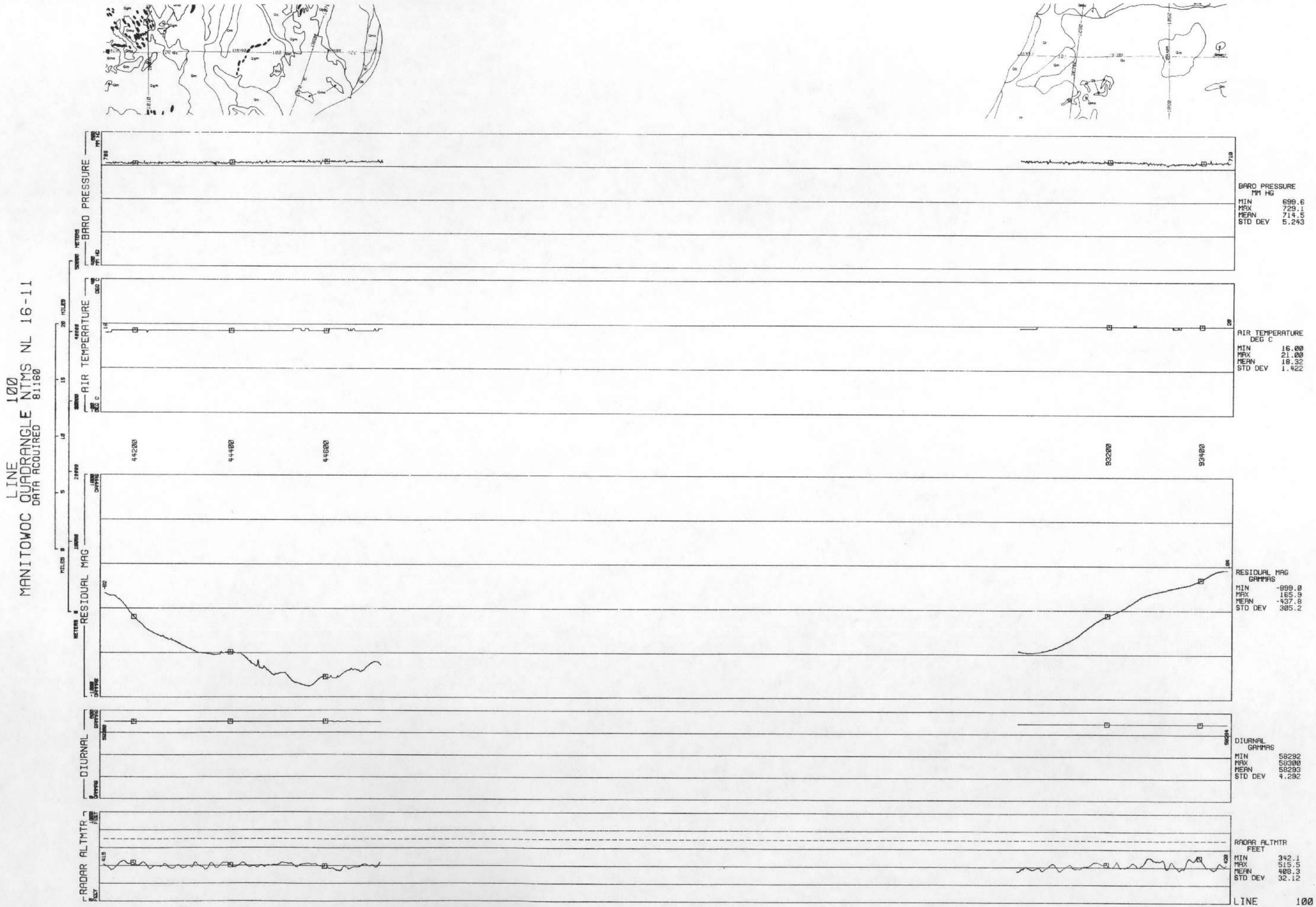
RESIDUAL MAG
GAMMAS
MIN -751.5
MAX -64.09
MEAN -398.3
STD DEV 186.8

DIURNAL
GAMMAS
MIN 58293
MAX 58298
MEAN 58292
STD DEV 3.360

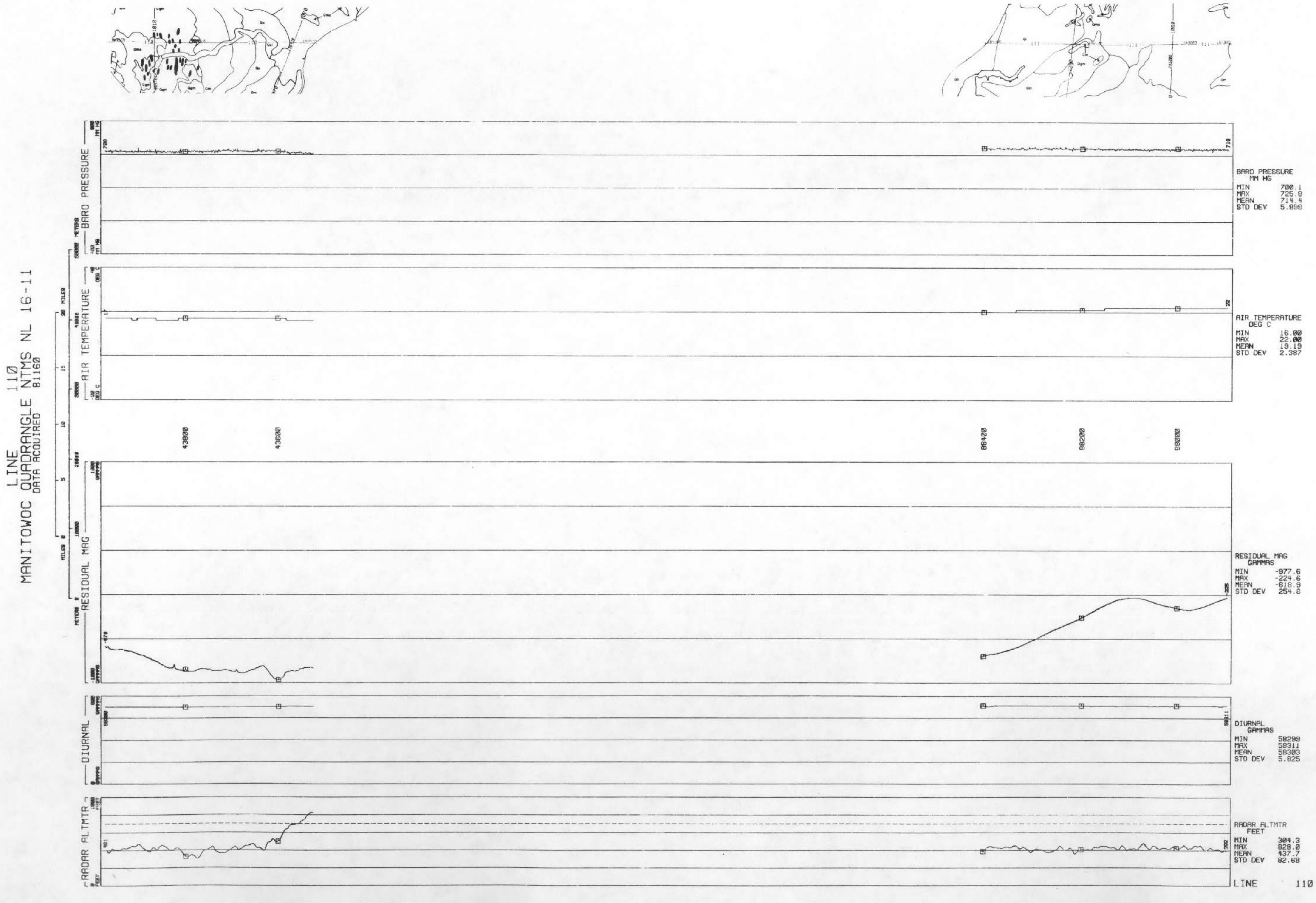
RADAR ALTMTR
FEET
MIN 338.9
MAX 474.7
MEAN 404.8
STD DEV 25.09

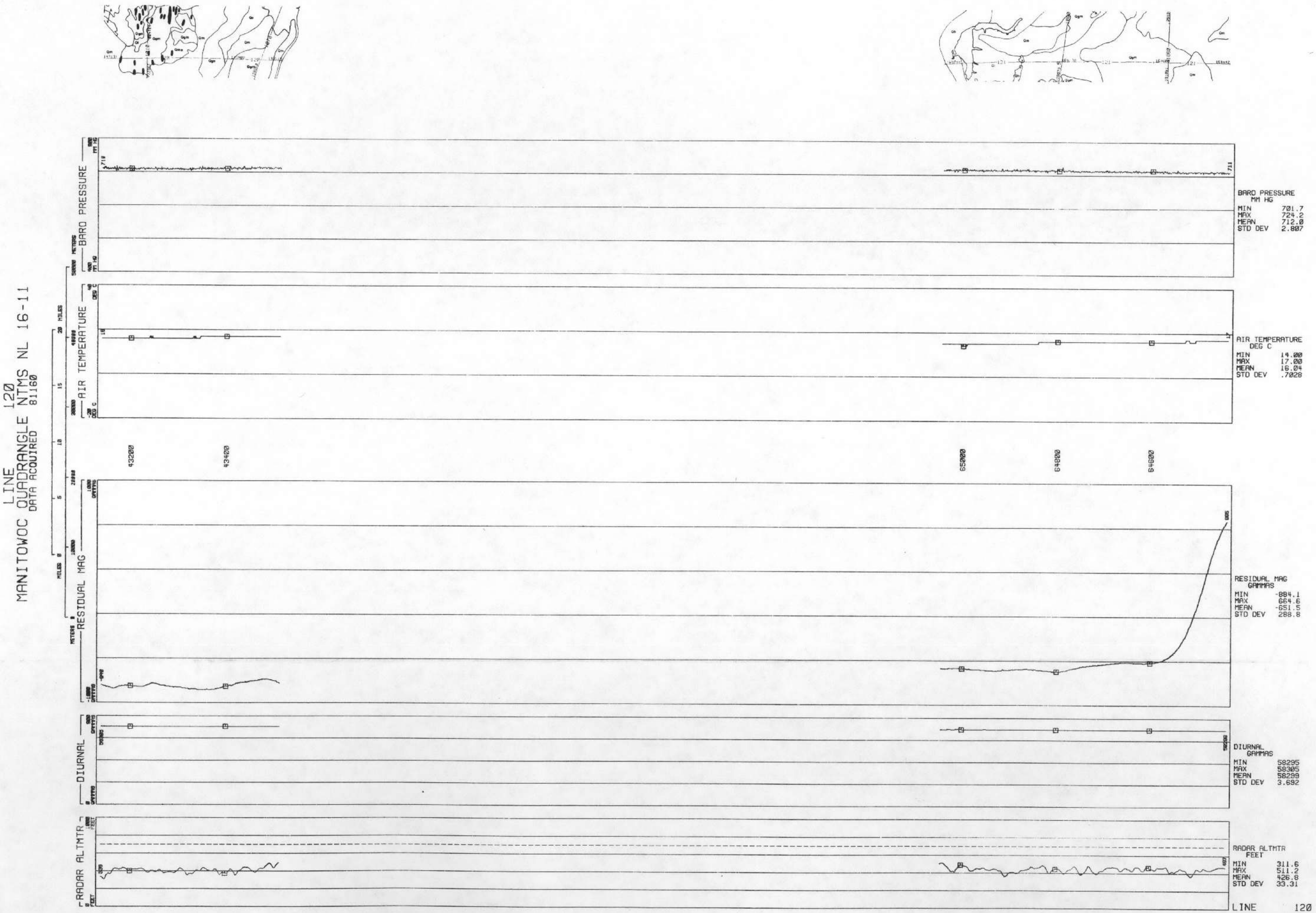
LINE 90

D26 mt

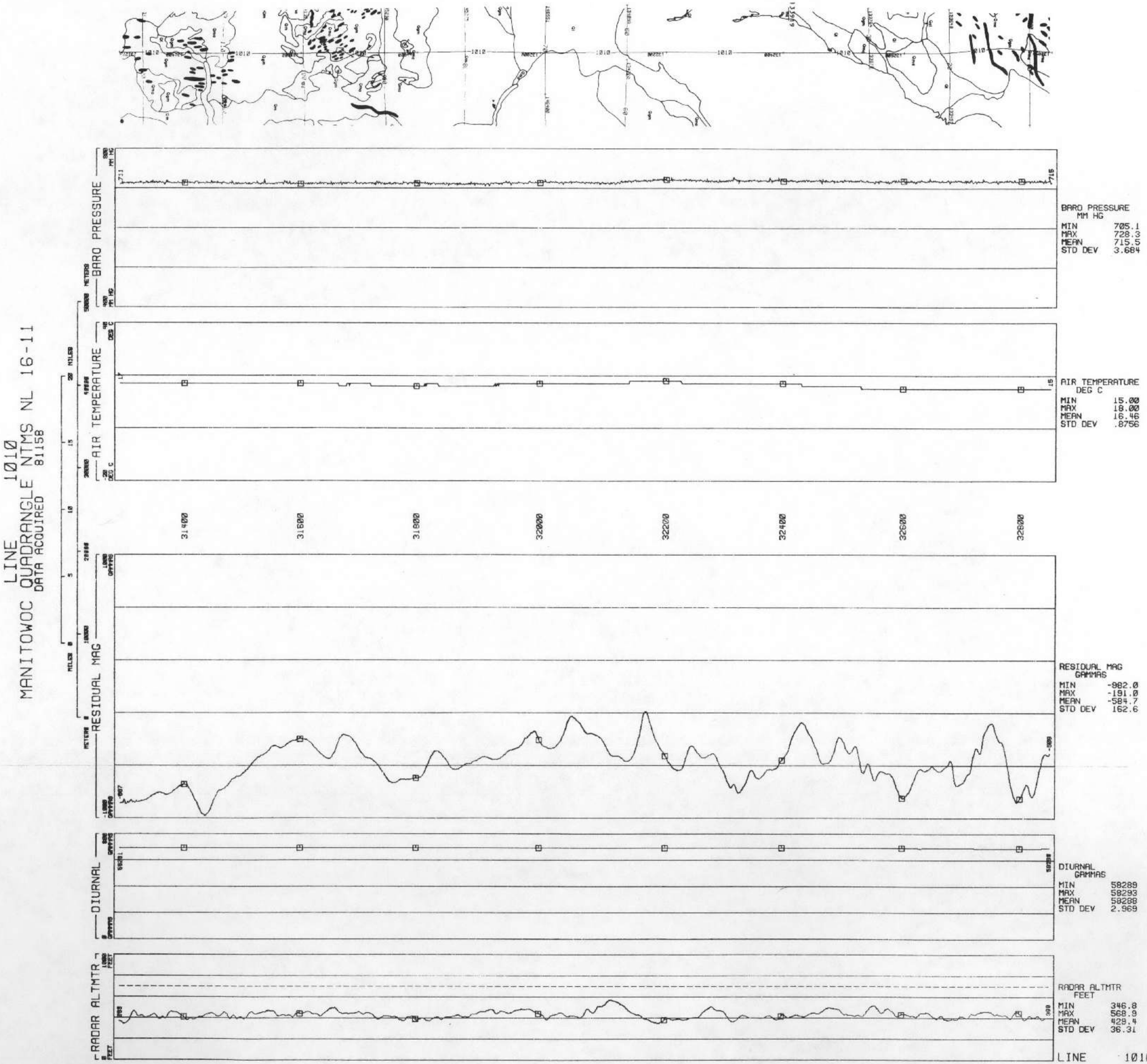


LINE 100
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
44200
44400
44600
93200
93400
BARO PRESSURE MM HG
MIN 699.6
MAX 729.1
MEAN 714.5
STD DEV 5.243
AIR TEMPERATURE DEG C
MIN 16.00
MAX 21.00
MEAN 18.32
STD DEV 1.422
RESIDUAL MAG GAMMAS
MIN -899.0
MAX 165.9
MEAN -437.8
STD DEV 305.2
DIURNAL GAMMAS
MIN 58292
MAX 58300
MEAN 58293
STD DEV 4.292
RADAR ALTMTR FEET
MIN 342.1
MAX 515.5
MEAN 408.3
STD DEV 32.12
LINE 100


LINE 110
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
43800
43600
08400
08200
08000
BARO PRESSURE
MM HG
MIN 700.1
MAX 725.8
MEAN 714.4
STD DEV 5.886
AIR TEMPERATURE
DEG C
MIN 16.00
MAX 22.00
MEAN 19.19
STD DEV 2.387
RESIDUAL MAG
GAMMAS
MIN -977.6
MAX -224.6
MEAN -618.9
STD DEV 254.8
DIURNAL
GAMMAS
MIN 58299
MAX 58311
MEAN 58303
STD DEV 5.825
RADAR ALTMTR
FEET
MIN 304.3
MAX 828.0
MEAN 437.7
STD DEV 82.68
LINE 110

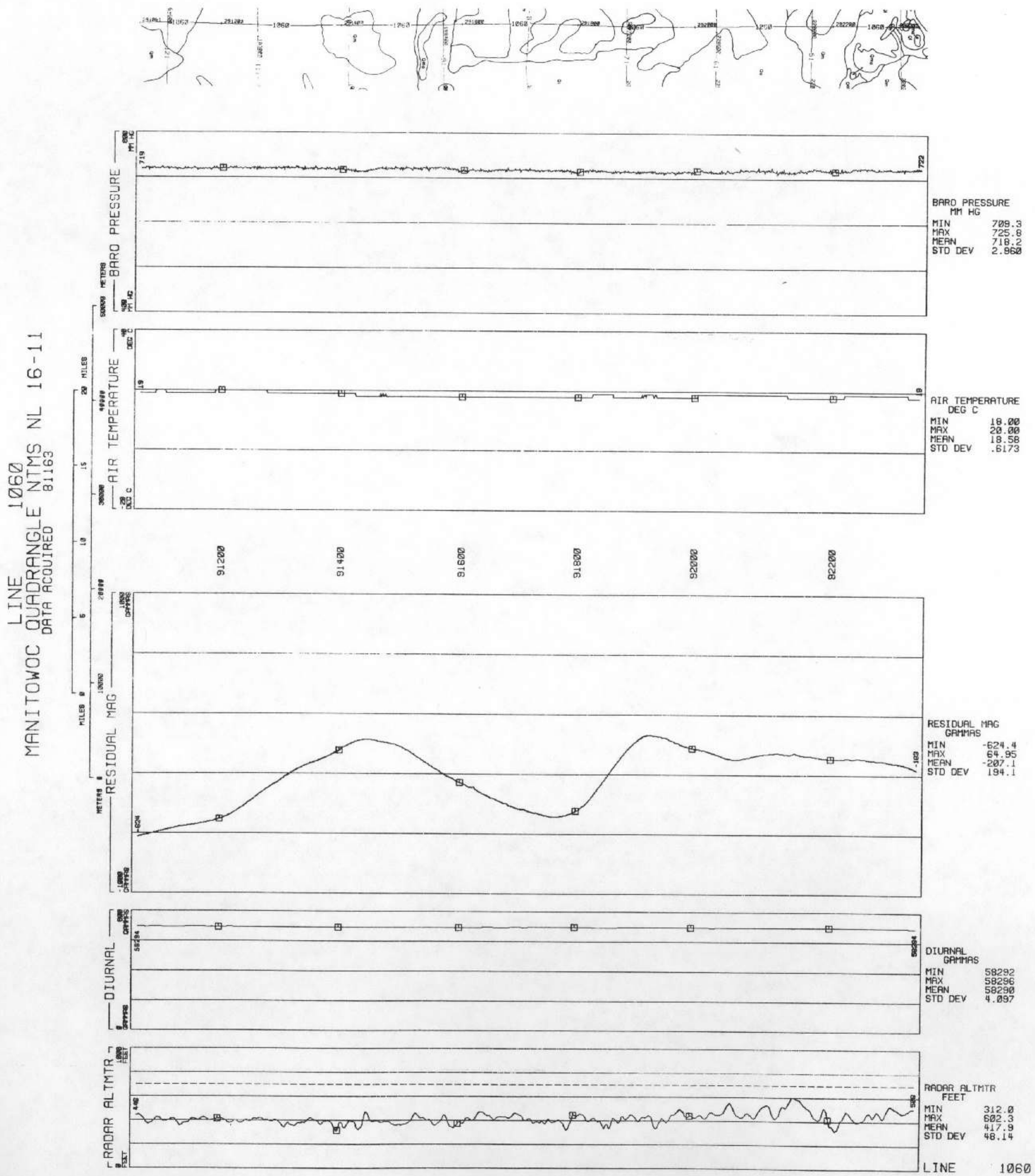

LINE 120
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81160
BARO PRESSURE
MM HG
MIN 701.7
MAX 724.2
MEAN 712.0
STD DEV 2.807
AIR TEMPERATURE
DEG C
MIN 14.00
MAX 17.00
MEAN 16.04
STD DEV .7028
RESIDUAL MAG
GAMMAS
MIN -884.1
MAX 664.6
MEAN -651.5
STD DEV 288.8
DIURNAL
GAMMAS
MIN 58295
MAX 58305
MEAN 58299
STD DEV 3.692
RADAR ALTMTR
FEET
MIN 311.6
MAX 511.2
MEAN 426.8
STD DEV 33.31
LINE 120

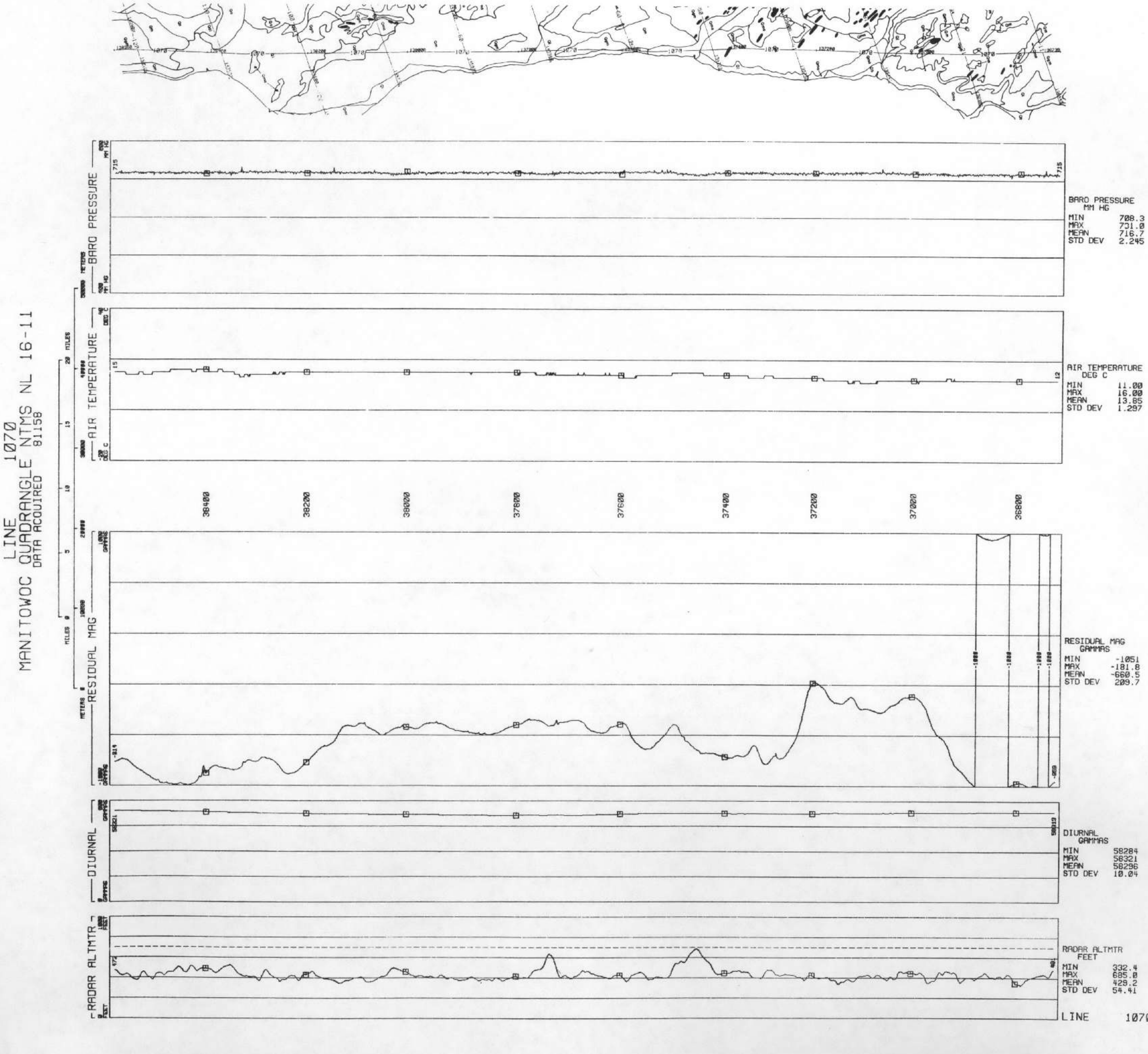
D29 mt

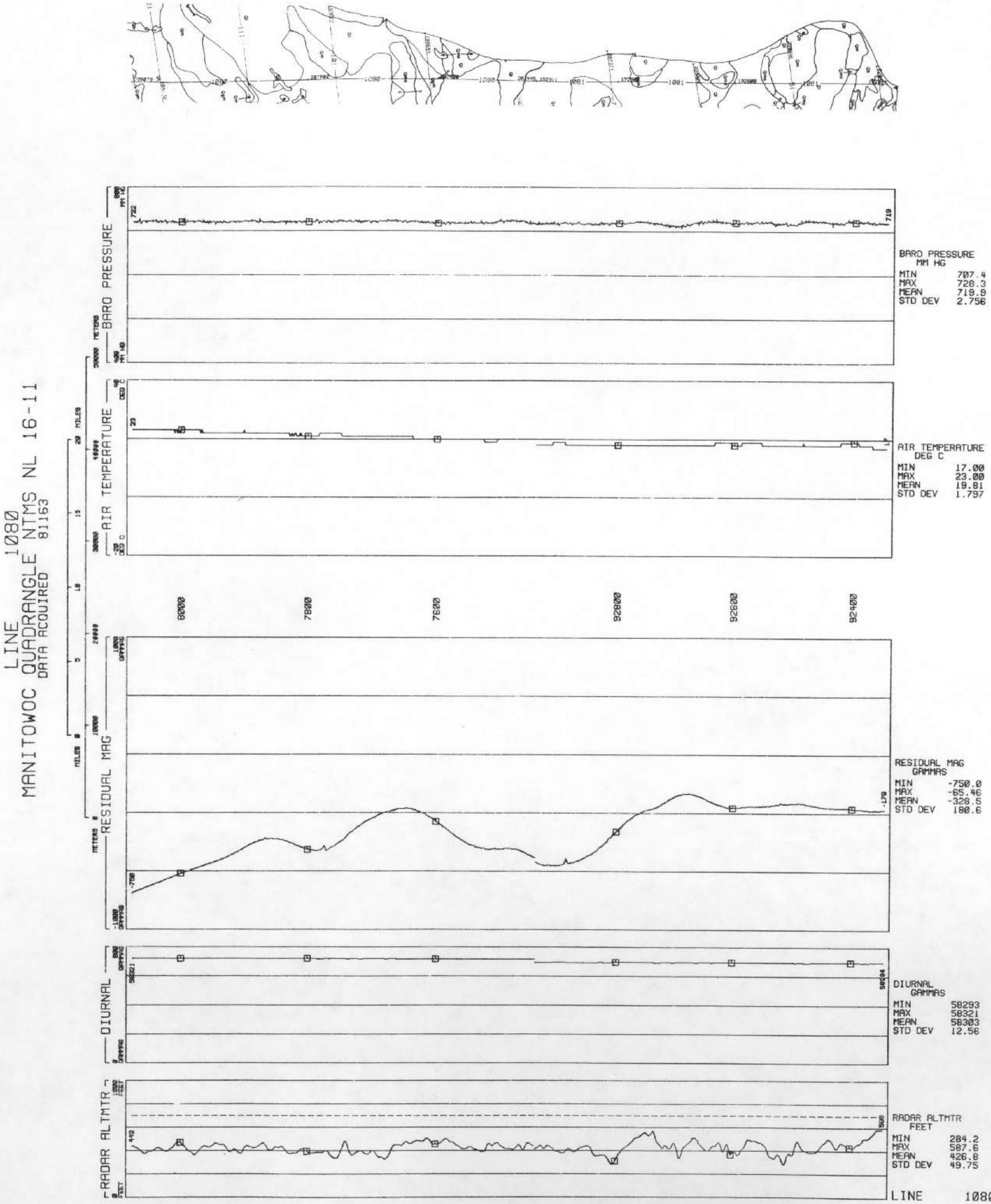


LINE 1010
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
31400
31600
31800
32000
32200
32400
32600
32800
BARO PRESSURE MM HG
MIN 705.1
MAX 728.3
MEAN 715.5
STD DEV 3.684
AIR TEMPERATURE DEG C
MIN 15.00
MAX 18.00
MEAN 16.46
STD DEV .8756
RESIDUAL MAG GAMMAS
MIN -982.0
MAX -191.0
MEAN -584.7
STD DEV 162.6
DIURNAL GAMMAS
MIN 58289
MAX 58293
MEAN 58288
STD DEV 2.969
RADAR ALTMTR FEET
MIN 346.8
MAX 568.9
MEAN 428.4
STD DEV 36.31
LINE 1010

D 30 mt


LINE 1060
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81163
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
91200
91400
91600
91800
92000
92200
BARO PRESSURE
MM HG
MIN 709.3
MAX 725.8
MEAN 718.2
STD DEV 2.860
AIR TEMPERATURE
DEG C
MIN 18.00
MAX 20.00
MEAN 18.58
STD DEV .6173
RESIDUAL MAG
GAMMAS
MIN -624.4
MAX 64.95
MEAN -207.1
STD DEV 194.1
DIURNAL
GAMMAS
MIN 58292
MAX 58296
MEAN 58290
STD DEV 4.097
RADAR ALTMTR
FEET
MIN 312.0
MAX 602.3
MEAN 417.9
STD DEV 48.14
LINE 1060

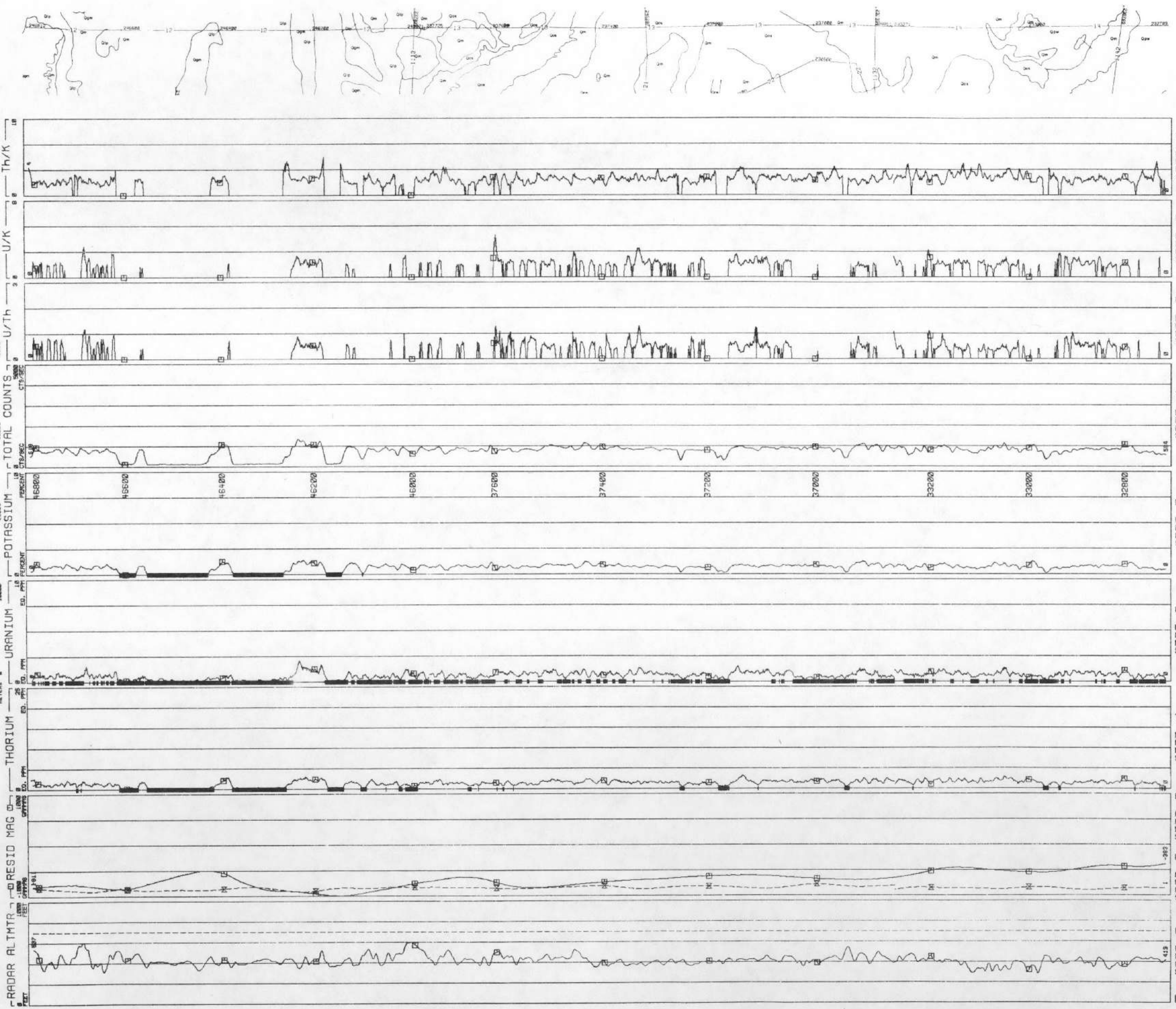

LINE 1070
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81158
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
38400
38200
38000
37800
37600
37400
37200
37000
36800
BARO PRESSURE MM HG
MIN 708.3
MAX 731.0
MEAN 716.7
STD DEV 2.245
AIR TEMPERATURE DEG C
MIN 11.00
MAX 16.00
MEAN 13.85
STD DEV 1.297
RESIDUAL MAG GAMMAS
MIN -1051
MAX -181.8
MEAN -660.5
STD DEV 209.7
DIURNAL GAMMAS
MIN 58284
MAX 58321
MEAN 58296
STD DEV 10.04
RADAR ALTMTR FEET
MIN 332.4
MAX 685.0
MEAN 428.2
STD DEV 54.41
LINE 1070


LINE 1080
MANITOWOC QUADRANGLE NTMS NL 16-11
DATA ACQUIRED 81163
BARO PRESSURE
BARO PRESSURE MM HG
MIN 707.4
MAX 728.3
MEAN 719.9
STD DEV 2.756
AIR TEMPERATURE
AIR TEMPERATURE DEG C
MIN 17.00
MAX 23.00
MEAN 19.81
STD DEV 1.797
8000
7800
7600
92800
92600
92400
RESIDUAL MAG
RESIDUAL MAG GAMMAS
MIN -750.0
MAX -65.46
MEAN -328.5
STD DEV 180.6
DIURNAL
DIURNAL GAMMAS
MIN 58293
MAX 58321
MEAN 58303
STD DEV 12.56
RADAR ALTMTR
RADAR ALTMTR FEET
MIN 284.2
MAX 587.6
MEAN 426.8
STD DEV 49.75
LINE 1080

LINE 10

TRAVERSE CITY QUADRANGLE - NTMS NL 16-12

DATA ACQUIRED 81158



Th/K

MIN .0000
MAX 4.910
MEAN 1.705
STD DEV .9870

U/K

MIN .0000
MAX 3.266
MEAN .4454
STD DEV .5787

U/Th

MIN .0000
MAX 1.285
MEAN .2167
STD DEV .2915

TOTAL COUNTS CTS/SEC

MIN 112.3
MAX 1348
MEAN 729.0
STD DEV 272.1

POTASSIUM PERCENT

MIN .0843
MAX 1.367
MEAN .7329
STD DEV .2088

URANIUM EQ. PPM

MIN .5156
MAX 2.065
MEAN .8733
STD DEV .2130

THORIUM EQ. PPM

MIN .7247
MAX 3.191
MEAN 1.594
STD DEV .4303

BI AIR CORR EQ. PPM

MIN .4098
MAX 1.077
MEAN .7306
STD DEV .1337

RESID MAG GAMMAS

MIN -998.1
MAX -383.4
MEAN -680.7
STD DEV 151.3

RADAR ALTMTR FEET

MIN 283.5
MAX 602.3
MEAN 417.1
STD DEV 49.46

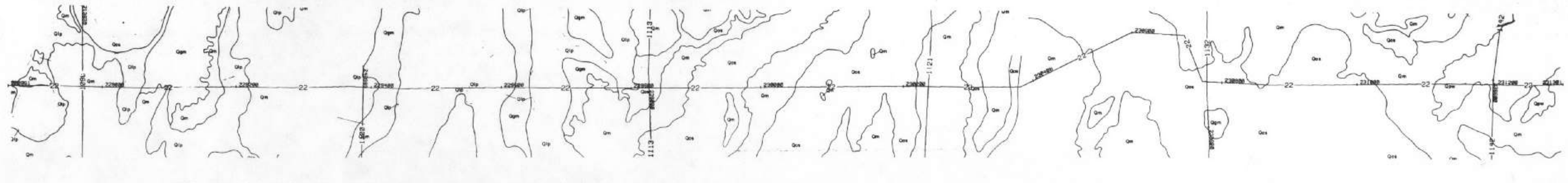
LINE 10

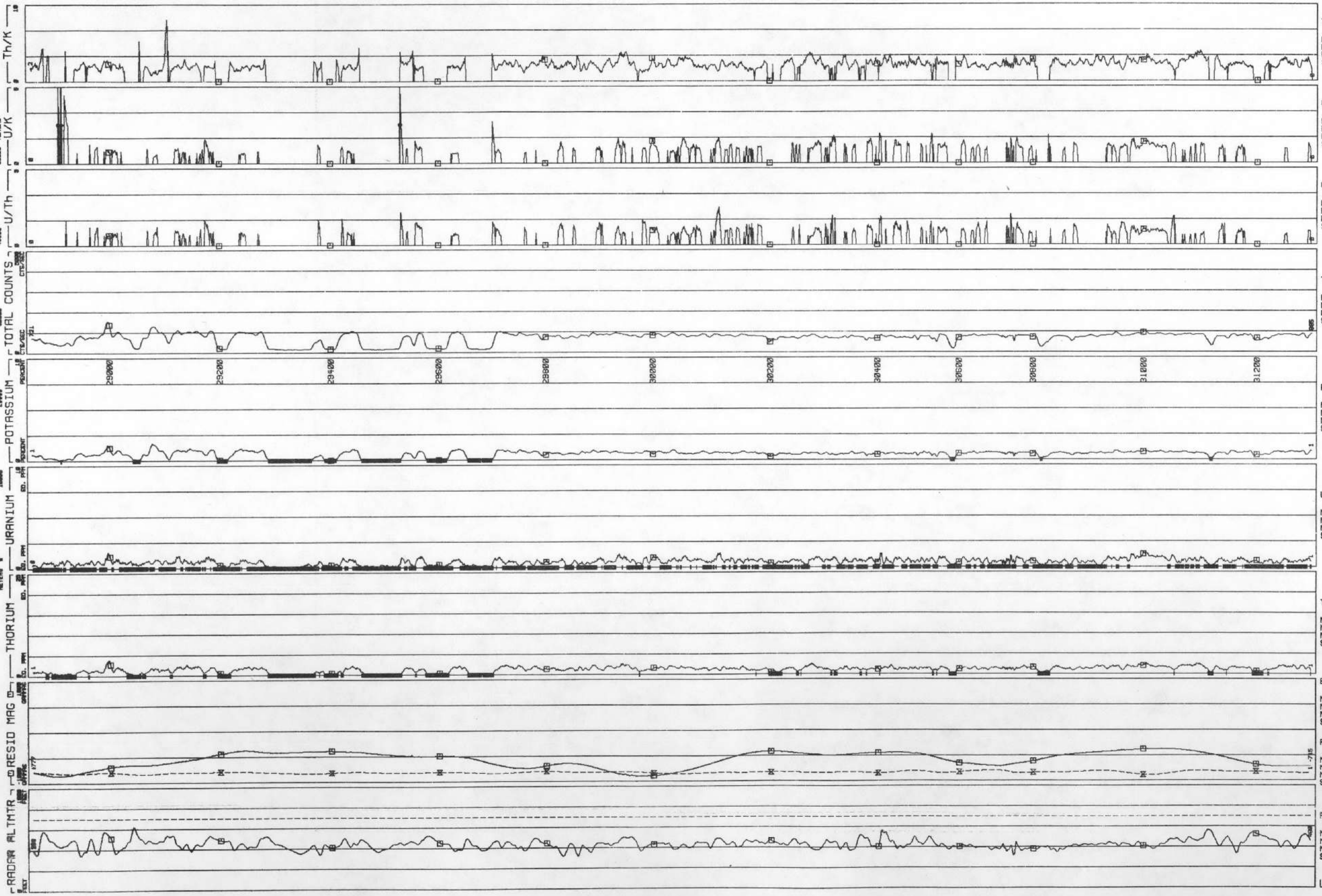
D 34 mt

LINE 20

TRAVERSE CITY QUADRANGLE - NTMS NL 16-12

DATA ACQUIRED 81158





Th/K
MIN .0000
MAX 8.025
MEAN 1.724
STD DEV 1.033

U/K
MIN .0000
MAX 7.391
MEAN .3810
STD DEV .6733

U/Th
MIN .0000
MAX 1.470
MEAN .1644
STD DEV .2786

TOTAL COUNTS CTS/SEC
MIN 147.1
MAX 1528
MEAN 704.2
STD DEV 239.5

POTASSIUM PERCENT
MIN .0788
MAX 1.676
MEAN .6475
STD DEV .2061

URANIUM EQ. PPM
MIN .5081
MAX 1.574
MEAN .8235
STD DEV .1549

THORIUM EQ. PPM
MIN .6500
MAX 3.858
MEAN 1.482
STD DEV .3921

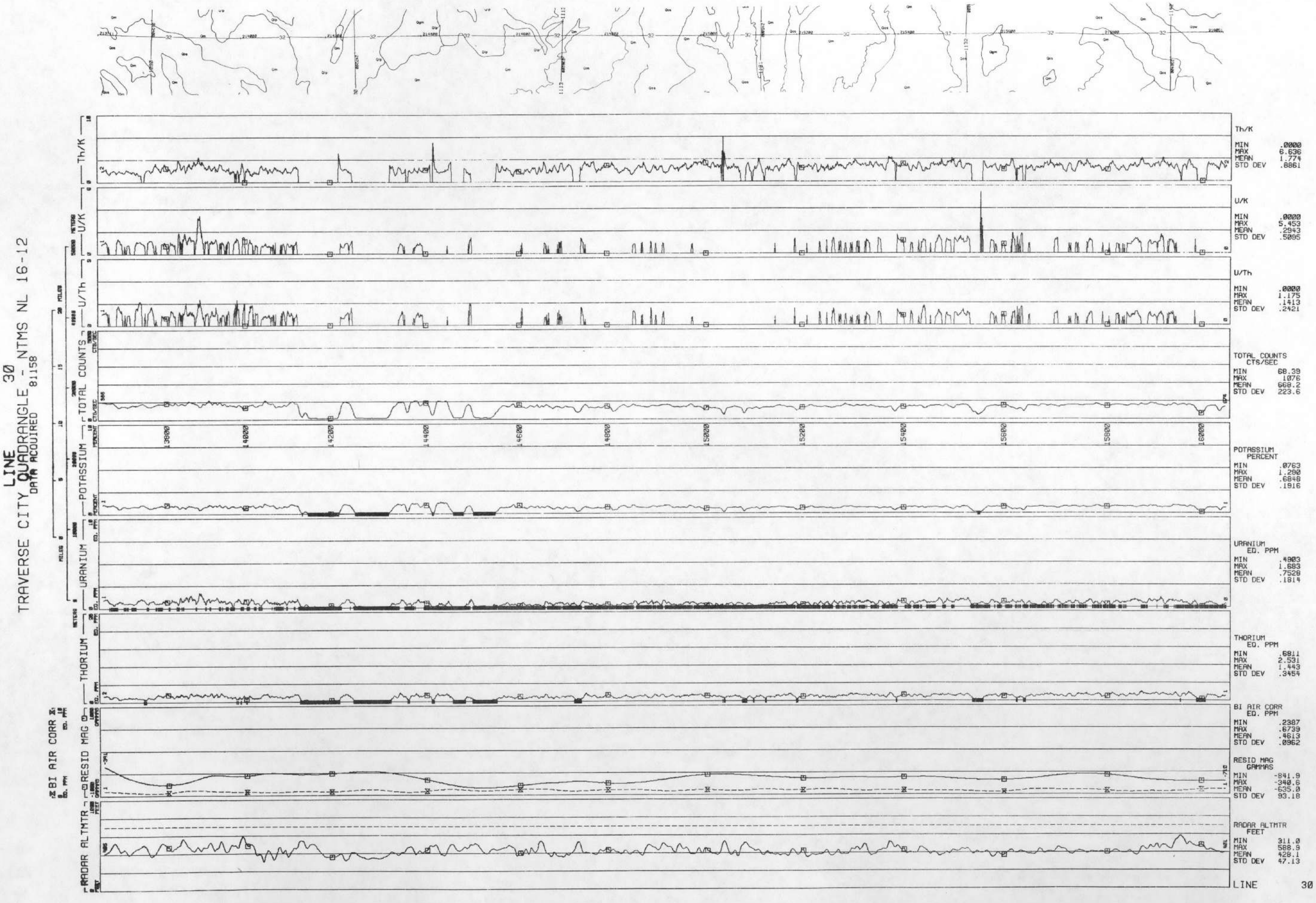
BI AIR CORR EQ. PPM
MIN .5264
MAX 1.138
MEAN .8785
STD DEV .1008

RESID MAG GAMMAS
MIN -901.5
MAX -373.0
MEAN -572.5
STD DEV 143.4

RADAR ALTMTR FEET
MIN 320.1
MAX 620.4
MEAN 434.8
STD DEV 46.89

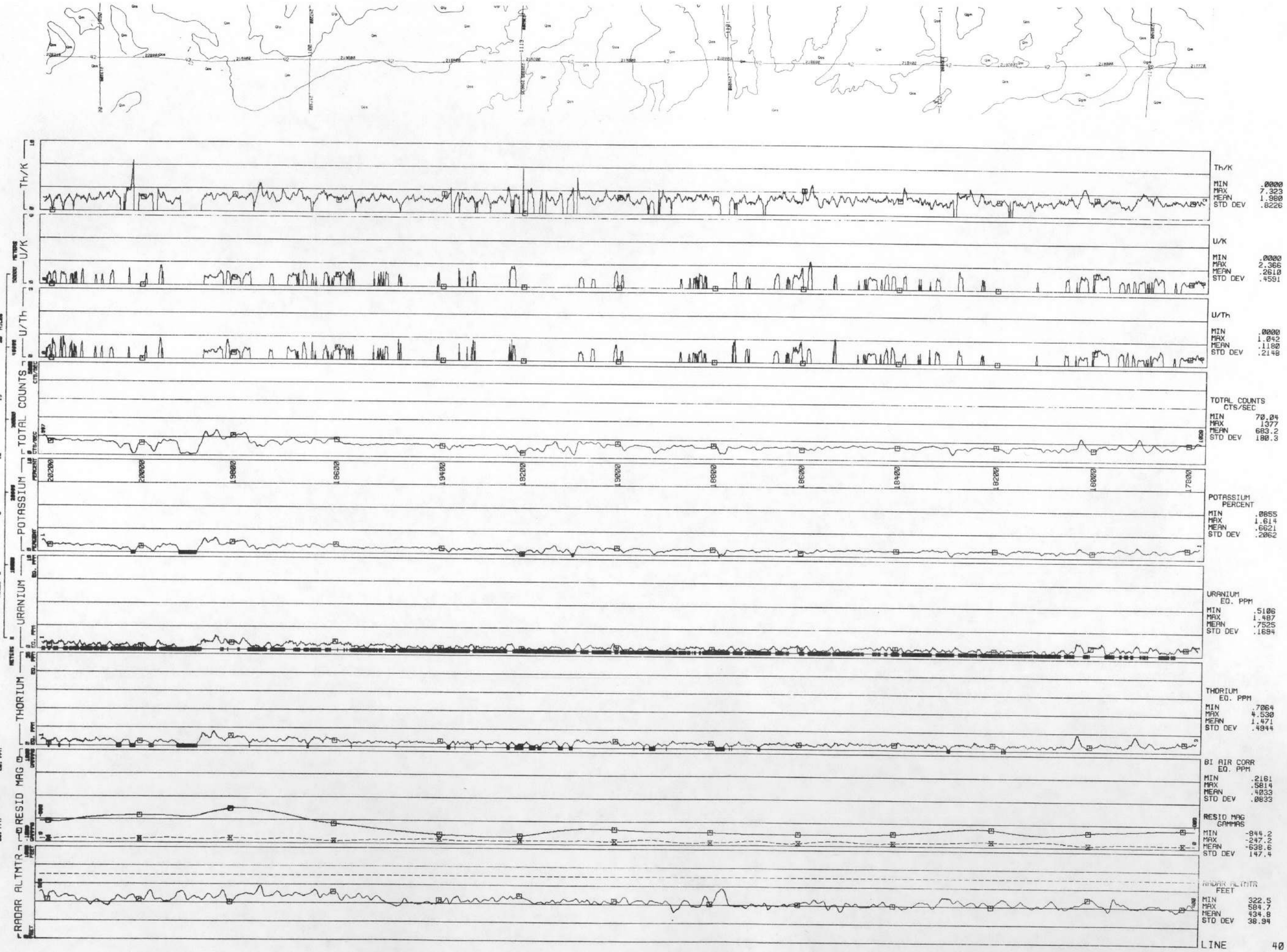
LINE 20

D 35 mt

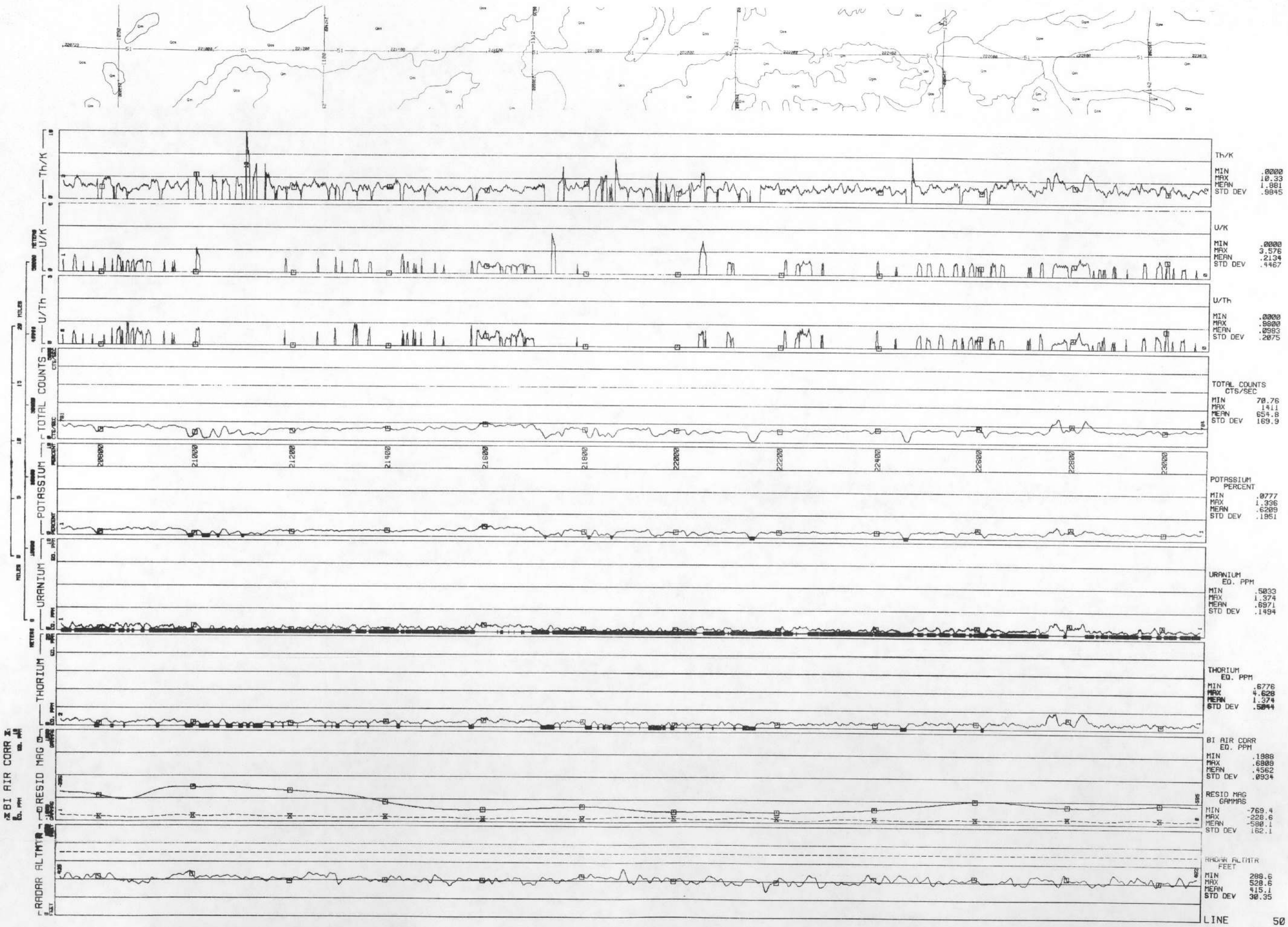

LINE 30
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158
Th/K
MIN .0000
MAX 6.636
MEAN 1.774
STD DEV .8861
U/K
MIN .0000
MAX 5.453
MEAN .2943
STD DEV .5095
U/Th
MIN .0000
MAX 1.175
MEAN .1413
STD DEV .2421
TOTAL COUNTS CTS/SEC
MIN 68.39
MAX 1076
MEAN 668.2
STD DEV 223.6
13800
14000
14200
14400
14600
14800
15000
15200
15400
15600
15800
16000
POTASSIUM PERCENT
MIN .0763
MAX 1.290
MEAN .6848
STD DEV .1916
URANIUM EQ. PPM
MIN .4803
MAX 1.683
MEAN .7528
STD DEV .1814
THORIUM EQ. PPM
MIN .6811
MAX 2.531
MEAN 1.443
STD DEV .3454
BI AIR CORR EQ. PPM
MIN .2387
MAX .6739
MEAN .4613
STD DEV .0962
RESID MAG GAMMAS
MIN -841.9
MAX -340.6
MEAN -635.0
STD DEV 93.18
RADAR ALTMTR FEET
MIN 311.0
MAX 588.9
MEAN 428.1
STD DEV 47.13
LINE 30

D 36 mt

LINE 40
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158



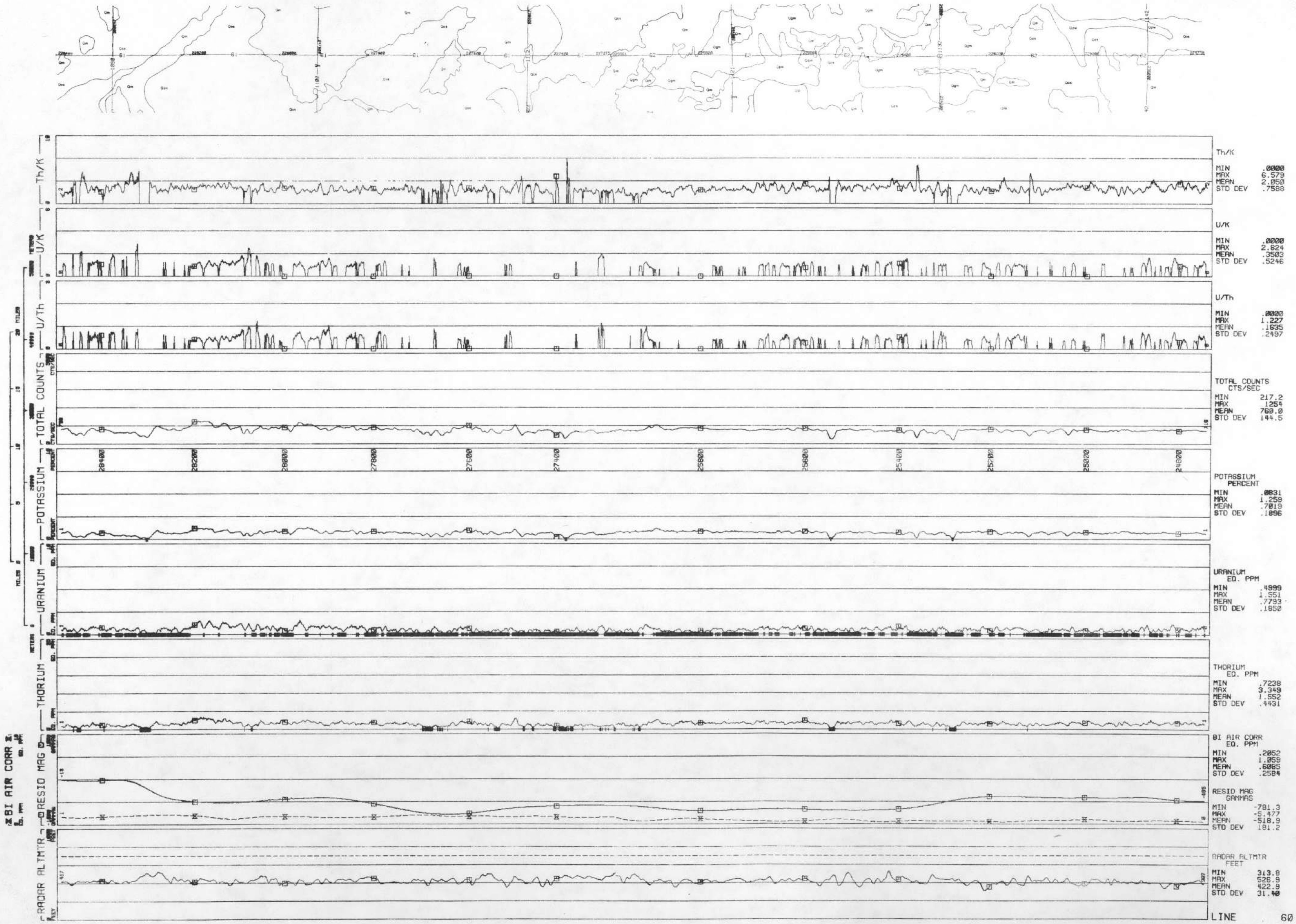
LINE 50
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158



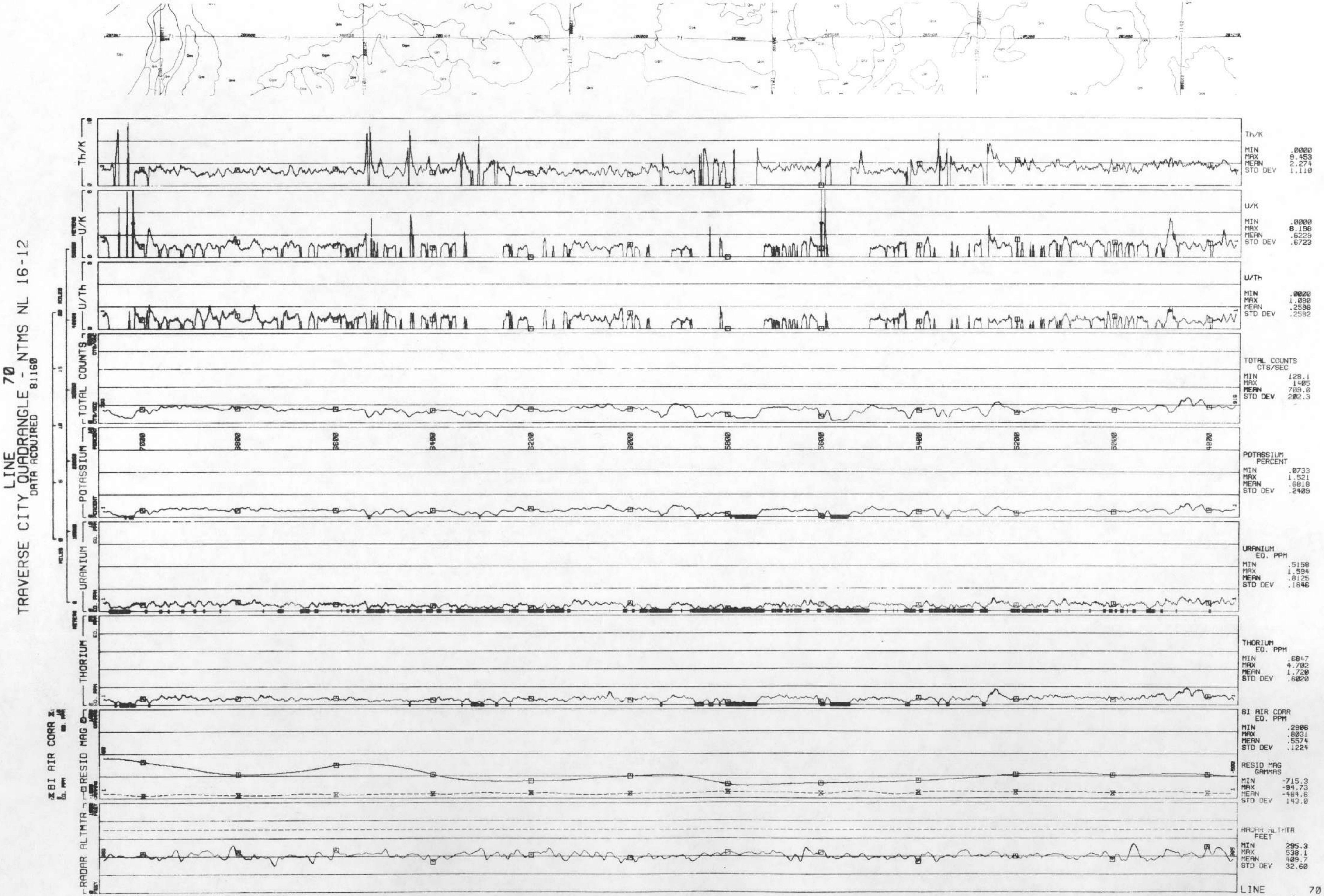
LINE 60

TRAVERSE CITY QUADRANGLE - NTMS NL 16-12

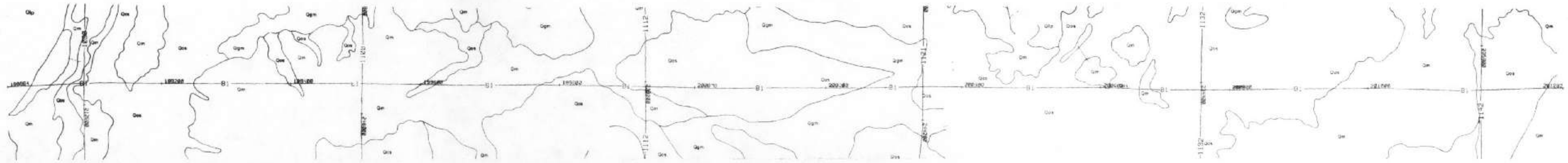
DATA ACQUIRED 81158

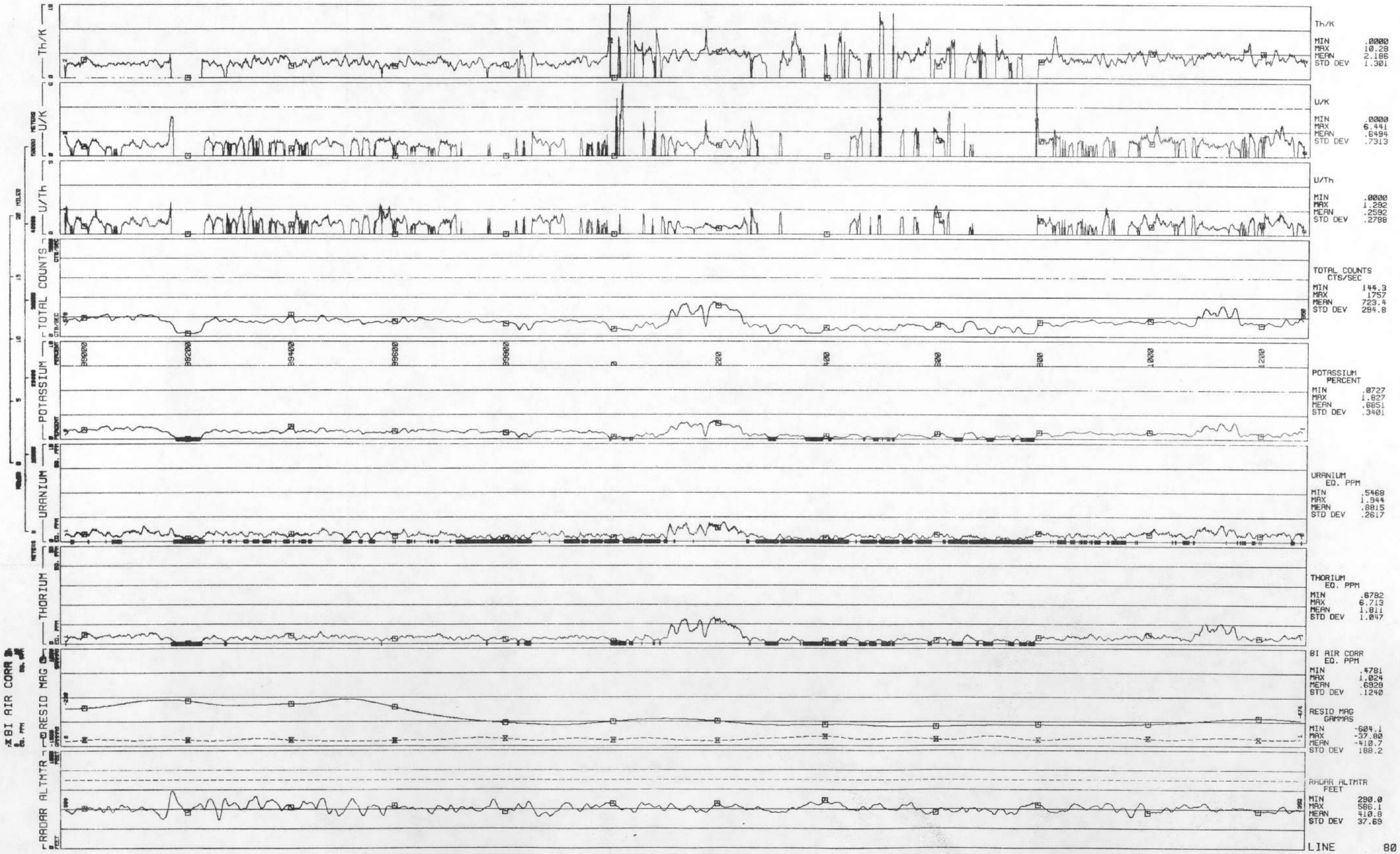


D 39 mt


LINE 70
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160
Th/K
MIN .0000
MAX 9.453
MEAN 2.274
STD DEV 1.110
U/K
MIN .0000
MAX 8.198
MEAN .6229
STD DEV .6723
U/Th
MIN .0000
MAX 1.080
MEAN .2598
STD DEV .2582
TOTAL COUNTS CTS/SEC
MIN 128.1
MAX 1405
MEAN 709.0
STD DEV 202.3
7000
6800
6600
6400
6200
6000
5800
5600
5400
5200
5000
4800
POTASSIUM PERCENT
MIN .0733
MAX 1.521
MEAN .6818
STD DEV .2409
URANIUM EQ. PPM
MIN .5158
MAX 1.594
MEAN .8125
STD DEV .1846
THORIUM EQ. PPM
MIN .6847
MAX 4.702
MEAN 1.720
STD DEV .6020
BI AIR CORR EQ. PPM
MIN .2906
MAX .8031
MEAN .5574
STD DEV .1224
RESID MAG GAMMAS
MIN -715.3
MAX -94.73
MEAN -484.6
STD DEV 143.0
RADAR ALTMTR FEET
MIN 295.3
MAX 538.1
MEAN 409.7
STD DEV 32.60
LINE 70

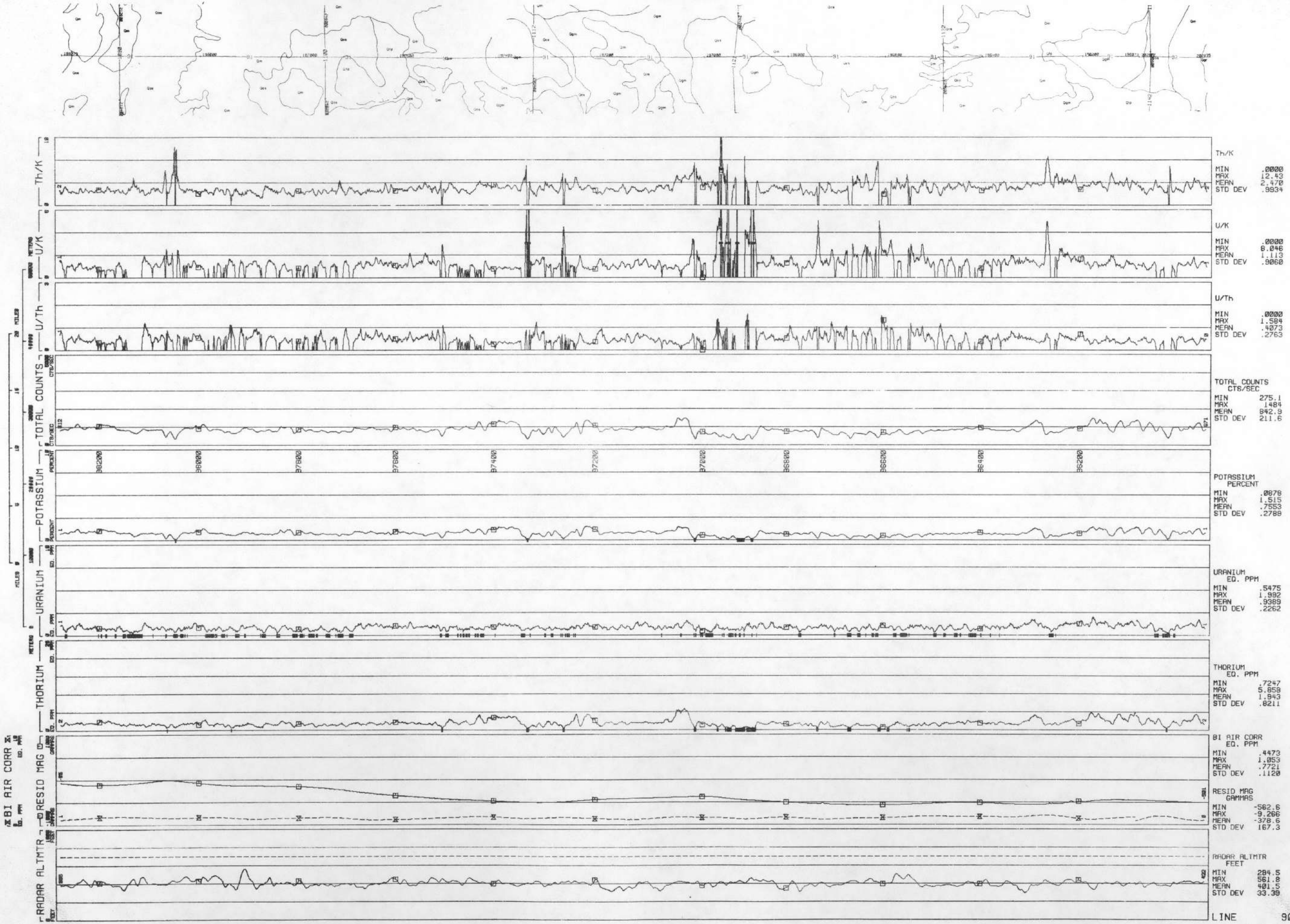
LINE 80
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160





D41 mt

LINE 90
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160

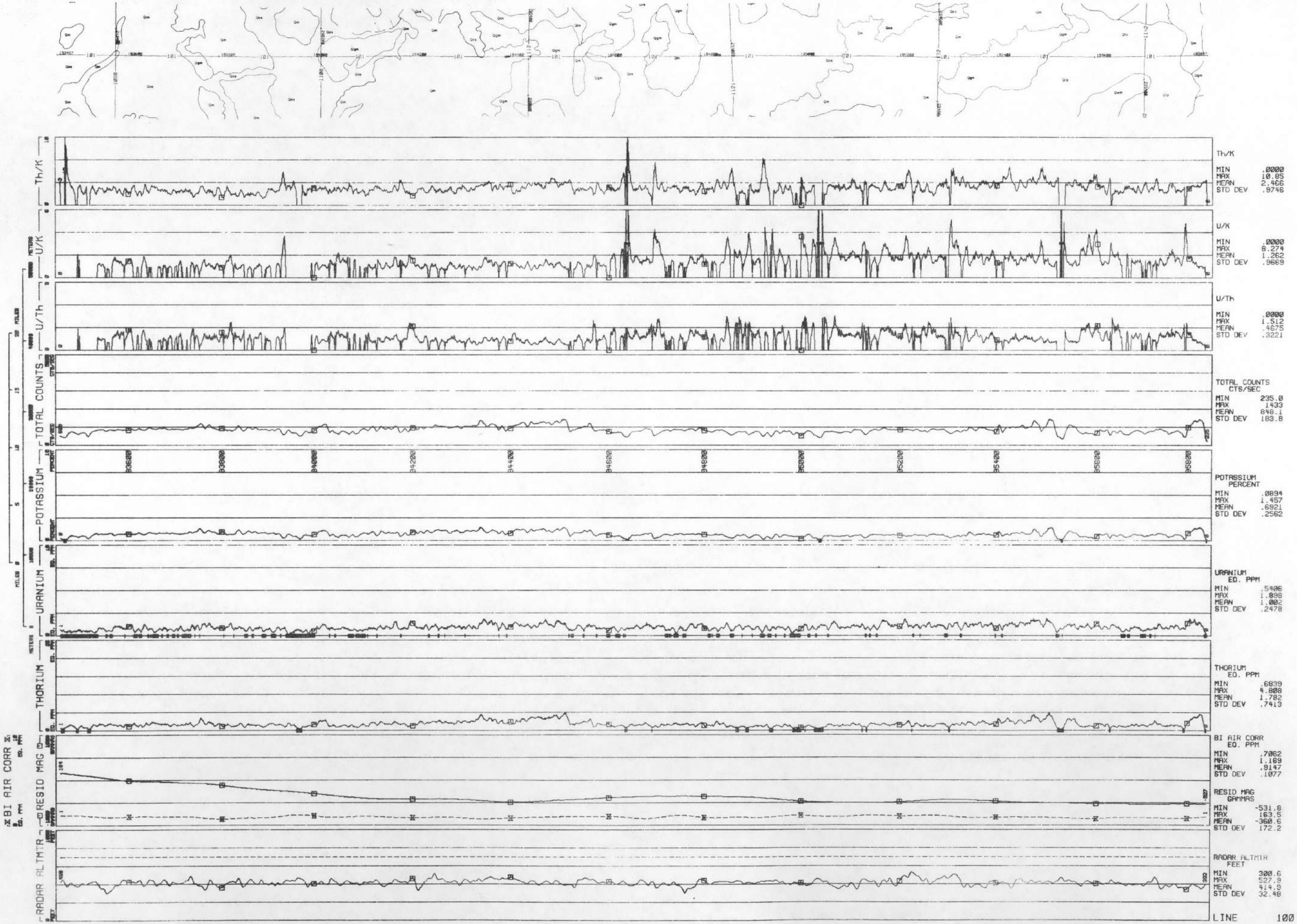


D42 mt

LINE 100

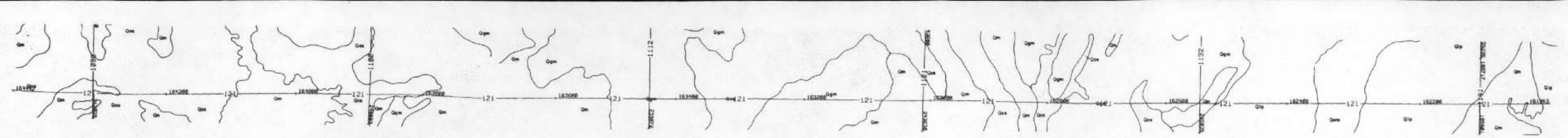
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12

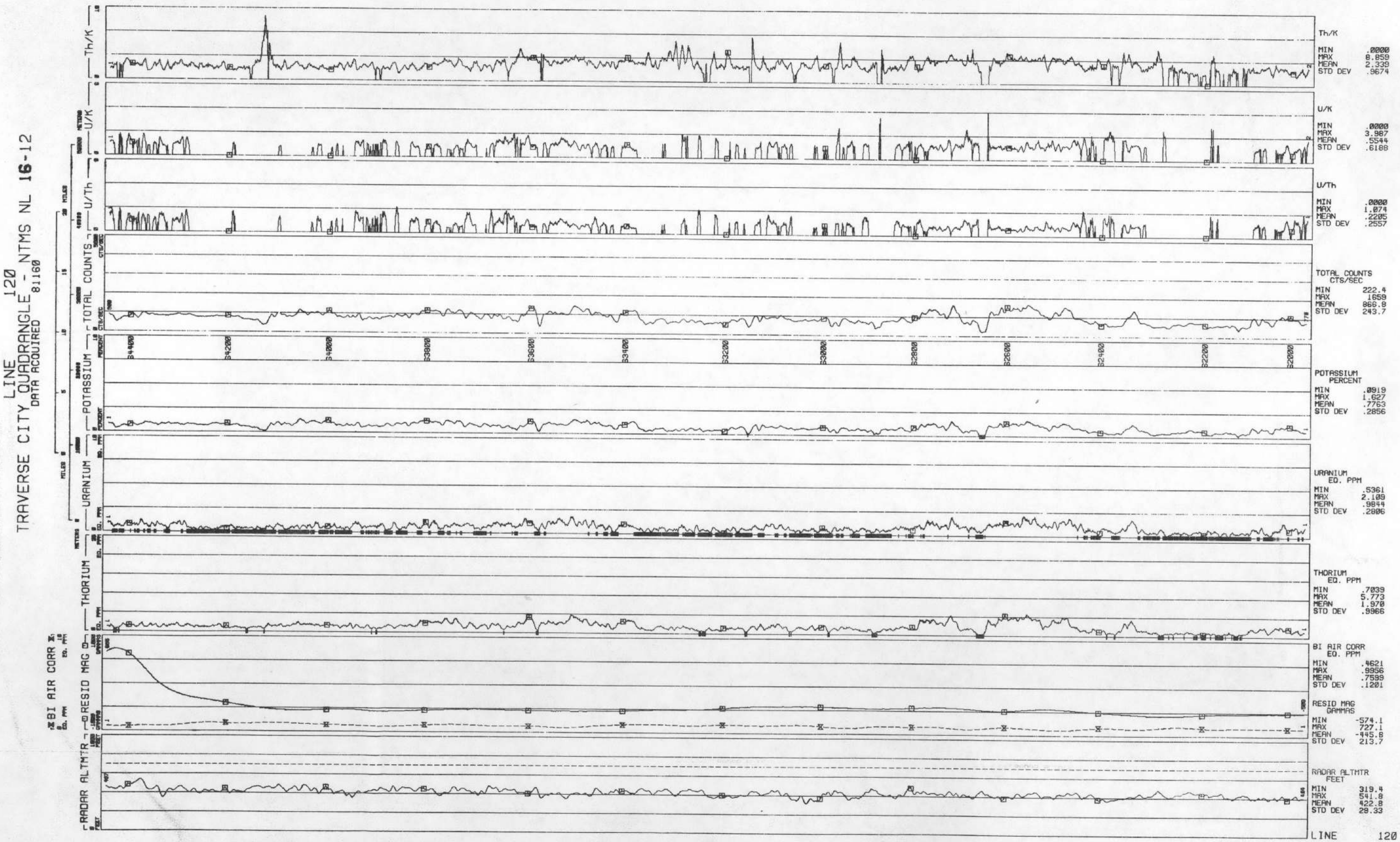
DATA ACQUIRED 81160



D4 3 mt

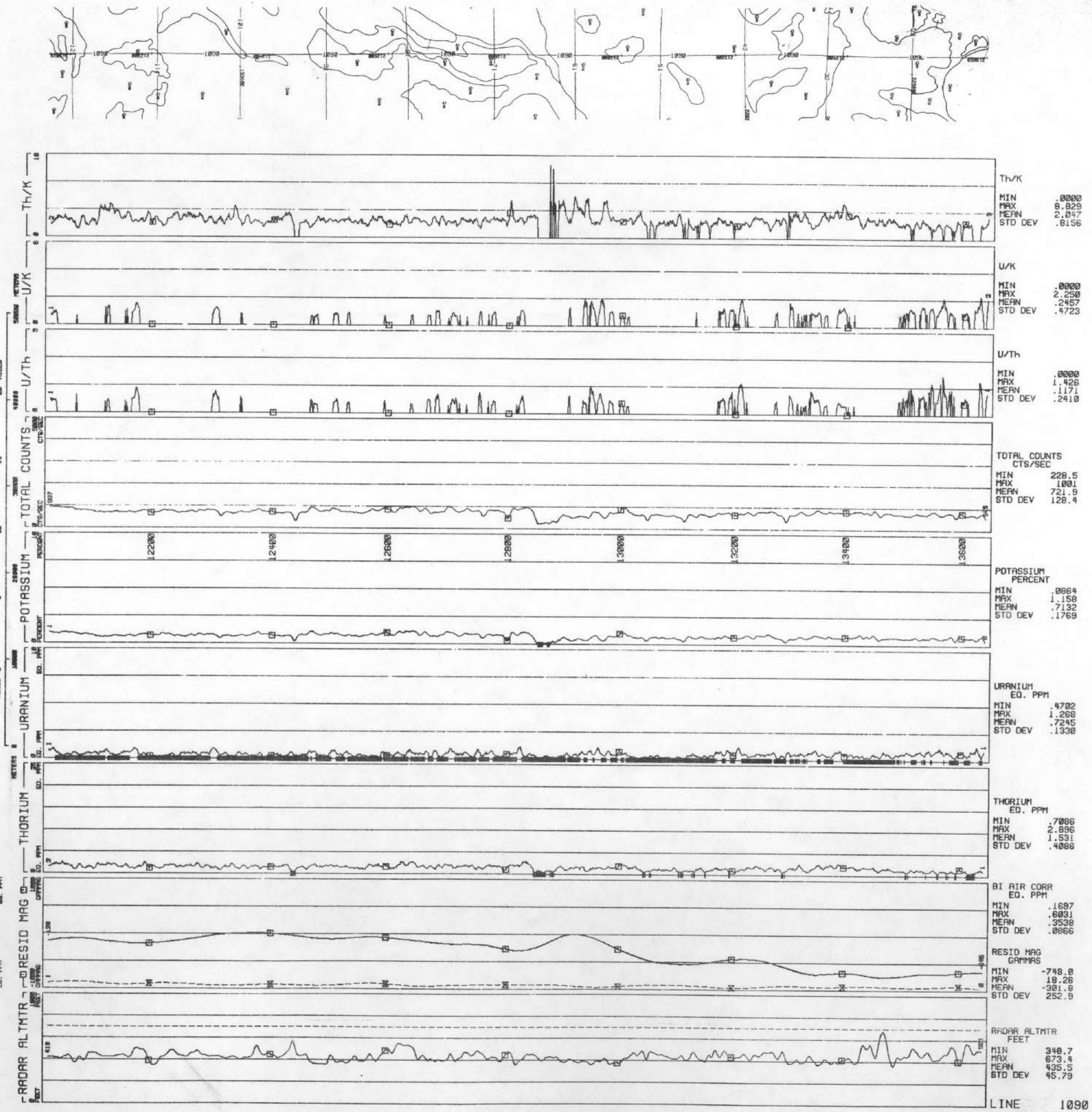

LINE 110
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160
Th/K
MIN .0000
MAX 5.562
MEAN 2.151
STD DEV .7560
U/K
MIN .0000
MAX 2.440
MEAN .4049
STD DEV .5050
U/Th
MIN .0000
MAX 1.426
MEAN .1878
STD DEV .2518
TOTAL COUNTS CTS/SEC
MIN 123.5
MAX 1566
MEAN 800.2
STD DEV 193.8
POTASSIUM PERCENT
MIN .0855
MAX 1.738
MEAN .7812
STD DEV .2494
URANIUM EQ. PPM
MIN .4909
MAX 1.427
MEAN .7867
STD DEV .1692
THORIUM EQ. PPM
MIN .7101
MAX 5.246
MEAN 1.779
STD DEV .7745
BI AIR CORR EQ. PPM
MIN .2638
MAX .9884
MEAN .5289
STD DEV .1556
RESID MAG GAMMAS
MIN -762.9
MAX -141.4
MEAN -397.3
STD DEV 109.6
RADAR ALTMTR FEET
MIN 326.3
MAX 541.6
MEAN 418.6
STD DEV 32.61
LINE 110




LINE 120
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160
Th/K
MIN .0000
MAX 8.859
MEAN 2.339
STD DEV .9674
U/K
MIN .0000
MAX 3.987
MEAN .5544
STD DEV .6188
U/Th
MIN .0000
MAX 1.074
MEAN .2205
STD DEV .2557
TOTAL COUNTS CTS/SEC
MIN 222.4
MAX 1659
MEAN 866.8
STD DEV 243.7
POTASSIUM PERCENT
MIN .0919
MAX 1.627
MEAN .7763
STD DEV .2856
URANIUM EQ. PPM
MIN .5361
MAX 2.109
MEAN .9844
STD DEV .2806
THORIUM EQ. PPM
MIN .7039
MAX 5.773
MEAN 1.970
STD DEV .9966
BI AIR CORR EQ. PPM
MIN .4621
MAX .9956
MEAN .7599
STD DEV .1201
RESID MAG GAMMAS
MIN -574.1
MAX 727.1
MEAN -445.8
STD DEV 213.7
RADAR ALTMTR FEET
MIN 319.4
MAX 541.8
MEAN 422.8
STD DEV 29.33
LINE 120

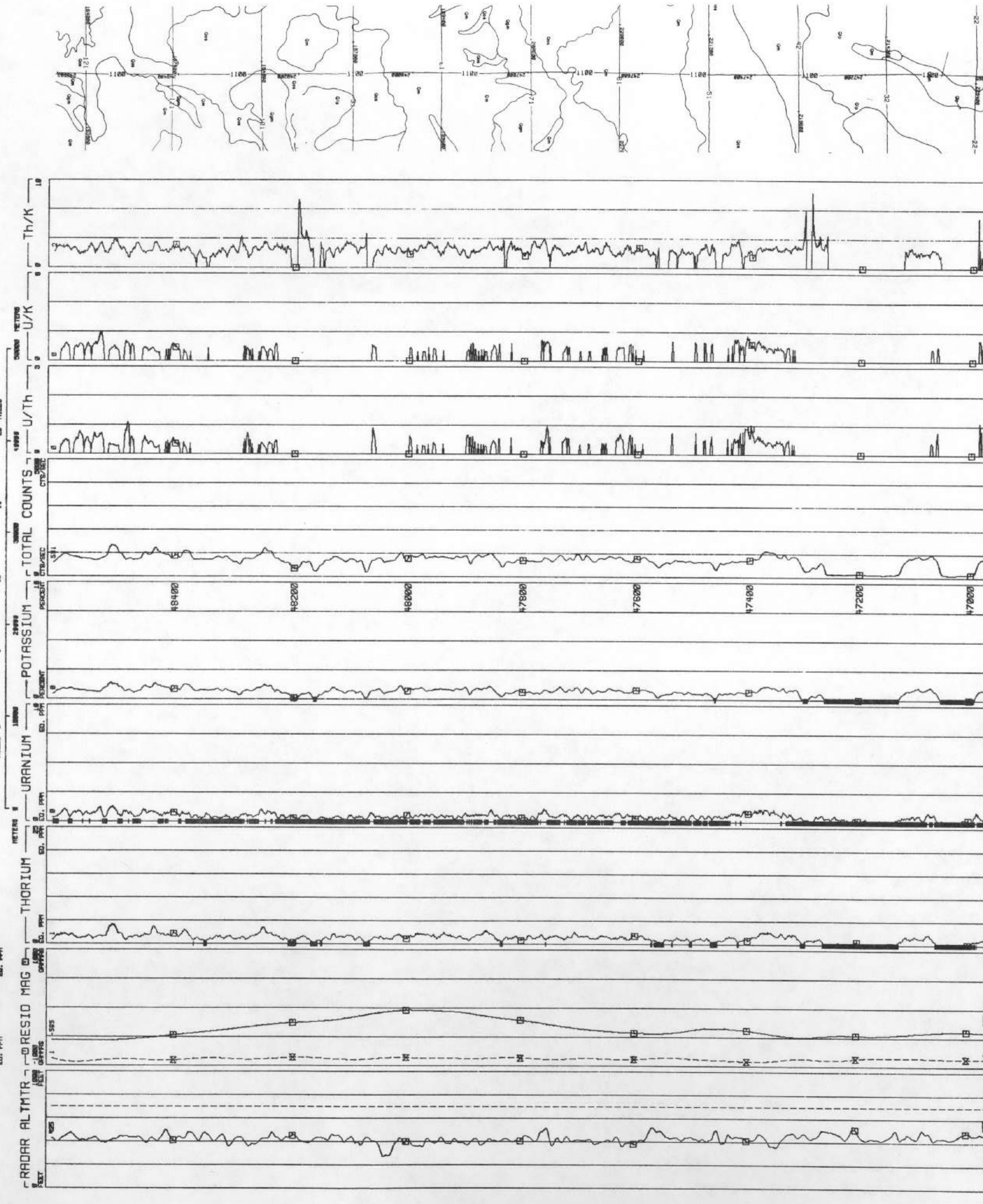
D45 mt

LINE 1090
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81166



LINE 1090

LINE 1100
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81167



Th/K	
MIN	.0000
MAX	8.629
MEAN	1.698
STD DEV	1.016

U/K	
MIN	.0000
MAX	2.010
MEAN	.2440
STD DEV	.4342

U/Th	
MIN	.0000
MAX	1.095
MEAN	.1195
STD DEV	.2228

TOTAL COUNTS CTS/SEC	
MIN	101.4
MAX	1346
MEAN	674.8
STD DEV	262.9

POTASSIUM PERCENT	
MIN	.0753
MAX	1.383
MEAN	.7208
STD DEV	.2353

URANIUM EQ. PPM	
MIN	.5187
MAX	1.297
MEAN	.7860
STD DEV	.1526

THORIUM EQ. PPM	
MIN	.7030
MAX	4.120
MEAN	1.538
STD DEV	.5362

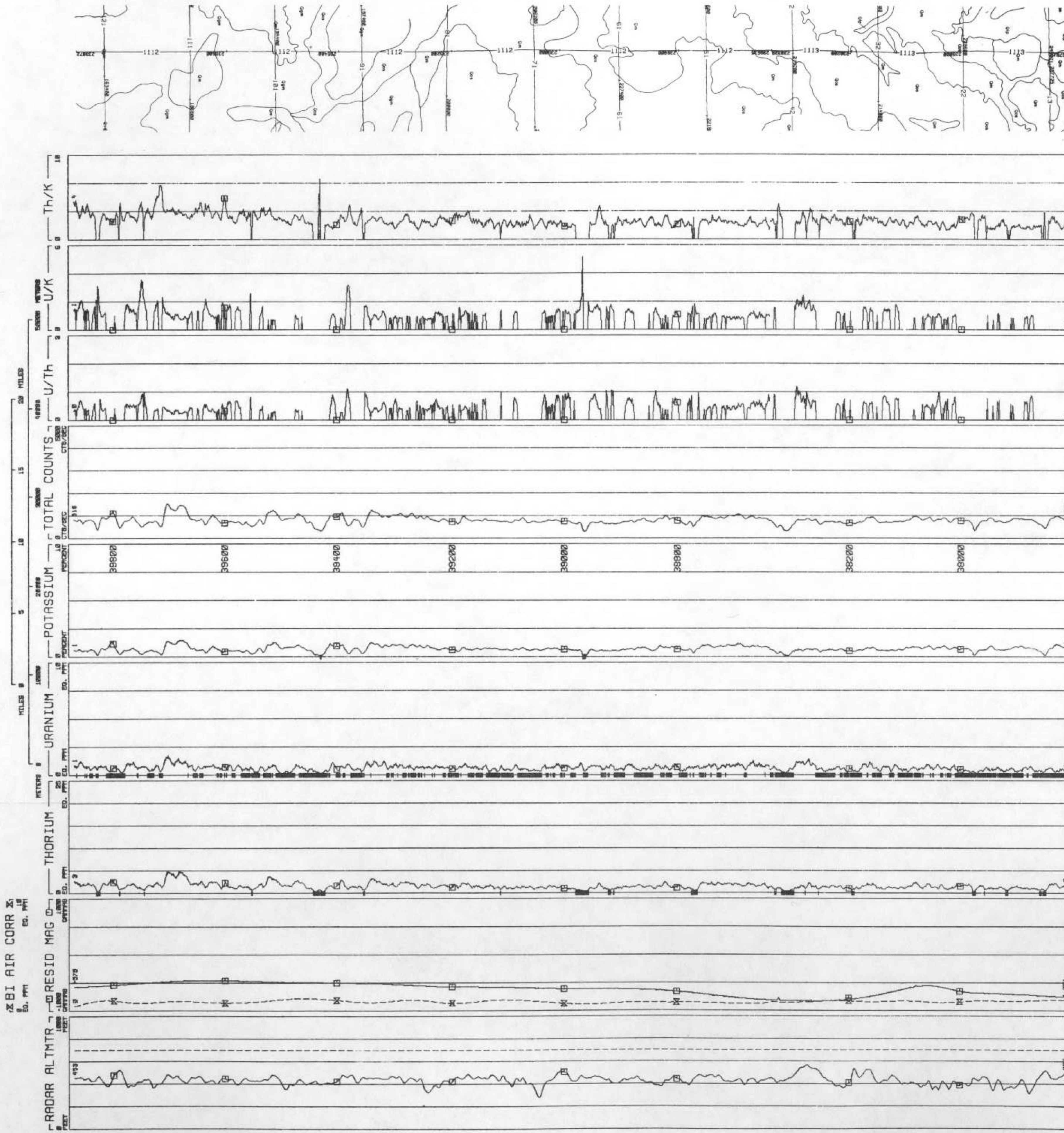
BI AIR CORR EQ. PPM	
MIN	.3061
MAX	.7635
MEAN	.5911
STD DEV	.0952

RESID MAG GAMMAS	
MIN	-565.0
MAX	-30.12
MEAN	-347.3
STD DEV	146.9

RADAR ALTMTR FEET	
MIN	273.0
MAX	520.8
MEAN	425.3
STD DEV	36.08

LINE 1100

LINE 1110
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81167



Th/K
MIN .0000
MAX 7.126
MEAN 2.114
STD DEV .8216

U/K
MIN .0000
MAX 5.145
MEAN .5480
STD DEV .6733

U/Th
MIN .0000
MAX 1.170
MEAN .2294
STD DEV .2890

TOTAL COUNTS CTS/SEC
MIN 293.6
MAX 1534
MEAN 795.3
STD DEV 173.4

POTASSIUM PERCENT
MIN .0904
MAX 1.453
MEAN .6921
STD DEV .2276

URANIUM EQ. PPM
MIN .5657
MAX 1.762
MEAN .8241
STD DEV .1677

THORIUM EQ. PPM
MIN .7067
MAX 4.892
MEAN 1.600
STD DEV .6408

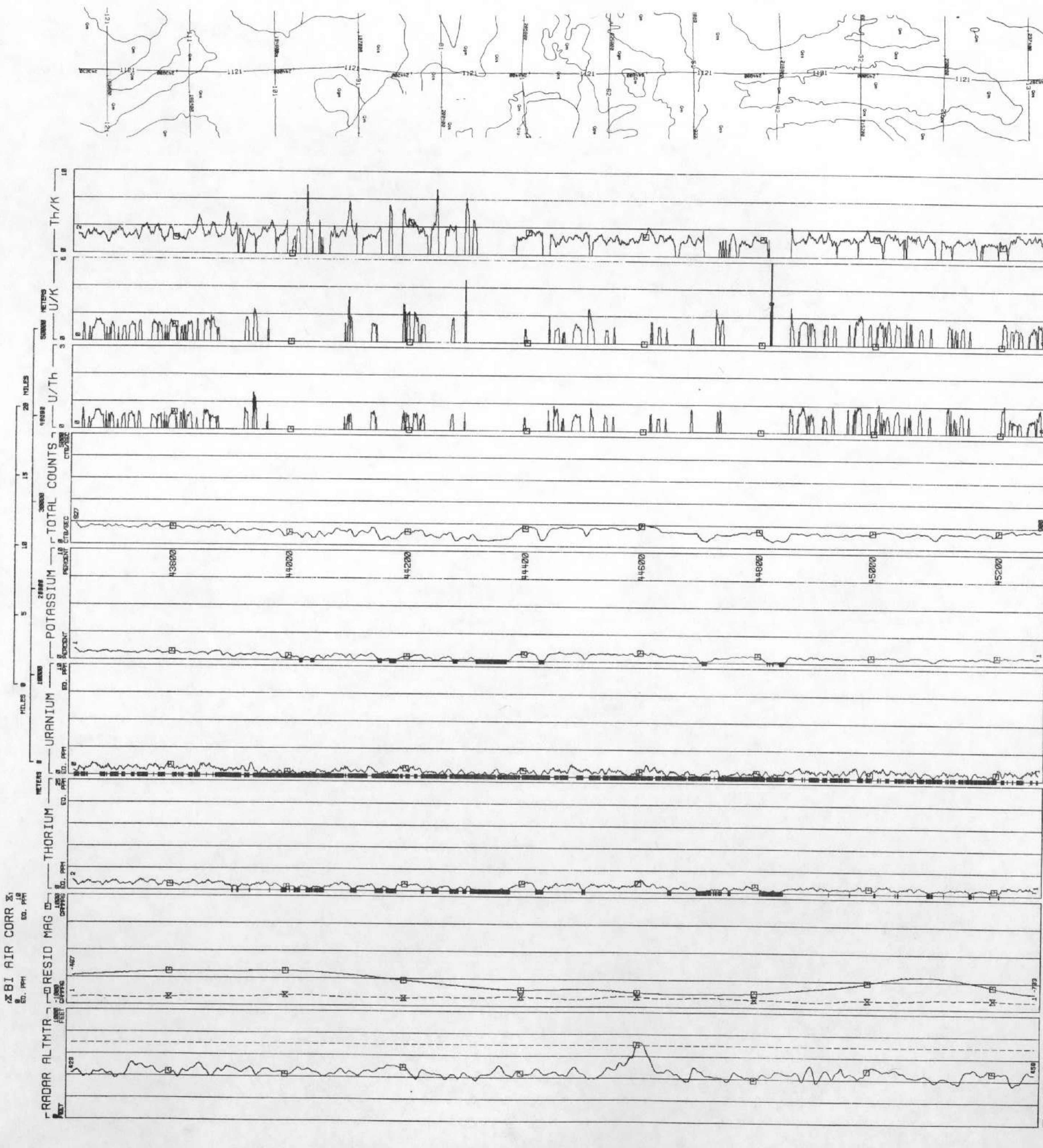
BI AIR CORR EQ. PPM
MIN .4476
MAX 1.103
MEAN .8115
STD DEV .1137

RESID MAG GAMMAS
MIN -836.3
MAX -455.9
MEAN -612.1
STD DEV 108.9

RADAR ALTMTR FEET
MIN 280.1
MAX 566.4
MEAN 430.9
STD DEV 40.27

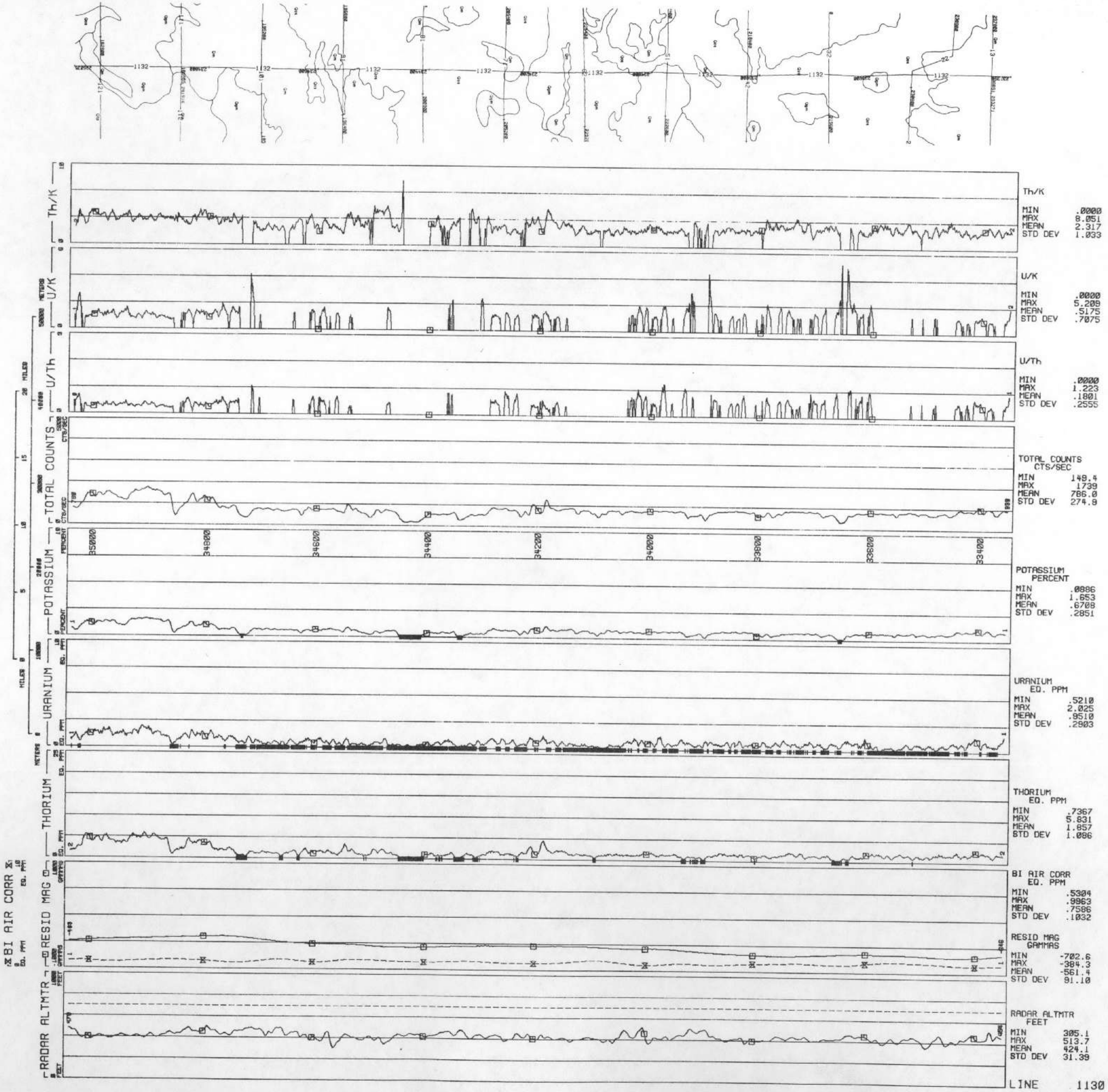
LINE 1110

LINE 1120
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81167

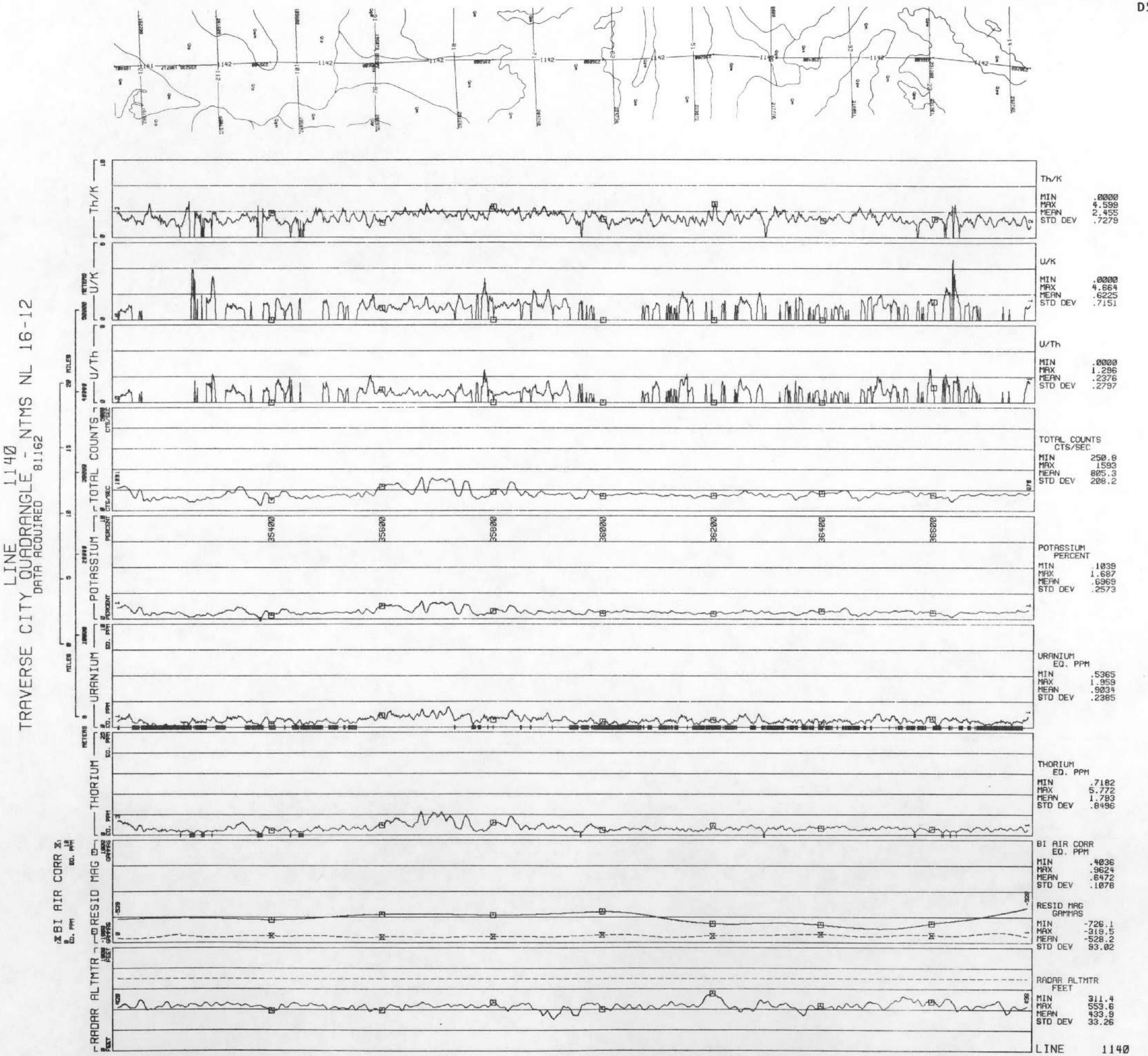


D49 mt

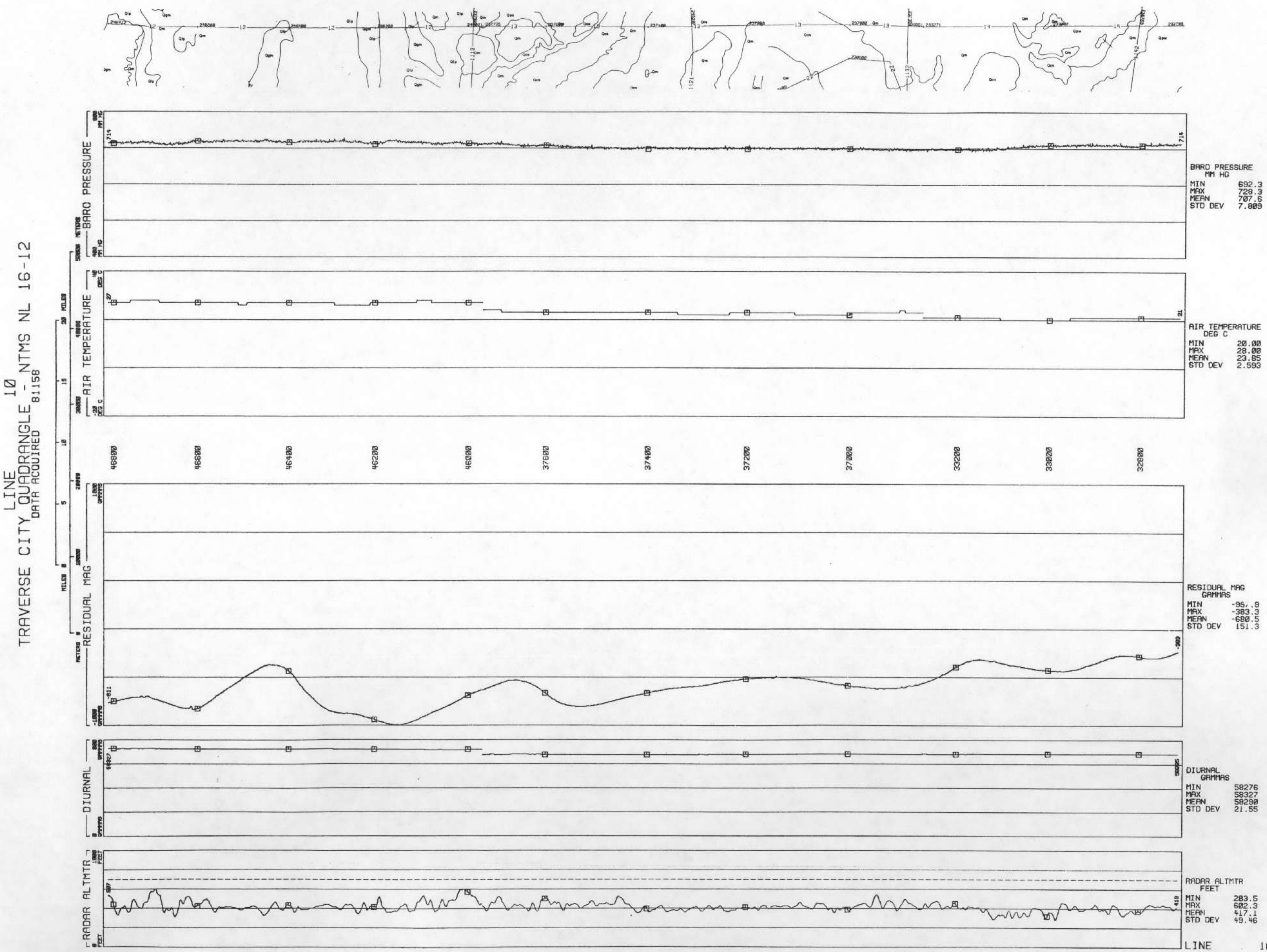
LINE 1130
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81167



D50 mt

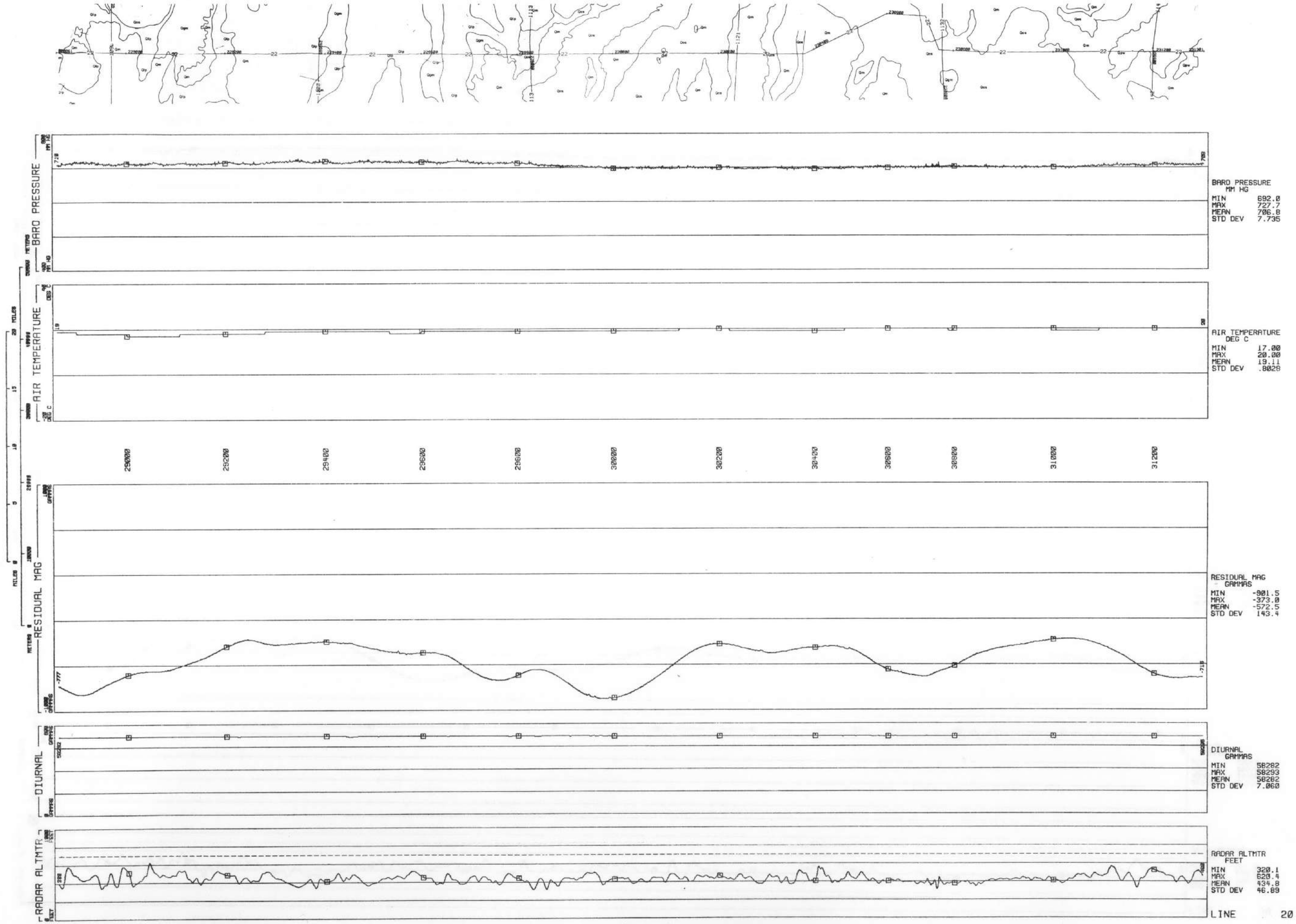


LINE 1140
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81162
Th/K
MIN .0000
MAX 4.599
MEAN 2.455
STD DEV .7279
U/K
MIN .0000
MAX 4.664
MEAN .6225
STD DEV .7151
U/Th
MIN .0000
MAX 1.296
MEAN .2376
STD DEV .2797
TOTAL COUNTS CTS/SEC
MIN 250.0
MAX 1593
MEAN 805.3
STD DEV 208.2
POTASSIUM PERCENT
MIN .1039
MAX 1.687
MEAN .6969
STD DEV .2573
URANIUM EQ. PPM
MIN .5365
MAX 1.959
MEAN .9034
STD DEV .2385
THORIUM EQ. PPM
MIN .7182
MAX 5.772
MEAN 1.793
STD DEV .8496
BI AIR CORR EQ. PPM
MIN .4036
MAX .9624
MEAN .6472
STD DEV .1076
RESID MAG GAMMAS
MIN -726.1
MAX -318.5
MEAN -528.2
STD DEV 93.02
RADAR ALTMTR FEET
MIN 311.4
MAX 553.6
MEAN 433.9
STD DEV 33.26
LINE 1140
35400
35600
35800
36000
36200
36400
36600


LINE 10
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
46800
46600
46400
46200
46000
37600
37400
37200
37000
33200
33000
32800
BARO PRESSURE MM HG
MIN 692.3
MAX 728.3
MEAN 707.6
STD DEV 7.809
AIR TEMPERATURE DEG C
MIN 20.00
MAX 28.00
MEAN 23.85
STD DEV 2.593
RESIDUAL MAG GAMMAS
MIN -99?.9
MAX -383.3
MEAN -680.5
STD DEV 151.3
DIURNAL GAMMAS
MIN 58276
MAX 58327
MEAN 58290
STD DEV 21.55
RADAR ALTMTR FEET
MIN 283.5
MAX 602.3
MEAN 417.1
STD DEV 49.46
LINE 10

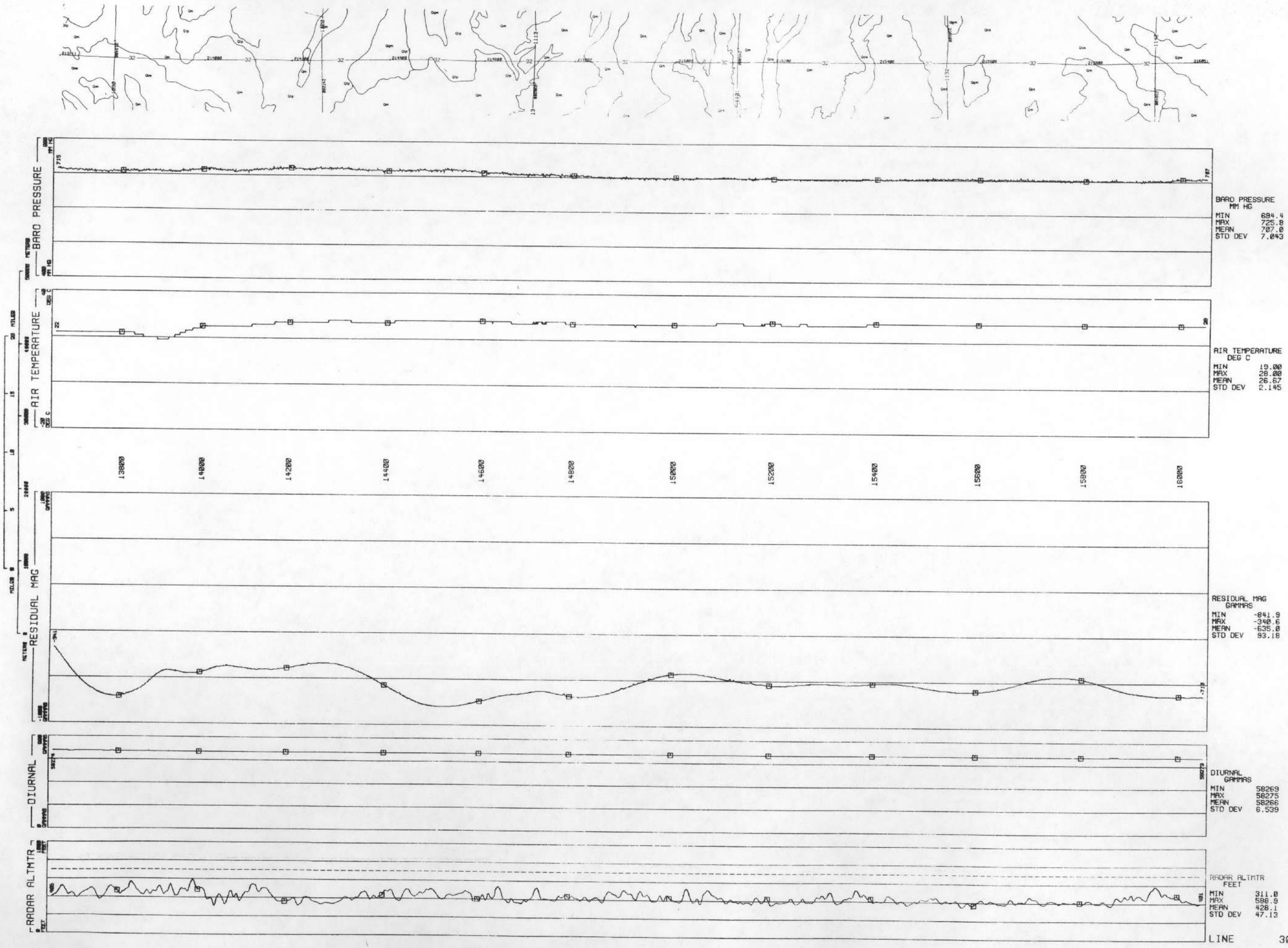
D52 mt

LINE 20
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158

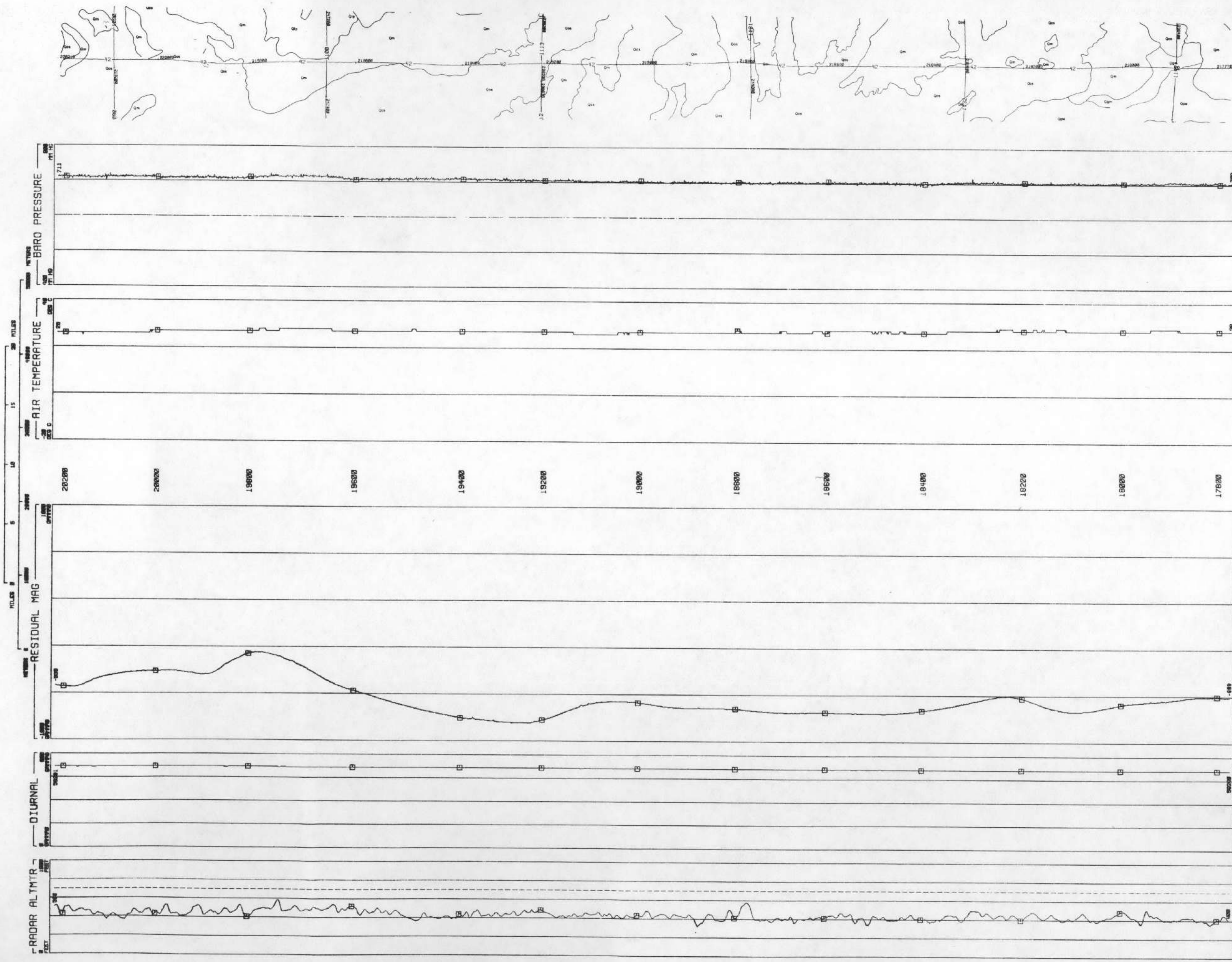


D5 3 mt

LINE 30
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158



LINE 40
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158



BARO PRESSURE
MM HG
MIN 694.4
MAX 721.0
MEAN 705.4
STD DEV 4.106

AIR TEMPERATURE
DEG C
MIN 25.00
MAX 29.00
MEAN 27.20
STD DEV .7366

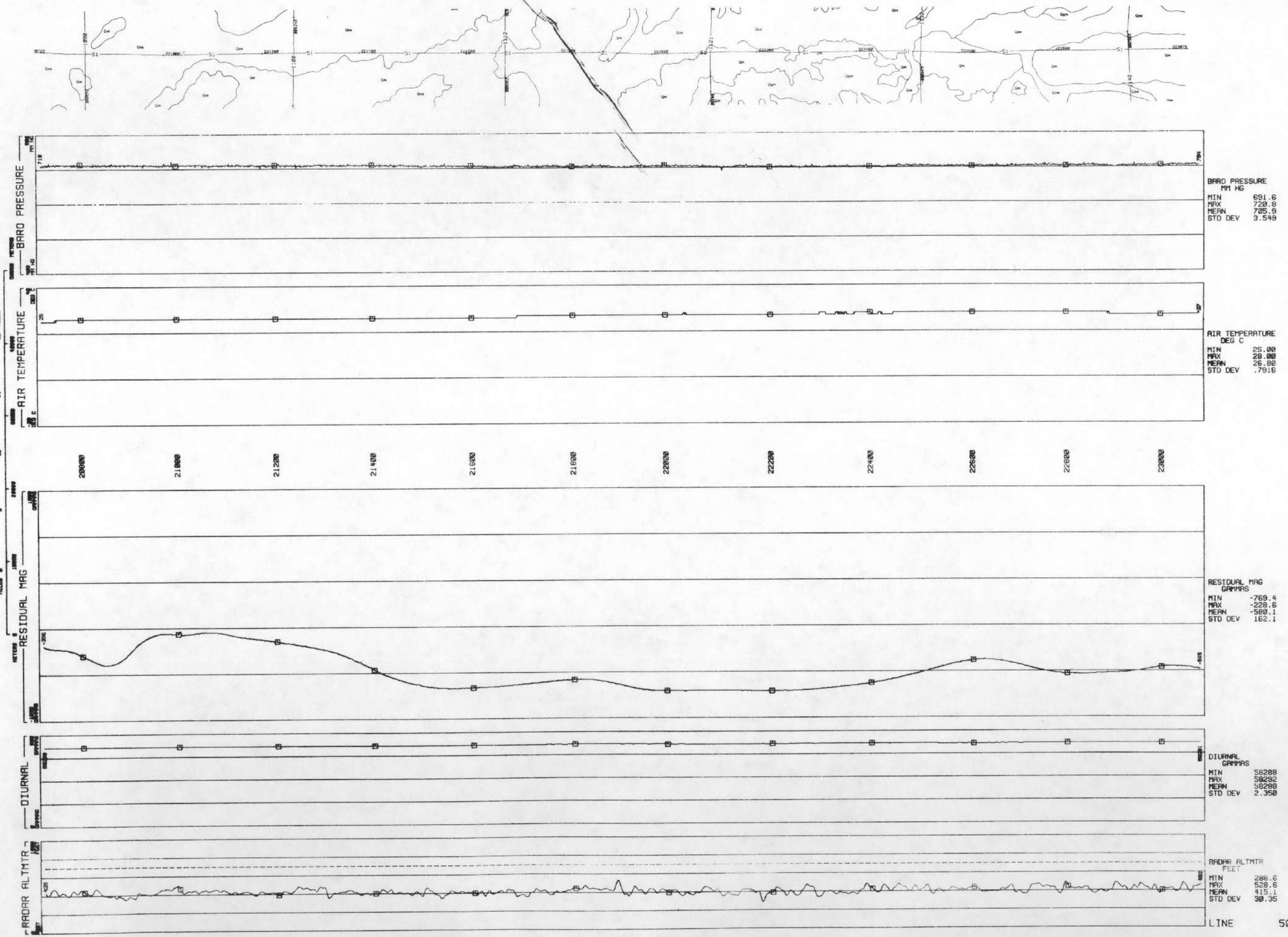
RESIDUAL MAG
GAMMAS
MIN -844.2
MAX -247.2
MEAN -638.6
STD DEV 147.4

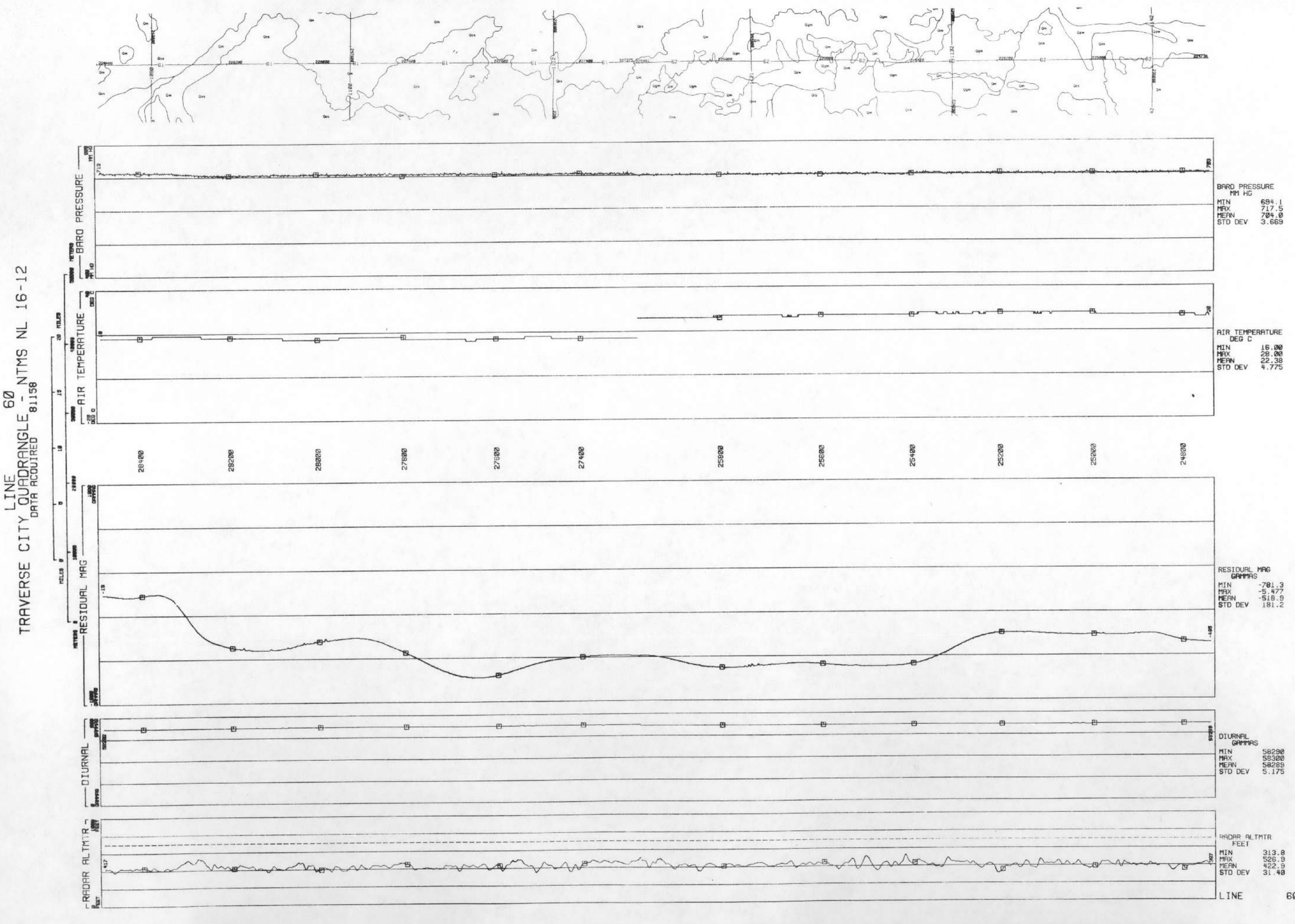
DIURNAL
GAMMAS
MIN 58270
MAX 58292
MEAN 58279
STD DEV 7.702

RADAR ALTMTR
FEET
MIN 322.5
MAX 584.7
MEAN 434.8
STD DEV 38.94

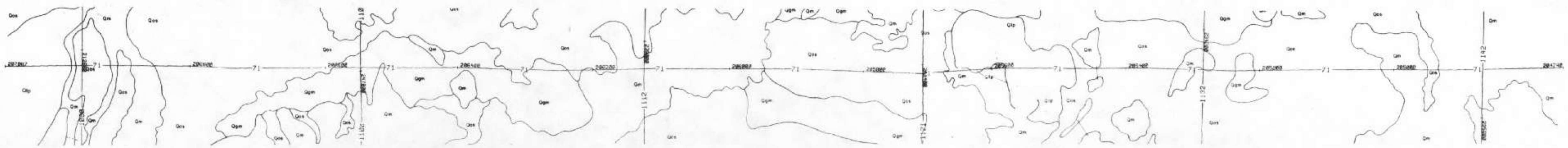
LINE 40

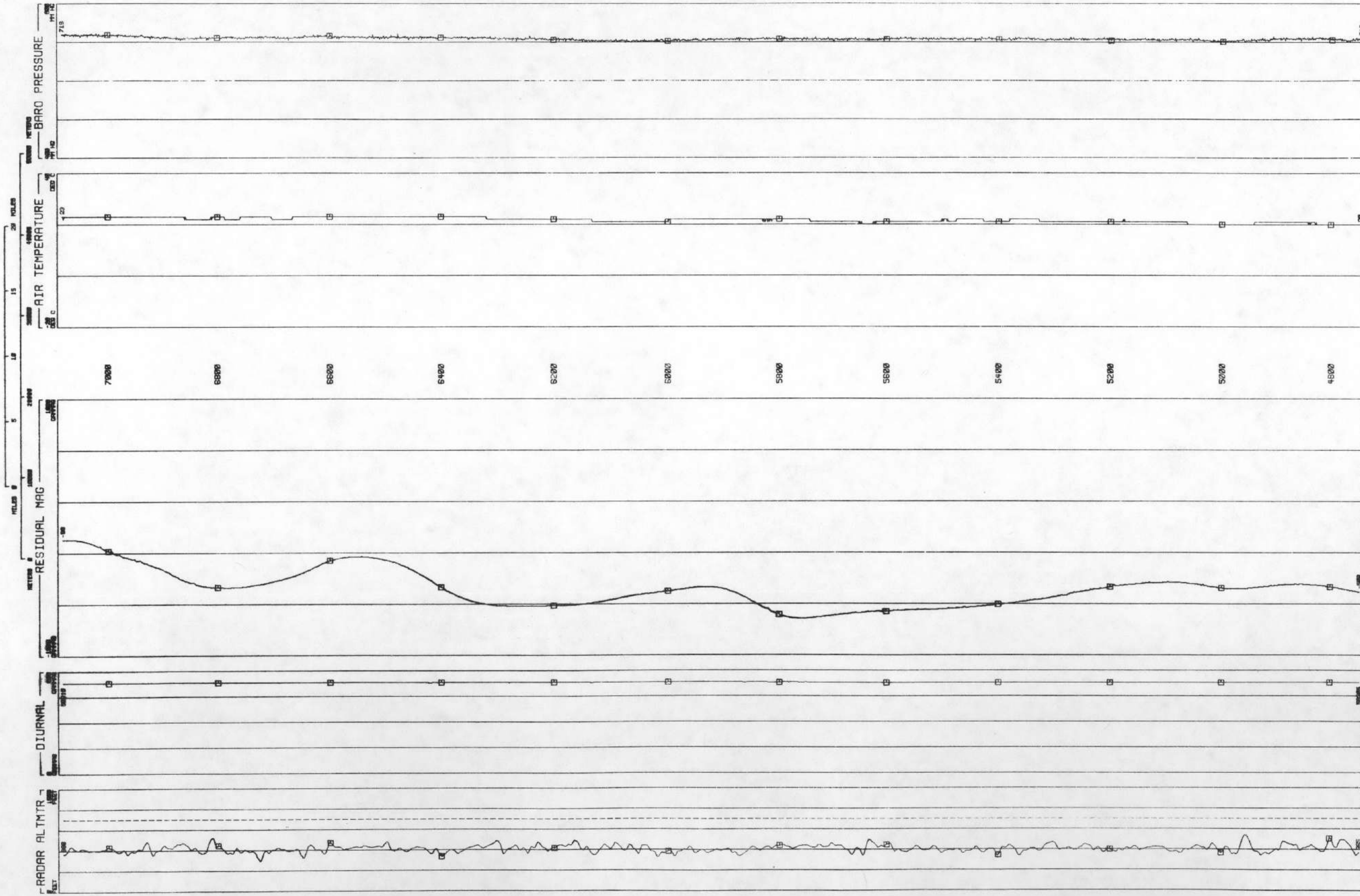
LINE 50
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158




LINE 60
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81158
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
28400
28200
28000
27800
27600
27400
25800
25600
25400
25200
25000
24800
BARO PRESSURE
MM HG
MIN 694.1
MAX 717.5
MEAN 704.0
STD DEV 3.669
AIR TEMPERATURE
DEG C
MIN 16.00
MAX 28.00
MEAN 22.38
STD DEV 4.775
RESIDUAL MAG
GAMMAS
MIN -701.3
MAX -5.477
MEAN -518.9
STD DEV 181.2
DIURNAL
GAMMAS
MIN 58290
MAX 58300
MEAN 58289
STD DEV 5.175
RADAR ALTMTR
FEET
MIN 313.8
MAX 526.9
MEAN 422.9
STD DEV 31.40
LINE 60

LINE 70
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160





BARO PRESSURE
MM HG

MIN	698.5
MAX	721.8
MEAN	708.6
STD DEV	3.904

AIR TEMPERATURE
DEG C

MIN	20.00
MAX	23.00
MEAN	21.74
STD DEV	.8771

RESIDUAL MAG
GAMMAS

MIN	-715.3
MAX	-94.73
MEAN	-484.6
STD DEV	143.0

DIURNAL
GAMMAS

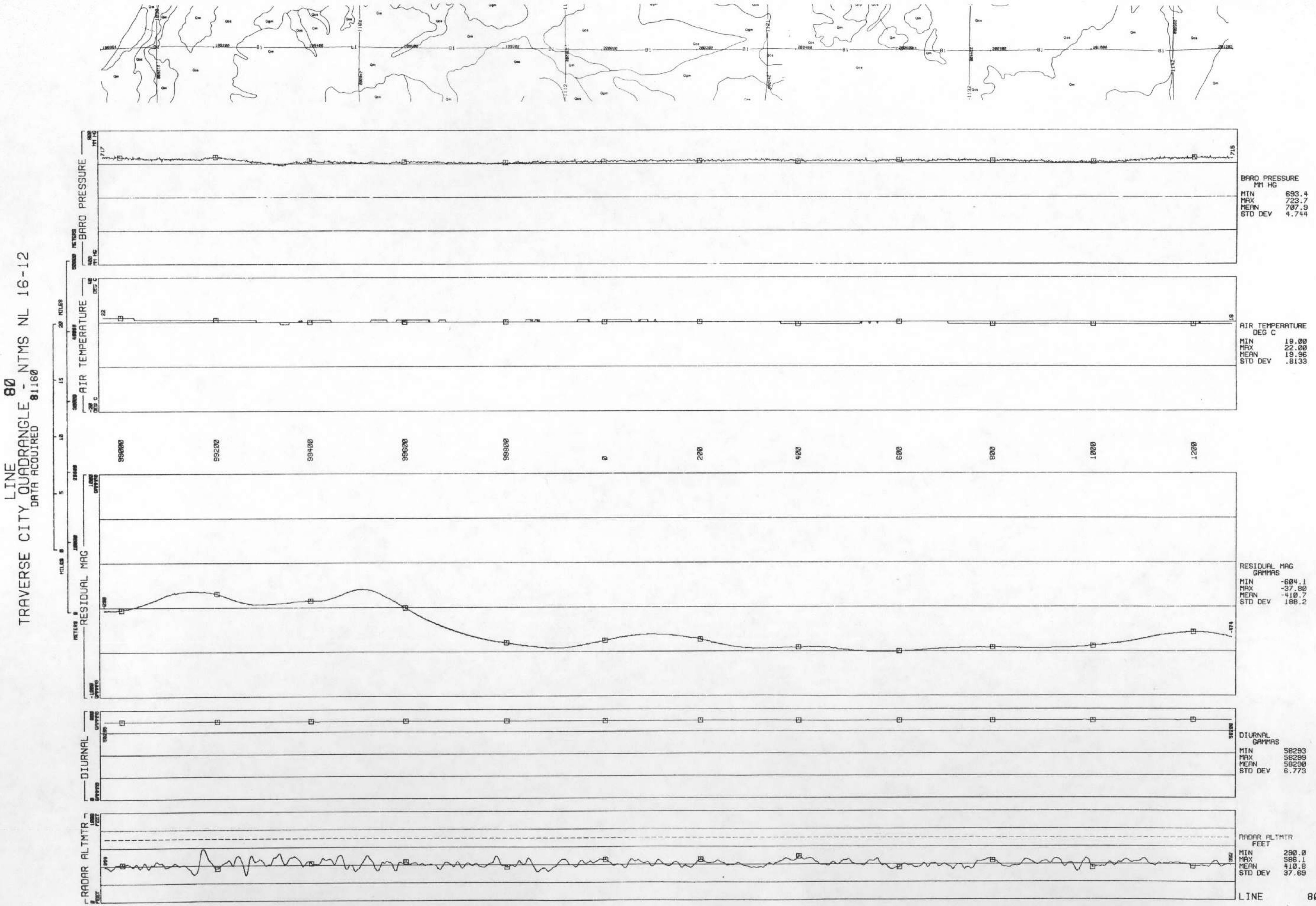
MIN	58303
MAX	58310
MEAN	58303
STD DEV	3.716

RADAR ALTMTR
FEET

MIN	295.3
MAX	538.1
MEAN	409.7
STD DEV	32.60

LINE 70

D58 mt

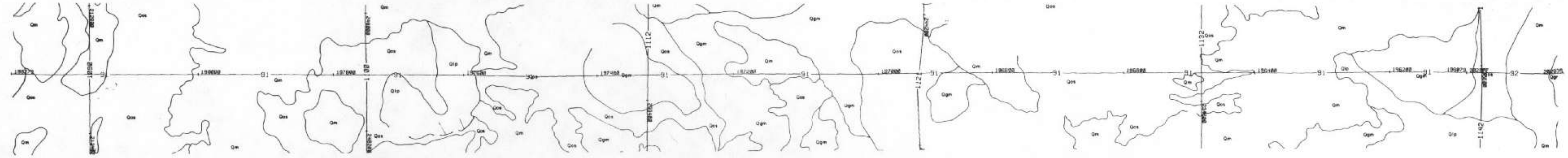


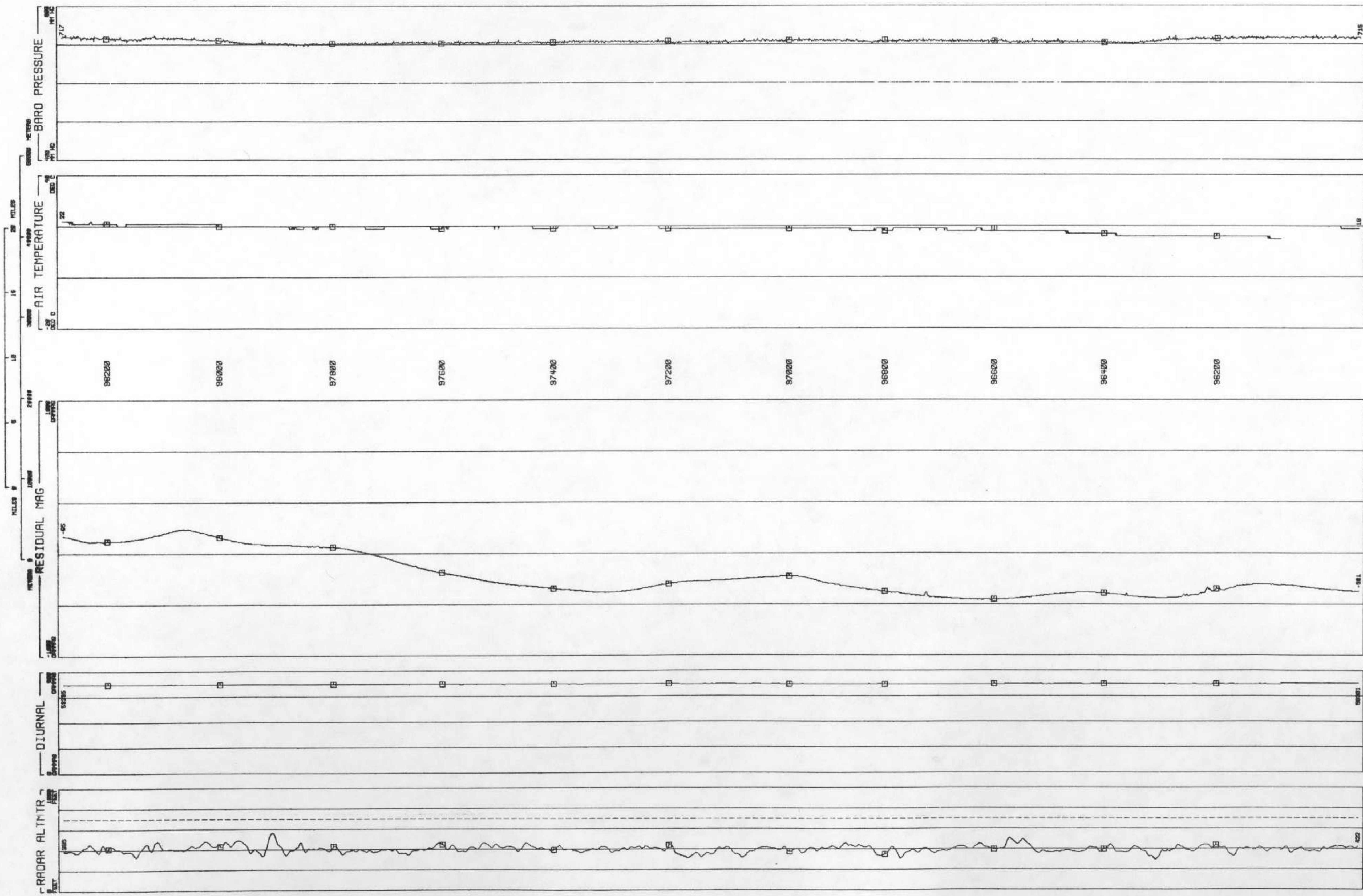
LINE 80
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
98000
99200
99400
99600
99800
0
200
400
600
800
1000
1200
BARO PRESSURE MM HG
MIN 693.4
MAX 723.7
MEAN 707.9
STD DEV 4.744
AIR TEMPERATURE DEG C
MIN 19.00
MAX 22.00
MEAN 19.96
STD DEV .8133
RESIDUAL MAG GAMMAS
MIN -604.1
MAX -37.80
MEAN -410.7
STD DEV 188.2
DIURNAL GAMMAS
MIN 58293
MAX 58299
MEAN 58290
STD DEV 6.773
RADAR ALTMTR FEET
MIN 280.0
MAX 586.1
MEAN 410.8
STD DEV 37.69
LINE 80

LINE 90

TRAVERSE CITY QUADRANGLE - NTMS NL 16-12

DATA ACQUIRED 81160





BARO PRESSURE MM HG
MIN 695.7
MAX 725.8
MEAN 708.3
STD DEV 5.004

AIR TEMPERATURE DEG C
MIN 15.00
MAX 22.00
MEAN 18.96
STD DEV 1.515

RESIDUAL MAG GAMMAS
MIN -562.6
MAX -9.266
MEAN -378.6
STD DEV 167.3

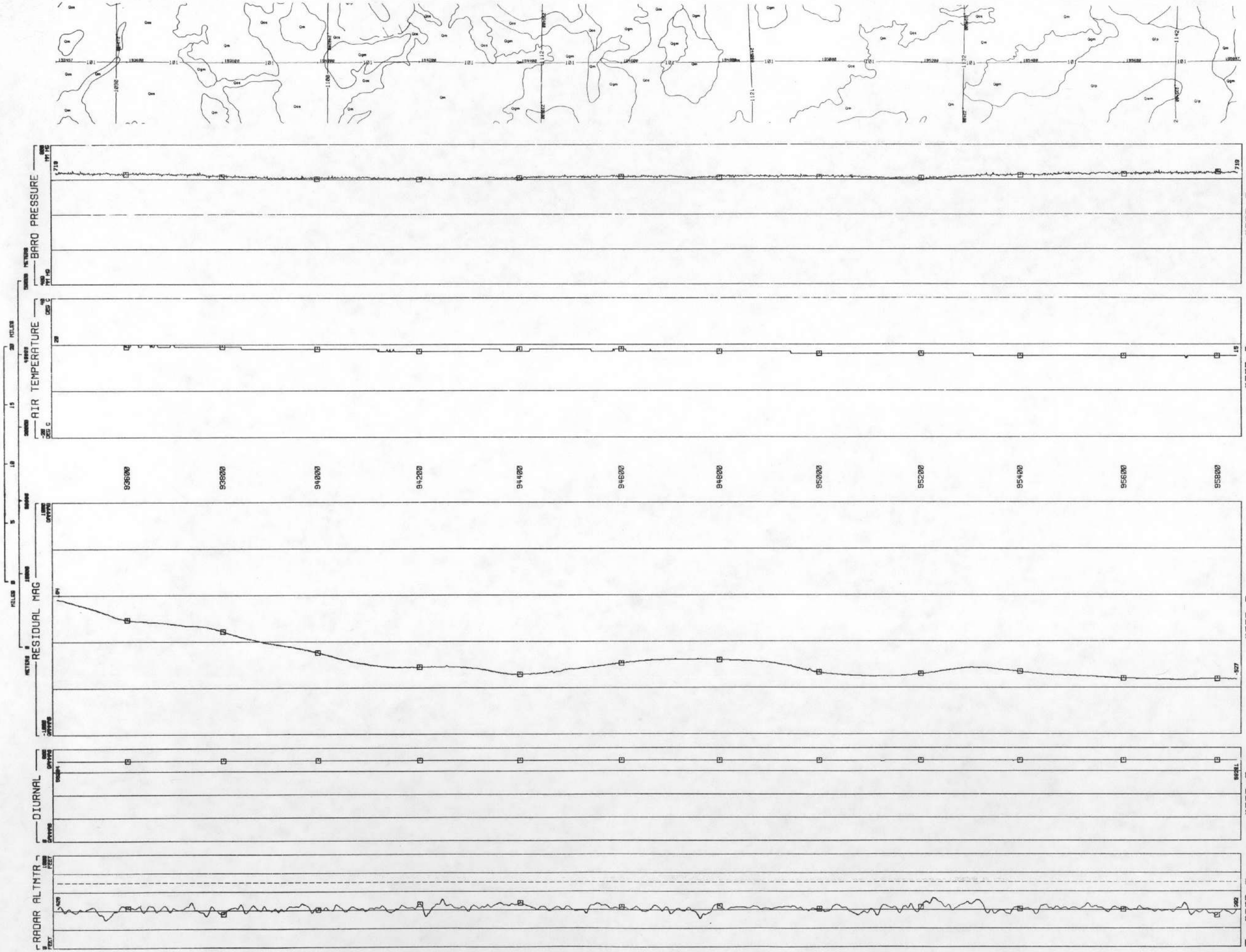
DIURNAL GAMMAS
MIN 58293
MAX 58302
MEAN 58289
STD DEV 6.050

RADAR ALTMTR FEET
MIN 294.5
MAX 561.8
MEAN 401.5
STD DEV 33.39

LINE 90

D60 mt

LINE 100
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160



BARO PRESSURE
MM HG
MIN 697.3
MAX 725.1
MEAN 709.6
STD DEV 5.492

AIR TEMPERATURE
DEG C
MIN 14.00
MAX 20.00
MEAN 17.00
STD DEV 1.514

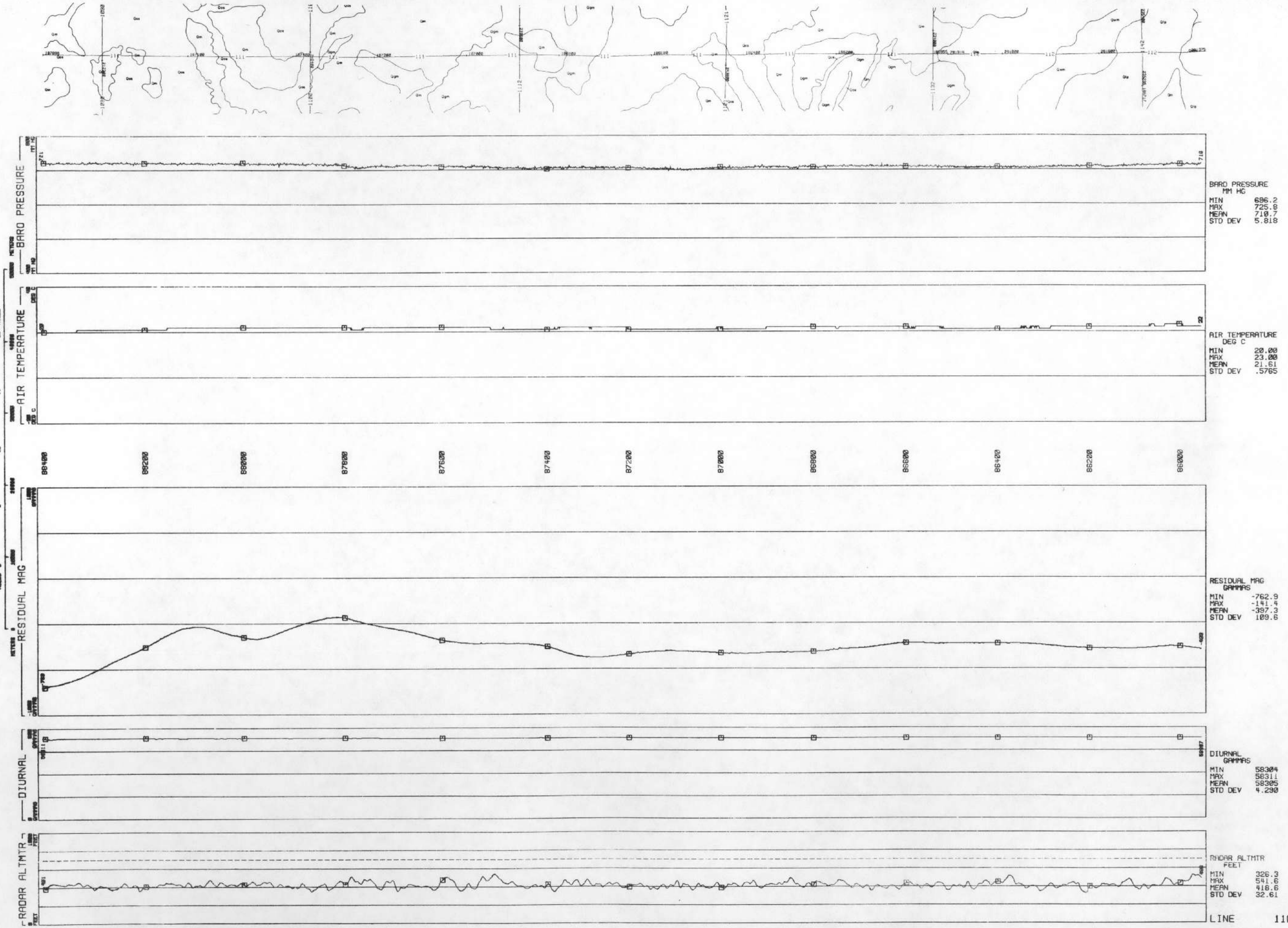
RESIDUAL MAG
GAMMAS
MIN -531.8
MAX 163.5
MEAN -360.6
STD DEV 172.2

DIURNAL
GAMMAS
MIN 58289
MAX 58294
MEAN 58289
STD DEV 3.667

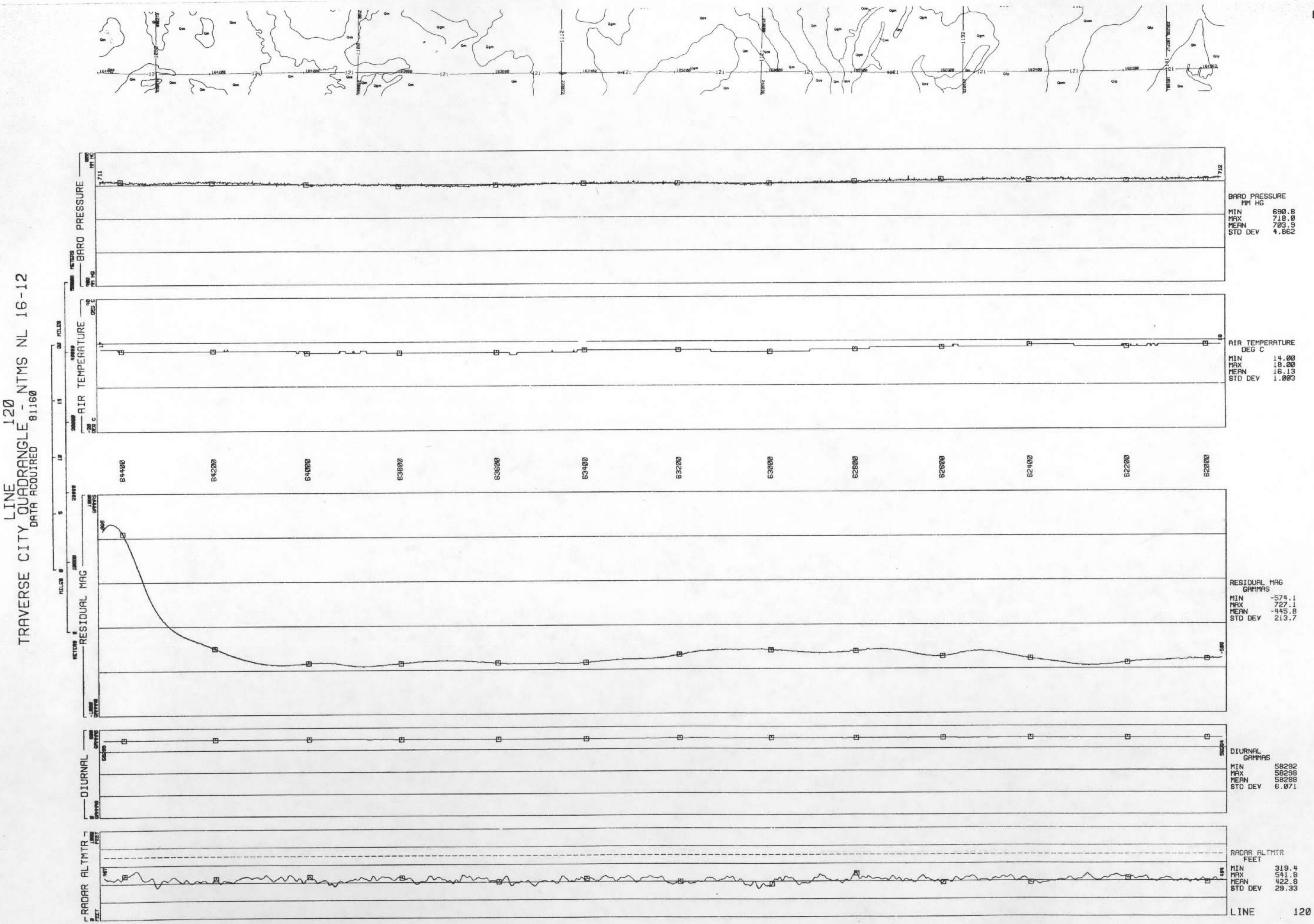
RADAR ALTMTR
FEET
MIN 300.6
MAX 527.9
MEAN 414.9
STD DEV 32.48

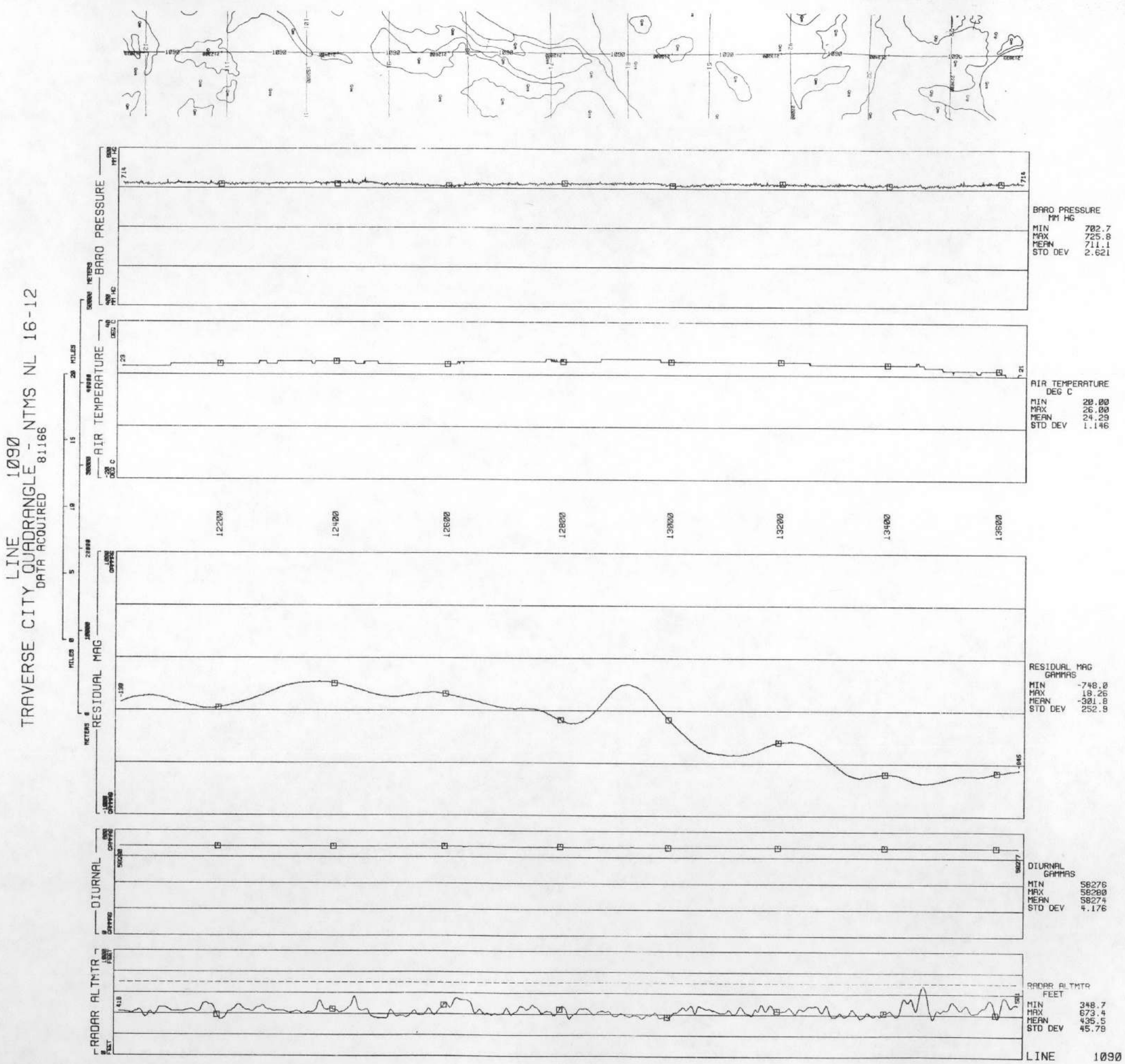
LINE 100

LINE 110
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160

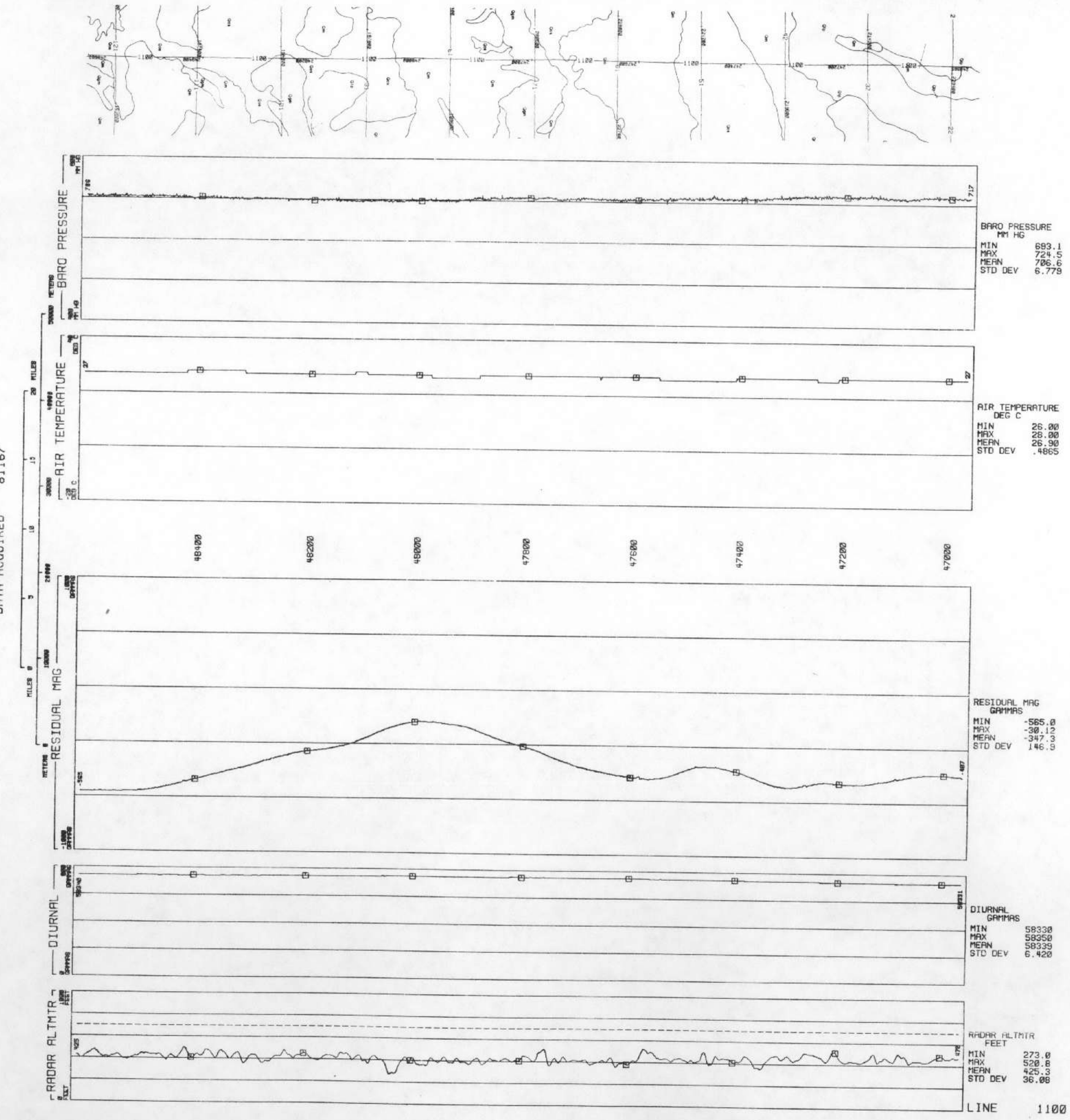


D62 mt

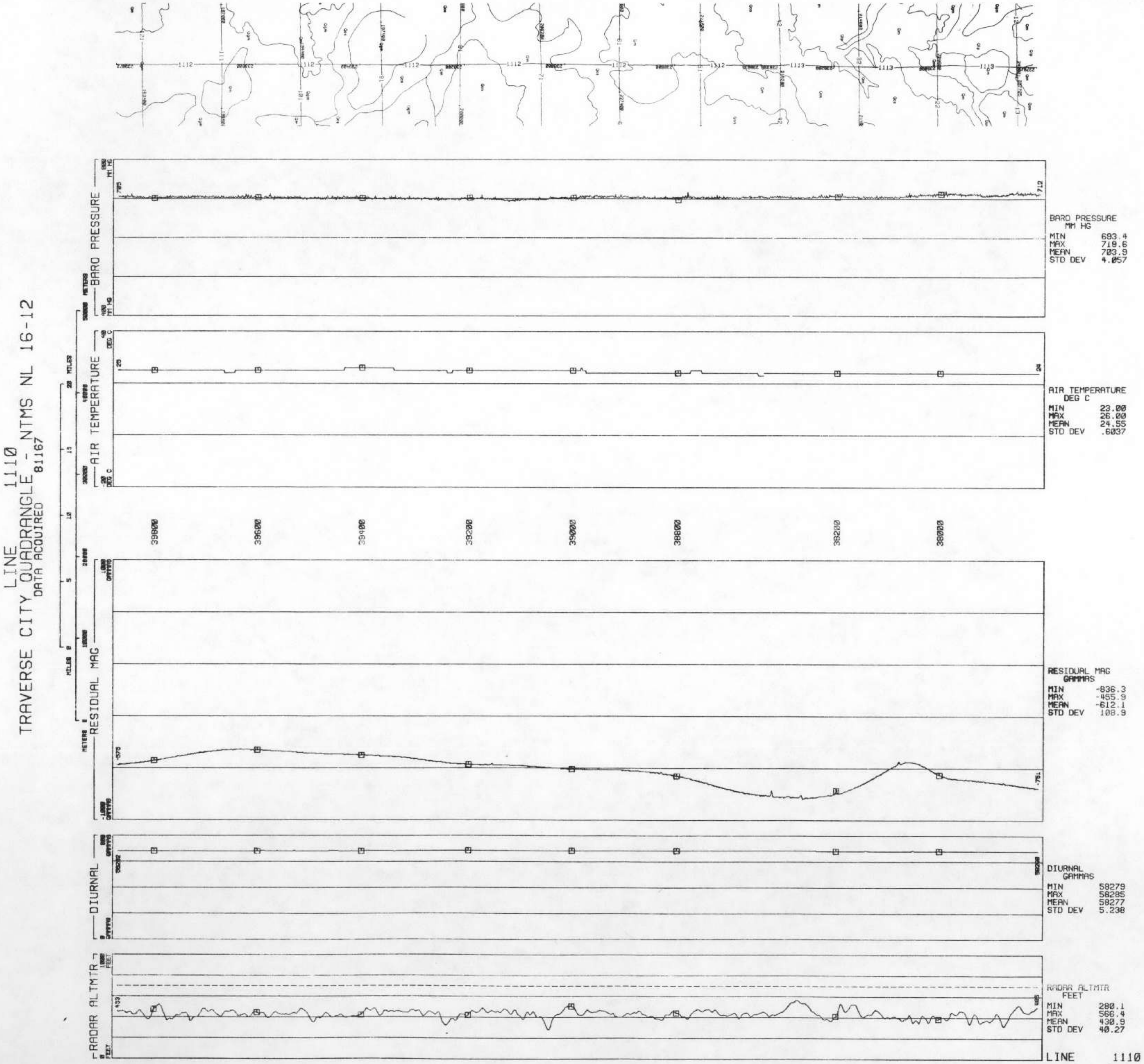

LINE 120
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81160
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
64400 64200 64000 63800 63600 63400 63200 63000 62800 62600 62400 62200 62000
BARO PRESSURE MM HG
MIN 690.8
MAX 718.0
MEAN 703.9
STD DEV 4.862
AIR TEMPERATURE DEG C
MIN 14.00
MAX 18.00
MEAN 16.13
STD DEV 1.003
RESIDUAL MAG GAMMAS
MIN -574.1
MAX 727.1
MEAN -445.8
STD DEV 213.7
DIURNAL GAMMAS
MIN 58292
MAX 58298
MEAN 58288
STD DEV 6.071
RADAR ALTMTR FEET
MIN 319.4
MAX 541.8
MEAN 422.8
STD DEV 29.33
LINE 120

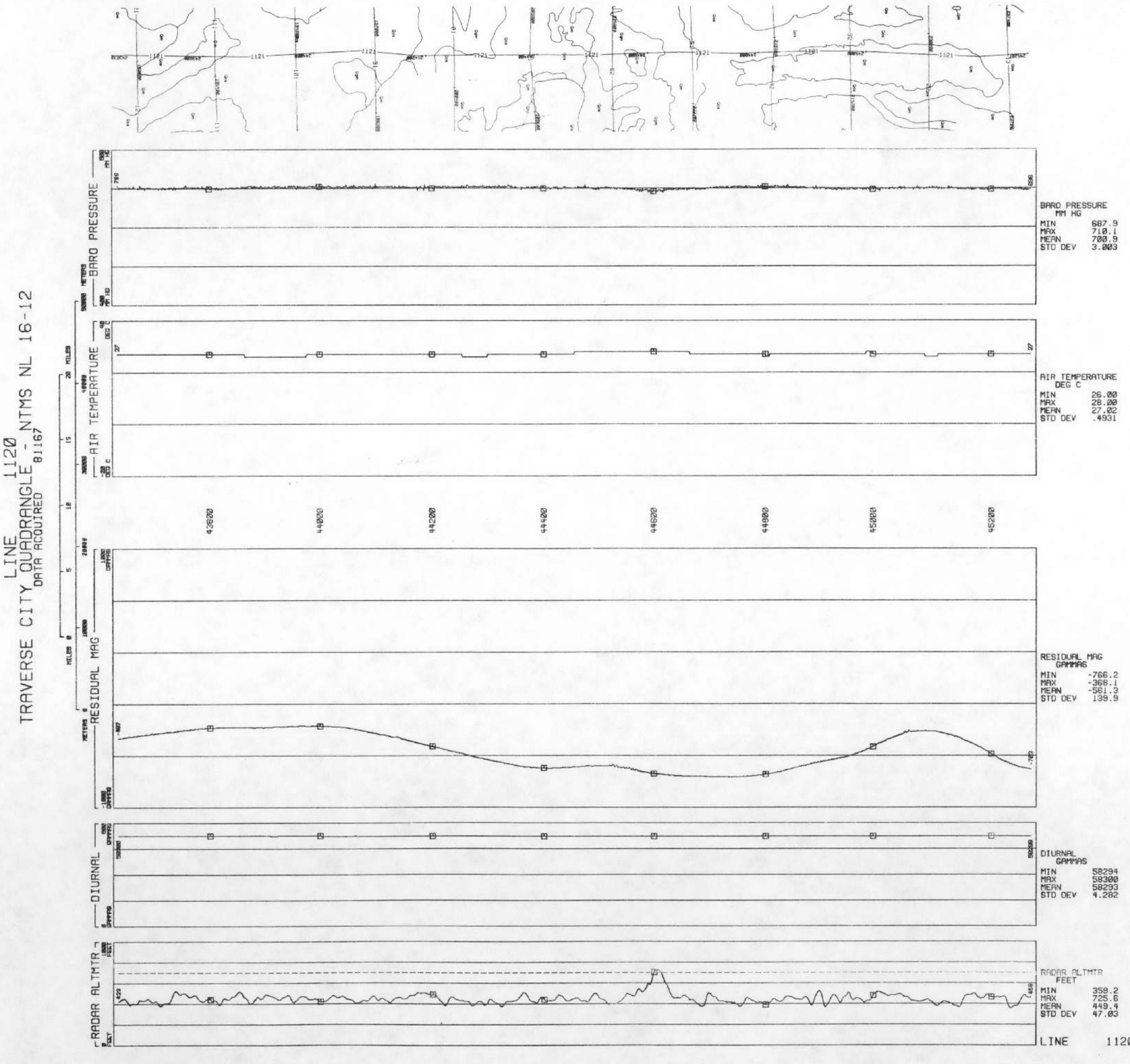

LINE 1090
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81166
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
12200
12400
12600
12800
13000
13200
13400
13600
BARO PRESSURE MM HG
MIN 702.7
MAX 725.8
MEAN 711.1
STD DEV 2.621
AIR TEMPERATURE DEG C
MIN 20.00
MAX 26.00
MEAN 24.29
STD DEV 1.146
RESIDUAL MAG GAMMAS
MIN -748.0
MAX 18.26
MEAN -301.8
STD DEV 252.9
DIURNAL GAMMAS
MIN 58276
MAX 58280
MEAN 58274
STD DEV 4.176
RADAR ALTMTR FEET
MIN 348.7
MAX 673.4
MEAN 435.5
STD DEV 45.79
LINE 1090

D64 mt

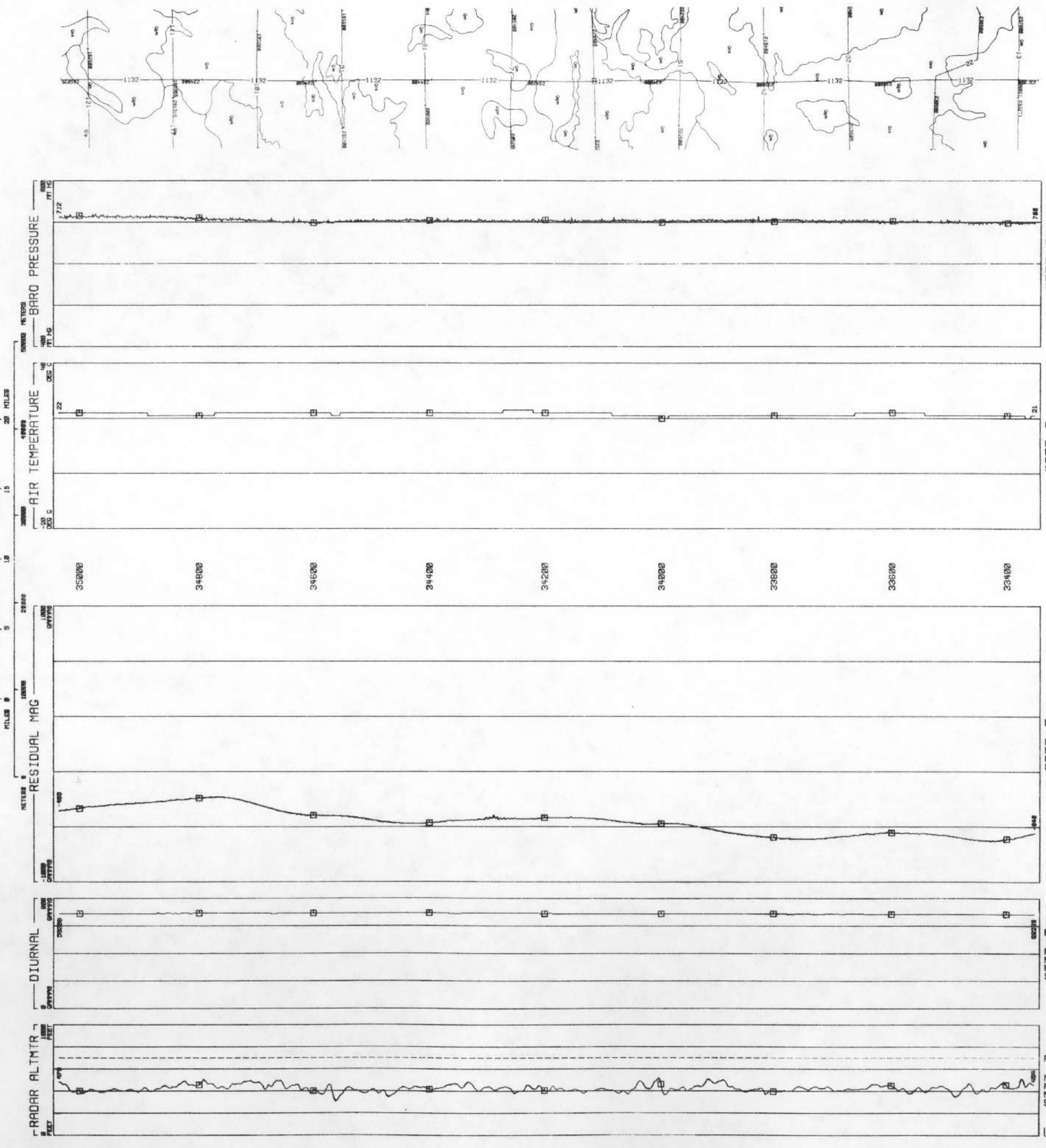

LINE 1100
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81167
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
48400
48200
48000
47800
47600
47400
47200
47000
BARO PRESSURE MM HG
MIN 683.1
MAX 724.5
MEAN 706.6
STD DEV 6.779
AIR TEMPERATURE DEG C
MIN 26.00
MAX 28.00
MEAN 26.90
STD DEV .4865
RESIDUAL MAG GAMMAS
MIN -565.0
MAX -30.12
MEAN -347.3
STD DEV 146.9
DIURNAL GAMMAS
MIN 58330
MAX 58350
MEAN 58339
STD DEV 6.420
RADAR ALTMTR FEET
MIN 273.0
MAX 520.8
MEAN 425.3
STD DEV 36.08
LINE 1100

D65 mt


LINE 1110
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81167
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
BARO PRESSURE
MM HG
MIN 693.4
MAX 710.6
MEAN 703.9
STD DEV 4.057
AIR TEMPERATURE
DEG C
MIN 23.00
MAX 26.00
MEAN 24.55
STD DEV .6037
RESIDUAL MAG
GAMMAS
MIN -836.3
MAX -455.9
MEAN -612.1
STD DEV 108.9
DIURNAL
GAMMAS
MIN 58279
MAX 58285
MEAN 58277
STD DEV 5.238
RADAR ALTMTR
FEET
MIN 280.1
MAX 566.4
MEAN 430.9
STD DEV 40.27
LINE 1110


LINE 1120
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81167
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
43800
44000
44200
44400
44600
44800
45000
45200
BARO PRESSURE MM HG
MIN 687.9
MAX 710.1
MEAN 700.9
STD DEV 3.003
AIR TEMPERATURE DEG C
MIN 26.00
MAX 28.00
MEAN 27.02
STD DEV .4931
RESIDUAL MAG GAMMAS
MIN -766.2
MAX -368.1
MEAN -561.3
STD DEV 139.9
DIURNAL GAMMAS
MIN 58294
MAX 58300
MEAN 58293
STD DEV 4.282
RADAR ALTMTR FEET
MIN 359.2
MAX 725.6
MEAN 449.4
STD DEV 47.03
LINE 1120

LINE 1130
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81167



BARO PRESSURE
MM HG

MIN	694.1
MAX	720.2
MEAN	703.9
STD DEV	4.352

AIR TEMPERATURE
DEG C

MIN	20.00
MAX	23.00
MEAN	21.58
STD DEV	.5763

RESIDUAL MAG
GAMMAS

MIN	-702.6
MAX	-384.3
MEAN	-561.4
STD DEV	91.10

DIURNAL
GAMMAS

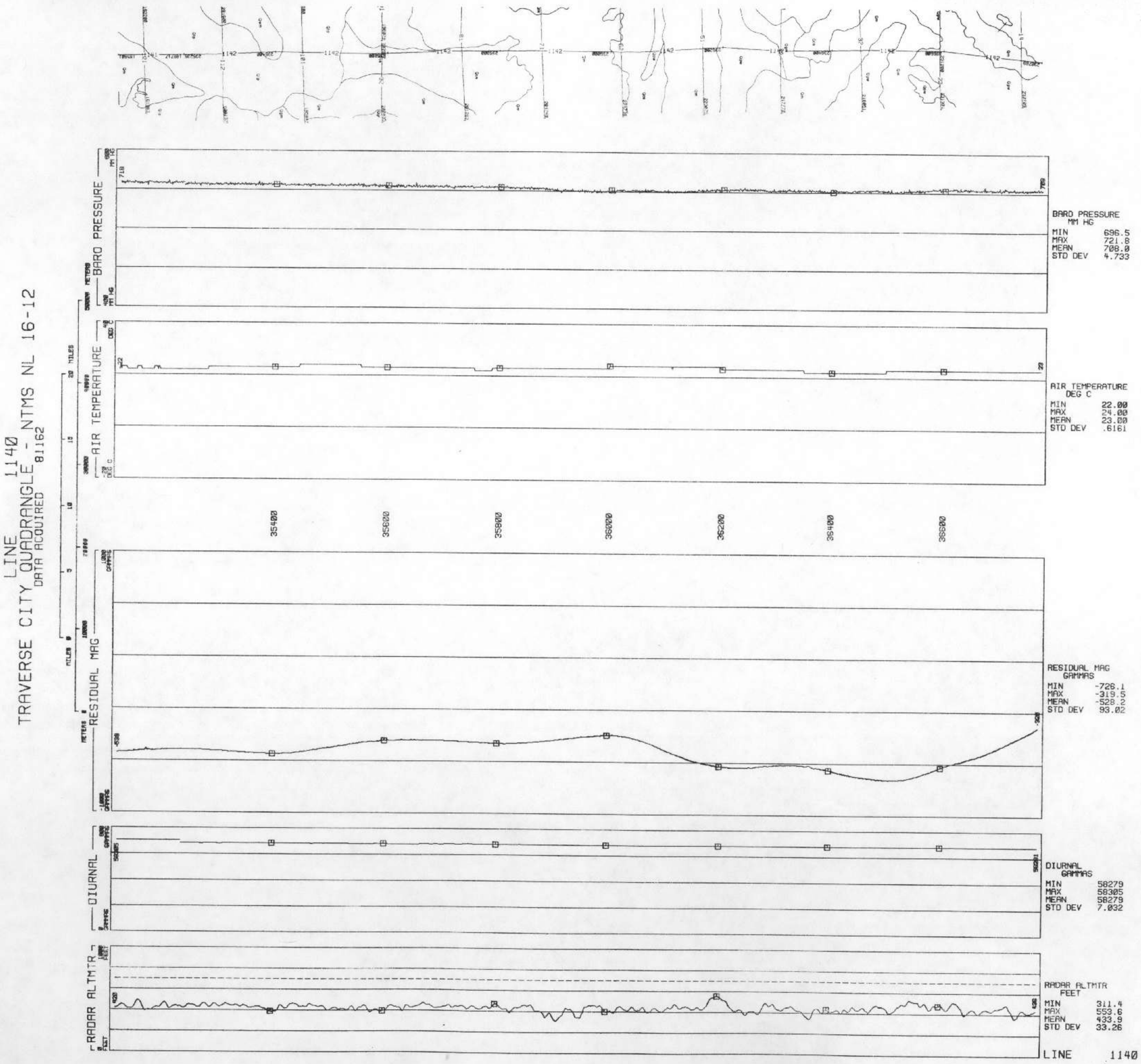
MIN	58283
MAX	58292
MEAN	58283
STD DEV	6.234

RADAR ALTMTR
FEET

MIN	305.1
MAX	513.7
MEAN	424.1
STD DEV	31.39

LINE 1130

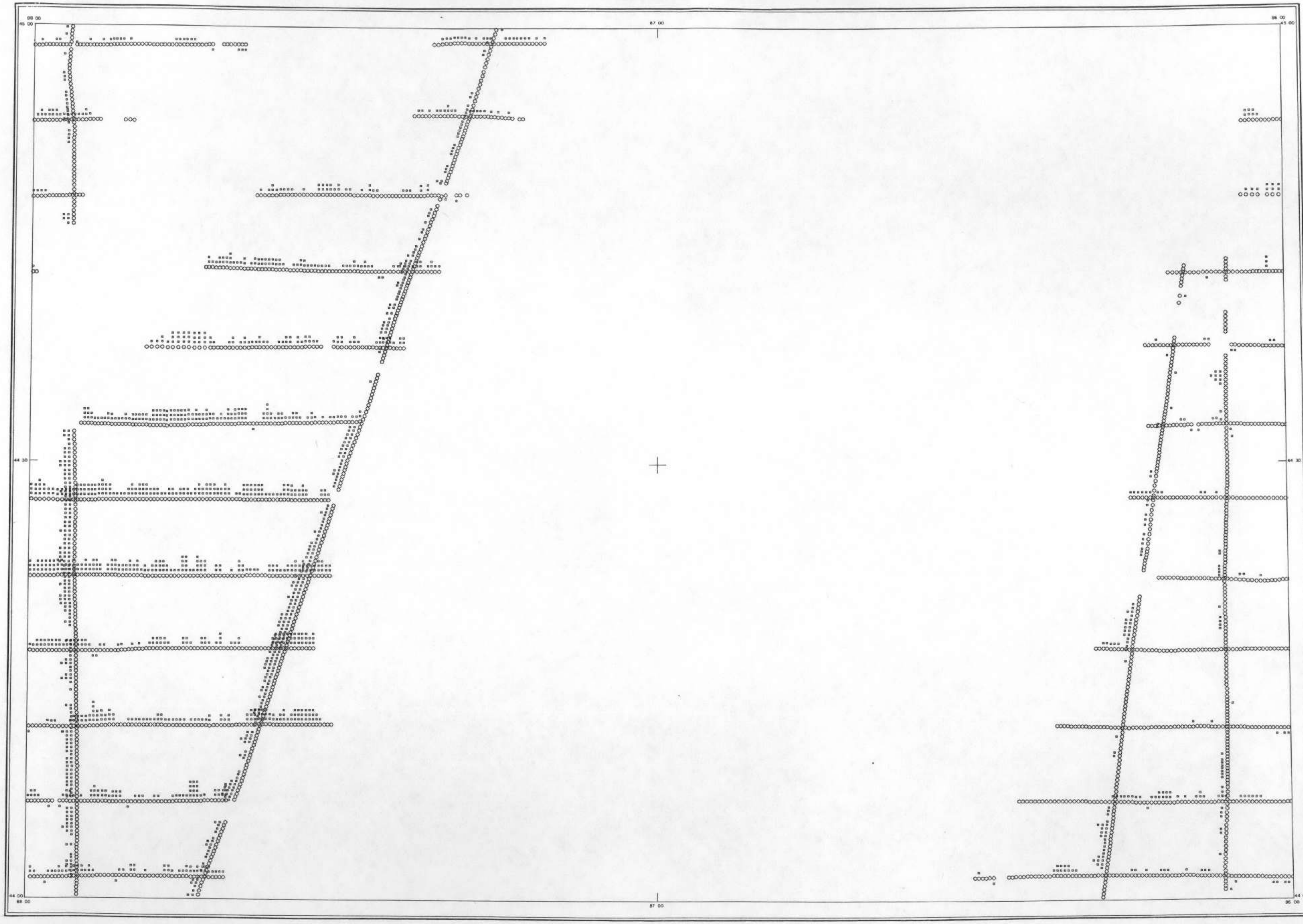
D68 mt



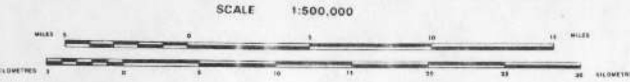
LINE 1140
TRAVERSE CITY QUADRANGLE - NTMS NL 16-12
DATA ACQUIRED 81162
BARO PRESSURE
MM HG
MIN 696.5
MAX 721.8
MEAN 708.0
STD DEV 4.733
AIR TEMPERATURE
DEG C
MIN 22.00
MAX 24.00
MEAN 23.00
STD DEV .6161
35400
35600
35800
36000
36200
36400
36600
RESIDUAL MAG
GAMMAS
MIN -726.1
MAX -319.5
MEAN -528.2
STD DEV 93.02
DIURNAL
GAMMAS
MIN 58279
MAX 58305
MEAN 58279
STD DEV 7.032
RADAR ALTMTR
FEET
MIN 311.4
MAX 553.6
MEAN 433.9
STD DEV 33.26
LINE 1140

APPENDIX E - Standard Deviation Maps

MANITOWOC

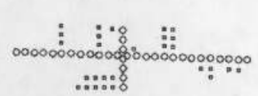


SCALE 1:500,000



SURVEY AND COMPILATION BY:

EG&G GEOMETRICS



○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

NOTE: ON E-W LINES. +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES. +σ TO WEST. -σ TO EAST.

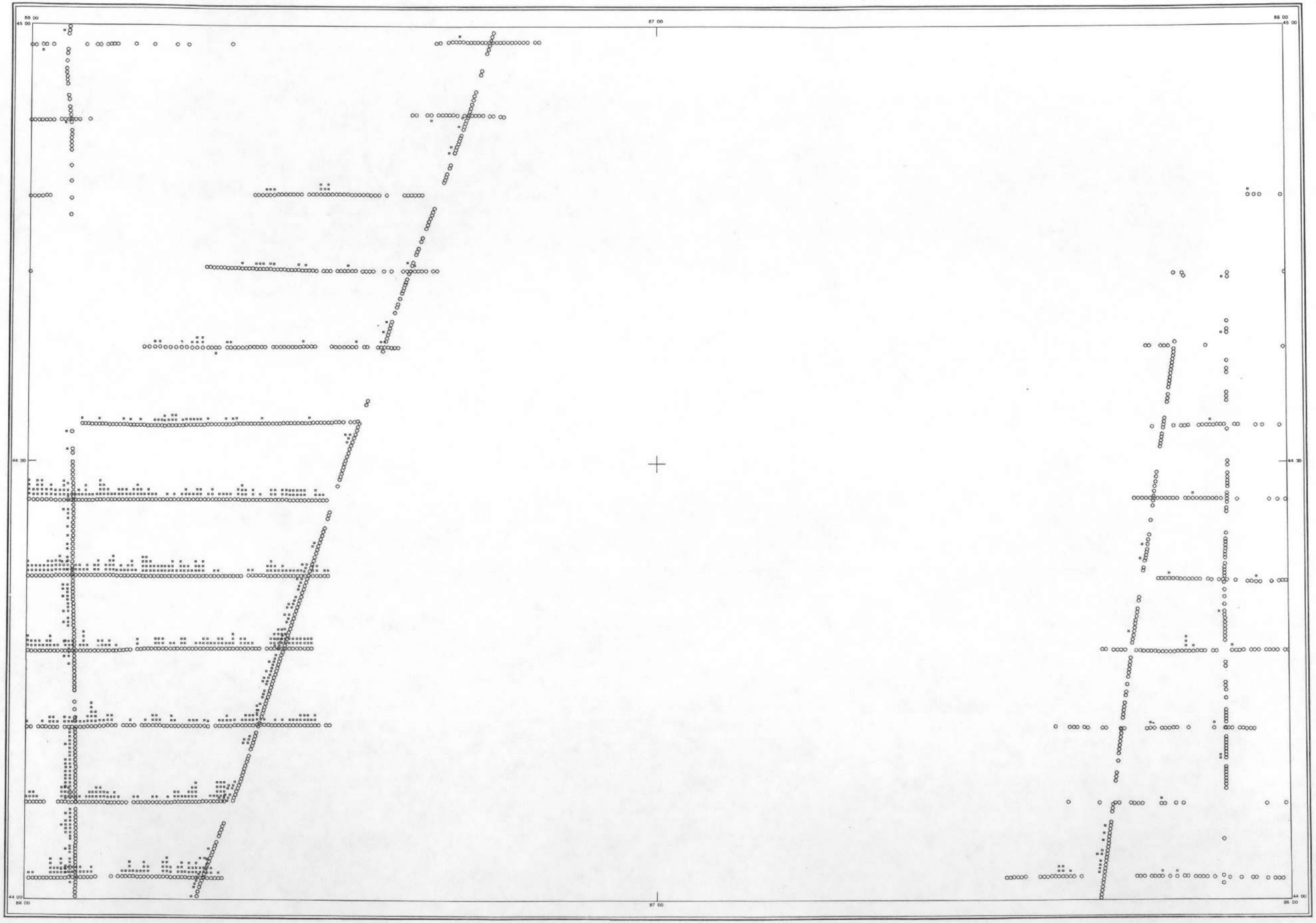
LOCATION DIAGRAM

POTASSIUM STANDARD DEVIATION MAP

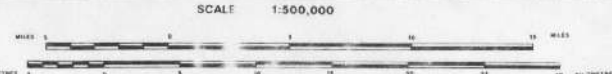
GREAT LAKES PROJECT

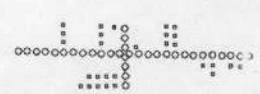
U. S. DEPARTMENT OF ENERGY

MANITOWOC



SCALE 1:500,000

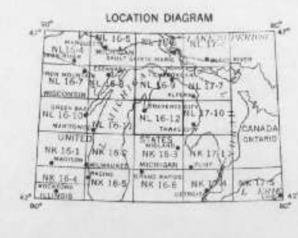




○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

LOCATION DIAGRAM



SURVEY AND COMPILATION BY:

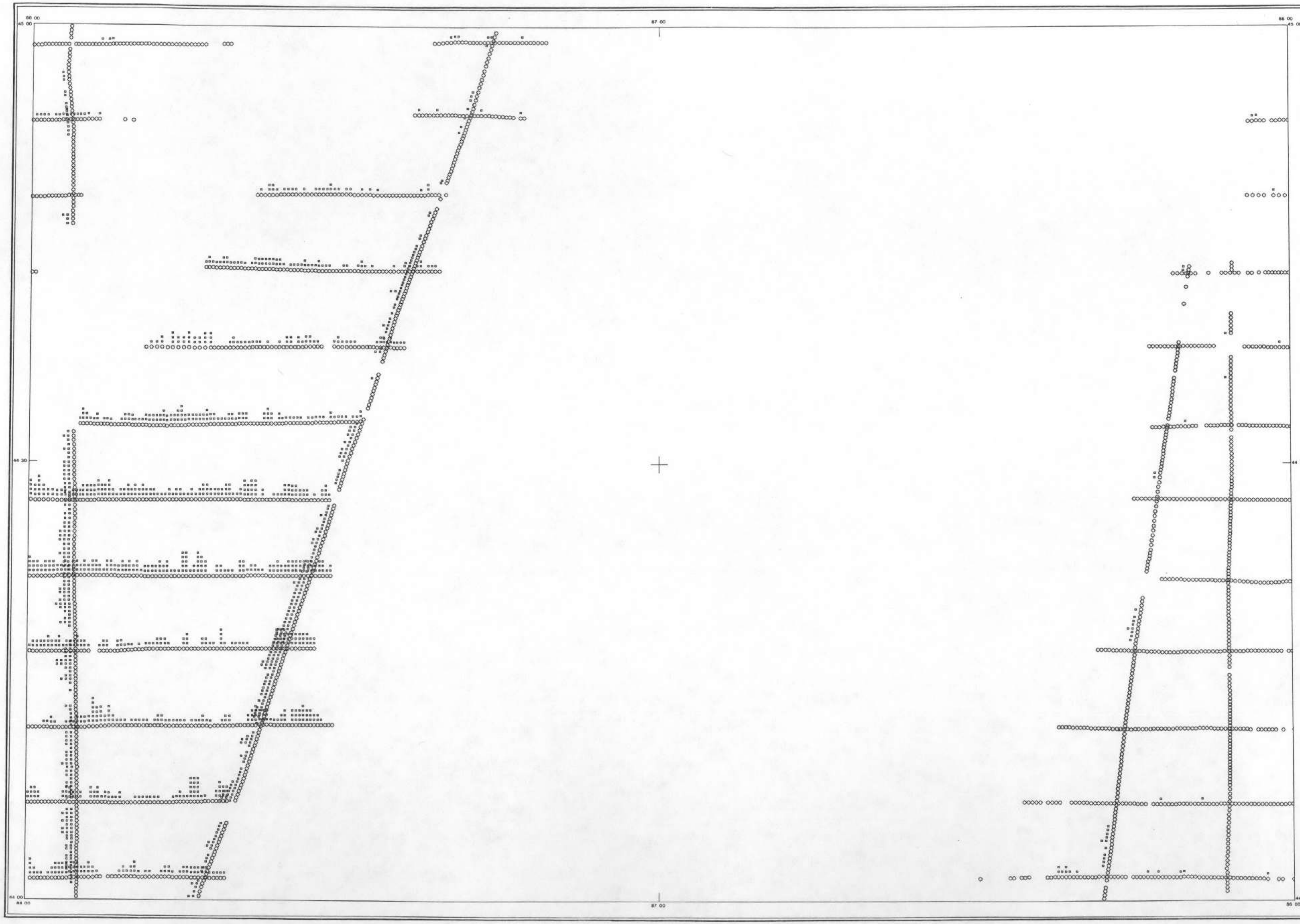
EG&G GEOMETRICS

URANIUM STANDARD DEVIATION MAP

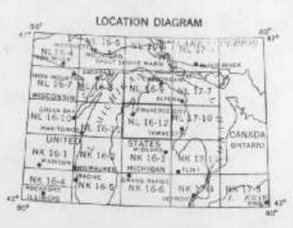
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

MANITOWOC



SCALE 1:500,000



THORIUM STANDARD DEVIATION MAP

○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

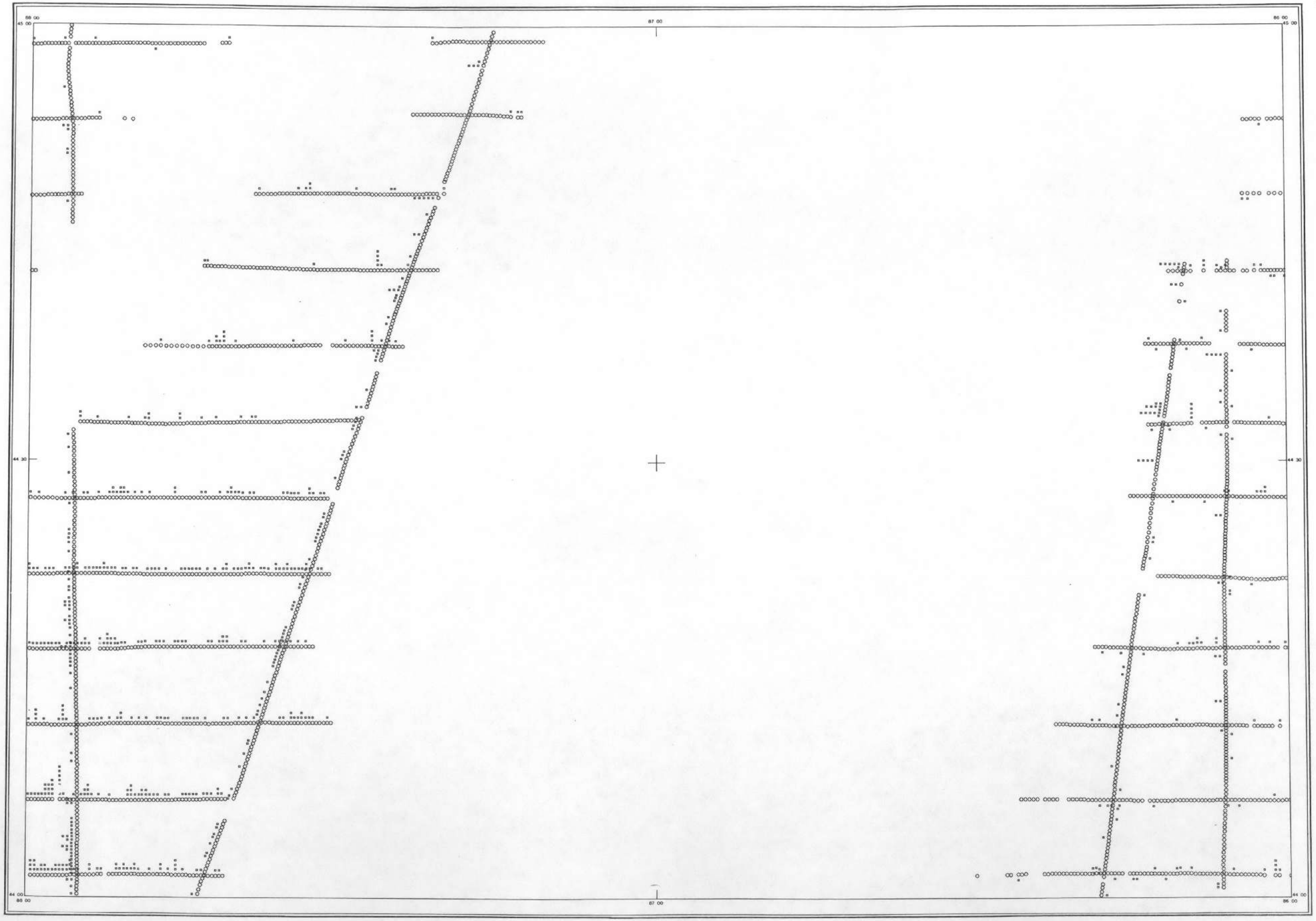
SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

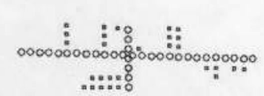
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

MANITOWOC

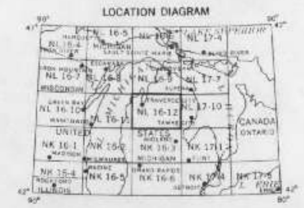


SCALE 1:500,000



O - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY
NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

LOCATION DIAGRAM



SURVEY AND COMPILATION BY:

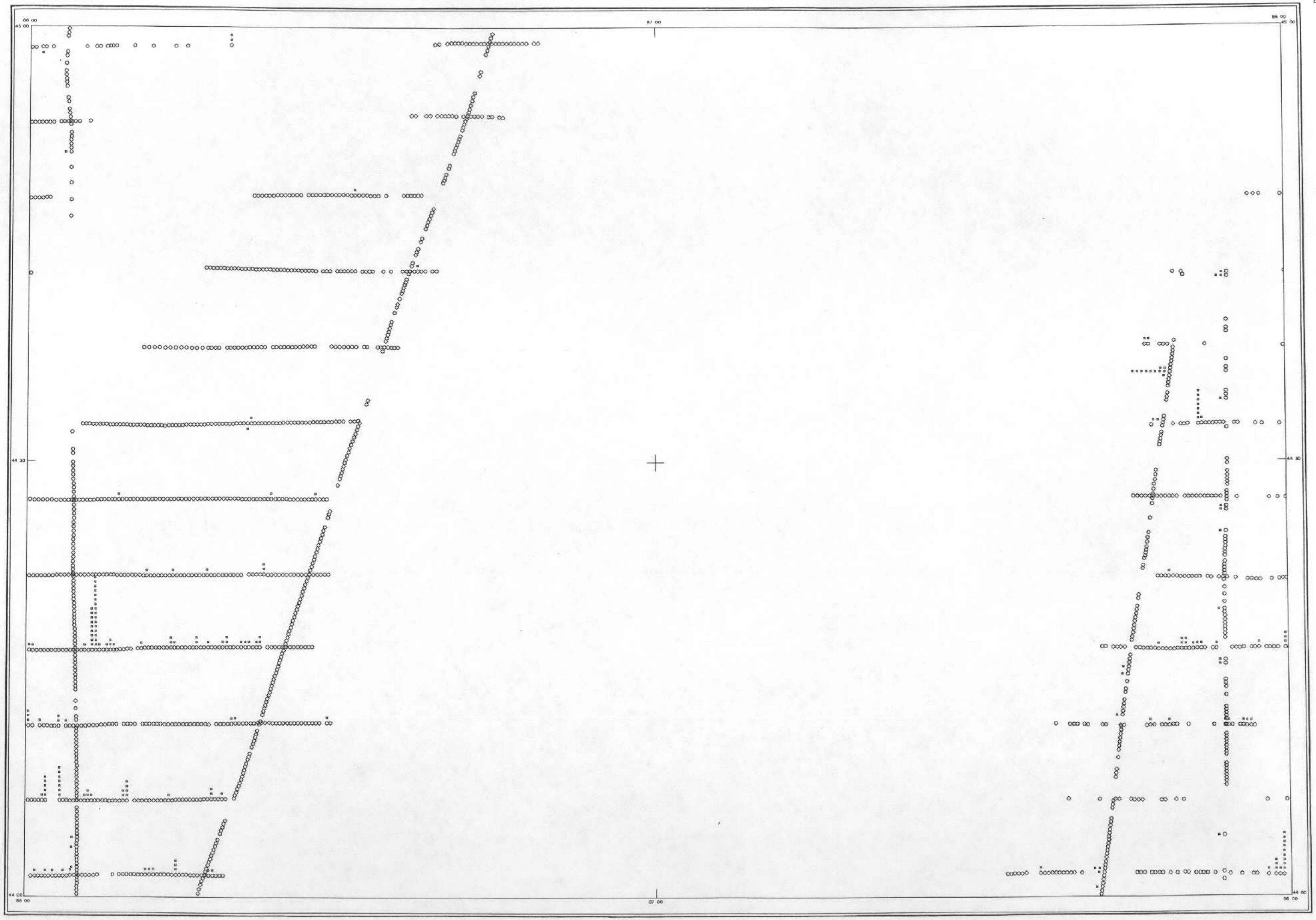
EG&G GEOMETRICS

THORIUM / POTASSIUM STANDARD DEVIATION MAP

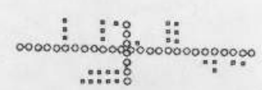
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

MANITOWOC



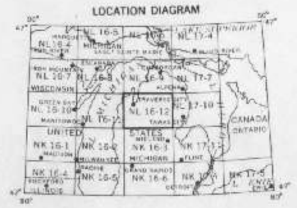
SCALE 1:500,000



O - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

LOCATION DIAGRAM



SURVEY AND COMPILATION BY

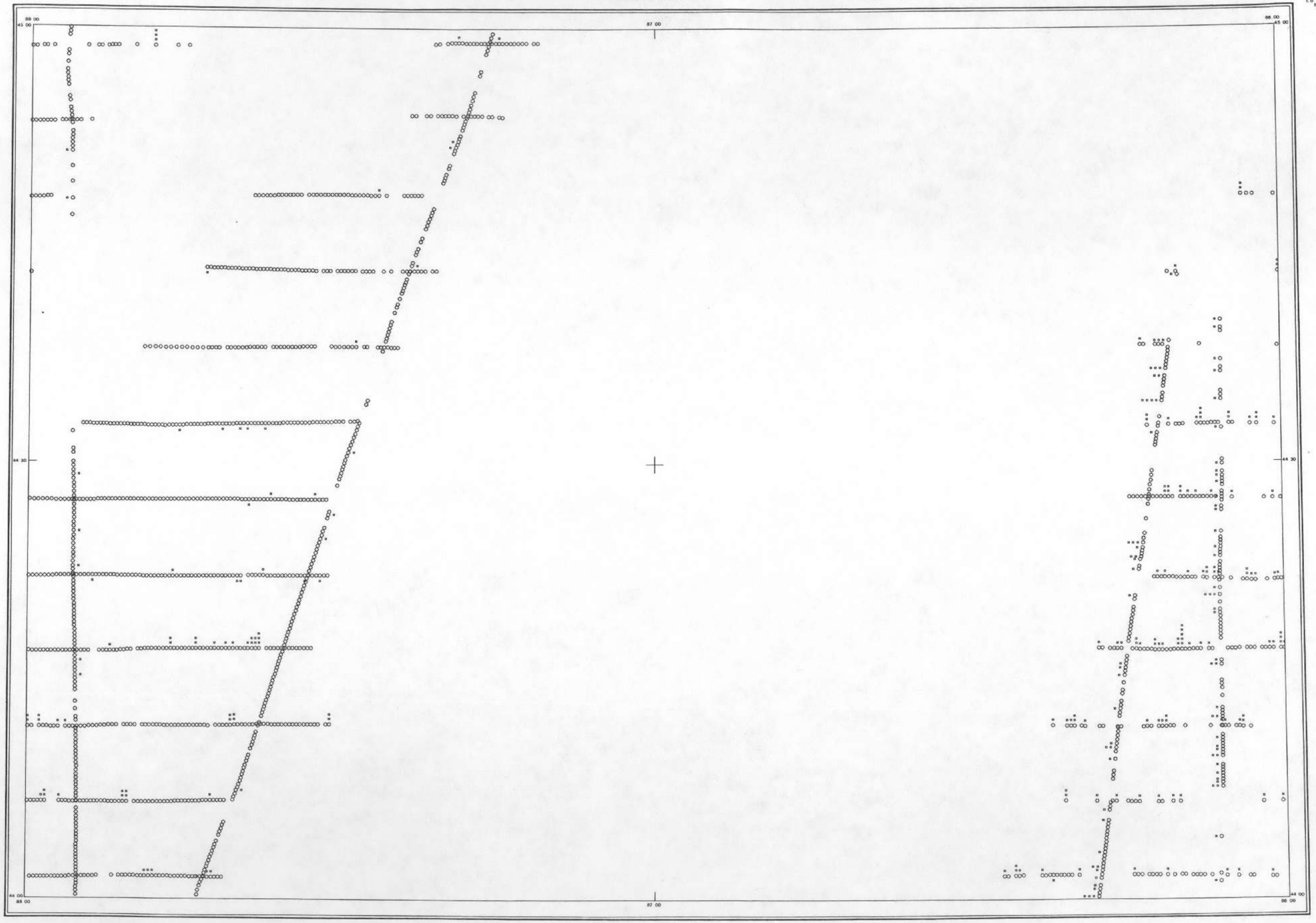
EG&G GEOMETRICS

URANIUM / POTASSIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

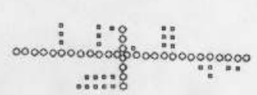
U. S. DEPARTMENT OF ENERGY

MANITOWOC



SCALE 1:500,000

MILES
KILOMETRES



O - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY
NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

LOCATION DIAGRAM

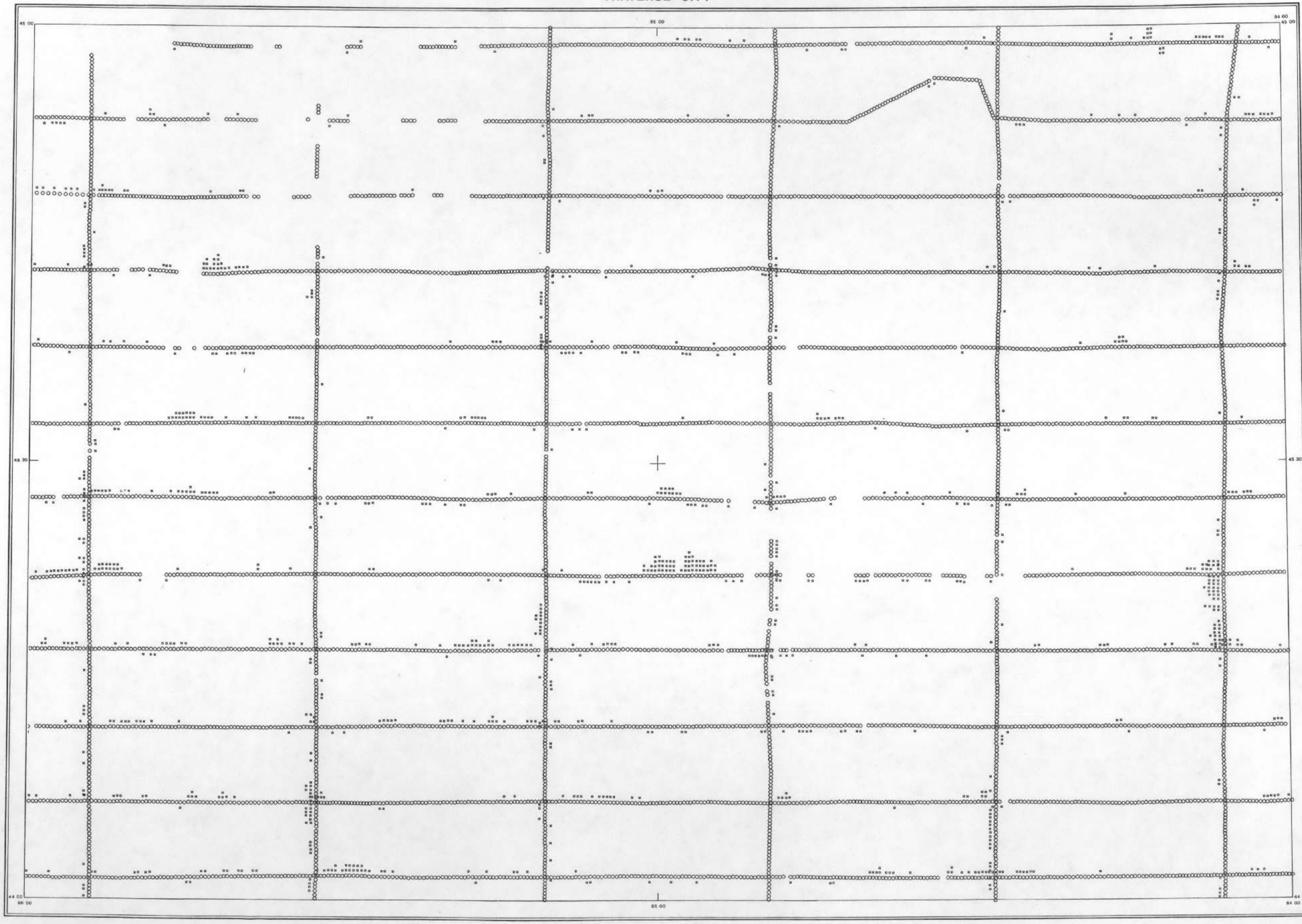
URANIUM / THORIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

SURVEY AND COMPILATION BY:
EG&G GEOMETRICS

TRAVERSE CITY



SCALE 1:500,000

MILES 5 0 5 10 15 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

SURVEY AND COMPILATION BY

EG&G GEOMETRICS

○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

NOTE: ON E-W LINES, +σ TO NORTH, −σ TO SOUTH.
ON N-S LINES, +σ TO WEST, −σ TO EAST.

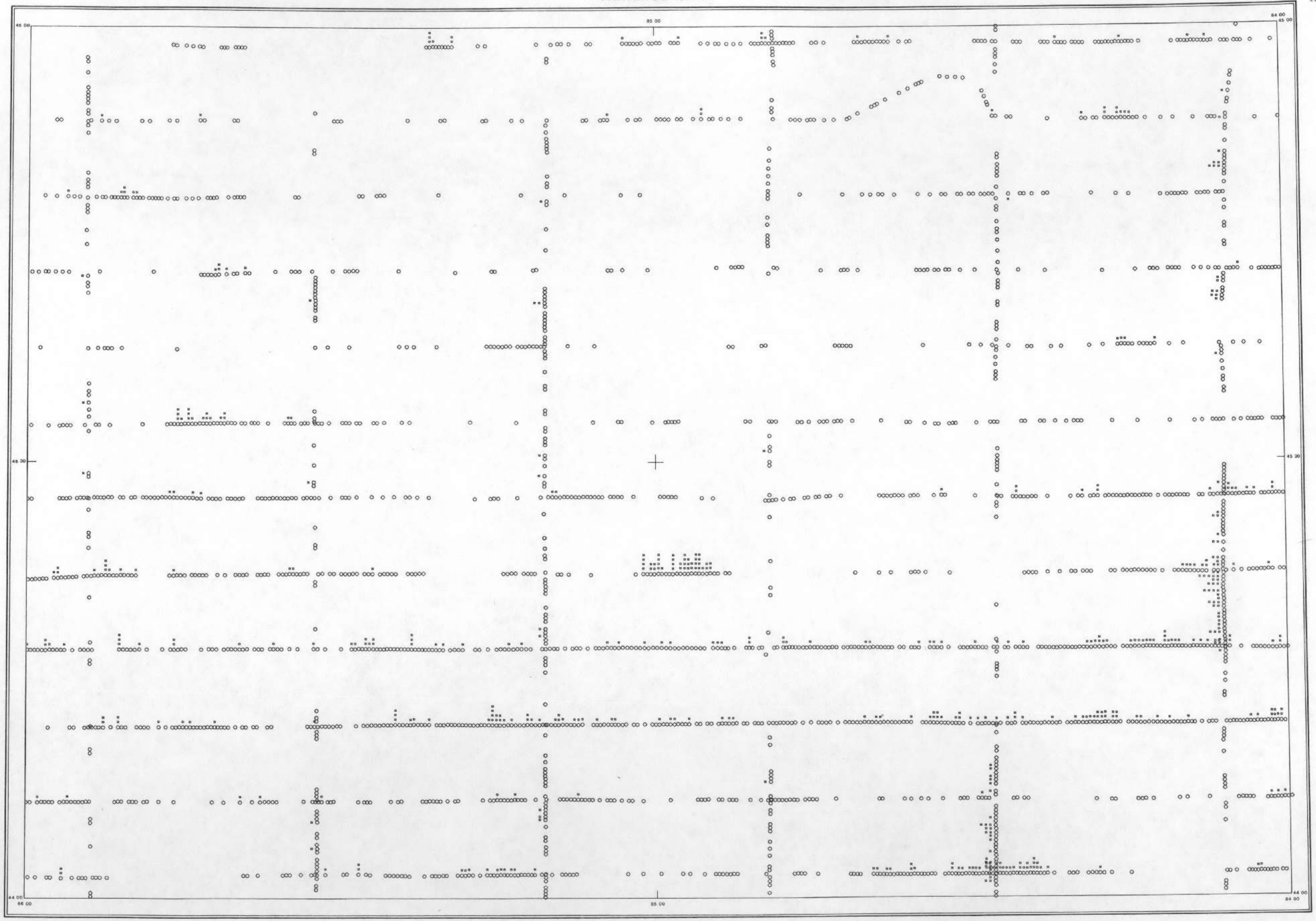
LOCATION DIAGRAM

POTASSIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

TRAVERSE CITY



SCALE 1:500,000

O - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY
NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

SURVEY AND
COMPILATION BY:

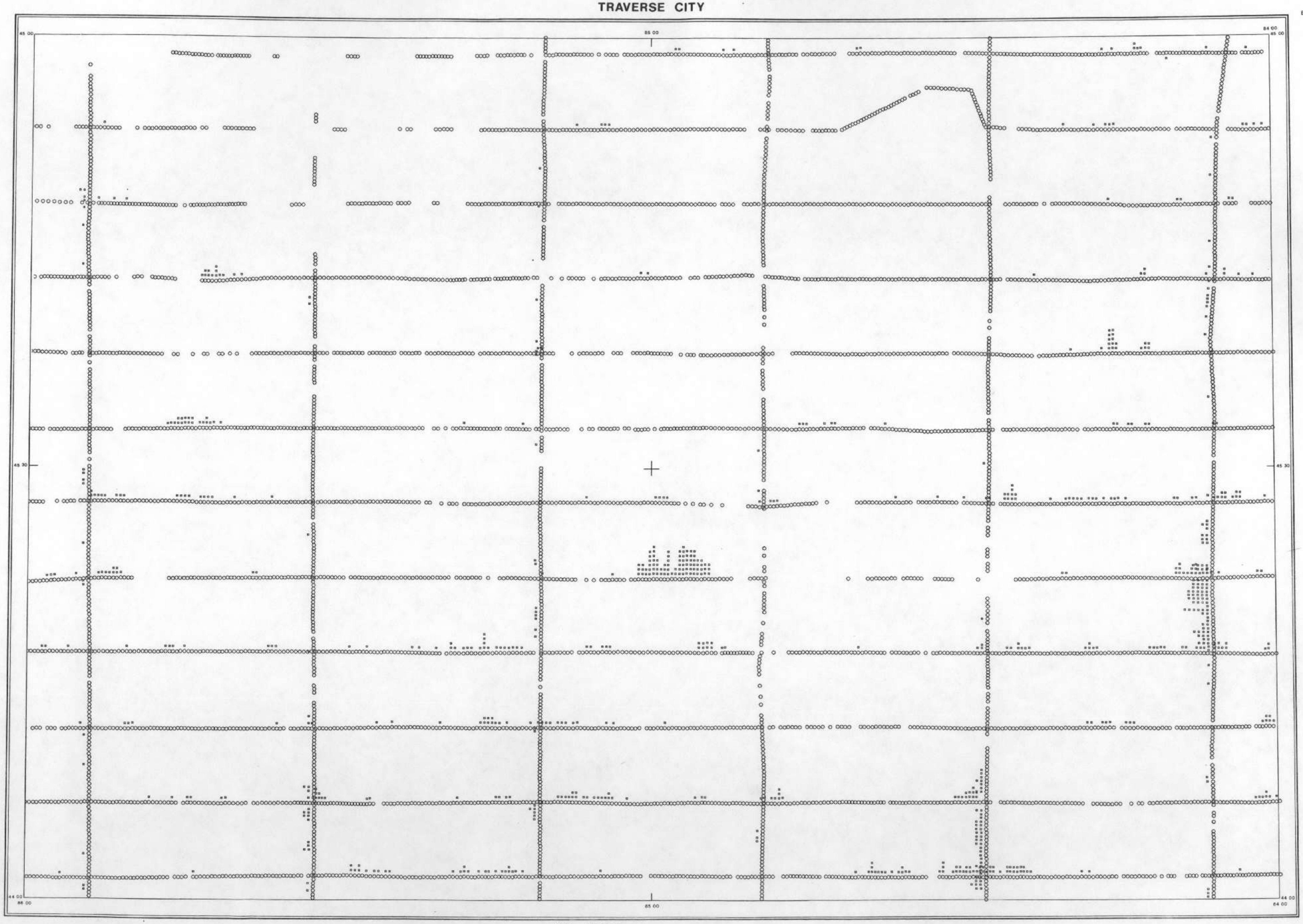
EG&G GEOMETRICS

URANIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

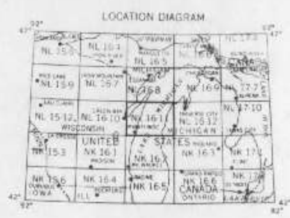
U. S. DEPARTMENT OF ENERGY

TRAVERSE CITY



SCALE 1:500,000

○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▫ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY
NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.



SURVEY AND
COMPILATION BY:

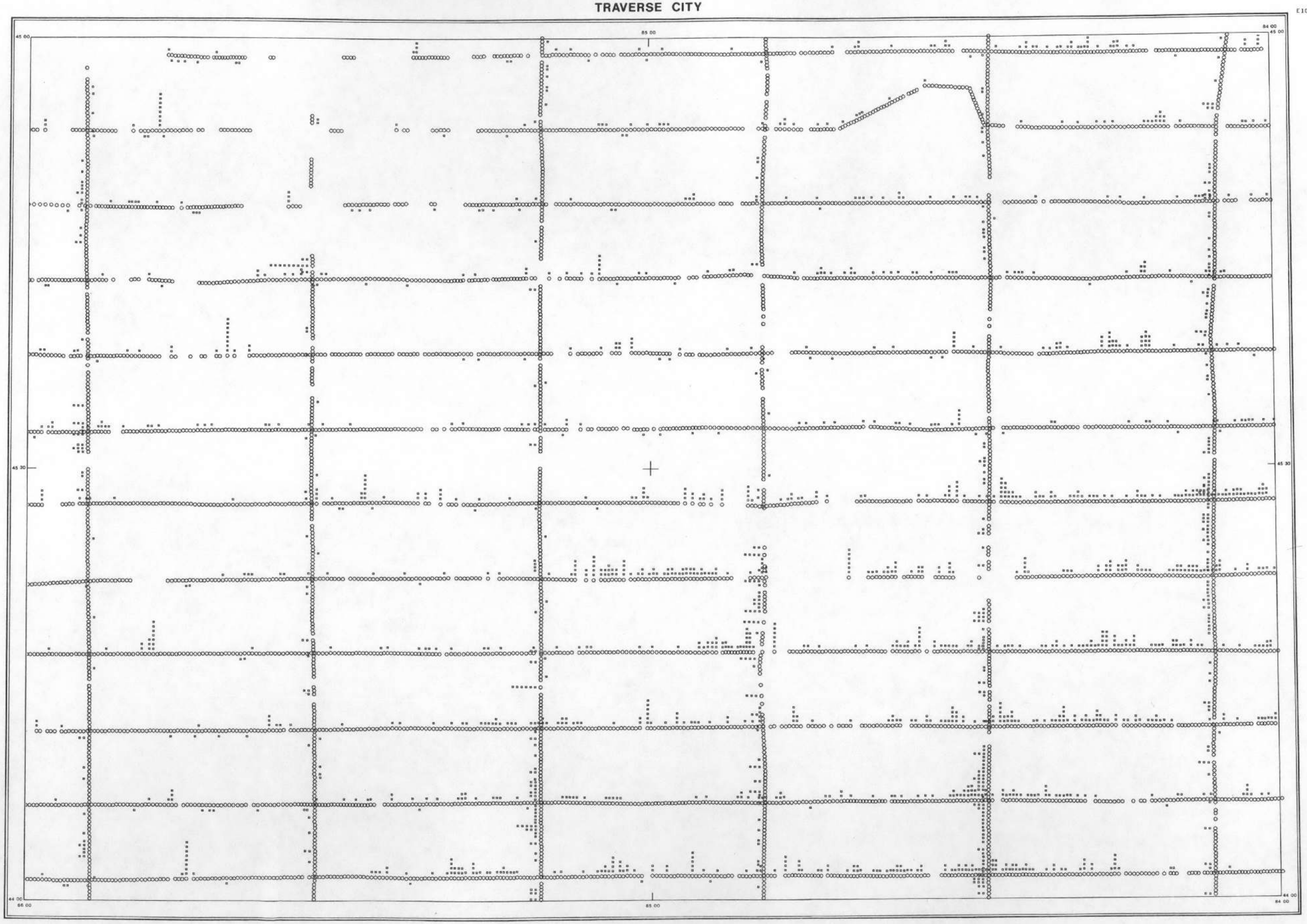
EG&G GEOMETRICS

THORIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

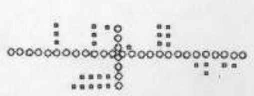
TRAVERSE CITY



SCALE 1:500,000

MILES

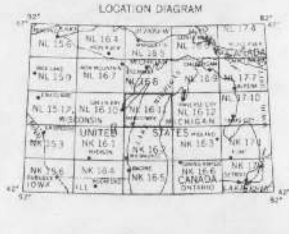
KILOMETRES



○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

LOCATION DIAGRAM



THORIUM / POTASSIUM STANDARD DEVIATION MAP

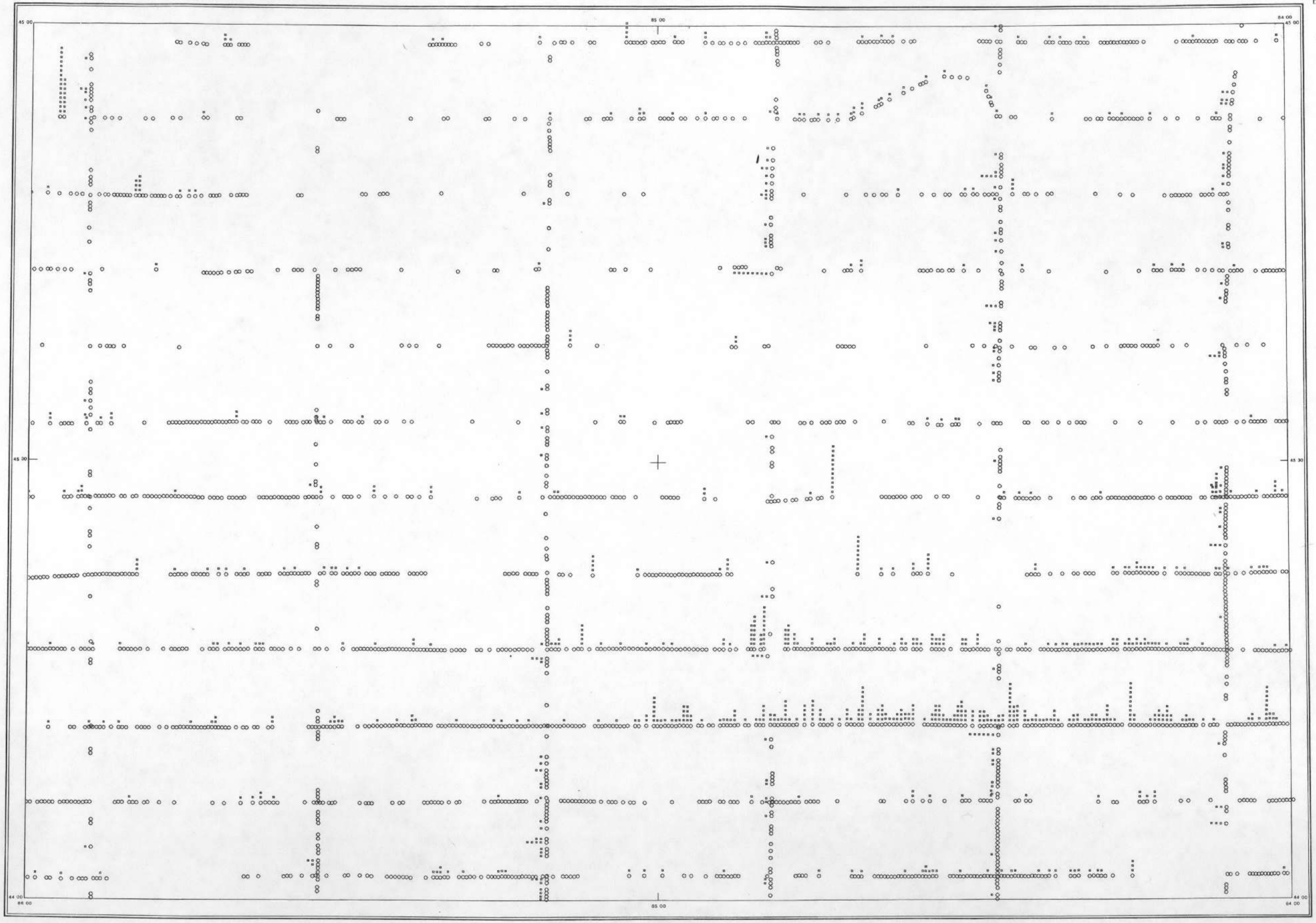
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

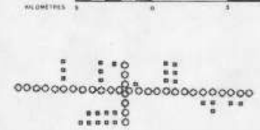
SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

TRAVERSE CITY



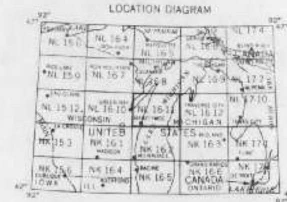
SCALE 1:500,000



○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

LOCATION DIAGRAM



SURVEY AND COMPILATION BY:

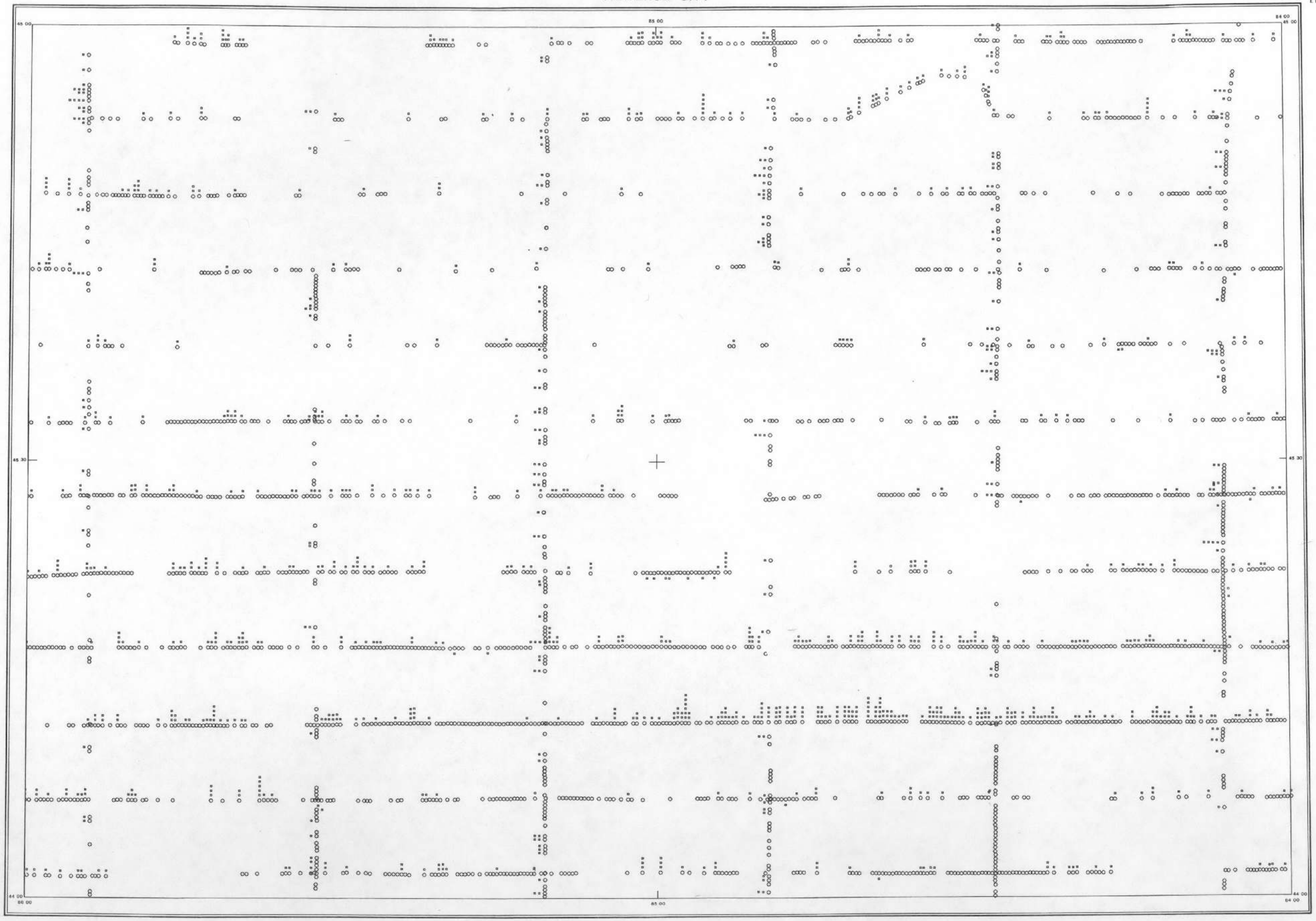
EG&G GEOMETRICS

URANIUM / POTASSIUM STANDARD DEVIATION MAP

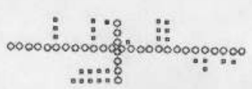
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

TRAVERSE CITY



SCALE 1:500,000



O - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

URANIUM / THORIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

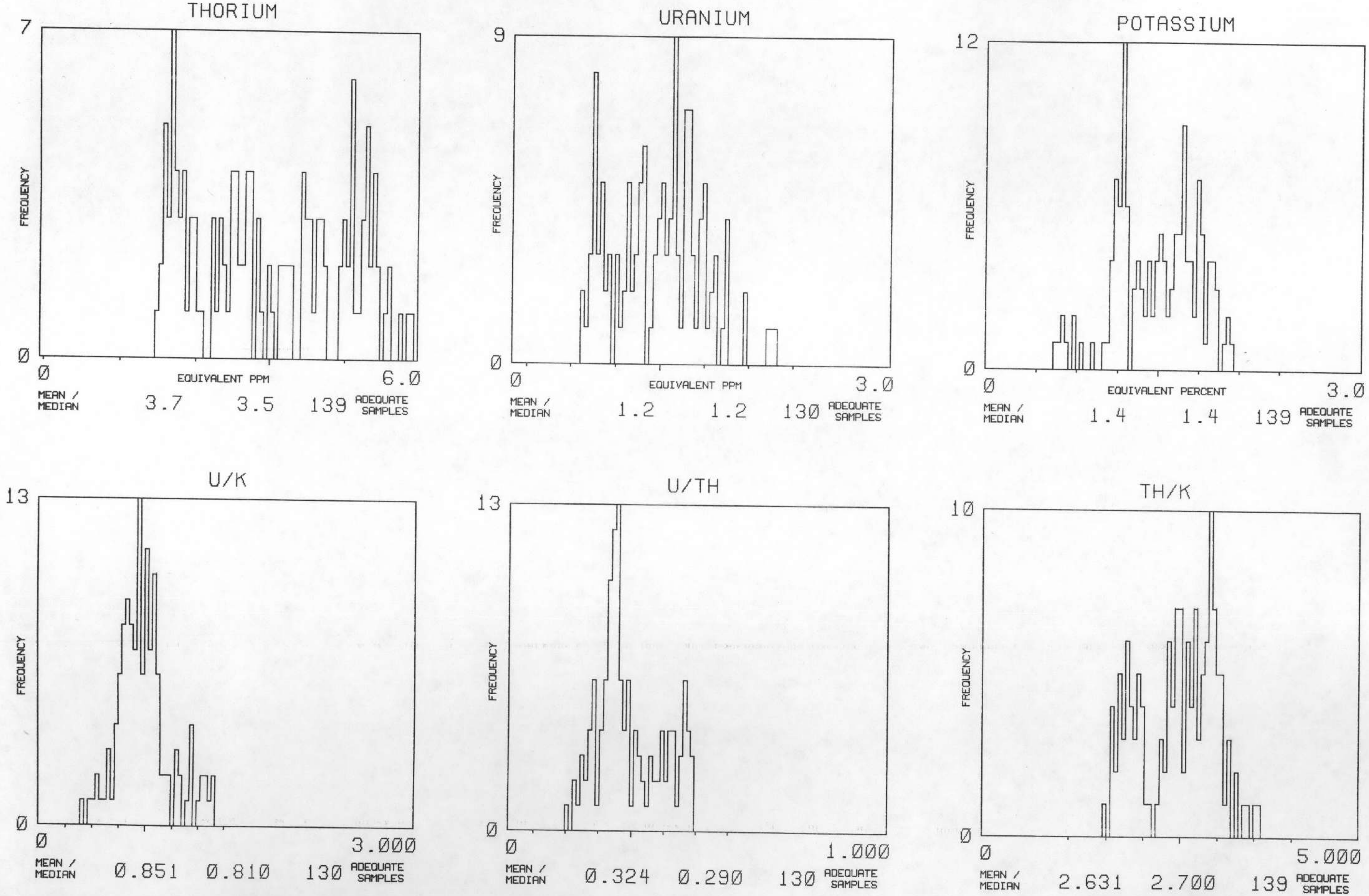
SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

APPENDIX F - Histograms and Map Unit Conversion Table

NL 16-11/12 MANITOVOC/TRAVERSE CITY MAP UNIT : QAL TOTAL NUMBER OF SAMPLES 139

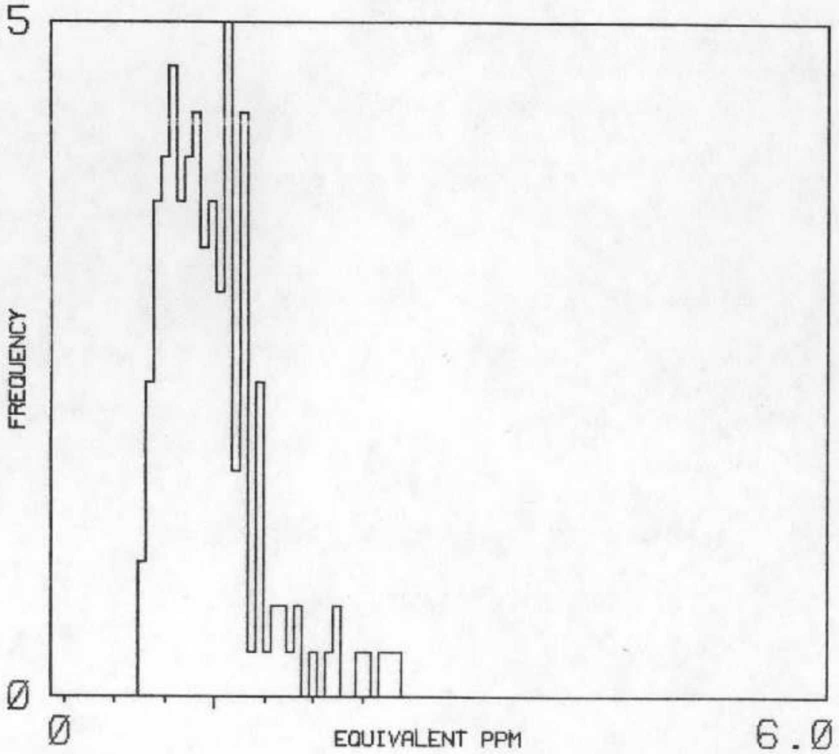
F1mt



NL 16-11/12 MANITOWOC/TRAVERSE CITY MAP UNIT : QB TOTAL NUMBER OF SAMPLES 248

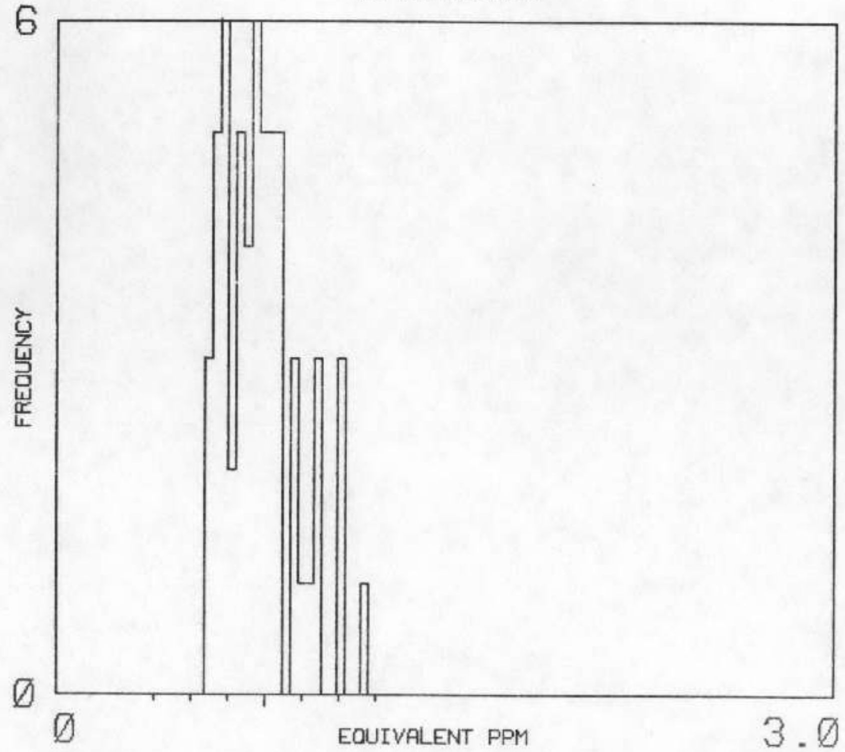
$F2_{mt}$

THORIUM



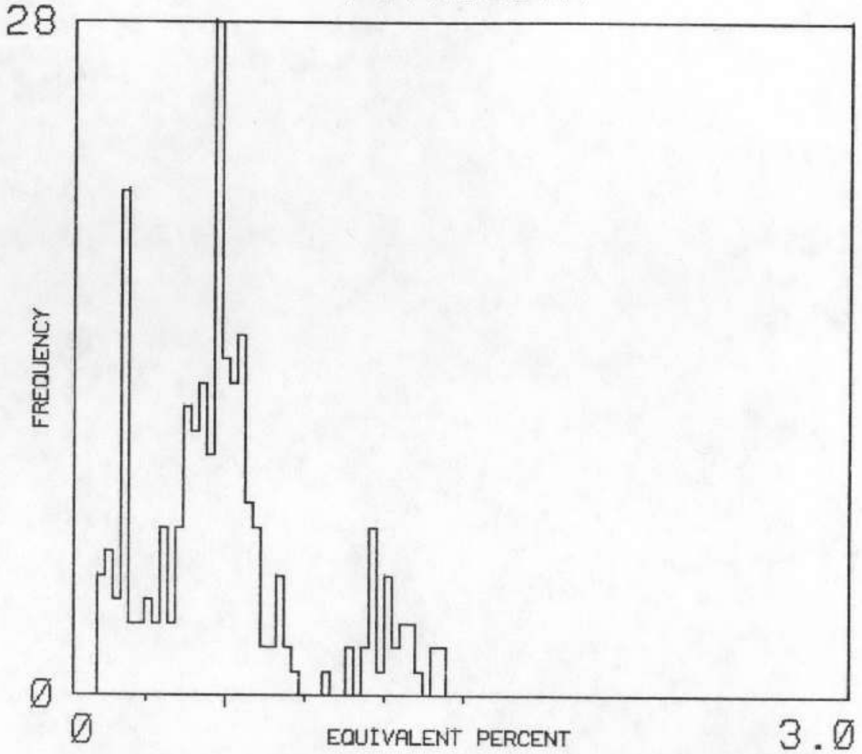
MEAN / MEDIAN 1.3 1.2 171 ADEQUATE SAMPLES

URANIUM



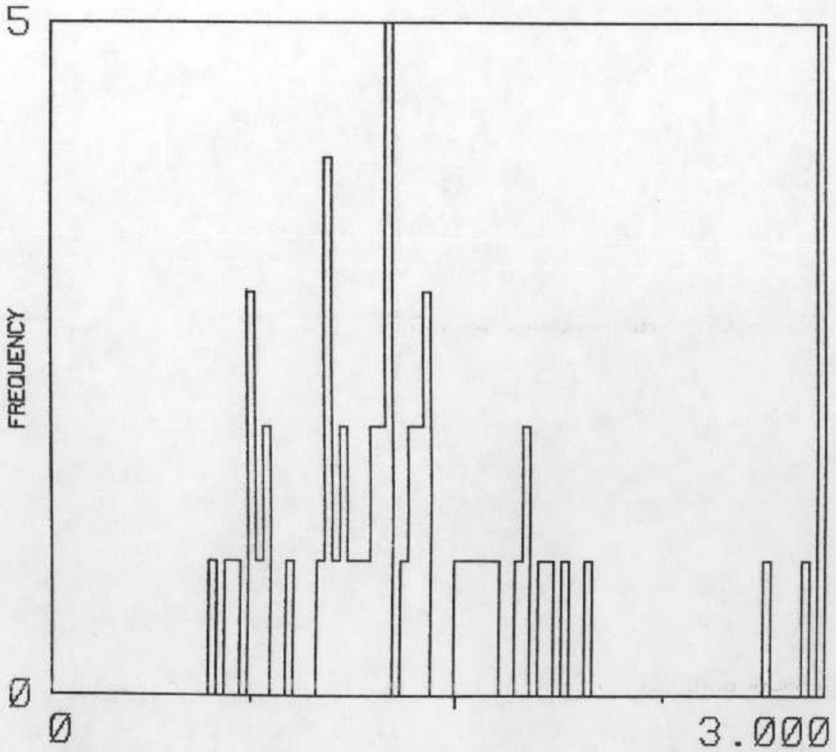
MEAN / MEDIAN 0.8 0.8 58 ADEQUATE SAMPLES

POTASSIUM



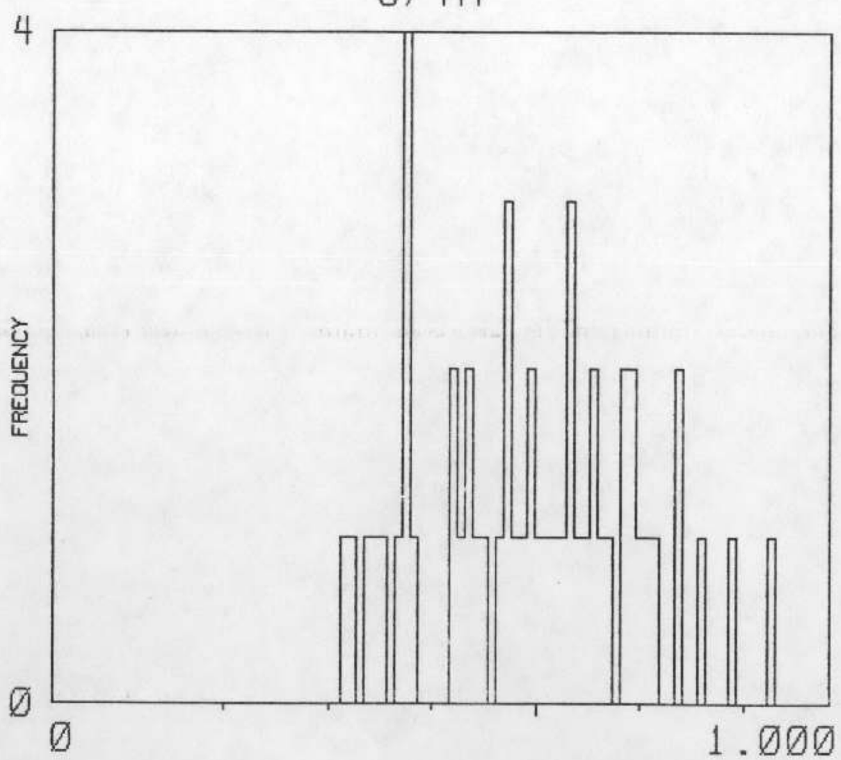
MEAN / MEDIAN 0.6 0.6 240 ADEQUATE SAMPLES

U/K



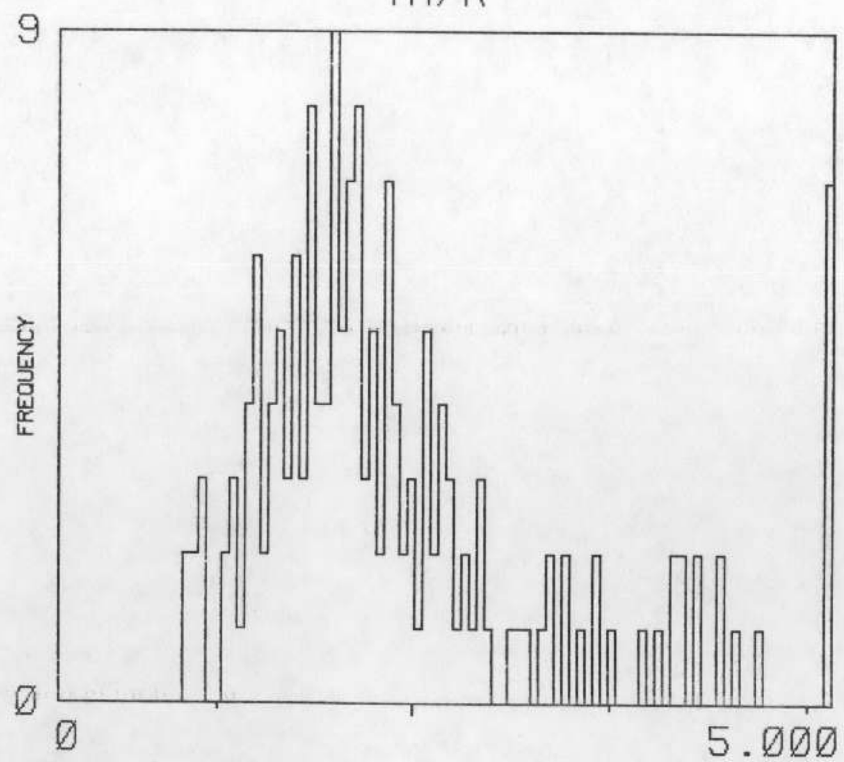
MEAN / MEDIAN 1.570 1.320 58 ADEQUATE SAMPLES

U/TH



MEAN / MEDIAN 0.622 0.620 51 ADEQUATE SAMPLES

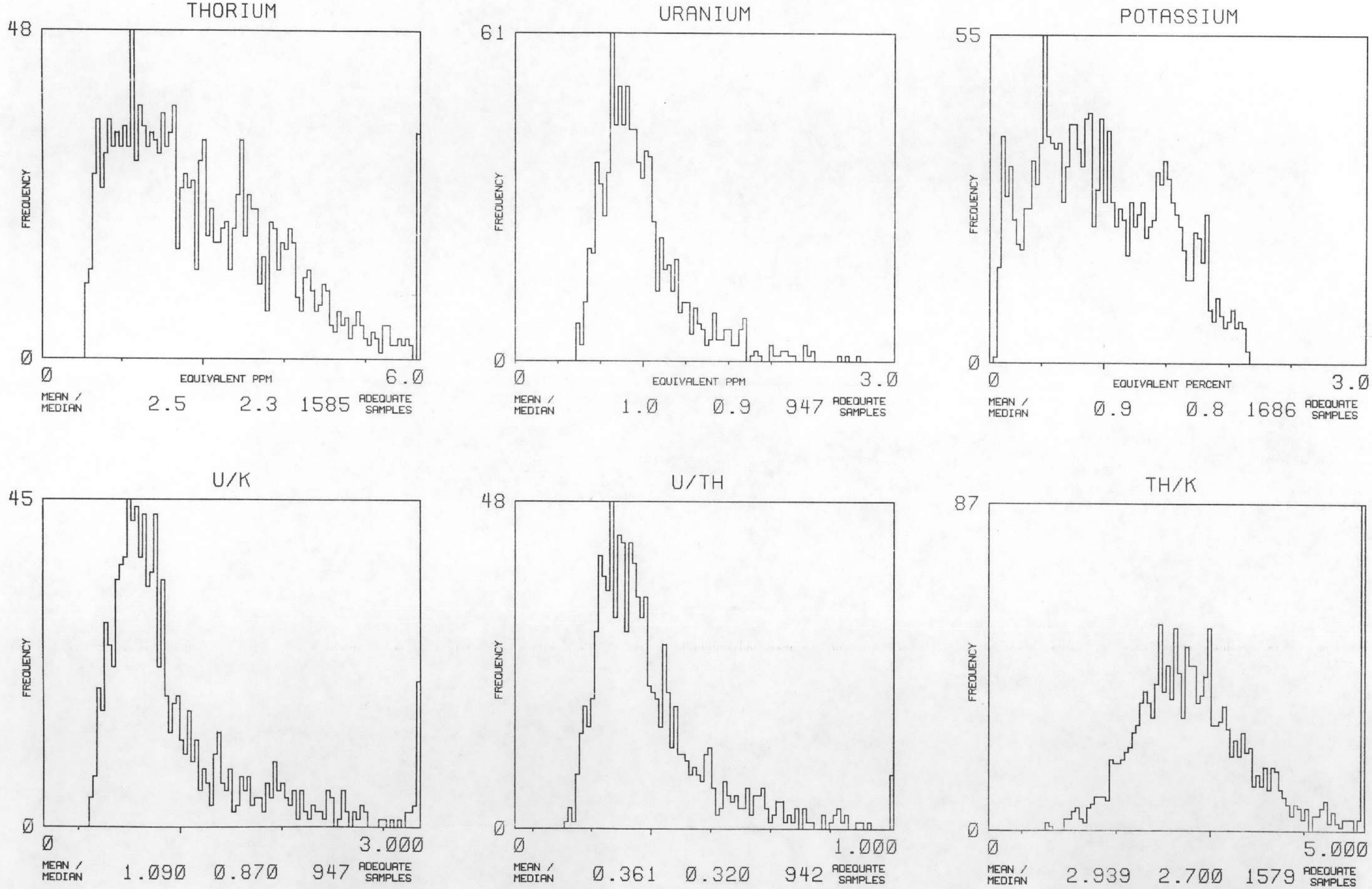
TH/K



MEAN / MEDIAN 2.293 1.950 171 ADEQUATE SAMPLES

NL 16-11/12 MANITOWOC/TRAVERSE CITY MAP UNIT : QMA TOTAL NUMBER OF SAMPLES 1771

F 3 mt



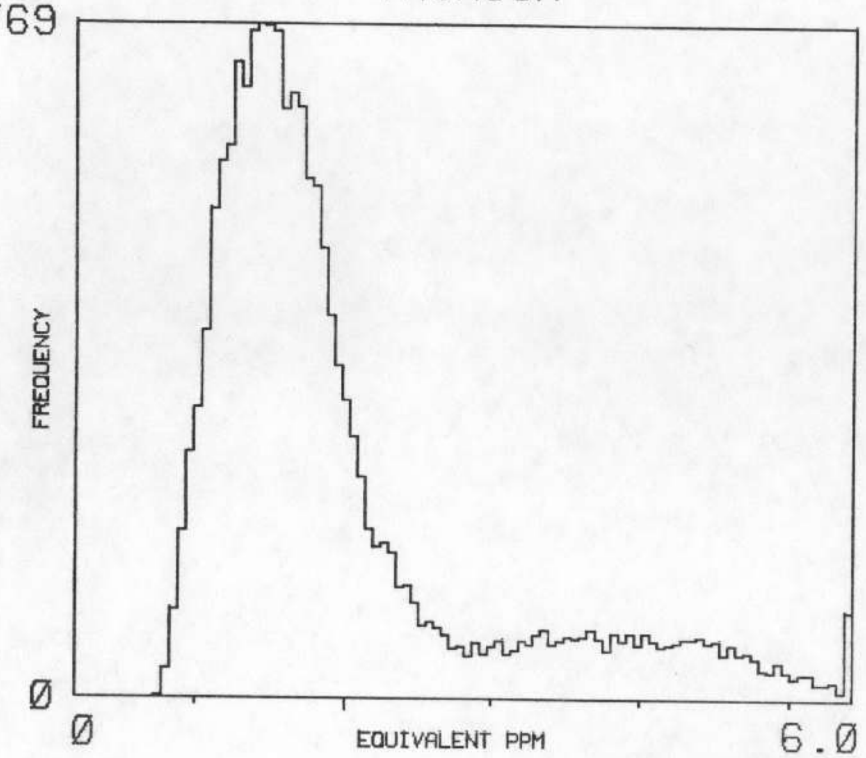
NL 16-11/12 MANITOWOC/TRAVERSE CITY

MAP UNIT : QM

TOTAL NUMBER OF SAMPLES 17942

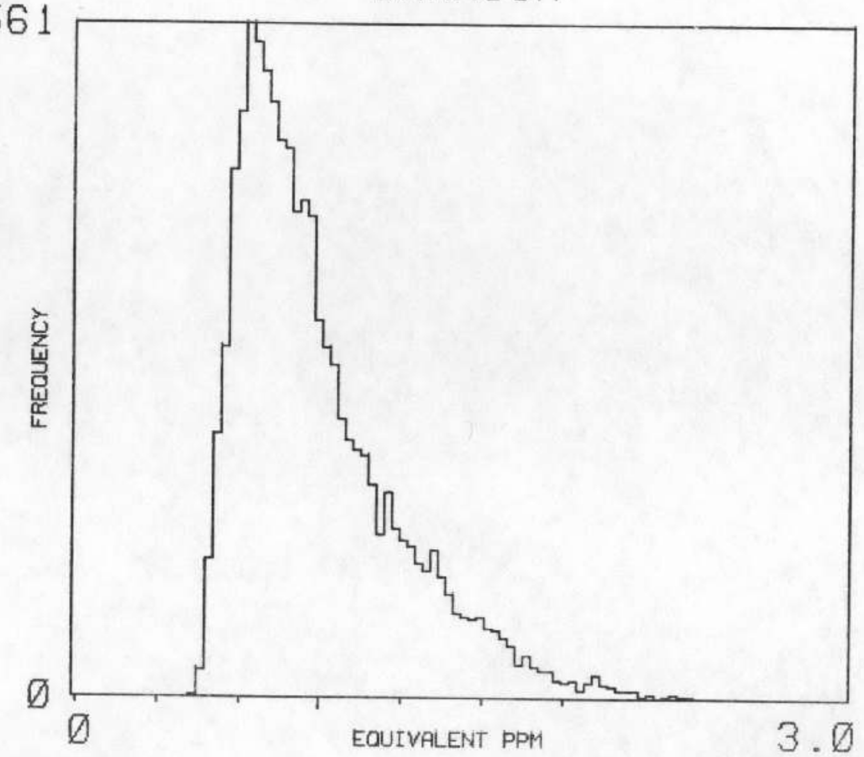
F4mt

THORIUM



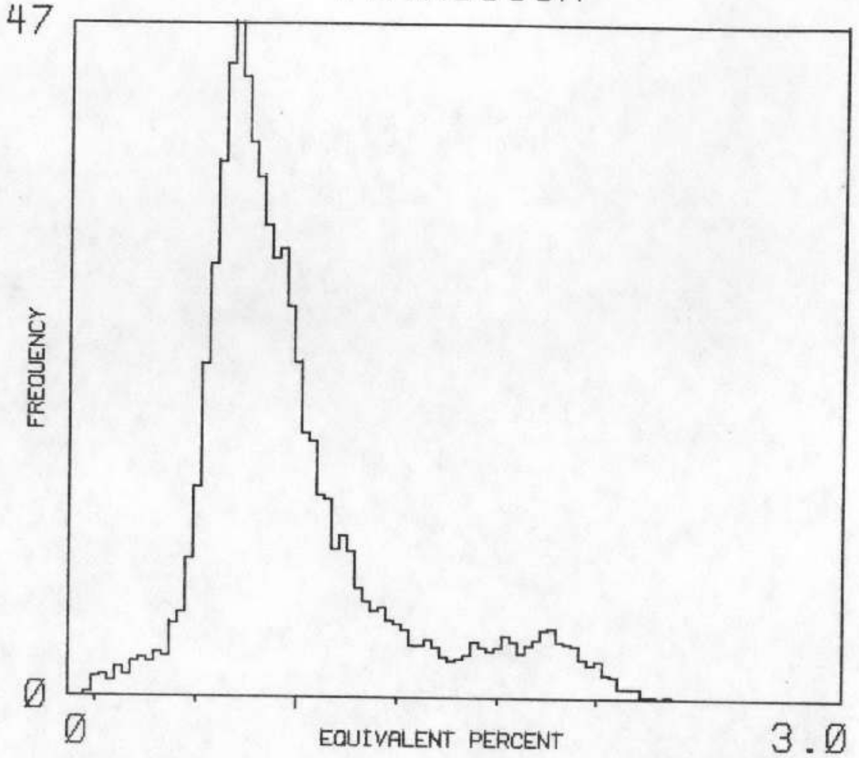
MEAN / MEDIAN 2.1 1.7 17393 ADEQUATE SAMPLES

URANIUM



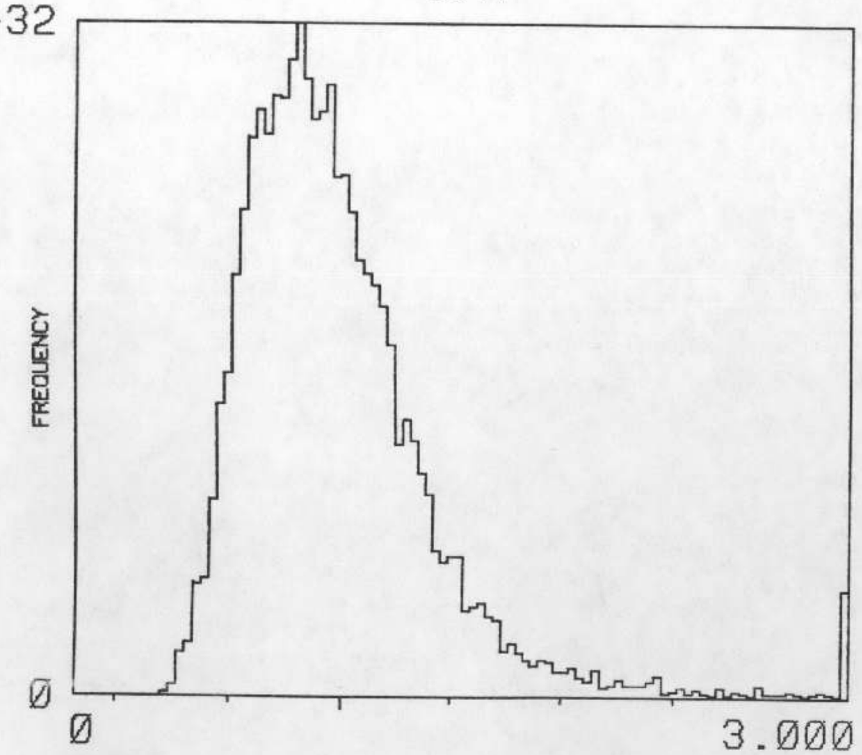
MEAN / MEDIAN 1.0 0.9 9734 ADEQUATE SAMPLES

POTASSIUM



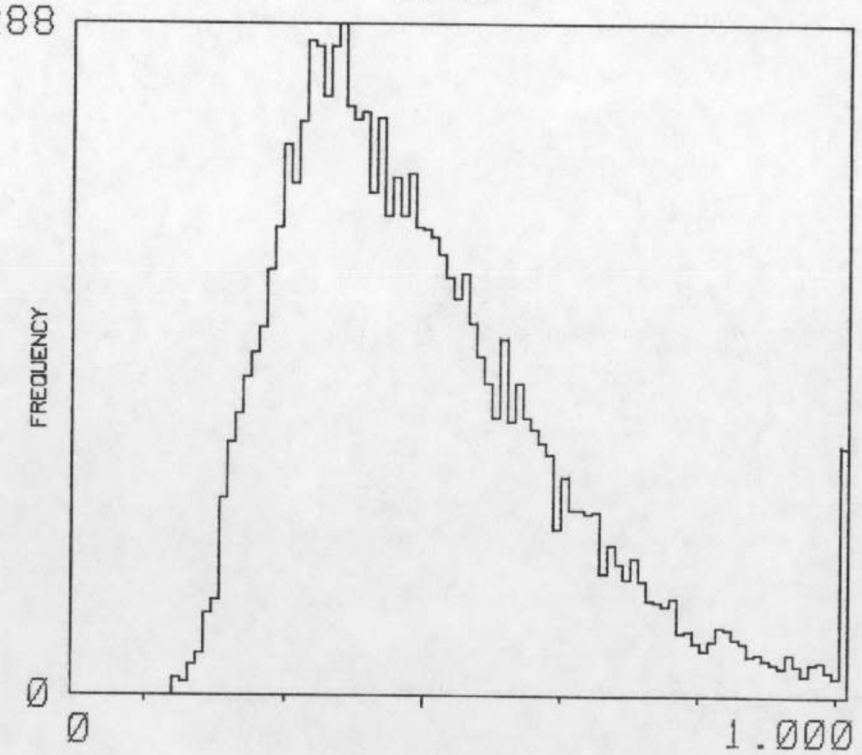
MEAN / MEDIAN 0.9 0.8 17876 ADEQUATE SAMPLES

U/K



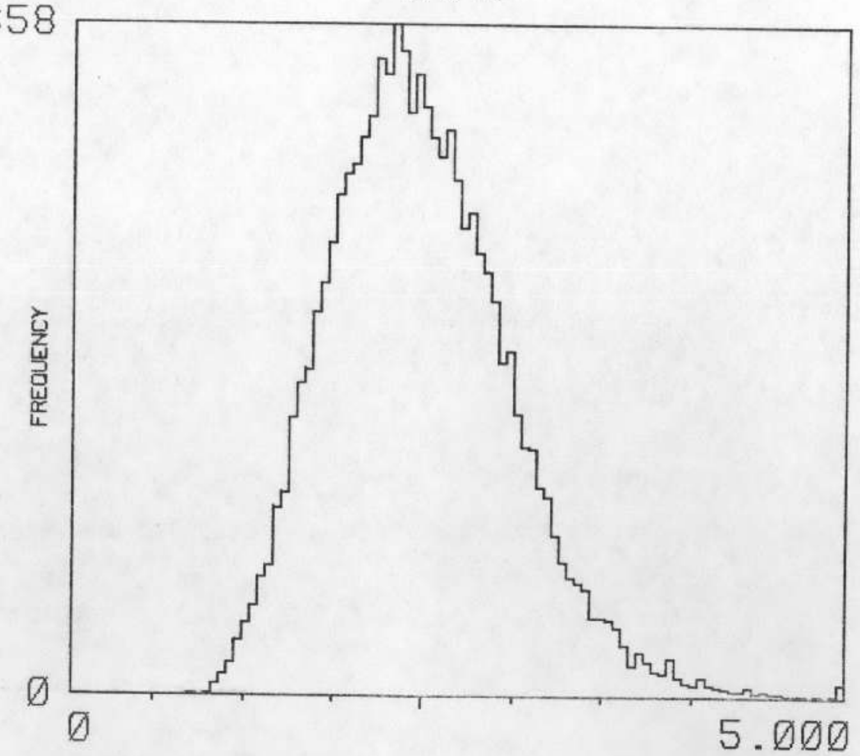
MEAN / MEDIAN 1.025 0.960 9721 ADEQUATE SAMPLES

U/TH



MEAN / MEDIAN 0.452 0.420 9623 ADEQUATE SAMPLES

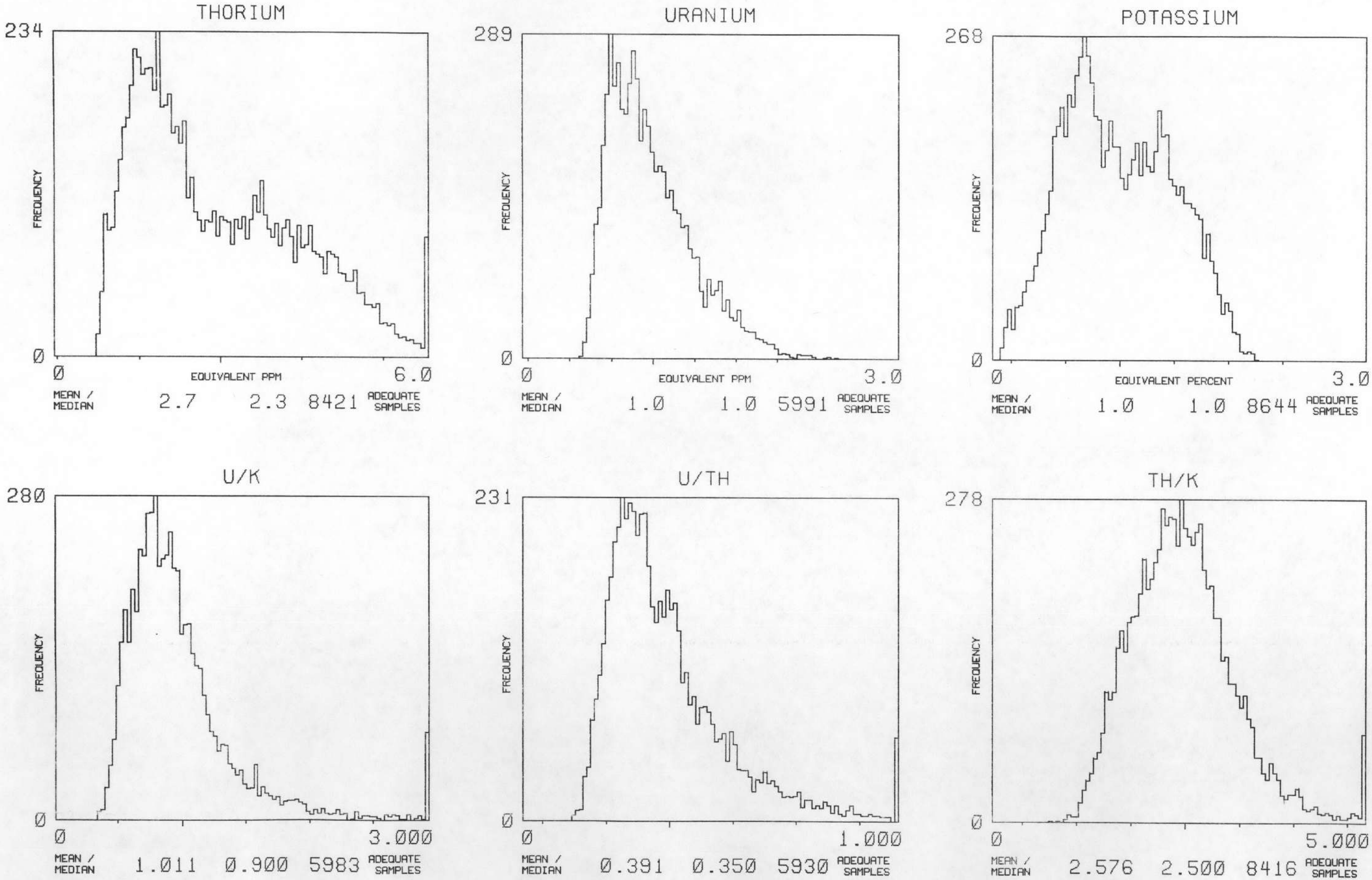
TH/K



MEAN / MEDIAN 2.268 2.200 17393 ADEQUATE SAMPLES

F5 mt

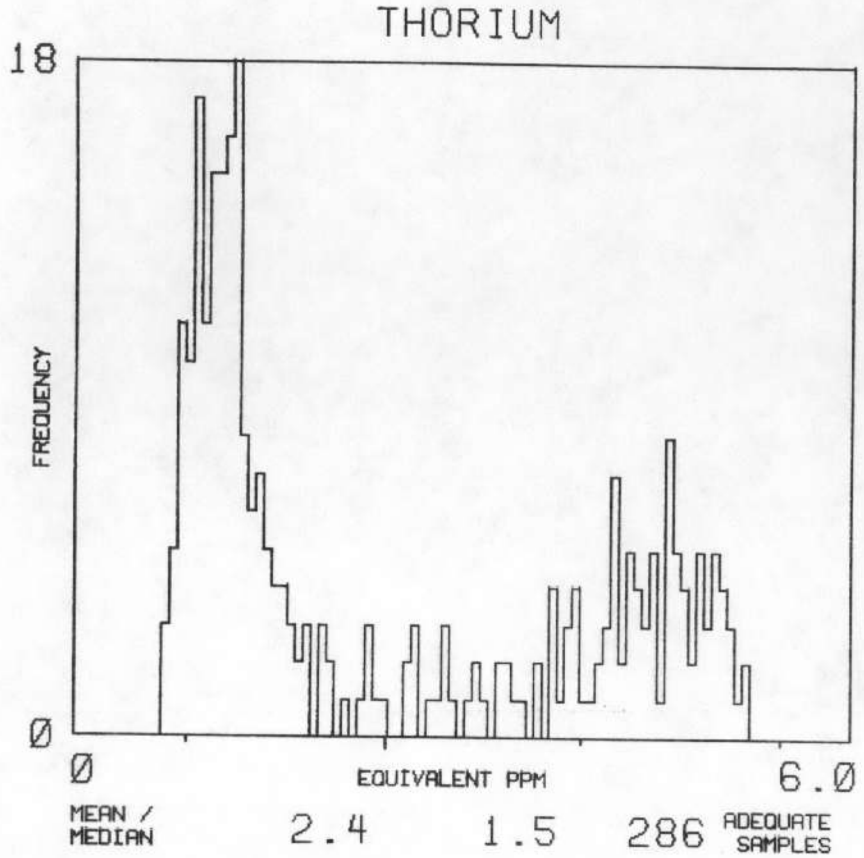
NL 16-11/12 MANITOVOC/TRAVERSE CITY MAP UNIT : QGM TOTAL NUMBER OF SAMPLES 8711

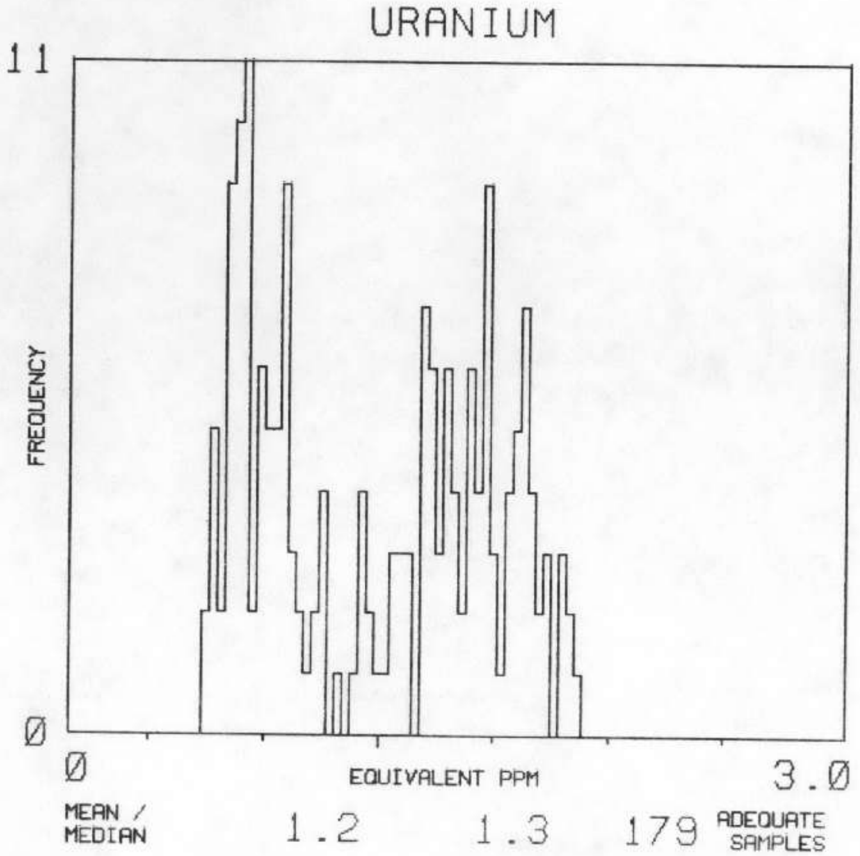


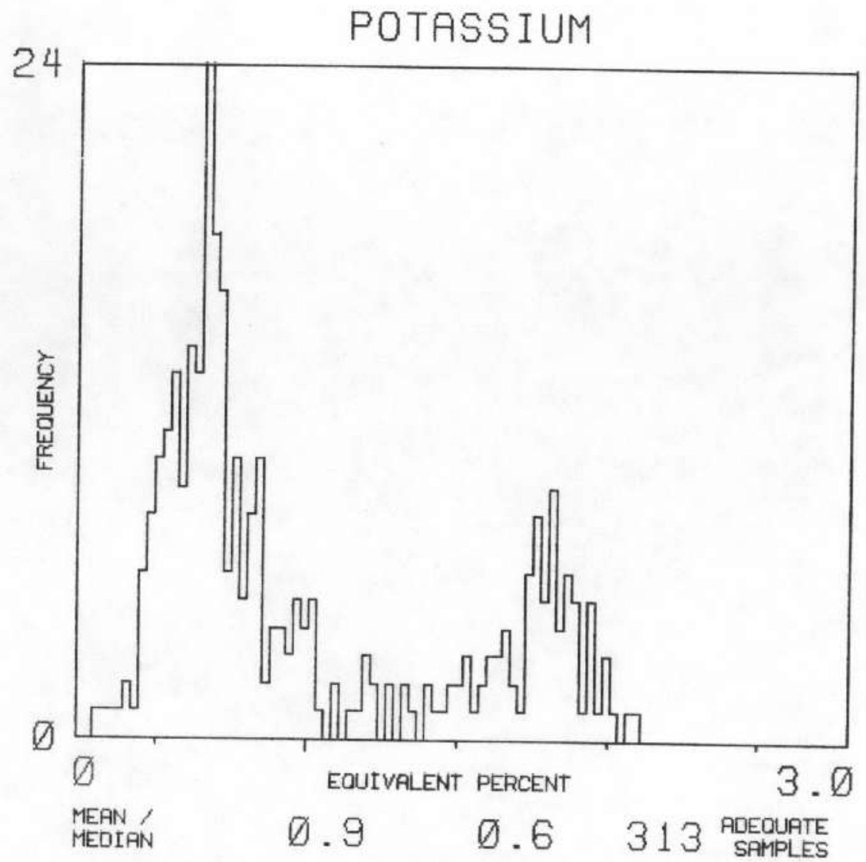
NL 16-11/12 MANITOVOC/TRAVERSE CITY

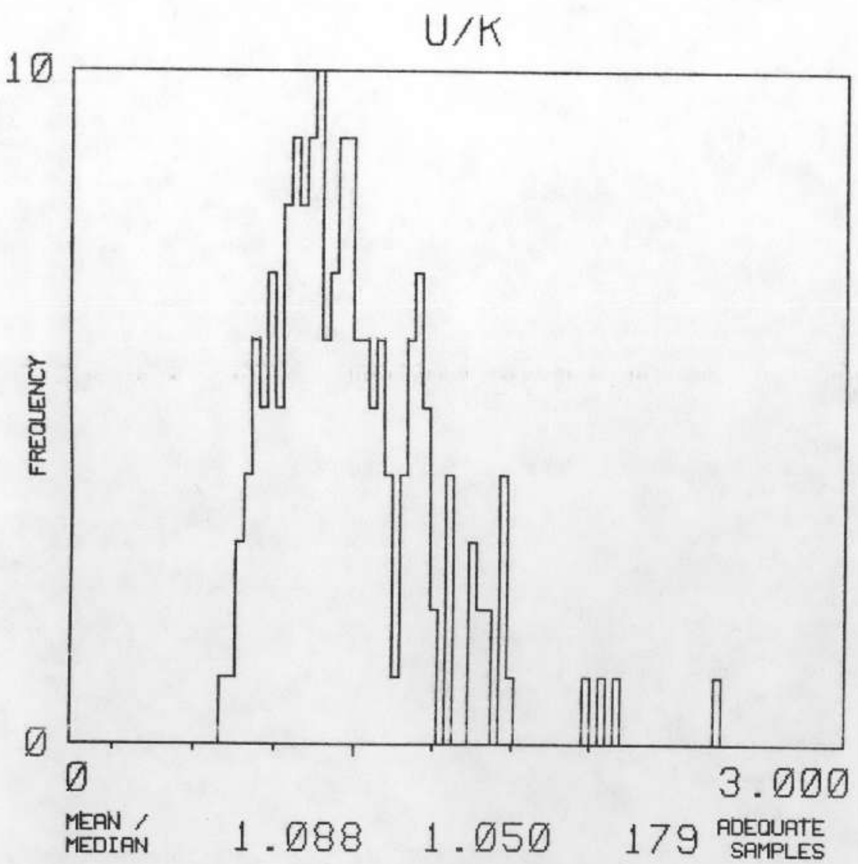
MAP UNIT : QWM TOTAL NUMBER OF SAMPLES 315

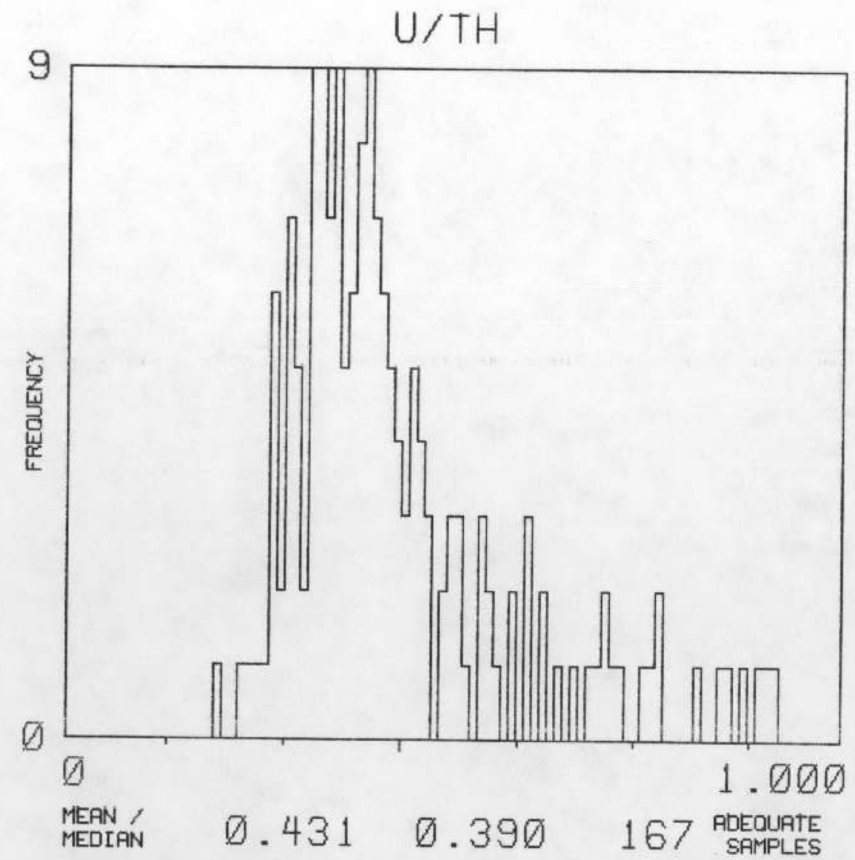
F6 mt

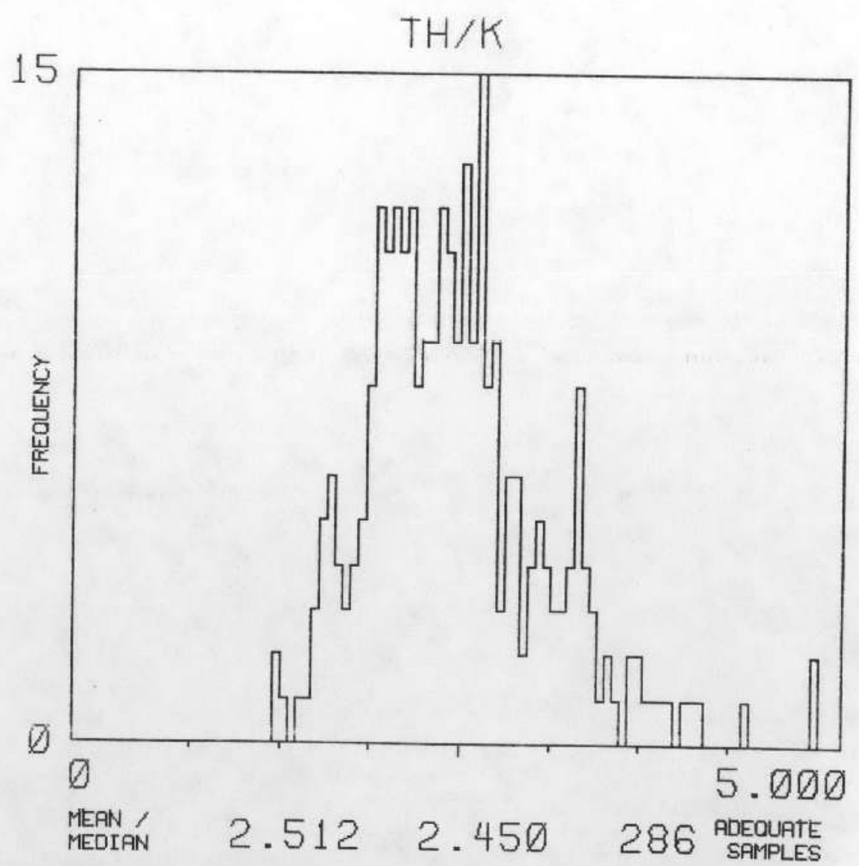






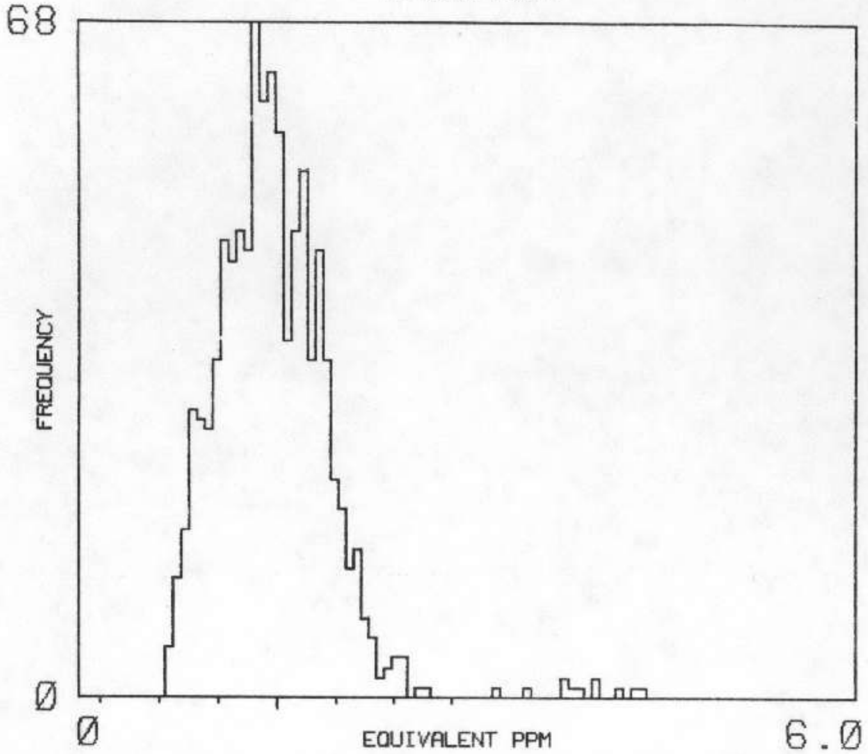






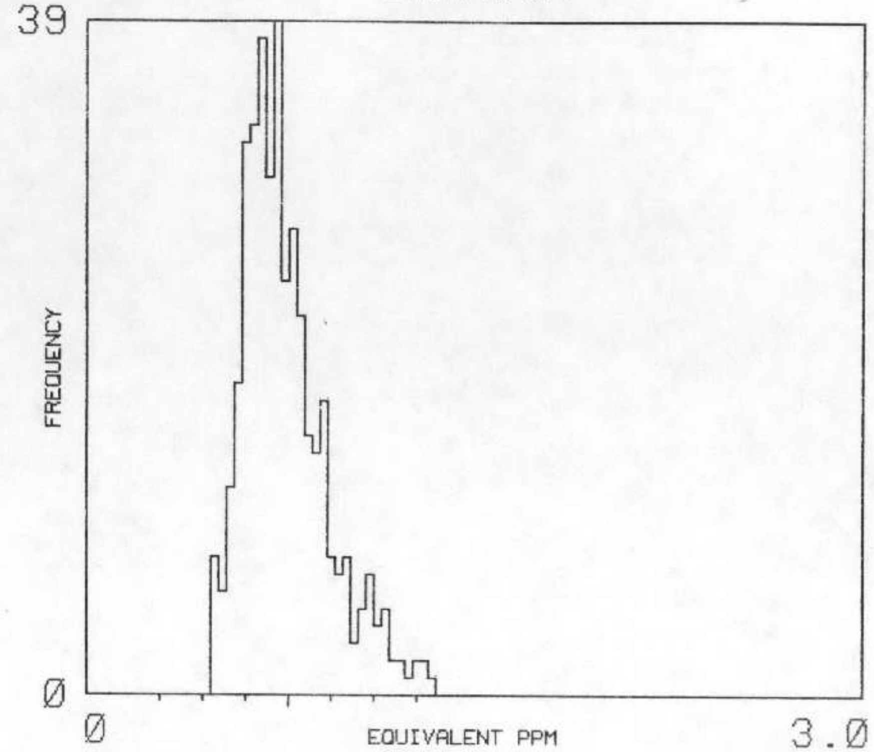
NL 16-11/12 MANITOVOC/TRAVERSE CITY MAP UNIT : QPW TOTAL NUMBER OF SAMPLES 1028 F7 mt

THORIUM



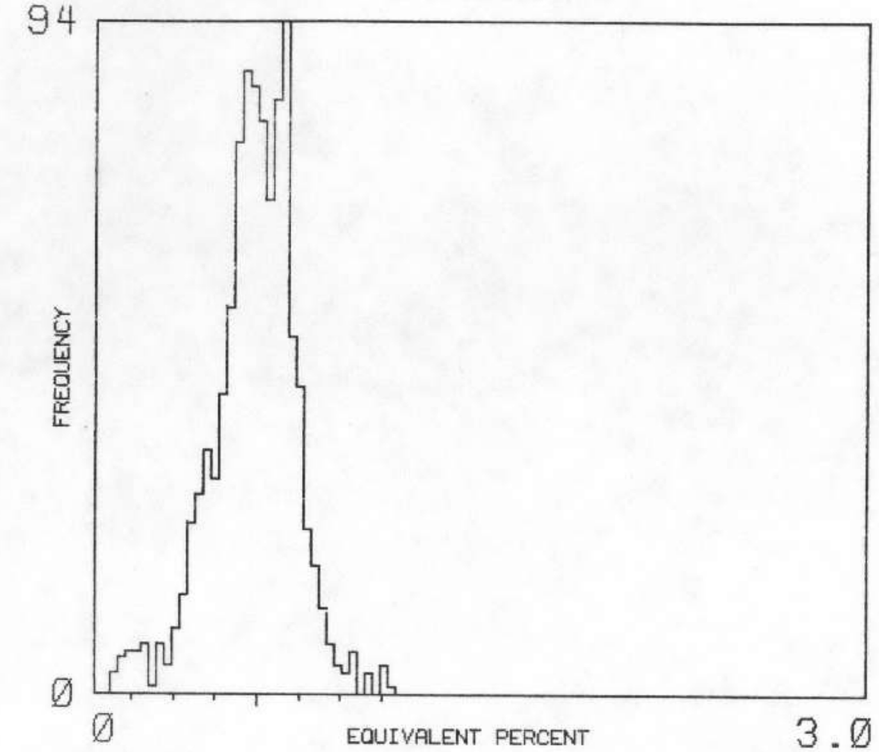
MEAN / MEDIAN 1.5 1.5 940 ADEQUATE SAMPLES

URANIUM



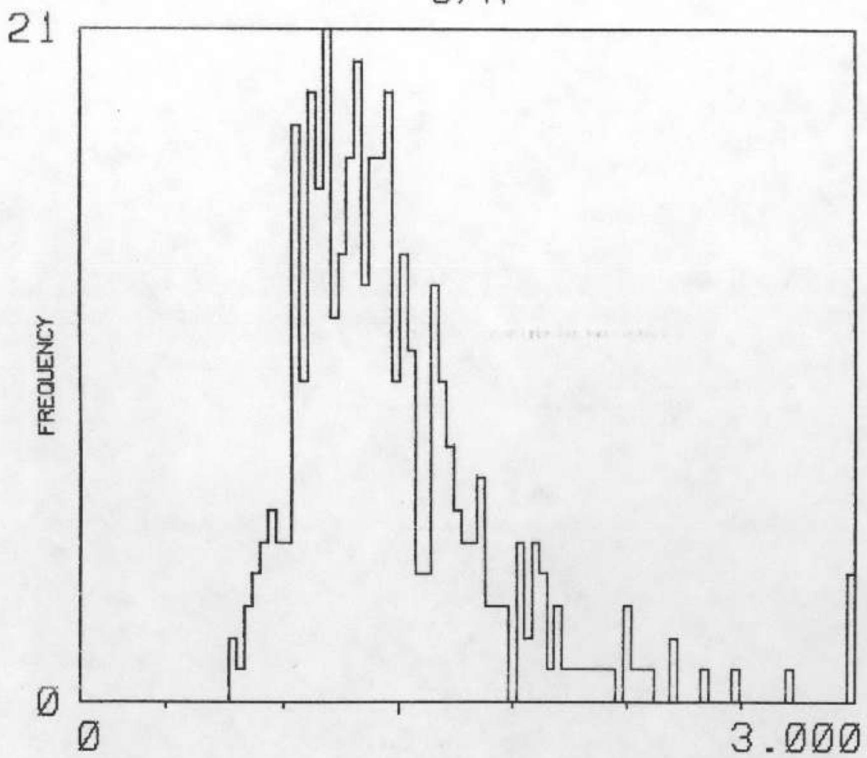
MEAN / MEDIAN 0.8 0.7 392 ADEQUATE SAMPLES

POTASSIUM



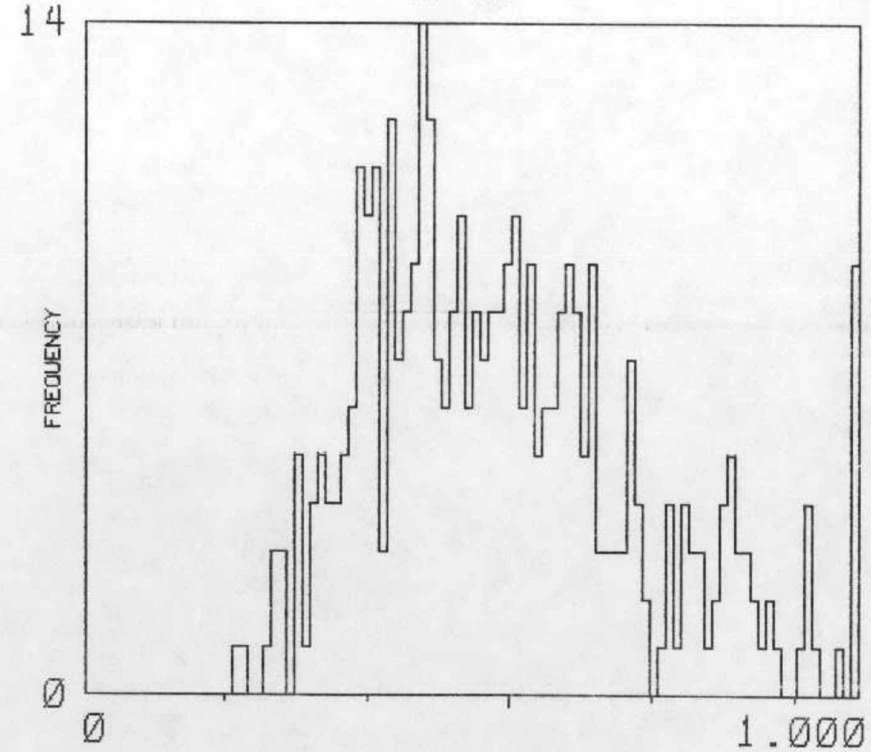
MEAN / MEDIAN 0.6 0.6 1023 ADEQUATE SAMPLES

U/K



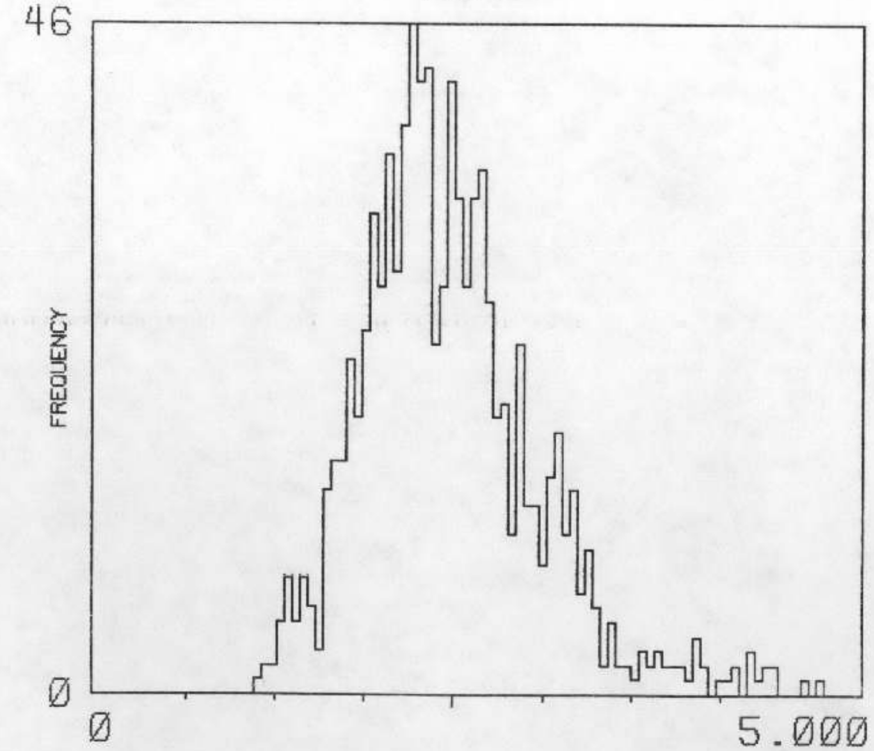
MEAN / MEDIAN 1.222 1.140 392 ADEQUATE SAMPLES

U/TH



MEAN / MEDIAN 0.548 0.520 379 ADEQUATE SAMPLES

TH/K

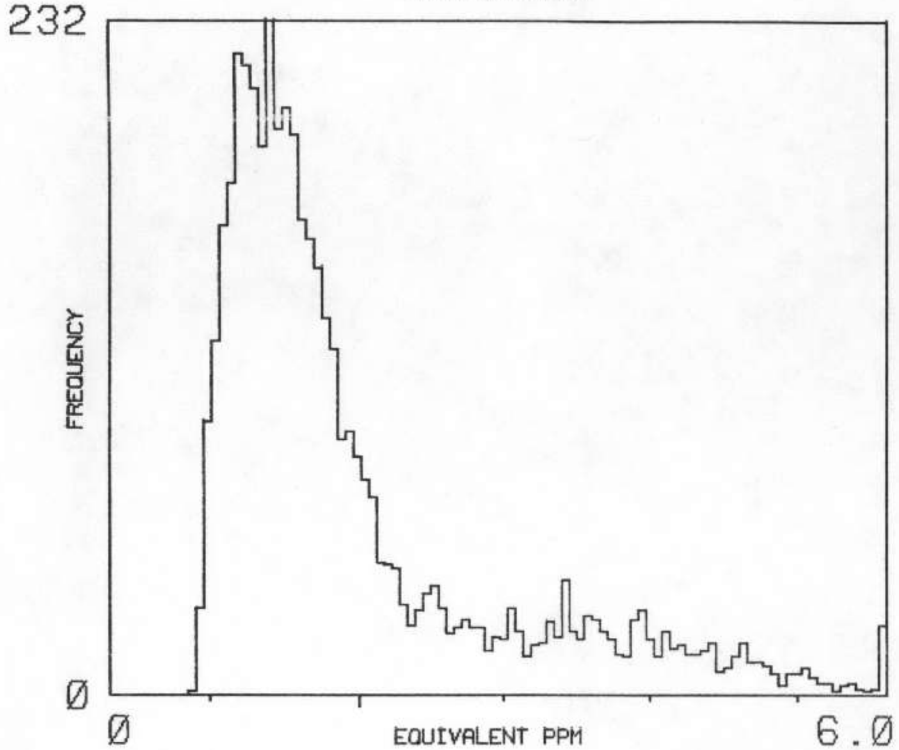


MEAN / MEDIAN 2.343 2.250 940 ADEQUATE SAMPLES

F8 mt

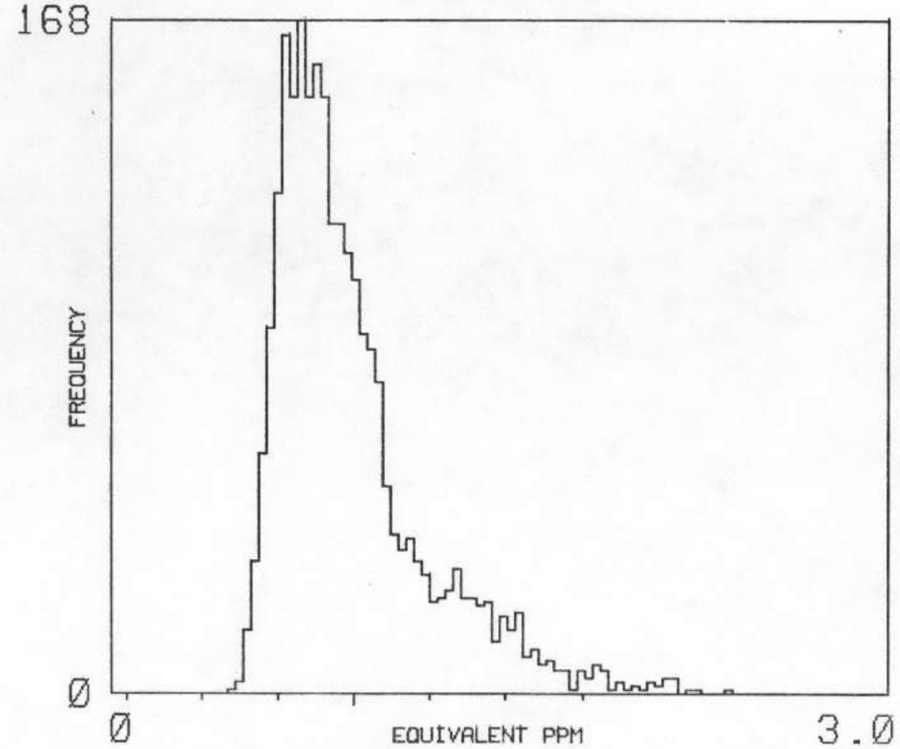
NL 16-11/12 MANITOWOC/TRAVERSE CITY MAP UNIT : QL TOTAL NUMBER OF SAMPLES 5141

THORIUM



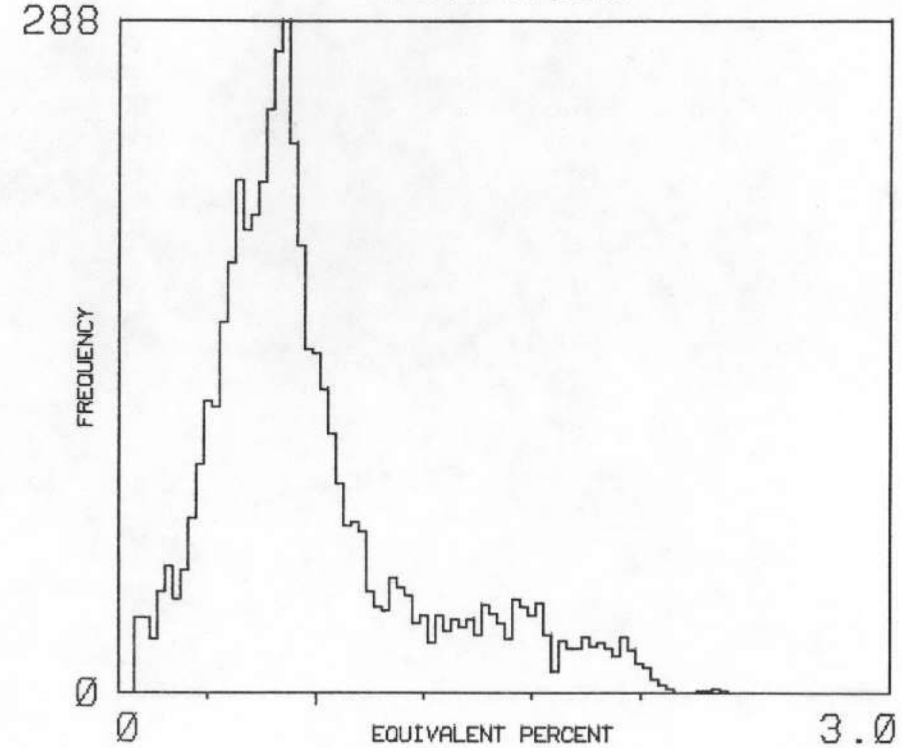
MEAN / MEDIAN 1.9 1.5 4569 ADEQUATE SAMPLES

URANIUM



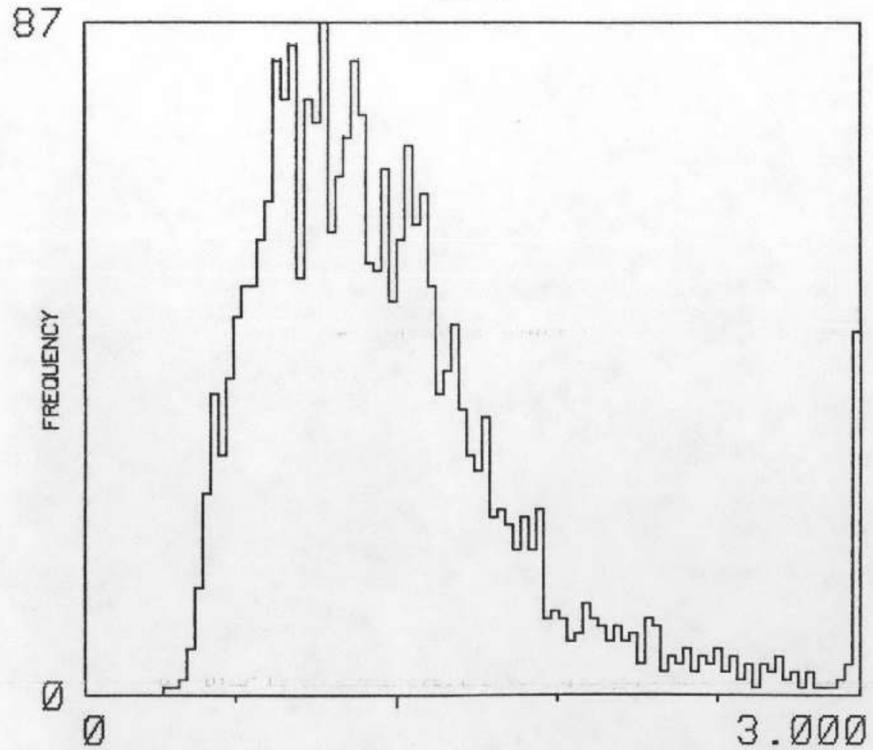
MEAN / MEDIAN Ø.9 Ø.9 2556 ADEQUATE SAMPLES

POTASSIUM



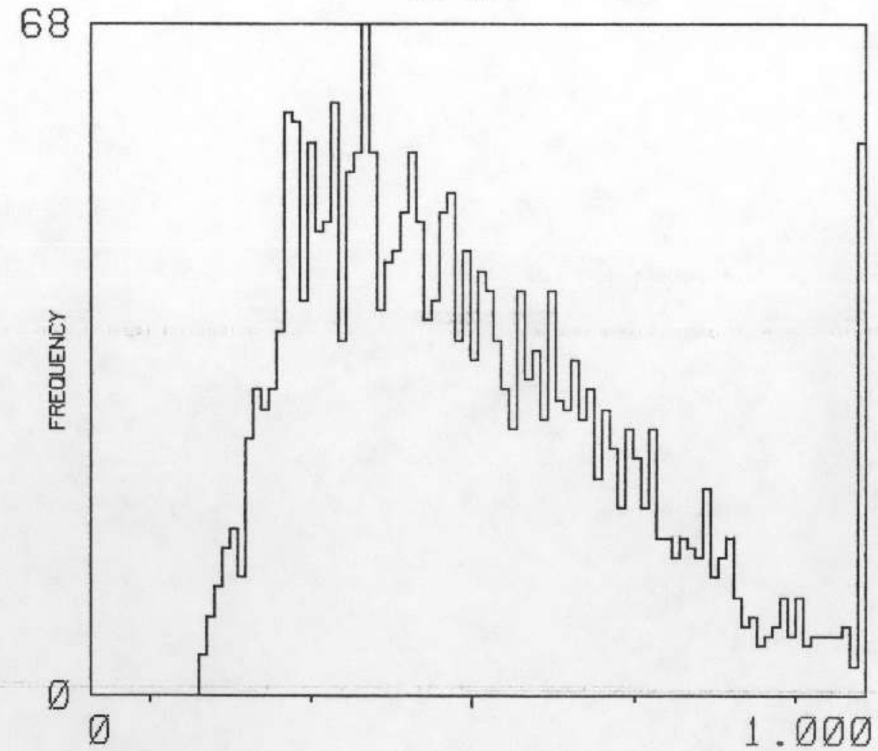
MEAN / MEDIAN Ø.8 Ø.7 5Ø21 ADEQUATE SAMPLES

U/K



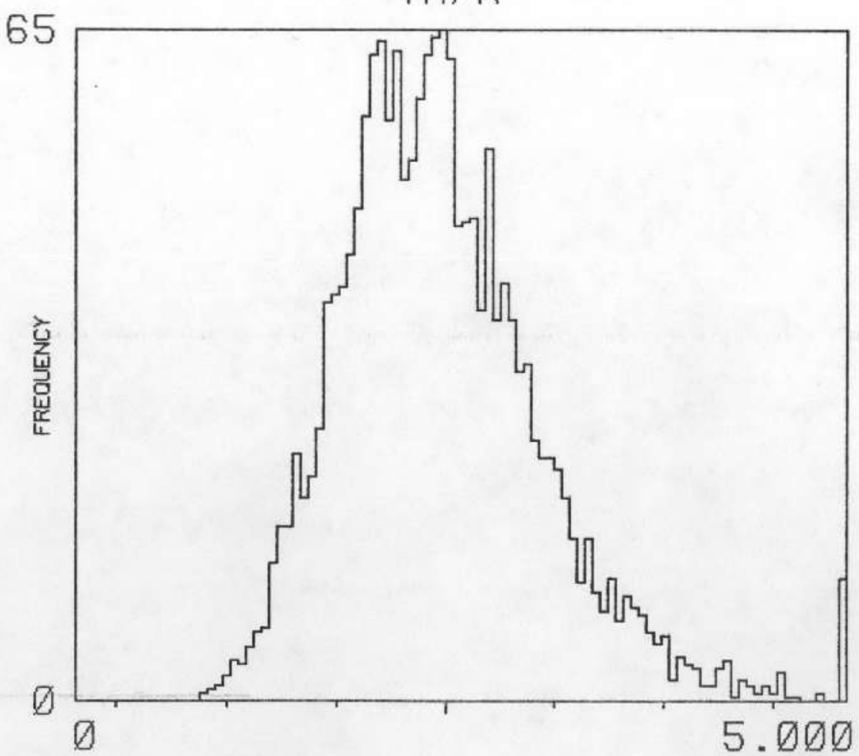
MEAN / MEDIAN 1.198 1.Ø8Ø 2544 ADEQUATE SAMPLES

U/TH



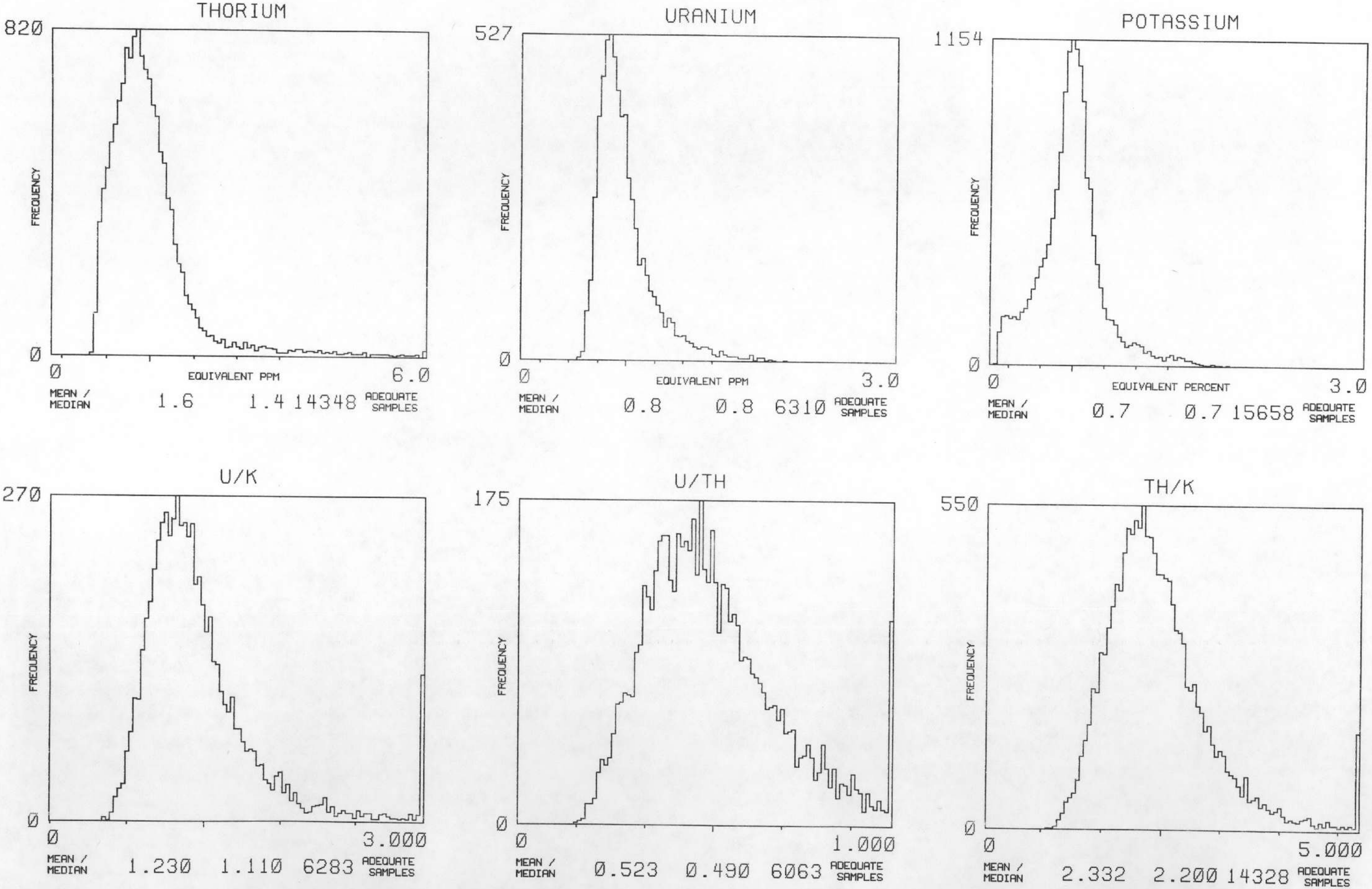
MEAN / MEDIAN Ø.493 Ø.46Ø 2446 ADEQUATE SAMPLES

TH/K



MEAN / MEDIAN 2.396 2.3ØØ 4563 ADEQUATE SAMPLES

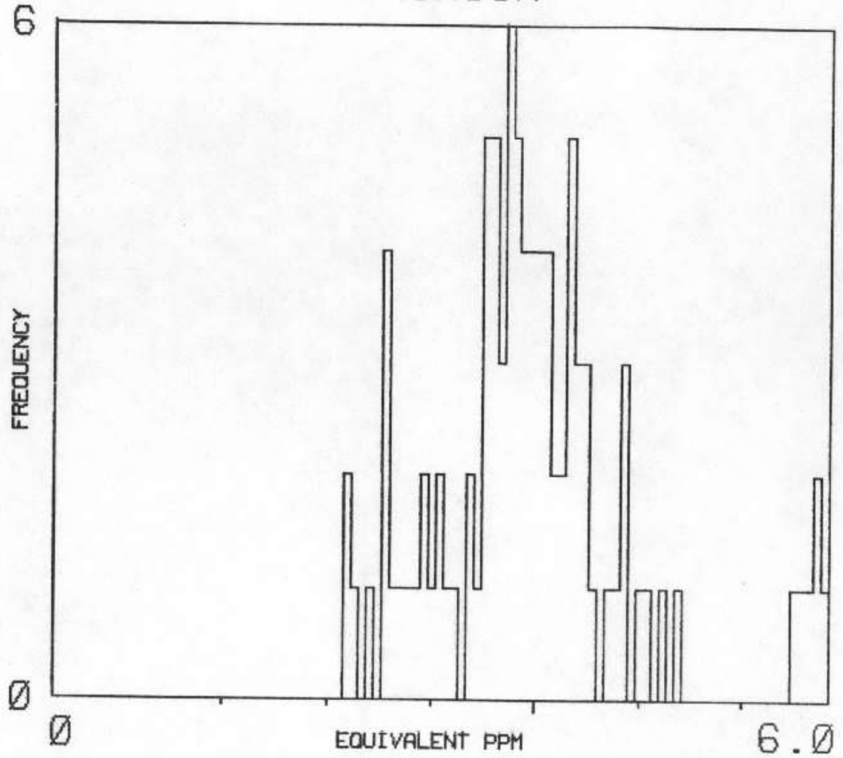
NL 16-11/12 MANITOWOC/TRAVERSE CITY MAP UNIT : QO TOTAL NUMBER OF SAMPLES 16060



NL 16-11/12 MANITOWOC/TRAVERSE CITY MAP UNIT : QDE TOTAL NUMBER OF SAMPLES 93

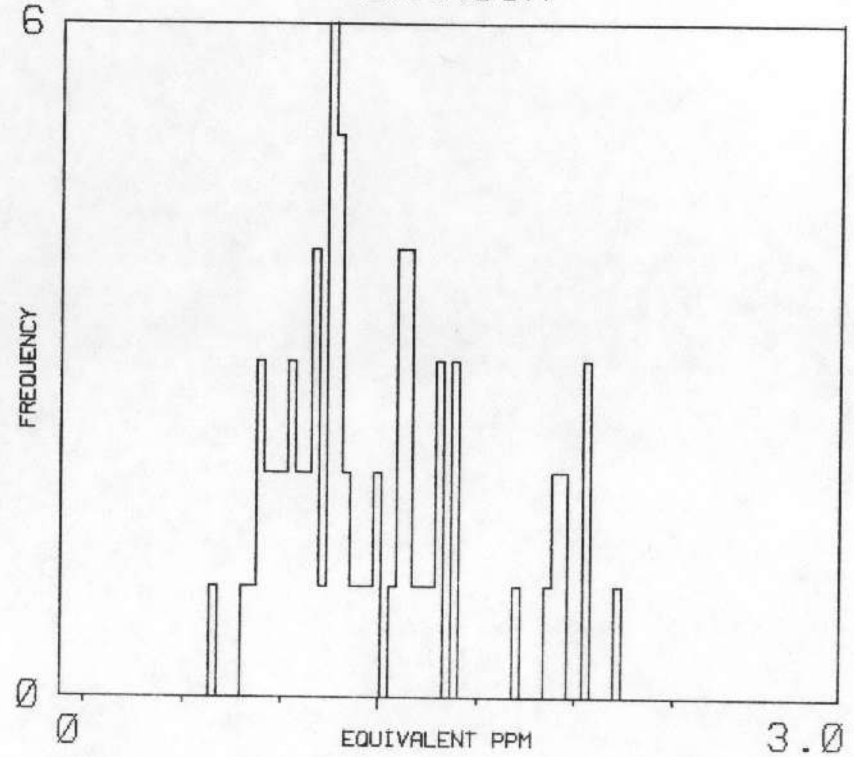
F10 mt

THORIUM



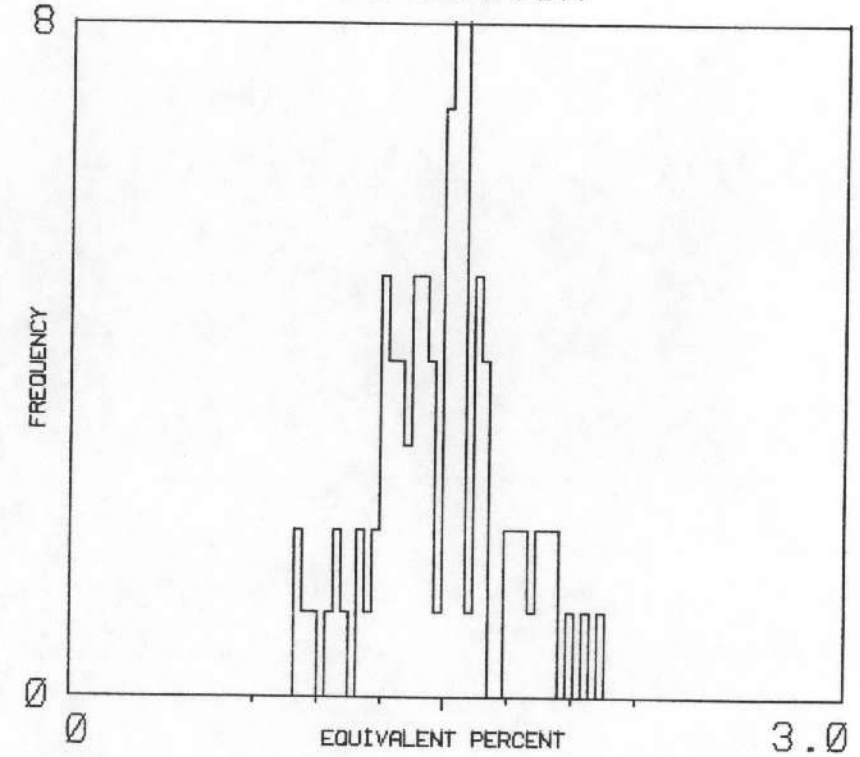
MEAN / MEDIAN 3.7 3.7 93 ADEQUATE SAMPLES

URANIUM



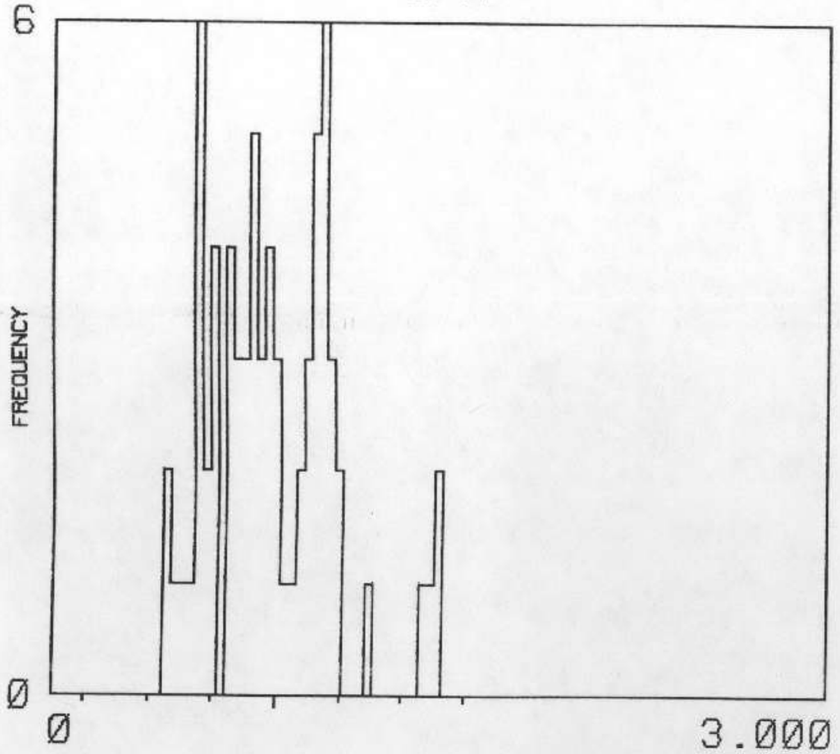
MEAN / MEDIAN 1.2 1.1 7Ø ADEQUATE SAMPLES

POTASSIUM



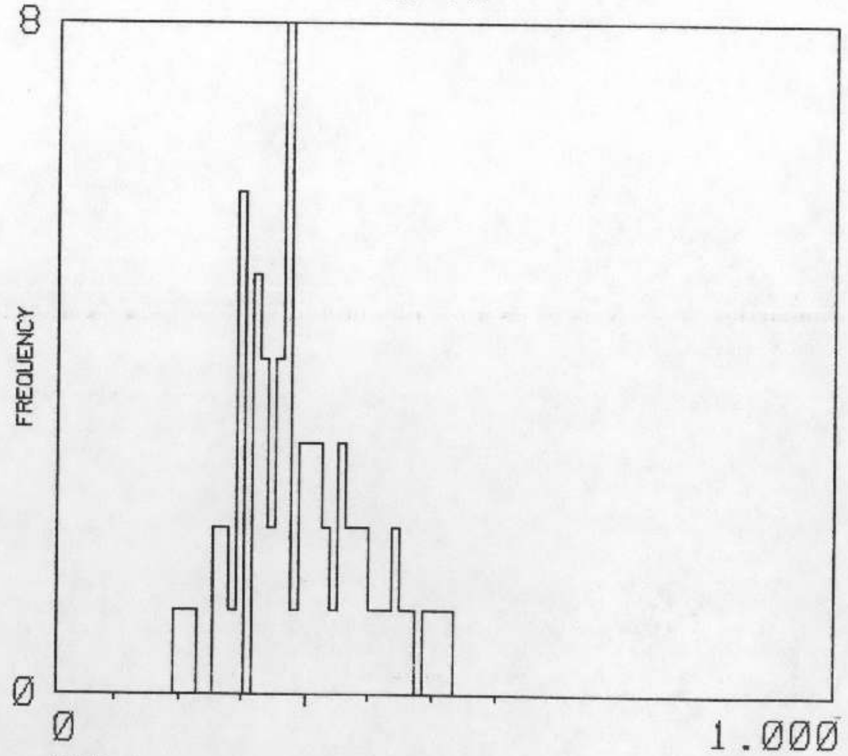
MEAN / MEDIAN 1.5 1.5 93 ADEQUATE SAMPLES

U/K



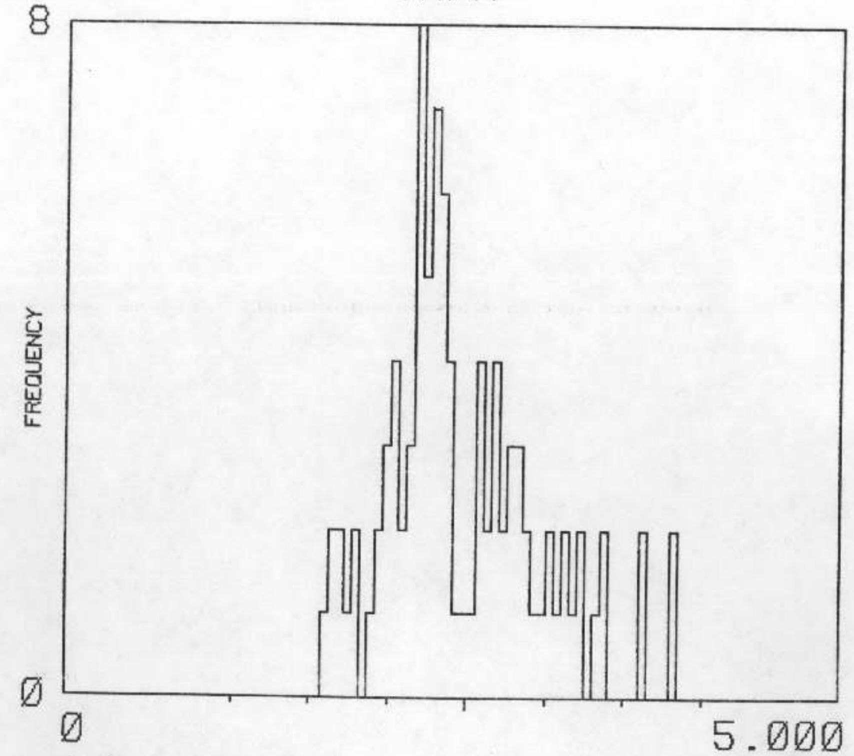
MEAN / MEDIAN Ø.854 Ø.81Ø 7Ø ADEQUATE SAMPLES

U/TH



MEAN / MEDIAN Ø.32Ø Ø.3ØØ 7Ø ADEQUATE SAMPLES

TH/K



MEAN / MEDIAN 2.59Ø 2.45Ø 93 ADEQUATE SAMPLES

MANITOWOC AND TRAVERSE CITY QUADRANGLES

Computer Map Unit Symbol Conversion Table

Computer Map Unit Symbol	Geologic Map Unit Symbol
QAL	Qal
QB	Qb
QMA	Qma
QM	Qm
QGM	Qgm
QWM	Qwm
QPW	Qpw
QL	Ql
QO	Qo
QDE	Drumlins and Eskers

NOTES:

On the following pages, histograms for each computer map unit are included in the same order as they appear on the above list.

Geologic descriptions of original geologic map units are in Appendix C.

Areas over water or cultural features were assigned separate map unit symbols and were removed from the data block during processing.

APPENDIX G - Uranium Anomaly Summary and Statistical Tables

ANOMALY SUMMARY TABLE

ANOMALY	FLIGHT	COMPUTER MAP UNIT AND NO. ANOMALOUS SAMPLES IN UNIT			PEAK PPM	NUMBER OF SAMPLES WITH A STANDARD DEVIATION OF : 1	2	3	4	5	6	7	GT7
1 C	80	QGM / 1	/ 0	/ 0	2.0	0	0	1	0	0	0	0	0
2 C	90	QGM / 1	/ 0	/ 0	2.0	0	0	1	0	0	0	0	0
3 C	90	QMA / 1	/ 0	/ 0	2.1	0	0	1	0	0	0	0	0
4 C	100	QO / 1	/ 0	/ 0	1.4	0	0	1	0	0	0	0	0
5 C	100	QM / 3	/ 0	/ 0	1.7	1	2	0	0	0	0	0	0
6 C	100	QM / 1	/ 0	/ 0	1.8	0	0	1	0	0	0	0	0
7 C	120	QGM / 2	/ 0	/ 0	2.0	0	1	1	0	0	0	0	0
8 C	120	QGM / 2	/ 0	/ 0	2.4	0	1	0	1	0	0	0	0
9 C	1140	QPW / 1	/ 0	/ 0	1.2	0	0	1	0	0	0	0	0

NOTES: M INDICATES THAT THE ANOMALY LIES OVER A URANIUM MINE OR PROSPECT.

C INDICATES THAT THE ANOMALY LIES OVER A CULTURAL FEATURE.

W INDICATES POSSIBLE INTERFERENCE BY WEATHER PHENOMENA.

MAP UNIT QAL

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.4061	0.7301	1.0541	1.3781	1.7021	2.0261	2.3501
URANIUM DIST NORMAL	0.1163	0.4681	0.8199	1.1717	1.5235	1.8753	2.2271
THORIUM DIST NORMAL	0.0668	1.2613	2.4558	3.6503	4.8448	6.0393	7.2338
U/K DIST NORMAL	0.2170	0.4283	0.6396	0.8509	1.0622	1.2735	1.4848
U/TH DIST NORMAL	0.0671	0.1527	0.2383	0.3239	0.4095	0.4951	0.5807
TH/K DIST NORMAL	1.1527	1.6454	2.1381	2.6308	3.1235	3.6162	4.1089

MAP UNIT QB

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.3349	-0.0281	0.2787	0.5855	0.8923	1.1991	1.5059
URANIUM DIST NORMAL	0.3730	0.5164	0.6598	0.8032	0.9466	1.0900	1.2334
THORIUM DIST NORMAL	0.1035	0.4859	0.8683	1.2507	1.6331	2.0155	2.3979
U/K DIST NORMAL	-0.8543	-0.0462	0.7619	1.5700	2.3781	3.1862	3.9943
U/TH DIST NORMAL	0.2211	0.3548	0.4885	0.6222	0.7559	0.8896	1.0233
TH/K DIST NORMAL	-1.5275	-0.2541	1.0193	2.2927	3.5661	4.8395	6.1129

MAP UNIT QMA

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.5872	-0.0891	0.4090	0.9071	1.4052	1.9033	2.4014
URANIUM DIST NORMAL	-0.0000	0.3375	0.6750	1.0125	1.3500	1.6875	2.0250
THORIUM DIST NORMAL	-1.3568	-0.0580	1.2408	2.5396	3.8384	5.1372	6.4360
U/K DIST NORMAL	-1.3390	-0.5292	0.2806	1.0904	1.9002	2.7100	3.5198
U/TH DIST NORMAL	-0.1108	0.0464	0.2036	0.3608	0.5180	0.6752	0.8324
TH/K DIST NORMAL	-0.8066	0.4418	1.6902	2.9386	4.1870	5.4354	6.6838

MAP UNIT QM

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.2796	0.1086	0.4968	0.8850	1.2732	1.6614	2.0496
URANIUM DIST NORMAL	0.0128	0.3271	0.6414	0.9557	1.2700	1.5843	1.8986
THORIUM DIST NORMAL	-1.3902	-0.2389	0.9124	2.0637	3.2150	4.3663	5.5176
U/K DIST NORMAL	-0.2753	0.1580	0.5913	1.0246	1.4579	1.8912	2.3245
U/TH DIST NORMAL	-0.0820	0.0960	0.2740	0.4520	0.6300	0.8080	0.9860
TH/K DIST NORMAL	0.5257	1.1064	1.6871	2.2678	2.8485	3.4292	4.0099

MAP UNIT QGM

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.2810	0.1532	0.5874	1.0216	1.4558	1.8900	2.3242
URANIUM DIST NORMAL	0.0468	0.3782	0.7096	1.0410	1.3724	1.7038	2.0352
THORIUM DIST NORMAL	-1.2697	0.0402	1.3501	2.6600	3.9699	5.2798	6.5897
U/K DIST NORMAL	-0.5311	-0.0171	0.4969	1.0109	1.5249	2.0389	2.5529
U/TH DIST NORMAL	-0.1158	0.0530	0.2218	0.3906	0.5594	0.7282	0.8970
TH/K DIST NORMAL	0.3979	1.1240	1.8501	2.5762	3.3023	4.0284	4.7545

MAP UNIT QWM

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.8590	-0.2741	0.3108	0.8957	1.4806	2.0655	2.6504
URANIUM DIST NORMAL	-0.1337	0.3093	0.7523	1.1953	1.6383	2.0813	2.5243
THORIUM DIST NORMAL	-2.2235	-0.6875	0.8485	2.3845	3.9205	5.4565	6.9925
U/K DIST NORMAL	0.1676	0.4744	0.7812	1.0880	1.3948	1.7016	2.0084
U/TH DIST NORMAL	-0.0210	0.1297	0.2804	0.4311	0.5818	0.7325	0.8832
TH/K DIST NORMAL	0.7598	1.3439	1.9280	2.5121	3.0962	3.6803	4.2644

MAP UNIT QPW

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.1438	0.3061	0.4684	0.6307	0.7930	0.9553	1.1176
URANIUM DIST NORMAL	0.2880	0.4529	0.6178	0.7827	0.9476	1.1125	1.2774
THORIUM DIST NORMAL	0.1620	0.6131	1.0642	1.5153	1.9664	2.4175	2.8686
U/K DIST NORMAL	-0.1141	0.3313	0.7767	1.2221	1.6675	2.1129	2.5583
U/TH DIST NORMAL	-0.0046	0.1796	0.3638	0.5480	0.7322	0.9164	1.1006
TH/K DIST NORMAL	0.6104	1.1879	1.7654	2.3429	2.9204	3.4979	4.0754

MAP UNIT QL

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.4959	-0.0751	0.3457	0.7665	1.1873	1.6081	2.0289
URANIUM DIST NORMAL	0.0590	0.3523	0.6456	0.9389	1.2322	1.5255	1.8188
THORIUM DIST NORMAL	-1.5015	-0.3672	0.7671	1.9014	3.0357	4.1700	5.3043
U/K DIST NORMAL	-0.6689	-0.0465	0.5759	1.1983	1.8207	2.4431	3.0655
U/TH DIST NORMAL	-0.1315	0.0767	0.2849	0.4931	0.7013	0.9095	1.1177
TH/K DIST NORMAL	0.2643	0.9747	1.6851	2.3955	3.1059	3.8163	4.5267

MAP UNIT QO

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.1053	0.1499	0.4051	0.6603	0.9155	1.1707	1.4259
URANIUM DIST NORMAL	0.1557	0.3844	0.6131	0.8418	1.0705	1.2992	1.5279
THORIUM DIST NORMAL	-0.5235	0.1722	0.8679	1.5636	2.2593	2.9550	3.6507
U/K DIST NORMAL	-0.6049	0.0068	0.6185	1.2302	1.8419	2.4536	3.0653
U/TH DIST NORMAL	-0.0263	0.1568	0.3399	0.5230	0.7061	0.8892	1.0723
TH/K DIST NORMAL	-0.0519	0.7426	1.5371	2.3316	3.1261	3.9206	4.7151

MAP UNIT QDE

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.7133	0.9590	1.2047	1.4504	1.6961	1.9418	2.1875
URANIUM DIST NORMAL	0.0903	0.4688	0.8473	1.2258	1.6043	1.9828	2.3613
THORIUM DIST NORMAL	1.2961	2.1030	2.9099	3.7168	4.5237	5.3306	6.1375
U/K DIST NORMAL	0.1191	0.3642	0.6093	0.8544	1.0995	1.3446	1.5897
U/TH DIST NORMAL	0.0750	0.1565	0.2380	0.3195	0.4010	0.4825	0.5640
TH/K DIST NORMAL	1.0732	1.5789	2.0846	2 5903	3.0960	3.6017	4.1074

LINE BASED MEAN CONCENTRATIONS
AND RATIOS PER ROCK TYPE

MAP UNIT QAL

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	0.000	1.338	0.000	0.000	0.000	0.982	0.000	1.319	1.465	1.535	1.469	0.000	0.000	0.000	0.000
URANIUM	0.000	0.810	0.000	0.000	0.000	0.657	0.000	1.106	1.307	1.547	1.232	0.000	0.000	0.000	0.000
THORIUM	0.000	2.703	0.000	0.000	0.000	2.680	0.000	2.924	3.893	3.979	4.381	0.000	0.000	0.000	0.000
U/K	0.000	0.610	0.000	0.000	0.000	0.764	0.000	0.797	0.911	1.009	0.857	0.000	0.000	0.000	0.000
U/TH	0.000	0.304	0.000	0.000	0.000	0.257	0.000	0.374	0.345	0.403	0.286	0.000	0.000	0.000	0.000
TH/K	0.000	2.017	0.000	0.000	0.000	2.890	0.000	2.132	2.653	2.549	2.987	0.000	0.000	0.000	0.000

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000

MAP UNIT QB

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	0.000	0.877	0.133	0.474	0.000	0.000	0.000	0.000	0.000	0.569	0.603	0.826	0.000	0.260	0.000
URANIUM	0.000	0.000	0.000	0.772	0.000	0.000	0.000	0.000	0.000	0.716	0.000	1.031	0.000	0.876	0.000
THORIUM	0.000	1.405	0.000	1.048	0.000	0.000	0.000	0.000	0.000	1.054	1.140	1.635	0.000	0.000	0.000
U/K	0.000	0.000	0.000	1.761	0.000	0.000	0.000	0.000	0.000	1.244	0.000	0.762	0.000	3.459	0.000
U/TH	0.000	0.000	0.000	0.631	0.000	0.000	0.000	0.000	0.000	0.708	0.000	0.433	0.000	0.000	0.000
TH/K	0.000	2.119	0.000	2.275	0.000	0.000	0.000	0.000	0.000	1.862	1.804	1.526	0.000	0.000	0.000

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	0.394	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.750	0.000	0.000	0.000	0.000	0.000	0.000
THORIUM	1.231	0.000	0.000	0.000	0.000	0.000	0.000
U/K	1.434	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.640	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	3.172	0.000	0.000	0.000	0.000	0.000	0.000

MAP UNIT QMA

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	0.866	0.536	0.912	0.726	1.225	1.441	1.370	1.073	0.600	1.041	0.941	0.589	0.914	0.461	0.803
URANIUM	0.766	0.757	0.966	0.828	0.970	0.963	0.970	0.925	1.054	1.335	1.408	1.011	1.064	0.824	0.865
THURIUM	1.986	1.786	2.502	2.106	3.422	3.668	2.831	3.483	1.764	3.179	3.314	2.155	2.658	1.414	2.217
U/K	0.701	0.616	0.794	0.772	0.725	0.696	0.711	0.940	1.809	1.213	2.049	1.280	0.991	1.830	0.790
U/TH	0.318	0.250	0.306	0.291	0.273	0.268	0.344	0.273	0.607	0.374	0.439	0.373	0.333	0.592	0.319
TH/K	2.271	3.076	2.735	2.460	2.730	2.609	2.068	3.395	3.120	3.395	4.861	3.749	2.922	3.077	2.920

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	0.539	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.911	0.000	0.000	0.000	0.000	0.000	0.000
THURIUM	1.528	0.000	0.000	0.000	0.000	0.000	0.000
U/K	1.632	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.552	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	3.398	0.000	0.000	0.000	0.000	0.000	0.000

MAP UNIT QM

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	0.696	0.679	0.734	0.734	0.799	0.963	1.098	1.100	1.031	0.866	0.845	0.879	1.700	0.847	1.481
URANIUM	0.792	0.822	0.773	0.759	0.795	0.914	1.097	1.116	1.111	1.042	0.839	0.984	1.224	0.812	1.066
THURIUM	1.535	1.507	1.502	1.618	1.713	2.104	2 762	2.771	2.603	2.116	2.002	2.107	4.458	1.662	3.787
U/K	1.094	1.301	1.003	0.911	0.851	0.858	0.999	1.003	1.141	1.365	0.976	1.065	0.728	0.920	0.676
U/TH	0.526	0.562	0.508	0.435	0.420	0.417	0.408	0.429	0.464	0.558	0.450	0.453	0.277	0.491	0.269
TH/K	2.197	2.202	2.066	2.189	2.093	2.120	2.507	2.428	2.453	2.431	2.357	2.363	2.638	1.981	2.562

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	1.047	0.764	0.796	0.766	0.580	0.704	0.709
URANIUM	0.849	0.714	0.776	0.769	0.769	0.940	0.860
THURIUM	2.010	1.610	1.702	1.491	1.263	1.895	1.779
U/K	0.813	0.997	0.903	1.004	1.328	1.220	1.185
U/TH	0.445	0.522	0.435	0.518	0.620	0.458	0.460
TH/K	1.877	2.118	2.078	1.969	2.171	2.508	2.513

MAP UNIT QGM

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	1.011	1.210	1.083	1.416	1.395	0.918	0.688	0.955	1.046	0.846	0.996	1.046	1.440	0.887	1.368
URANIUM	0.885	0.848	0.849	0.988	0.977	0.851	0.778	1.051	1.119	1.106	1.054	1.233	1.238	0.825	1.042
THORIUM	2.261	2.625	2.330	3.641	3.637	2.164	1.471	2.161	2.861	2.443	2.713	3.111	4.139	1.693	3.377
U/K	0.815	0.656	0.722	0.669	0.700	0.817	1.022	0.992	1.173	1.509	0.904	1.067	0.845	0.892	0.735
U/TH	0.391	0.314	0.340	0.267	0.269	0.356	0.513	0.476	0.428	0.533	0.344	0.374	0.288	0.489	0.308
TH/K	2.169	2.162	2.154	2.614	2.686	2.305	2.384	2.211	2.716	2.833	2.656	2.871	2.900	1.970	2.450

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	1.337	0.000	0.772	0.699	0.521	0.931	0.562
URANIUM	1.037	0.000	0.766	0.899	0.760	1.222	0.697
THORIUM	2.774	0.000	1.592	2.042	1.413	2.774	1.758
U/K	0.755	0.000	0.830	1.374	1.707	1.038	1.224
U/TH	0.373	0.000	0.385	0.459	0.562	0.325	0.417
TH/K	2.072	0.000	2.060	2.962	2.731	2.778	3.139

MAP UNIT QWM

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	1.790	0.000	0.000	0.000	0.546	0.664	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	1.570	0.000	0.000	0.000	0.682	1.135	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	4.511	0.000	0.000	0.000	1.264	1.966	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.883	0.000	0.000	0.000	1.226	1.299	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.349	0.000	0.000	0.000	0.562	0.426	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	2.555	0.000	0.000	0.000	2.175	2.915	0.000	0.000	0.000

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.454
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.835
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	1.359
U/K	0.000	0.000	0.000	0.000	0.000	0.000	1.336
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.561
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	2.749

MAP UNIT QPW

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	0.617	0.609	0.513	0.780	0.651	0.749	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.734	0.714	0.717	0.818	0.804	0.706	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
THORIUM	1.374	1.442	1.396	1.781	1.733	1.752	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/K	1.120	1.099	1.201	1.006	1.060	0.918	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.555	0.529	0.615	0.434	0.389	0.421	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	2.188	2.195	2.330	2.270	2.589	2.372	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.622
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.849
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	1.511
U/K	0.000	0.000	0.000	0.000	0.000	0.000	1.465
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.623
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	2.465

MAP UNIT QL

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	0.687	0.674	0.772	0.866	1.650	1.407	0.831	0.779	0.762	0.746	0.557	0.683	1.461	0.530	1.304
URANIUM	0.871	0.781	0.860	0.814	0.946	1.016	1.116	0.830	0.947	0.993	0.691	0.974	1.118	0.803	1.044
THORIUM	1.629	1.559	1.741	2.369	3.830	3.881	2.211	1.498	1.832	1.957	1.310	1.679	3.567	1.350	3.500
U/K	1.142	1.093	0.881	0.712	0.573	0.564	1.260	1.109	1.353	1.581	1.183	1.262	0.720	2.167	0.759
U/TH	0.510	0.516	0.432	0.311	0.242	0.240	0.473	0.597	0.542	0.602	0.538	0.532	0.301	0.528	0.295
TH/K	2.325	2.182	2.038	2.376	2.335	2.621	2.598	1.923	2.503	2.581	2.424	2.294	2.436	2.375	2.640

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	0.788	0.521	0.495	0.479	0.000	0.560	0.562
URANIUM	0.871	0.738	0.788	0.000	0.000	0.786	0.808
THORIUM	1.537	1.078	1.093	1.208	0.000	1.386	1.343
U/K	1.248	0.973	1.082	0.000	0.000	1.546	1.442
U/TH	0.597	0.683	0.888	0.000	0.000	0.614	0.573
TH/K	2.183	1.684	2.605	2.109	0.000	2.401	2.372

MAP UNIT QU

	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	0.665	0.618	0.668	0.635	0.559	0.655	0.715	0.683	0.653	0.674	0.764	0.659	1.289	0.782	0.000
URANIUM	0.781	0.836	0.746	0.748	0.649	0.831	0.835	0.958	0.888	0.932	0.832	0.848	0.971	0.779	0.000
THURIUM	1.415	1.424	1.438	1.364	1.229	1.500	1.842	2.010	1.672	1.637	1.638	1.515	3.577	1.307	0.000
U/K	1.189	1.307	1.077	1.085	1.152	1.151	1.045	1.294	1.621	1.378	1.018	1.445	0.736	1.020	0.000
U/TH	0.583	0.604	0.504	0.500	0.549	0.527	0.445	0.474	0.580	0.555	0.486	0.554	0.266	0.651	0.000
TH/K	2.097	2.226	2.134	2.102	2.165	2.232	2.549	2.872	2.651	2.439	2.104	2.393	2.779	1.747	0.000

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	0.674	0.690	0.683	0.644	0.495	0.502	0.854
URANIUM	0.702	0.731	0.759	0.785	0.784	0.761	1.004
THURIUM	1.448	1.494	1.446	1.420	1.328	1.397	2.307
U/K	1.039	1.101	0.996	1.177	1.407	1.302	1.141
U/TH	0.513	0.534	0.514	0.587	0.579	0.493	0.426
TH/K	2.208	2.223	2.088	2.102	2.483	2.748	2.645

MAP UNIT QDE

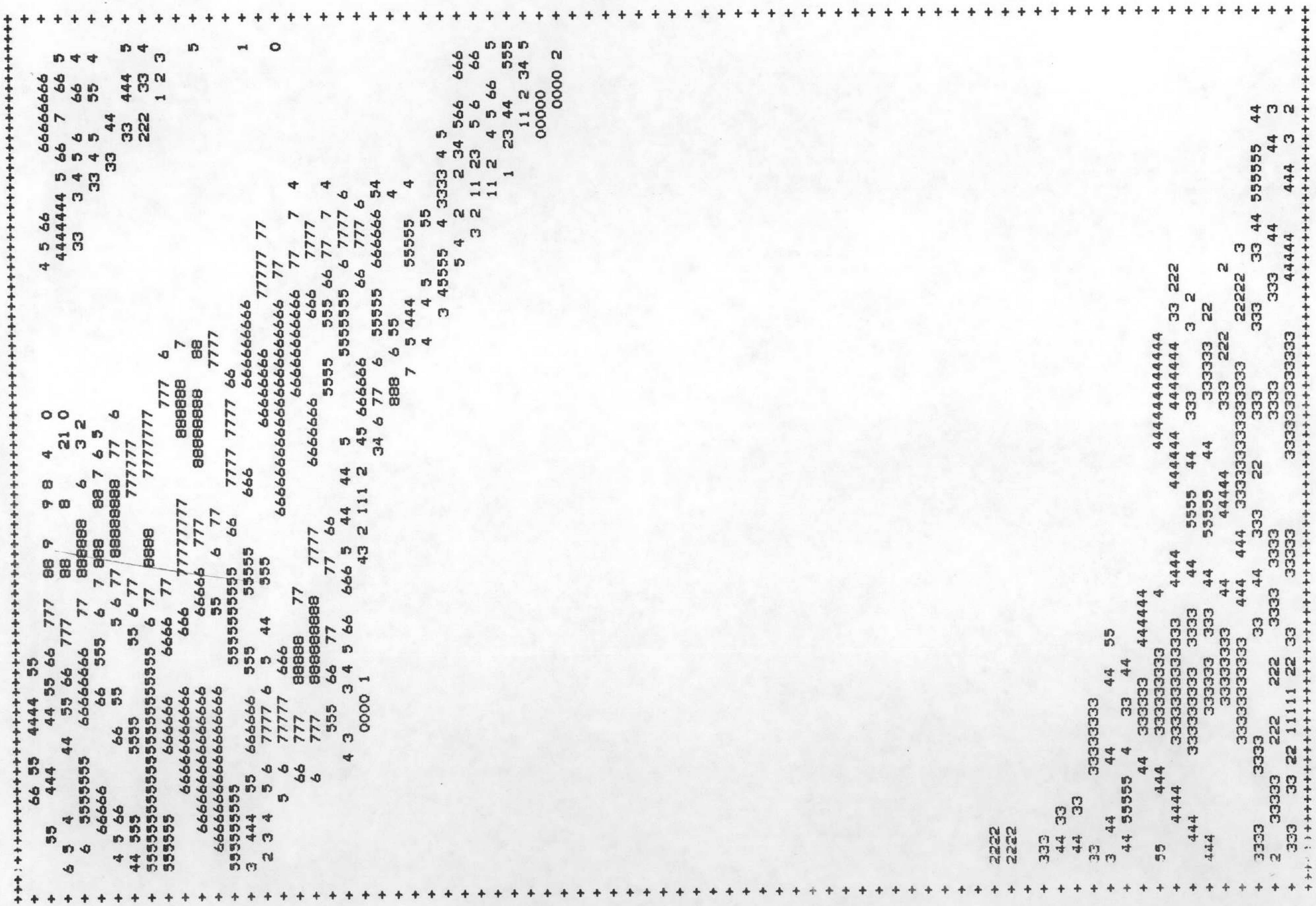
	10	20	30	40	50	60	70	80	90	100	110	120	1010	1060	1070
POTASIUM	1.515	1.393	0.000	0.000	1.701	0.000	0.000	0.000	1.541	1.218	1.894	1.100	1.237	0.000	1.499
URANIUM	0.854	0.000	0.000	0.000	1.381	0.000	0.000	0.000	0.816	1.221	1.971	1.113	0.906	0.000	1.187
THURIUM	3.361	3.600	0.000	0.000	3.884	0.000	0.000	0.000	4.548	3.614	5.144	4.053	2.596	0.000	3.549
U/K	0.580	0.000	0.000	0.000	0.813	0.000	0.000	0.000	0.526	1.037	1.042	1.013	0.760	0.000	0.793
U/TH	0.245	0.000	0.000	0.000	0.356	0.000	0.000	0.000	0.184	0.346	0.397	0.275	0.332	0.000	0.334
TH/K	2.221	2.585	0.000	0.000	2.285	0.000	0.000	0.000	2.954	2.996	2.715	3.699	2.104	0.000	2.368

	1080	1090	1100	1110	1120	1130	1140
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
THURIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000

APPENDIX H - Pseudo Contour Maps

H1 mt

MANITOWOC



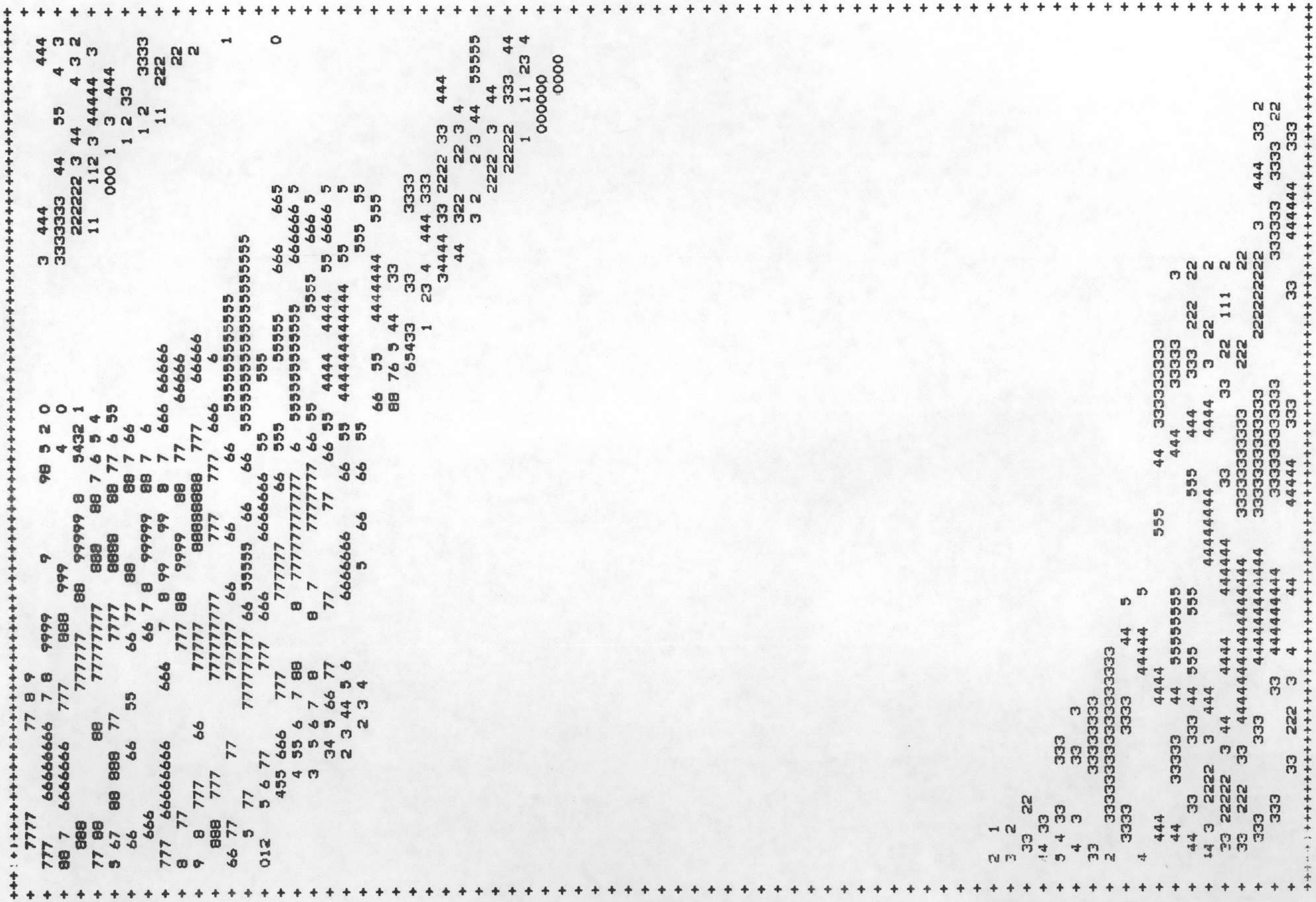
EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.1250
1	0.1250	0.2500
	0.2500	0.3750
2	0.3750	0.5000
	0.5000	0.6250
3	0.6250	0.7500
	0.7500	0.8750
4	0.8750	1.0000
	1.0000	1.1250
5	1.1250	1.2500
	1.2500	1.3750
6	1.3750	1.5000
	1.5000	1.6250
7	1.6250	1.7500
	1.7500	1.8750
8	1.8750	2.0000
	2.0000	2.1250
9	2.1250	2.2500
	GT	2.2500

SCALE IN EQUIVALENT PERCENT

Potassium Pseudo-Contour Map - Manitowoc Quadrangle

MANITOWOC



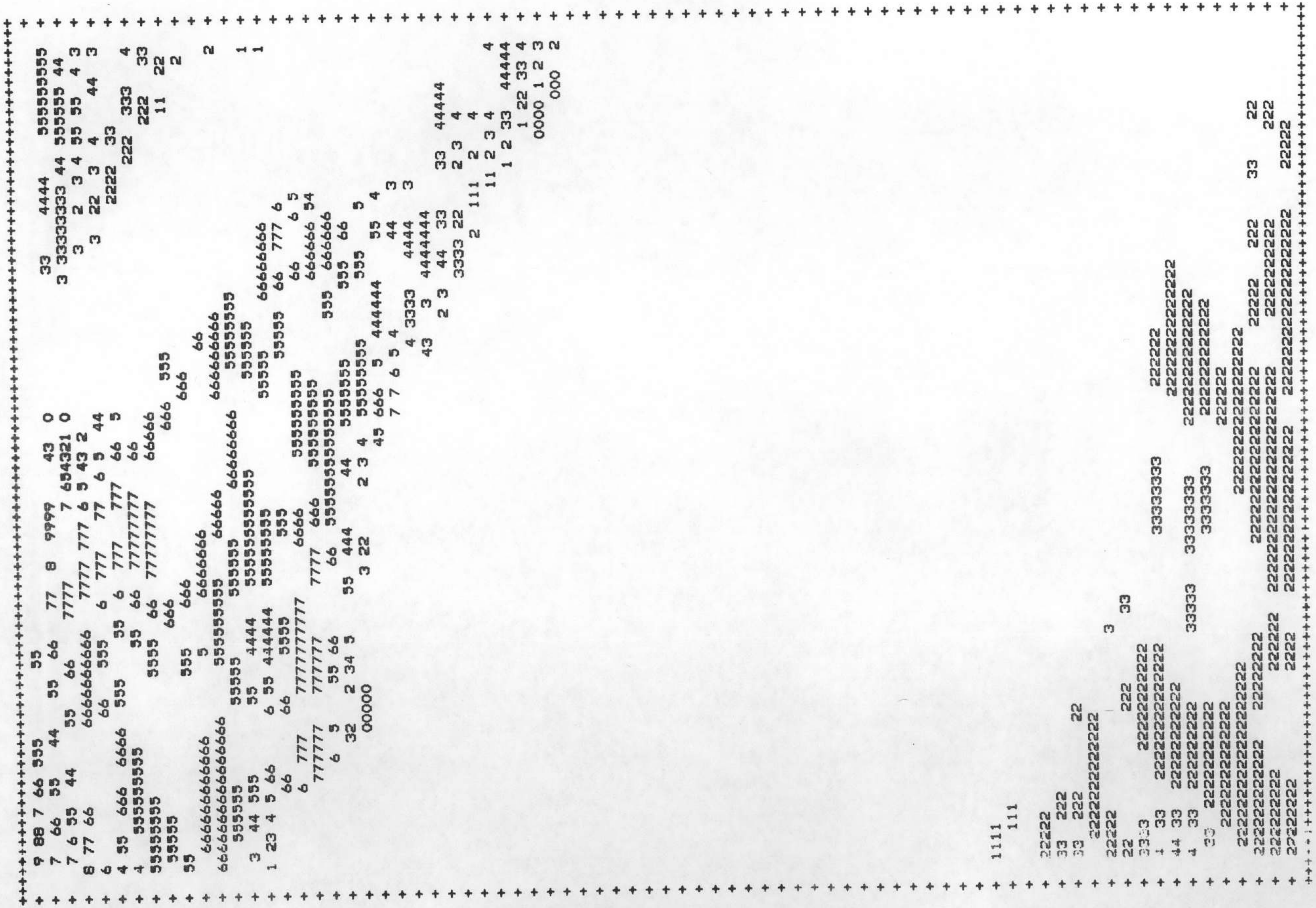
EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.1000
1	0.1000	0.2000
	0.2000	0.3000
2	0.3000	0.4000
	0.4000	0.5000
3	0.5000	0.6000
	0.6000	0.7000
4	0.7000	0.8000
	0.8000	0.9000
5	0.9000	1.0000
	1.0000	1.1000
6	1.1000	1.2000
	1.2000	1.3000
7	1.3000	1.4000
	1.4000	1.5000
8	1.5000	1.6000
	1.6000	1.7000
9	1.7000	1.8000
	GT	1.8000

SCALE IN EQUIVALENT PPM

Uranium Pseudo-Contour Map - Manitowoc Quadrangle

MANITOWOC



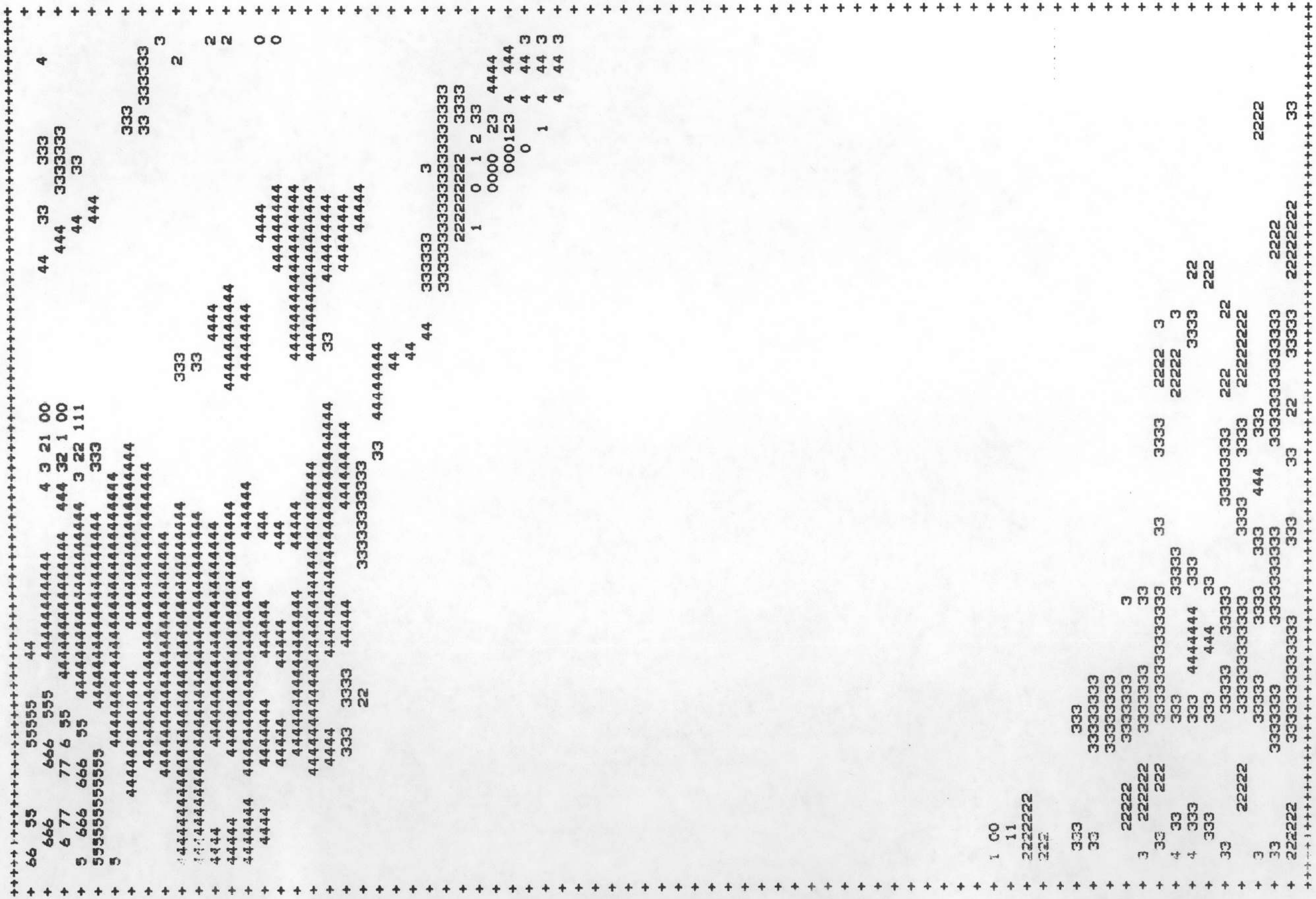
Thorium Pseudo-Contour Map - Manitowoc Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.3750
1	0.3750	0.7500
	0.7500	1.1250
2	1.1250	1.5000
	1.5000	1.8750
3	1.8750	2.2500
	2.2500	2.6250
4	2.6250	3.0000
	3.0000	3.3750
5	3.3750	3.7500
	3.7500	4.1250
6	4.1250	4.5000
	4.5000	4.8750
7	4.8750	5.2500
	5.2500	5.6250
8	5.6250	6.0000
	6.0000	6.3750
9	6.3750	6.7500
	GT	6.7500

SCALE IN EQUIVALENT PPM

MANITOWOC

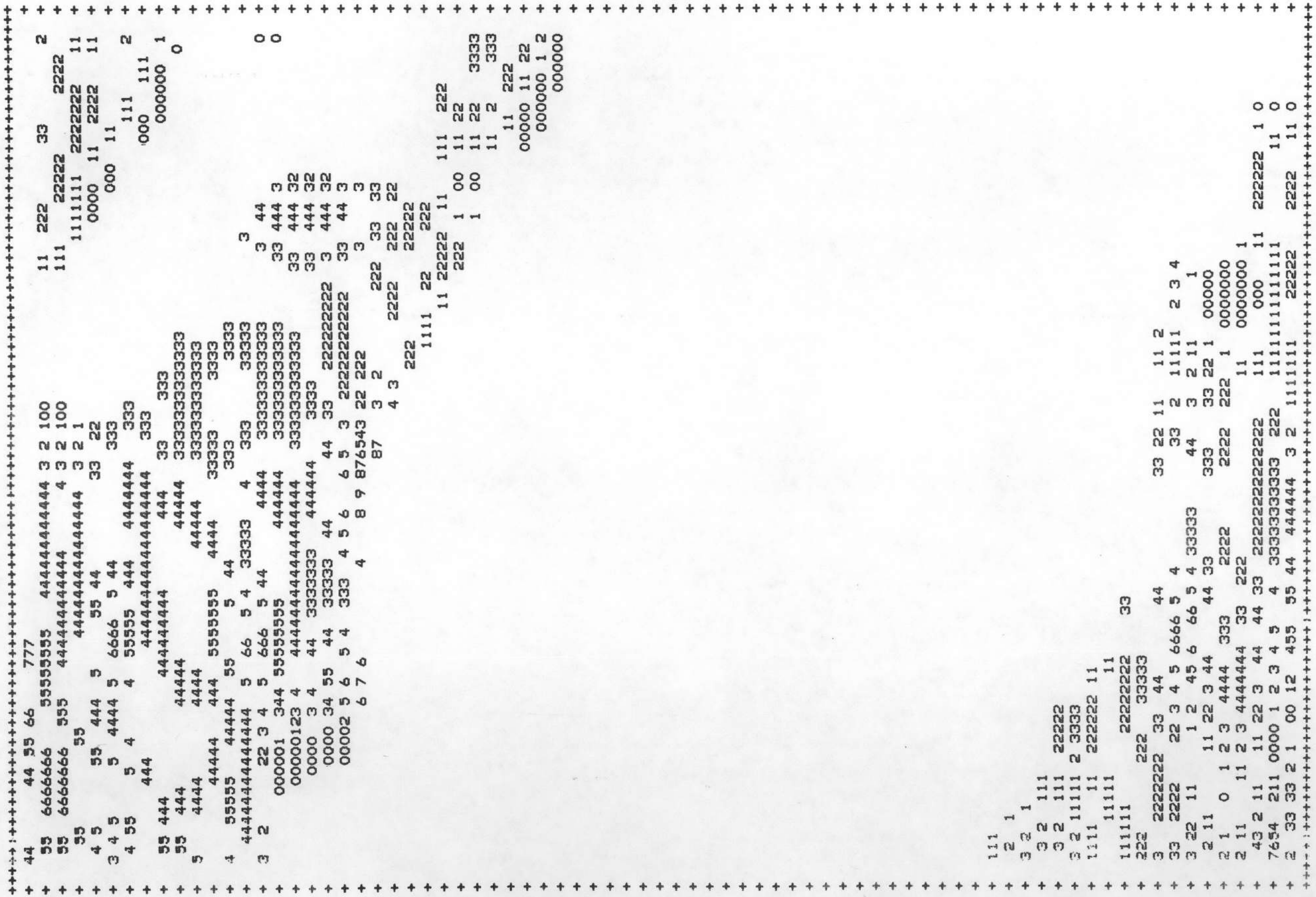


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.3750
1	0.3750	0.7500
	0.7500	1.1250
2	1.1250	1.5000
	1.5000	1.8750
3	1.8750	2.2500
	2.2500	2.6250
4	2.6250	3.0000
	3.0000	3.3750
5	3.3750	3.7500
	3.7500	4.1250
6	4.1250	4.5000
	4.5000	4.8750
7	4.8750	5.2500
	5.2500	5.6250
8	5.6250	6.0000
	6.0000	6.3750
9	6.3750	6.7500
	GT	6.7500

Thorium/Potassium Pseudo-Contour Map - Manitowoc Quadrangle

MANITOWOC

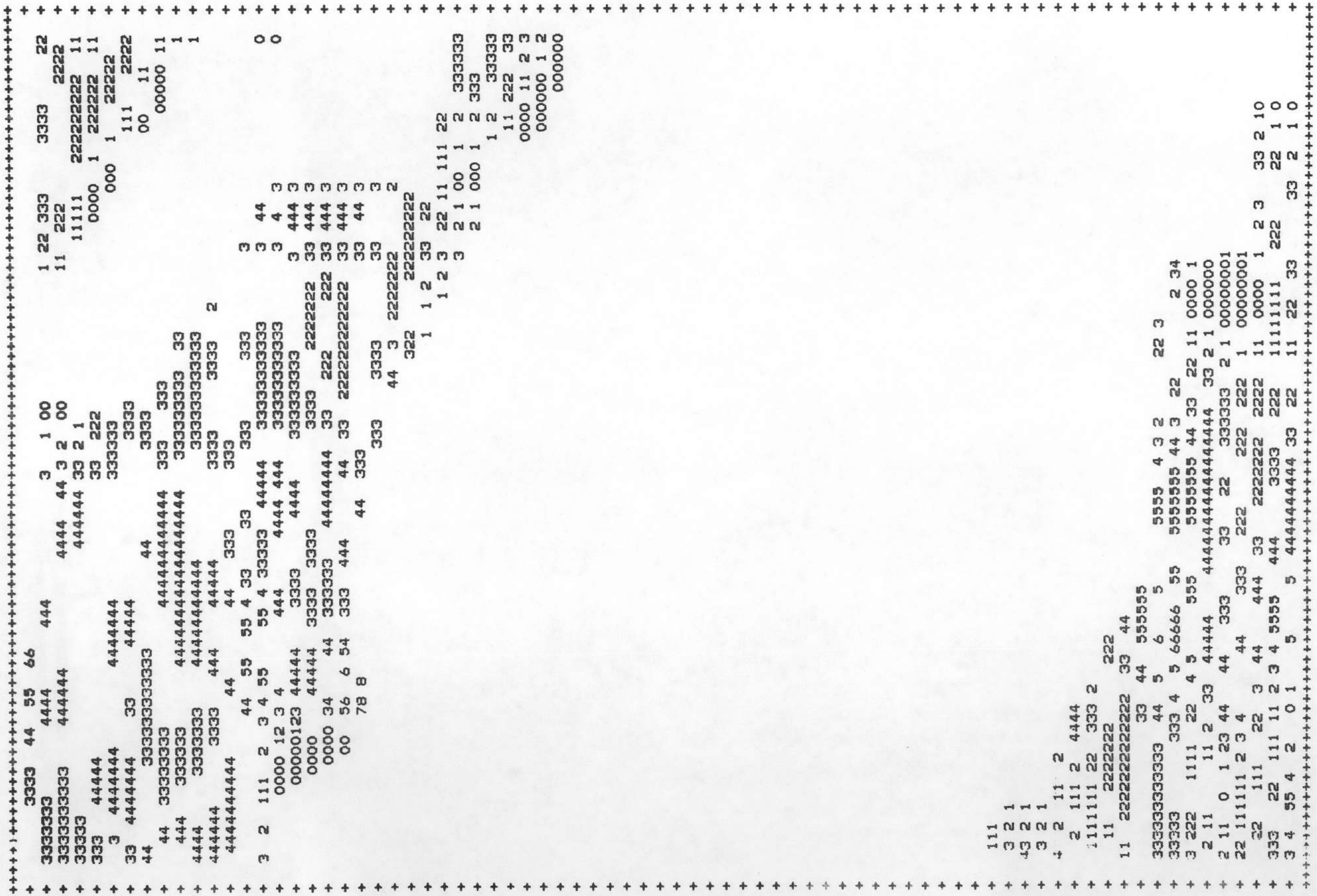


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.1250
1	0.1250	0.2500
	0.2500	0.3750
2	0.3750	0.5000
	0.5000	0.6250
3	0.6250	0.7500
	0.7500	0.8750
4	0.8750	1.0000
	1.0000	1.1250
5	1.1250	1.2500
	1.2500	1.3750
6	1.3750	1.5000
	1.5000	1.6250
7	1.6250	1.7500
	1.7500	1.8750
8	1.8750	2.0000
	2.0000	2.1250
9	2.1250	2.2500
	GT	2.2500

Uranium/Potassium Pseudo-Contour Map - Manitowoc Quadrangle

MANITOWOC

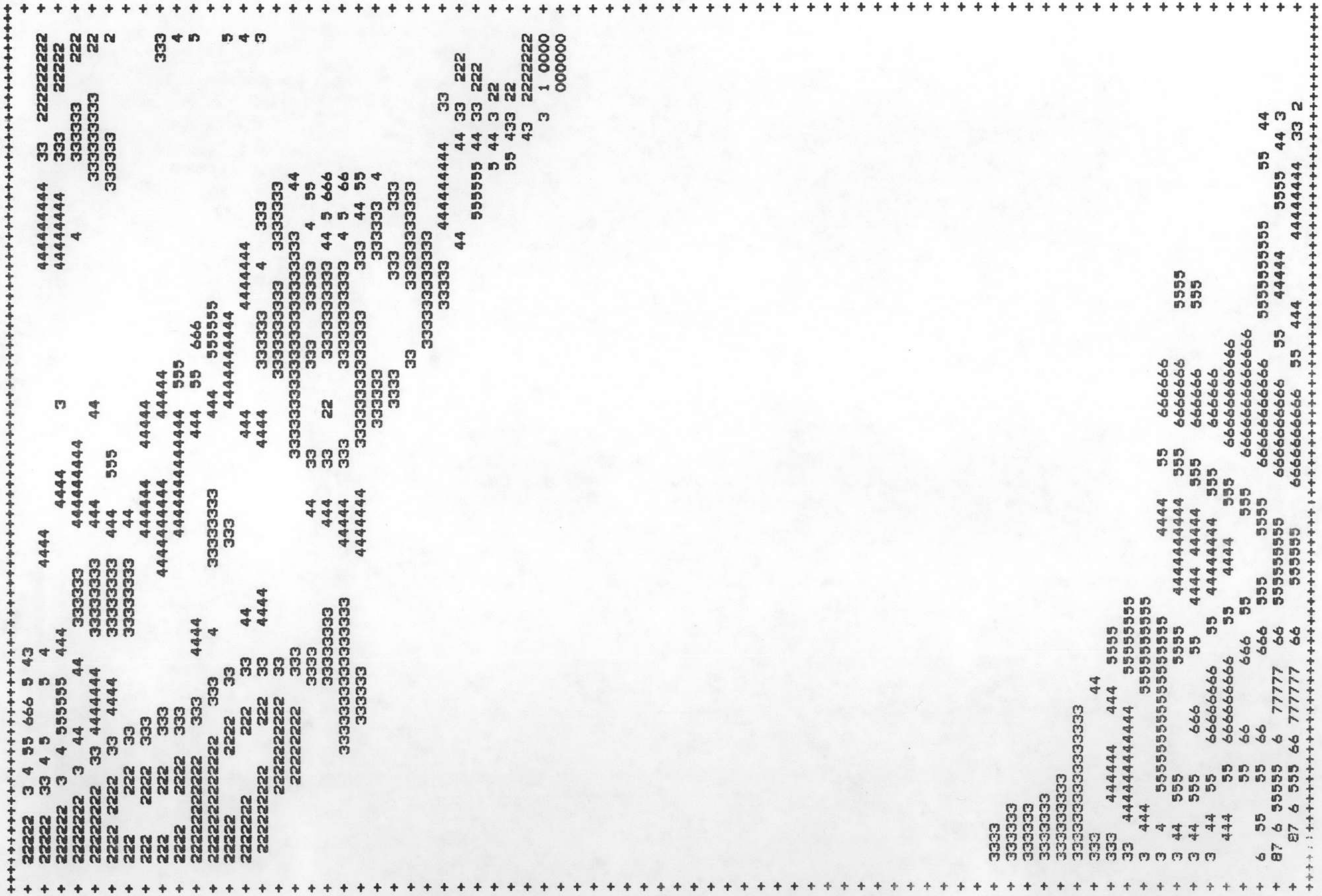


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.0500
1	0.0500	0.1000
	0.1000	0.1500
2	0.1500	0.2000
	0.2000	0.2500
3	0.2500	0.3000
	0.3000	0.3500
4	0.3500	0.4000
	0.4000	0.4500
5	0.4500	0.5000
	0.5000	0.5500
6	0.5500	0.6000
	0.6000	0.6500
7	0.6500	0.7000
	0.7000	0.7500
8	0.7500	0.8000
	0.8000	0.8500
9	0.8500	0.9000
	GT	0.9000

Uranium/Thorium Pseudo-Contour Map - Manitowoc Quadrangle

MANITOWOC



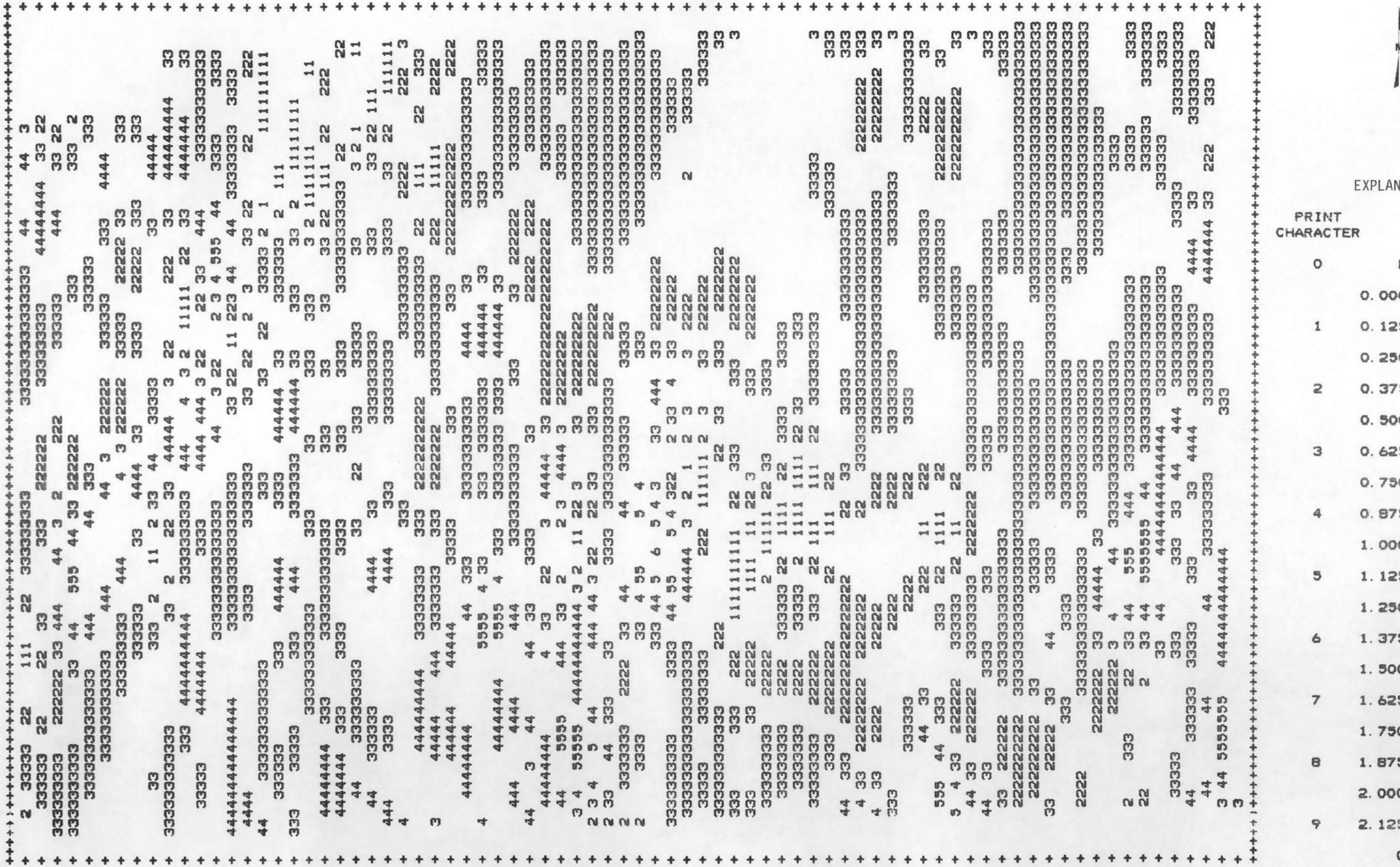
Residual Magnetic Pseudo-Contour Map - Manitowoc Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE
0	LE-1200.0000
	-1200.0000-1100.0000
1	-1100.0000-1000.0000
	-1000.0000 -900.0000
2	-900.0000 -800.0000
	-800.0000 -700.0000
3	-700.0000 -600.0000
	-600.0000 -500.0000
4	-500.0000 -400.0000
	-400.0000 -300.0000
5	-300.0000 -200.0000
	-200.0000 -100.0000
6	-100.0000 0.0000
	0.0000 100.0000
7	100.0000 200.0000
	200.0000 300.0000
8	300.0000 400.0000
	400.0000 500.0000
9	500.0000 600.0000
	GT 600.0000

SCALE IN GAMMAS

TRAVERSE CITY



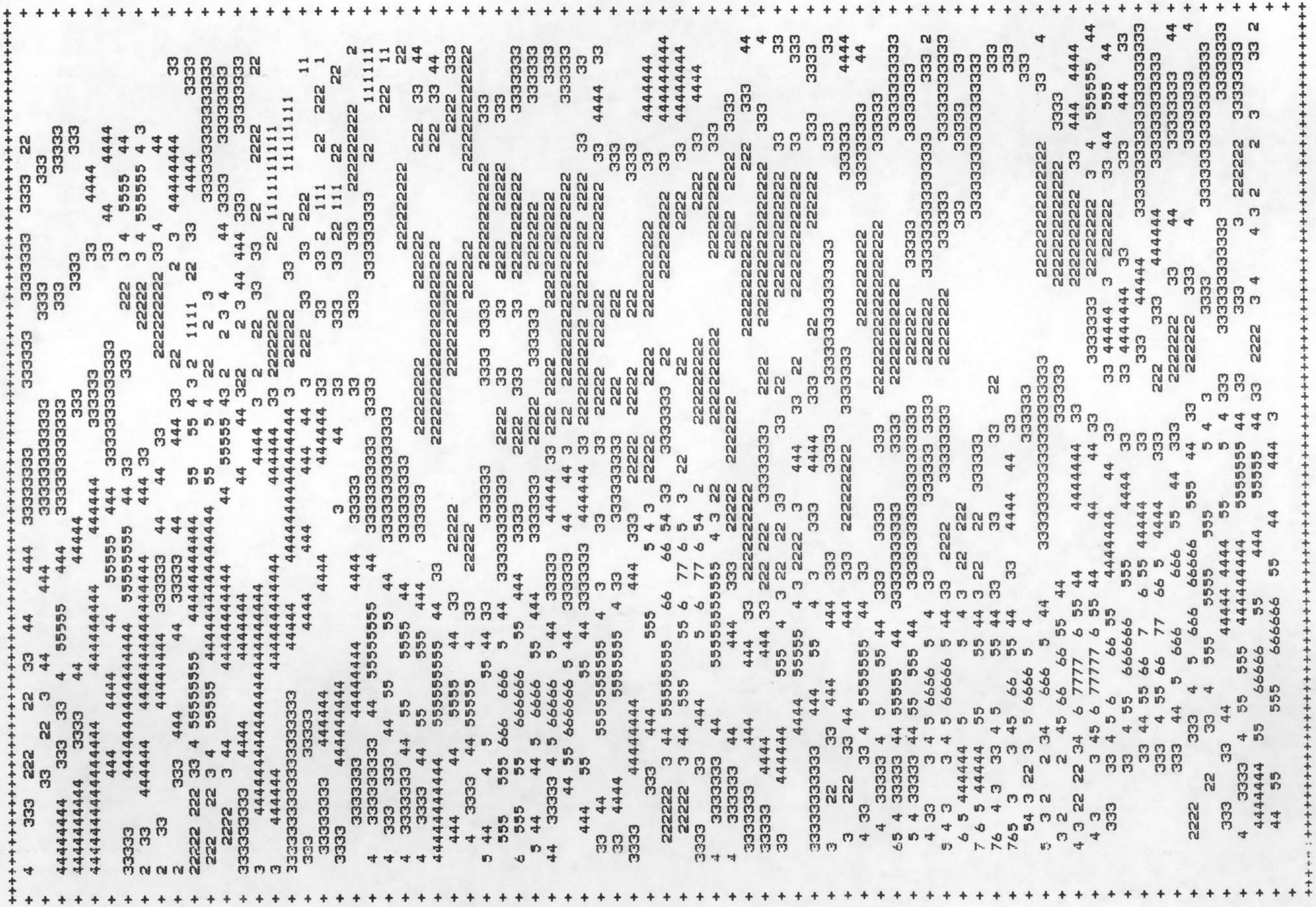
Potassium Pseudo-Contour Map - Traverse City Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.1250
1	0.1250	0.2500
	0.2500	0.3750
2	0.3750	0.5000
	0.5000	0.6250
3	0.6250	0.7500
	0.7500	0.8750
4	0.8750	1.0000
	1.0000	1.1250
5	1.1250	1.2500
	1.2500	1.3750
6	1.3750	1.5000
	1.5000	1.6250
7	1.6250	1.7500
	1.7500	1.8750
8	1.8750	2.0000
	2.0000	2.1250
9	2.1250	2.2500
	GT	2.2500

SCALE IN EQUIVALENT PERCENT

TRAVERSE CITY



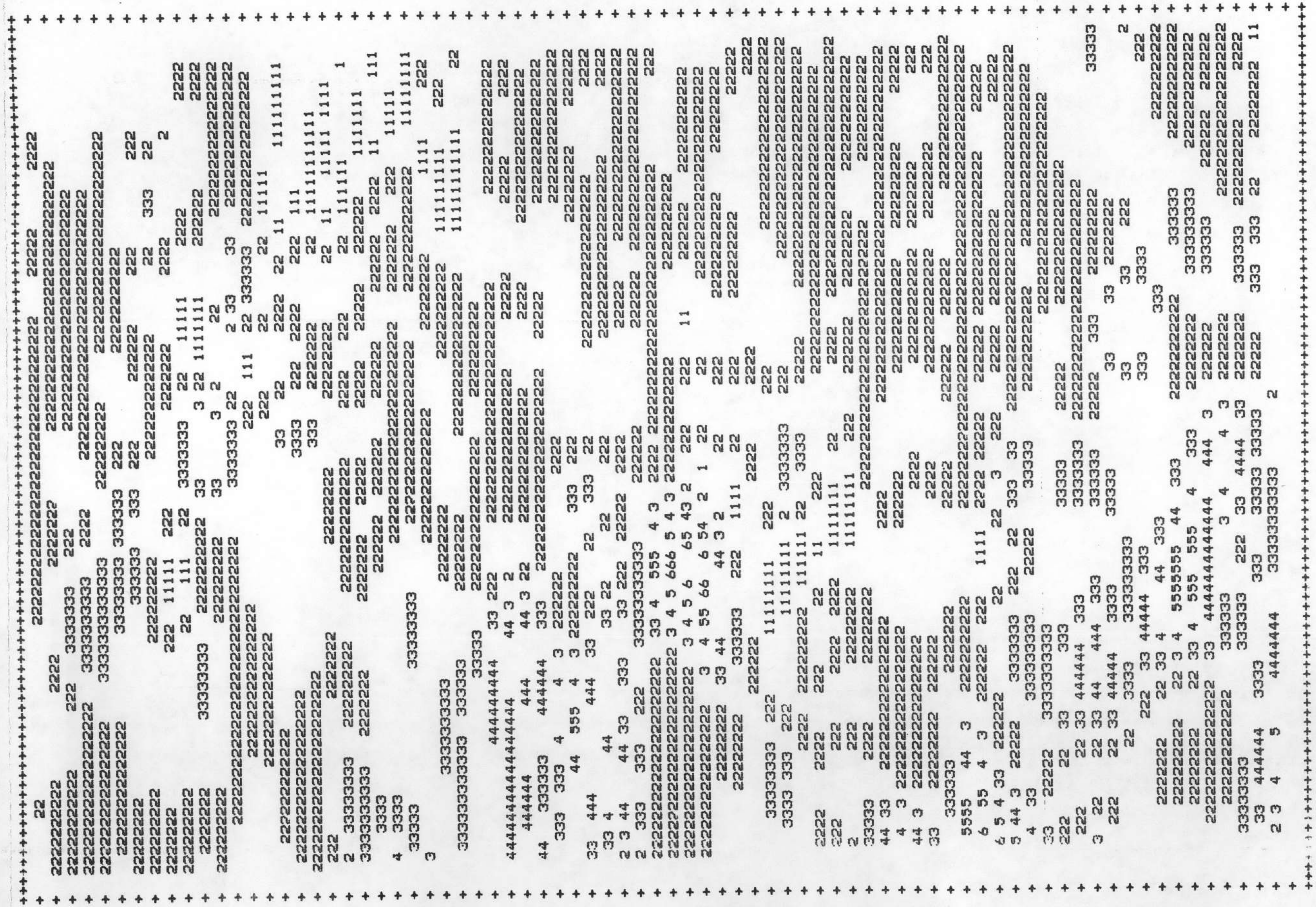
EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.1000
1	0.1000	0.2000
	0.2000	0.3000
2	0.3000	0.4000
	0.4000	0.5000
3	0.5000	0.6000
	0.6000	0.7000
4	0.7000	0.8000
	0.8000	0.9000
5	0.9000	1.0000
	1.0000	1.1000
6	1.1000	1.2000
	1.2000	1.3000
7	1.3000	1.4000
	1.4000	1.5000
8	1.5000	1.6000
	1.6000	1.7000
9	1.7000	1.8000
	GT	1.8000

Uranium Pseudo-Contour Map - Traverse City Quadrangle

SCALE IN EQUIVALENT PPM

TRAVERSE CITY



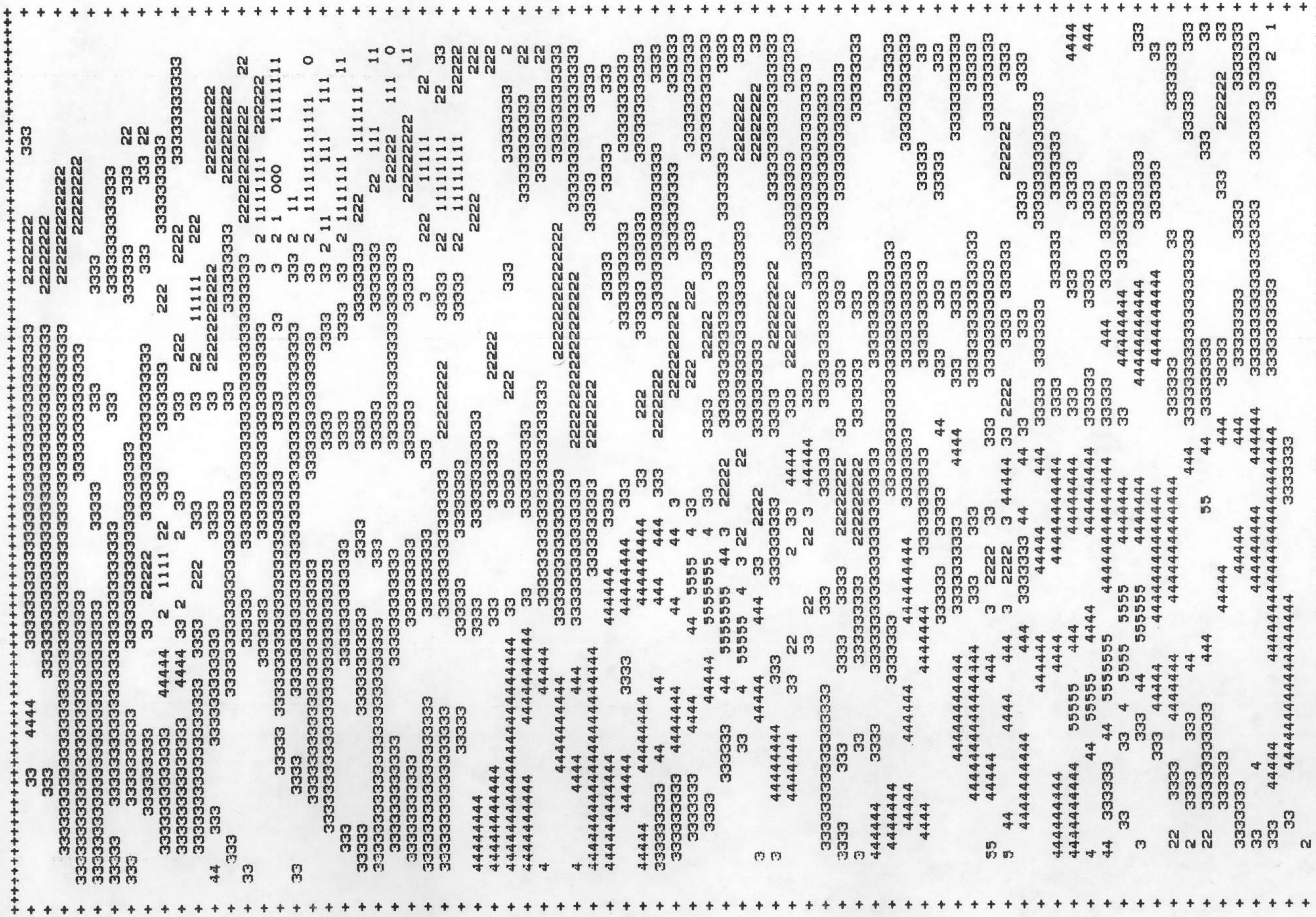
Thorium Pseudo-Contour Map - Traverse City Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.3750
1	0.3750	0.7500
	0.7500	1.1250
2	1.1250	1.5000
	1.5000	1.8750
3	1.8750	2.2500
	2.2500	2.6250
4	2.6250	3.0000
	3.0000	3.3750
5	3.3750	3.7500
	3.7500	4.1250
6	4.1250	4.5000
	4.5000	4.8750
7	4.8750	5.2500
	5.2500	5.6250
8	5.6250	6.0000
	6.0000	6.3750
9	6.3750	6.7500
	GT	6.7500

SCALE IN EQUIVALENT PPM

TRAVERSE CITY

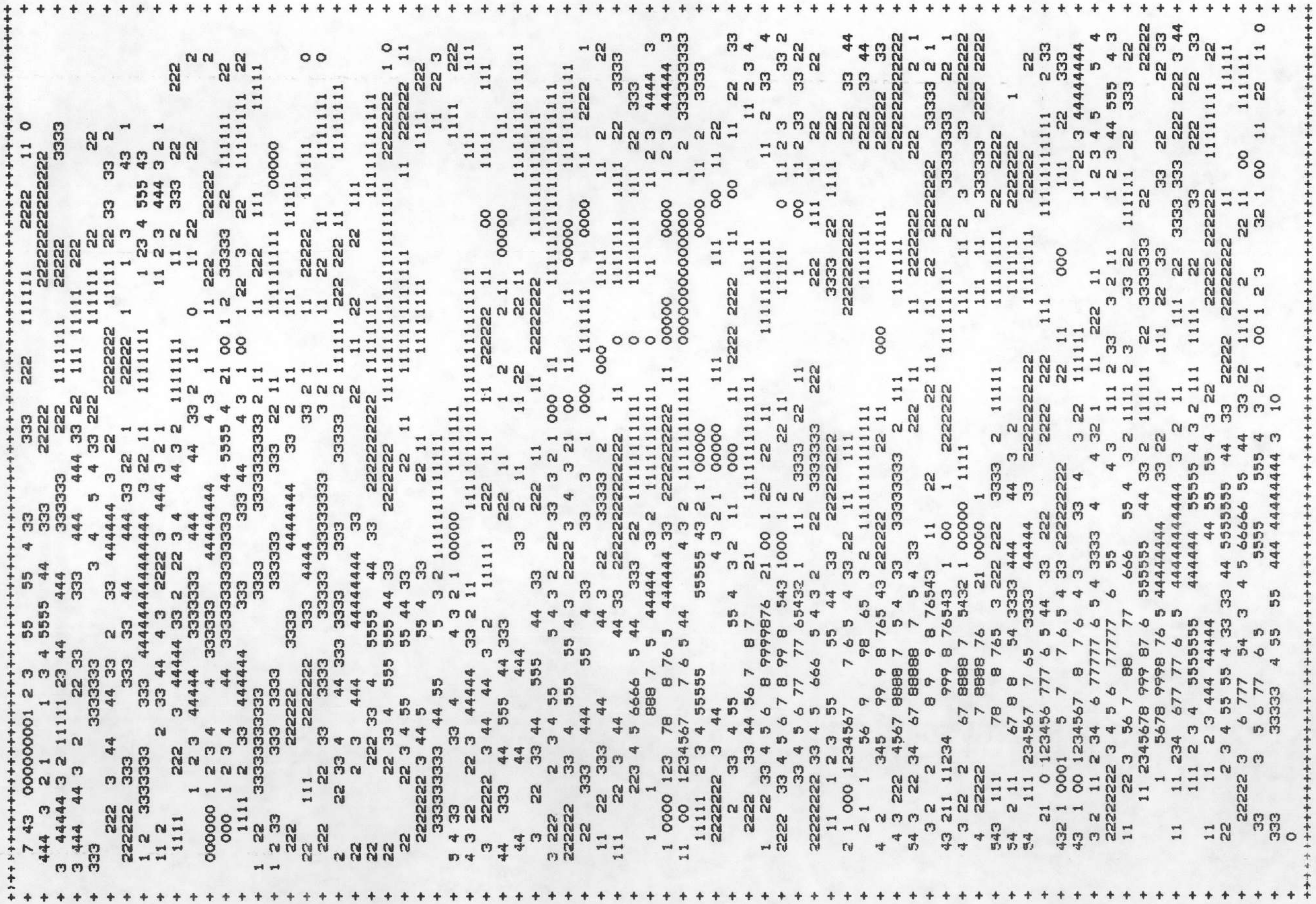


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.3750
1	0.3750	0.7500
	0.7500	1.1250
2	1.1250	1.5000
	1.5000	1.8750
3	1.8750	2.2500
	2.2500	2.6250
4	2.6250	3.0000
	3.0000	3.3750
5	3.3750	3.7500
	3.7500	4.1250
6	4.1250	4.5000
	4.5000	4.8750
7	4.8750	5.2500
	5.2500	5.6250
8	5.6250	6.0000
	6.0000	6.3750
9	6.3750	6.7500
	GT	6.7500

Thorium/Potassium Pseudo-Contour Map - Traverse City Quadrangle

TRAVERSE CITY

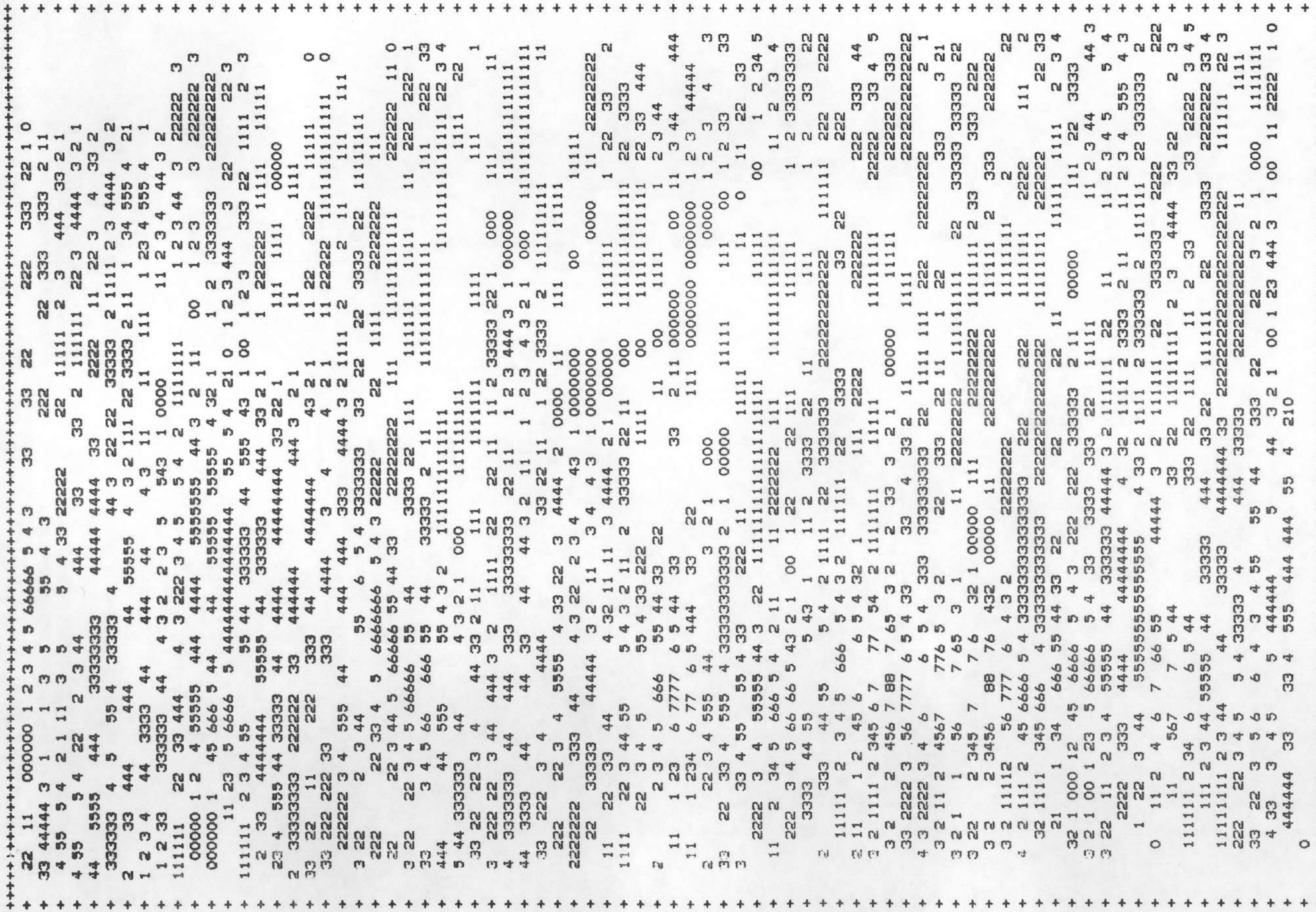


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.1250
1	0.1250	0.2500
	0.2500	0.3750
2	0.3750	0.5000
	0.5000	0.6250
3	0.6250	0.7500
	0.7500	0.8750
4	0.8750	1.0000
	1.0000	1.1250
5	1.1250	1.2500
	1.2500	1.3750
6	1.3750	1.5000
	1.5000	1.6250
7	1.6250	1.7500
	1.7500	1.8750
8	1.8750	2.0000
	2.0000	2.1250
9	2.1250	2.2500
	GT	2.2500

Uranium/Potassium Pseudo-Contour Map - Traverse City Quadrangle

TRAVERSE CITY

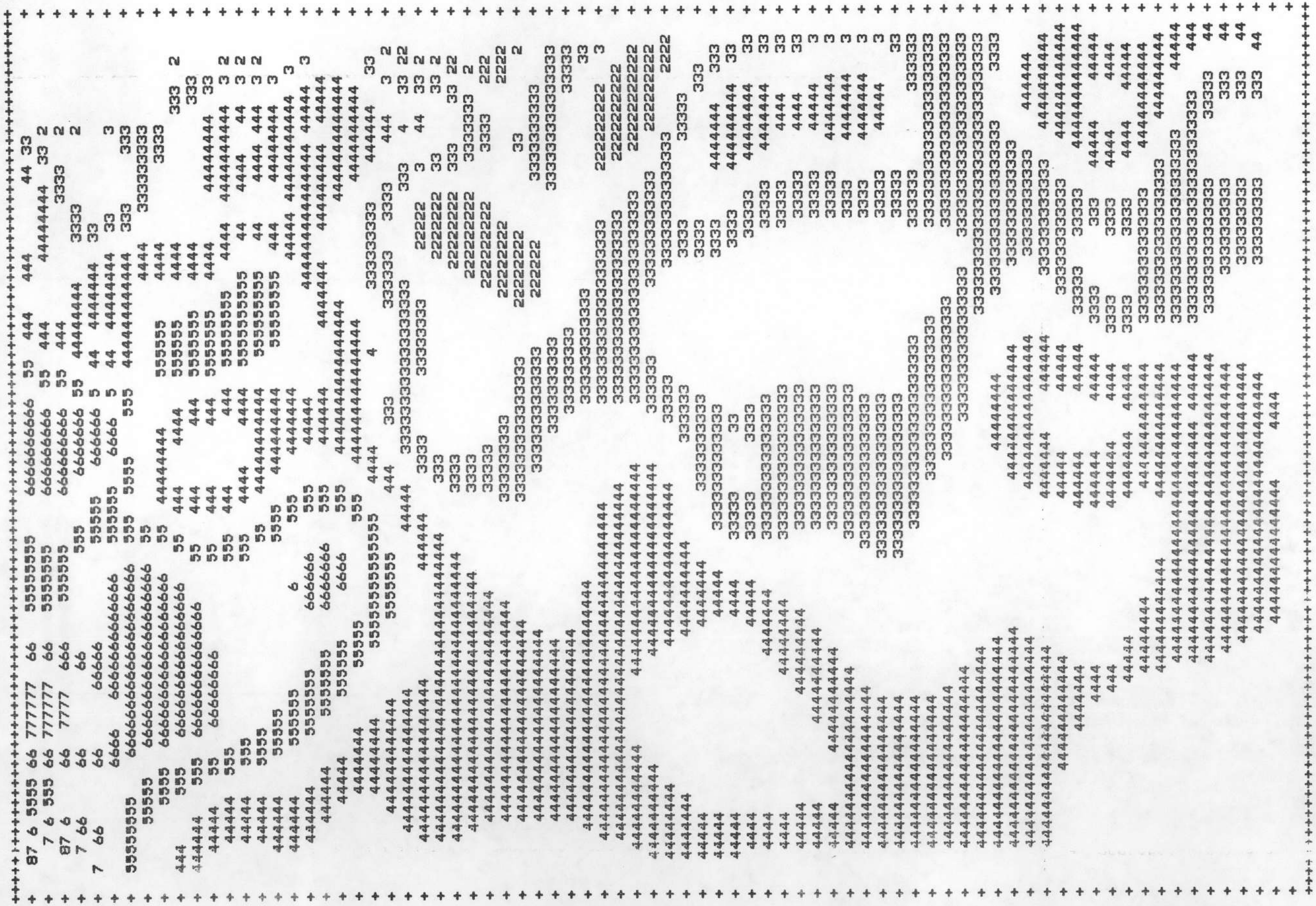


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.0500
1	0.0500	0.1000
	0.1000	0.1500
2	0.1500	0.2000
	0.2000	0.2500
3	0.2500	0.3000
	0.3000	0.3500
4	0.3500	0.4000
	0.4000	0.4500
5	0.4500	0.5000
	0.5000	0.5500
6	0.5500	0.6000
	0.6000	0.6500
7	0.6500	0.7000
	0.7000	0.7500
8	0.7500	0.8000
	0.8000	0.8500
9	0.8500	0.9000
	GT	0.9000

Uranium/Thorium Pseudo-Contour Map - Traverse City Quadrangle

TRAVERSE CITY



EXPLANATION

PRINT CHARACTER	VALUE
0	LE-1200.0000
	-1200.0000-1100.0000
1	-1100.0000-1000.0000
	-1000.0000 -900.0000
2	-900.0000 -800.0000
	-800.0000 -700.0000
3	-700.0000 -600.0000
	-600.0000 -500.0000
4	-500.0000 -400.0000
	-400.0000 -300.0000
5	-300.0000 -200.0000
	-200.0000 -100.0000
6	-100.0000 0.0000
	0.0000 100.0000
7	100.0000 200.0000
	200.0000 300.0000
8	300.0000 400.0000
	400.0000 500.0000
9	500.0000 600.0000
	GT 600.0000

SCALE IN GAMMAS

Residual Magnetic Pseudo-Contour Map - Traverse City Quadrangle