National Uranium Resource Evaluation

AERIAL GAMMA RAY AND MAGNETIC SURVEY
TAWAS CITY AND FLINT QUADRANGLES
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
TAWAS CITY AND FLINT QUADRANGLES
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 Tawas City and Flint quadrangles of Michigan cover a land area of 6,500 square miles, and an additional water surface area of 7,200 square miles. Extremely thick Paleozoic deposits overlie a regional downwarp of the Precambrian basement called the Michigan Basin. These Paleozoic deposits shoal to only 1,500 feet in the northeast corner. The entire survey area is covered by a mantle of Quaternary glacial material.

A search of available literature revealed no economically feasible uranium deposits.

A total of thirty-five (35) uranium anomalies were detected and are discussed briefly in this report. All appear to have cultural, and/or locally unsaturated associations, and none appear to contain significant measured quantities of uranium.

Magnetic data appears to be in good agreement with existing structural interpretations of the area.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

General

The Tawas City and Flint quadrangles include a land area of approximately 6,500 square miles and an additional water surface area of 7,200 square miles. Both quadrangles include parts of Michigan and Ontario, Canada (see Figure 1).

The geologic base maps used in this report were compiled at a scale of 1:250,000 by Fremont Geologic Consultants (Flint quadrangle, 1980) and Amuedo and Ivey, Consulting Geologists (Tawas City quadrangle, 1980) from published and unpublished sources. Published sources include information from maps and reports issued by the Michigan Geological Survey between 1900 and 1957 at scales of 1:125,000 and larger. Map data was also extracted from the 1970 U.S. Geological Survey Hydrologic Investigations Atlas, 1:125,000 scale. 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 Flint (rev. 1971) and Tawas City (rev. 1967) topographic quadrangle.

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

Physiography

The land surface within the Tawas City and Flint quadrangles is part of a broad glaciated plain that is situated at the northern edge of the Midwestern Physiographic Province. Land forms produced by the most recent stage of glaciation characterize the region and include such features as moraines, dissected landscape and glacial lake plains which border modern lake shorelines. A deranged drainage pattern, typical of glaciated regions, is developed over ground moraine deposits. An area that contains drift with this type of drainage extends from the south central Flint quadrangle into Michigan's thumb peninsula, the inland part of the Tawas City quadrangle. Numerous glacially formed lakes and ponds (kettle lakes) are scattered among marshes and short meandering drainage channels. The gently sloping plains that surround the peninsula display flatter topography than inland areas and have developed a trellis type drainage pattern on their surfaces. Runoff flows directly into Lake Huron via many small streams or into the Saginaw and Au Sable Rivers which flow north toward Saginaw Bay and east into Lake Huron respectively (see Figure 3 and 3a). Marshlands occupy extensive tracts on the lake plain of the Tawas City quadrangle. These continue inter-

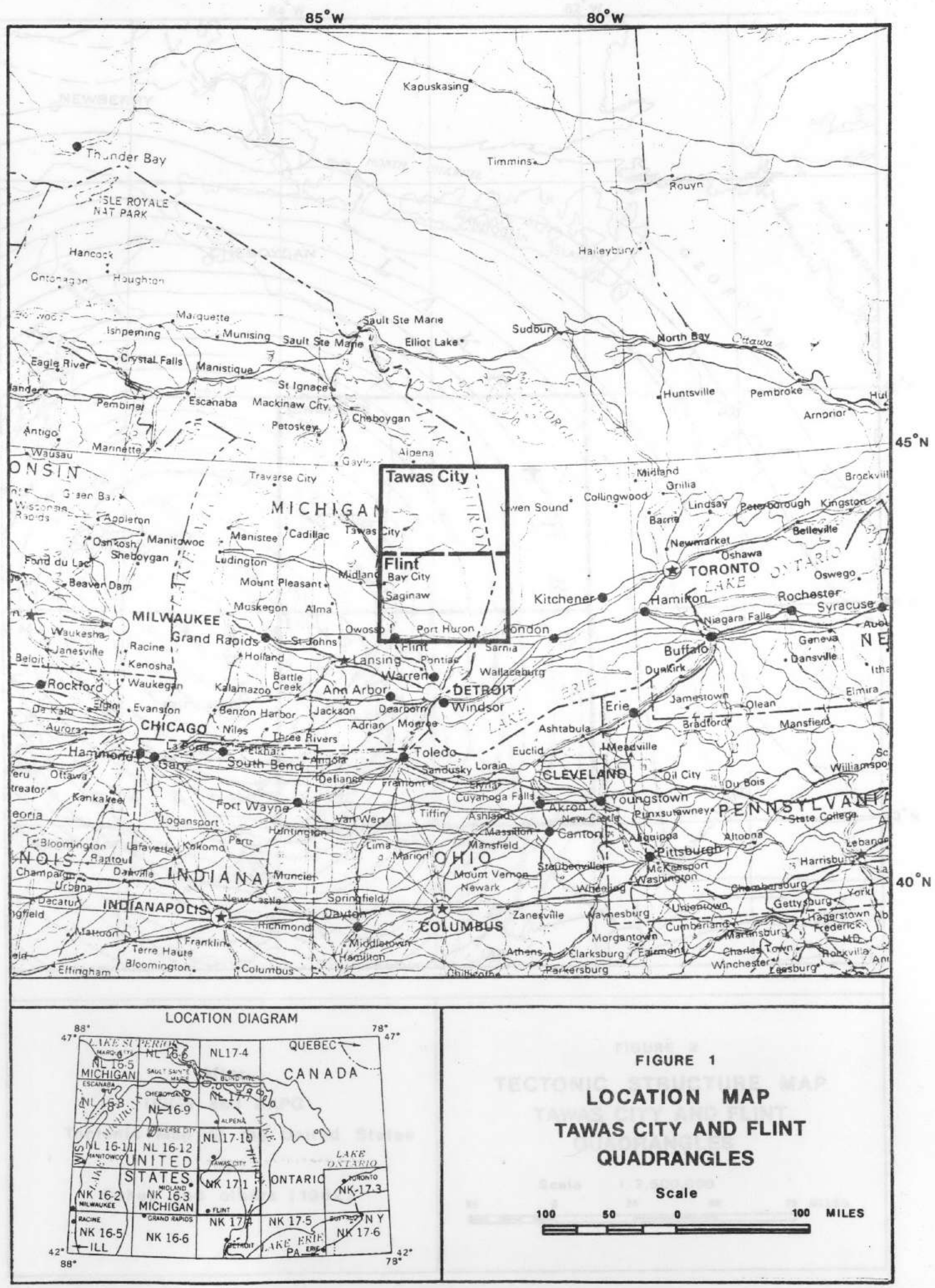


FIGURE 1
LOCATION MAP
TAWAS CITY AND FLINT QUADRANGLES

mittently along the shoreline from the north to south map boundaries and on around the periphery of Saginaw Bay.

The topography varies from areas with relatively flat surfaces to areas where stream erosion has caused up to 300 feet of local relief. The lowest elevation is the mean level of Lake Huron, which is 580 feet. The highest point, 1,485 feet, is on the west edge of the Tawas City quadrangle, resulting in a total elevation difference of 905 feet over the entire region.

A mixed urban and rural population becomes increasingly more rural toward the north. In the south, the cities of Flint (193,000 pop.), Saginaw (83,000 pop.) and Bay City (49,000 pop.) are served by a well developed rectilinear network of primary and secondary roads but farther north access is limited to secondary and unimproved dirt roads. One coastal highway connects three of the four towns located in the area. Railroads extend from the cities to most of the population centers in the south but only one line serves the northern area along the Lake Huron shoreline.

GEOLOGY

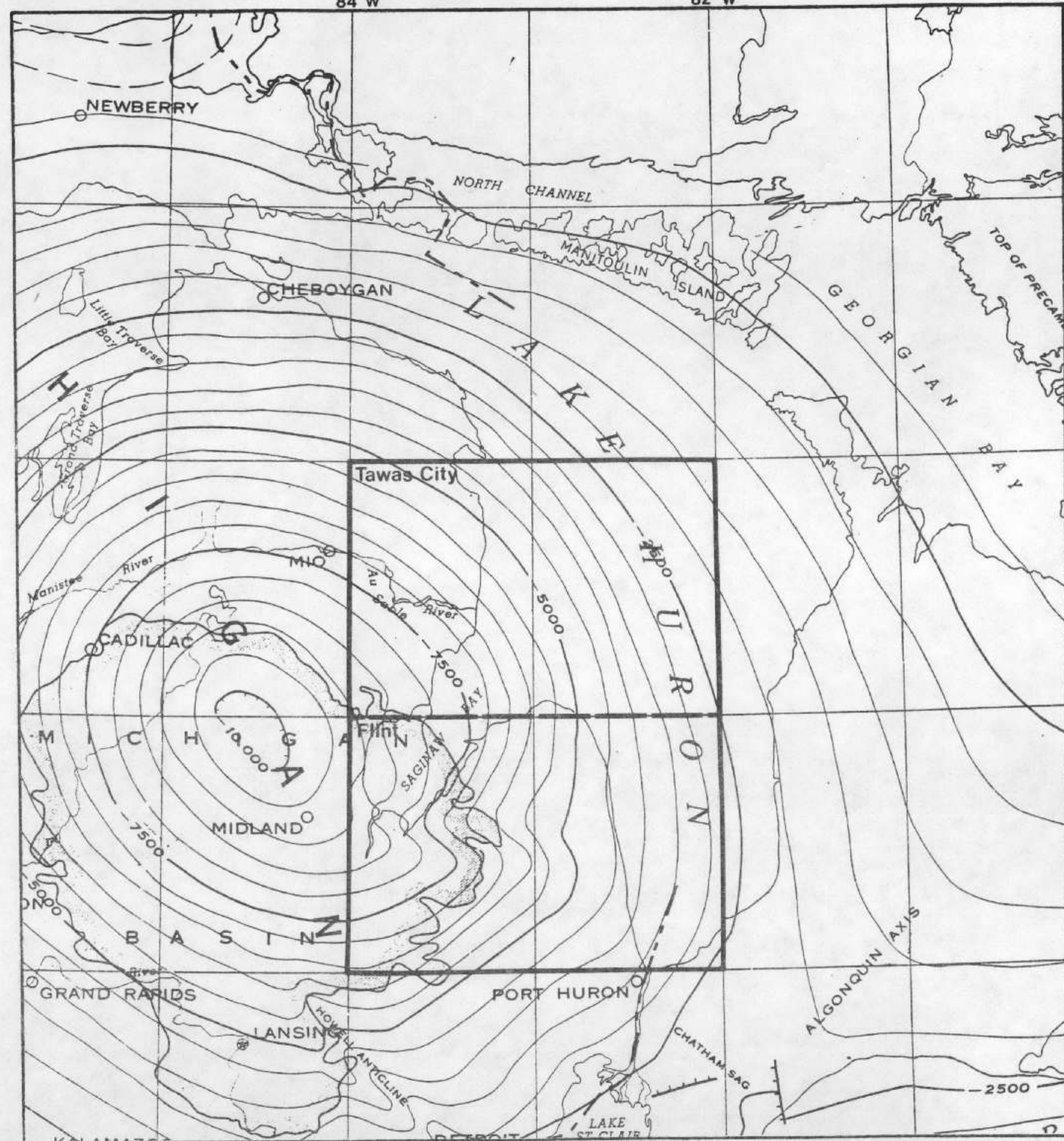
Structure

The basement rocks underlying the Tawas City and Flint quadrangles are influenced by a regional downwarping called the Michigan Basin which contains as much as 10,000 feet of Paleozoic sediments (see Figure 2). The two quadrangles overlie the east and northeast sectors of the Michigan Basin where a total relief of 8,000 feet in the basement surface occurs between the east and west quadrangle boundaries. Sedimentary strata reach a maximum thickness of 10,000 feet beneath the west end of the coterminous boundary. The strata thin to 1,500 feet in the northeast under Lake Huron and 3,500 feet in the southeast. Some anticlinal folding affects the west-dipping basement (Cohee and others, 1962) but the surface deposits bear no discernable evidence of this structure. Elsewhere the constant dip of the basement surface contains no faults or fold. No faults in surface deposits are shown on the geologic base maps for these quadrangles.

Surface Geology

A mantle of Pleistocene sediments spreads across the entire surface within this region. The sediments consist of a combination of glacial, periglacial and post-glacial material. Bedrock units do not outcrop through this cover, and therefore no exposures older than Pleistocene are shown on the base maps.

Drift from the Wisconsinan Stage of glaciation forms the predominant deposits throughout the two quadrangles. These deposits occupy inland locations and border on lake bottom sediments that were exposed when earlier high water levels in Lake Huron receded. A wide variety of



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

FIGURE 2

TECTONIC STRUCTURE MAP
TAWAS CITY AND FLINT QUADRANGLES

Scale 1:2,500,000

25 0 25 50 75 MILES

glacial deposits form a mosaic of interfingering ground, lateral and end moraines, outwash deposits and ponded lake beds. Four major end moraines (Flint, 1959) occupy concentric positions on the peninsula within the Flint quadrangle, marking successive glacial advances. Large deposits of glacial outwash follow modern drainage channels, particularily along the Au Sable River. One deposit of ponded water sediments occurs at the northwestern terminus of the Au Sable River outwash deposits.

Glacial deposits account for 60% of all mapped surface exposures and the balance consist of lake bottom sediments. About 10% of the glacial deposits are ponded water deposits and outwash material. The remaining glacial drift forms various kinds of moraines including broad, smooth-surfaced ground moraines and hummocky end moraines. The moraines are typically composed of unsorted, unstratified material (till containing clay, silt, sand, and gravel) while lake bed deposits contain sand and silt which exhibits some degree of sorting and stratification. Lake bed sediments are sometimes covered by marl and peat.

Uranium

According to available literature, there are no known uranium deposits in the Flint and Tawas City quadrangles (Butler, 1962, Schnabel, 1955).

INTERPRETATION OF GEOPHYSICAL DATA

Radiometric Data

A total of 35 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 derived 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 very low, and exhibit a wide range of values within the same geologic unit. This inconsistancy of values appears to be due to the local saturation (marshes, valleys) of the ground which suppresses the emission of gamma rays from the geologic units into the atmosphere. This suppression factor must be taken into consideration when interpreting the values for each geologic unit, i.e., an entire unit may contain suppressed values instead of an accurate radiometric response for that unit. The area-wide potassium average is .95 percent. Uranium and thorium averages are 1.17 ppmeU and 3.3 ppmeT respectively. These values are mainly reflected by the Flint quadrangle and the conterminous border area. Slightly lower than average values dominate the northern two-thirds of the Tawas City quadrangle, and appears to be attributable to the suppression factor. Values for all three radiometric elements exhibit higher than average values within a broad zone which extends the entire perimeter of the Michigan peninsula (Flint quadrangle), adjacent to the shorelines of Saginaw Bay and Lake Huron (see Appendix H). Other localities include the southeast quadrant and southwest corner of the Flint quadrangle. The broad zone mainly overlies the map unit QLC (Quaternary Lake Beds, Clay). Within the Tawas City quadrangle, higher than average values are exhibited in the southern portion, in addition to, a small locality within the west-central portion of the quadrangle.

The highest average potassium value at 1.23 percent is contained in map unit QWM (Quaternary water-laid moraines), with map unit QLC averaging only slightly lower at 1.18 percent. The peak potassium value at 1.98 percent was contained in map unit QLP (Quaternary Glacial Lake Plains). Map unit QP (Quaternary Ponded Lake Beds) contains both the highest average and peak thorium values at 4.4 and 9.2 ppmeT respectively. Map unit QLC is only slightly lower at 4.2 ppmeT. The highest average uranium value overlies map unit QLC at 1.35 ppmeU. The peak uranium value is contained in map unit QGM (Quaternary Ground moraines) at 2.77 ppmeU, with map unit QLP being only slightly less at 2.71 ppmeU.

Most of the map units show either a bimodal tendency or a skewing toward higher and lower populations in all three radiometric elements (see Appendix F). These traits may be attributable to the obvious contrast of saturated versus unsaturated conditions within each geologic unit. The ratio of these two conditions would define the direction of skewing (i.e., if there is more saturated area versus unsaturated, then the skew will be towards higher values).

Over half of the uranium anomalies are clustered in the southeast corner of the Flint quadrangle. The remainder are scattered throughout the rest of the survey area (see Figures 3 and 3a). The dominate geologic unit within this cluster is QLC. This unit also contains the highest values within an anomaly and range from 2.0 to 2.6 ppmeU. The remaining anomalies range in peak values from 1.1 to 2.4 ppmeU. Specific anomalies appear to result from cultural influences (roads, railroads, pipelines, quarries, etc.) and unsaturated localities that appear to enhance local uranium values.

The overall apparent low uranium values, coupled with the high correlation with culture and unsaturated localities, suggests that none of the anomalies in the survey area depict significant quantities of naturally occurring uranium.

Magnetic Data

The magnetic field pseudo-contour map appears in Appendix H.

The structural picture of the two quadrangles is one of thick to extremely thick (east (2,000 feet) to west (10,000 feet)) deposits of mainly Paleozoic material.

The magnetic field corresponds reasonably well to the present structural interpretation of the region. Moderate to low gradients, and long wavelengths appear to indicate a thick sequence of nonmagnetic deposits. Higher gradients and shorter wavelengths occur in the northeast and southeast corners of the survey area which tends to agree with the shoaling of the Paleozoic deposits in both of these directions.

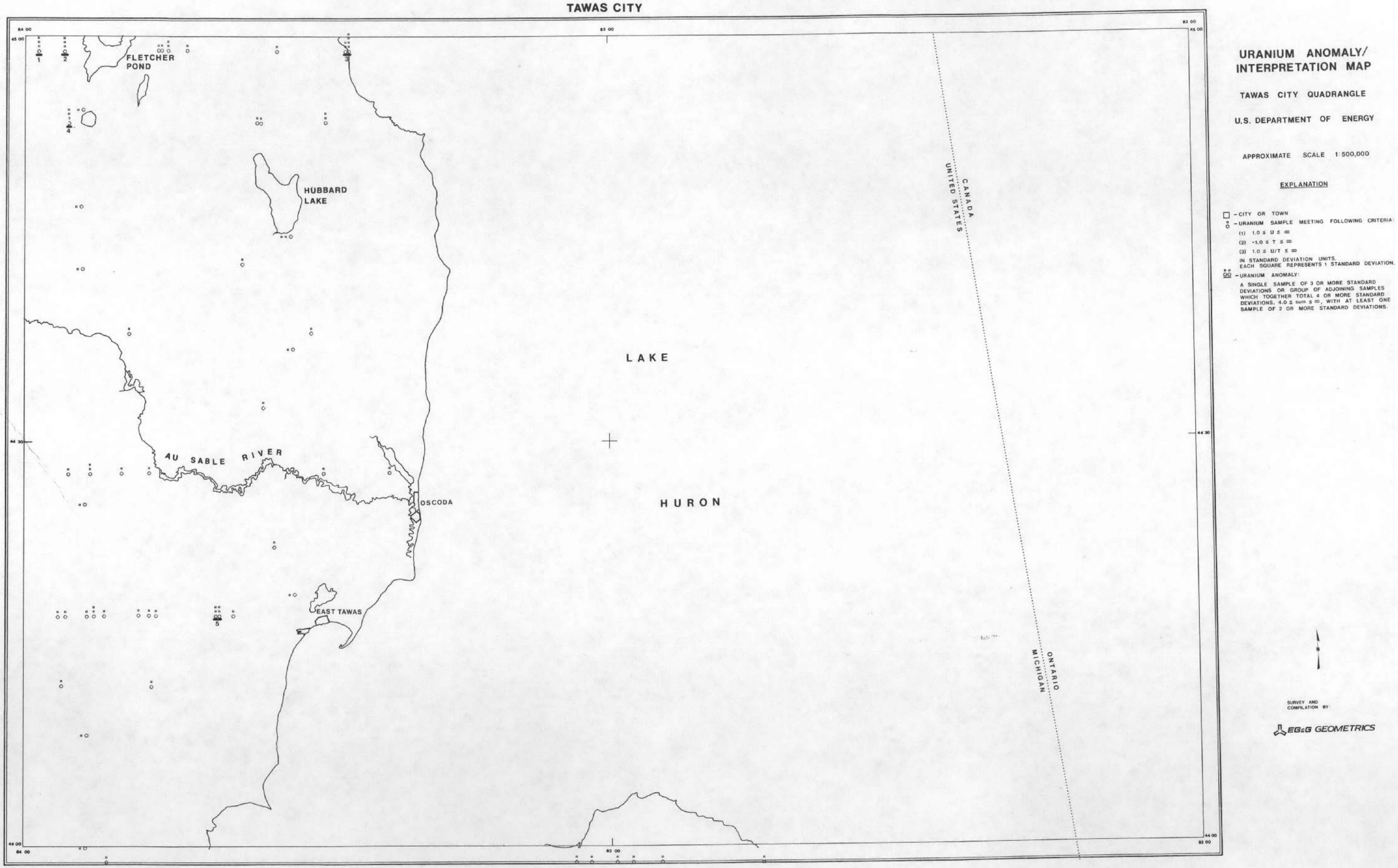
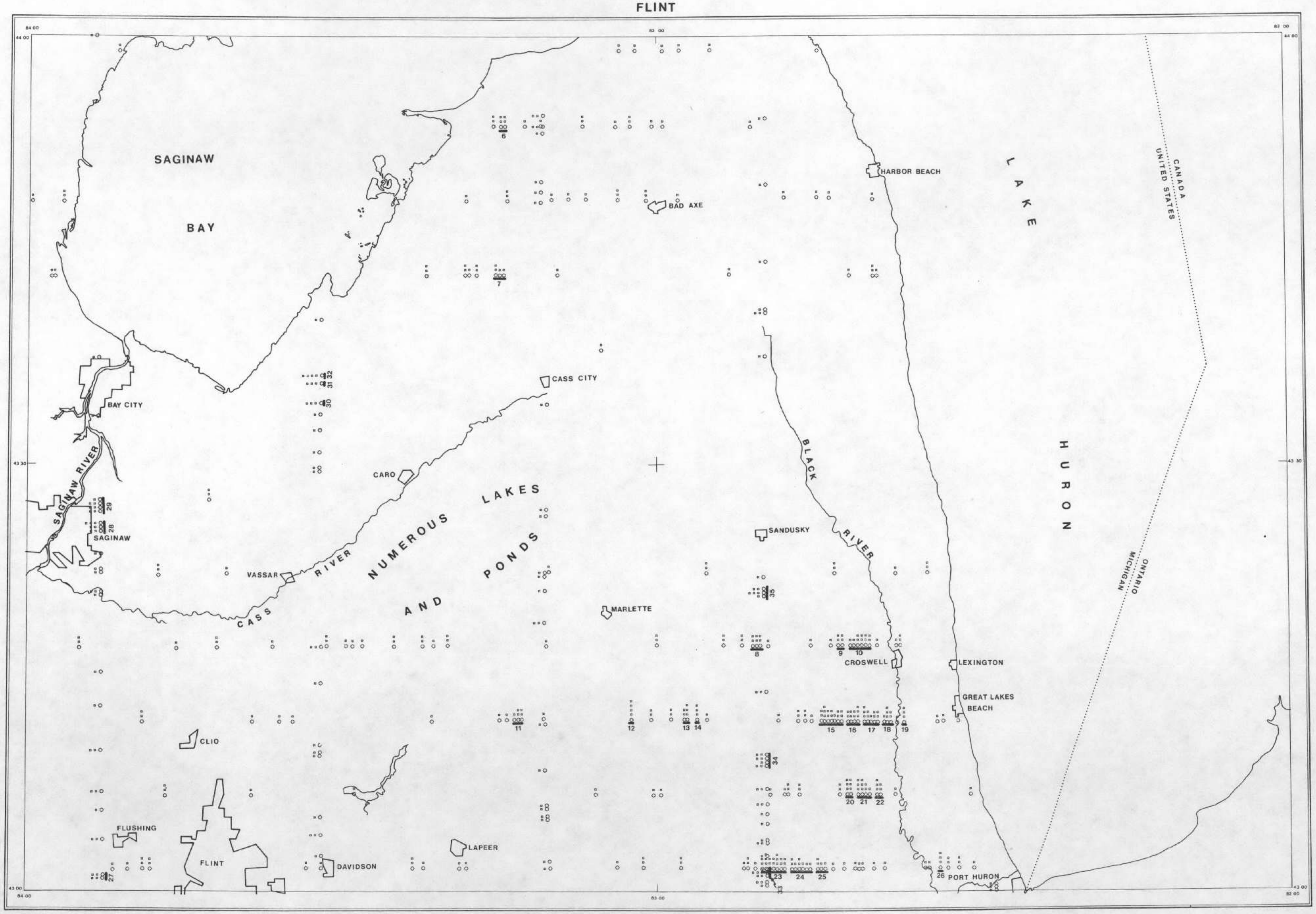


Figure 3 - Uranium Anomaly/Interpretation Map - Tawas City Quadrangle



URANIUM ANOMALY/ INTERPRETATION MAP

FLINT QUADRANGLE

U.S. DEPARTMENT OF ENERGY

APPROXIMATE SCALE 1:500,000

EXPLANATION

- CITY OR TOWN
- URANIUM SAMPLE MEETING FOLLOWING CRITERIA:
  - (1) $1.0 \leq U \leq \infty$
  - (2) $-1.0 \leq T \leq \infty$
  - (3) $1.0 \leq U/T \leq \infty$

  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, $4.0 \leq$ sum $\leq \infty$, WITH AT LEAST ONE SAMPLE OF 2 OR MORE STANDARD DEVIATIONS.

SURVEY AND COMPILATION BY

EG&G GEOMETRICS

Figure 3a- Uranium Anomaly/Interpretation Map - Flint Quadrangle

BIBLIOGRAPHY

Amuedo and Ivey, Consulting Geologists, 1980, Geology of the Tawas 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 Flint 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 1 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.

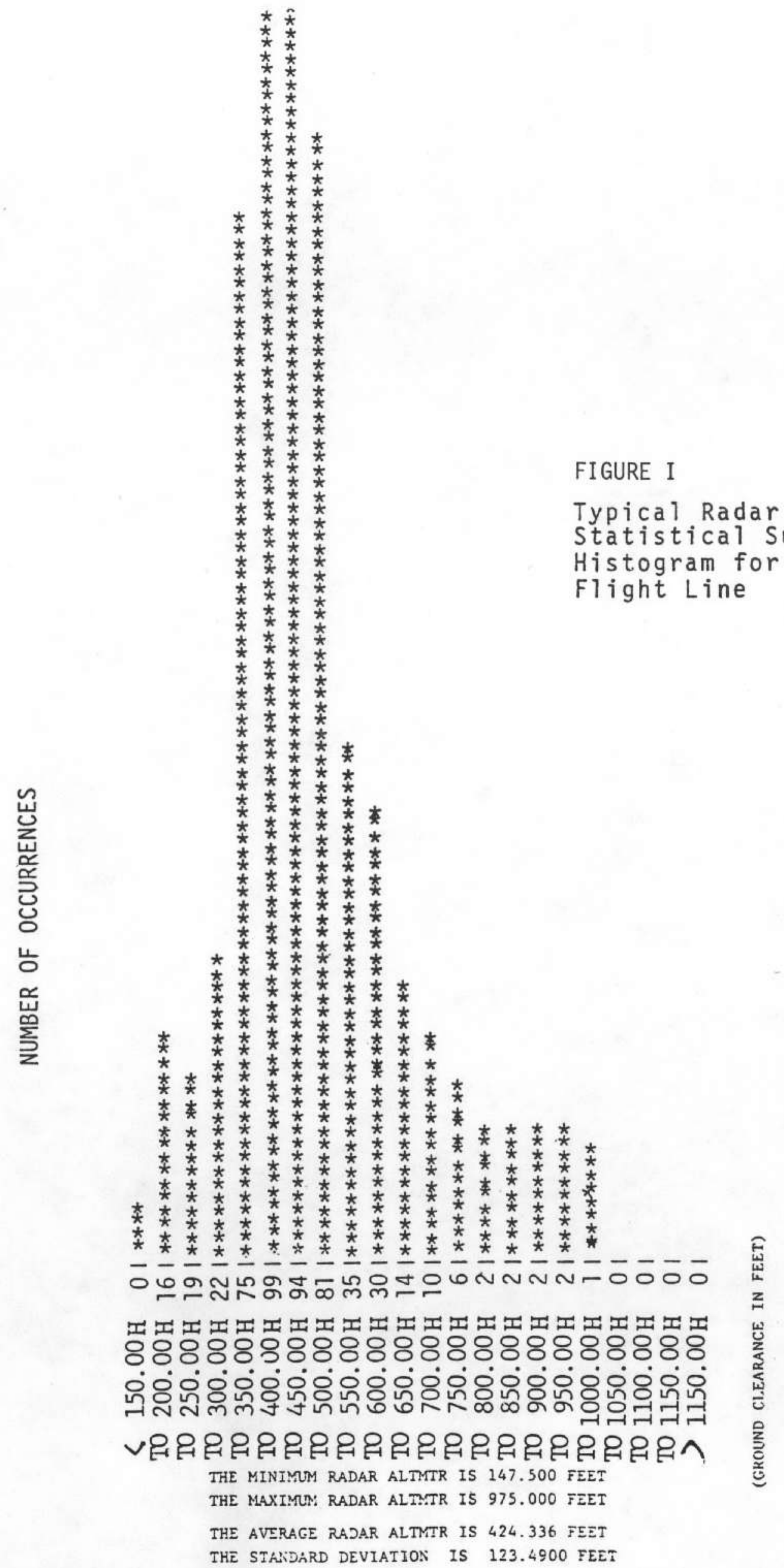


FIGURE I

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.

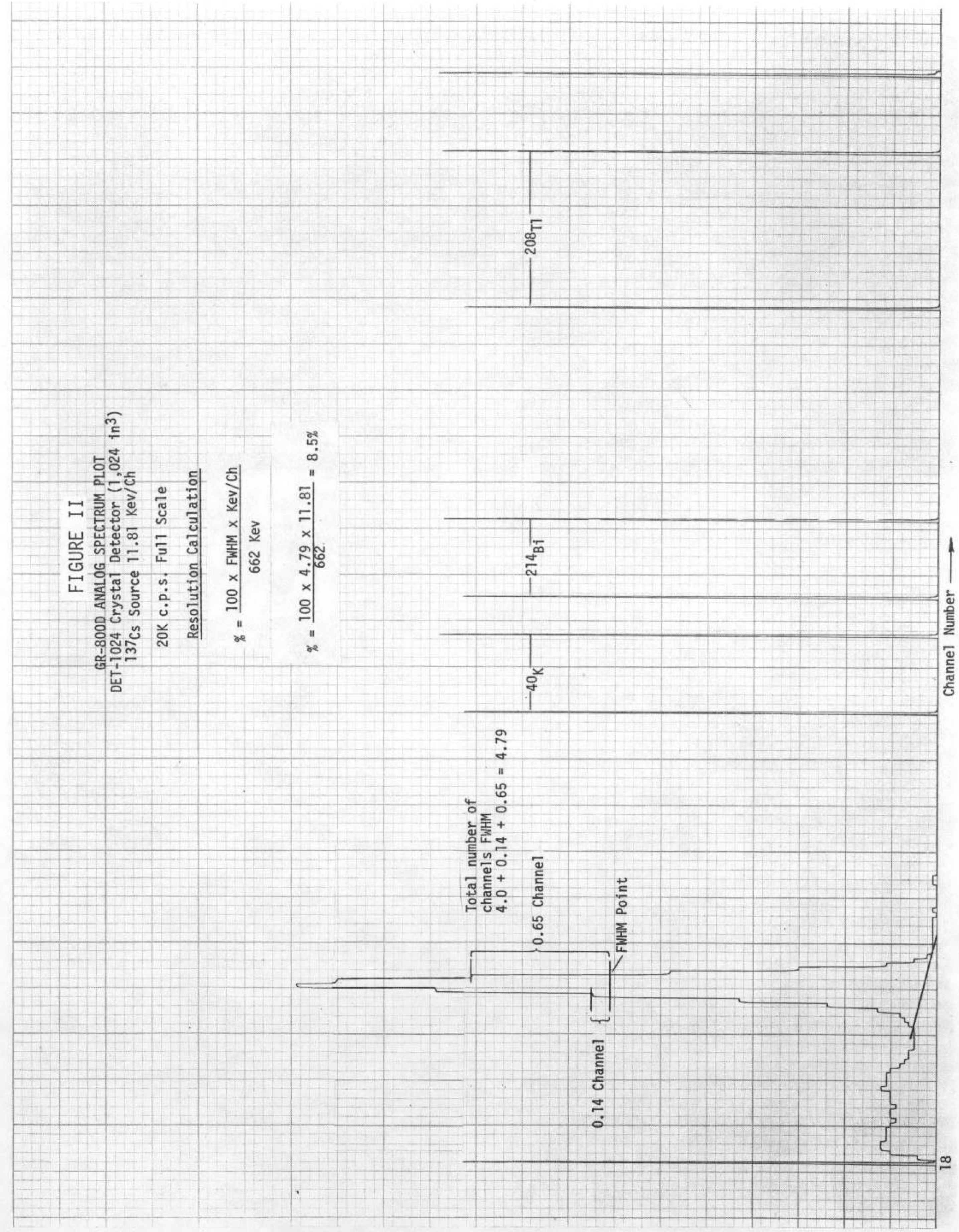
3. Finally run a full thorium analog spectrum of the down crystals and check for centering of K40 and Tl208 peaks in spectrum.

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 Tl208 window.

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

4. Determine shift, if any, in Tl208 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.

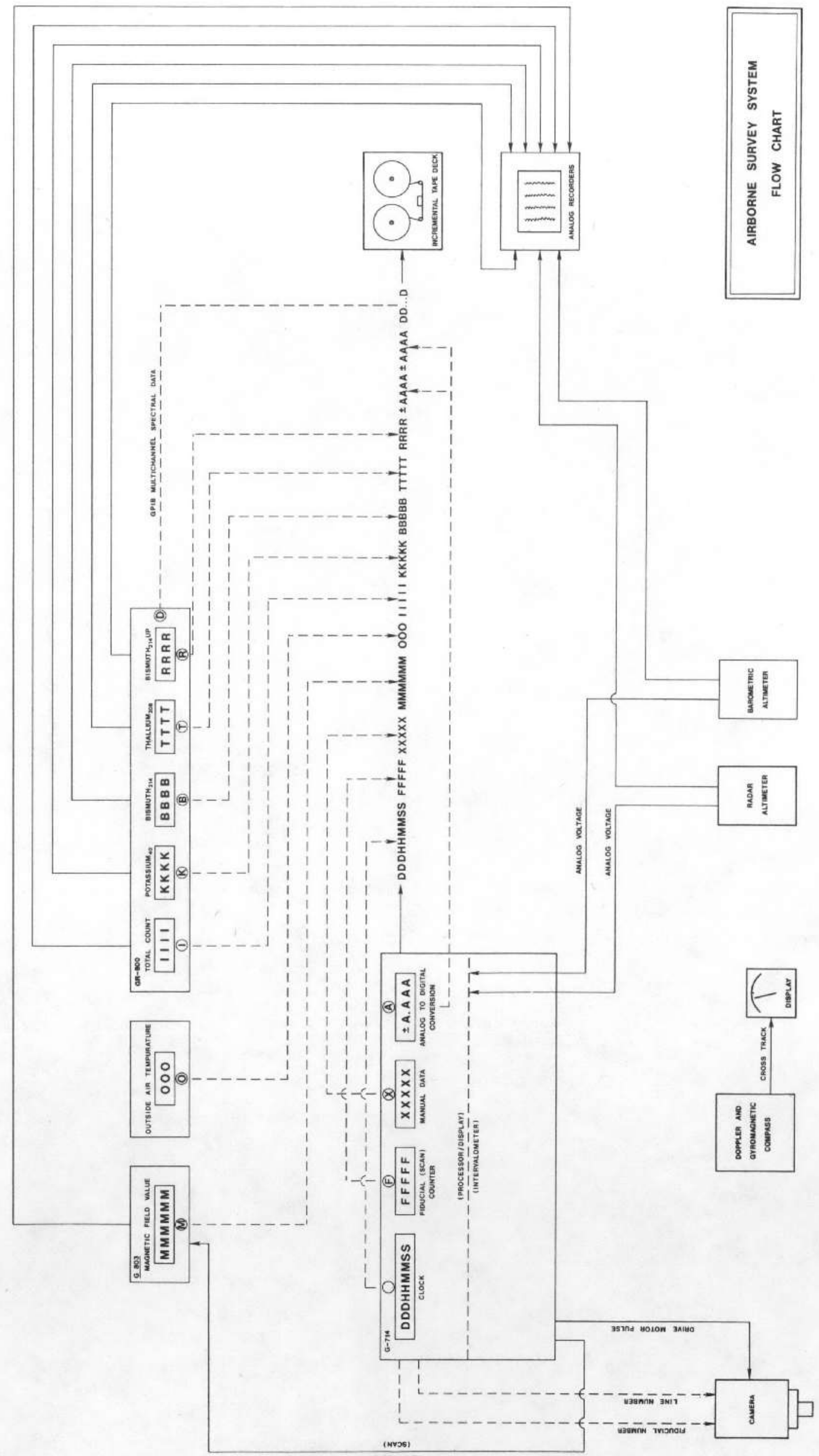


FIGURE III

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:

$$\frac{C_{12}(h_i)}{\Delta C} X \Delta S = \Delta C\ (12,000)$$ 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:

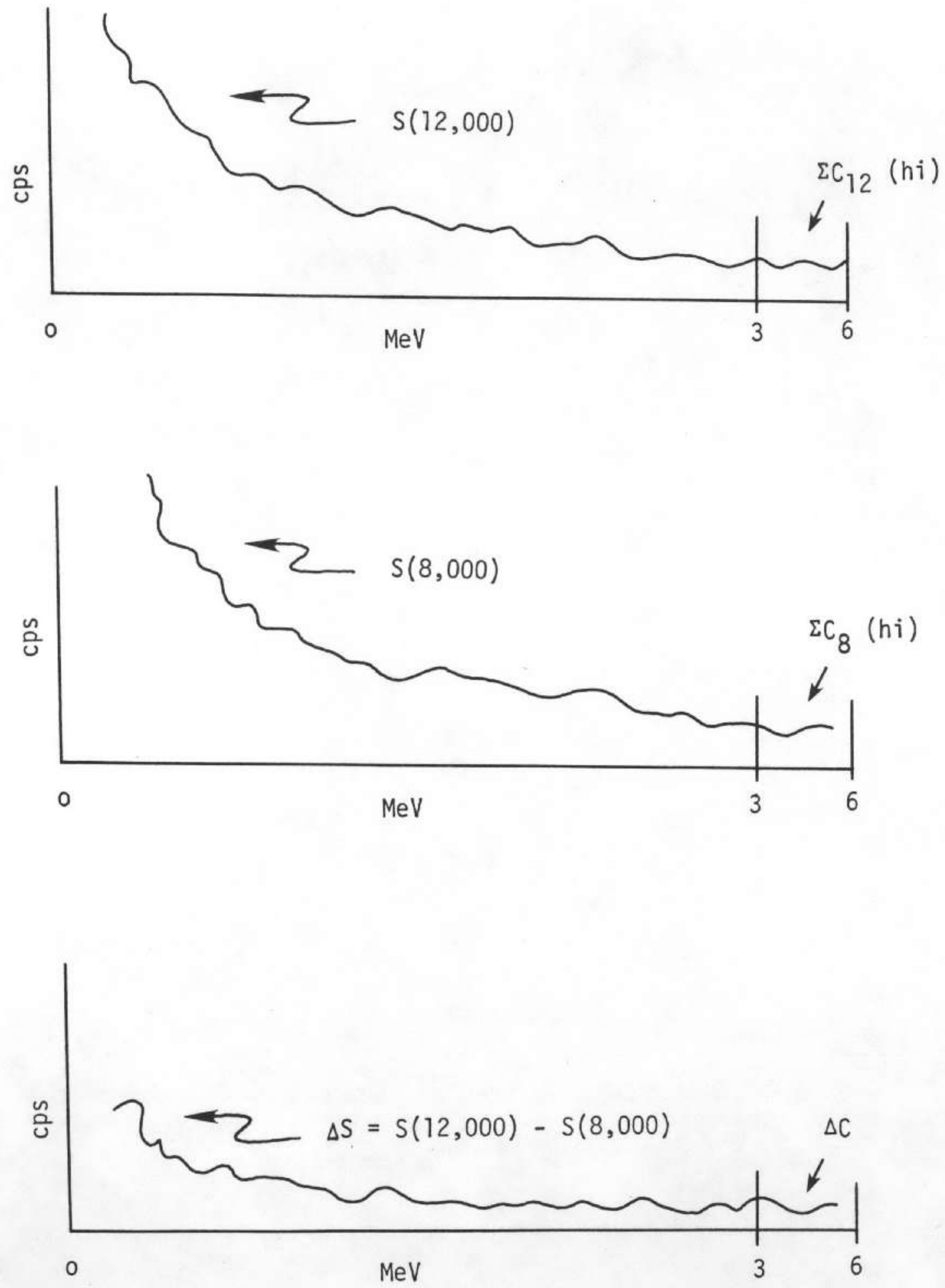


FIGURE IV - Multiple altitude spectra schematic

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 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	
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)	1.091 CPS	
CH 19	(0.225 MEV)	1.313 CPS	
CH 20	(0.236 MEV)	2.226 CPS	
CH 21	(0.248 MEV)	26.345 CPS	
CH 22	(0.260 MEV)	89.243 CPS	
CH 23	(0.272 MEV)	100.516 CPS	
CH 24	(0.284 MEV)	103.036 CPS	
CH 25	(0.295 MEV)	94.423 CPS	
CH 26	(0.307 MEV)	88.893 CPS	
CH 27	(0.319 MEV)	85.032 CPS	
CH 28	(0.331 MEV)	80.528 CPS	
CH 29	(0.343 MEV)	78.271 CPS	
CH 30	(0.355 MEV)	72.498 CPS	
CH 31	(0.366 MEV)	74.934 CPS	
CH 32	(0.378 MEV)	65.560 CPS	
CH 33	(0.390 MEV)	65.966 CPS	
CH 34	(0.402 MEV)	63.189 CPS	TOTAL COUNT
CH 35	(0.414 MEV)	62.880 CPS	
CH 36	(0.426 MEV)	64.078 CPS	
CH 37	(0.437 MEV)	67.602 CPS	
CH 38	(0.449 MEV)	69.116 CPS	
CH 39	(0.461 MEV)	76.972 CPS	
CH 40	(0.473 MEV)	84.879 CPS	
CH 41	(0.485 MEV)	96.049 CPS	
CH 42	(0.496 MEV)	94.167 CPS	
CH 43	(0.508 MEV)	86.706 CPS	
CH 44	(0.520 MEV)	68.016 CPS	
CH 45	(0.532 MEV)	48.444 CPS	
CH 46	(0.544 MEV)	40.965 CPS	
CH 47	(0.556 MEV)	30.512 CPS	
CH 48	(0.567 MEV)	33.160 CPS	
CH 49	(0.579 MEV)	31.892 CPS	
CH 50	(0.591 MEV)	25.907 CPS	
CH 51	(0.603 MEV)	30.781 CPS	
CH 52	(0.615 MEV)	27.055 CPS	
CH 53	(0.626 MEV)	27.982 CPS	
CH 54	(0.638 MEV)	25.776 CPS	
CH 55	(0.650 MEV)	22.988 CPS	
CH 56	(0.662 MEV)	27.787 CPS	
CH 57	(0.674 MEV)	25.274 CPS	
CH 58	(0.686 MEV)	25.240 CPS	
CH 59	(0.697 MEV)	23.489 CPS	
CH 60	(0.709 MEV)	24.769 CPS	
CH 61	(0.721 MEV)	22.350 CPS	
CH 62	(0.733 MEV)	22.242 CPS	
CH 63	(0.745 MEV)	22.424 CPS	
CH 64	(0.756 MEV)	22.234 CPS	
CH 65	(0.768 MEV)	20.332 CPS	
CH 66	(0.780 MEV)	18.821 CPS	
CH 67	(0.792 MEV)	20.493 CPS	
CH 68	(0.804 MEV)	19.339 CPS	
CH 69	(0.816 MEV)	19.021 CPS	
CH 70	(0.827 MEV)	17.949 CPS	
CH 71	(0.839 MEV)	20.235 CPS	
CH 72	(0.851 MEV)	17.491 CPS	
CH 73	(0.863 MEV)	18.370 CPS	
CH 74	(0.875 MEV)	16.244 CPS	
CH 75	(0.887 MEV)	16.331 CPS	
CH 76	(0.898 MEV)	17.519 CPS	
CH 77	(0.910 MEV)	16.689 CPS	
CH 78	(0.922 MEV)	17.150 CPS	
CH 79	(0.934 MEV)	19.230 CPS	
CH 80	(0.946 MEV)	17.111 CPS	
CH 81	(0.957 MEV)	16.248 CPS	
CH 82	(0.969 MEV)	14.954 CPS	
CH 83	(0.981 MEV)	17.324 CPS	
CH 84	(0.993 MEV)	16.276 CPS	
CH 85	(1.005 MEV)	14.813 CPS	
CH 86	(1.017 MEV)	15.703 CPS	
CH 87	(1.028 MEV)	13.767 CPS	
CH 88	(1.040 MEV)	16.414 CPS	
CH 89	(1.052 MEV)	13.642 CPS	BISMUTH 214
CH 90	(1.064 MEV)	13.624 CPS	
CH 91	(1.076 MEV)	13.517 CPS	
CH 92	(1.087 MEV)	13.700 CPS	
CH 93	(1.099 MEV)	14.633 CPS	
CH 94	(1.111 MEV)	14.303 CPS	
CH 95	(1.123 MEV)	13.766 CPS	
CH 96	(1.135 MEV)	14.949 CPS	
CH 97	(1.147 MEV)	13.503 CPS	
CH 98	(1.158 MEV)	13.481 CPS	
CH 99	(1.170 MEV)	13.189 CPS	
CH 100	(1.182 MEV)	13.602 CPS	BISMUTH 214
CH 101	(1.194 MEV)	12.965 CPS	
CH 102	(1.206 MEV)	12.538 CPS	
CH 103	(1.217 MEV)	14.001 CPS	
CH 104	(1.229 MEV)	11.346 CPS	
CH 105	(1.241 MEV)	11.113 CPS	
CH 106	(1.253 MEV)	13.669 CPS	
CH 107	(1.265 MEV)	11.910 CPS	
CH 108	(1.277 MEV)	12.345 CPS	
CH 109	(1.288 MEV)	10.736 CPS	
CH 110	(1.300 MEV)	11.444 CPS	
CH 111	(1.312 MEV)	11.433 CPS	
CH 112	(1.324 MEV)	11.927 CPS	
CH 113	(1.336 MEV)	11.846 CPS	
CH 114	(1.347 MEV)	11.896 CPS	
CH 115	(1.359 MEV)	11.470 CPS	
CH 116	(1.371 MEV)	11.864 CPS	POTASSIUM 40
CH 117	(1.383 MEV)	10.286 CPS	
CH 118	(1.395 MEV)	10.084 CPS	
CH 119	(1.407 MEV)	9.648 CPS	
CH 120	(1.418 MEV)	11.779 CPS	
CH 121	(1.430 MEV)	12.036 CPS	
CH 122	(1.442 MEV)	10.601 CPS	
CH 123	(1.454 MEV)	9.140 CPS	
CH 124	(1.466 MEV)	11.144 CPS	
CH 125	(1.477 MEV)	10.766 CPS	
CH 126	(1.489 MEV)	9.256 CPS	
CH 127	(1.501 MEV)	11.961 CPS	
CH 128	(1.513 MEV)	10.296 CPS	
CH 129	(1.525 MEV)	10.900 CPS	
CH 130	(1.537 MEV)	9.022 CPS	
CH 131	(1.548 MEV)	10.311 CPS	
CH 132	(1.560 MEV)	10.151 CPS	POTASSIUM 40
CH 133	(1.572 MEV)	9.381 CPS	
CH 134	(1.584 MEV)	8.753 CPS	
CH 135	(1.596 MEV)	11.176 CPS	
CH 136	(1.608 MEV)	10.130 CPS	
CH 137	(1.619 MEV)	10.651 CPS	
CH 138	(1.631 MEV)	9.204 CPS	
CH 139	(1.643 MEV)	9.159 CPS	
CH 140	(1.655 MEV)	8.738 CPS	
CH 141	(1.667 MEV)	8.679 CPS	BISMUTH 214
CH 142	(1.678 MEV)	10.154 CPS	
CH 143	(1.690 MEV)	9.743 CPS	
CH 144	(1.702 MEV)	9.453 CPS	
CH 145	(1.714 MEV)	9.418 CPS	
CH 146	(1.726 MEV)	8.426 CPS	
CH 147	(1.738 MEV)	9.263 CPS	
CH 148	(1.749 MEV)	9.653 CPS	
CH 149	(1.761 MEV)	9.418 CPS	
CH 150	(1.773 MEV)	9.619 CPS	
CH 151	(1.785 MEV)	9.329 CPS	
CH 152	(1.797 MEV)	10.232 CPS	
CH 153	(1.808 MEV)	9.686 CPS	
CH 154	(1.820 MEV)	7.911 CPS	
CH 155	(1.832 MEV)	8.104 CPS	
CH 156	(1.844 MEV)	9.608 CPS	
CH 157	(1.856 MEV)	9.473 CPS	BISMUTH 214
CH 158	(1.868 MEV)	8.568 CPS	
CH 159	(1.879 MEV)	8.105 CPS	
CH 160	(1.891 MEV)	8.014 CPS	
CH 161	(1.903 MEV)	8.365 CPS	
CH 162	(1.915 MEV)	8.759 CPS	
CH 163	(1.927 MEV)	6.994 CPS	
CH 164	(1.938 MEV)	8.477 CPS	
CH 165	(1.950 MEV)	8.144 CPS	
CH 166	(1.962 MEV)	7.798 CPS	
CH 167	(1.974 MEV)	8.214 CPS	
CH 168	(1.986 MEV)	9.240 CPS	
CH 169	(1.998 MEV)	7.945 CPS	
CH 170	(2.009 MEV)	7.615 CPS	
CH 171	(2.021 MEV)	6.816 CPS	
CH 172	(2.033 MEV)	8.408 CPS	
CH 173	(2.045 MEV)	7.196 CPS	
CH 174	(2.057 MEV)	7.231 CPS	
CH 175	(2.068 MEV)	7.473 CPS	
CH 176	(2.080 MEV)	9.062 CPS	
CH 177	(2.092 MEV)	8.116 CPS	
CH 178	(2.104 MEV)	8.236 CPS	
CH 179	(2.116 MEV)	7.653 CPS	
CH 180	(2.128 MEV)	8.338 CPS	
CH 181	(2.139 MEV)	7.237 CPS	
CH 182	(2.151 MEV)	7.528 CPS	
CH 183	(2.163 MEV)	8.039 CPS	
CH 184	(2.175 MEV)	8.536 CPS	
CH 185	(2.187 MEV)	8.888 CPS	
CH 186	(2.199 MEV)	7.485 CPS	
CH 187	(2.210 MEV)	8.211 CPS	
CH 188	(2.222 MEV)	8.233 CPS	
CH 189	(2.234 MEV)	8.055 CPS	
CH 190	(2.246 MEV)	7.825 CPS	
CH 191	(2.258 MEV)	7.062 CPS	
CH 192	(2.269 MEV)	8.435 CPS	
CH 193	(2.281 MEV)	7.440 CPS	
CH 194	(2.293 MEV)	7.686 CPS	
CH 195	(2.305 MEV)	7.116 CPS	
CH 196	(2.317 MEV)	7.329 CPS	
CH 197	(2.329 MEV)	7.890 CPS	
CH 198	(2.340 MEV)	7.771 CPS	
CH 199	(2.352 MEV)	7.147 CPS	
CH 200	(2.364 MEV)	6.729 CPS	
CH 201	(2.376 MEV)	6.264 CPS	
CH 202	(2.388 MEV)	6.318 CPS	
CH 203	(2.399 MEV)	7.058 CPS	
CH 204	(2.411 MEV)	6.506 CPS	THALLIUM 208
CH 205	(2.423 MEV)	6.486 CPS	
CH 206	(2.435 MEV)	6.589 CPS	
CH 207	(2.447 MEV)	7.033 CPS	
CH 208	(2.459 MEV)	6.515 CPS	
CH 209	(2.470 MEV)	6.858 CPS	
CH 210	(2.482 MEV)	6.871 CPS	
CH 211	(2.494 MEV)	6.573 CPS	
CH 212	(2.506 MEV)	6.417 CPS	
CH 213	(2.518 MEV)	5.846 CPS	
CH 214	(2.529 MEV)	6.127 CPS	
CH 215	(2.541 MEV)	6.355 CPS	
CH 216	(2.553 MEV)	6.964 CPS	
CH 217	(2.565 MEV)	6.820 CPS	
CH 218	(2.577 MEV)	6.676 CPS	
CH 219	(2.589 MEV)	6.808 CPS	
CH 220	(2.600 MEV)	5.948 CPS	
CH 221	(2.612 MEV)	6.177 CPS	
CH 222	(2.624 MEV)	6.176 CPS	
CH 223	(2.636 MEV)	6.109 CPS	
CH 224	(2.648 MEV)	6.347 CPS	
CH 225	(2.660 MEV)	7.049 CPS	
CH 226	(2.671 MEV)	5.757 CPS	
CH 227	(2.683 MEV)	5.645 CPS	
CH 228	(2.695 MEV)	5.229 CPS	
CH 229	(2.707 MEV)	5.415 CPS	
CH 230	(2.719 MEV)	6.190 CPS	
CH 231	(2.730 MEV)	6.092 CPS	
CH 232	(2.742 MEV)	6.466 CPS	
CH 233	(2.754 MEV)	7.032 CPS	
CH 234	(2.766 MEV)	5.533 CPS	
CH 235	(2.778 MEV)	6.309 CPS	
CH 236	(2.790 MEV)	5.559 CPS	
CH 237	(2.801 MEV)	5.206 CPS	THALLIUM 208
CH 238	(2.813 MEV)	6.045 CPS	
CH 239	(2.825 MEV)	5.257 CPS	
CH 240	(2.837 MEV)	5.640 CPS	
CH 241	(2.849 MEV)	5.835 CPS	
CH 242	(2.860 MEV)	5.348 CPS	
CH 243	(2.872 MEV)	4.804 CPS	
CH 244	(2.884 MEV)	4.742 CPS	
CH 245	(2.896 MEV)	5.304 CPS	
CH 246	(2.908 MEV)	5.248 CPS	
CH 247	(2.920 MEV)	6.036 CPS	
CH 248	(2.931 MEV)	5.711 CPS	
CH 249	(2.943 MEV)	5.513 CPS	
CH 250	(2.955 MEV)	5.010 CPS	
CH 251	(2.967 MEV)	5.579 CPS	
CH 252	(2.979 MEV)	6.256 CPS	
CH 253	(2.990 MEV)	5.207 CPS	
CH 254	(3.002 MEV)	9.302 CPS	TOTAL COUNT
CH 255	(3.014 MEV)	1000.000 CPS	

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)

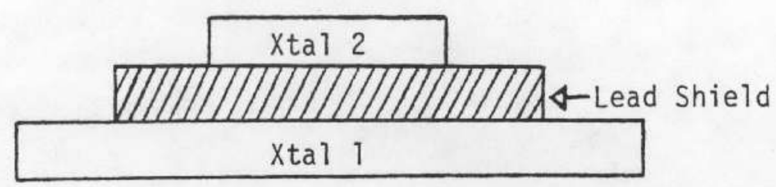
$S_{tu} = \frac{\Delta_{tu}}{\Delta_{tt}}$ (effect of uranium on thorium)

$S_{tk} = \frac{\Delta_{tk}}{\Delta_{tt}}$ (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)

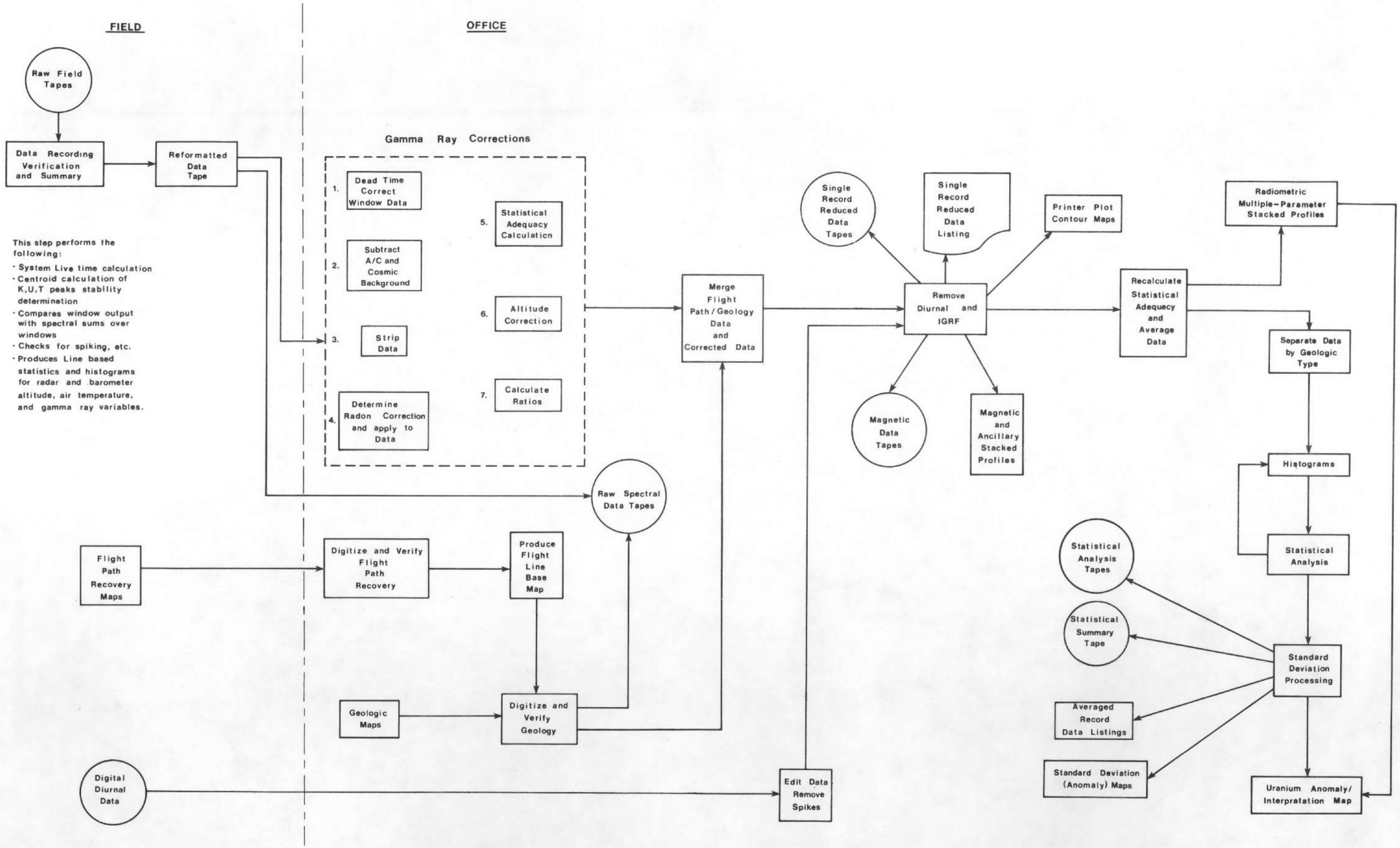
Aircraft and Cosmic background for the Queen Air/Aero Commander over these windows are as follows:

	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:

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

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

MAGNETIC DATA REDUCTION

The magnetic data reduction processes are: correction for diurnal variation, tieing to a common magnetic datum, and subtraction of the regional magnetic field as defined by the International Geomagnetic Reference Field (IGRF). During data acquisition, the magnetic field is monitored by a ground-based diurnal magnetometer that samples every four seconds at a sensitivity of one-quarter gamma. These data are recorded on magnetic tape along with the time for synchronization with the airborne data.

The diurnal data are edited to keep only samples taken during flight time and remove spikes and man-made magnetic events. After editing, these data are displayed in profile form to ensure that all corrections necessary have been made. Next, the data are synchronized in time with the airborne data, interpolated, and subtracted from the airborne magnetic data.

The diurnally corrected magnetic data are then processed by a tieing program that compares the magnetic differences at intersections of flight lines and tie lines. This program calculates individual magnetic field biases for each flight tie line based on tie line intersections. This allows miss-ties to be minimized throughout the survey. These biases usually represent, after diurnal correction, systematic magnetic changes caused by such things as heading error, changes in location of the ground-based magnetometer, or changes in the airborne equipment. The biases are manually evaluated and selectively applied.

DATA PRESENTATION

General

The majority of the data products are presented in this report. These include the uranium anomaly/interpretation maps and pseudo-contour maps of potassium, uranium, thorium, and magnetic data which are integrated as part of the text in the interpretation section. In addition to these data, this report contains data presented in the form of radiometric profiles, flight path recovery maps, standard deviation maps, and histograms. Microfiche data are contained in the back cover of each report. Data tapes are available separately.

Radiometric Profiles

Stacked profiles were prepared from the averaged data for each traverse and tie line. These stacked profiles, plotted at a linear scale of 1:250,000, contain the following parameters: corrected Total Count, percent potassium, equivalent ppm uranium, equivalent ppm thorium, eU/eT, eU/%K, and eT/%K ratios, equivalent ppm Bi Air, radar altimeter, and magnetometer data. Each of the stacked profile sheets contains a plot of the flight path superimposed on a geologic strip map. Included along these profiles are the fiducial numbers which correspond to flight path position as displayed on the flight path recovery maps. Each of the stacked profiles represents the data contained on the specific flight line within the boundaries of the specified NTMS Quadrangle sheet.

Radiometric traces on the stacked profiles contain an indicator showing those data which are statistically inadequate. These statistically inadequate data are marked by a small vertical tick at the sample location. The altitude profile has been limited in display to 1,000 feet. A dashed line at the 700 foot level is presented to show those data which do not meet the altitude specifications. The vertical scale of each variable remains constant on all stacked profiles. When overranging occurs, the trace is stepped and the step labeled showing the actual value. A pictorial representation of such a stepping profile is shown in Figure VIII. At the end of each stacked profile, a statistical summary of the minimum value, maximum value, mean, and standard deviation for that variable is presented.

This report contains an equivalent set of stacked profiles for each quadrangle, photographically reduced to an approximate scale of 1:500,000.

MAGNETIC PROFILES

A set of profiles containing the magnetic data (corrected, with IGRF removed), barometric altimeter data, radar altimeter data, diurnal monitor data, and temperature data are available at a linear scale of 1:250,000. Each of the stacked profiles contains a plot of the flight path superimposed on the geology over which the aircraft flew. Reduced scale (1:500,000) copies of these are presented in of this report.

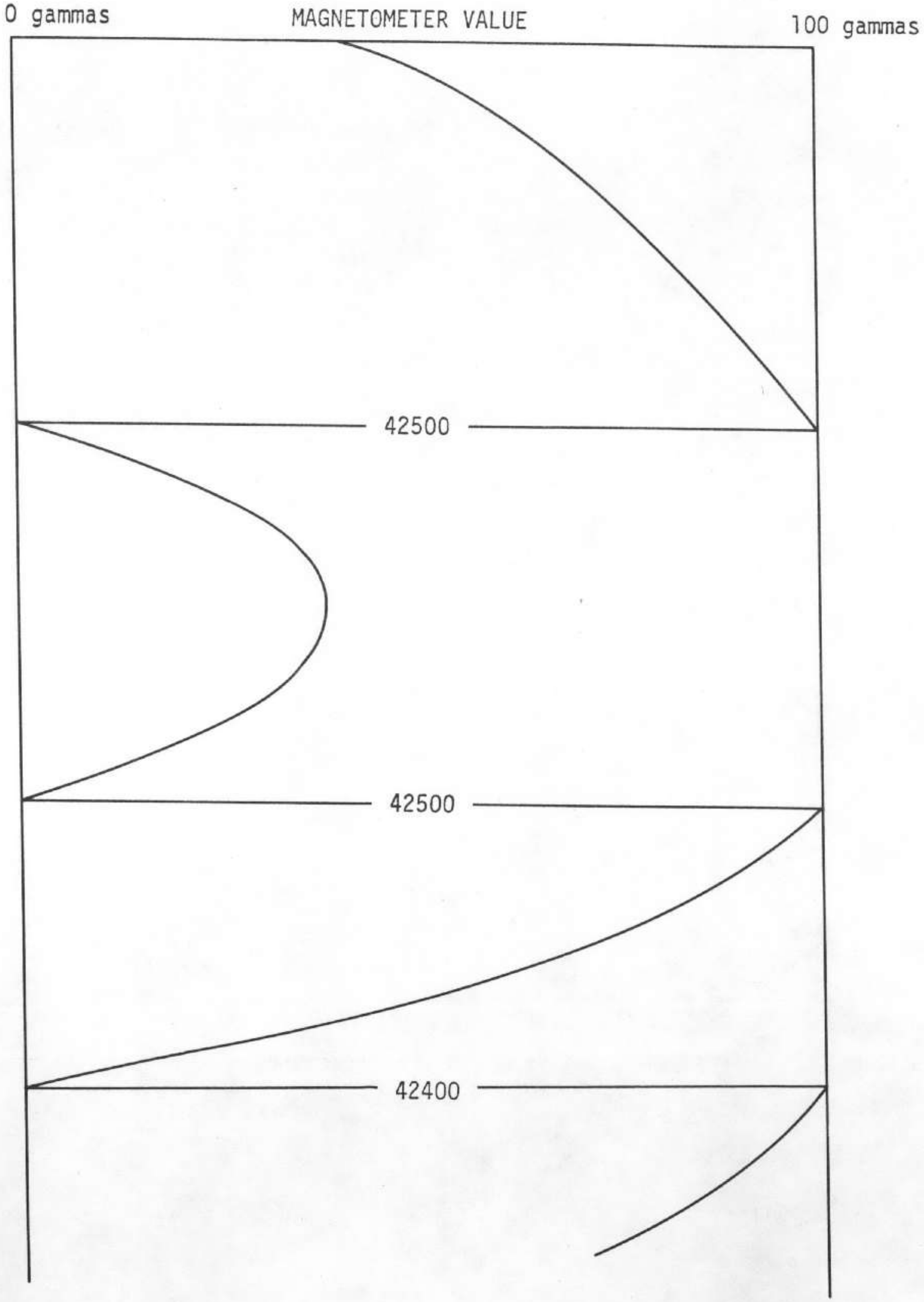


FIGURE VIII Plotter Step Value Labeling

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.

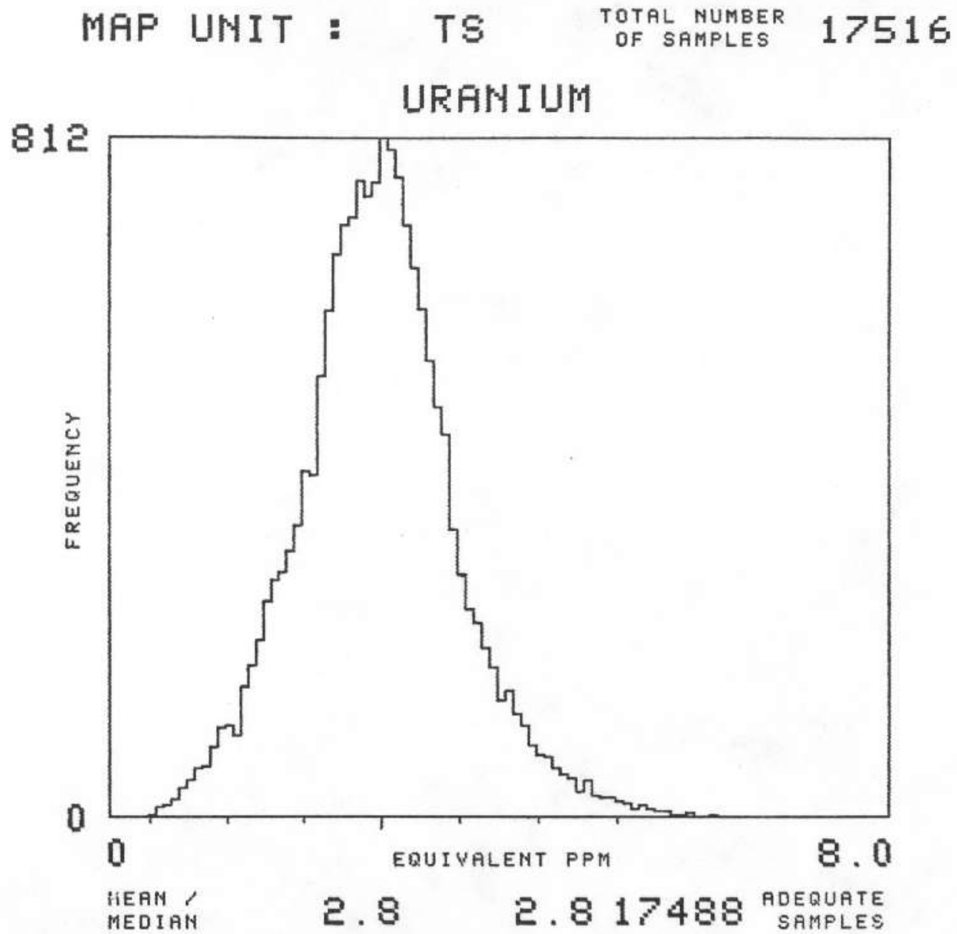


FIGURE IX Sample Computer Map Unit Histogram

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 (Tl208) 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

ITEM	FORMAT	DESCRIPTION
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 " " " " " " "

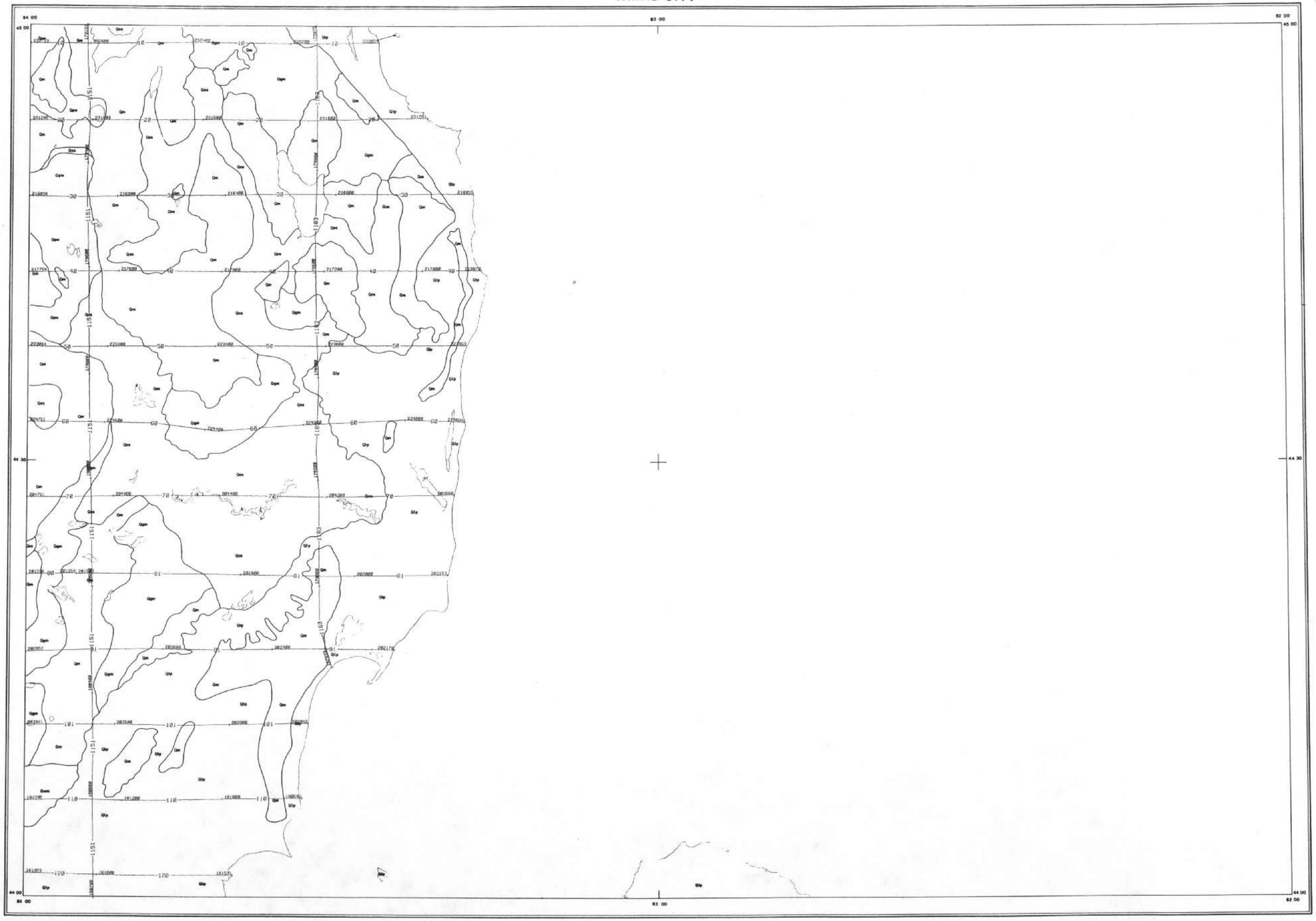
Total miles for the above periods = 8701.4 line miles

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

TAWAS CITY



SCALE 1:500,000

FIDUCIAL NUMBER — 053-0 — LINE NUMBER

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

LOCATION DIAGRAM

SURVEY AND COMPILATION BY:

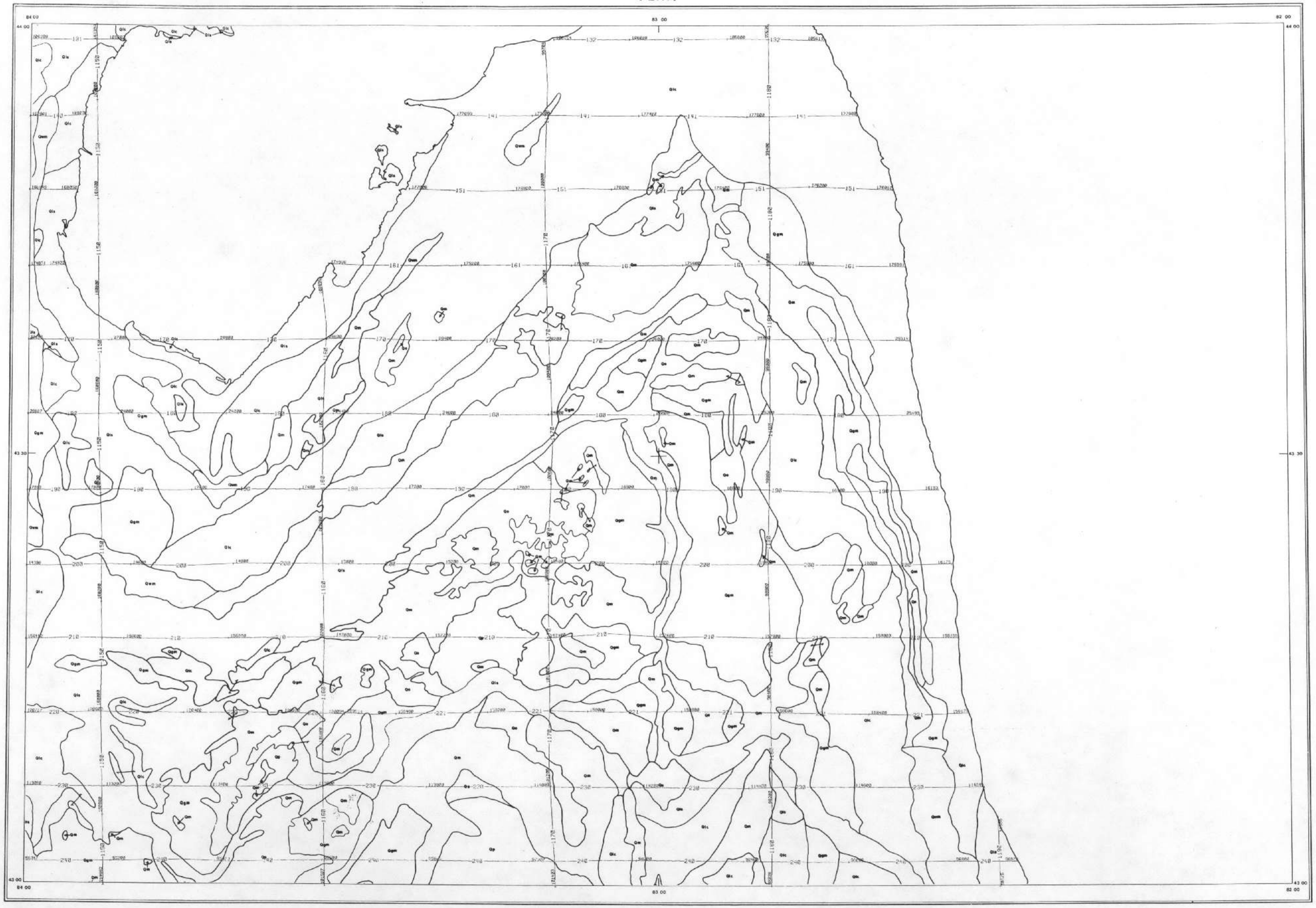
EG&G GEOMETRICS

FLIGHT PATH RECOVERY

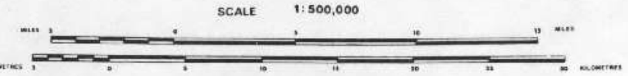
GREAT LAKES PROJECT

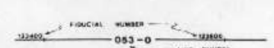
U. S. DEPARTMENT OF ENERGY

FLINT



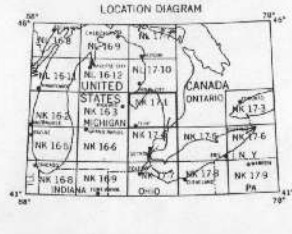
SCALE 1:500,000





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

LOCATION DIAGRAM



SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

FLIGHT PATH RECOVERY

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

TAWAS CITY QUADRANGLE
GEOLOGIC MAP EXPLANANTION
(Martel Laboratories, 1981)

CENOZOIC — PLEISTOCENE — QUATERNARY

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

FLINT QUADRANGLE
GEOLOGIC MAP EXPLANATION
(Martel Laboratories, 1981)

Cenozoic — Quaternary — Pleistocene

Qm **Moraines**
Unconsolidated, unsorted deposits. Includes lateral & end moraines.

Qwm **Water-laid moraines**
Morainal debris interbedded with lacustrine sediments.

Qlc **Lake beds, clay**
Off-shore clay deposits with sand lenses. Locally includes alluvium.

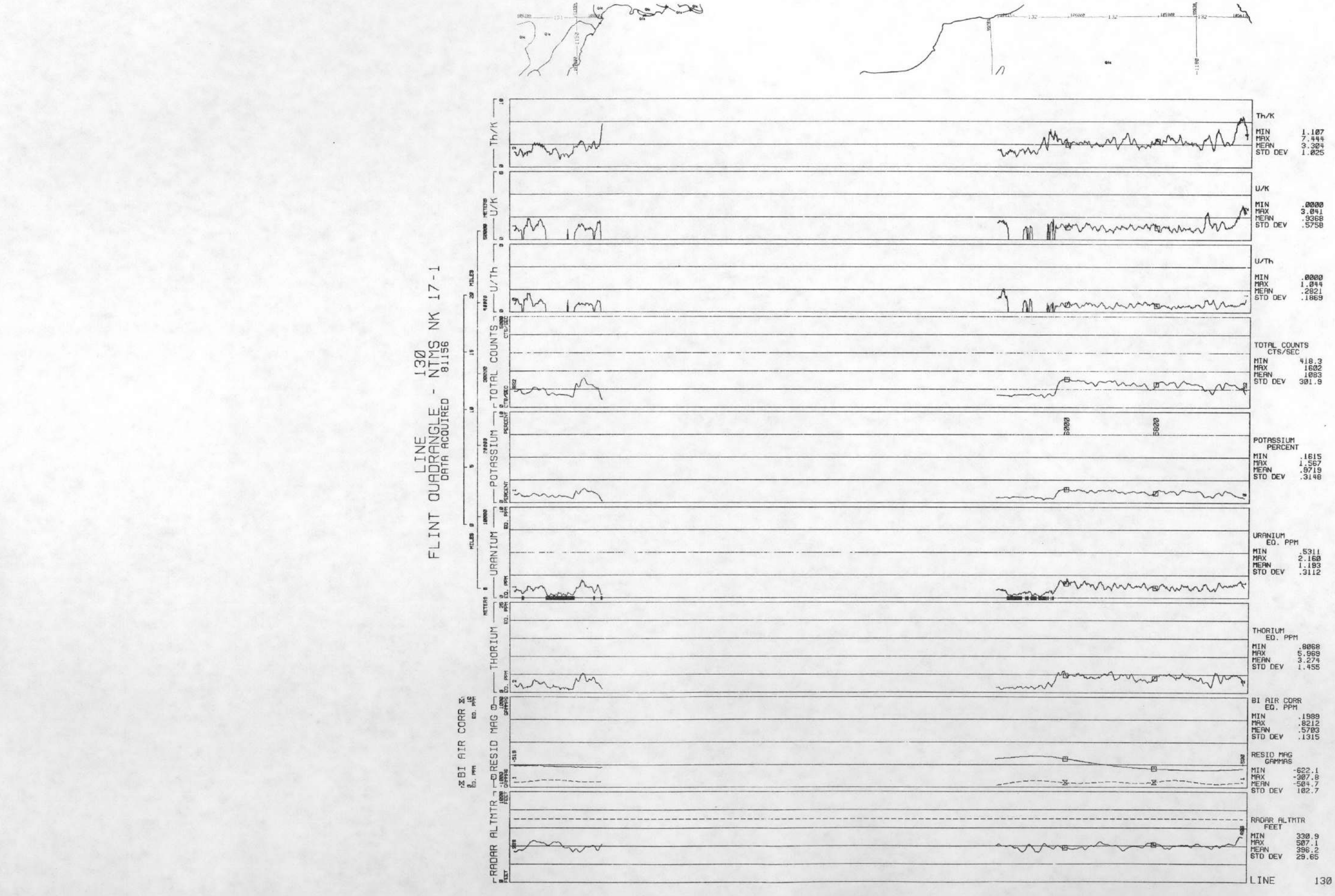
Qls **Lake beds, sand**
Near-shore sand deposits. Locally includes alluvium.

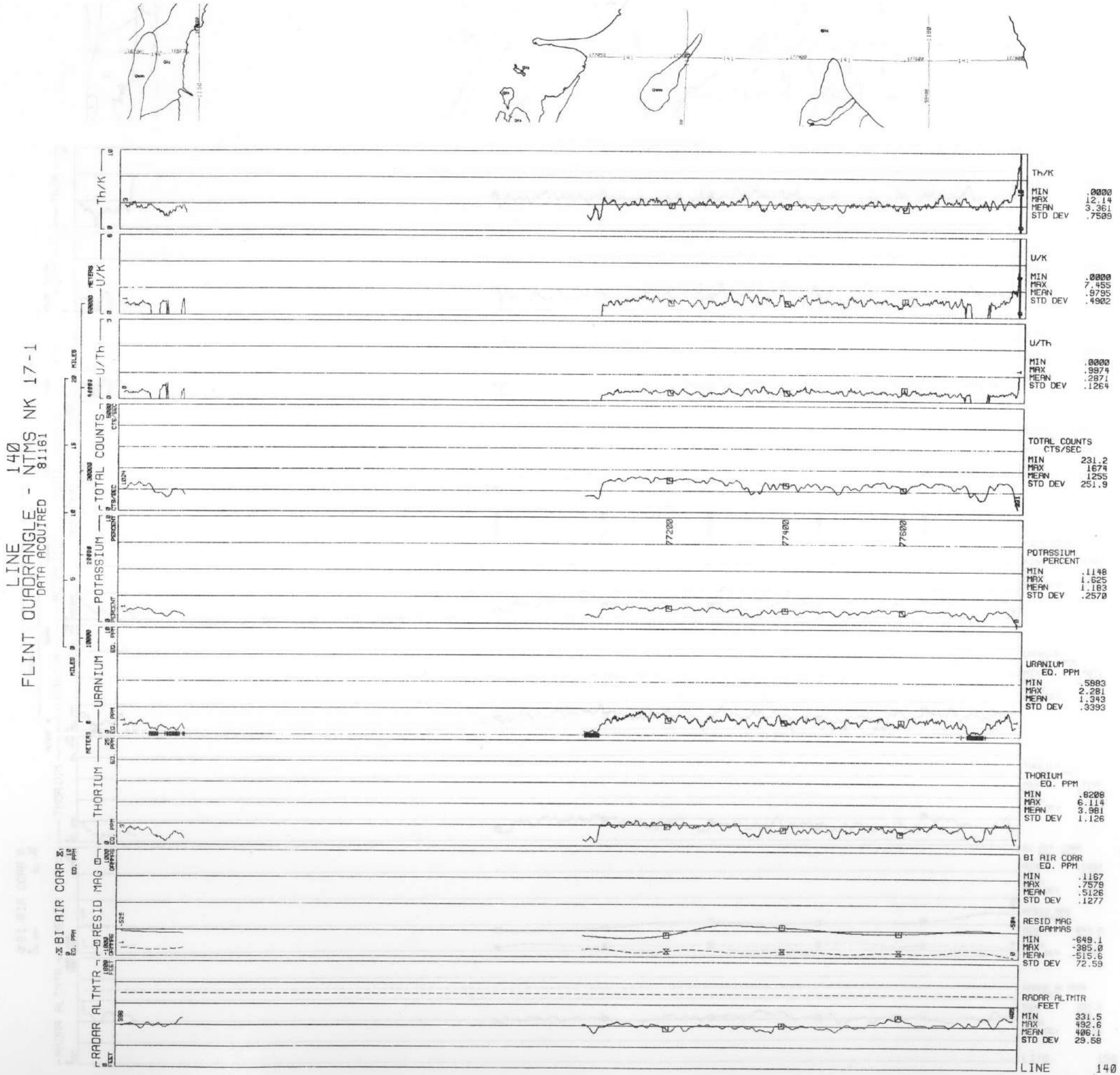
Qo **Outwash**
Meltwater deposits. Includes glacial channel deposits & alluvium.

Qgm **Ground moraines**
Till plains.

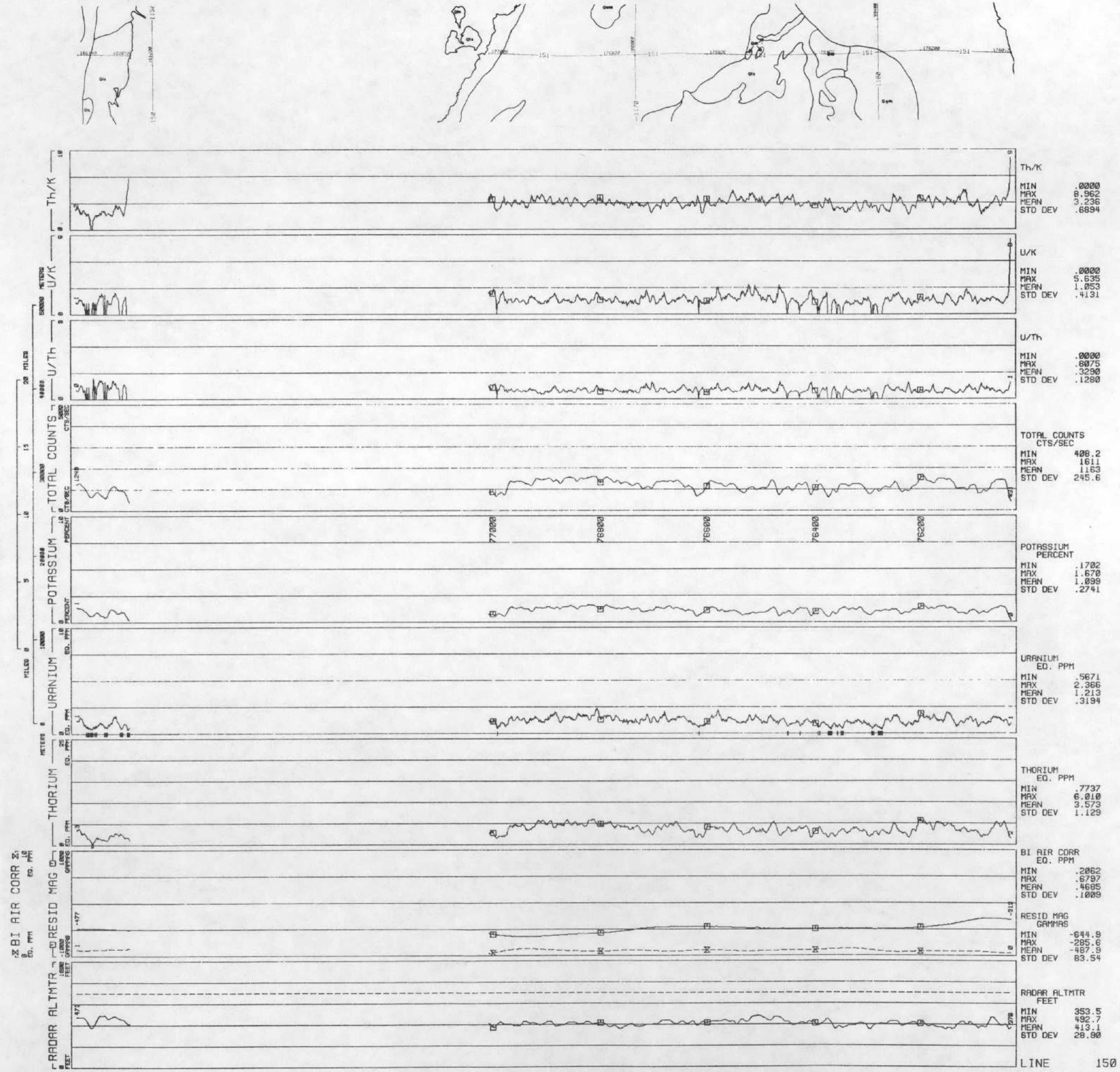
Qp **Ponded lake beds**
Silt with clay & some sand & gravel.

APPENDIX D - Profiles

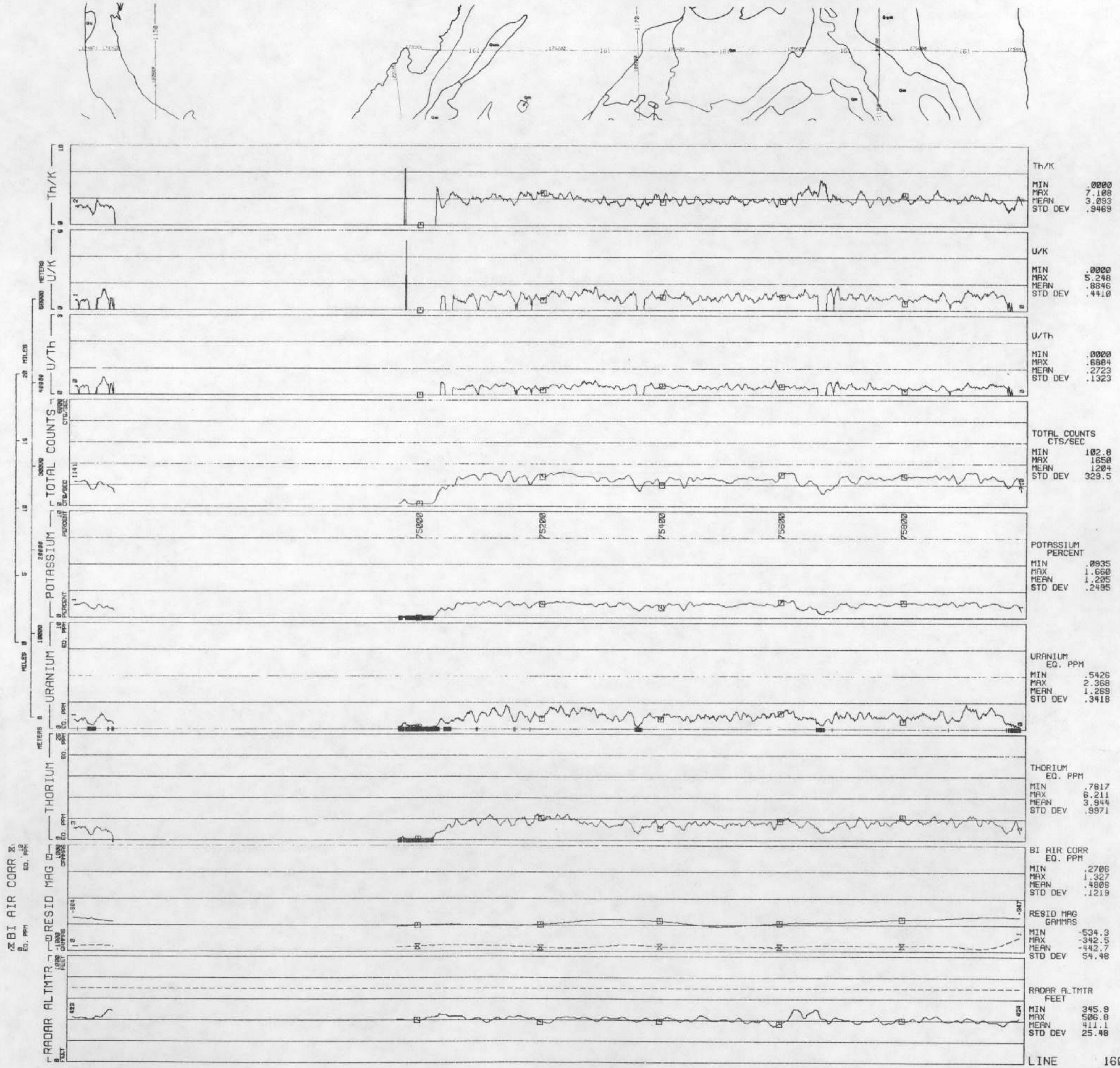

LINE 130
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156
Th/K
MIN 1.107
MAX 7.444
MEAN 3.304
STD DEV 1.025
U/K
MIN .0000
MAX 3.041
MEAN .9368
STD DEV .5758
U/Th
MIN .0000
MAX 1.044
MEAN .2821
STD DEV .1869
TOTAL COUNTS CTS/SEC
MIN 418.3
MAX 1602
MEAN 1083
STD DEV 301.9
POTASSIUM PERCENT
MIN .1615
MAX 1.567
MEAN .9719
STD DEV .3148
URANIUM EQ. PPM
MIN .5311
MAX 2.160
MEAN 1.193
STD DEV .3112
THORIUM EQ. PPM
MIN .8068
MAX 5.969
MEAN 3.274
STD DEV 1.455
BI AIR CORR EQ. PPM
MIN .1989
MAX .8212
MEAN .5703
STD DEV .1315
RESID MAG GAMMAS
MIN -622.1
MAX -307.8
MEAN -504.7
STD DEV 102.7
RADAR ALTMTR FEET
MIN 330.9
MAX 507.1
MEAN 396.2
STD DEV 29.65
LINE 130


LINE 140
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81161
Th/K
MIN .0000
MAX 12.14
MEAN 3.361
STD DEV .7509
U/K
MIN .0000
MAX 7.455
MEAN .9795
STD DEV .4902
U/Th
MIN .0000
MAX .9974
MEAN .2871
STD DEV .1264
TOTAL COUNTS CTS/SEC
MIN 231.2
MAX 1674
MEAN 1255
STD DEV 251.9
77200
77400
77600
POTASSIUM PERCENT
MIN .1148
MAX 1.625
MEAN 1.183
STD DEV .2570
URANIUM EQ. PPM
MIN .5803
MAX 2.281
MEAN 1.343
STD DEV .3393
THORIUM EQ. PPM
MIN .8208
MAX 6.114
MEAN 3.981
STD DEV 1.126
BI AIR CORR EQ. PPM
MIN .1167
MAX .7579
MEAN .5126
STD DEV .1277
RESID MAG GAMMAS
MIN -649.1
MAX -385.0
MEAN -515.6
STD DEV 72.59
RADAR ALTMTR FEET
MIN 331.5
MAX 492.6
MEAN 406.1
STD DEV 29.58
LINE 140

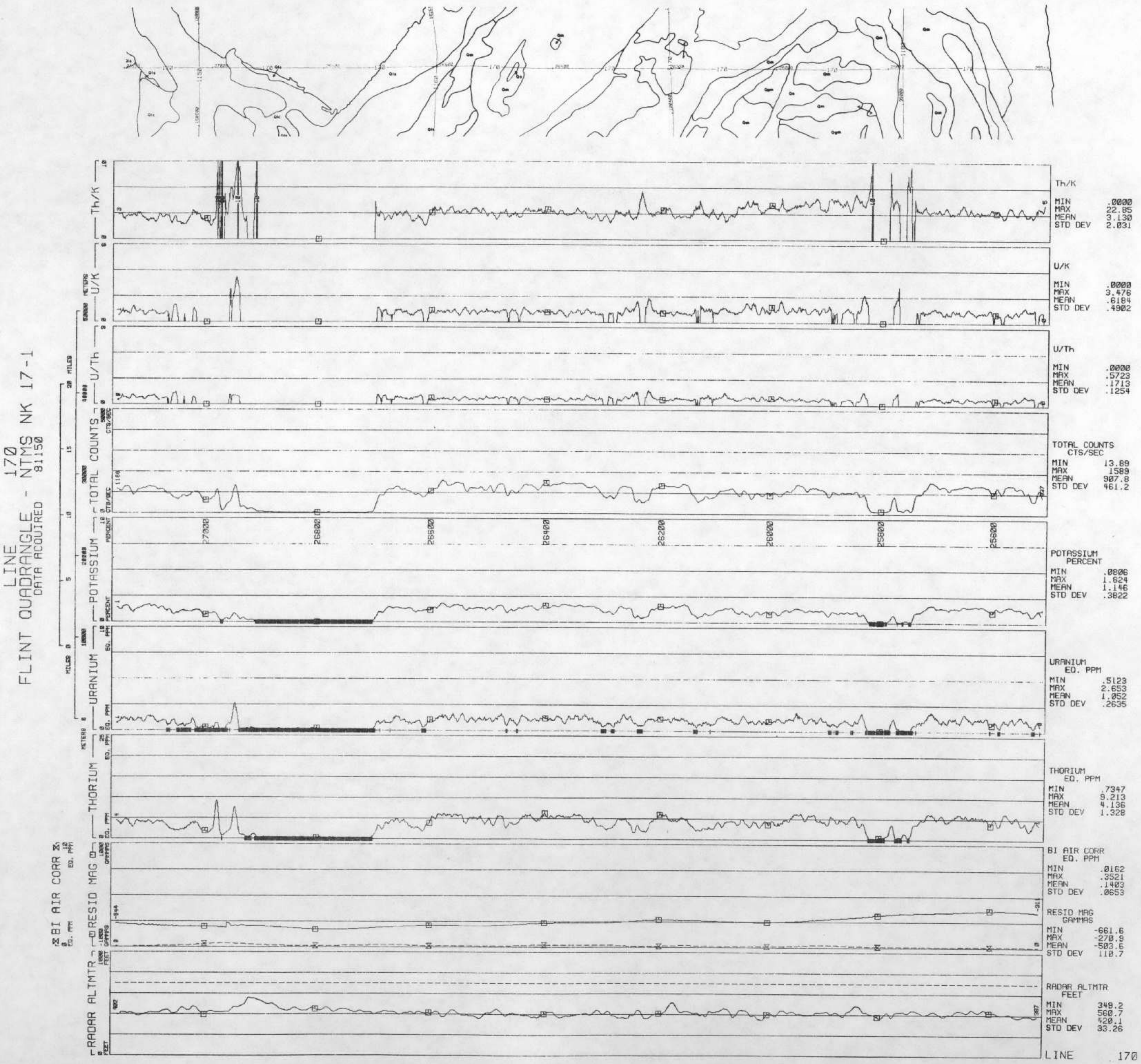
D3tf


LINE 150
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81161
Th/K
MIN .0000
MAX 8.962
MEAN 3.236
STD DEV .6894
U/K
MIN .0000
MAX 5.635
MEAN 1.053
STD DEV .4131
U/Th
MIN .0000
MAX .8075
MEAN .3290
STD DEV .1280
TOTAL COUNTS CTS/SEC
MIN 408.2
MAX 1611
MEAN 1163
STD DEV 245.6
POTASSIUM PERCENT
MIN .1702
MAX 1.670
MEAN 1.099
STD DEV .2741
URANIUM EQ. PPM
MIN .5671
MAX 2.366
MEAN 1.213
STD DEV .3194
THORIUM EQ. PPM
MIN .7737
MAX 6.010
MEAN 3.573
STD DEV 1.129
BI AIR CORR EQ. PPM
MIN .2062
MAX .6797
MEAN .4685
STD DEV .1009
RESID MAG GAMMAS
MIN -644.9
MAX -285.6
MEAN -487.5
STD DEV 83.54
RADAR ALTMTR FEET
MIN 353.5
MAX 492.7
MEAN 413.1
STD DEV 28.90
LINE 150

LINE 160
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81162

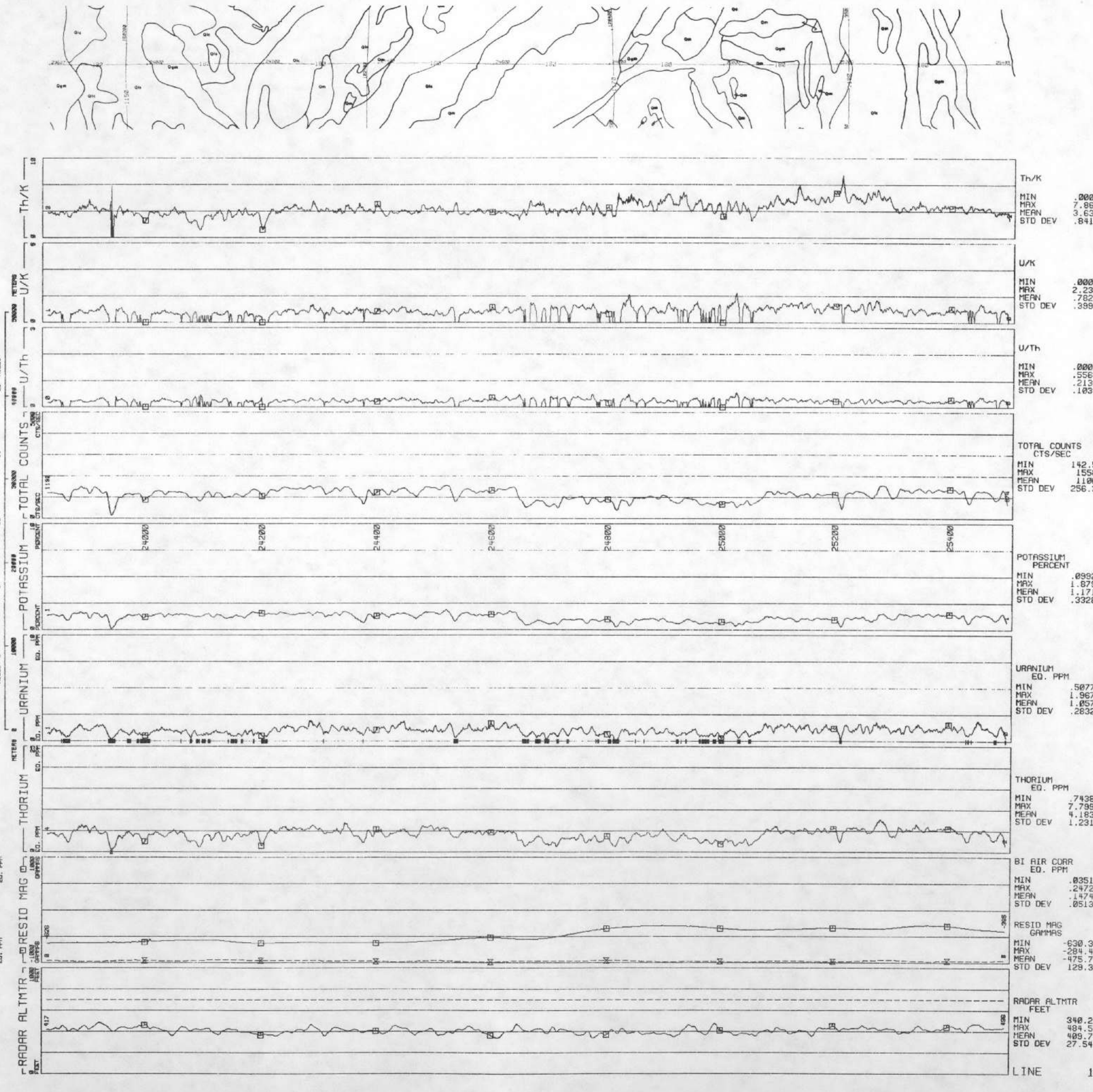


D5 tf

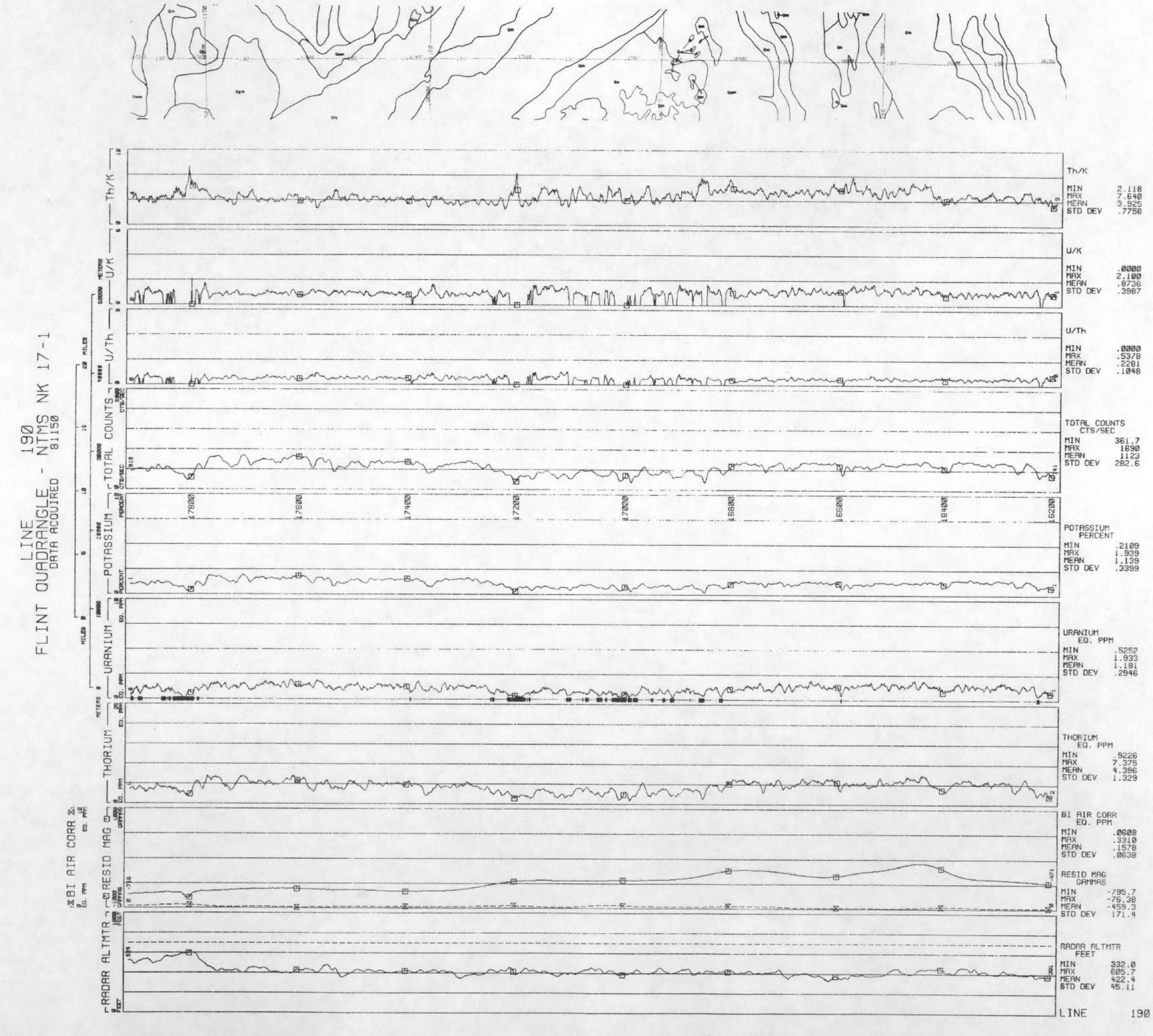

LINE 170
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81150
Th/K
MIN .0000
MAX 22.85
MEAN 3.130
STD DEV 2.031
U/K
MIN .0000
MAX 3.476
MEAN .6184
STD DEV .4902
U/Th
MIN .0000
MAX .5723
MEAN .1713
STD DEV .1254
TOTAL COUNTS CTS/SEC
MIN 13.89
MAX 1589
MEAN 907.8
STD DEV 461.2
POTASSIUM PERCENT
MIN .0806
MAX 1.624
MEAN 1.146
STD DEV .3822
URANIUM EQ. PPM
MIN .5123
MAX 2.553
MEAN 1.052
STD DEV .2635
THORIUM EQ. PPM
MIN .7347
MAX 9.213
MEAN 4.136
STD DEV 1.328
BI AIR CORR EQ. PPM
MIN .0162
MAX .3521
MEAN .1403
STD DEV .0653
RESID MAG GAMMAS
MIN -661.6
MAX -270.9
MEAN -503.6
STD DEV 110.7
RADAR ALTMTR FEET
MIN 349.2
MAX 560.7
MEAN 420.1
STD DEV 33.26
LINE 170

D6tf

LINE 180
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81150

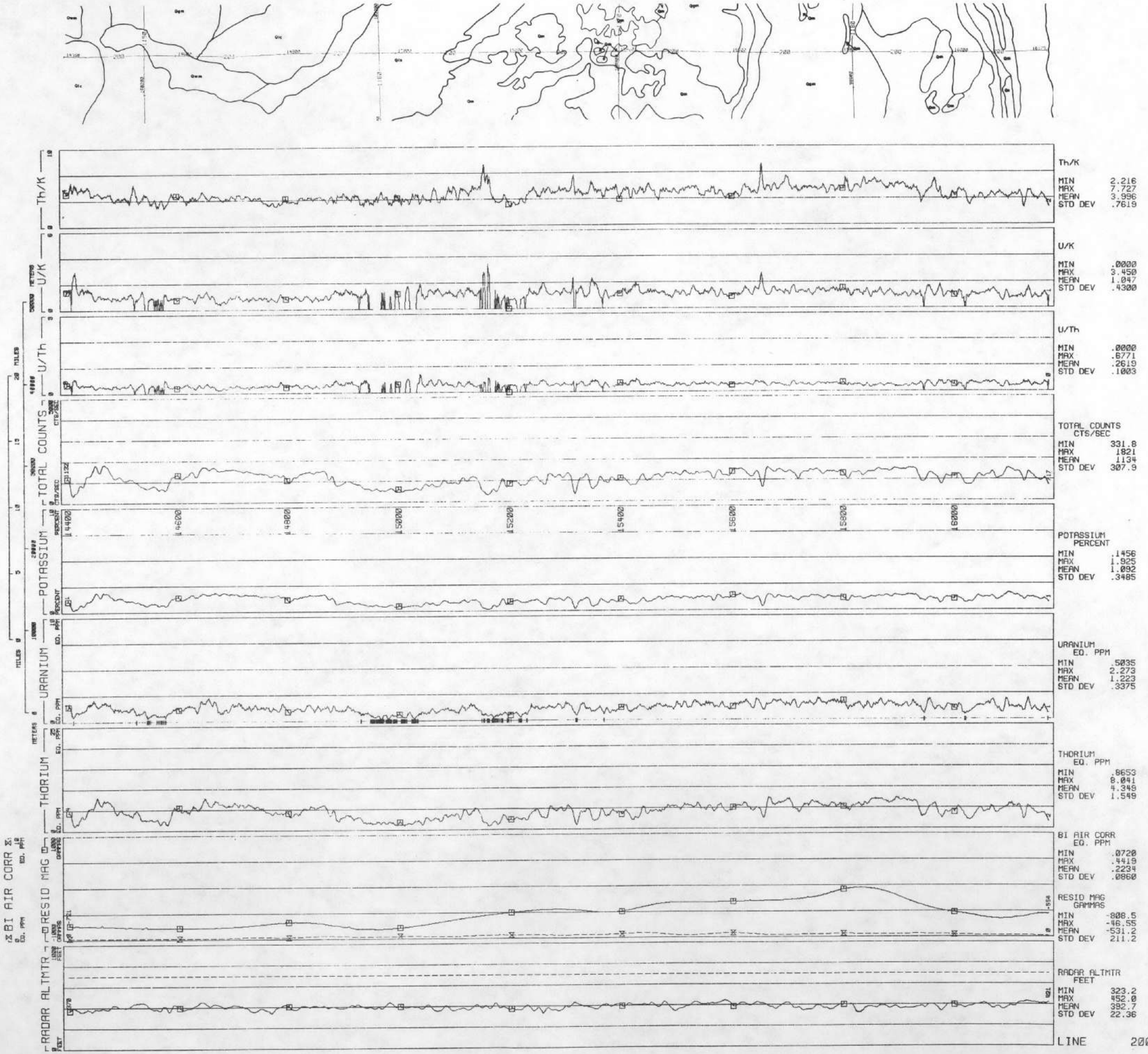


D7tf



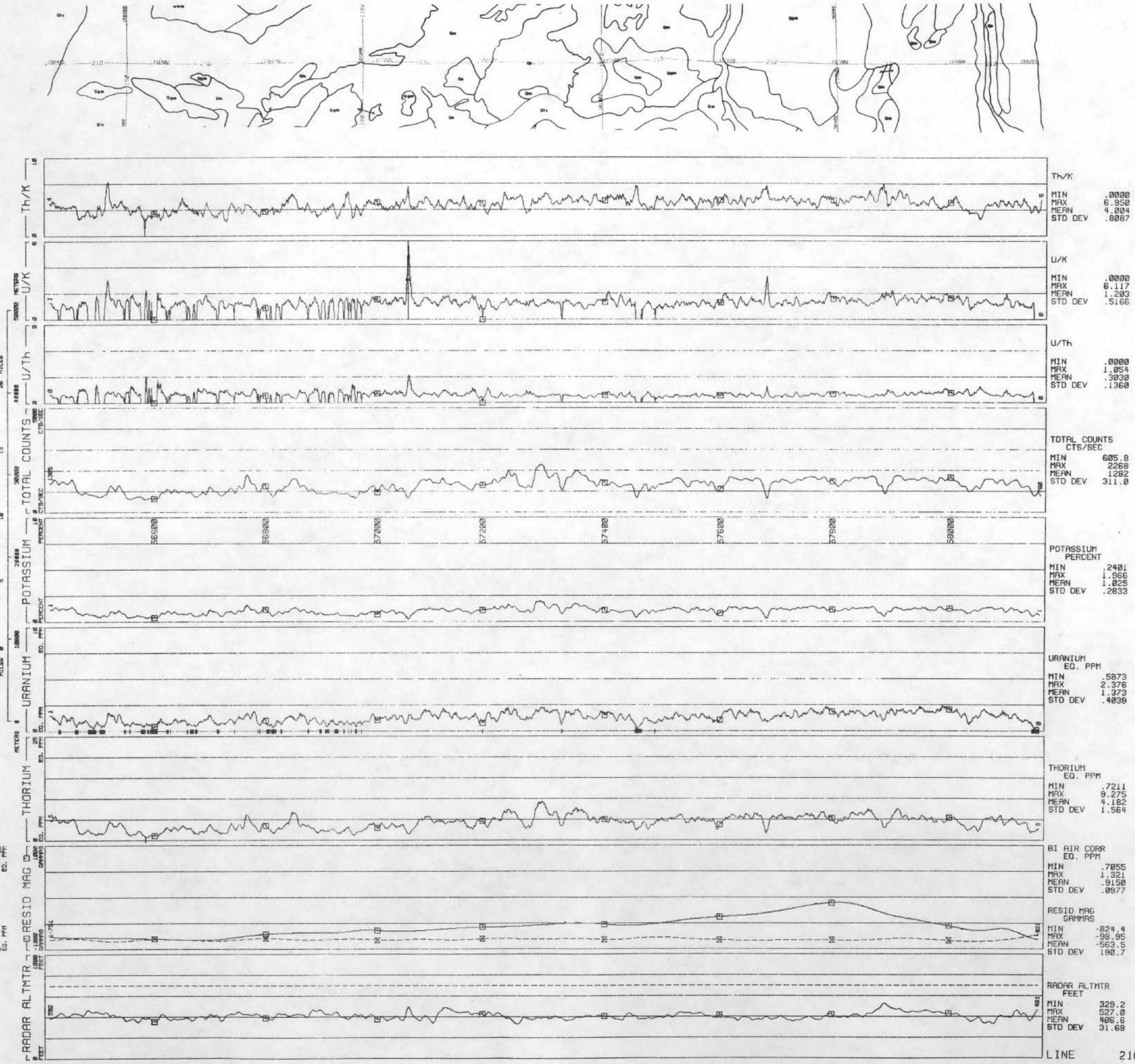
LINE 190
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81150
Th/K
MIN 2.118
MAX 7.640
MEAN 3.925
STD DEV .7758
U/K
MIN .0000
MAX 2.100
MEAN .8736
STD DEV .3987
U/Th
MIN .0000
MAX .5378
MEAN .2281
STD DEV .1048
TOTAL COUNTS CTS/SEC
MIN 361.7
MAX 1690
MEAN 1123
STD DEV 282.6
POTASSIUM PERCENT
MIN .2109
MAX 1.939
MEAN 1.139
STD DEV .3399
URANIUM EQ. PPM
MIN .5252
MAX 1.933
MEAN 1.181
STD DEV .2946
THORIUM EQ. PPM
MIN .9226
MAX 7.375
MEAN 4.396
STD DEV 1.329
BI AIR CORR EQ. PPM
MIN .0608
MAX .3310
MEAN .1578
STD DEV .0638
RESID MAG GAMMAS
MIN -795.7
MAX -76.38
MEAN -459.3
STD DEV 171.4
RADAR ALTMTR FEET
MIN 332.0
MAX 605.7
MEAN 422.4
STD DEV 45.11
LINE 190
17800
17600
17400
17200
17000
16800
16600
16400
16200

LINE 200
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81150

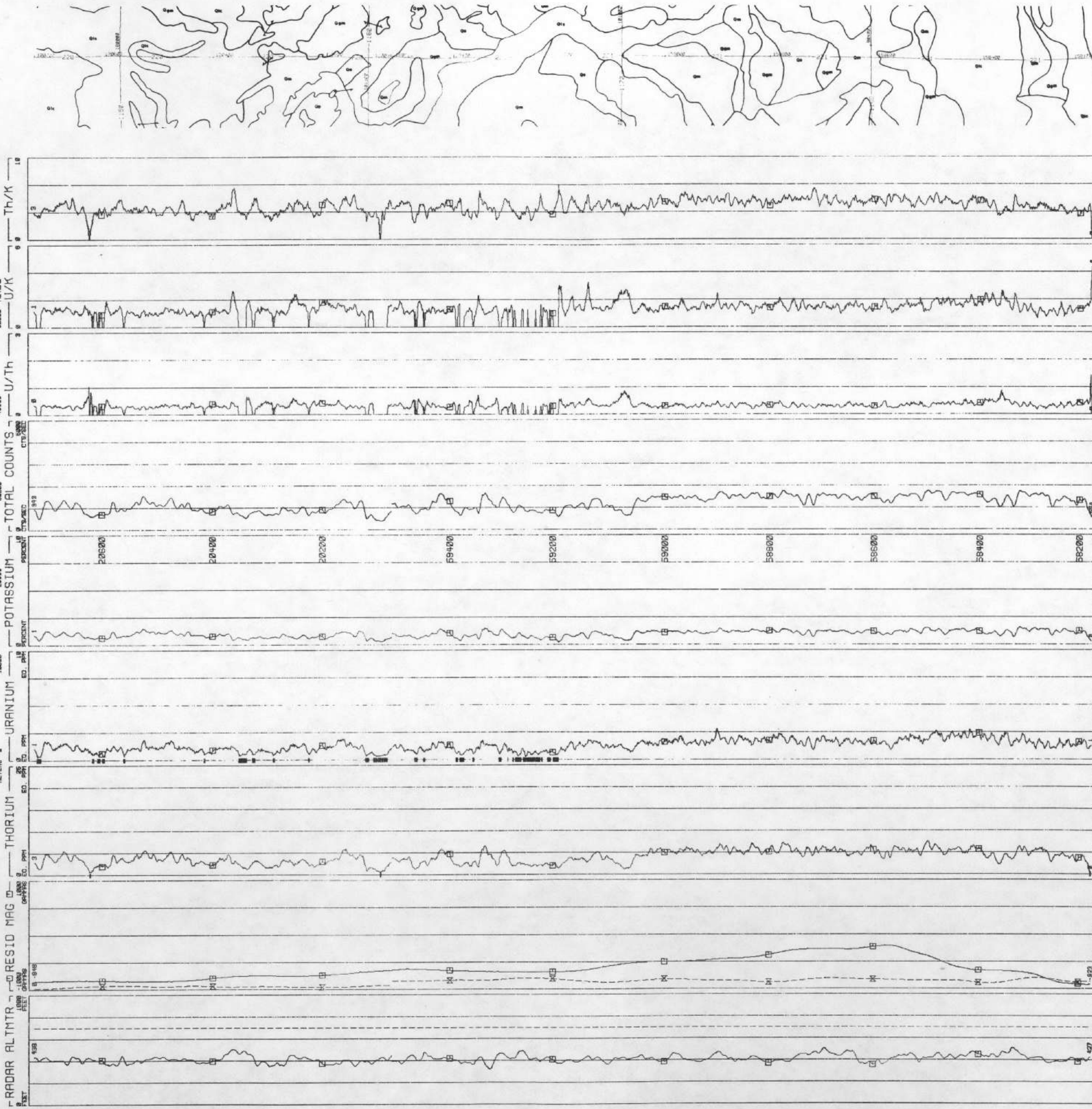


D9 tf

LINE 210
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81161



LINE 220
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81157



Th/K	
MIN	.0000
MAX	6.615
MEAN	4.008
STD DEV	.7825

U/K	
MIN	.0000
MAX	4.328
MEAN	1.284
STD DEV	.5247

U/Th	
MIN	.0000
MAX	1.419
MEAN	.3192
STD DEV	.1357

TOTAL COUNTS CTS/SEC	
MIN	394.7
MAX	1752
MEAN	1188
STD DEV	316.5

POTASSIUM PERCENT	
MIN	.2197
MAX	1.549
MEAN	.9789
STD DEV	.2679

URANIUM EQ. PPM	
MIN	.5129
MAX	2.775
MEAN	1.388
STD DEV	.4377

THORIUM EQ. PPM	
MIN	.7554
MAX	7.500
MEAN	4.002
STD DEV	1.434

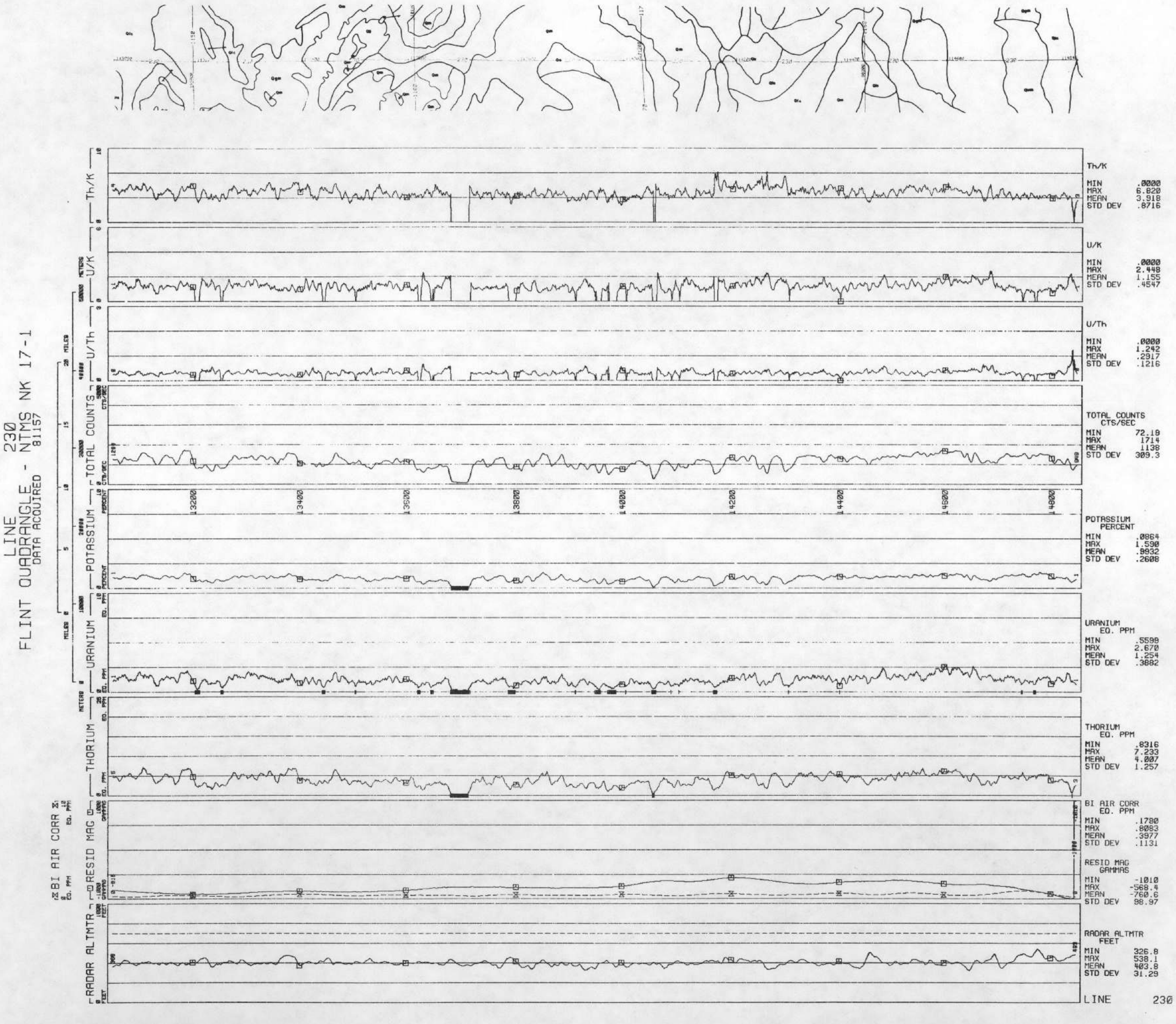
BI AIR CORR EQ. PPM	
MIN	.0985
MAX	1.022
MEAN	.6093
STD DEV	.2649

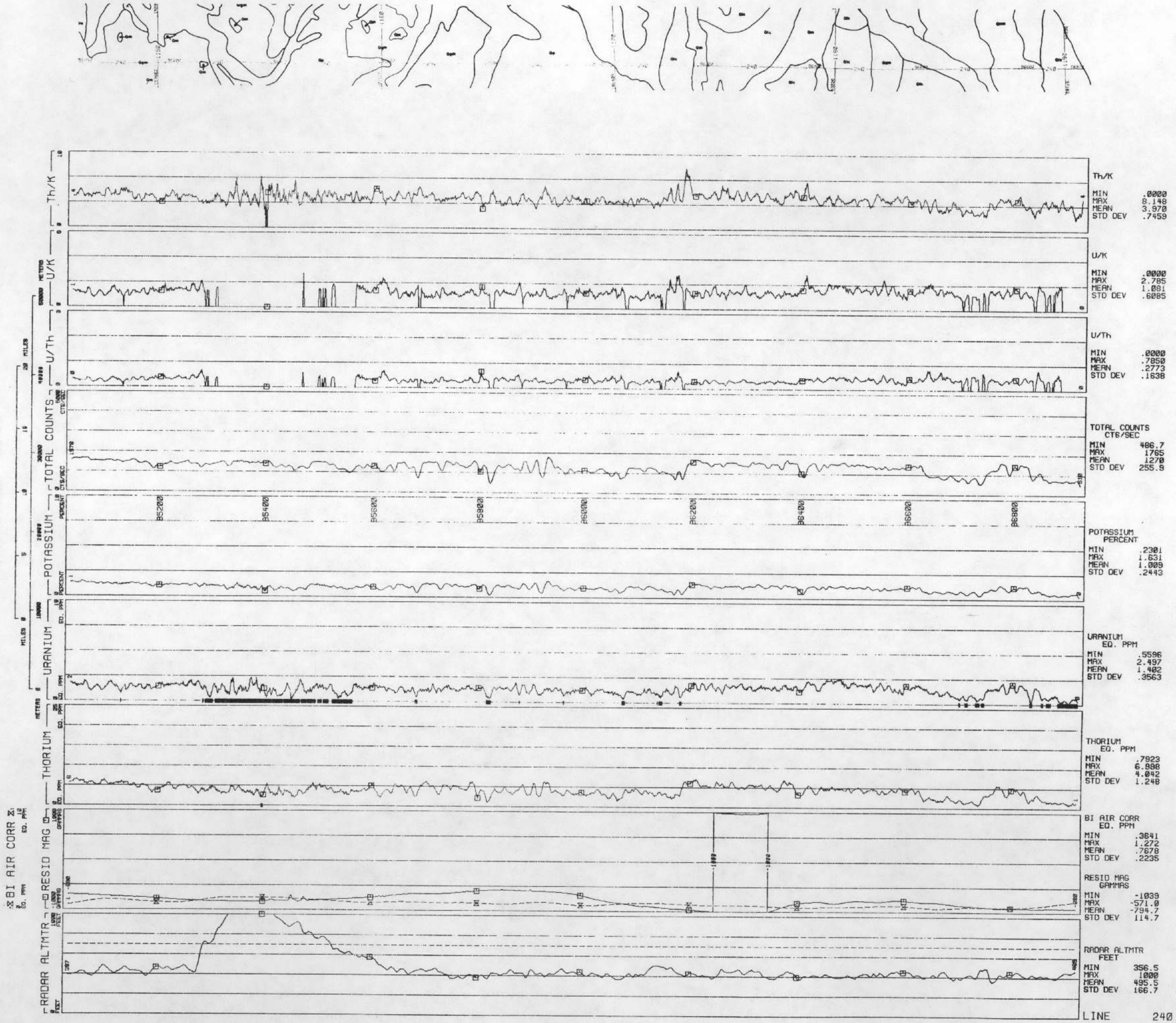
RESID MAG GAMMAS	
MIN	-926.2
MAX	-204.9
MEAN	-622.5
STD DEV	190.7

RADAR ALTMTR FEET	
MIN	320.8
MAX	510.6
MEAN	413.9
STD DEV	32.01

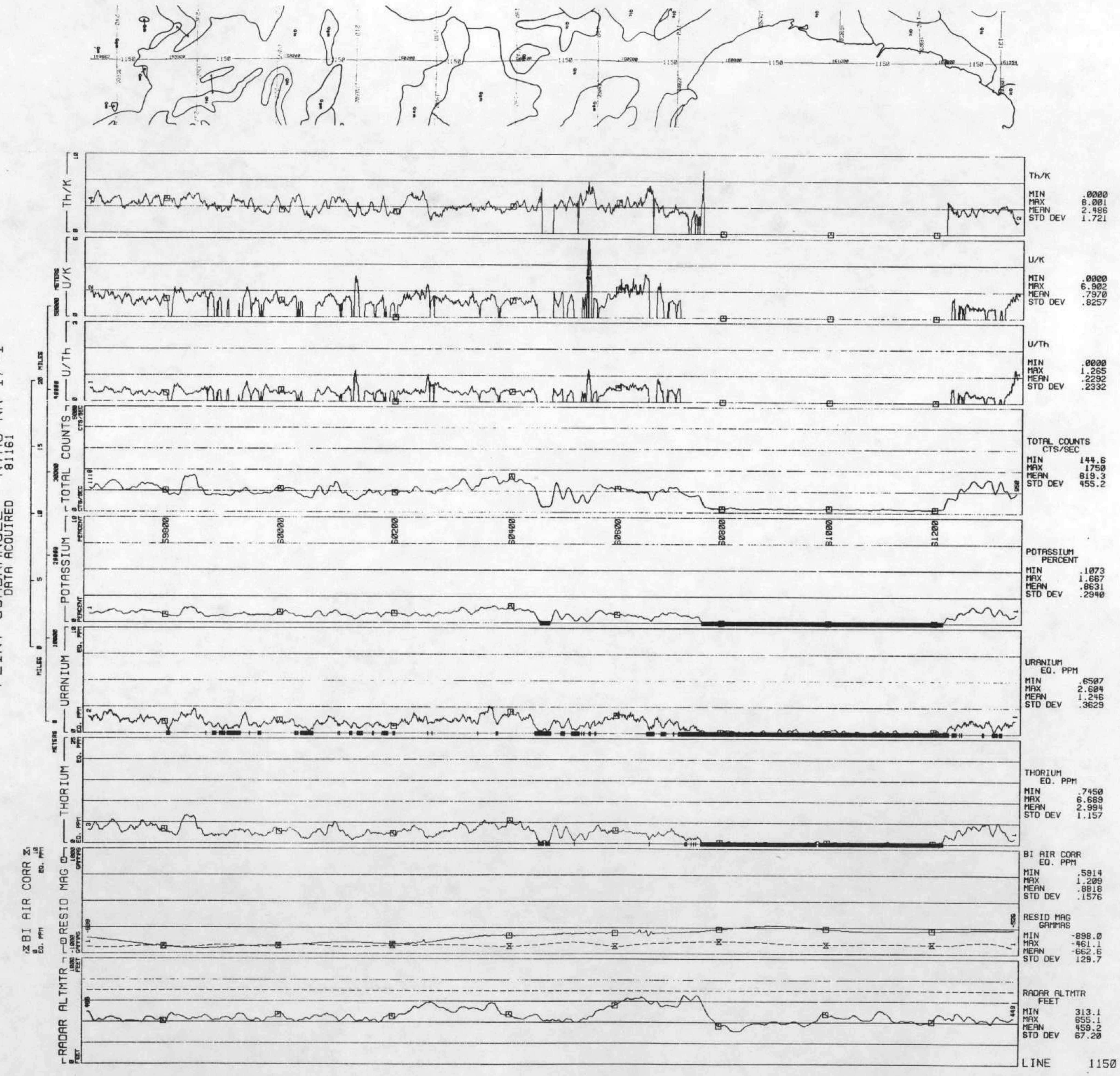
LINE 220

D11 tf

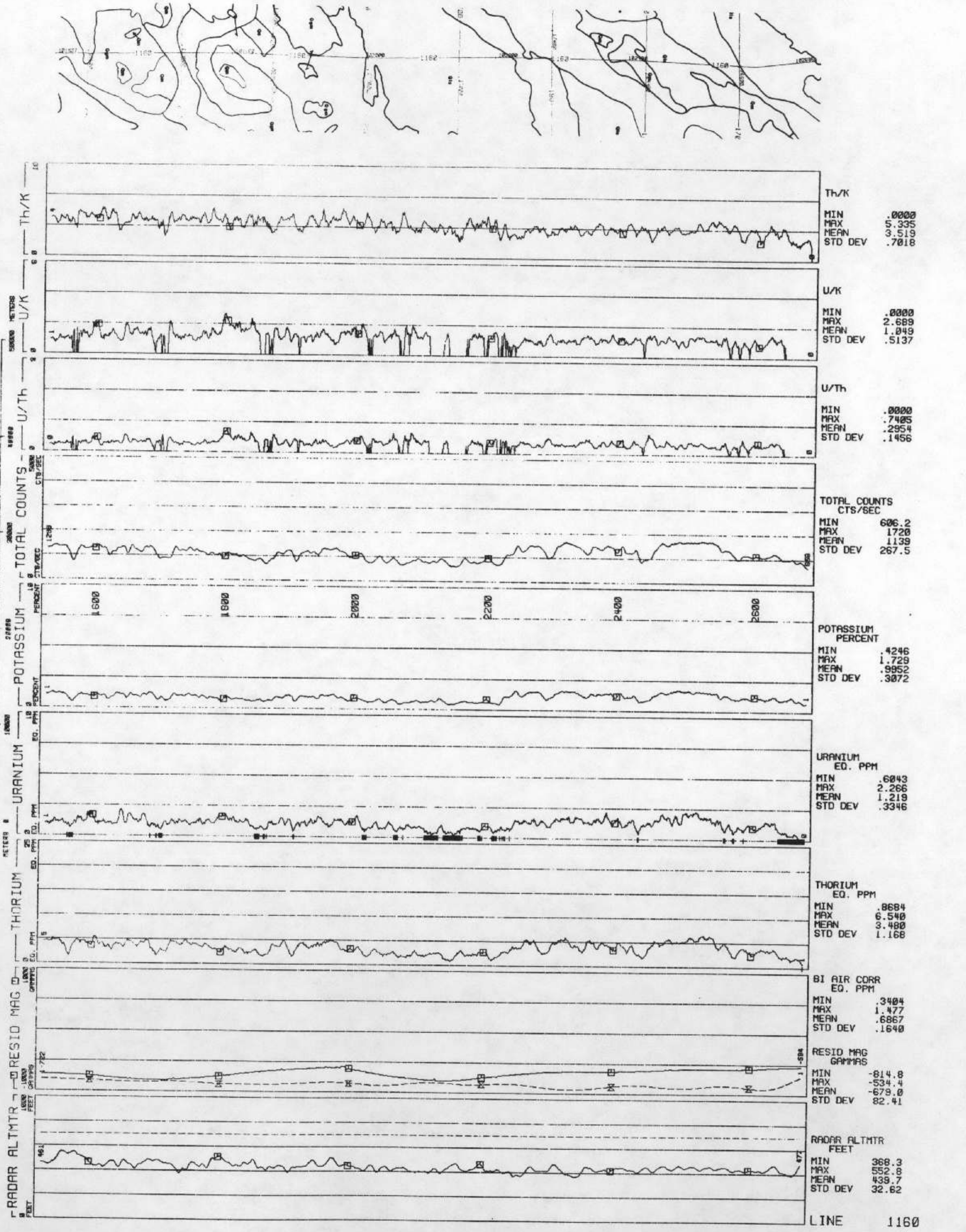

LINE 230
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81157
Th/K
MIN .0000
MAX 6.820
MEAN 3.918
STD DEV .8716
U/K
MIN .0000
MAX 2.448
MEAN 1.155
STD DEV .4547
U/Th
MIN .0000
MAX 1.242
MEAN .2917
STD DEV .1216
TOTAL COUNTS CTS/SEC
MIN 72.19
MAX 1714
MEAN 1138
STD DEV 309.3
POTASSIUM PERCENT
MIN .0864
MAX 1.590
MEAN .8932
STD DEV .2608
URANIUM EQ. PPM
MIN .5598
MAX 2.670
MEAN 1.254
STD DEV .3882
THORIUM EQ. PPM
MIN .8316
MAX 7.233
MEAN 4.007
STD DEV 1.257
BI AIR CORR EQ. PPM
MIN .1780
MAX .8083
MEAN .3977
STD DEV .1131
RESID MAG GAMMAS
MIN -1010
MAX -568.4
MEAN -760.6
STD DEV 98.97
RADAR ALTMTR FEET
MIN 326.8
MAX 538.1
MEAN 403.8
STD DEV 31.29
13200
13400
13600
13800
14000
14200
14400
14600
14800
LINE 230


LINE 240
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156
Th/K
MIN .0000
MAX 8.148
MEAN 3.970
STD DEV .7459
U/K
MIN .0000
MAX 2.785
MEAN 1.081
STD DEV .6085
U/Th
MIN .0000
MAX .7850
MEAN .2773
STD DEV .1638
TOTAL COUNTS CTS/SEC
MIN 486.7
MAX 1765
MEAN 1270
STD DEV 255.9
POTASSIUM PERCENT
MIN .2301
MAX 1.631
MEAN 1.009
STD DEV .2443
URANIUM EQ. PPM
MIN .5596
MAX 2.497
MEAN 1.402
STD DEV .3563
THORIUM EQ. PPM
MIN .7923
MAX 6.888
MEAN 4.042
STD DEV 1.248
BI AIR CORR EQ. PPM
MIN .3641
MAX 1.272
MEAN .7678
STD DEV .2235
RESID MAG GAMMAS
MIN -1039
MAX -571.0
MEAN -794.7
STD DEV 114.7
RADAR ALTMTR FEET
MIN 356.5
MAX 1000
MEAN 495.5
STD DEV 166.7
B5200
B5400
B5600
B5800
B6000
B6200
B6400
B6600
B6800
LINE 240

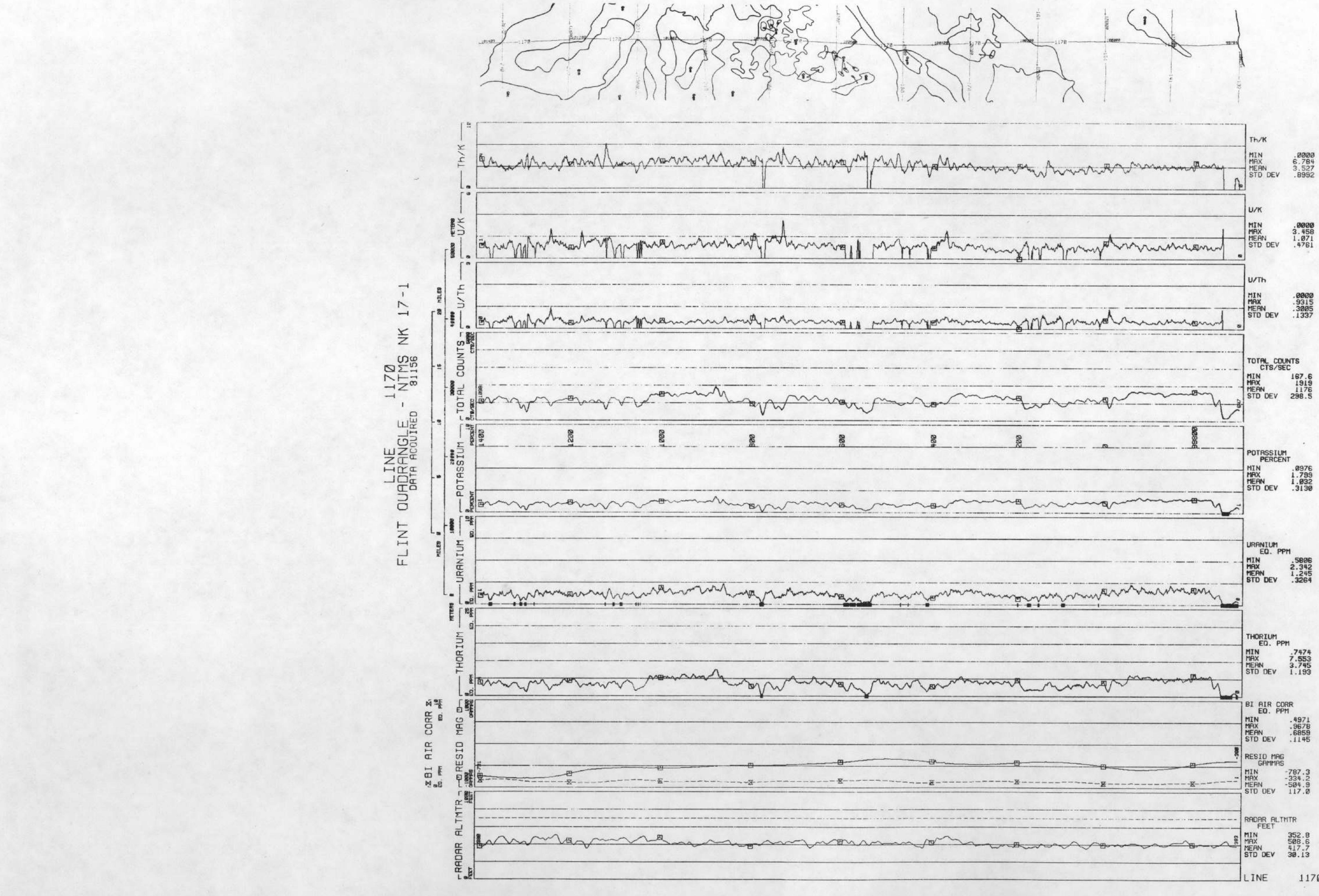
D13 tf


LINE 1150
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81161
Th/K
MIN .0000
MAX 8.001
MEAN 2.486
STD DEV 1.721
U/K
MIN .0000
MAX 6.902
MEAN .7970
STD DEV .8257
U/Th
MIN .0000
MAX 1.265
MEAN .2292
STD DEV .2332
TOTAL COUNTS CTS/SEC
MIN 144.6
MAX 1750
MEAN 819.3
STD DEV 455.2
POTASSIUM PERCENT
MIN .1073
MAX 1.667
MEAN .8631
STD DEV .2940
URANIUM EQ. PPM
MIN .6507
MAX 2.604
MEAN 1.246
STD DEV .3629
THORIUM EQ. PPM
MIN .7450
MAX 6.689
MEAN 2.994
STD DEV 1.157
BI AIR CORR EQ. PPM
MIN .5914
MAX 1.209
MEAN .8818
STD DEV .1576
RESID MAG GAMMAS
MIN -898.0
MAX -461.1
MEAN -662.6
STD DEV 129.7
RADAR ALTMTR FEET
MIN 313.1
MAX 655.1
MEAN 459.2
STD DEV 67.20
LINE 1150

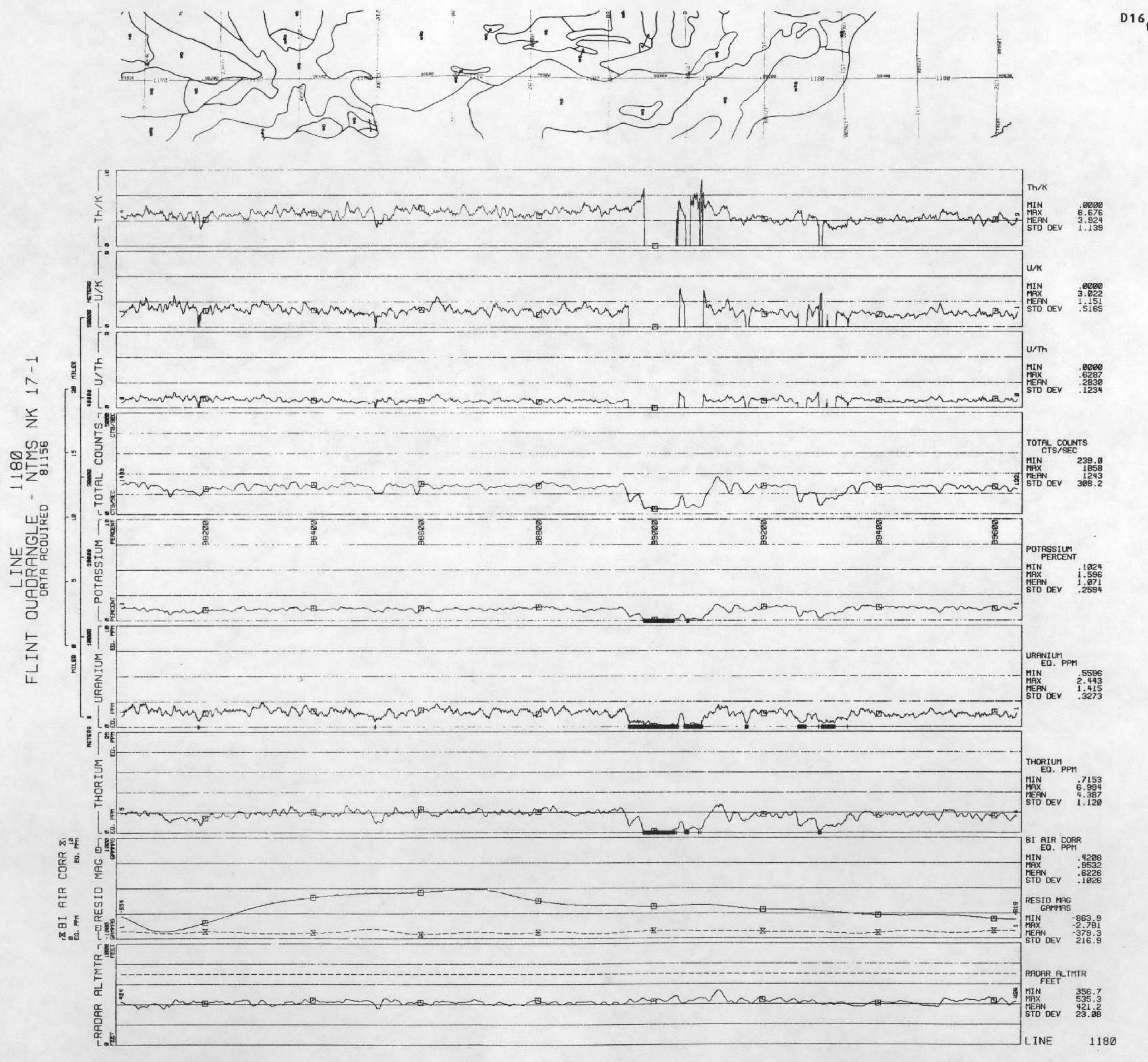
LINE 1160
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156



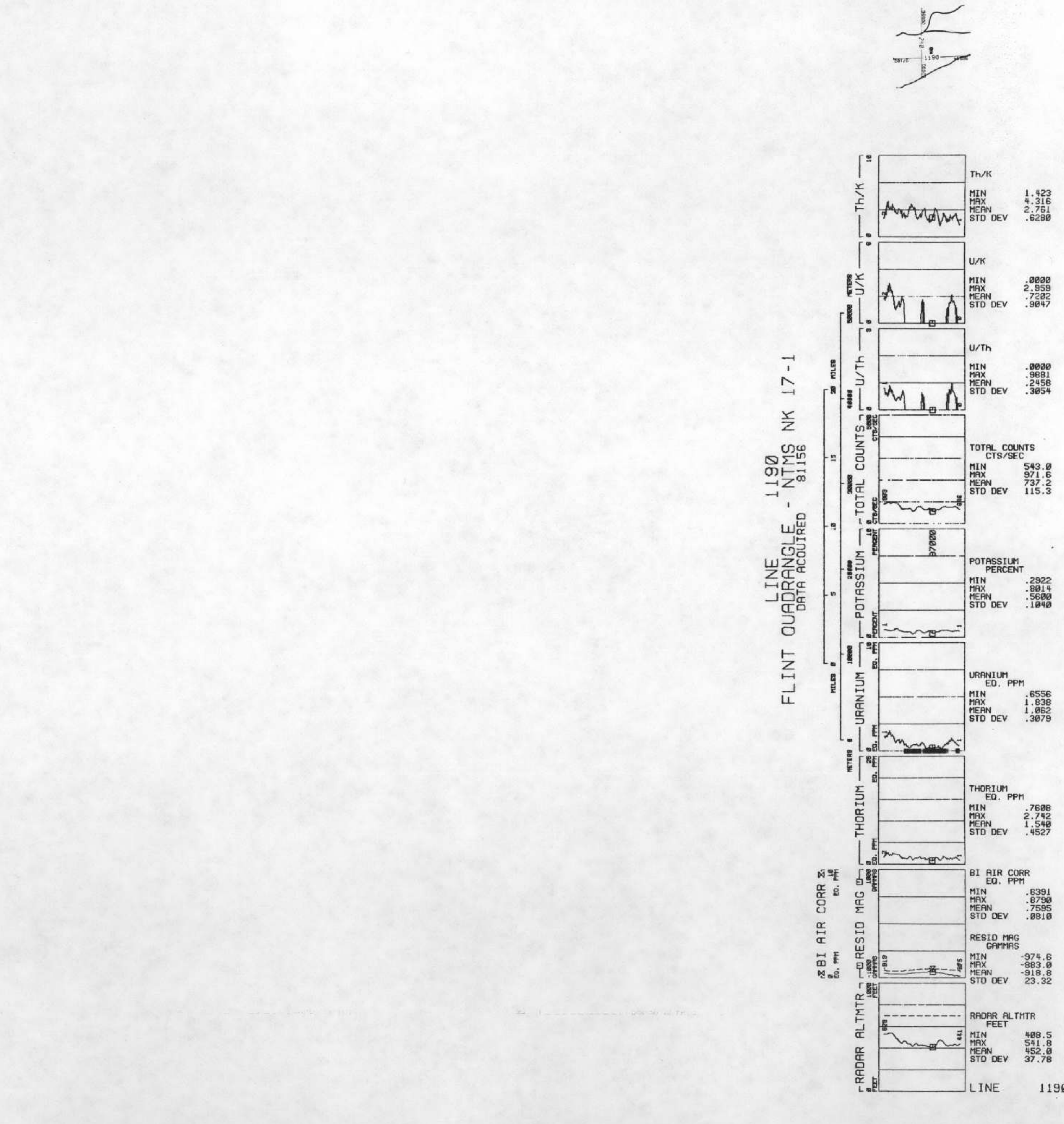
D15tf


LINE 1170
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156
Th/K
MIN .0000
MAX 6.784
MEAN 3.527
STD DEV .8982
U/K
MIN .0000
MAX 3.458
MEAN 1.071
STD DEV .4761
U/Th
MIN .0000
MAX .9315
MEAN .3005
STD DEV .1337
TOTAL COUNTS CTS/SEC
MIN 167.6
MAX 1919
MEAN 1176
STD DEV 298.5
POTASSIUM PERCENT
MIN .0976
MAX 1.799
MEAN 1.032
STD DEV .3130
URANIUM EQ. PPM
MIN .5806
MAX 2.342
MEAN 1.245
STD DEV .3264
THORIUM EQ. PPM
MIN .7474
MAX 7.553
MEAN 3.745
STD DEV 1.193
BI AIR CORR EQ. PPM
MIN .4971
MAX .9678
MEAN .6859
STD DEV .1145
RESID MAG GAMMAS
MIN -787.3
MAX -334.2
MEAN -504.9
STD DEV 117.0
RADAR ALTMTR FEET
MIN 352.8
MAX 508.6
MEAN 417.7
STD DEV 30.13
LINE 1170

D16tf

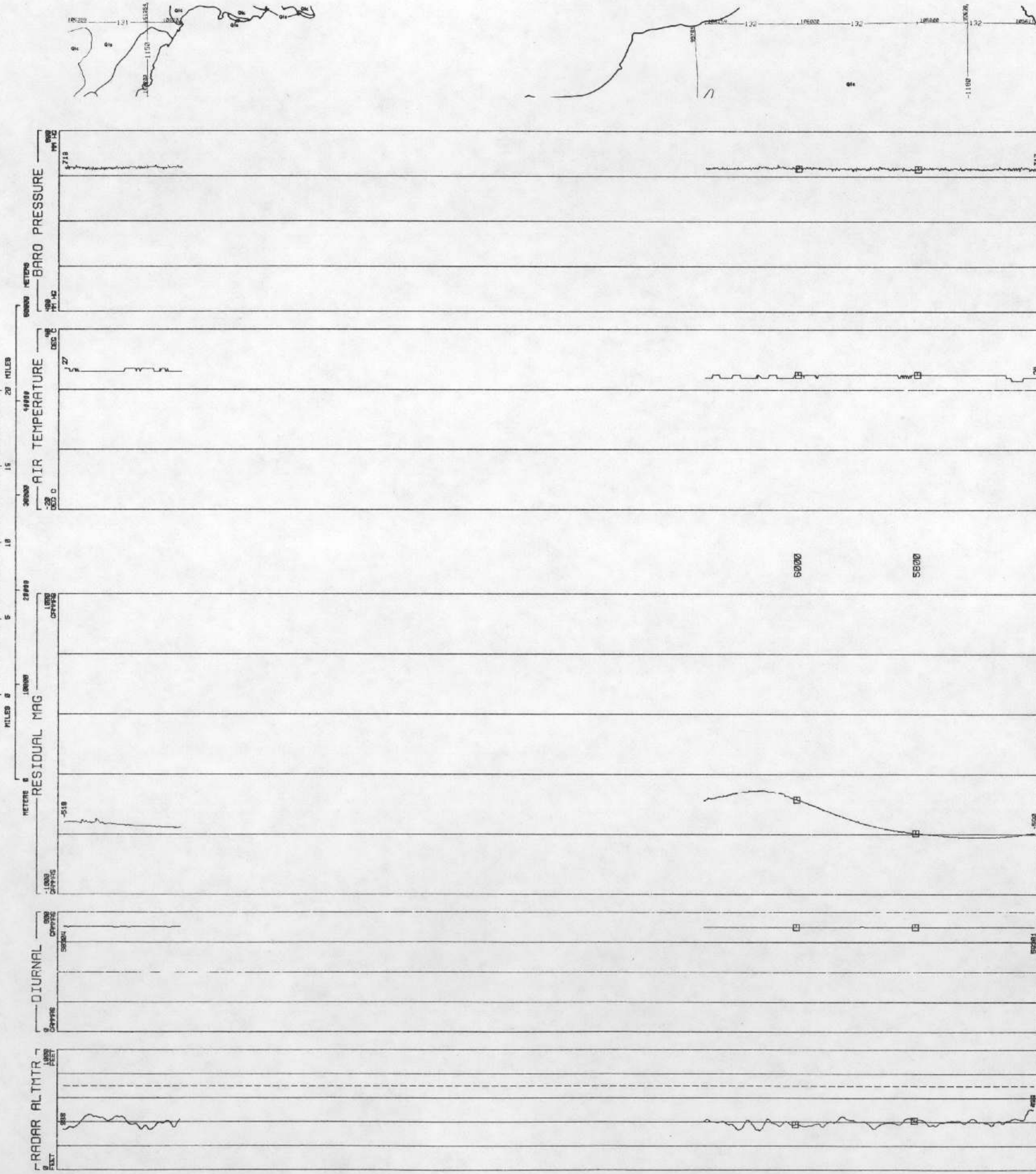

LINE 1180
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156
Th/K
MIN .0000
MAX 8.676
MEAN 3.924
STD DEV 1.139
U/K
MIN .0000
MAX 3.022
MEAN 1.151
STD DEV .5165
U/Th
MIN .0000
MAX .6287
MEAN .2830
STD DEV .1234
TOTAL COUNTS CTS/SEC
MIN 239.0
MAX 1858
MEAN 1243
STD DEV 308.2
POTASSIUM PERCENT
MIN .1024
MAX 1.596
MEAN 1.071
STD DEV .2594
URANIUM EQ. PPM
MIN .5596
MAX 2.443
MEAN 1.415
STD DEV .3273
THORIUM EQ. PPM
MIN .7153
MAX 6.994
MEAN 4.387
STD DEV 1.120
BI AIR CORR EQ. PPM
MIN .4208
MAX .9532
MEAN .6226
STD DEV .1026
RESID MAG GAMMAS
MIN -863.9
MAX -2.781
MEAN -379.3
STD DEV 216.9
RADAR ALTMTR FEET
MIN 356.7
MAX 535.3
MEAN 421.2
STD DEV 23.08
LINE 1180

D17tf



LINE 1190
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156
Th/K
MIN 1.423
MAX 4.316
MEAN 2.761
STD DEV .6280
U/K
MIN .0000
MAX 2.959
MEAN .7202
STD DEV .9047
U/Th
MIN .0000
MAX .9881
MEAN .2458
STD DEV .3054
TOTAL COUNTS CTS/SEC
MIN 543.0
MAX 971.6
MEAN 737.2
STD DEV 115.3
POTASSIUM PERCENT
MIN .2922
MAX .8014
MEAN .5600
STD DEV .1040
URANIUM EQ. PPM
MIN .6556
MAX 1.838
MEAN 1.062
STD DEV .3079
THORIUM EQ. PPM
MIN .7600
MAX 2.742
MEAN 1.540
STD DEV .4527
BI AIR CORR EQ. PPM
MIN .6391
MAX .8790
MEAN .7595
STD DEV .0810
RESID MAG GAMMAS
MIN -974.6
MAX -883.0
MEAN -918.8
STD DEV 23.32
RADAR ALTMTR FEET
MIN 408.5
MAX 541.8
MEAN 452.0
STD DEV 37.78
LINE 1190

LINE 130
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156



BARO PRESSURE
MM HG
MIN 712.5
MAX 725.6
MEAN 717.7
STD DEV 1.876

AIR TEMPERATURE
DEG C
MIN 23.00
MAX 27.00
MEAN 25.12
STD DEV .9121

RESIDUAL MAG
GAMMAS
MIN -622.1
MAX -307.8
MEAN -504.7
STD DEV 102.7

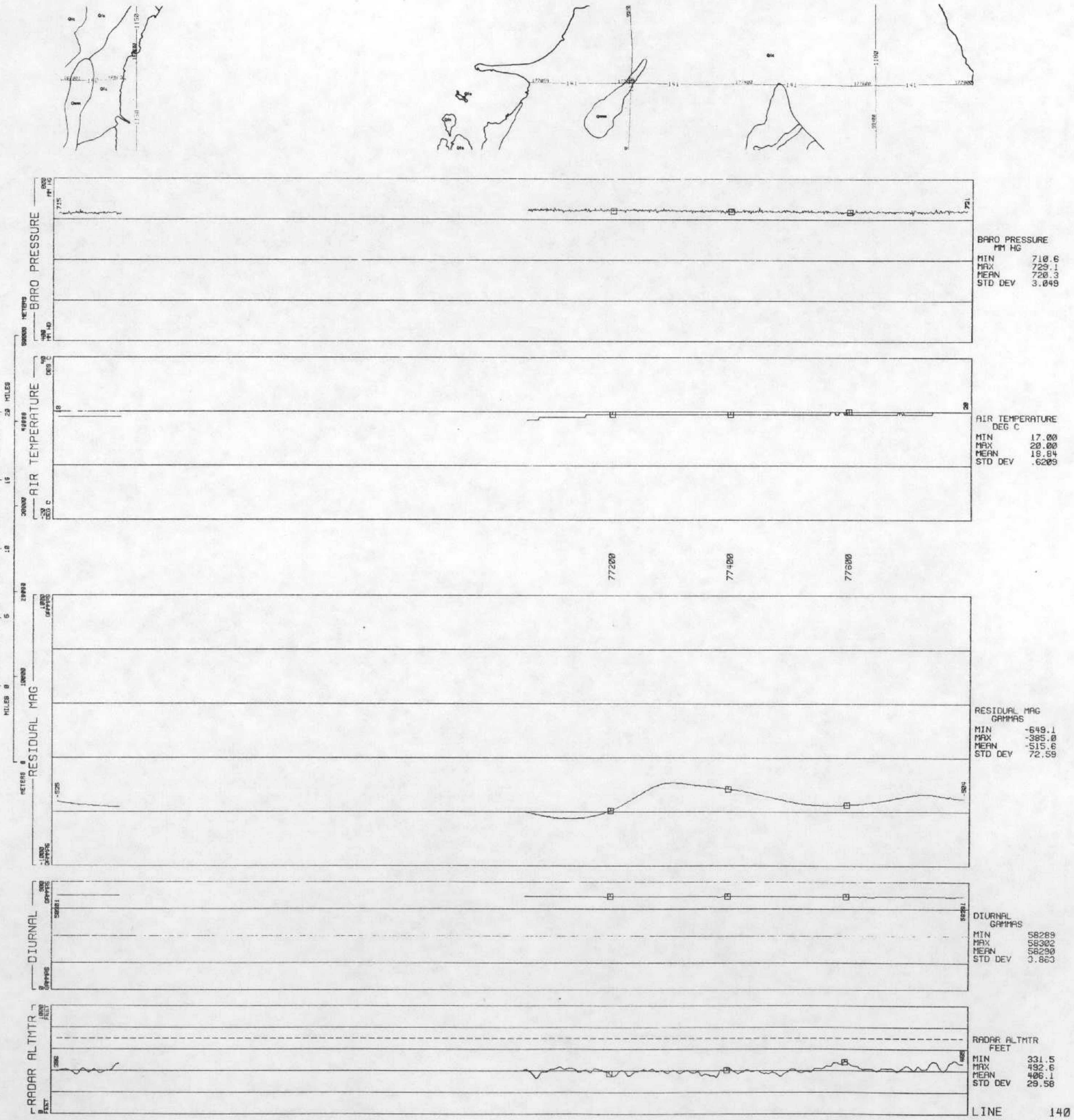
DIURNAL
GAMMAS
MIN 58299
MAX 58304
MEAN 58300
STD DEV 1.904

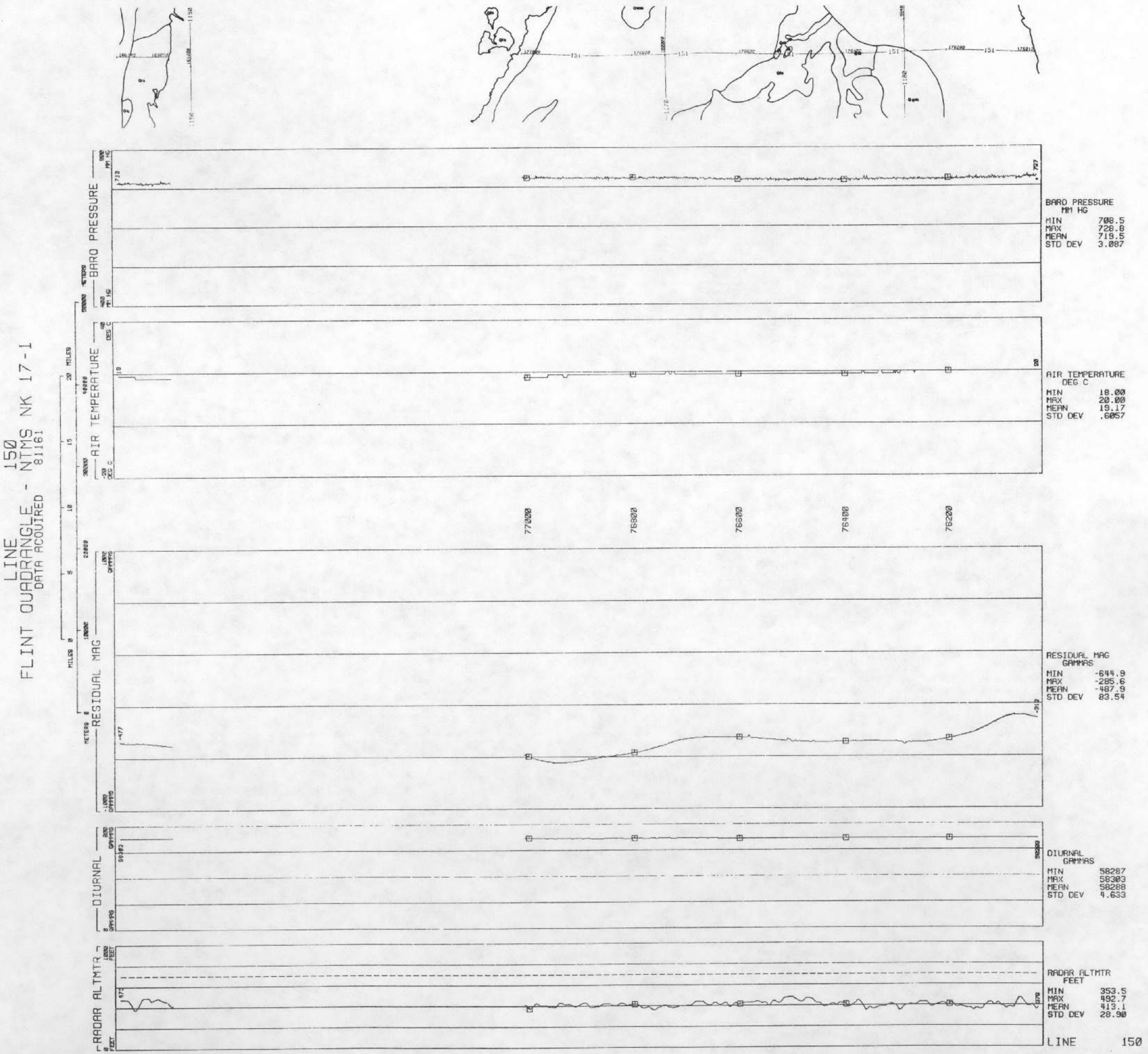
RADAR ALTMTR
FEET
MIN 330.9
MAX 507.1
MEAN 396.2
STD DEV 29.65

LINE 130

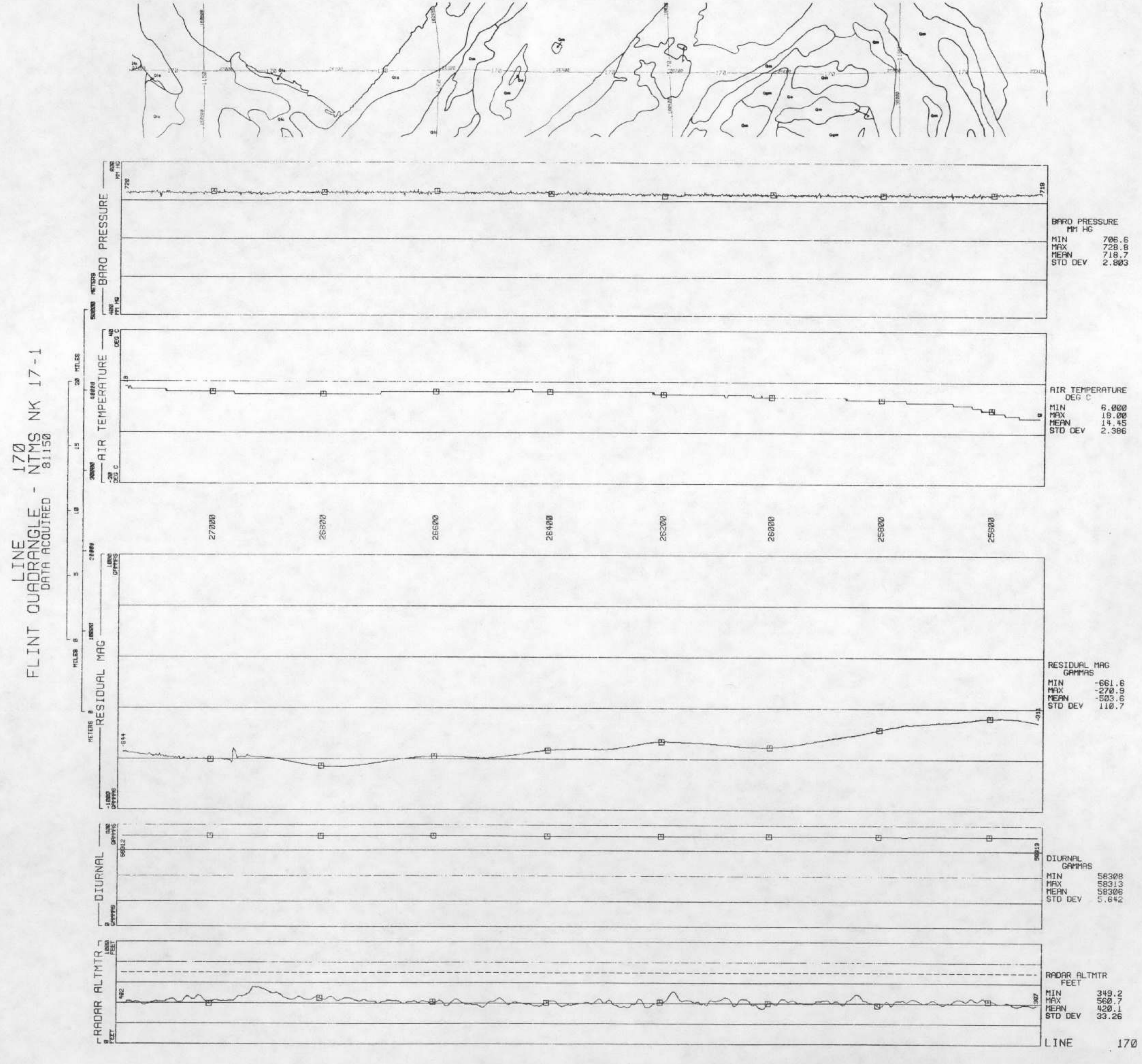
D19 tf

LINE 140
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81161



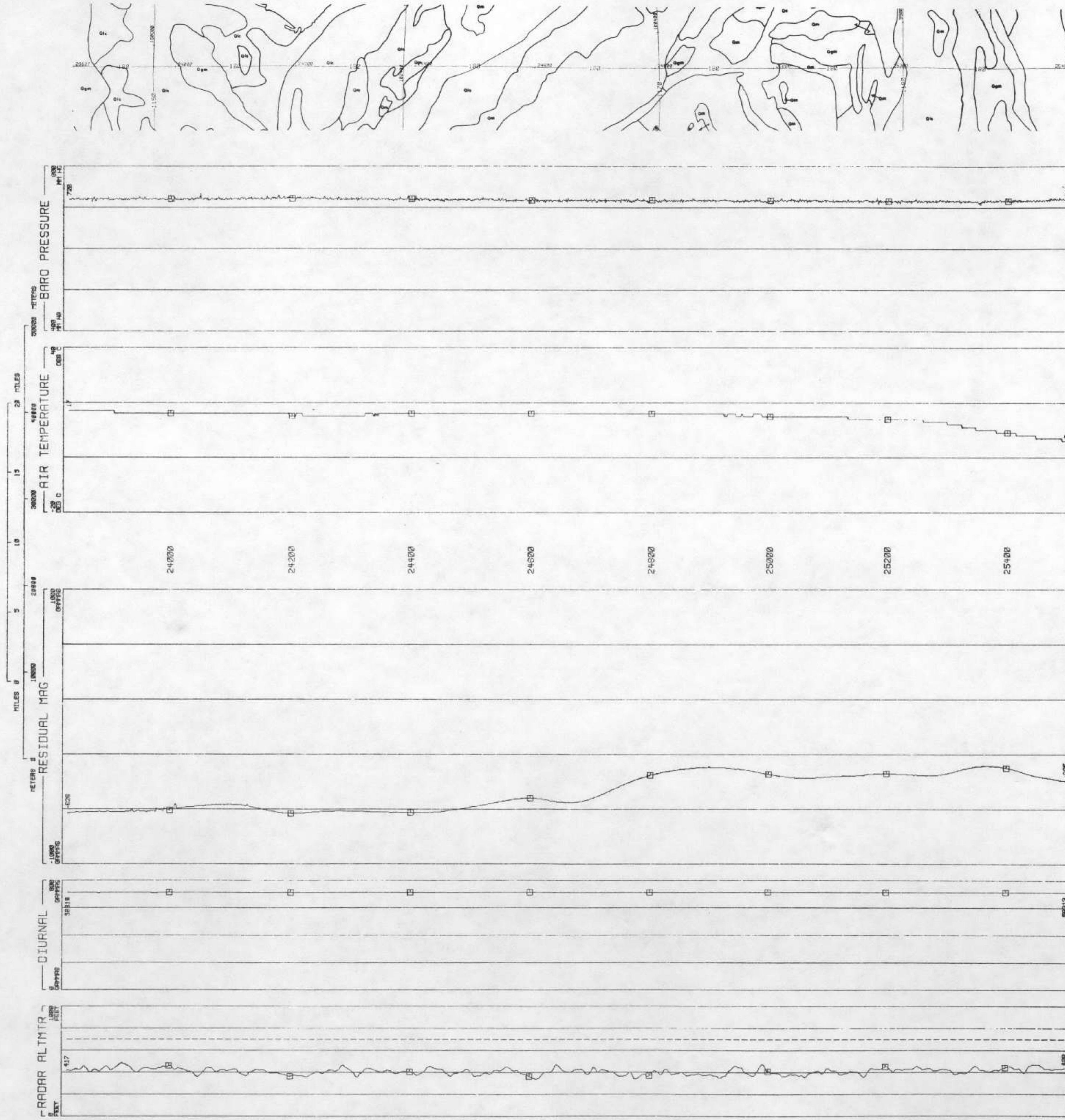

LINE 150
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 811161
MILES 0 5 10 15 20 MILES
METERS 0 10000 20000 30000 40000 50000 METERS
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
77000
76800
76600
76400
76200
BARO PRESSURE
MM HG
MIN 708.5
MAX 728.8
MEAN 719.5
STD DEV 3.087
AIR TEMPERATURE
DEG C
MIN 18.00
MAX 20.00
MEAN 19.17
STD DEV .6057
RESIDUAL MAG
GAMMAS
MIN -644.9
MAX -285.6
MEAN -487.9
STD DEV 83.54
DIURNAL
GAMMAS
MIN 58287
MAX 58303
MEAN 58288
STD DEV 4.633
RADAR ALTMTR
FEET
MIN 353.5
MAX 492.7
MEAN 413.1
STD DEV 28.90
LINE 150


LINE 160
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81162
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
75000
75200
75400
75600
75800
BARO PRESSURE MM HG
MIN 709.6
MAX 731.5
MEAN 720.3
STD DEV 2.928
AIR TEMPERATURE DEG C
MIN 17.00
MAX 20.00
MEAN 18.72
STD DEV .6284
RESIDUAL MAG GAMMAS
MIN -534.3
MAX -342.5
MEAN -442.7
STD DEV 54.48
DIURNAL GAMMAS
MIN 58289
MAX 58298
MEAN 58290
STD DEV 2.498
RADAR ALTMTR FEET
MIN 345.9
MAX 506.8
MEAN 411.1
STD DEV 25.48
LINE 160


LINE 170
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81150
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
27000
26800
26600
26400
26200
26000
25800
25600
BARO PRESSURE MM HG
MIN 706.6
MAX 728.8
MEAN 718.7
STD DEV 2.803
AIR TEMPERATURE DEG C
MIN 6.000
MAX 18.00
MEAN 14.45
STD DEV 2.386
RESIDUAL MAG GAMMAS
MIN -661.6
MAX -270.5
MEAN -503.8
STD DEV 110.7
DIURNAL GAMMAS
MIN 58300
MAX 58313
MEAN 58306
STD DEV 5.642
RADAR ALTMTR FEET
MIN 349.2
MAX 560.7
MEAN 420.1
STD DEV 33.26

D2 3 tf

LINE 180
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81150



BARO PRESSURE
MM HG
MIN 708.3
MAX 734.0
MEAN 718.3
STD DEV 2.798

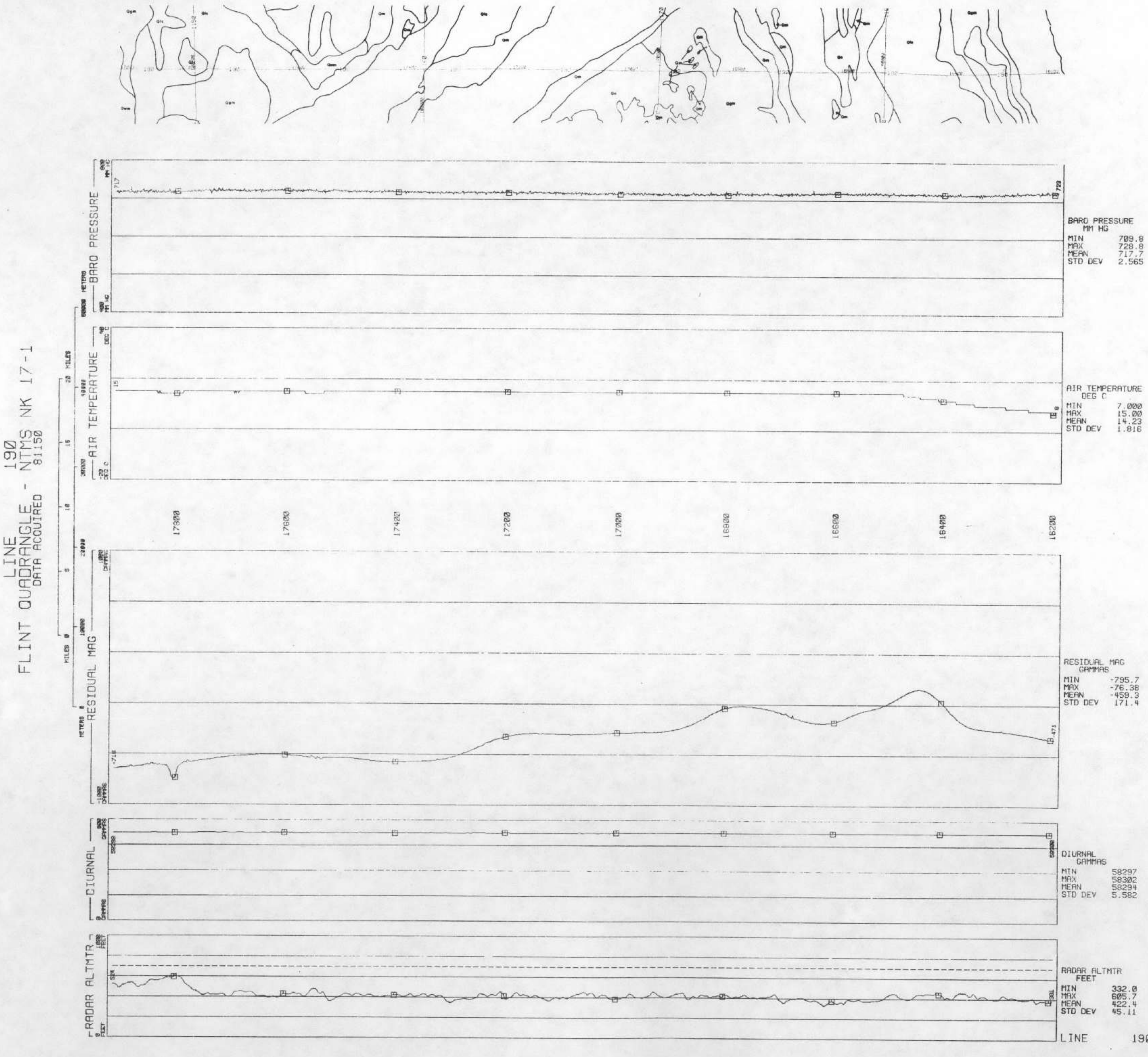
AIR TEMPERATURE
DEG C
MIN 6.000
MAX 17.00
MEAN 14.82
STD DEV 2.335

RESIDUAL MAG
GAMMAS
MIN -630.3
MAX -284.4
MEAN -475.7
STD DEV 128.3

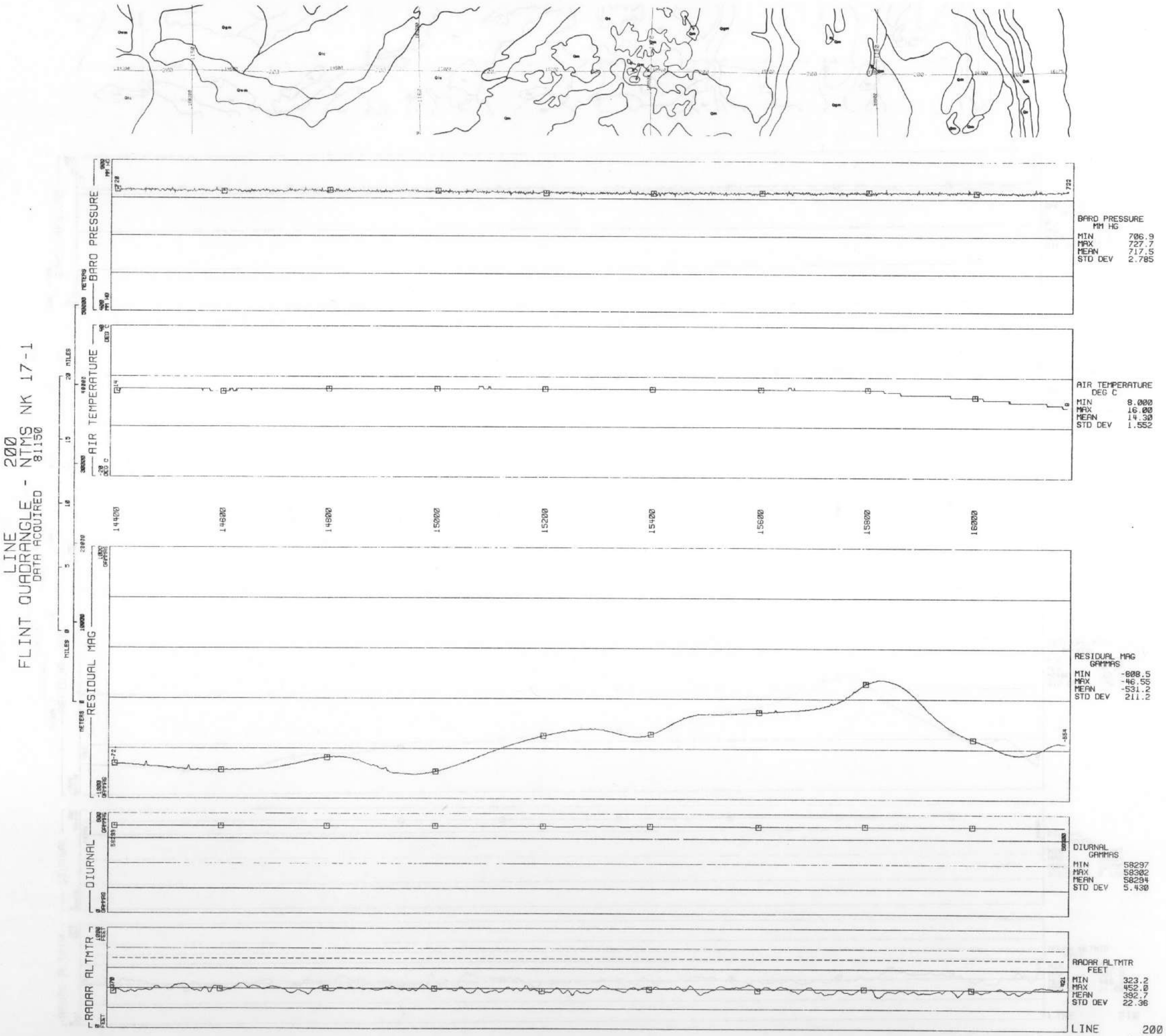
DIURNAL
GAMMAS
MIN 58310
MAX 58313
MEAN 58309
STD DEV 3.424

RADAR ALTMTR
FEET
MIN 340.2
MAX 484.5
MEAN 409.7
STD DEV 27.54

LINE 180

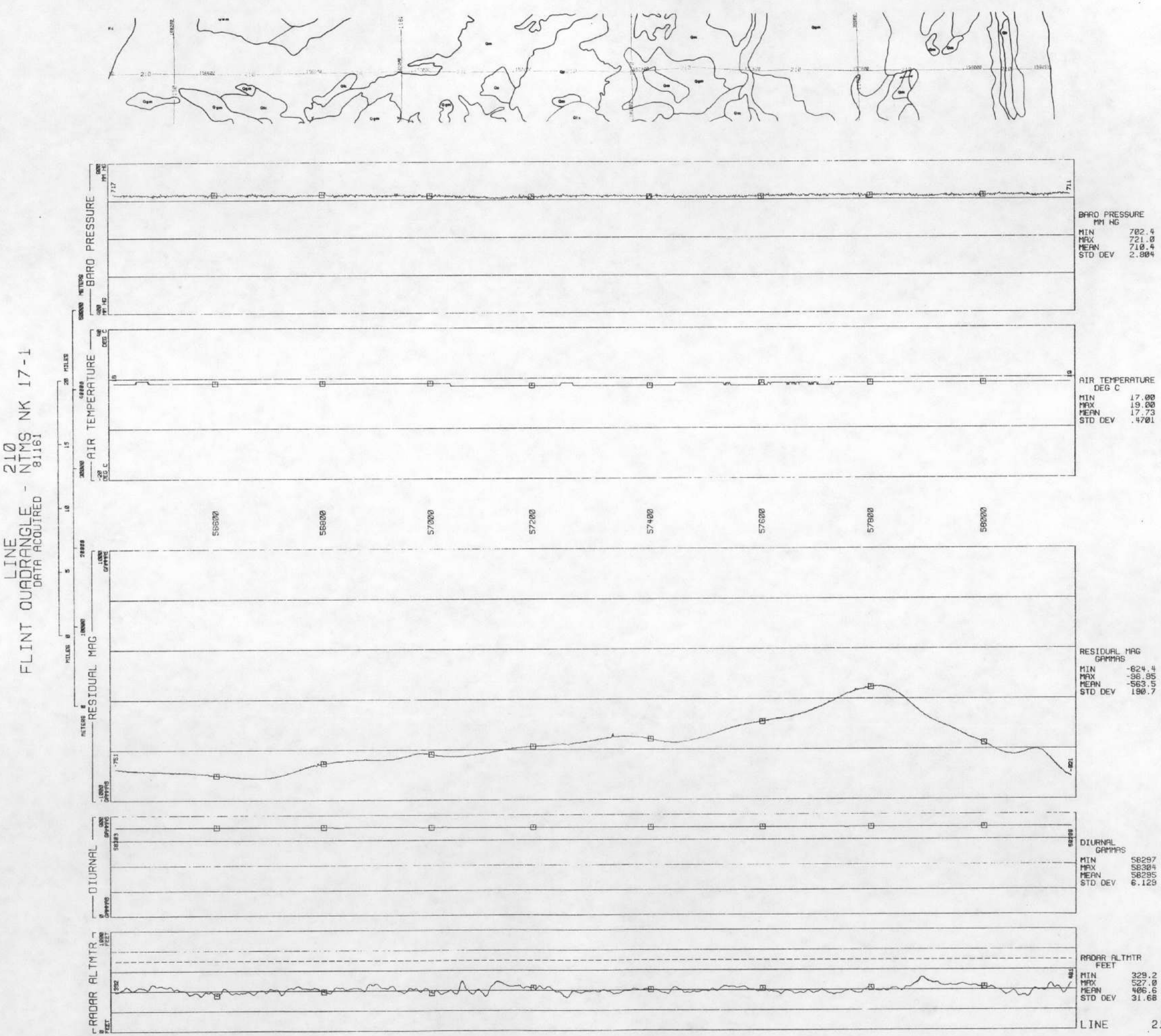

LINE 190
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81150
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
17800
17600
17400
17200
17000
16800
16600
16400
16200
BARO PRESSURE MM HG
MIN 709.8
MAX 728.8
MEAN 717.7
STD DEV 2.565
AIR TEMPERATURE DEG C
MIN 7.000
MAX 15.00
MEAN 14.23
STD DEV 1.816
RESIDUAL MAG GAMMAS
MIN -795.7
MAX -76.38
MEAN -459.3
STD DEV 171.4
DIURNAL GAMMAS
MIN 58297
MAX 58302
MEAN 58294
STD DEV 5.582
RADAR ALTMTR FEET
MIN 332.0
MAX 605.7
MEAN 422.4
STD DEV 45.11
LINE 190

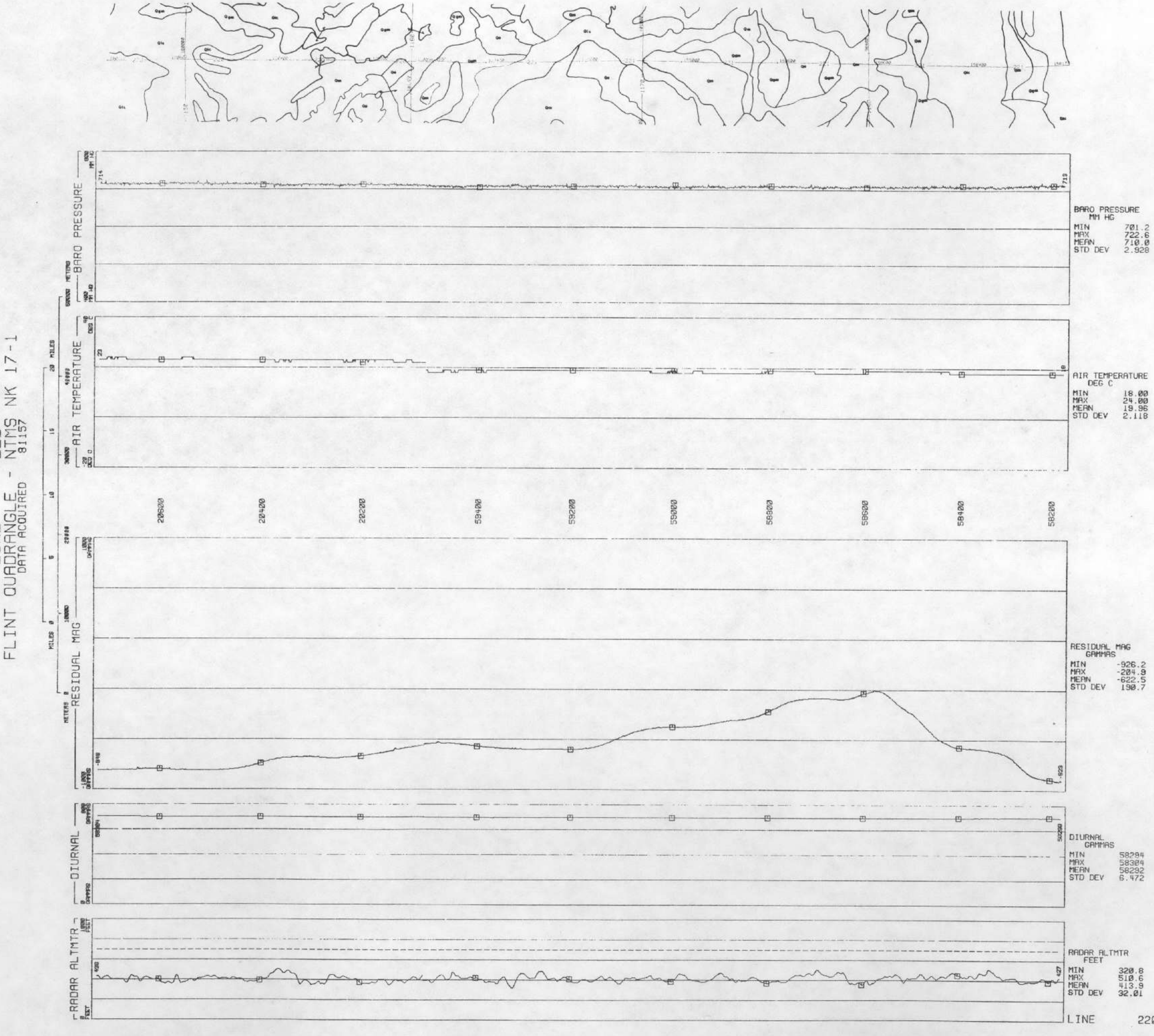
D25 tf



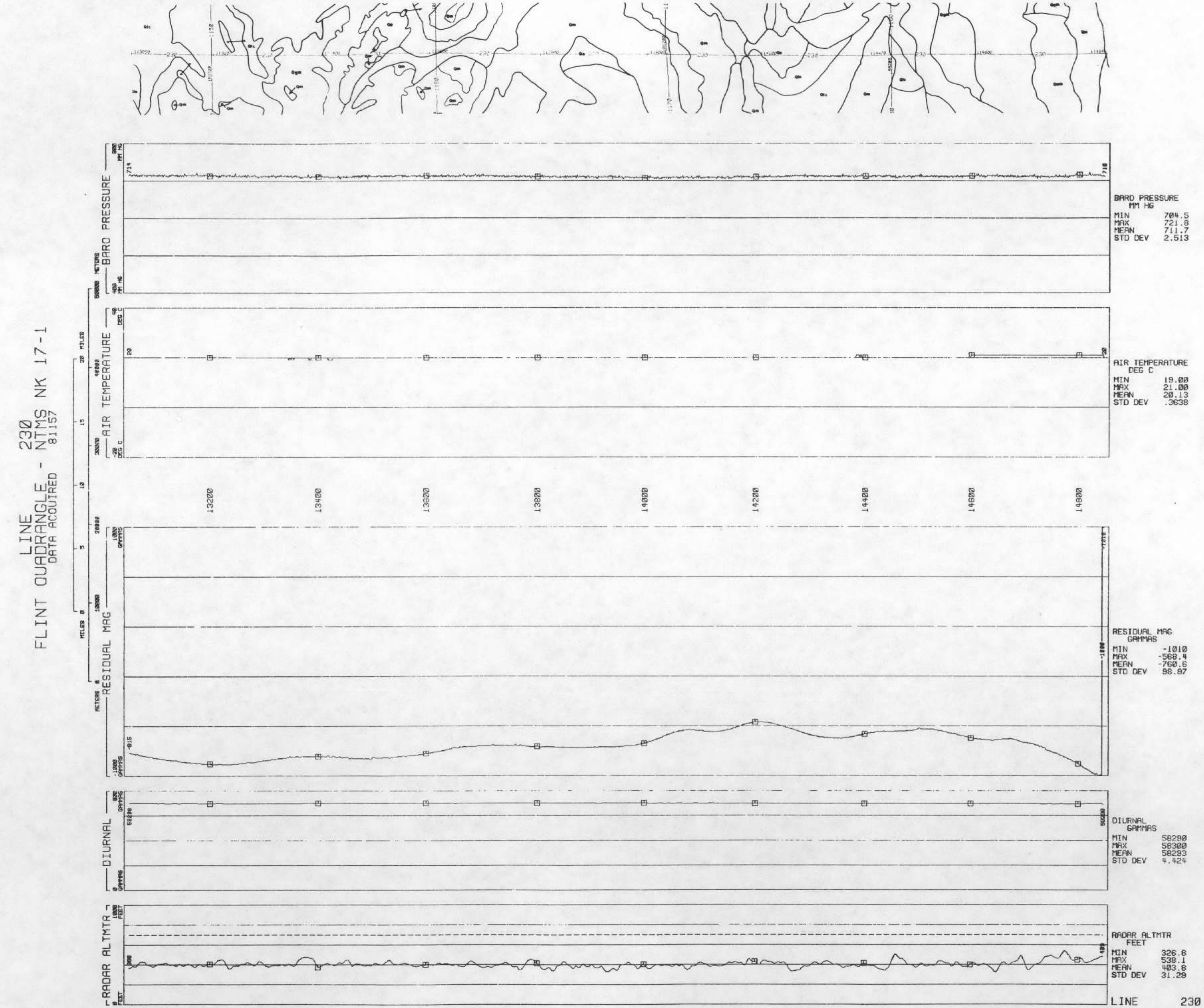
LINE 200
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81150
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
14400
14600
14800
15000
15200
15400
15600
15800
16000
BARO PRESSURE MM HG
MIN 706.9
MAX 727.7
MEAN 717.5
STD DEV 2.785
AIR TEMPERATURE DEG C
MIN 8.000
MAX 16.00
MEAN 14.30
STD DEV 1.552
RESIDUAL MAG GAMMAS
MIN -808.5
MAX -46.55
MEAN -531.2
STD DEV 211.2
DIURNAL GAMMAS
MIN 58297
MAX 58302
MEAN 58284
STD DEV 5.430
RADAR ALTMTR FEET
MIN 323.2
MAX 452.0
MEAN 392.7
STD DEV 22.36
LINE 200

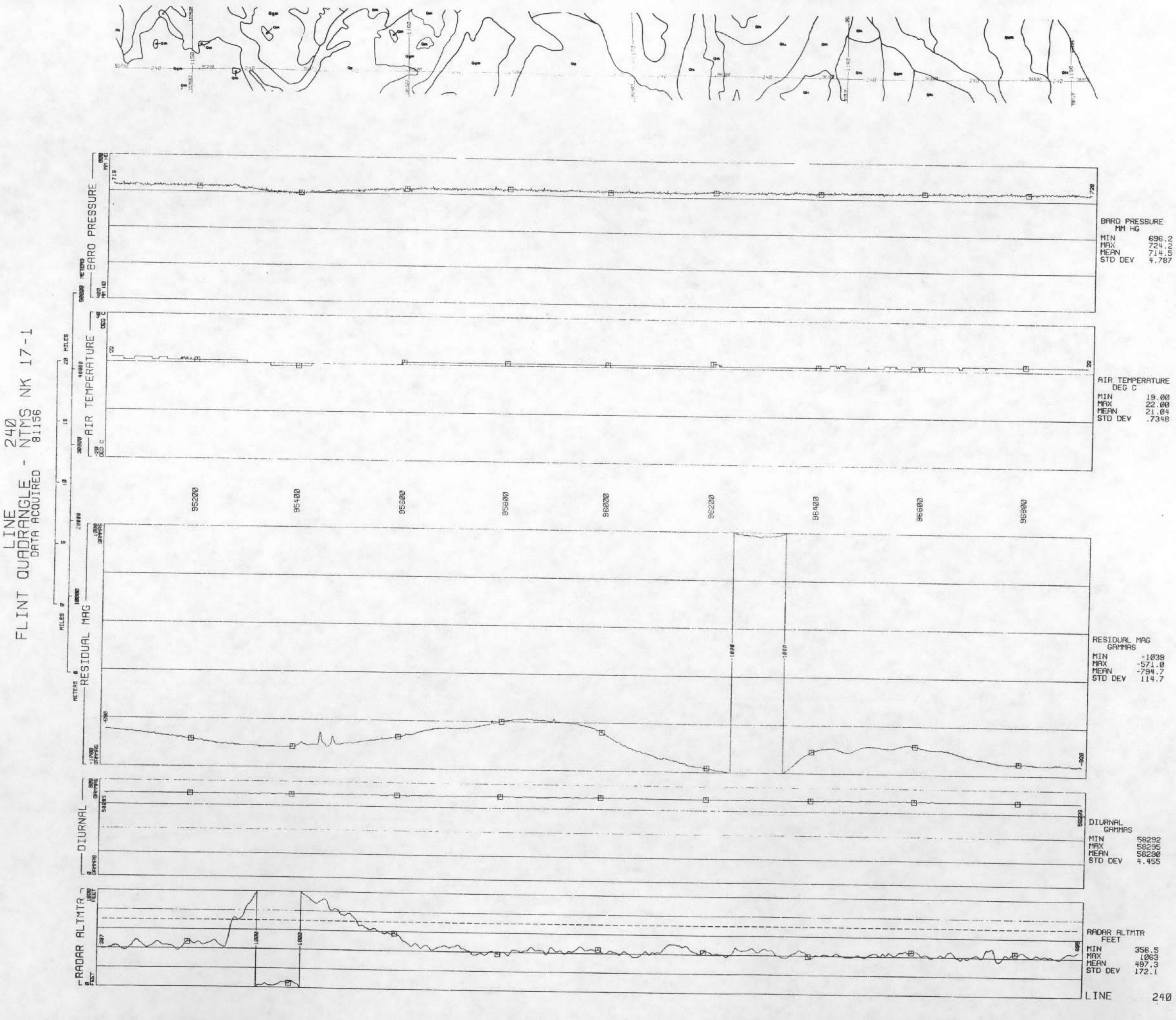
D26tf


LINE 210
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81161
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
56800
56800
57000
57200
57400
57600
57800
58000
BARO PRESSURE MM HG
MIN 702.4
MAX 721.0
MEAN 710.4
STD DEV 2.804
AIR TEMPERATURE DEG C
MIN 17.00
MAX 19.00
MEAN 17.73
STD DEV .4701
RESIDUAL MAG GAMMAS
MIN -824.4
MAX -36.85
MEAN -563.5
STD DEV 190.7
DIURNAL GAMMAS
MIN 58297
MAX 58304
MEAN 58295
STD DEV 6.129
RADAR ALTMTR FEET
MIN 329.2
MAX 527.0
MEAN 406.6
STD DEV 31.68
LINE 210

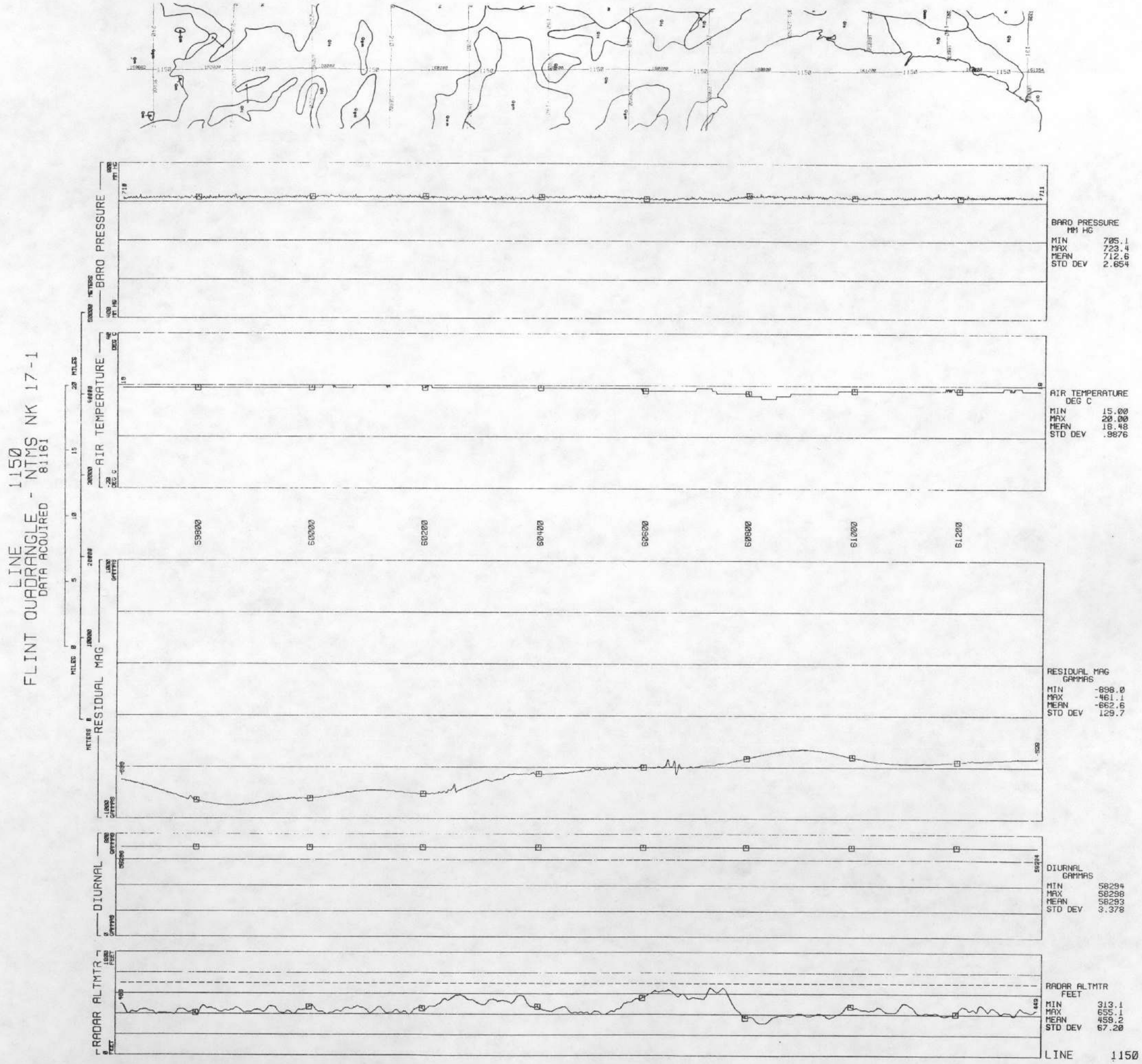

LINE 220
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81157
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
20600
20400
20200
59400
59200
59000
58800
58600
58400
58200
BARO PRESSURE
MM HG
MIN 701.2
MAX 722.6
MEAN 710.0
STD DEV 2.928
AIR TEMPERATURE
DEG C
MIN 18.00
MAX 24.00
MEAN 19.96
STD DEV 2.118
RESIDUAL MAG
GAMMAS
MIN -926.2
MAX -204.9
MEAN -622.5
STD DEV 190.7
DIURNAL
GAMMAS
MIN 58294
MAX 58304
MEAN 58292
STD DEV 6.472
RADAR ALTMTR
FEET
MIN 320.8
MAX 510.6
MEAN 413.9
STD DEV 32.01
LINE 220

D28 tf


LINE 230
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81157
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
13200
13400
13600
13800
14000
14200
14400
14600
14800
BARO PRESSURE
MM HG
MIN 704.5
MAX 721.8
MEAN 711.7
STD DEV 2.513
AIR TEMPERATURE
DEG C
MIN 19.00
MAX 21.00
MEAN 20.13
STD DEV .3638
RESIDUAL MAG
GAMMAS
MIN -1010
MAX -568.4
MEAN -760.6
STD DEV 96.87
DIURNAL
GAMMAS
MIN 58280
MAX 58300
MEAN 58293
STD DEV 4.424
RADAR ALTMTR
FEET
MIN 326.8
MAX 538.1
MEAN 403.8
STD DEV 31.29
LINE 230

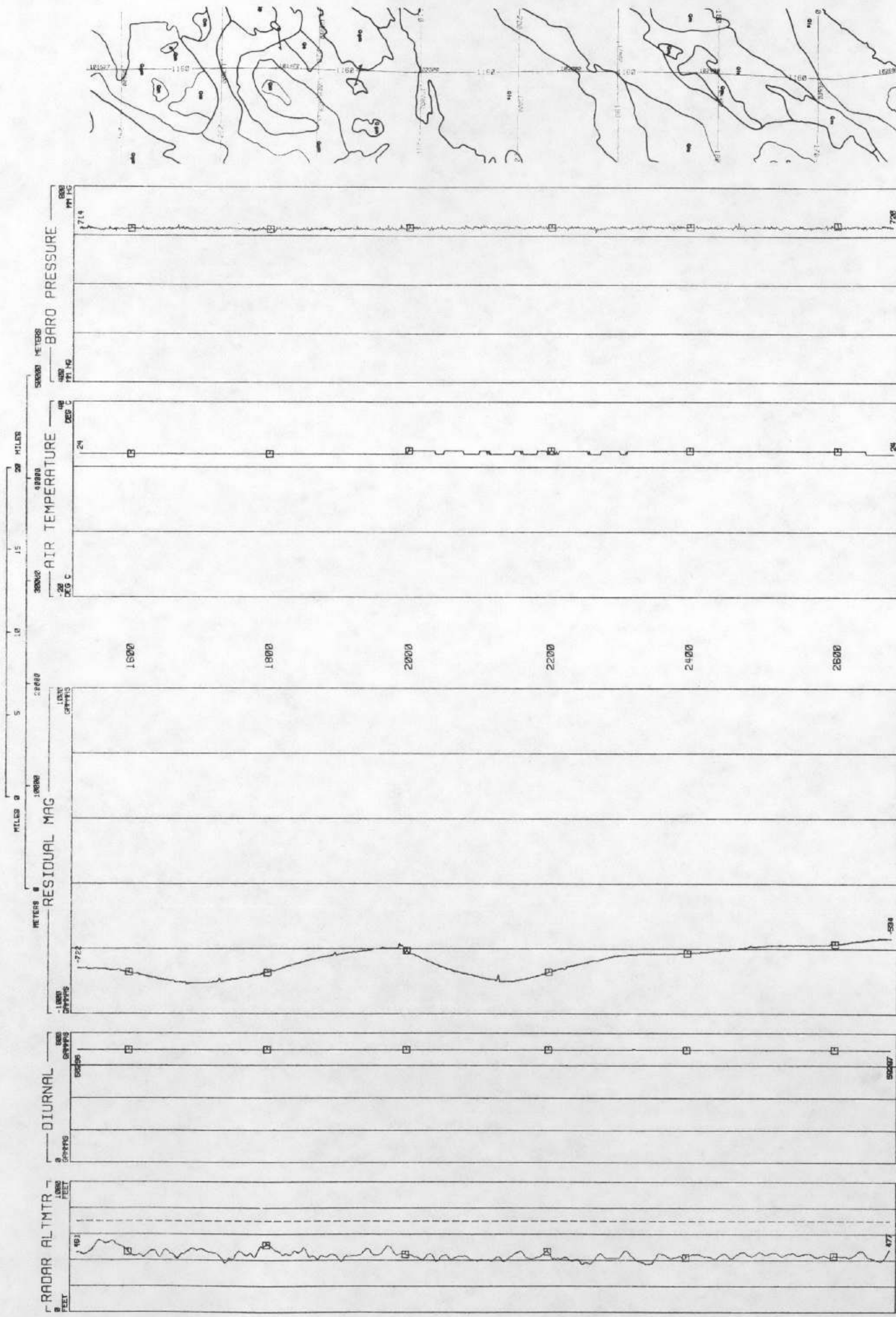

LINE 240
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
95200
95400
95600
95800
96000
96200
96400
96600
96800
BARO PRESSURE MM HG
MIN 696.2
MAX 724.2
MEAN 714.5
STD DEV 4.787
AIR TEMPERATURE DEG C
MIN 19.00
MAX 22.00
MEAN 21.04
STD DEV .7348
RESIDUAL MAG GAMMAS
MIN -1039
MAX -571.0
MEAN -794.7
STD DEV 114.7
DIURNAL GAMMAS
MIN 58292
MAX 58295
MEAN 58290
STD DEV 4.455
RADAR ALTMTR FEET
MIN 356.5
MAX 1063
MEAN 497.3
STD DEV 172.1
LINE 240

D 30 tf



LINE 1150
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81161
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
59800
60000
60200
60400
60600
60800
61000
61200
BARO PRESSURE MM HG
MIN 705.1
MAX 723.4
MEAN 712.6
STD DEV 2.654
AIR TEMPERATURE DEG C
MIN 15.00
MAX 20.00
MEAN 18.48
STD DEV .9876
RESIDUAL MAG GAMMAS
MIN -898.0
MAX -461.1
MEAN -662.6
STD DEV 129.7
DIURNAL GAMMAS
MIN 58294
MAX 58298
MEAN 58293
STD DEV 3.378
RADAR ALTMTR FEET
MIN 313.1
MAX 655.1
MEAN 459.2
STD DEV 67.20
LINE 1150

LINE 1160
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156



BARO PRESSURE
MM HG
MIN 708.0
MAX 727.4
MEAN 716.4
STD DEV 2.739

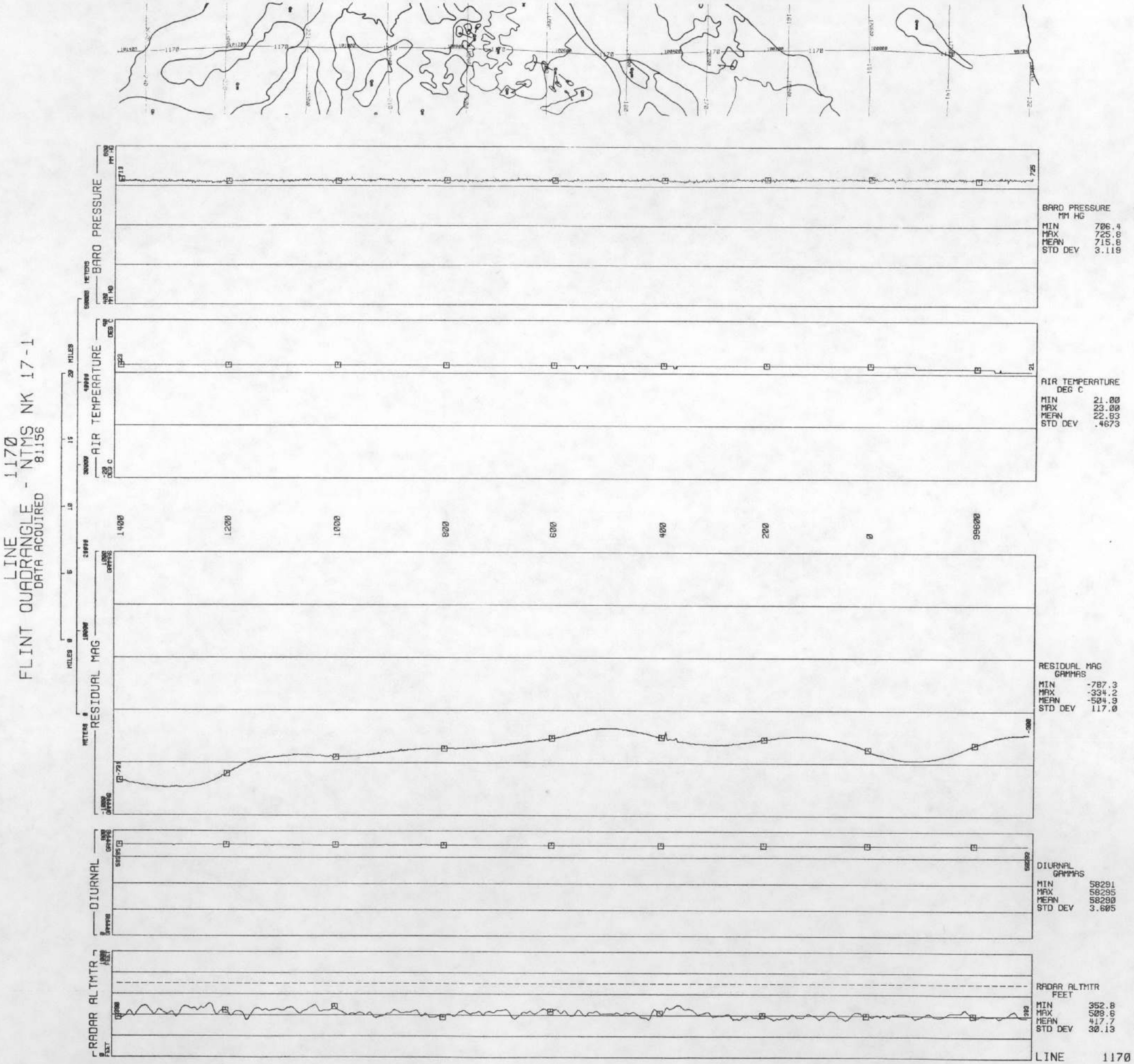
AIR TEMPERATURE
DEG C
MIN 24.00
MAX 25.00
MEAN 24.45
STD DEV .4970

RESIDUAL MAG
GAMMAS
MIN -814.8
MAX -534.4
MEAN -679.0
STD DEV 82.41

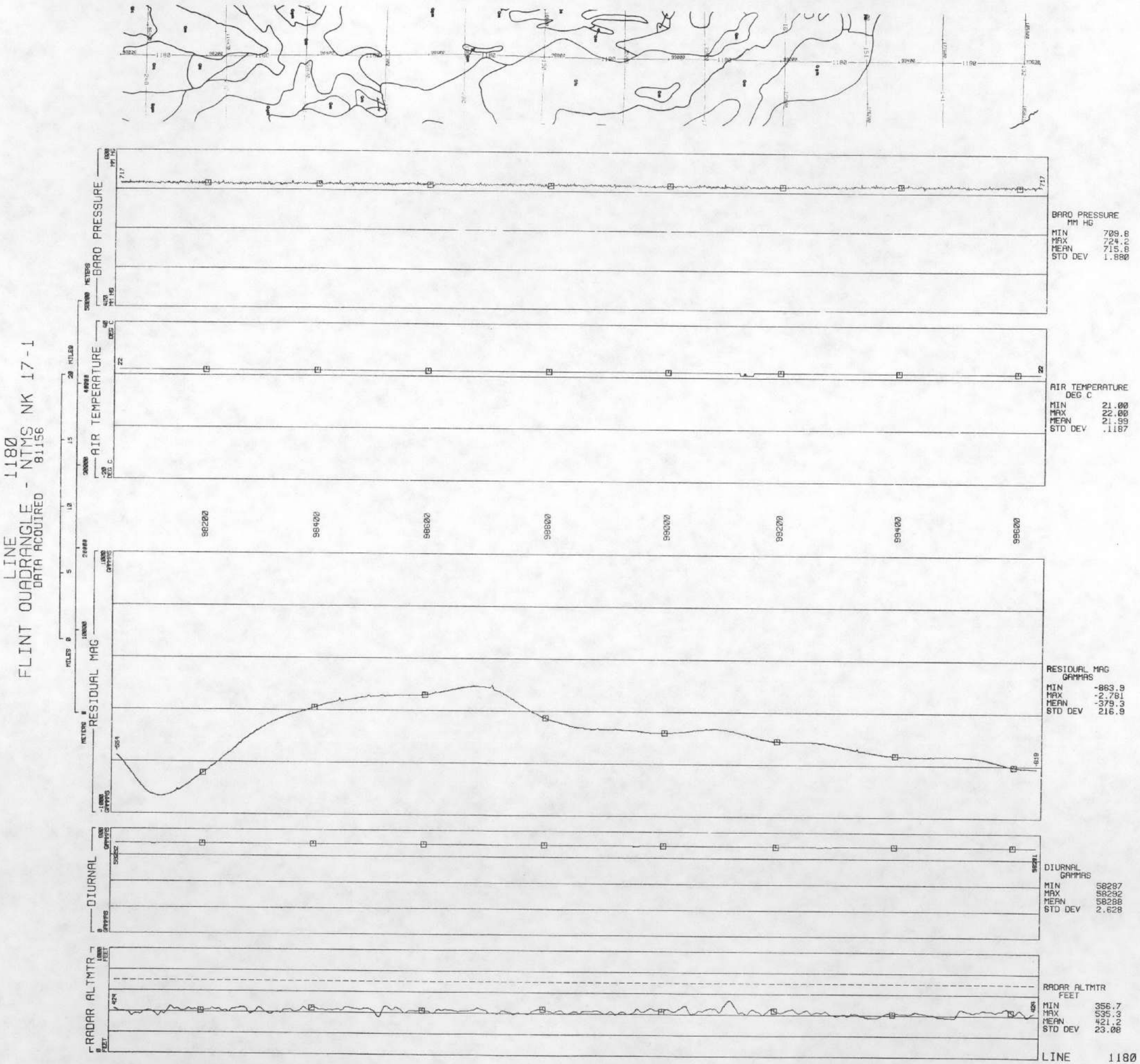
DIURNAL
GAMMAS
MIN 58294
MAX 58298
MEAN 58295
STD DEV 1.349

RADAR ALTMTR
FEET
MIN 368.3
MAX 552.8
MEAN 439.7
STD DEV 32.62

LINE 1160

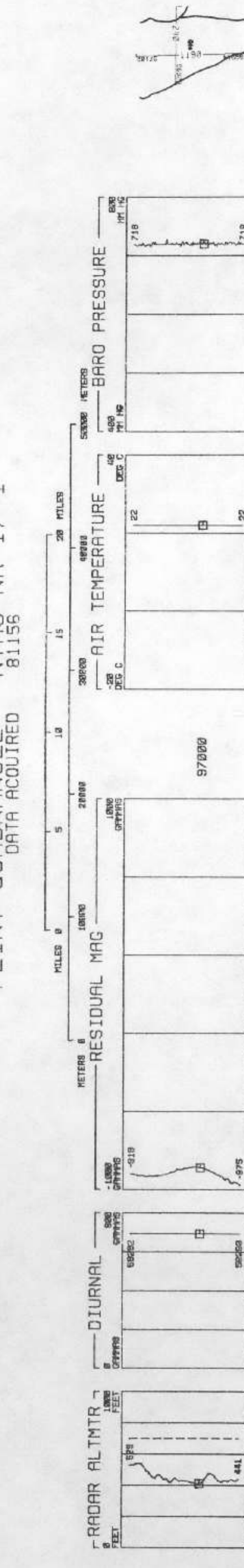

LINE 1170
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
1400
1200
1000
800
600
400
200
0
99800
BARO PRESSURE
MM HG
MIN 706.4
MAX 725.8
MEAN 715.8
STD DEV 3.119
AIR TEMPERATURE
DEG C
MIN 21.00
MAX 23.00
MEAN 22.83
STD DEV .4673
RESIDUAL MAG
GAMMAS
MIN -787.3
MAX -334.2
MEAN -504.9
STD DEV 117.0
DIURNAL
GAMMAS
MIN 58281
MAX 58295
MEAN 58288
STD DEV 3.605
RADAR ALTMTR
FEET
MIN 352.8
MAX 509.6
MEAN 417.7
STD DEV 30.13
LINE 1170

D33 tf


LINE 1180
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
98200
98400
98600
98800
99000
99200
99400
99600
BARO PRESSURE MM HG
MIN 709.8
MAX 724.2
MEAN 715.8
STD DEV 1.880
AIR TEMPERATURE DEG C
MIN 21.00
MAX 22.00
MEAN 21.99
STD DEV .1187
RESIDUAL MAG GAMMAS
MIN -863.9
MAX -2.781
MEAN -379.3
STD DEV 216.9
DIURNAL GAMMAS
MIN 58287
MAX 58292
MEAN 58288
STD DEV 2.628
RADAR ALTMTR FEET
MIN 356.7
MAX 535.3
MEAN 421.2
STD DEV 23.08
LINE 1180

D 34 tf

LINE 1190
FLINT QUADRANGLE - NTMS NK 17-1
DATA ACQUIRED 81156



BARO PRESSURE
MM HG
MIN 714.3
MAX 726.4
MEAN 719.7
STD DEV 1.906

AIR TEMPERATURE
DEG C
MIN 22.00
MAX 22.00
MEAN 22.00
STD DEV .0000

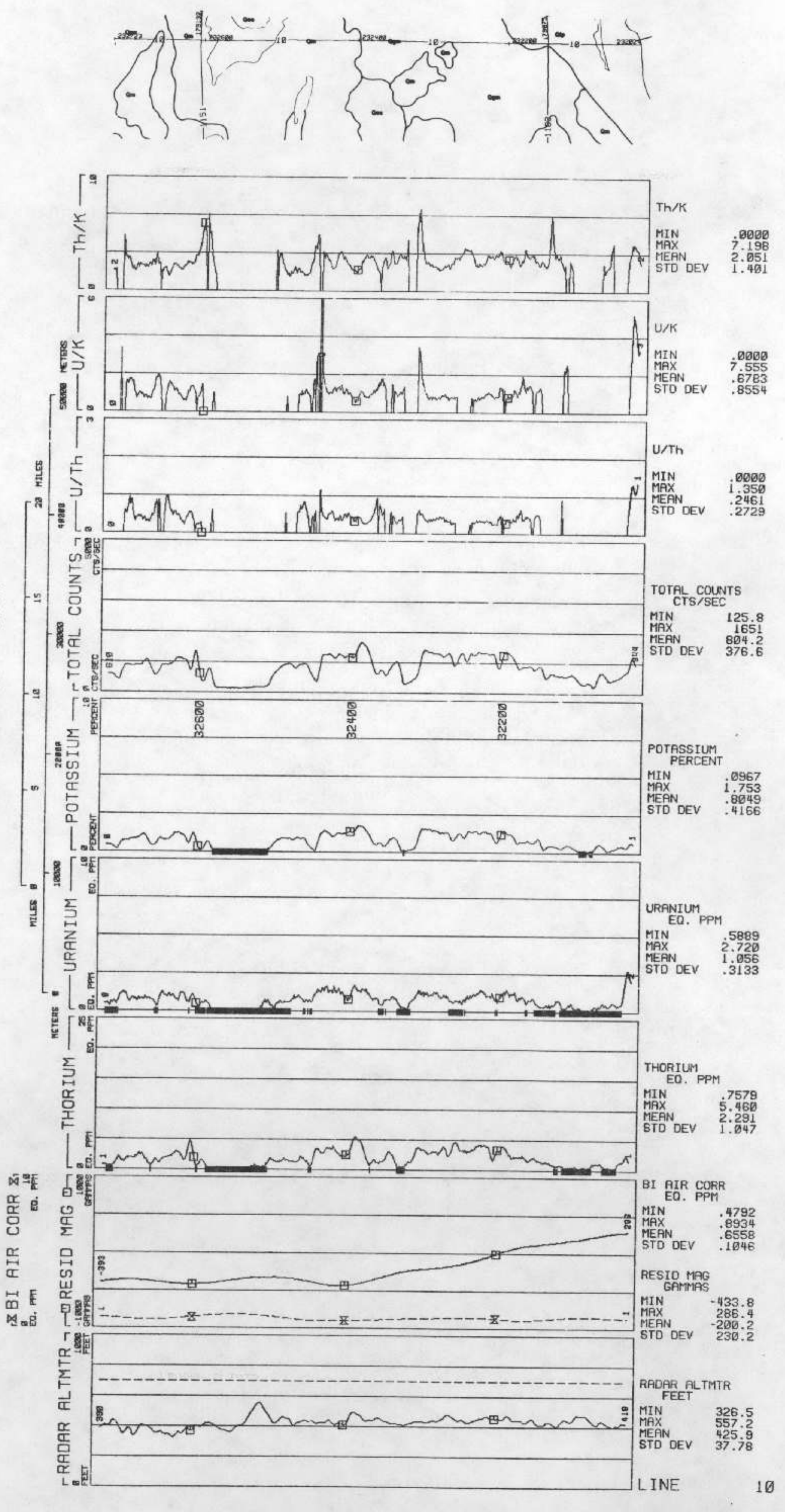
RESIDUAL MAG
GAMMAS
MIN -974.6
MAX -883.0
MEAN -918.8
STD DEV 23.32

DIURNAL
GAMMAS
MIN 58290
MAX 58293
MEAN 58292
STD DEV .6502

RADAR ALTMTR
FEET
MIN 408.5
MAX 541.8
MEAN 452.0
STD DEV 37.78

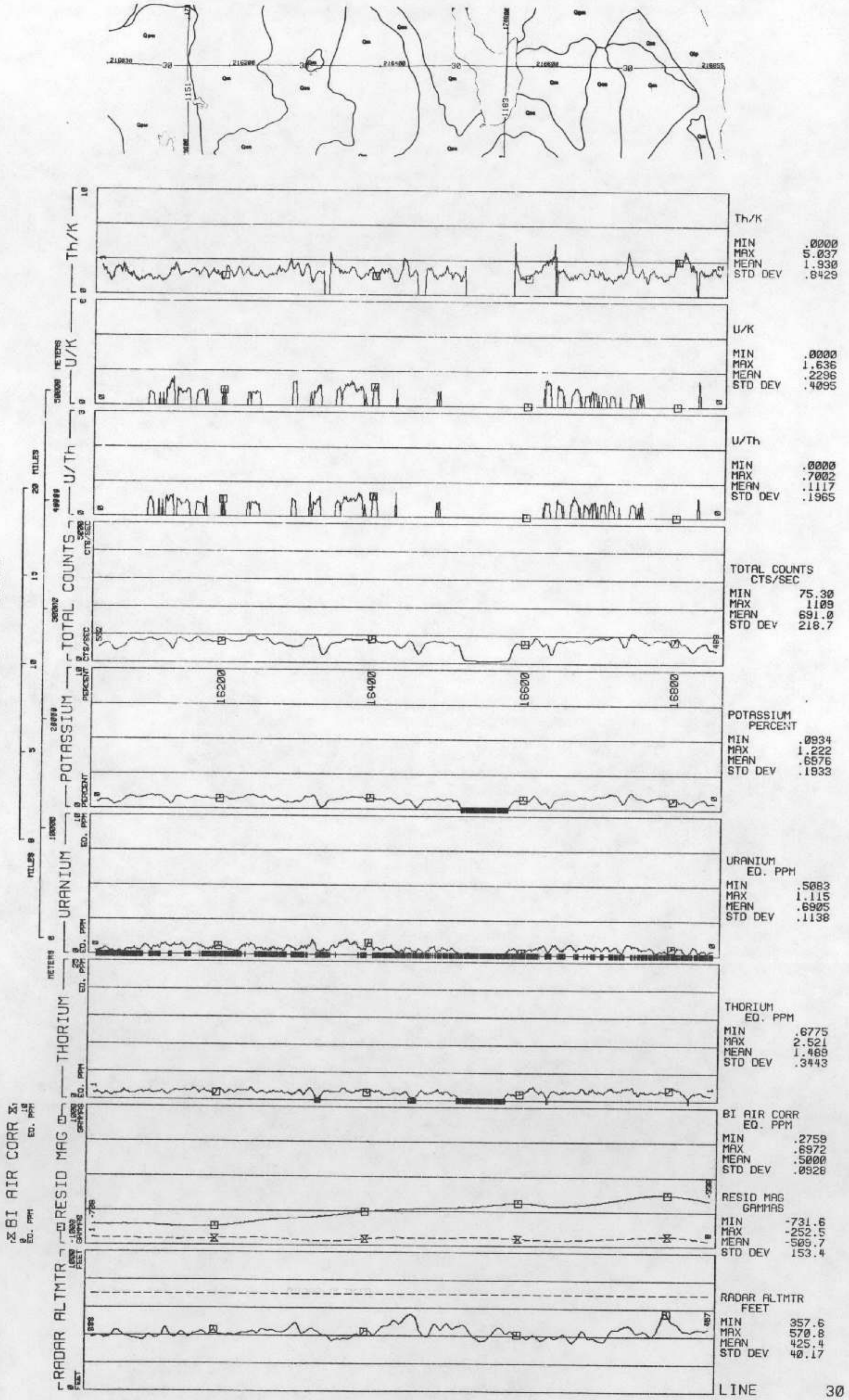
LINE 1190

D 35 tf

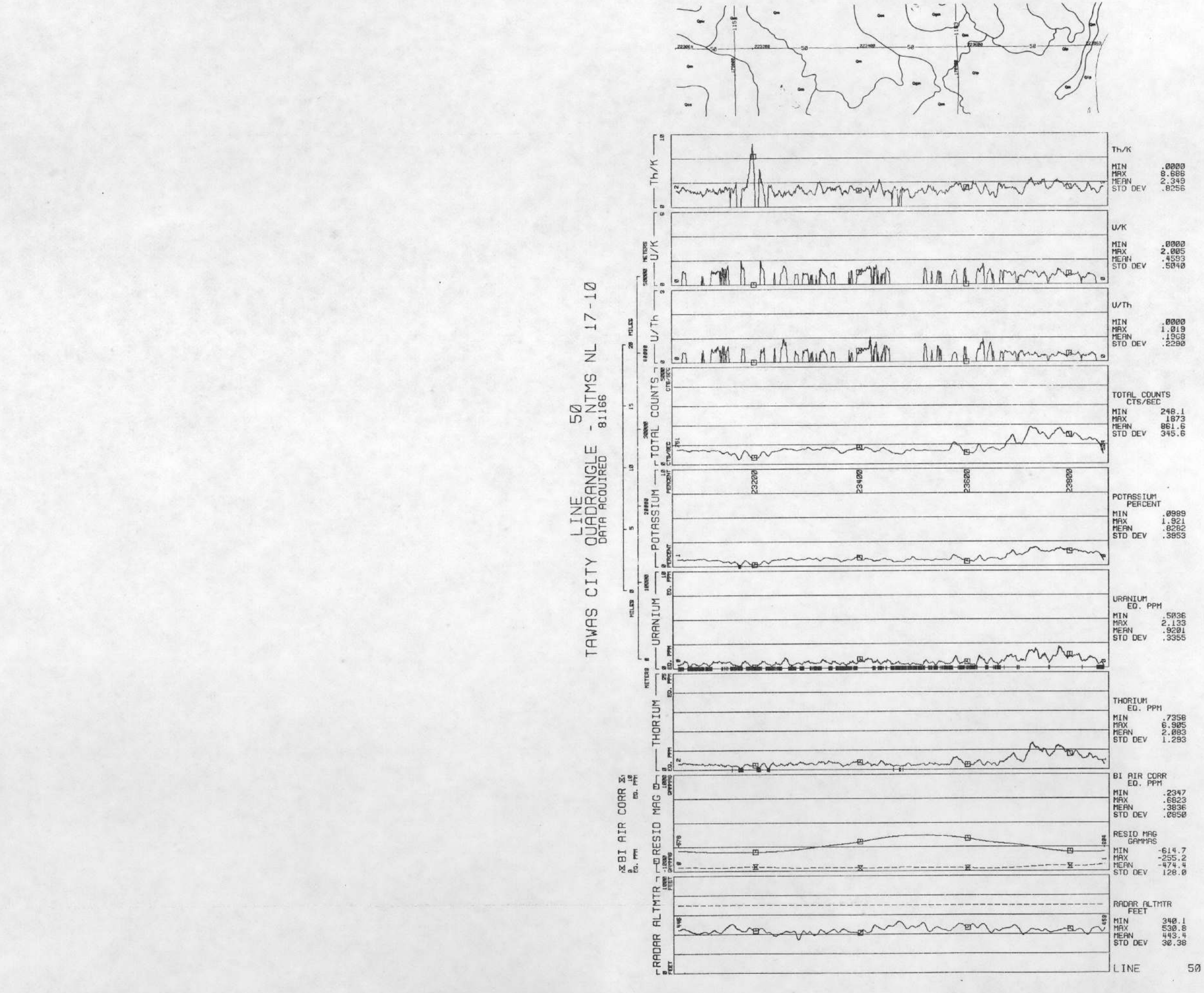


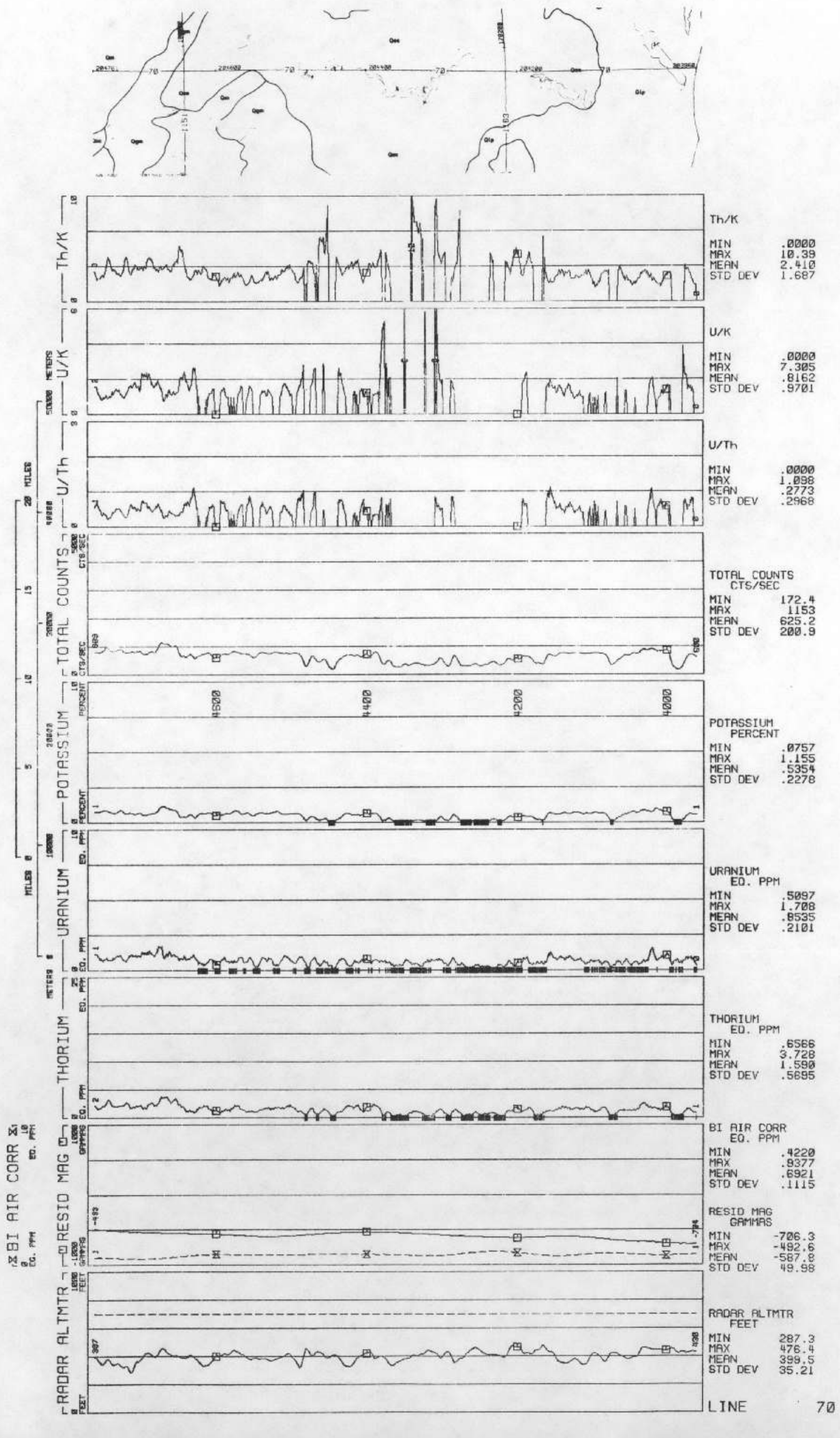
LINE 10
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81167
Th/K
MIN .0000
MAX 7.198
MEAN 2.051
STD DEV 1.401
U/K
MIN .0000
MAX 7.555
MEAN .6783
STD DEV .8554
U/Th
MIN .0000
MAX 1.350
MEAN .2461
STD DEV .2729
TOTAL COUNTS CTS/SEC
MIN 125.8
MAX 1651
MEAN 804.2
STD DEV 376.6
POTASSIUM PERCENT
MIN .0967
MAX 1.753
MEAN .8049
STD DEV .4166
URANIUM EQ. PPM
MIN .5809
MAX 2.720
MEAN 1.056
STD DEV .3133
THORIUM EQ. PPM
MIN .7579
MAX 5.460
MEAN 2.291
STD DEV 1.047
BI AIR CORR EQ. PPM
MIN .4792
MAX .8934
MEAN .6558
STD DEV .1046
RESID MAG GAMMAS
MIN -433.8
MAX 286.4
MEAN -200.2
STD DEV 230.2
RADAR ALTMTR FEET
MIN 326.5
MAX 557.2
MEAN 425.9
STD DEV 37.78
32600
32400
32200
LINE 10

LINE 30
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81166

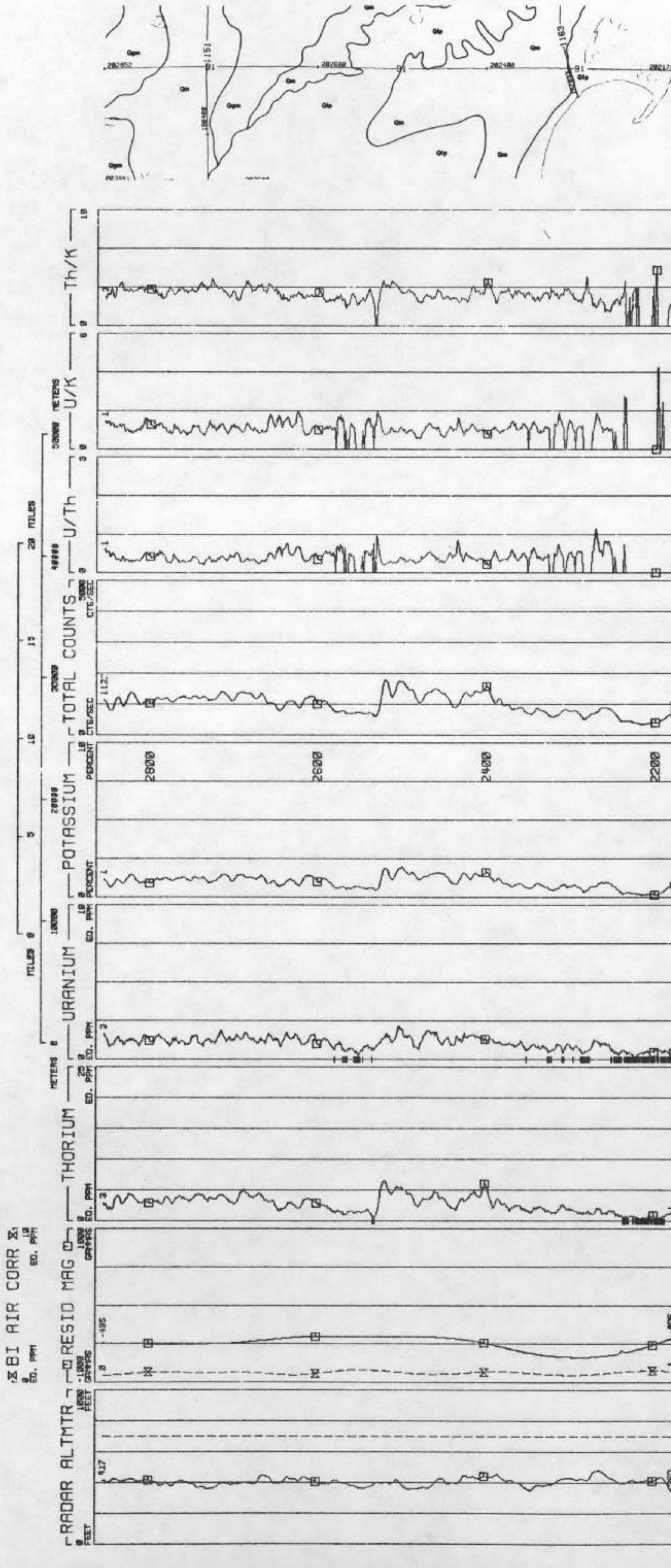


D 37 tf


LINE 50
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81166
Th/K
MIN .0000
MAX 8.686
MEAN 2.349
STD DEV .8256
U/K
MIN .0000
MAX 2.005
MEAN .4593
STD DEV .5040
U/Th
MIN .0000
MAX 1.019
MEAN .1968
STD DEV .2290
TOTAL COUNTS CTS/SEC
MIN 248.1
MAX 1873
MEAN 861.6
STD DEV 345.6
POTASSIUM PERCENT
MIN .0989
MAX 1.921
MEAN .8282
STD DEV .3953
URANIUM EQ. PPM
MIN .5036
MAX 2.133
MEAN .9201
STD DEV .3355
THORIUM EQ. PPM
MIN .7358
MAX 6.905
MEAN 2.083
STD DEV 1.293
BI AIR CORR EQ. PPM
MIN .2347
MAX .6823
MEAN .3836
STD DEV .0850
RESID MAG GAMMAS
MIN -614.7
MAX -255.2
MEAN -474.4
STD DEV 128.0
RADAR ALTMTR FEET
MIN 340.1
MAX 530.8
MEAN 443.4
STD DEV 30.38
LINE 50


LINE 70
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81163
Th/K
MIN .0000
MAX 10.39
MEAN 2.410
STD DEV 1.687
U/K
MIN .0000
MAX 7.305
MEAN .8162
STD DEV .9701
U/Th
MIN .0000
MAX 1.098
MEAN .2773
STD DEV .2968
TOTAL COUNTS CTS/SEC
MIN 172.4
MAX 1153
MEAN 625.2
STD DEV 200.9
POTASSIUM PERCENT
MIN .0757
MAX 1.155
MEAN .5354
STD DEV .2278
URANIUM EQ. PPM
MIN .5097
MAX 1.708
MEAN .8535
STD DEV .2101
THORIUM EQ. PPM
MIN .6566
MAX 3.728
MEAN 1.590
STD DEV .5695
BI AIR CORR EQ. PPM
MIN .4220
MAX .8377
MEAN .6921
STD DEV .1115
RESID MAG GAMMAS
MIN -706.3
MAX -492.6
MEAN -587.8
STD DEV 49.98
RADAR ALTMTR FEET
MIN 287.3
MAX 476.4
MEAN 399.5
STD DEV 35.21
LINE 70

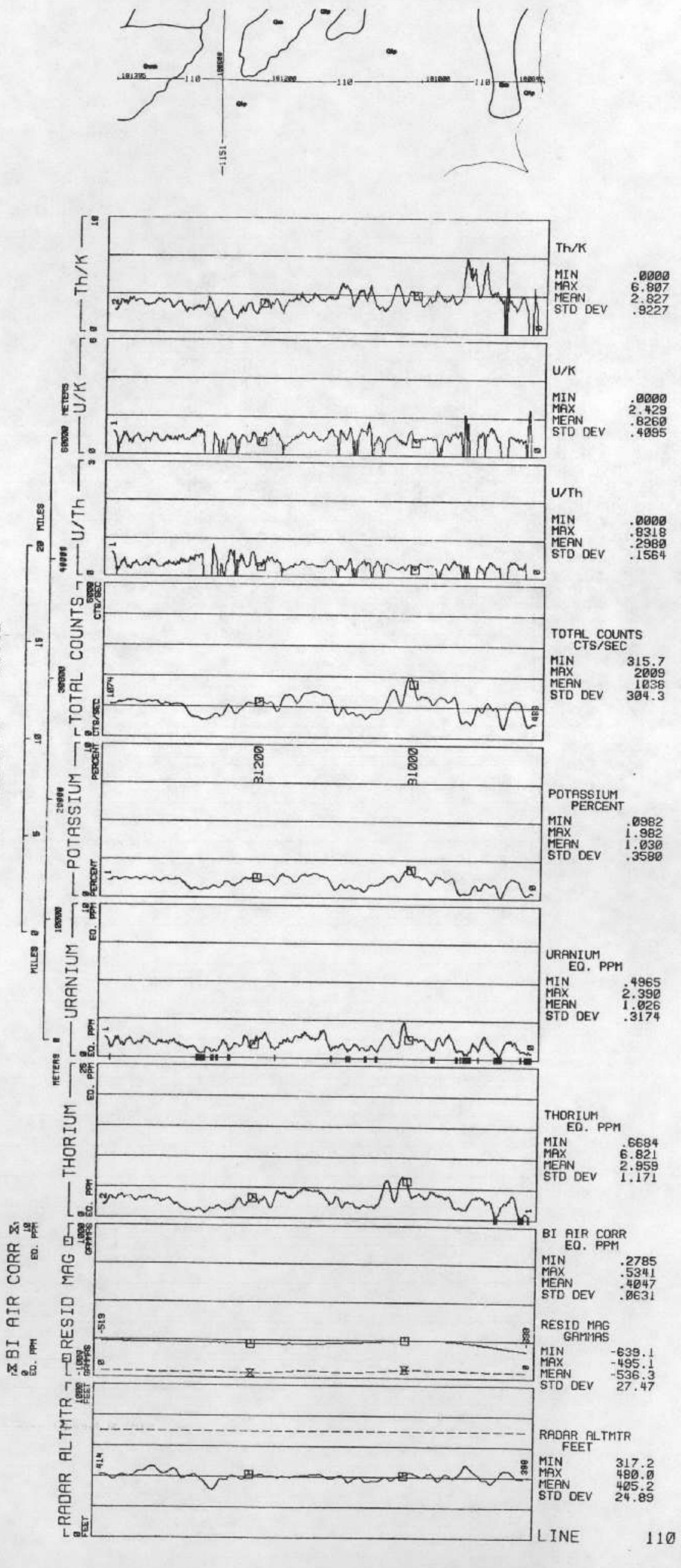
LINE 90
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81163



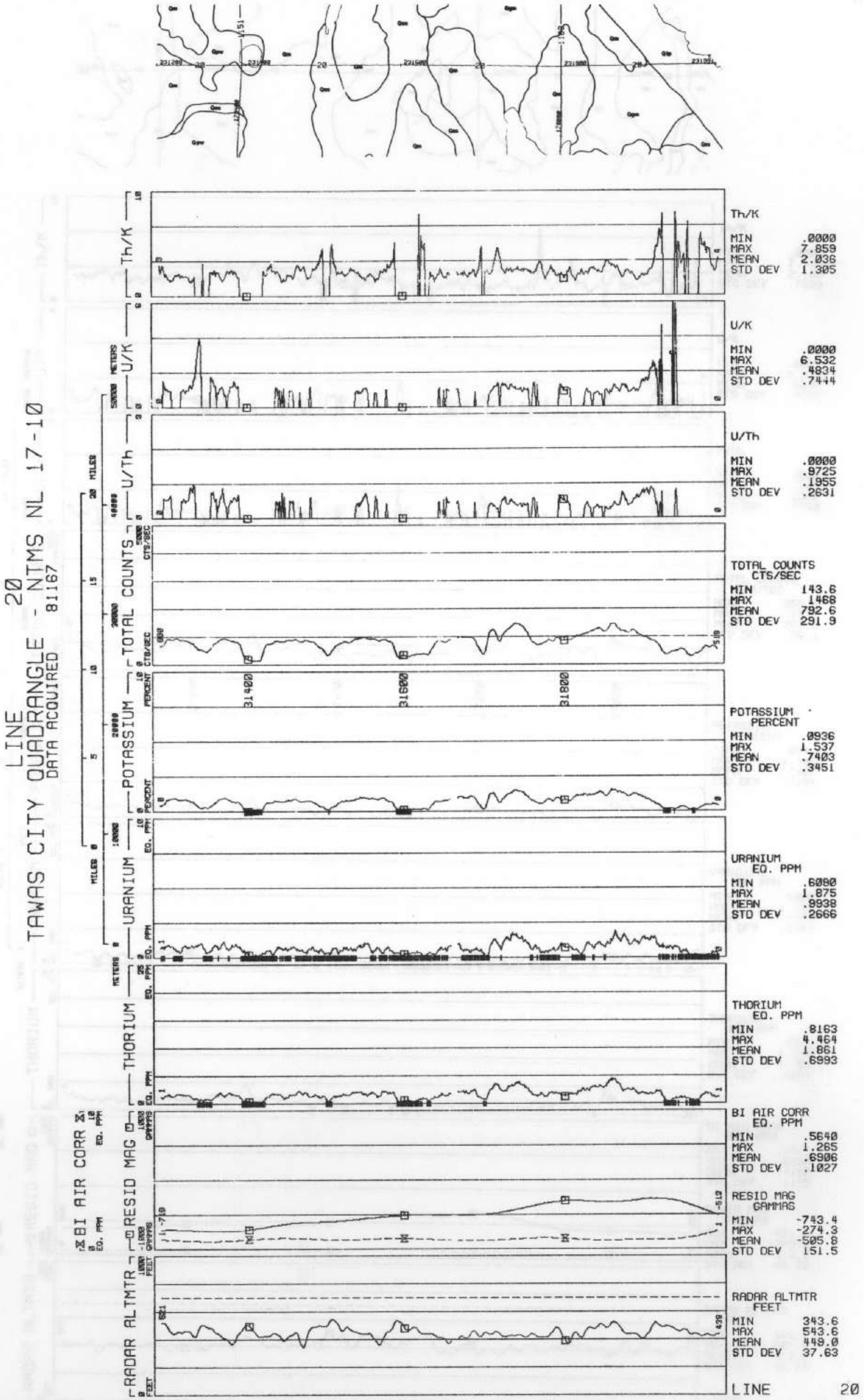
Th/K	
MIN	.0000
MAX	4.817
MEAN	2.578
STD DEV	.8371
U/K	
MIN	.0000
MAX	4.242
MEAN	.9653
STD DEV	.5065
U/Th	
MIN	.0000
MAX	1.149
MEAN	.3510
STD DEV	.1870
TOTAL COUNTS CTS/SEC	
MIN	346.6
MAX	1778
MEAN	1004
STD DEV	319.1
POTASSIUM PERCENT	
MIN	.1497
MAX	1.927
MEAN	.8784
STD DEV	.3893
URANIUM EQ. PPM	
MIN	.5846
MAX	2.137
MEAN	1.176
STD DEV	.3008
THORIUM EQ. PPM	
MIN	.7159
MAX	6.521
MEAN	2.875
STD DEV	1.223
BI AIR CORR EQ. PPM	
MIN	.4492
MAX	.8025
MEAN	.6105
STD DEV	.0877
RESID MAG GAMMAS	
MIN	-677.4
MAX	-406.5
MEAN	-502.8
STD DEV	86.38
RADAR ALTMTR FEET	
MIN	351.3
MAX	478.4
MEAN	404.8
STD DEV	24.44

LINE 90

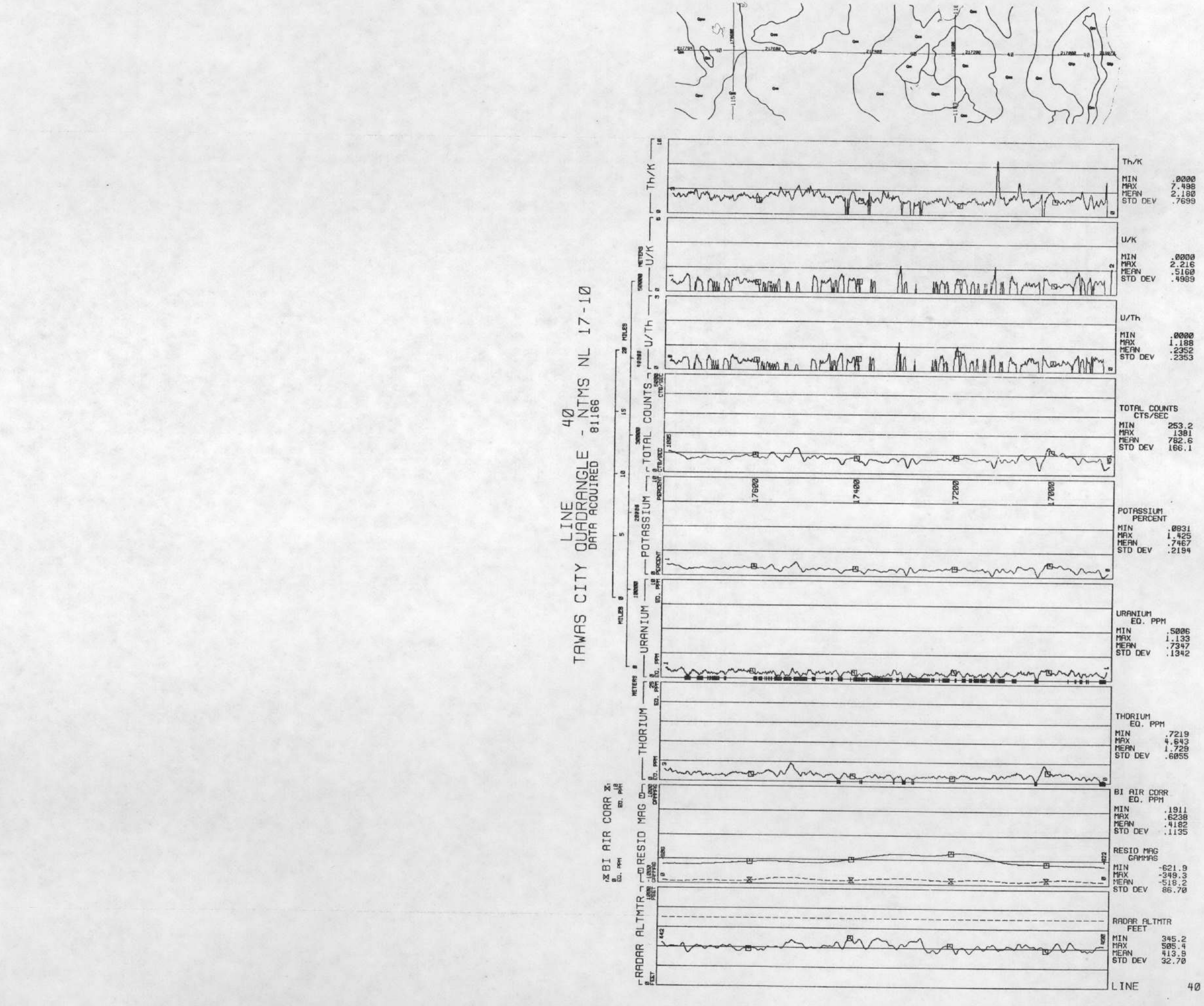
D40tf



LINE 110
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81162
Th/K
MIN .0000
MAX 6.807
MEAN 2.827
STD DEV .9227
U/K
MIN .0000
MAX 2.429
MEAN .8260
STD DEV .4085
U/Th
MIN .0000
MAX .9318
MEAN .2980
STD DEV .1564
TOTAL COUNTS CTS/SEC
MIN 315.7
MAX 2009
MEAN 1036
STD DEV 304.3
POTASSIUM PERCENT
MIN .0982
MAX 1.962
MEAN 1.030
STD DEV .3580
URANIUM EQ. PPM
MIN .4965
MAX 2.390
MEAN 1.026
STD DEV .3174
THORIUM EQ. PPM
MIN .6684
MAX 6.821
MEAN 2.959
STD DEV 1.171
BI AIR CORR EQ. PPM
MIN .2785
MAX .5341
MEAN .4047
STD DEV .0631
RESID MAG GAMMAS
MIN -639.1
MAX -495.1
MEAN -536.3
STD DEV 27.47
RADAR ALTMTR FEET
MIN 317.2
MAX 480.0
MEAN 405.2
STD DEV 24.89
LINE 110

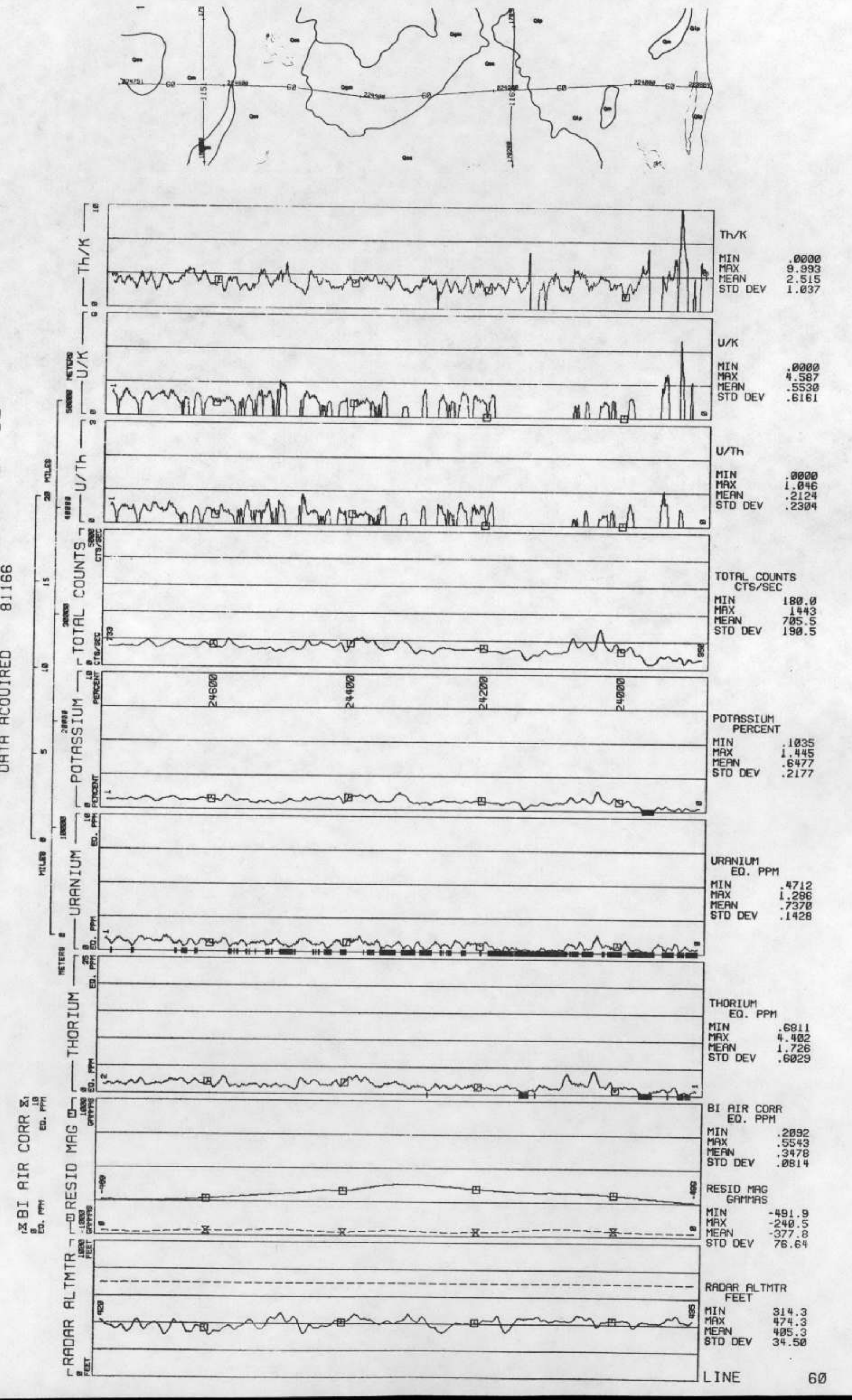

LINE 20
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81167
Th/K
MIN .0000
MAX 7.859
MEAN 2.036
STD DEV 1.305
U/K
MIN .0000
MAX 6.532
MEAN .4834
STD DEV .7444
U/Th
MIN .0000
MAX .9725
MEAN .1955
STD DEV .2631
TOTAL COUNTS CTS/SEC
MIN 143.6
MAX 1468
MEAN 792.6
STD DEV 291.9
POTASSIUM PERCENT
MIN .0936
MAX 1.537
MEAN .7403
STD DEV .3451
URANIUM EQ. PPM
MIN .6000
MAX 1.875
MEAN .9938
STD DEV .2666
THORIUM EQ. PPM
MIN .8163
MAX 4.464
MEAN 1.861
STD DEV .6893
BI AIR CORR EQ. PPM
MIN .5640
MAX 1.265
MEAN .6906
STD DEV .1027
RESID MAG GAMMAS
MIN -743.4
MAX -274.3
MEAN -505.8
STD DEV 151.5
RADAR ALTMTR FEET
MIN 343.6
MAX 543.6
MEAN 448.0
STD DEV 37.63
LINE 20

D42tf


LINE 40
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81166
Th/K
MIN .0000
MAX 7.498
MEAN 2.180
STD DEV .7699
U/K
MIN .0000
MAX 2.216
MEAN .5160
STD DEV .4989
U/Th
MIN .0000
MAX 1.188
MEAN .2352
STD DEV .2353
TOTAL COUNTS CTS/SEC
MIN 253.2
MAX 1381
MEAN 782.6
STD DEV 166.1
POTASSIUM PERCENT
MIN .0831
MAX 1.425
MEAN .7467
STD DEV .2194
URANIUM EQ. PPM
MIN .5006
MAX 1.133
MEAN .7347
STD DEV .1342
THORIUM EQ. PPM
MIN .7219
MAX 4.643
MEAN 1.729
STD DEV .6055
BI AIR CORR EQ. PPM
MIN .1911
MAX .6238
MEAN .4182
STD DEV .1135
RESID MAG GAMMAS
MIN -621.9
MAX -349.3
MEAN -518.2
STD DEV 86.70
RADAR ALTMTR FEET
MIN 345.2
MAX 505.4
MEAN 413.9
STD DEV 32.70
LINE 40
17600
17400
17200
17000

D4 3tf

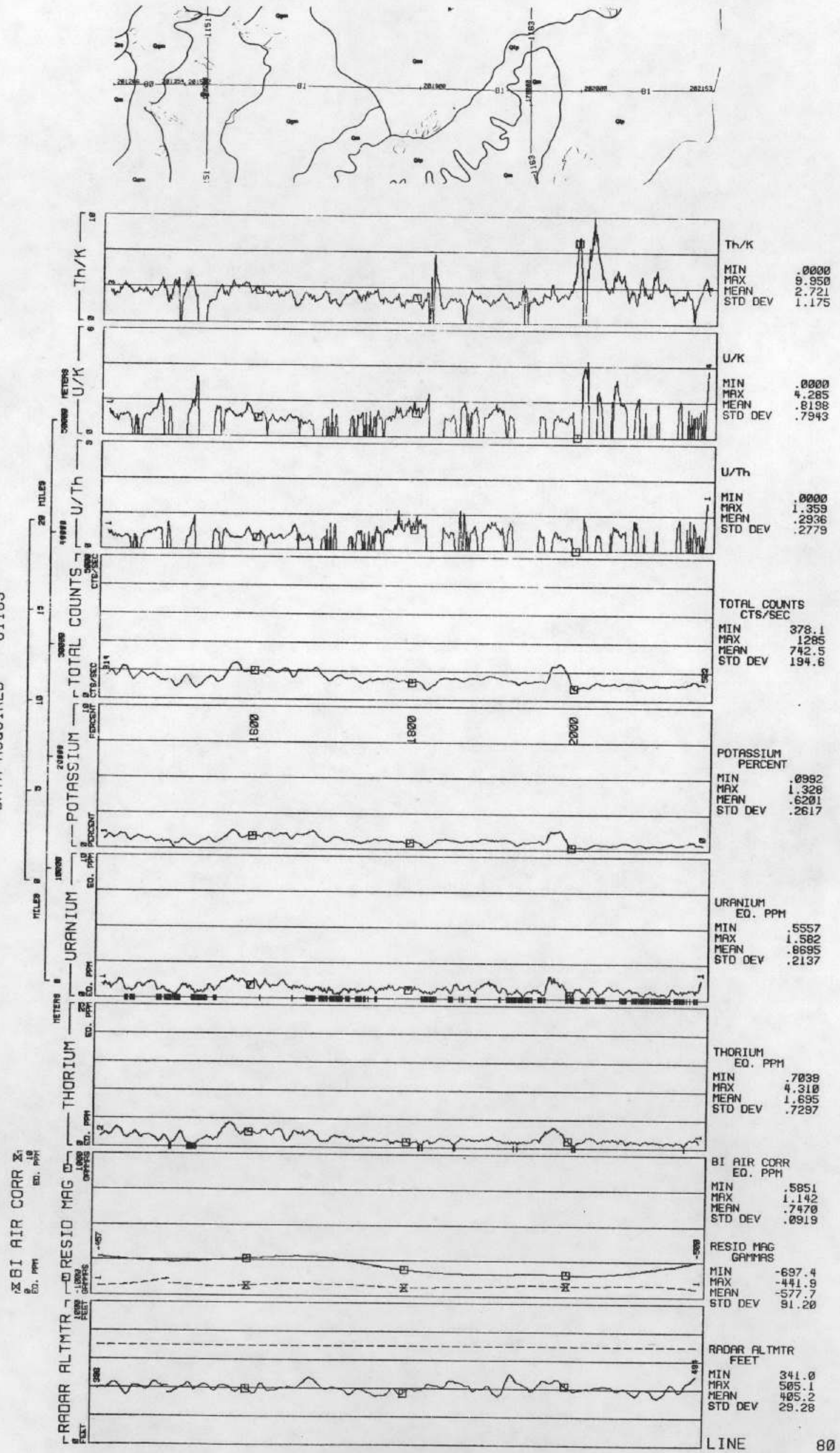
LINE 60
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81166



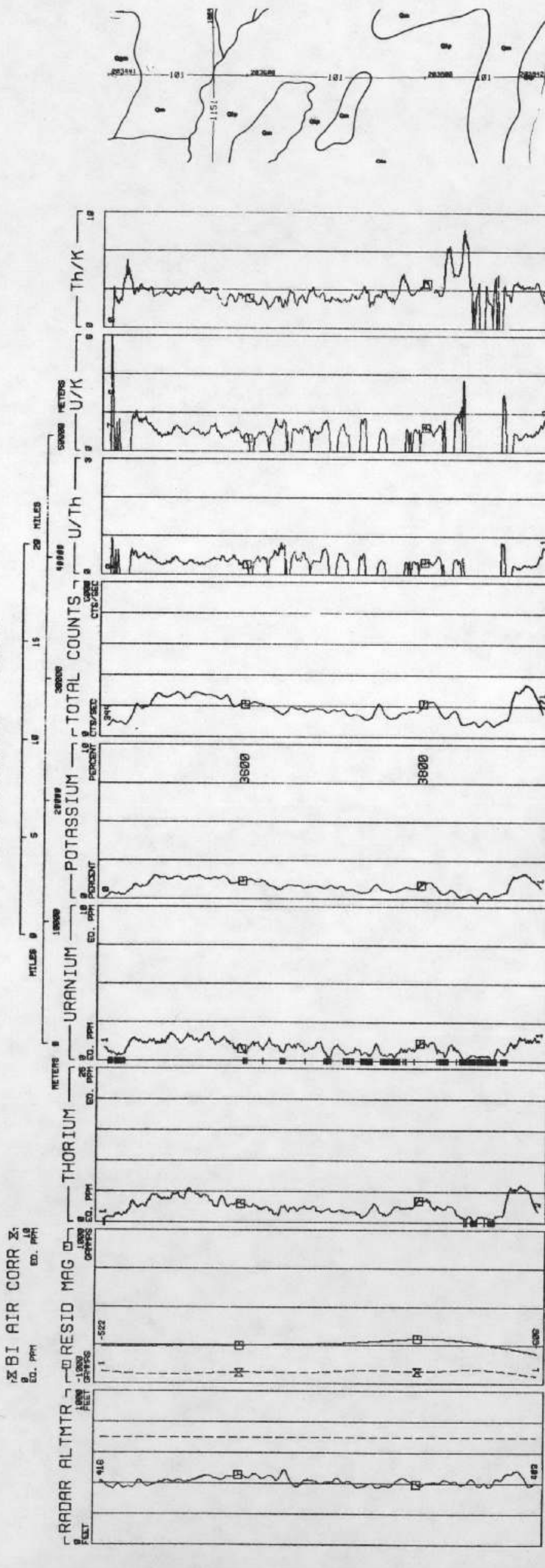
LINE 80

TAWAS CITY QUADRANGLE - NTMS NL 17-10

DATA ACQUIRED 81163



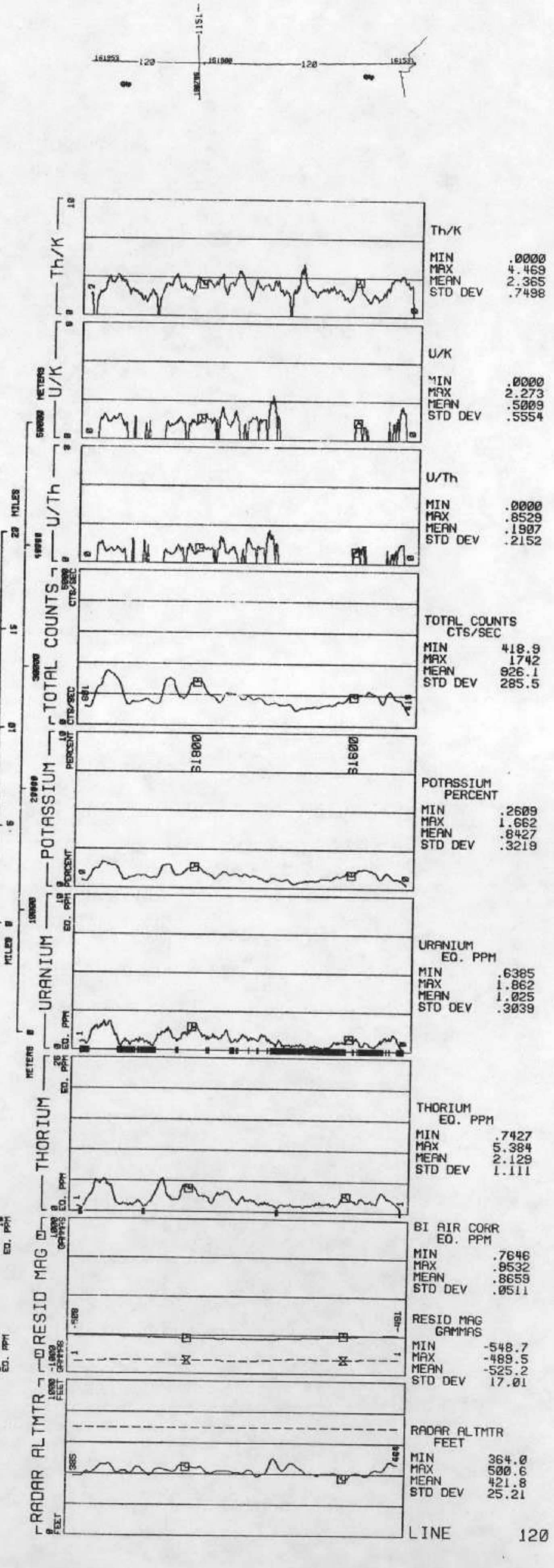
LINE 100
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81163



Th/K		
MIN	.0000	
MAX	8.556	
MEAN	3.052	
STD DEV	1.134	
U/K		
MIN	.0000	
MAX	6.929	
MEAN	.8358	
STD DEV	.7601	
U/Th		
MIN	.0000	
MAX	.8389	
MEAN	.2662	
STD DEV	.2106	
TOTAL COUNTS CTS/SEC		
MIN	344.2	
MAX	1705	
MEAN	923.6	
STD DEV	321.9	
POTASSIUM PERCENT		
MIN	.0952	
MAX	1.642	
MEAN	.8447	
STD DEV	.3960	
URANIUM EQ. PPM		
MIN	.5635	
MAX	1.814	
MEAN	1.099	
STD DEV	.2777	
THORIUM EQ. PPM		
MIN	.7073	
MAX	6.072	
MEAN	2.662	
STD DEV	1.255	
BI AIR CORR EQ. PPM		
MIN	.5026	
MAX	.9048	
MEAN	.7360	
STD DEV	.0951	
RESID MAG GAMMAS		
MIN	-605.9	
MAX	-416.4	
MEAN	-489.5	
STD DEV	40.58	
RADAR ALTMTR FEET		
MIN	367.0	
MAX	485.8	
MEAN	414.6	
STD DEV	25.71	

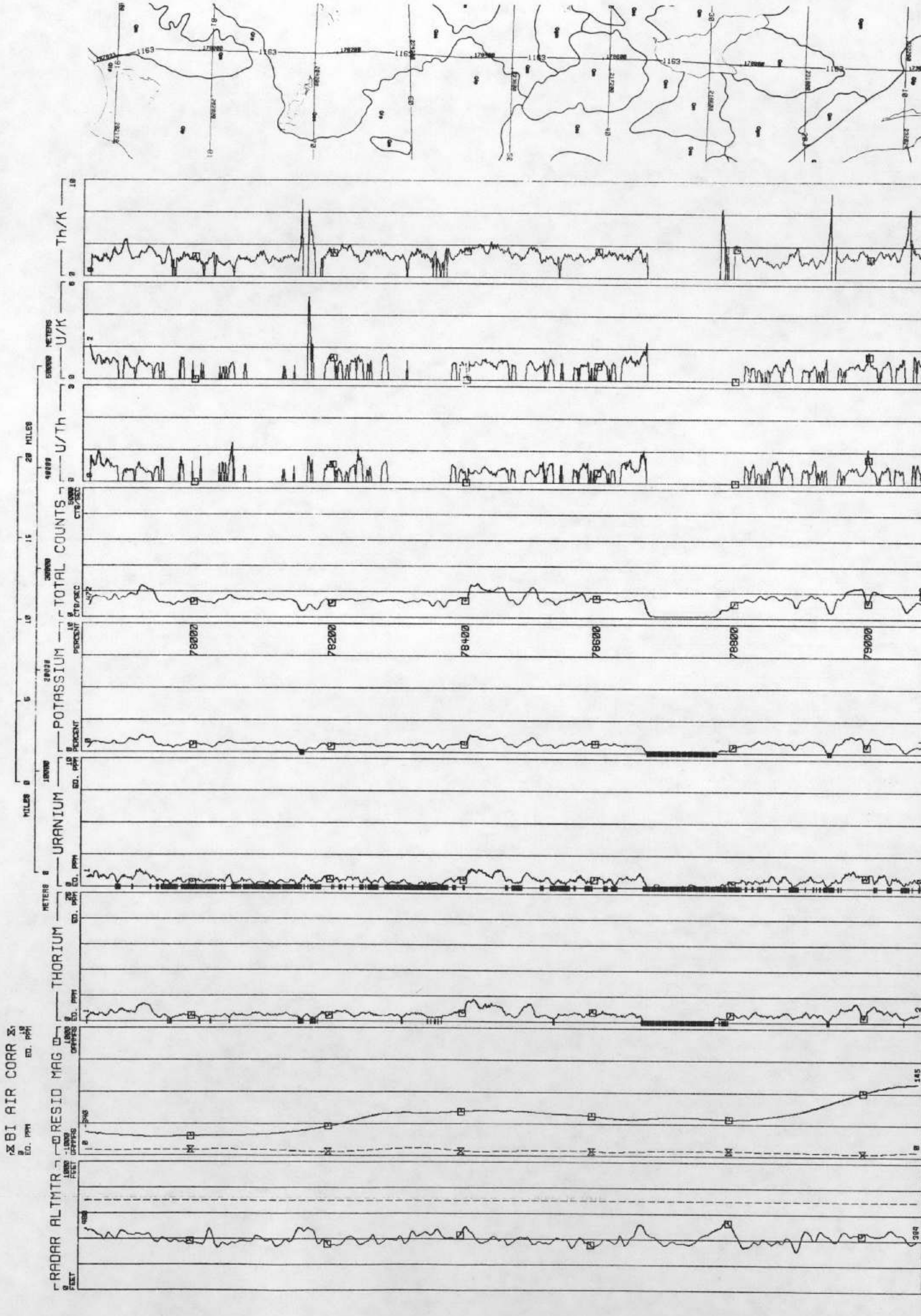
LINE 100

D46tf


LINE 120
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81161
Th/K
MIN .0000
MAX 4.469
MEAN 2.365
STD DEV .7498
U/K
MIN .0000
MAX 2.273
MEAN .5009
STD DEV .5554
U/Th
MIN .0000
MAX .8529
MEAN .1907
STD DEV .2152
TOTAL COUNTS CTS/SEC
MIN 418.9
MAX 1742
MEAN 926.1
STD DEV 285.5
POTASSIUM PERCENT
MIN .2609
MAX 1.662
MEAN .8427
STD DEV .3219
URANIUM EQ. PPM
MIN .6305
MAX 1.862
MEAN 1.025
STD DEV .3039
THORIUM EQ. PPM
MIN .7427
MAX 5.384
MEAN 2.129
STD DEV 1.111
BI AIR CORR EQ. PPM
MIN .7646
MAX .9532
MEAN .8659
STD DEV .0511
RESID MAG GAMMAS
MIN -548.7
MAX -489.5
MEAN -525.2
STD DEV 17.01
RADAR ALTMTR FEET
MIN 364.0
MAX 500.6
MEAN 421.8
STD DEV 25.21
LINE 120

D47 tf

LINE 1160
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81156



Th/K
MIN .0000
MAX 8.832
MEAN 2.032
STD DEV 1.047

U/K
MIN .0000
MAX 5.120
MEAN .5035
STD DEV .5862

U/Th
MIN .0000
MAX 1.237
MEAN .2205
STD DEV .2541

TOTAL COUNTS CTS/SEC
MIN 65.72
MAX 1314
MEAN 676.9
STD DEV 253.8

POTASSIUM PERCENT
MIN .1008
MAX 1.346
MEAN .6932
STD DEV .2348

URANIUM EQ. PPM
MIN .4827
MAX 1.436
MEAN .7941
STD DEV .2197

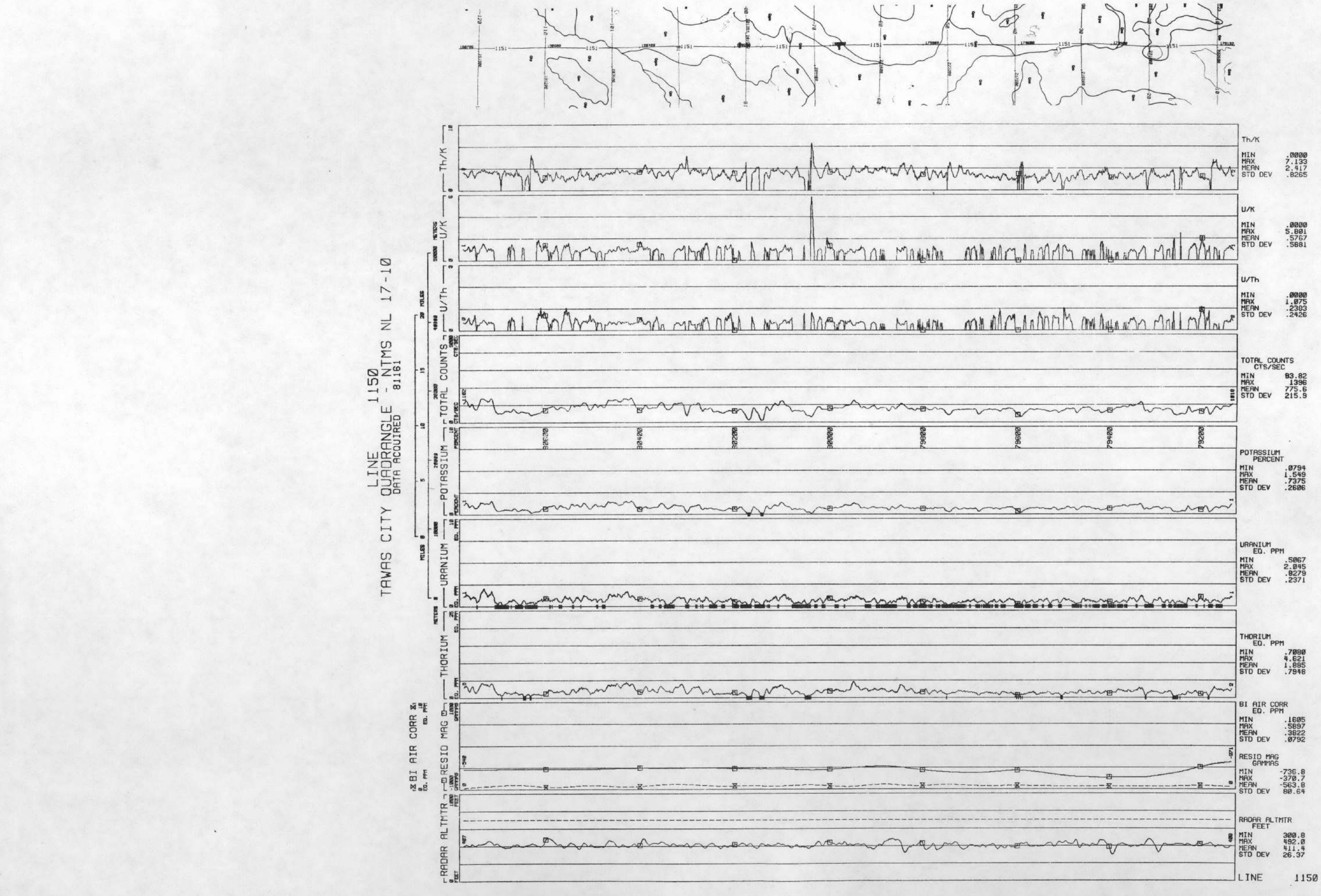
THORIUM EQ. PPM
MIN .6762
MAX 4.334
MEAN 1.609
STD DEV .6892

BI AIR CORR EQ. PPM
MIN .2448
MAX .6064
MEAN .3918
STD DEV .0764

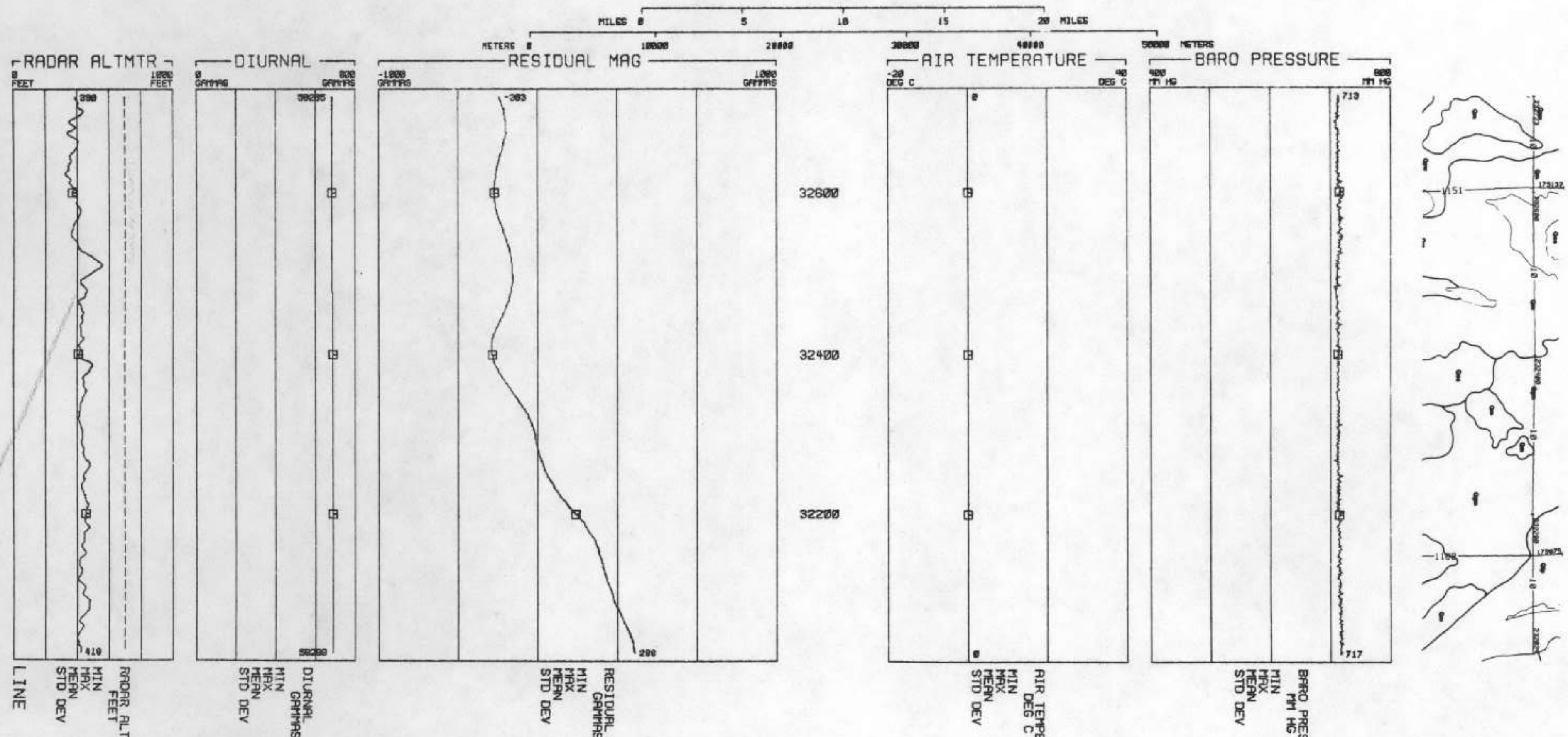
RESID MAG GAMMAS
MIN -709.2
MAX 145.8
MEAN -411.5
STD DEV 211.3

RADAR ALTMTR FEET
MIN 313.7
MAX 540.2
MEAN 407.2
STD DEV 40.19

LINE 1160

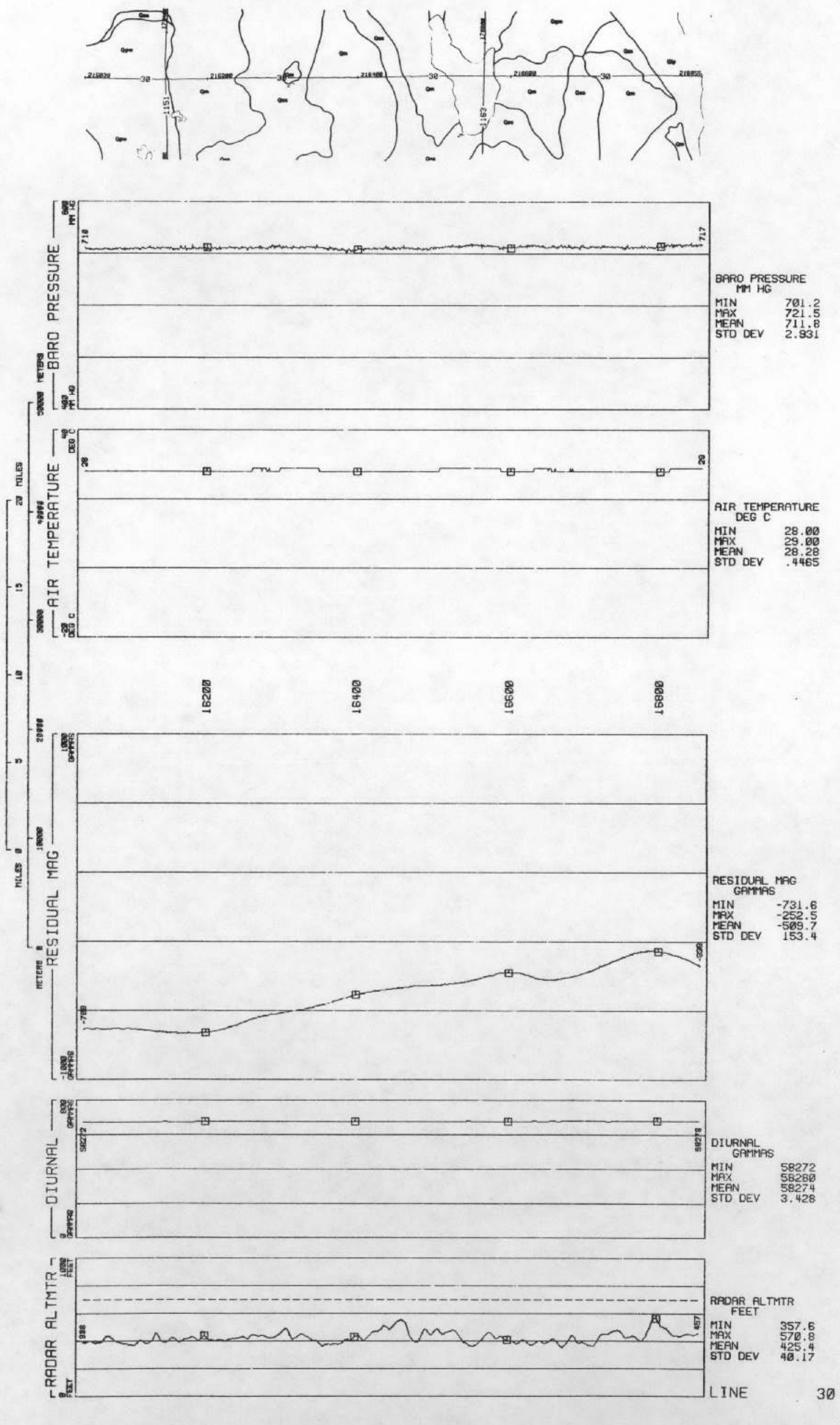

LINE 1150
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81161
Th/K
MIN .0000
MAX 7.133
MEAN 2.417
STD DEV .8265
U/K
MIN .0000
MAX 5.801
MEAN .5767
STD DEV .5881
U/Th
MIN .0000
MAX 1.075
MEAN .2303
STD DEV .2426
TOTAL COUNTS CTS/SEC
MIN 83.82
MAX 1396
MEAN 775.6
STD DEV 215.9
POTASSIUM PERCENT
MIN .0794
MAX 1.549
MEAN .7375
STD DEV .2606
URANIUM EQ. PPM
MIN .5067
MAX 2.045
MEAN .8279
STD DEV .2371
THORIUM EQ. PPM
MIN .7080
MAX 4.621
MEAN 1.885
STD DEV .7948
BI AIR CORR EQ. PPM
MIN .1605
MAX .5897
MEAN .3822
STD DEV .0792
RESID MAG GAMMAS
MIN -736.8
MAX -370.7
MEAN -563.8
STD DEV 80.64
RADAR ALTMTR FEET
MIN 300.8
MAX 492.0
MEAN 411.4
STD DEV 26.37
LINE 1150
Th/K
U/K
U/Th
TOTAL COUNTS
POTASSIUM
URANIUM
THORIUM
BI AIR CORR
RESID MAG
RADAR ALTMTR
80600
80400
80200
80000
79800
79600
79400
79200

LINE 10
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81167

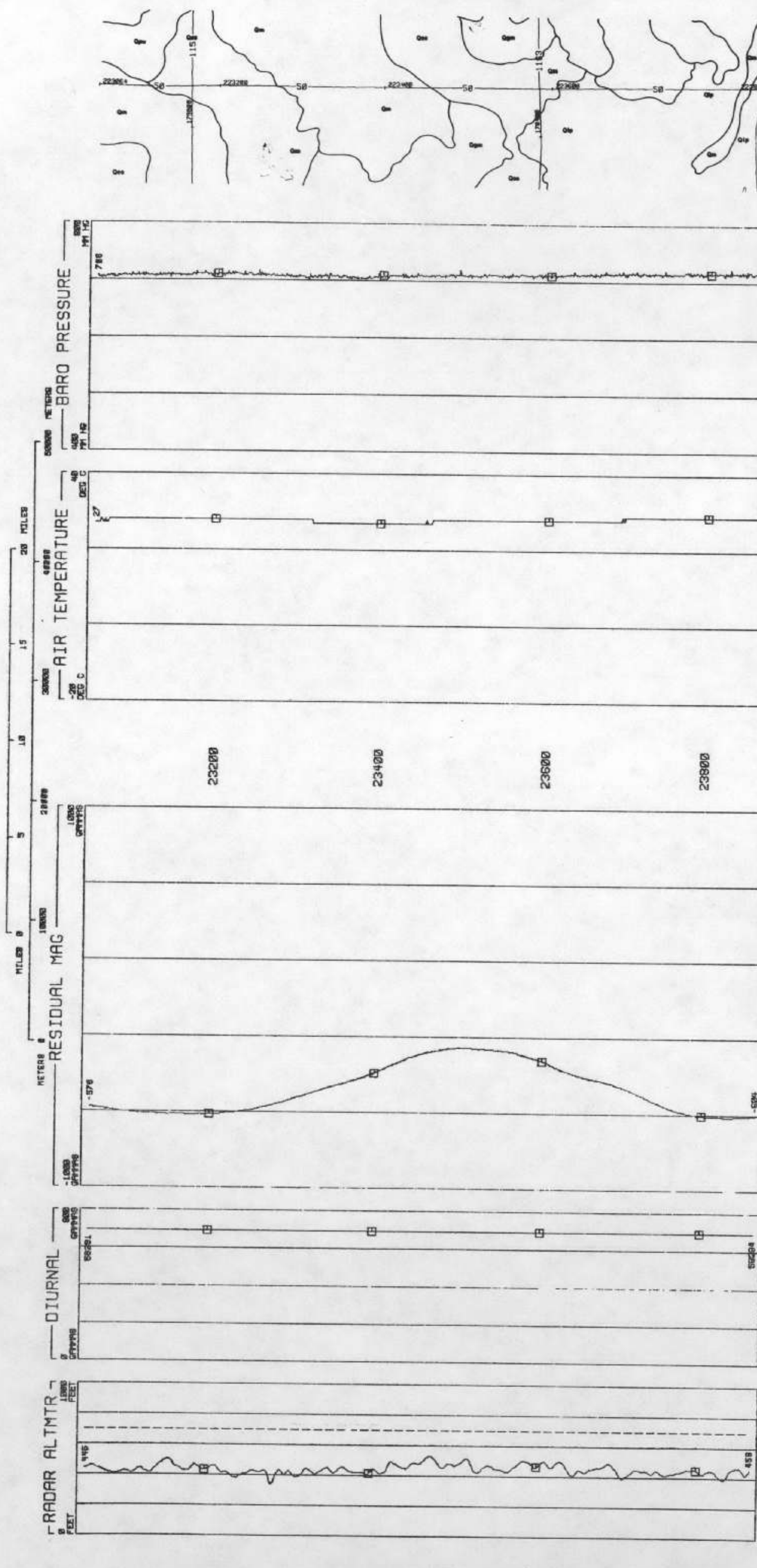


LINE 10

D50 tf



LINE 30
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81166
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
16200
16400
16600
16800
BARO PRESSURE MM HG
MIN 701.2
MAX 721.5
MEAN 711.8
STD DEV 2.931
AIR TEMPERATURE DEG C
MIN 28.00
MAX 29.00
MEAN 28.28
STD DEV .4465
RESIDUAL MAG GAMMAS
MIN -731.6
MAX -252.5
MEAN -509.7
STD DEV 153.4
DIURNAL GAMMAS
MIN 58272
MAX 58280
MEAN 58274
STD DEV 3.428
RADAR ALTMTR FEET
MIN 357.6
MAX 570.8
MEAN 425.4
STD DEV 40.17
LINE 30



BARO PRESSURE
MM HG

MIN	701.9
MAX	722.6
MEAN	710.6
STD DEV	3.728

AIR TEMPERATURE
DEG C

MIN	27.00
MAX	29.00
MEAN	28.03
STD DEV	.6434

RESIDUAL MAG
GAMMAS

MIN	-614.7
MAX	-255.2
MEAN	-474.4
STD DEV	128.0

DIURNAL
GAMMAS

MIN	58280
MAX	58294
MEAN	58289
STD DEV	2.799

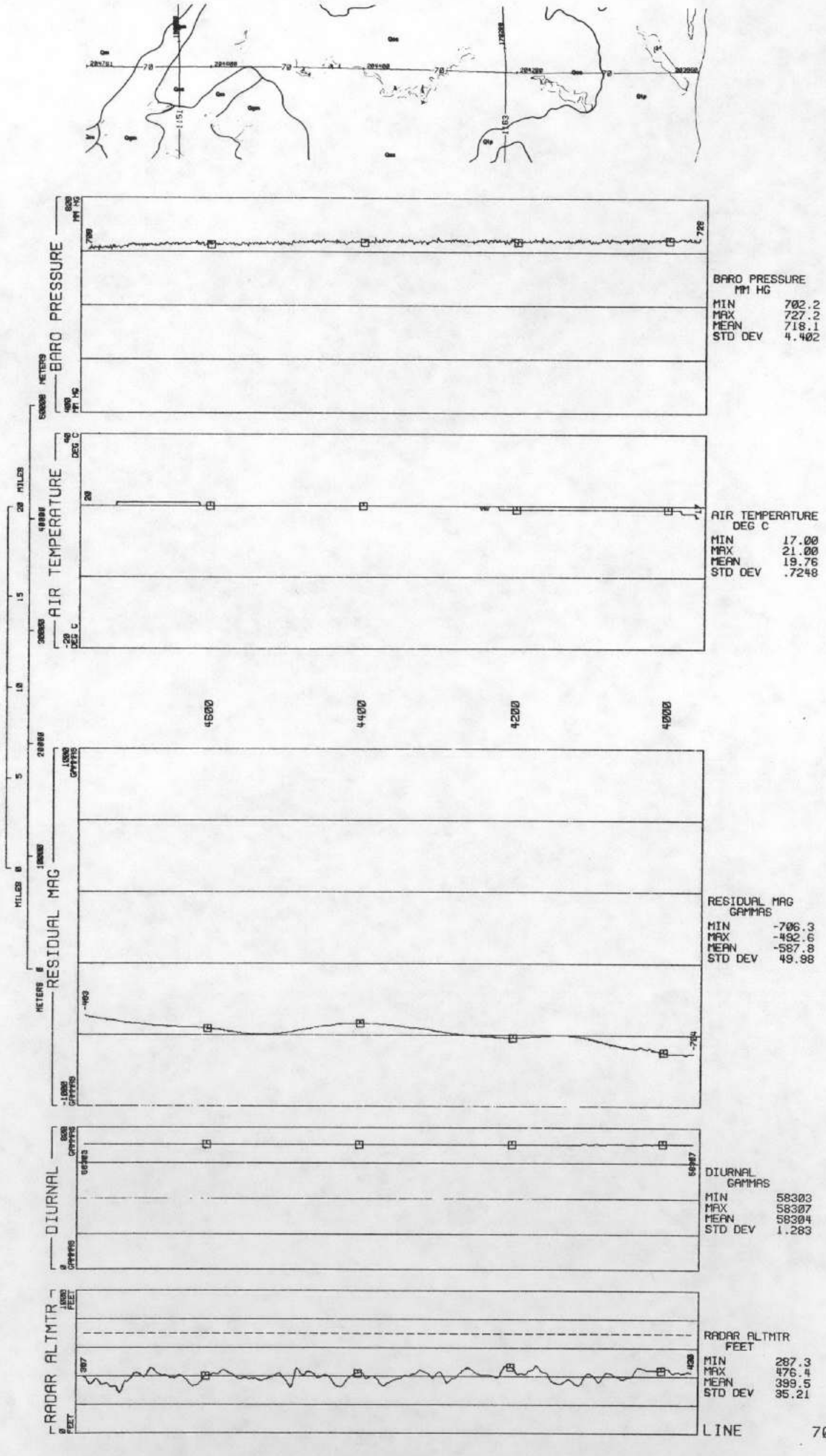
RADAR ALTMTR
FEET

MIN	340.1
MAX	530.8
MEAN	443.4
STD DEV	30.38

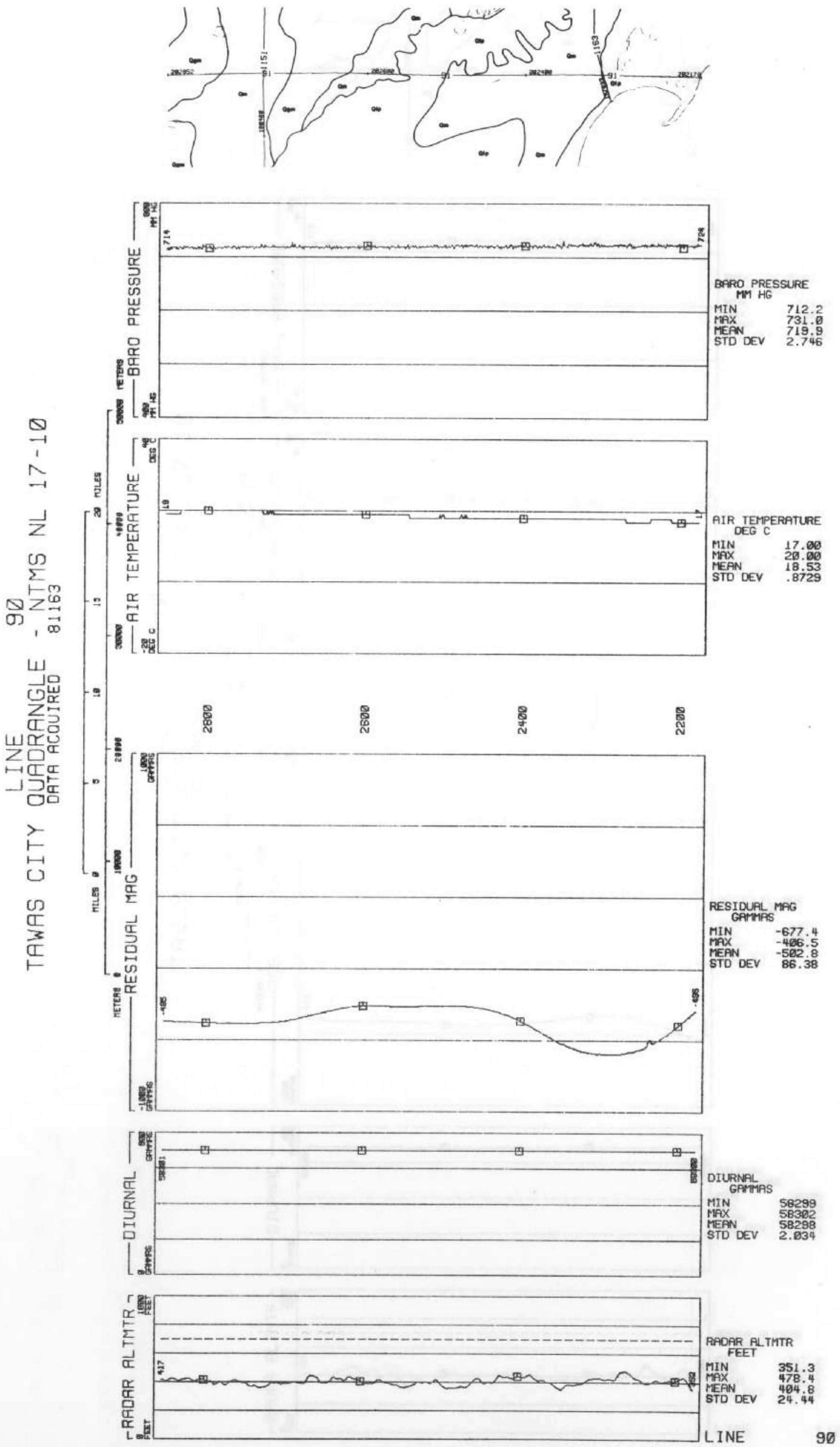
LINE 70

TAWAS CITY QUADRANGLE - NTMS NL 17-10

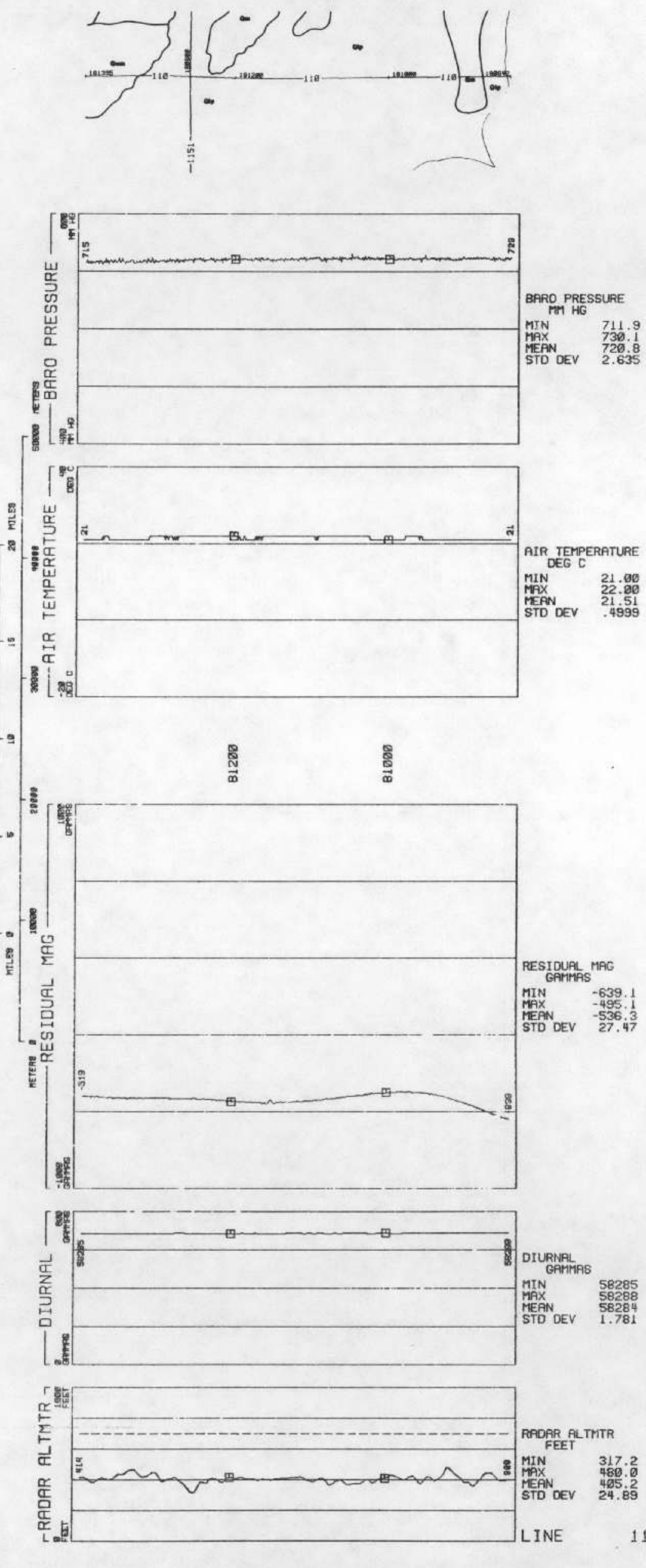
DATA ACQUIRED 81163



D53 tf

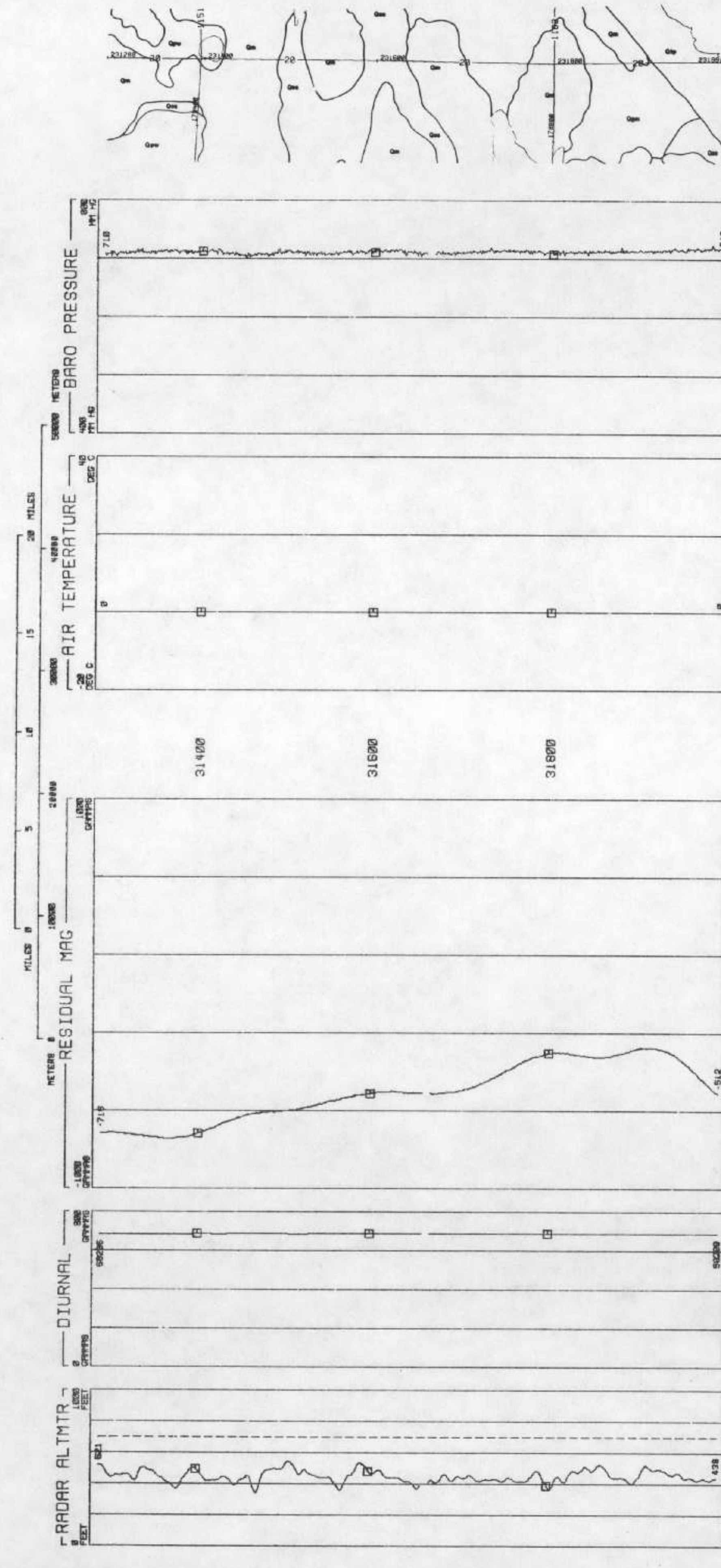

LINE 90
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81163
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
2800
2600
2400
2200
BARO PRESSURE MM HG
MIN 712.2
MAX 731.0
MEAN 719.9
STD DEV 2.746
AIR TEMPERATURE DEG C
MIN 17.00
MAX 20.00
MEAN 18.53
STD DEV .8729
RESIDUAL MAG GAMMAS
MIN -677.4
MAX -406.5
MEAN -502.8
STD DEV 86.38
DIURNAL GAMMAS
MIN 58299
MAX 58302
MEAN 58288
STD DEV 2.034
RADAR ALTMTR FEET
MIN 351.3
MAX 478.4
MEAN 404.8
STD DEV 24.44
LINE 90

D54 tf


LINE 110
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81162
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
81200
81000
BARO PRESSURE MM HG
MIN 711.9
MAX 730.1
MEAN 720.8
STD DEV 2.635
AIR TEMPERATURE DEG C
MIN 21.00
MAX 22.00
MEAN 21.51
STD DEV .4999
RESIDUAL MAG GAMMAS
MIN -639.1
MAX -495.1
MEAN -536.3
STD DEV 27.47
DIURNAL GAMMAS
MIN 58285
MAX 58288
MEAN 58284
STD DEV 1.781
RADAR ALTMTR FEET
MIN 317.2
MAX 480.0
MEAN 405.2
STD DEV 24.89
LINE 110

D55tf

LINE 20
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81167



BARO PRESSURE
MM HG
MIN 701.0
MAX 724.0
MEAN 711.6
STD DEV 3.097

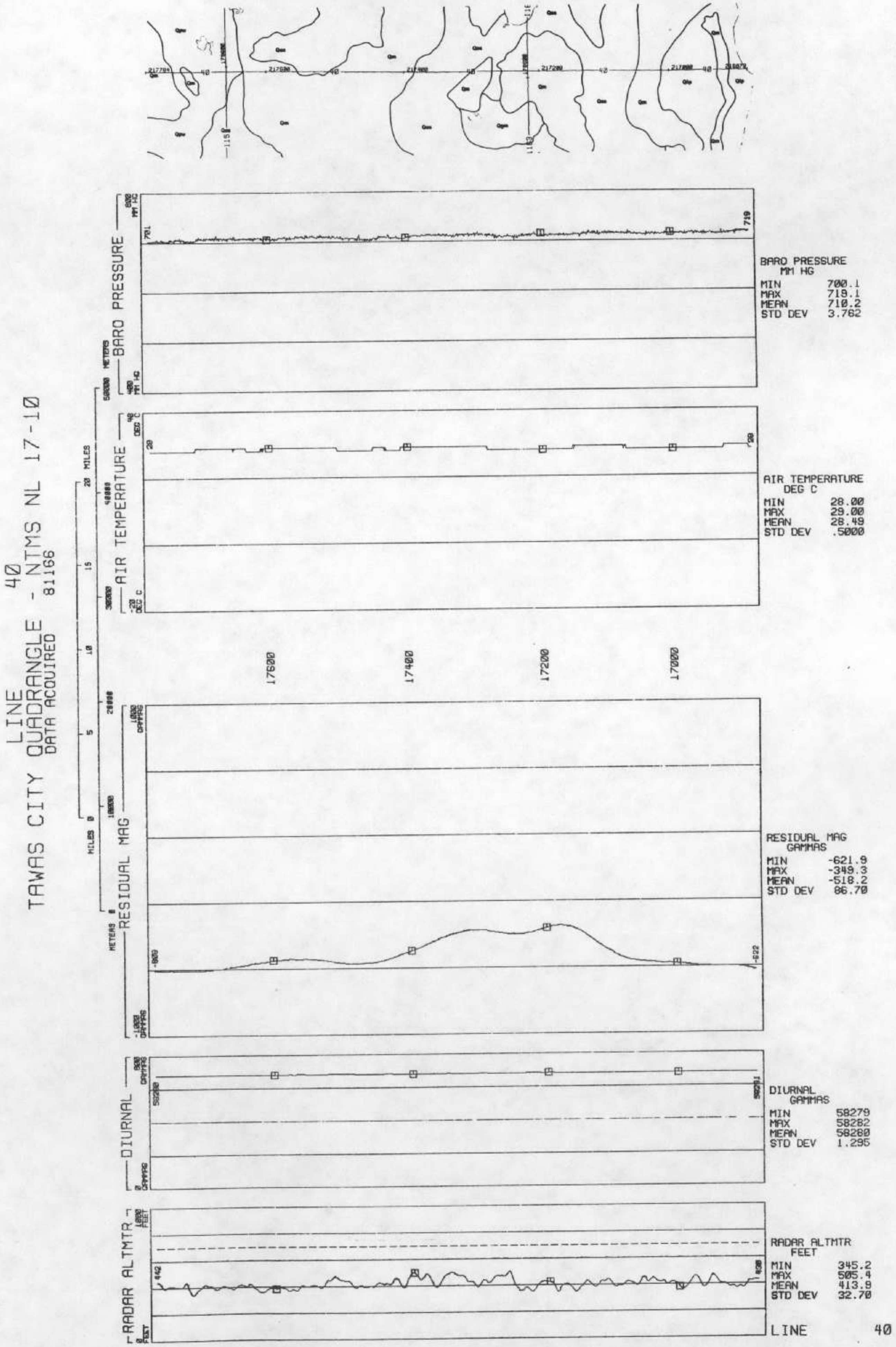
AIR TEMPERATURE
DEG C
MIN .0000
MAX .0000
MEAN .0000
STD DEV .0000

RESIDUAL MAG
GAMMAS
MIN -743.4
MAX -274.3
MEAN -505.8
STD DEV 151.5

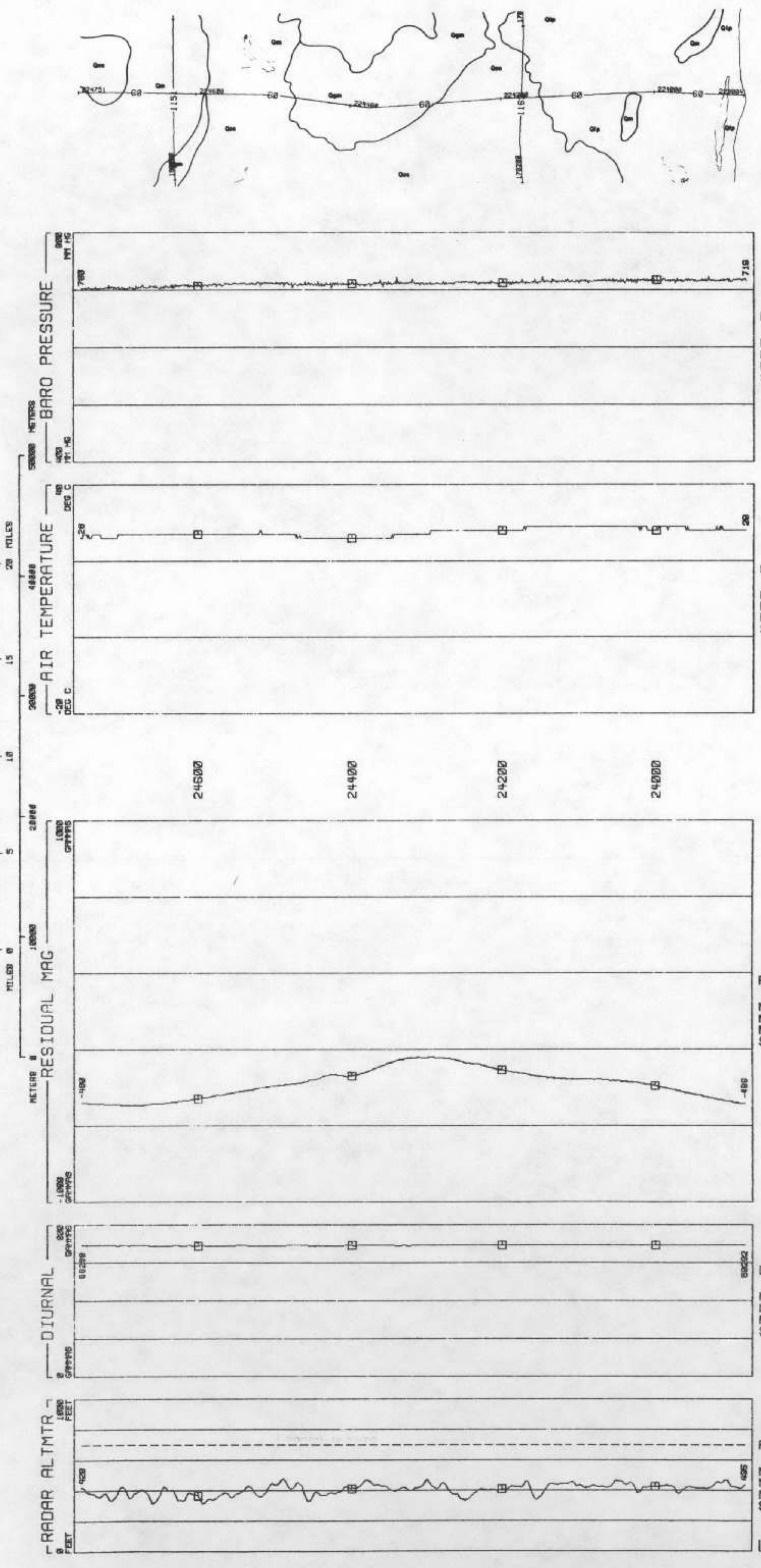
DIURNAL
GAMMAS
MIN 58285
MAX 58289
MEAN 58286
STD DEV 1.818

RADAR ALTMTR
FEET
MIN 343.6
MAX 543.6
MEAN 449.0
STD DEV 37.63

LINE 20


LINE 40
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81166
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
17600
17400
17200
17000
BARO PRESSURE MM HG
MIN 700.1
MAX 719.1
MEAN 710.2
STD DEV 3.762
AIR TEMPERATURE DEG C
MIN 28.00
MAX 29.00
MEAN 28.49
STD DEV .5000
RESIDUAL MAG GAMMAS
MIN -621.9
MAX -349.3
MEAN -518.2
STD DEV 86.70
DIURNAL GAMMAS
MIN 58279
MAX 58282
MEAN 58280
STD DEV 1.295
RADAR ALTMTR FEET
MIN 345.2
MAX 505.4
MEAN 413.9
STD DEV 32.70
LINE 40

LINE 60
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81166



BARO PRESSURE
MM HG

MIN	699.3
MAX	722.9
MEAN	711.4
STD DEV	4.350

AIR TEMPERATURE
DEG C

MIN	26.00
MAX	29.00
MEAN	27.53
STD DEV	1.030

RESIDUAL MAG
GAMMAS

MIN	-491.9
MAX	-240.5
MEAN	-377.8
STD DEV	76.64

DIURNAL
GAMMAS

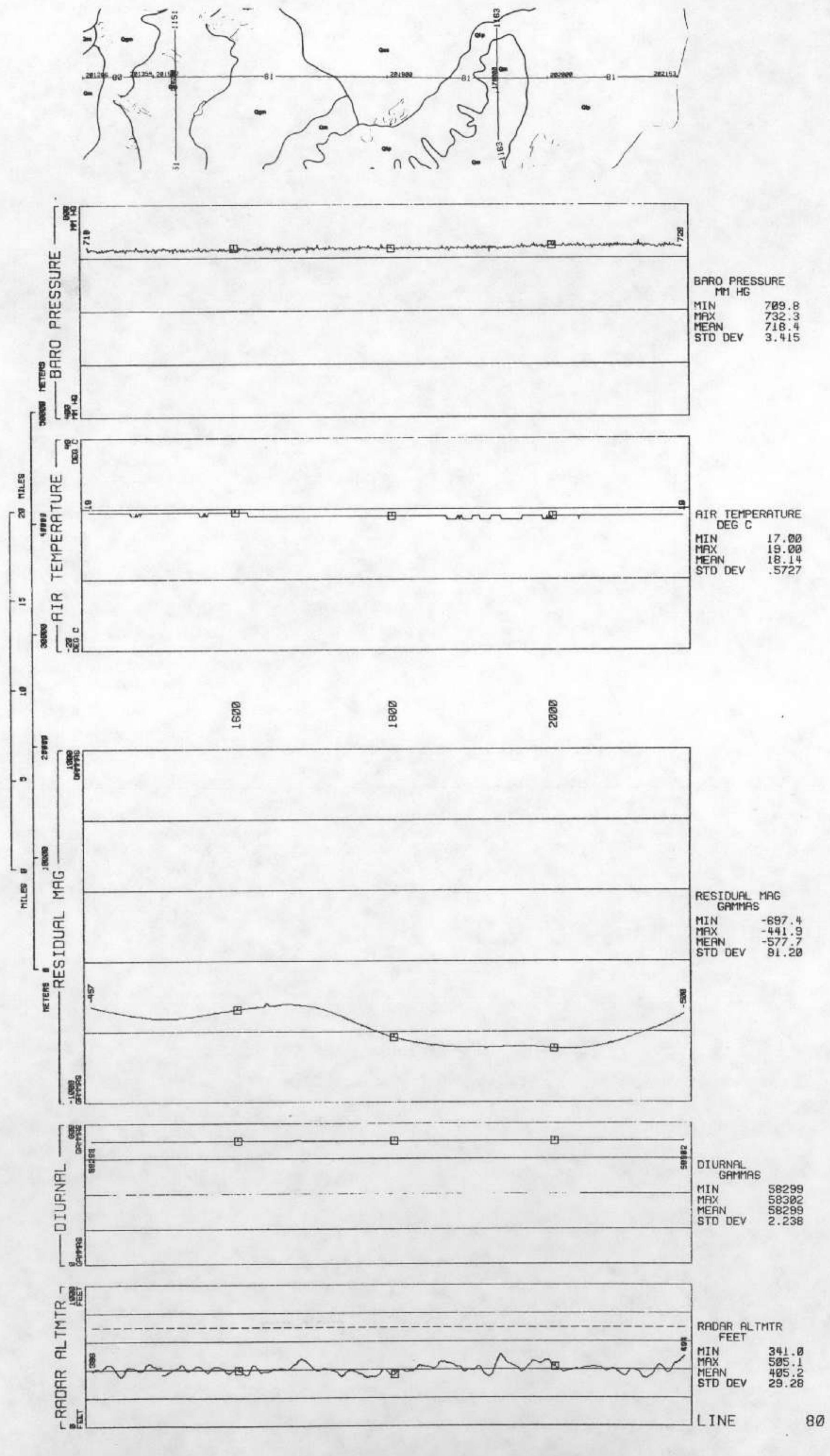
MIN	58289
MAX	58292
MEAN	58288
STD DEV	2.345

RADAR ALTMTR
FEET

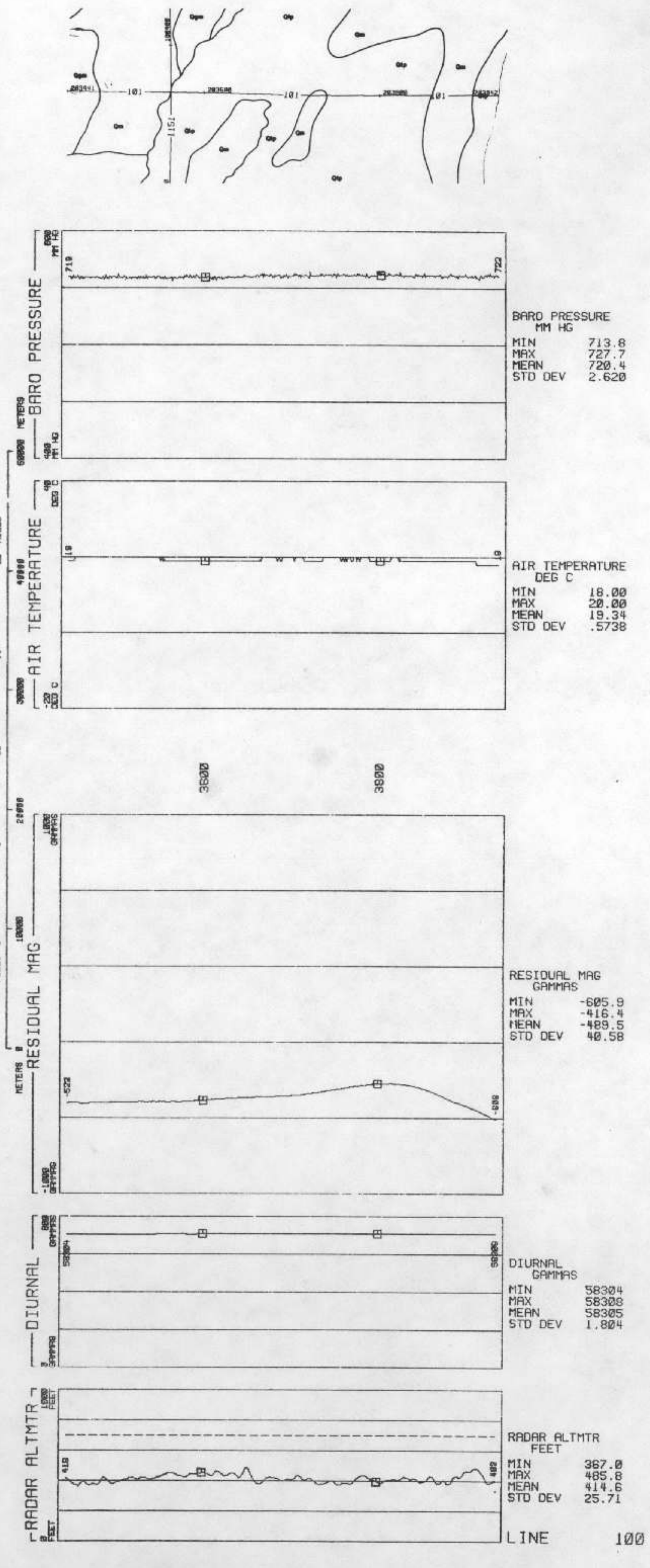
MIN	314.3
MAX	474.3
MEAN	405.3
STD DEV	34.50

LINE 60

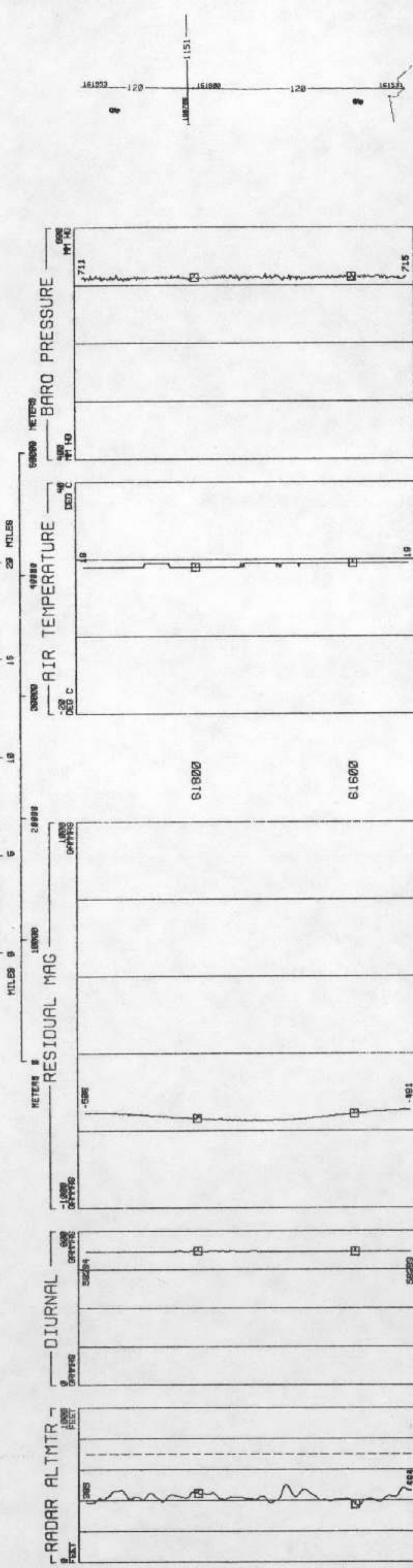
LINE 80
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81163



D59 tf


LINE 100
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81163
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
BARO PRESSURE MM HG
MIN 713.8
MAX 727.7
MEAN 720.4
STD DEV 2.620
AIR TEMPERATURE DEG C
MIN 18.00
MAX 20.00
MEAN 19.34
STD DEV .5738
RESIDUAL MAG GAMMAS
MIN -605.9
MAX -416.4
MEAN -489.5
STD DEV 40.58
DIURNAL GAMMAS
MIN 58304
MAX 58308
MEAN 58305
STD DEV 1.804
RADAR ALTMTR FEET
MIN 367.0
MAX 485.8
MEAN 414.6
STD DEV 25.71
LINE 100

LINE 120
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81161



BARO PRESSURE
MM HG
MIN 707.7
MAX 719.6
MEAN 712.9
STD DEV 1.872

AIR TEMPERATURE
DEG C
MIN 18.00
MAX 19.00
MEAN 18.56
STD DEV .4960

RESIDUAL MAG
GAMMAS
MIN -548.7
MAX -489.5
MEAN -525.2
STD DEV 17.01

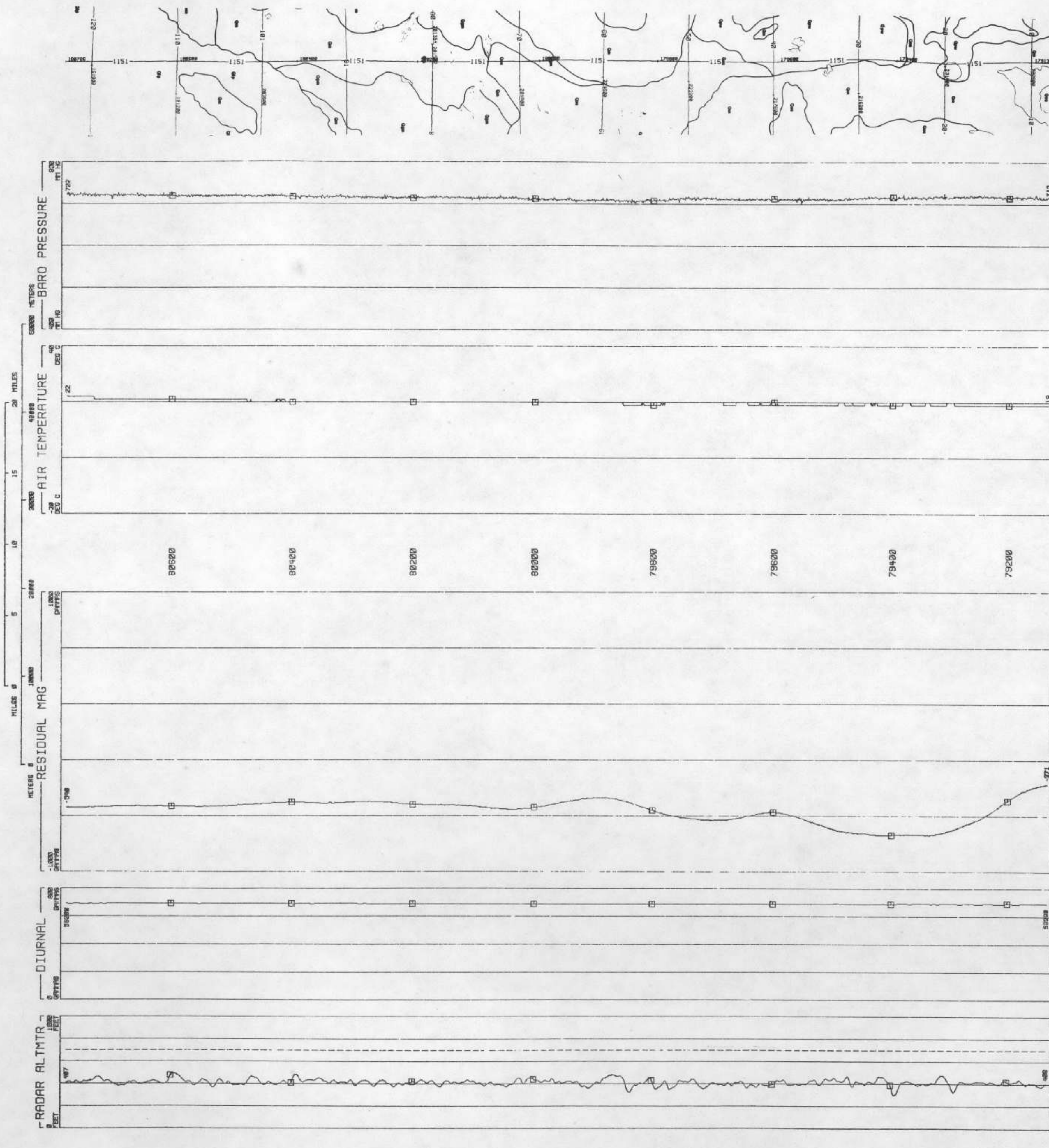
DIURNAL
GAMMAS
MIN 58293
MAX 58294
MEAN 58293
STD DEV 1.078

RADAR ALTMTR
FEET
MIN 364.0
MAX 500.6
MEAN 421.8
STD DEV 25.21

LINE 120

D61 tf

LINE 1150
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81161



BARO PRESSURE
MM HG
MIN 701.7
MAX 727.7
MEAN 714.5
STD DEV 3.853

AIR TEMPERATURE
DEG C
MIN 19.00
MAX 22.00
MEAN 19.90
STD DEV .7609

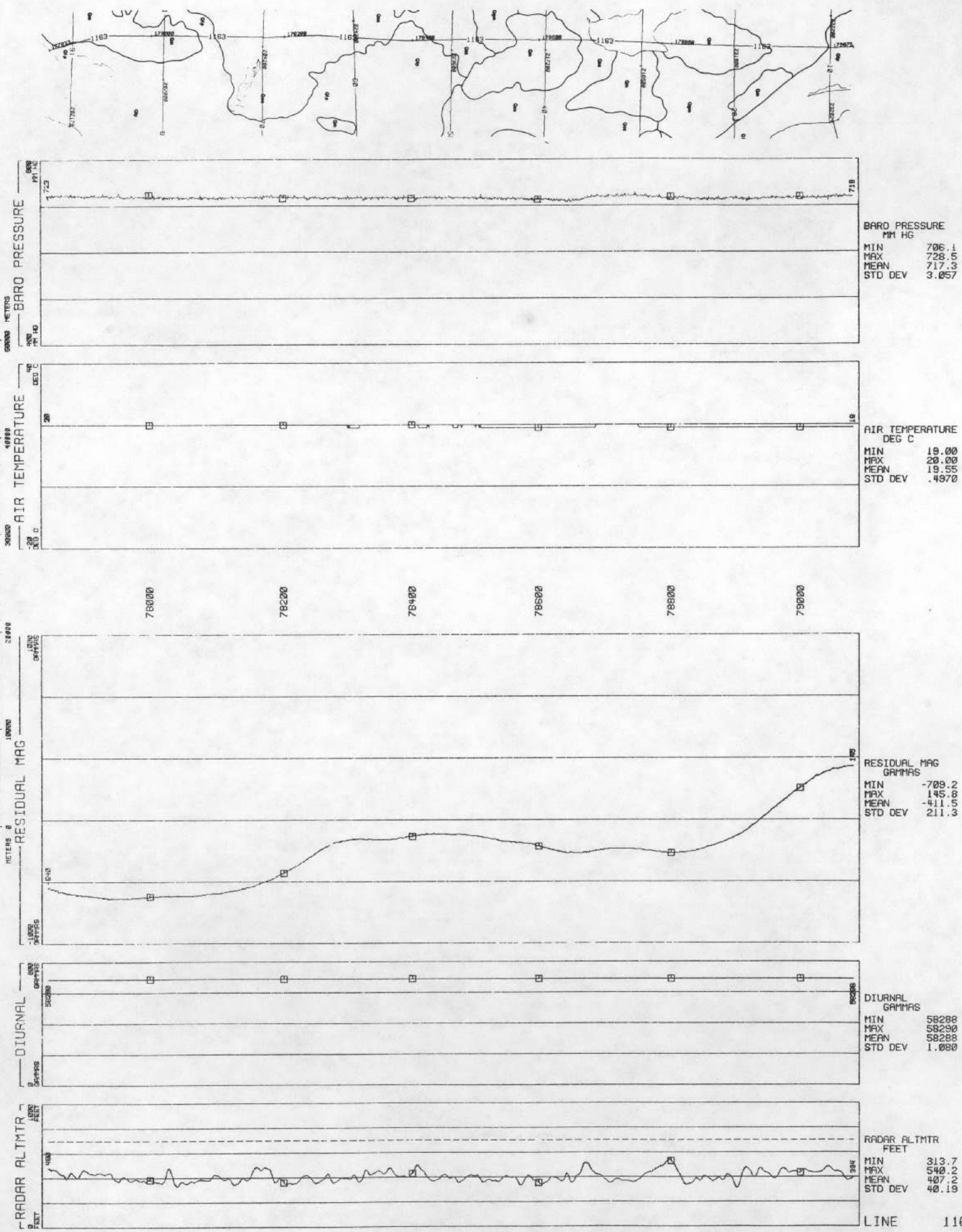
RESIDUAL MAG
GAMMAS
MIN -736.8
MAX -370.7
MEAN -563.8
STD DEV 80.64

DIURNAL
GAMMAS
MIN 58288
MAX 58291
MEAN 58288
STD DEV 1.504

RADAR ALTMTR
FEET
MIN 300.8
MAX 492.0
MEAN 411.4
STD DEV 26.37

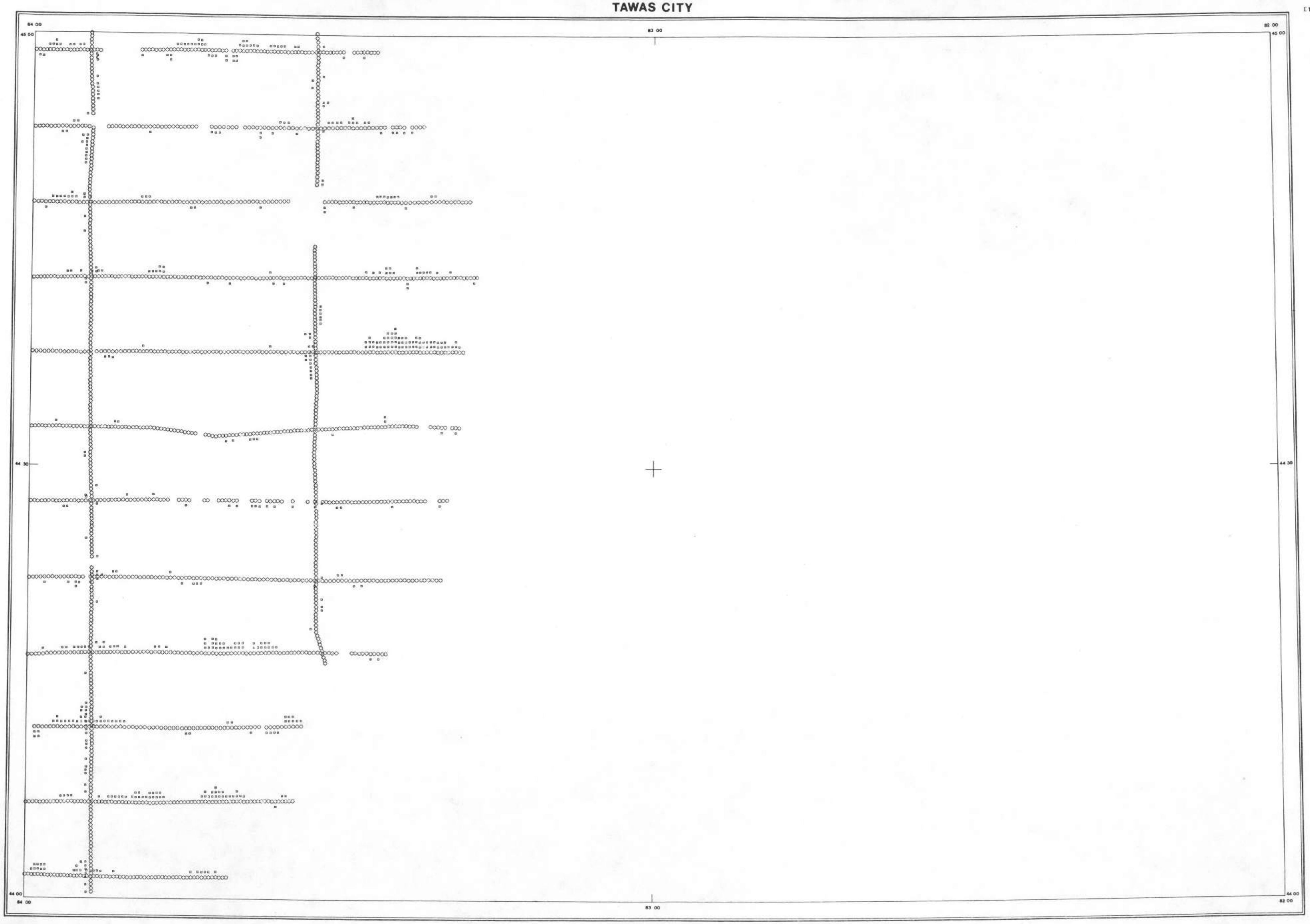
LINE 1150

LINE 1160
TAWAS CITY QUADRANGLE - NTMS NL 17-10
DATA ACQUIRED 81156



APPENDIX E - Standard Deviation Maps

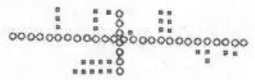
TAWAS CITY



SCALE 1:500,000

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS



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.

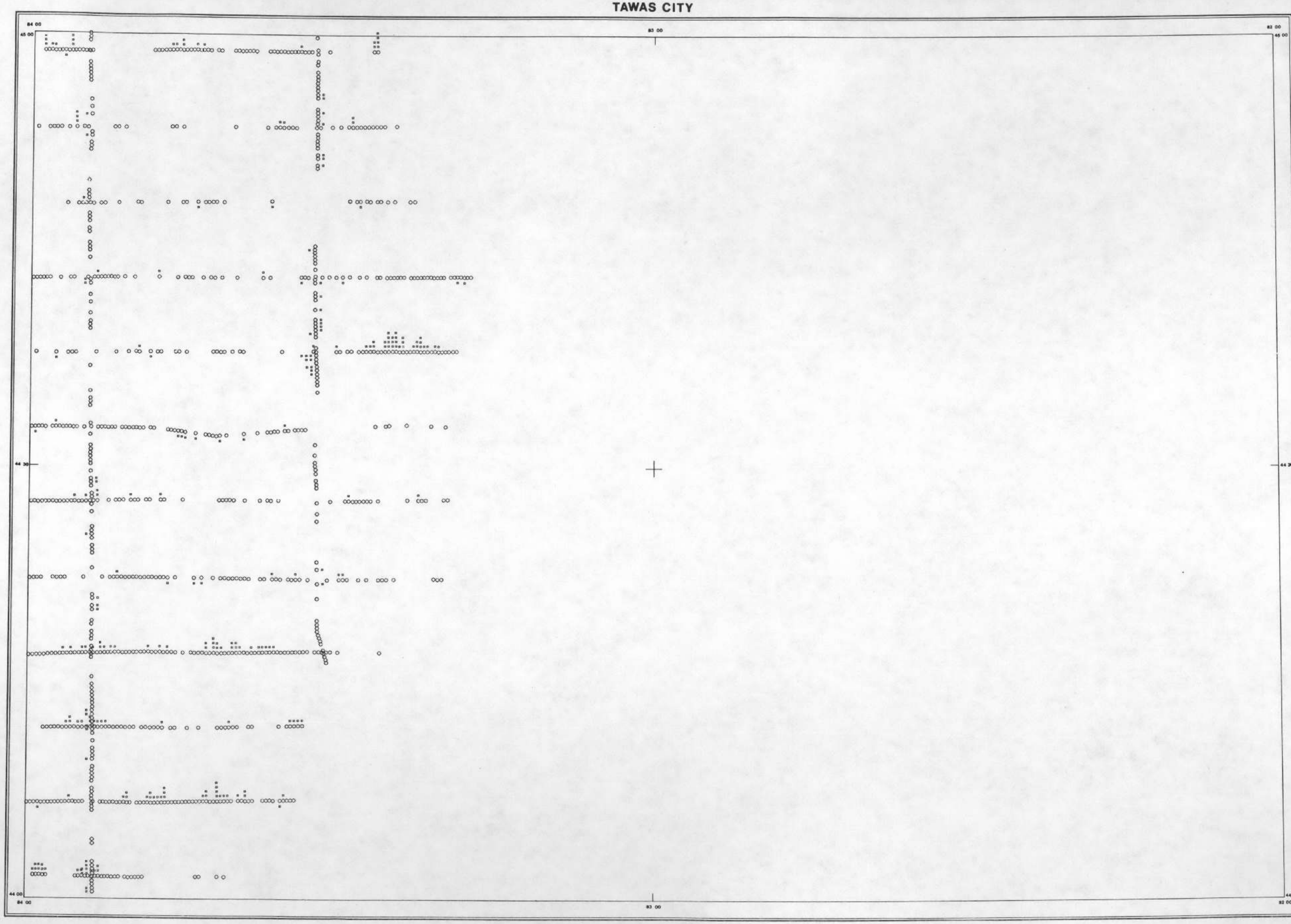
LOCATION DIAGRAM

POTASSIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

TAWAS 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

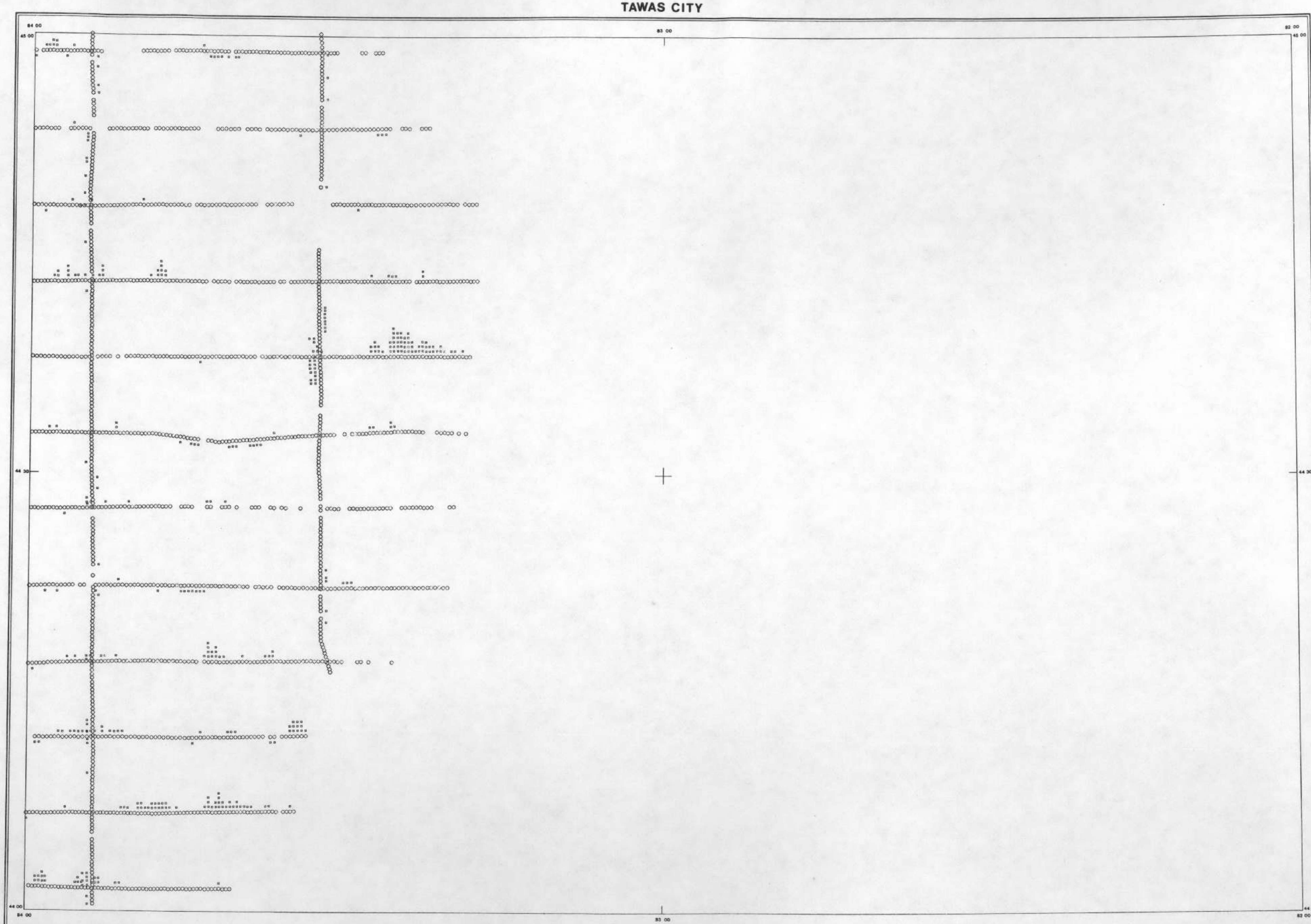
LOCATION DIAGRAM

URANIUM STANDARD DEVIATION MAP

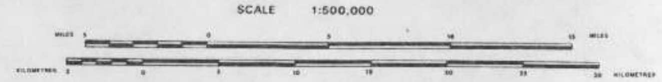
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

TAWAS CITY

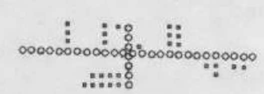


SCALE 1:500,000



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.

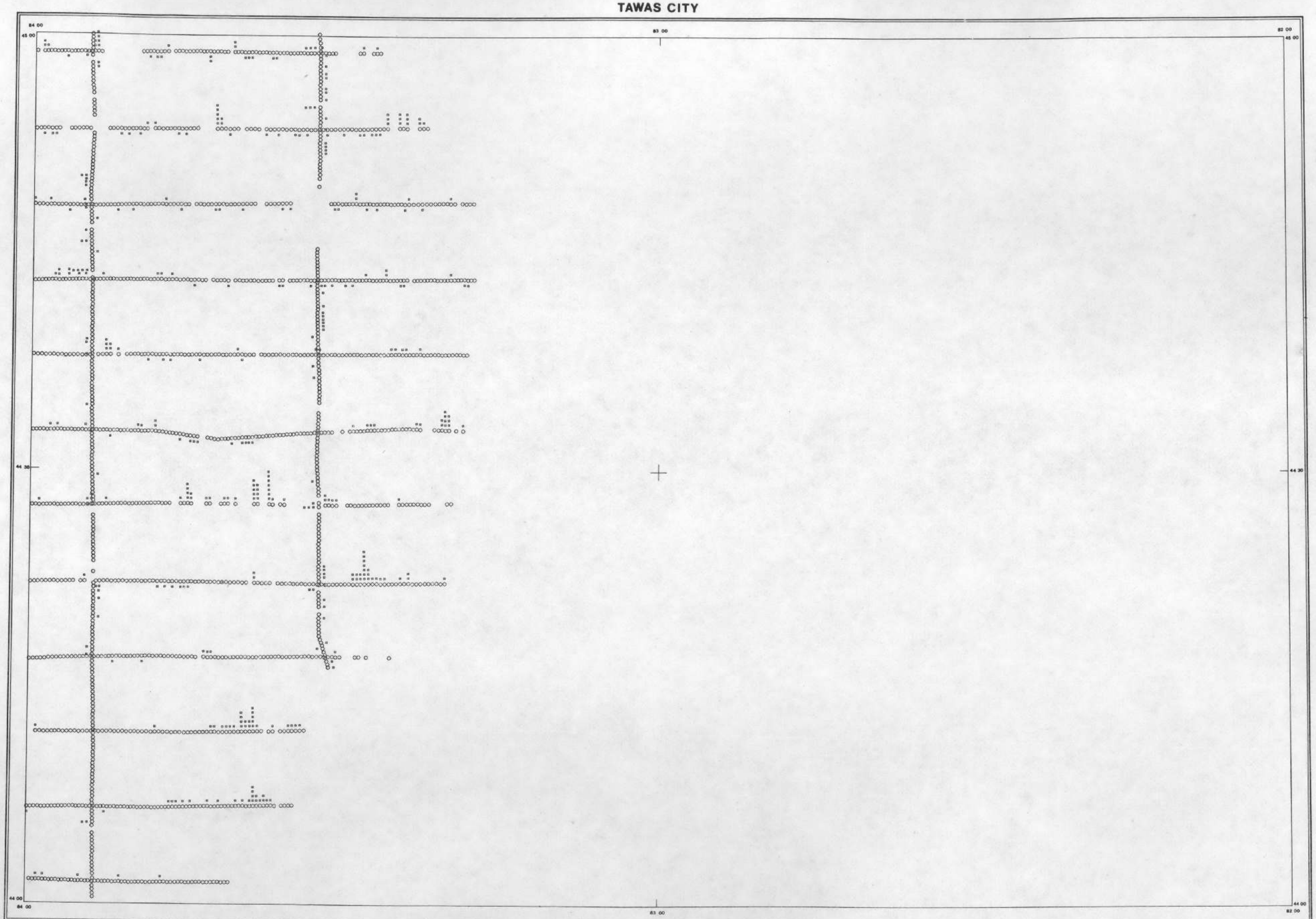
LOCATION DIAGRAM

THORIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

TAWAS 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

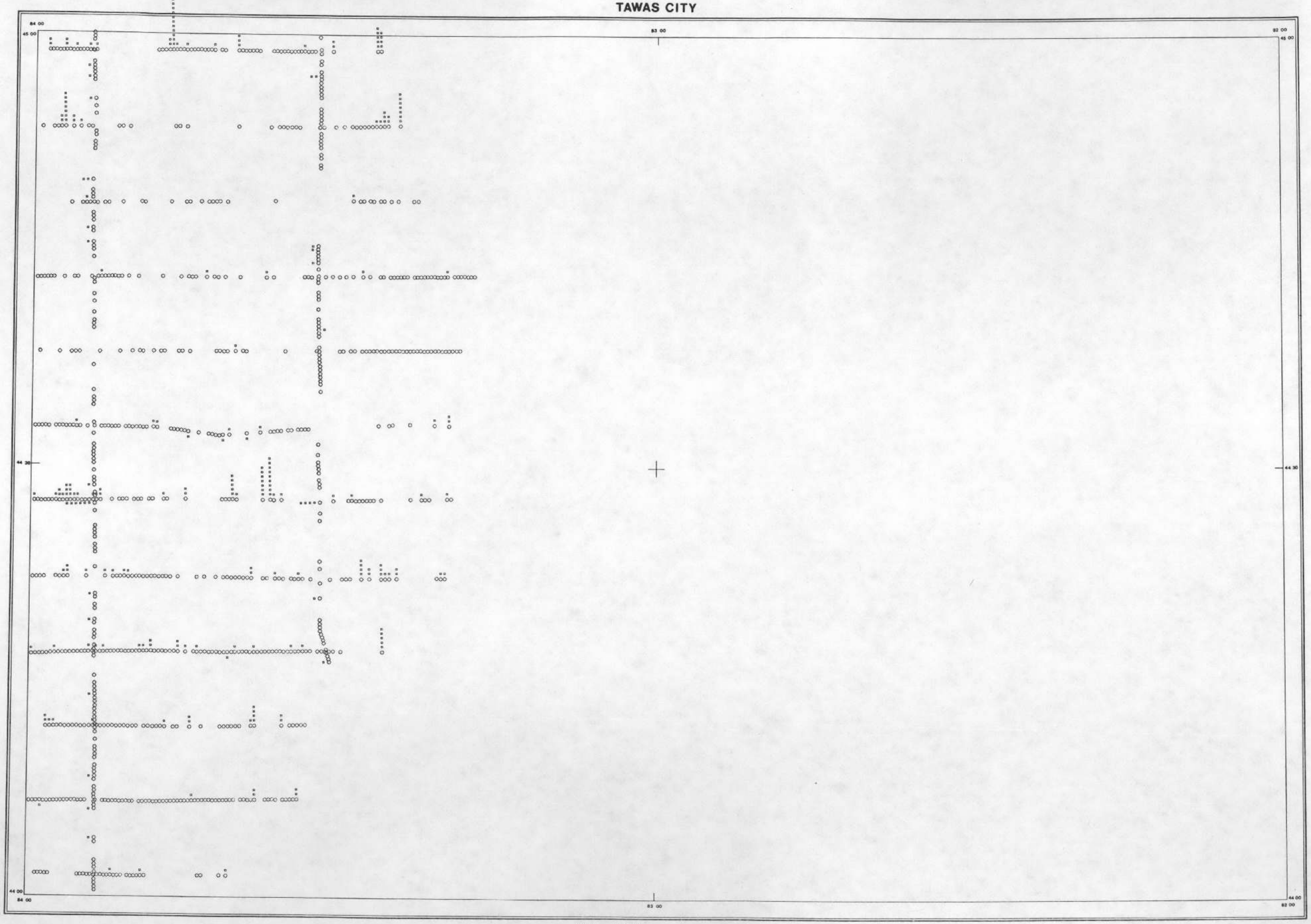
LOCATION DIAGRAM

THORIUM / POTASSIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

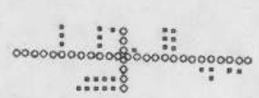
TAWAS CITY



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.

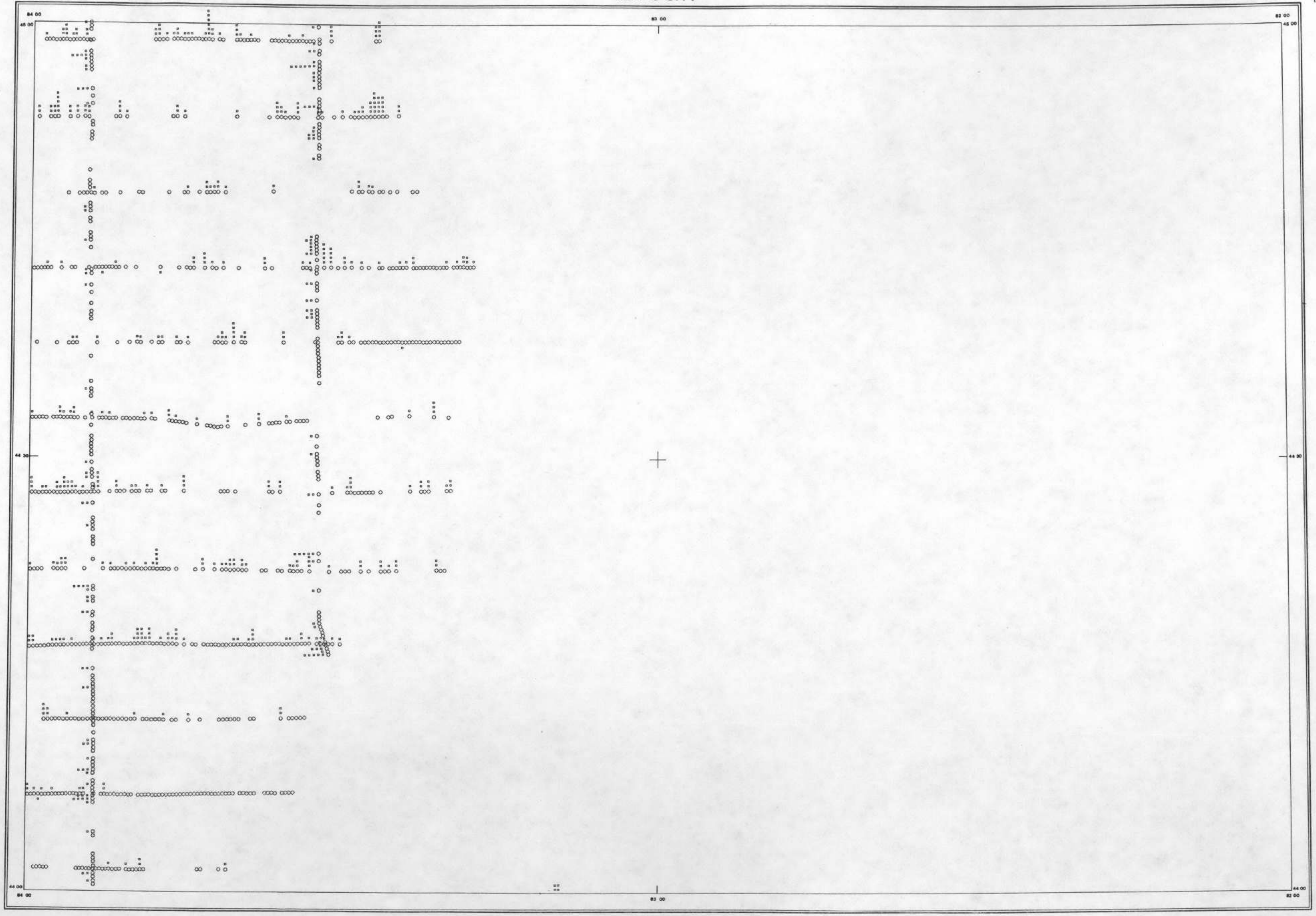
LOCATION DIAGRAM

URANIUM / POTASSIUM STANDARD DEVIATION MAP

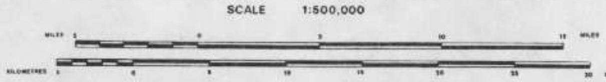
GREAT LAKES PROJECT

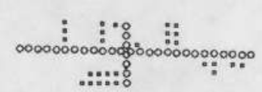
U. S. DEPARTMENT OF ENERGY

TAWAS CITY



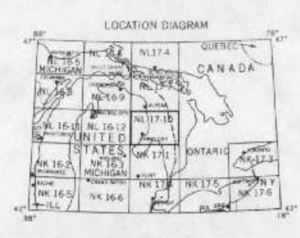
SCALE 1:500,000





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

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



SURVEY AND COMPILATION BY:

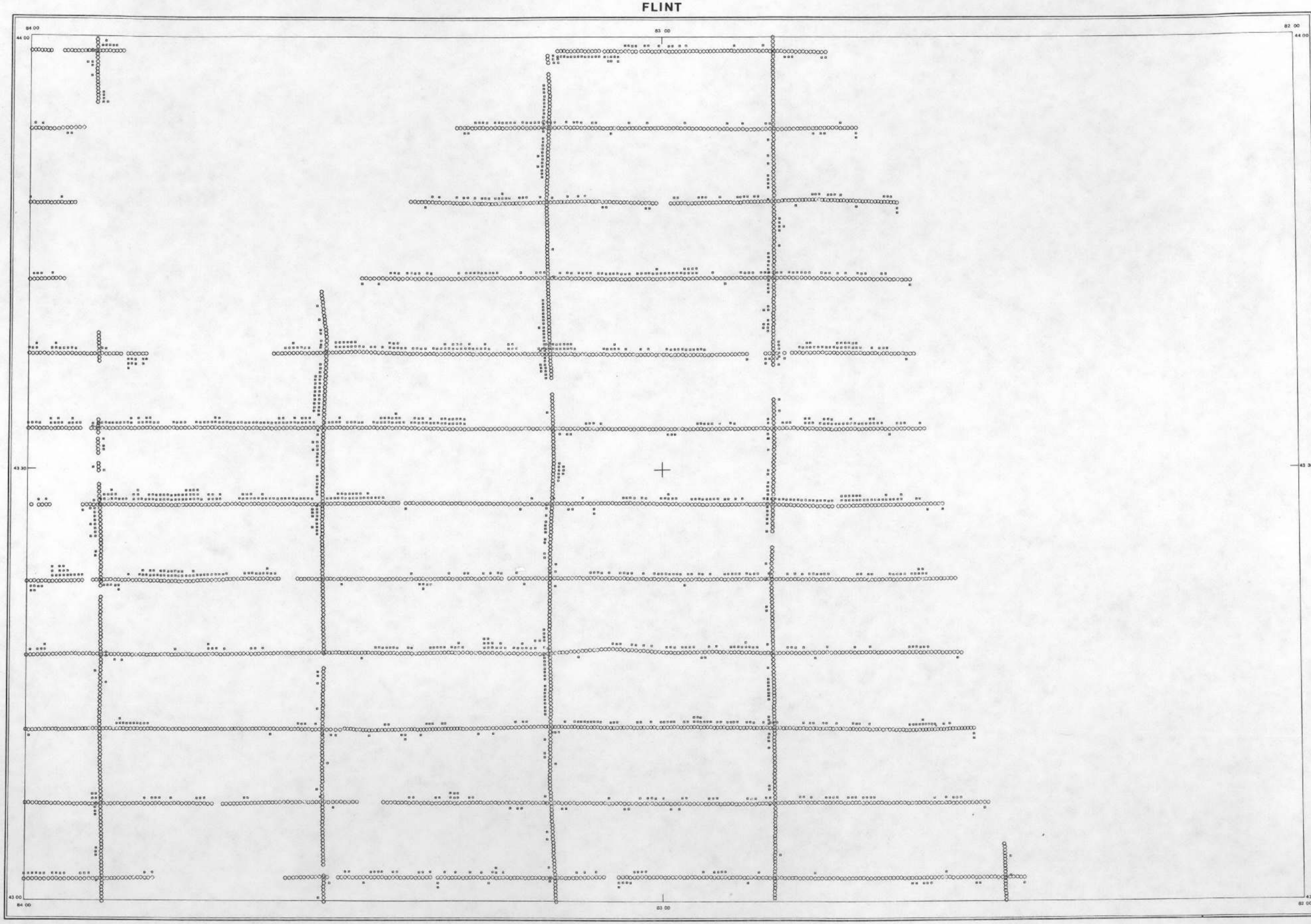
EG&G GEOMETRICS

URANIUM / THORIUM STANDARD DEVIATION MAP

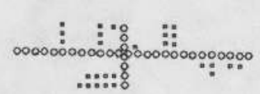
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

FLINT



SCALE 1:500,000

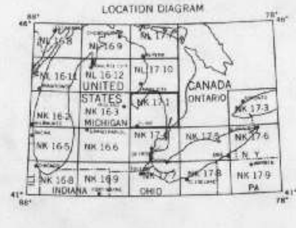


○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▪ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY
NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH. ON N-S LINES, +σ TO WEST, -σ TO EAST.

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

LOCATION DIAGRAM

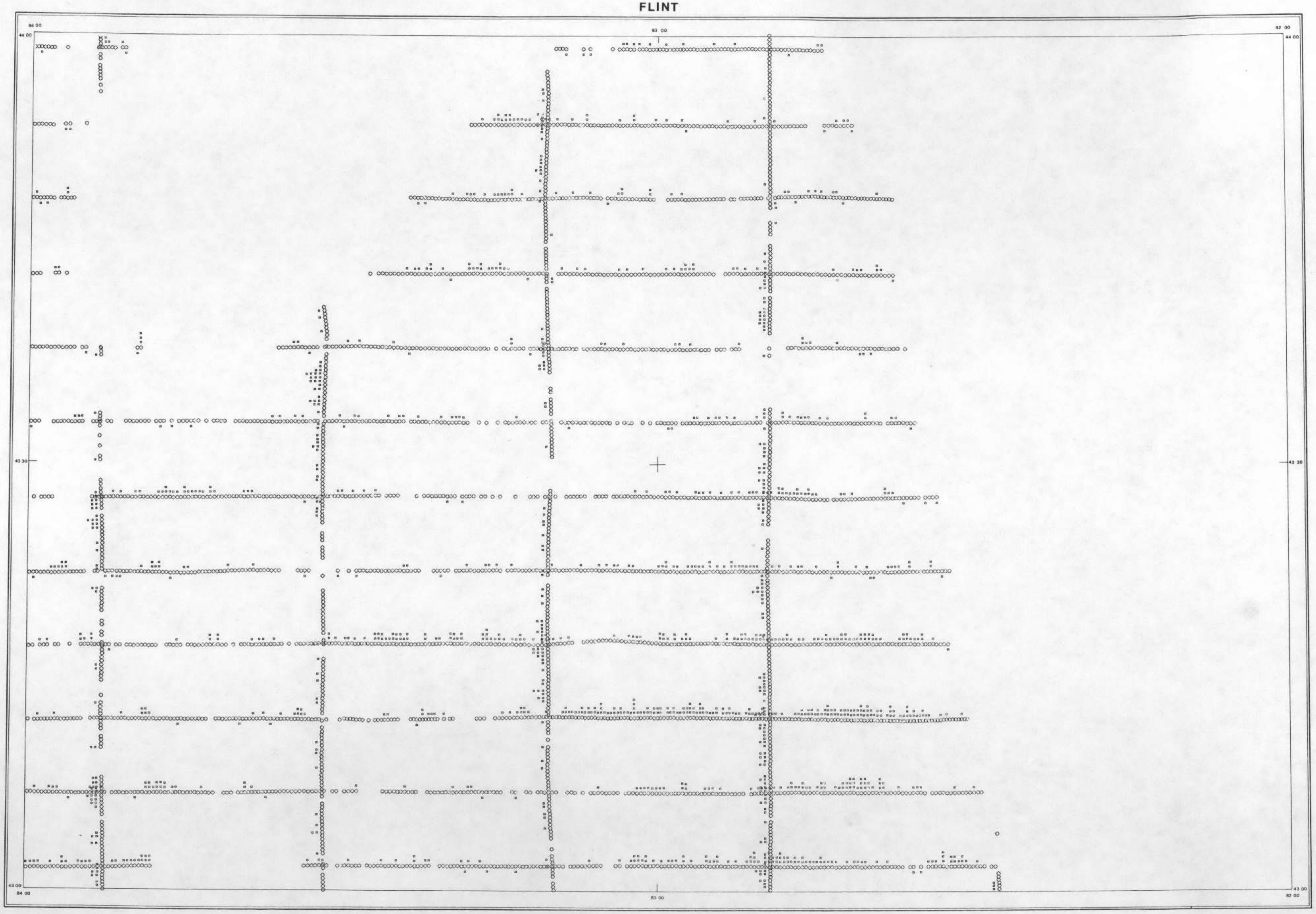


POTASSIUM STANDARD DEVIATION MAP

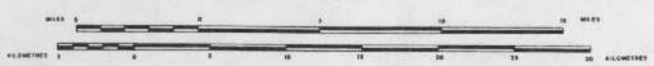
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

FLINT

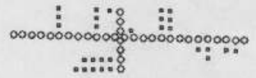


SCALE 1:500,000



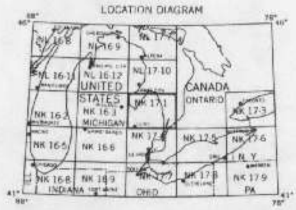
SURVEY AND COMPILATION BY:

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.

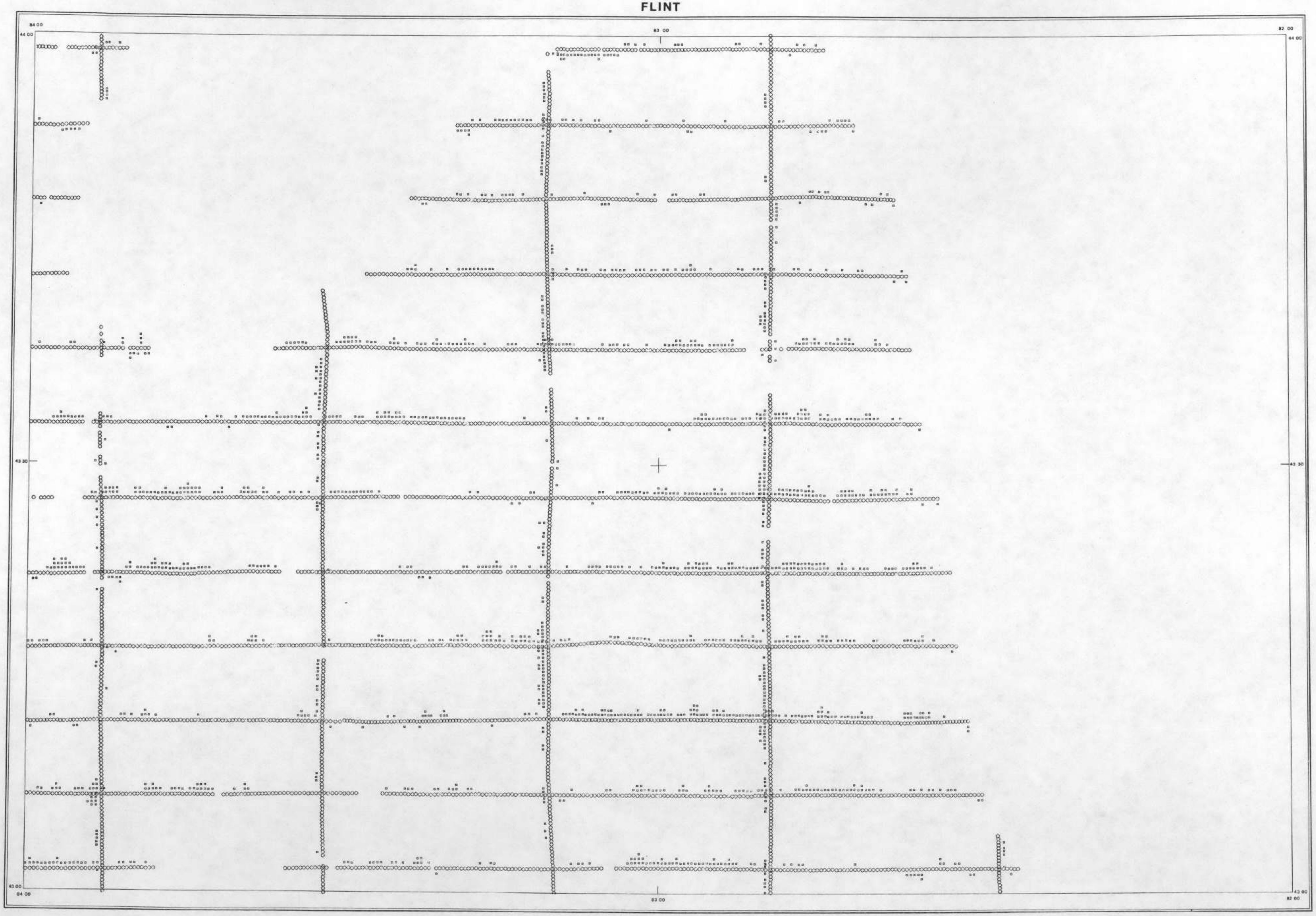


URANIUM STANDARD DEVIATION MAP

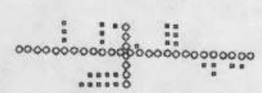
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

FLINT

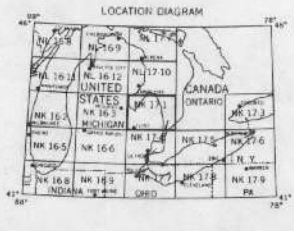


SCALE 1:500,000



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:

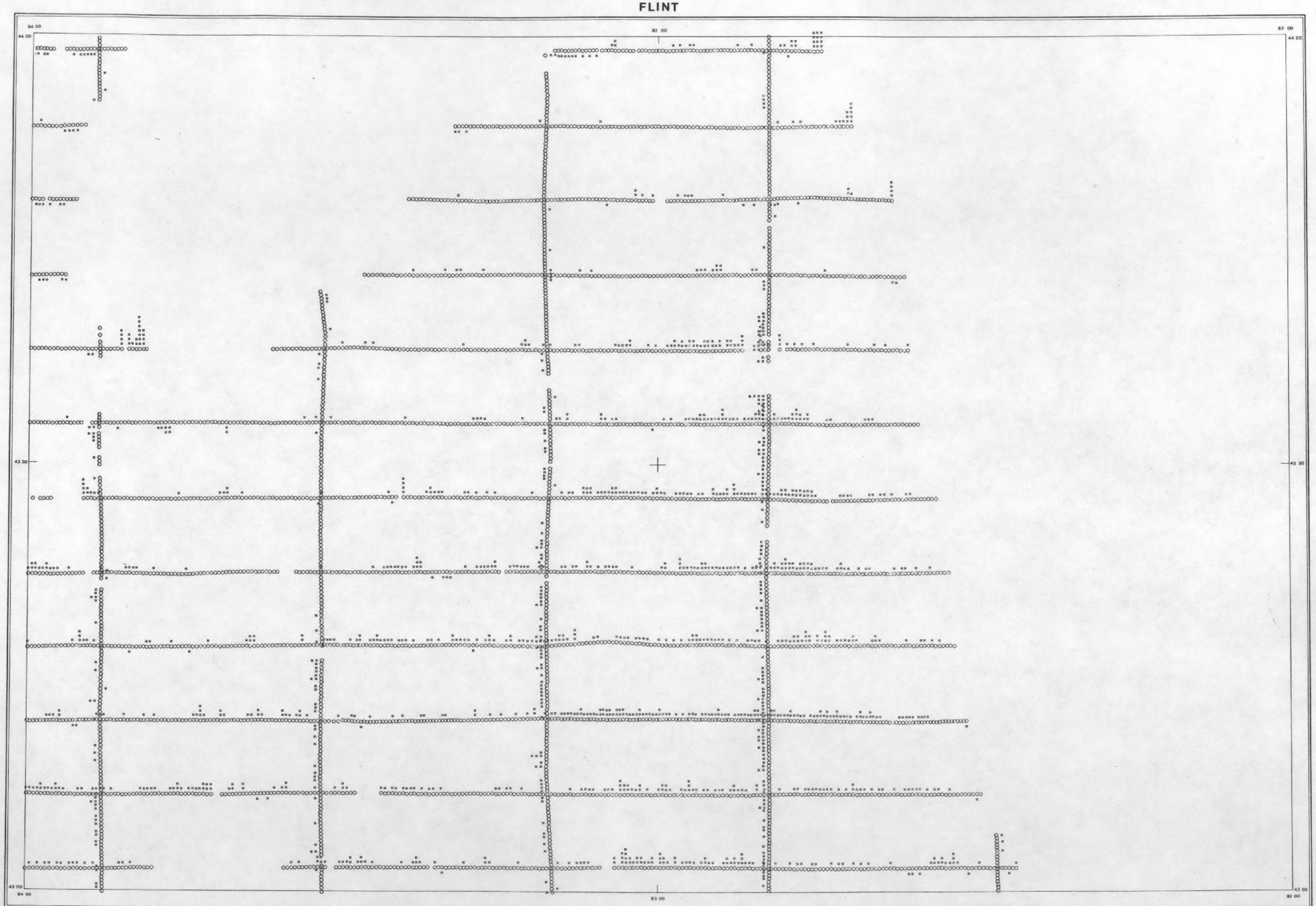
EG&G GEOMETRICS

THORIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

FLINT



SCALE 1:500,000

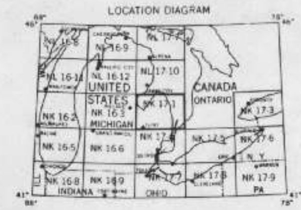
MILES 0 5 10 15 MILES

KILOMETRES 0 5 10 15 20 25 30 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



SURVEY AND COMPILATION BY:

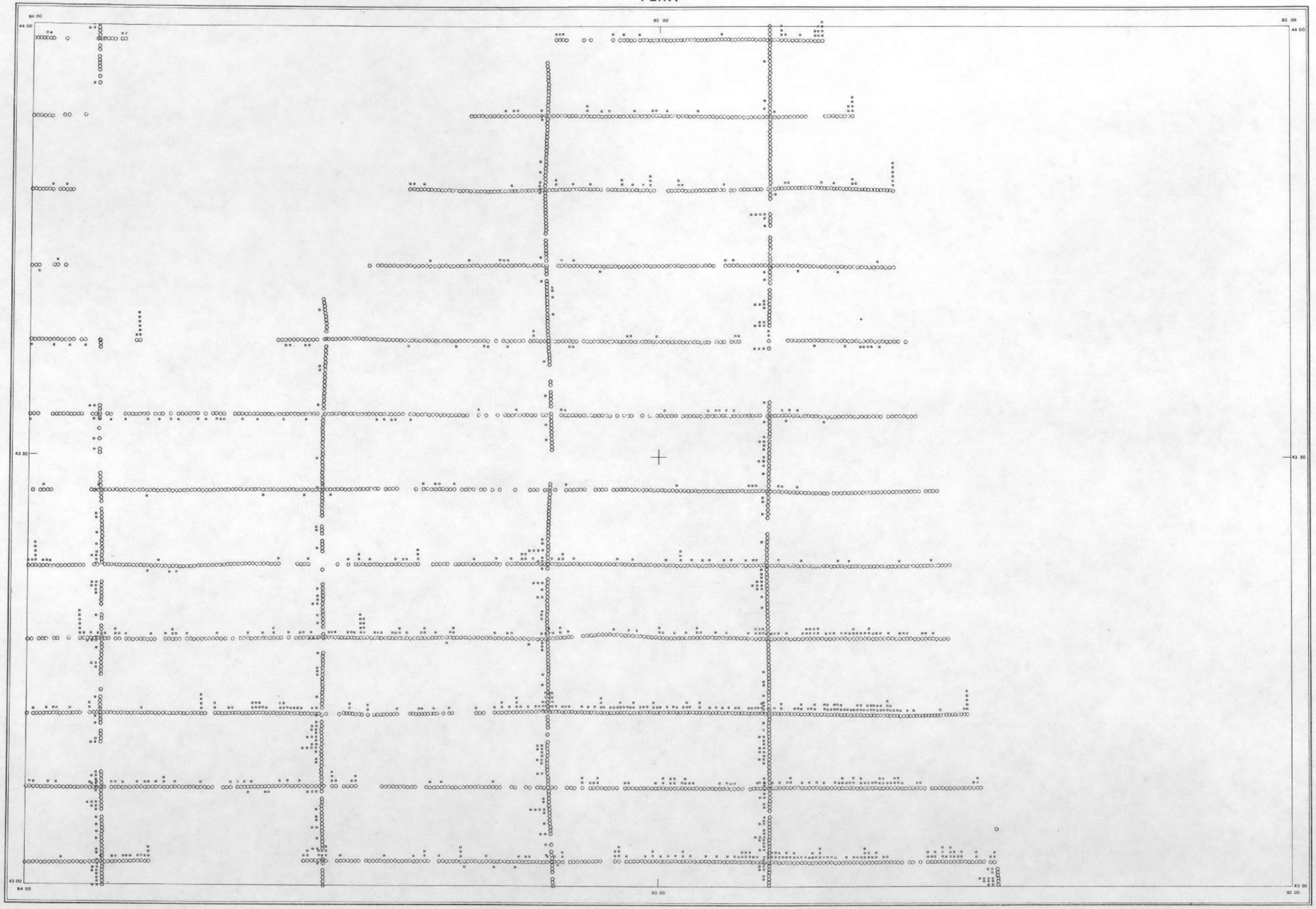
EG&G GEOMETRICS

THORIUM / POTASSIUM STANDARD DEVIATION MAP

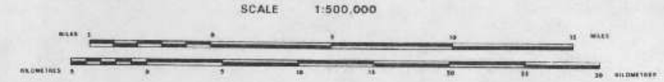
GREAT LAKES PROJECT

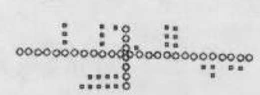
U. S. DEPARTMENT OF ENERGY

FLINT

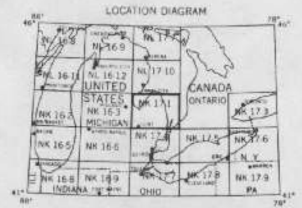


SCALE 1:500,000





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

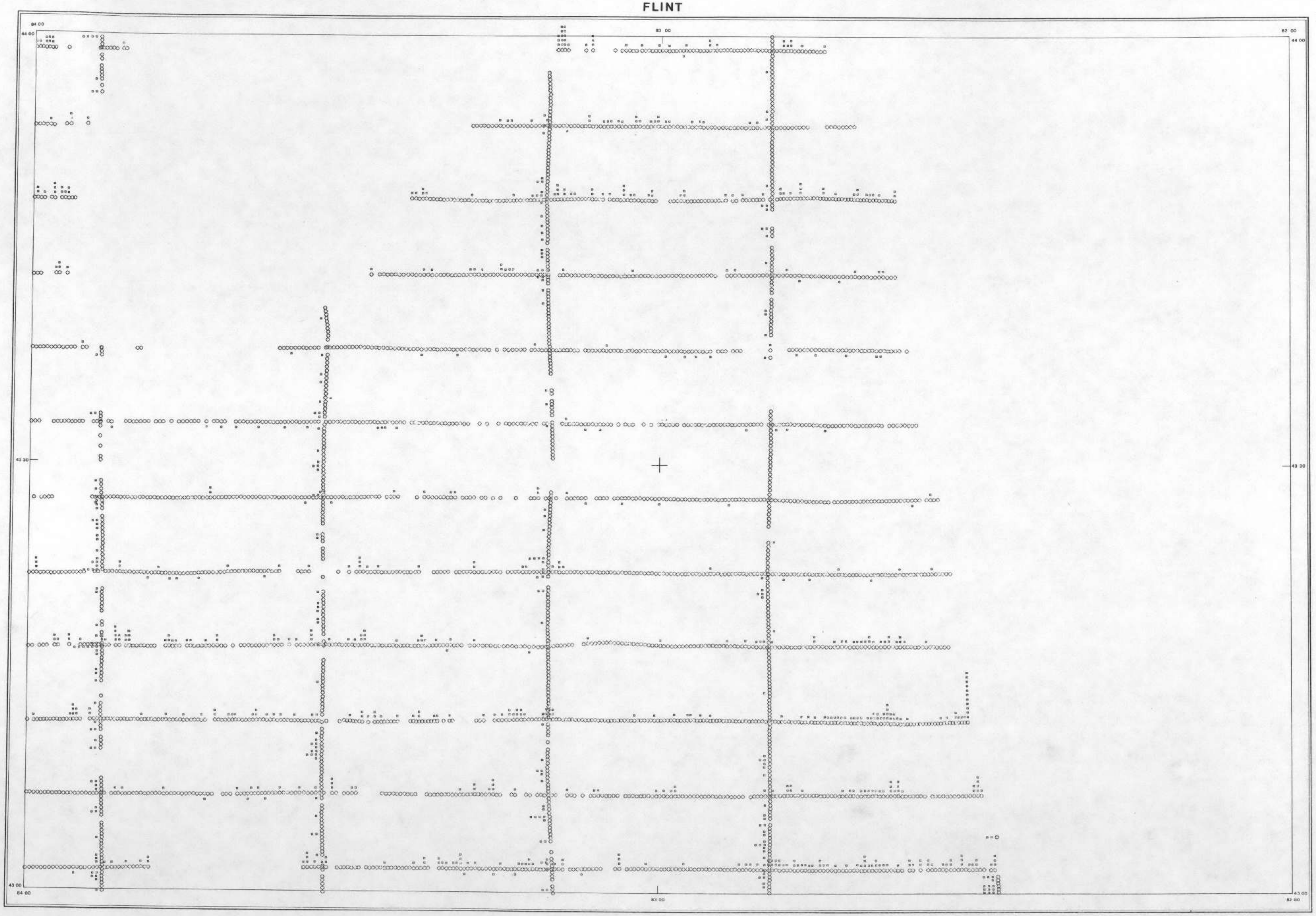
EG&G GEOMETRICS

URANIUM / POTASSIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

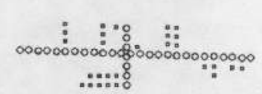
FLINT



SCALE 1:500,000

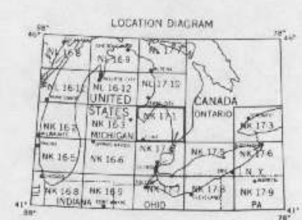
SURVEY AND COMPILATION BY:

EG&G GEOMETRICS



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.



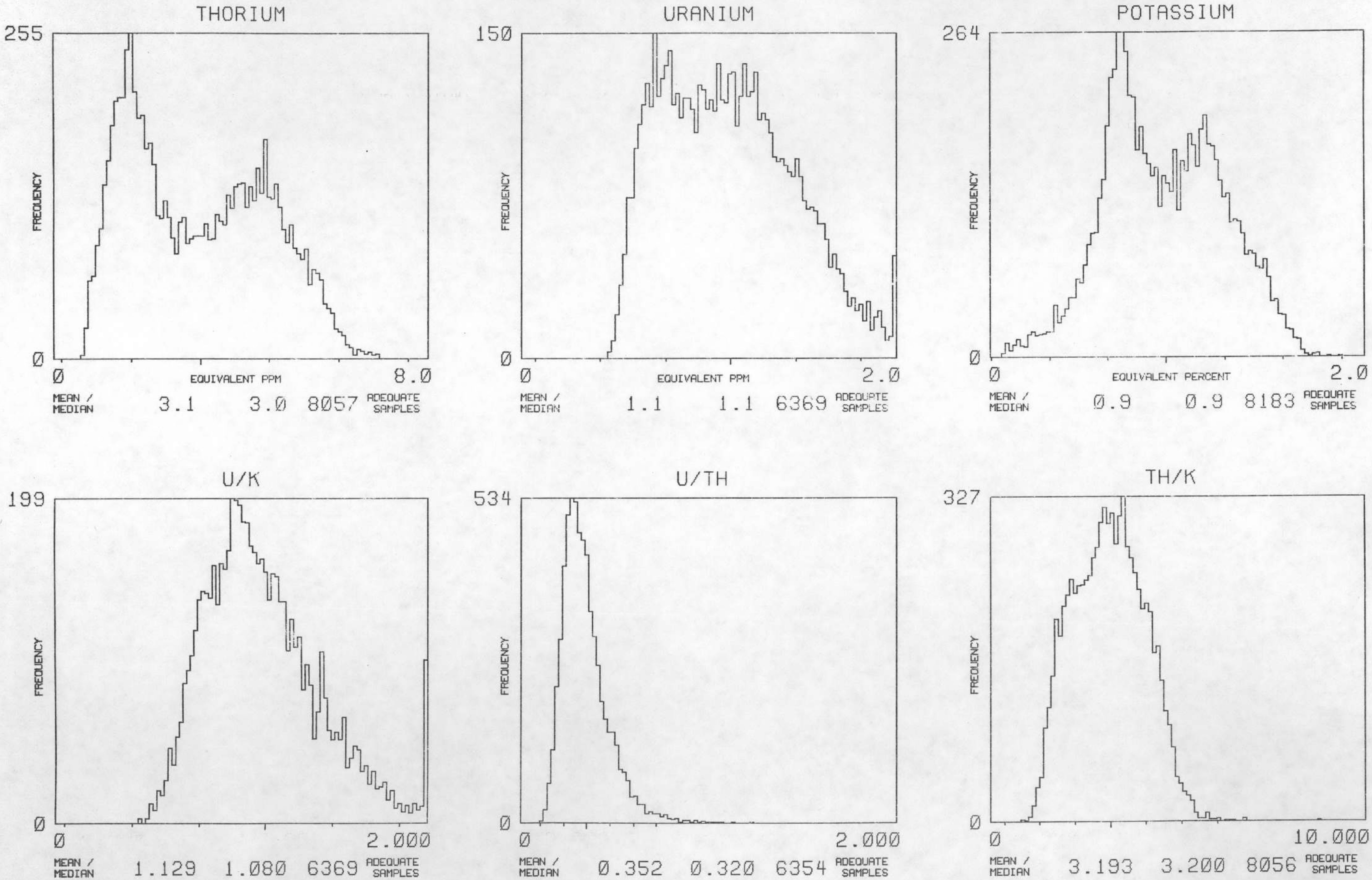
URANIUM / THORIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

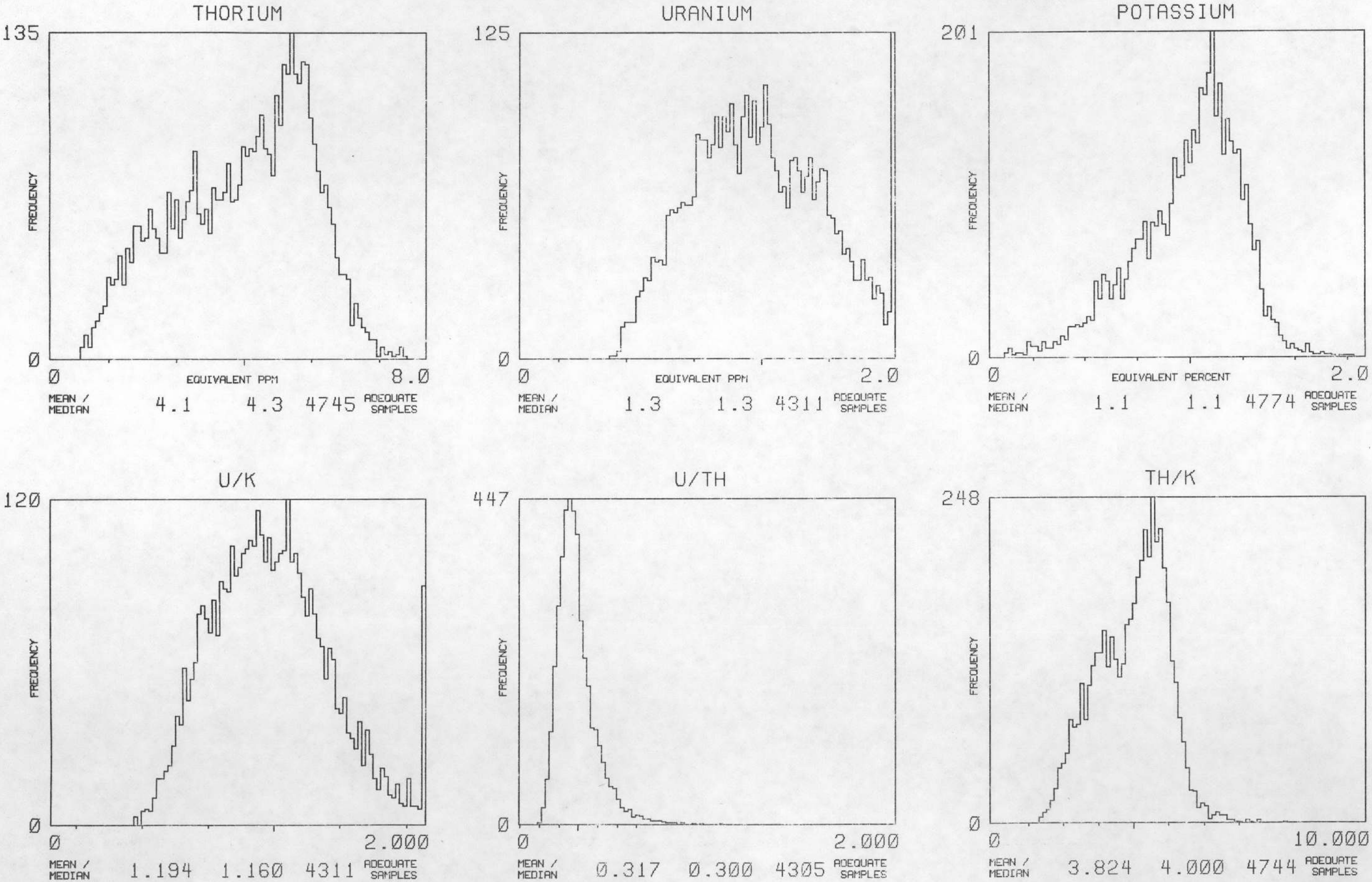
U. S. DEPARTMENT OF ENERGY

APPENDIX F – Histograms and Map Unit Conversion Table

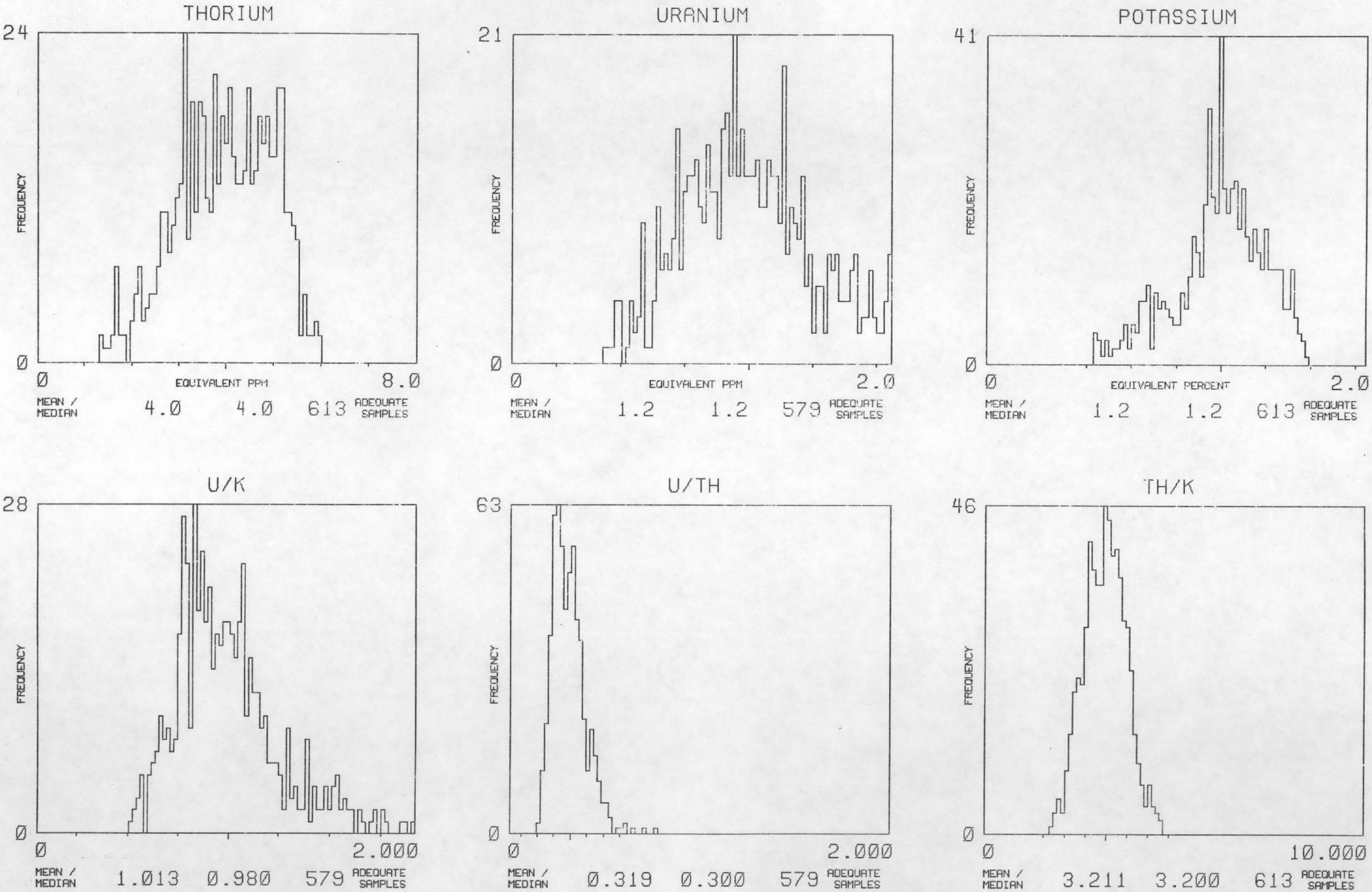
NK/NL 17-1/10 FLINT/TAVAS CITY MAP UNIT : QM TOTAL NUMBER OF SAMPLES 8193



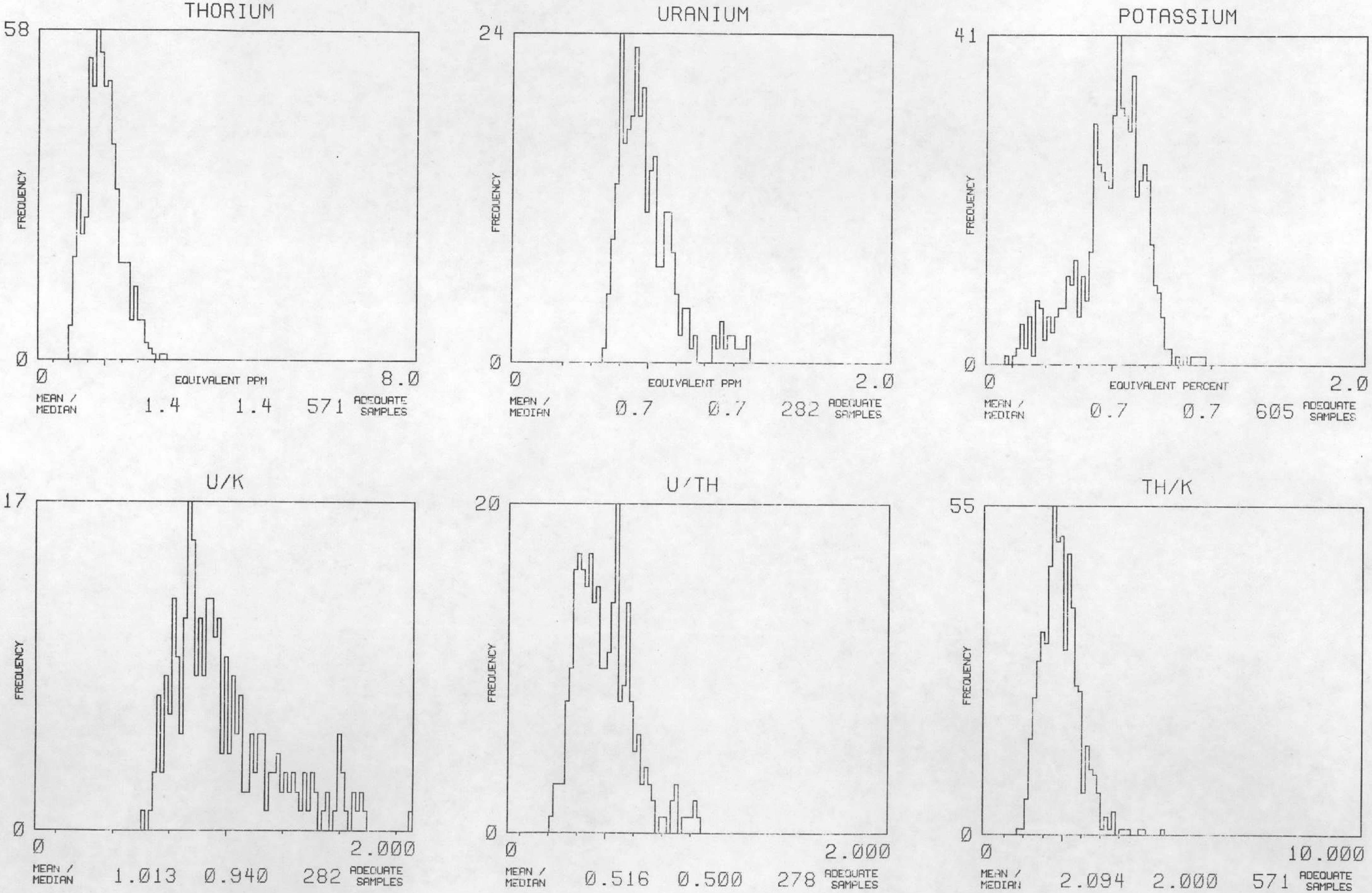
NK/NL 17-1/10 FLINT/TAWAS CITY MAP UNIT : QGM TOTAL NUMBER OF SAMPLES 4788 F2tf



NK/NL 17-1/10 FLINT/TAWAS CITY MAP UNIT : QWM TOTAL NUMBER OF SAMPLES 613



NK/NL 17-1/10 FLINT/TAWAS CITY MAP UNIT : QPW TOTAL NUMBER OF SAMPLES 606

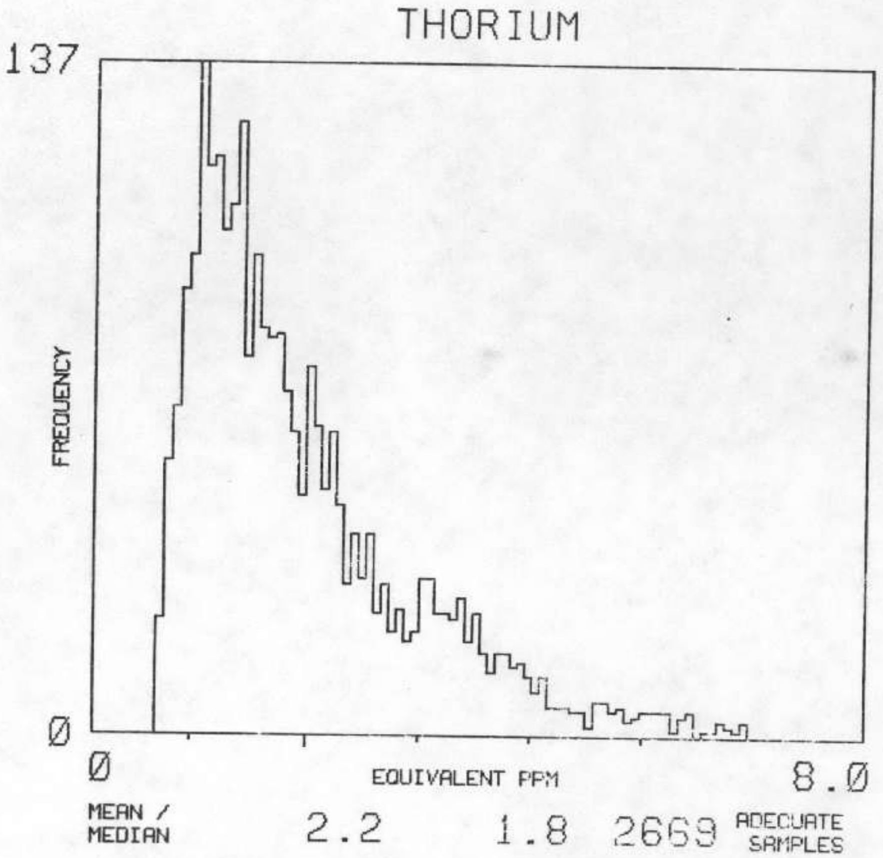


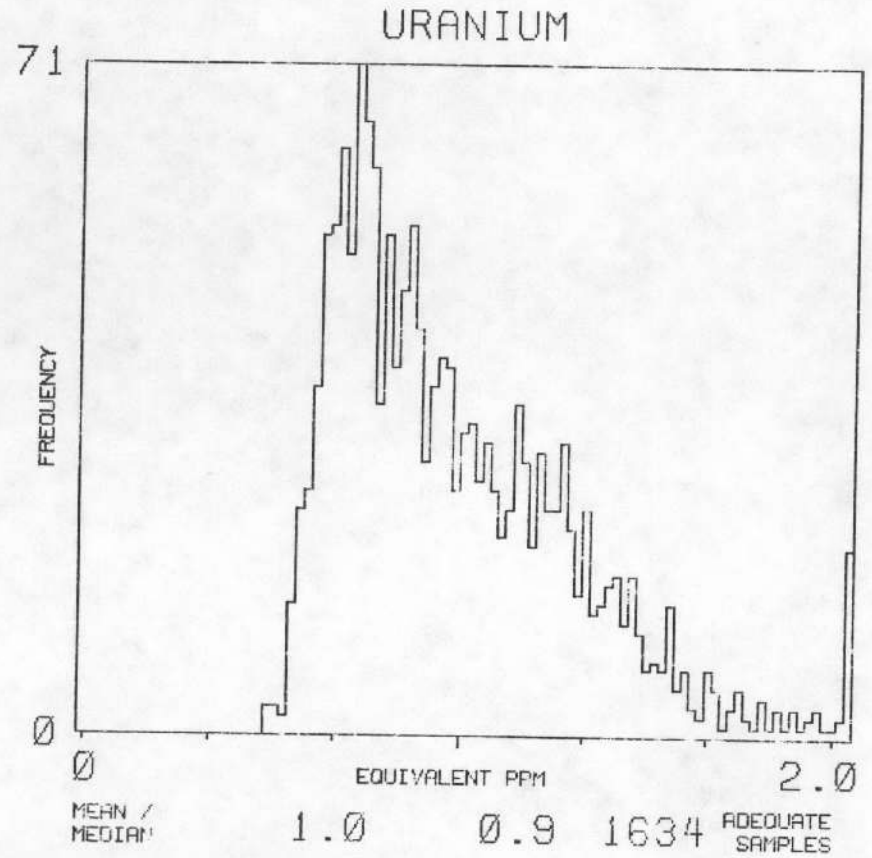
F4tf

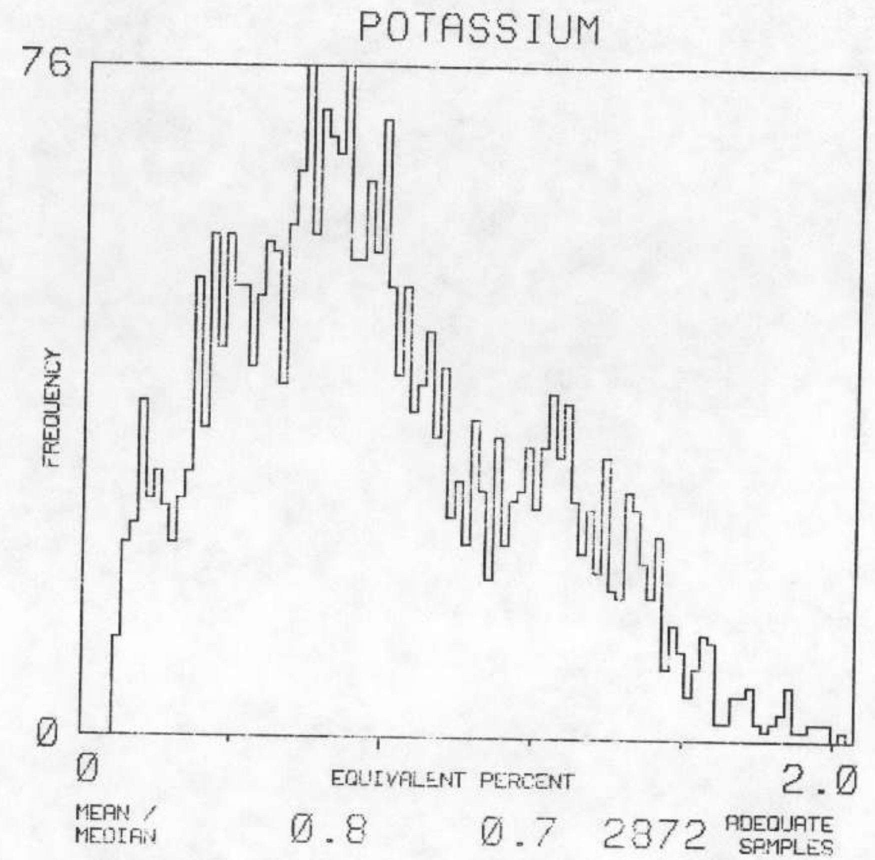
NK/NL 17-1/10 FLINT/TAVAS CITY

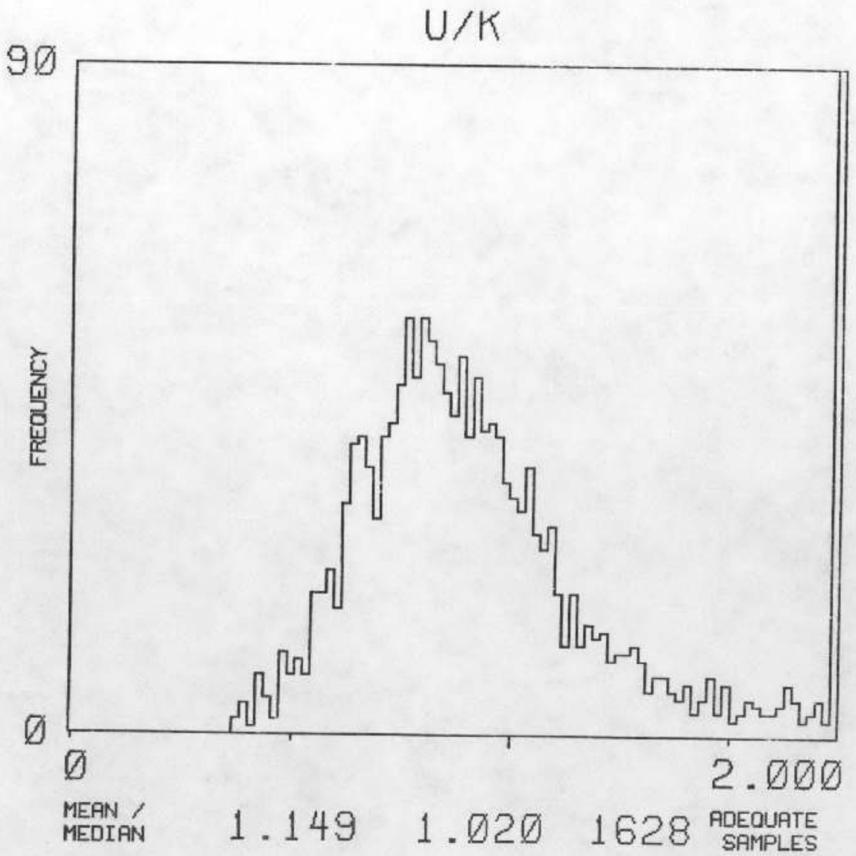
MAP UNIT : QLP TOTAL NUMBER OF SAMPLES 2921

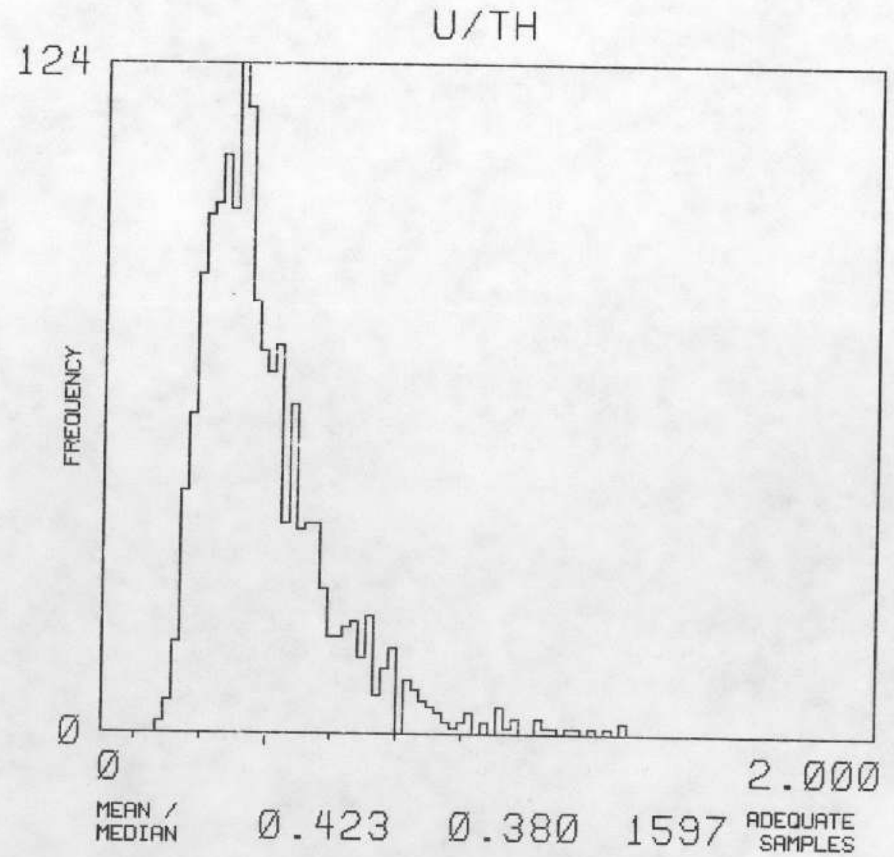
F5 tf

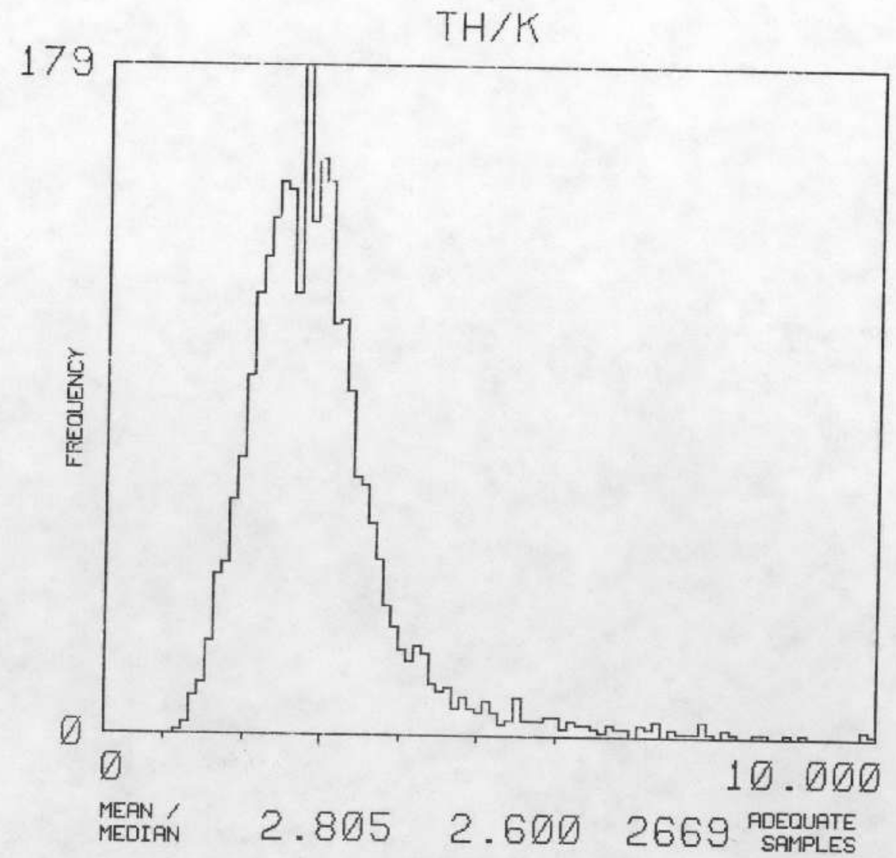








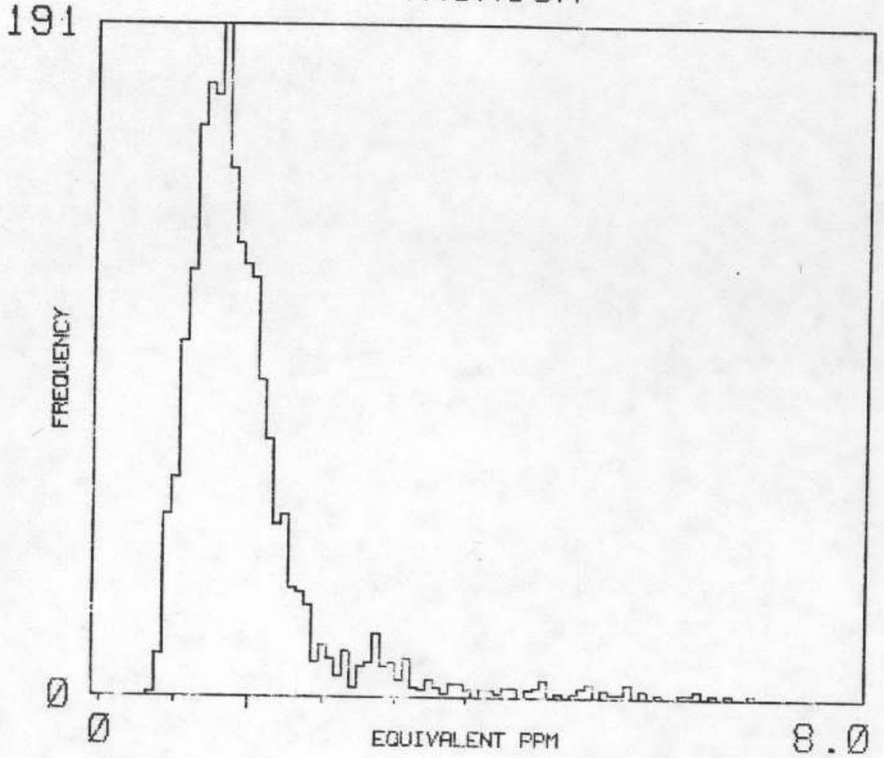




NK/NL 17-1/10 FLINT/TAVAS CITY

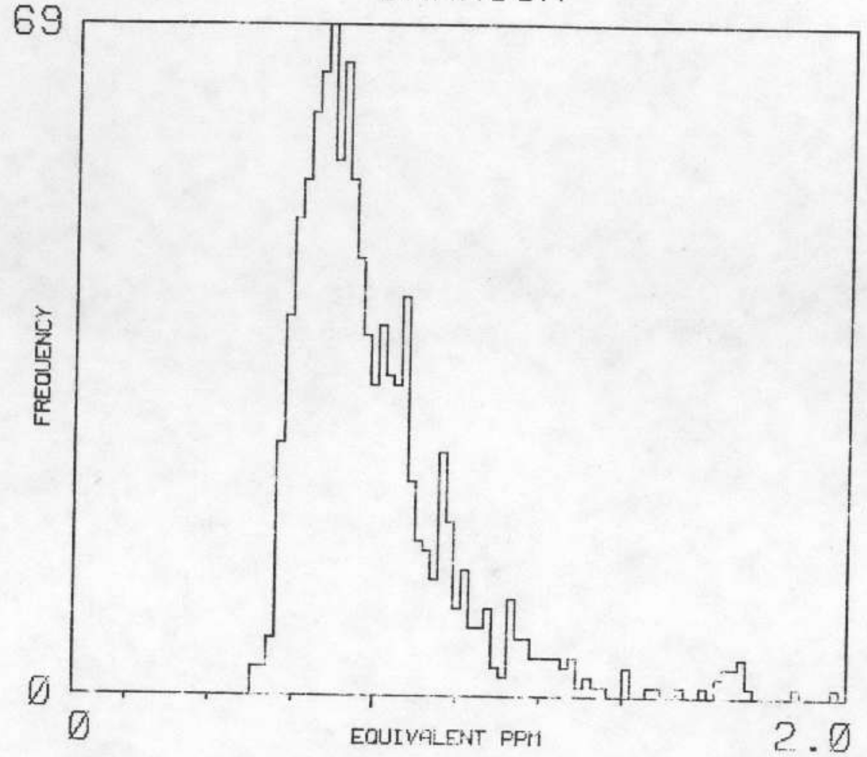
MAP UNIT : QOS TOTAL NUMBER OF SAMPLES 2372

THORIUM



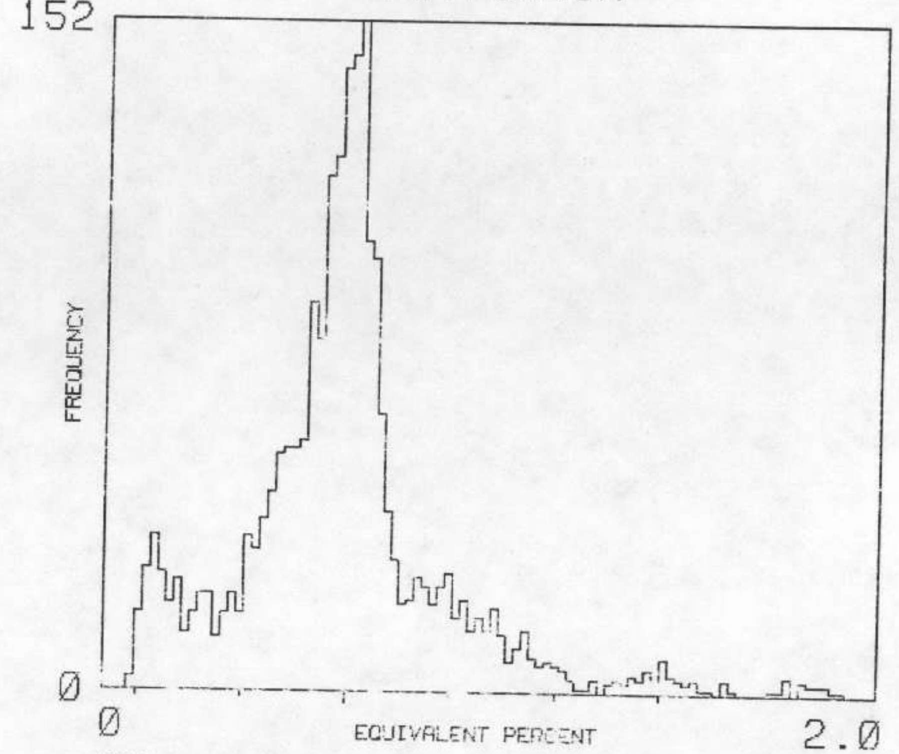
MEAN / MEDIAN 1.6 1.4 2121 ADEQUATE SAMPLES

URANIUM



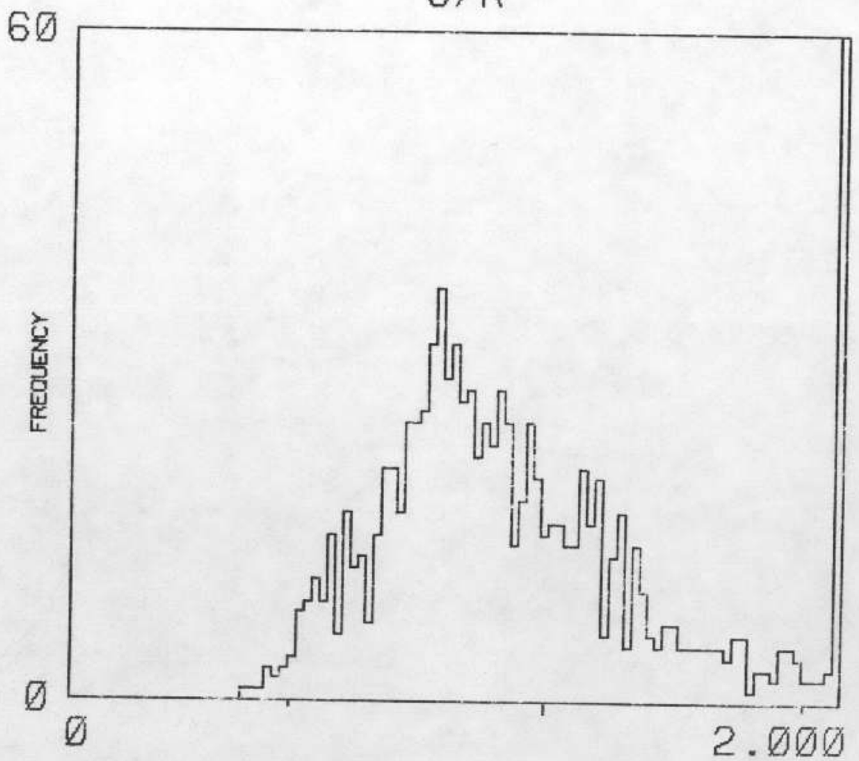
MEAN / MEDIAN 0.8 0.7 1033 ADEQUATE SAMPLES

POTASSIUM



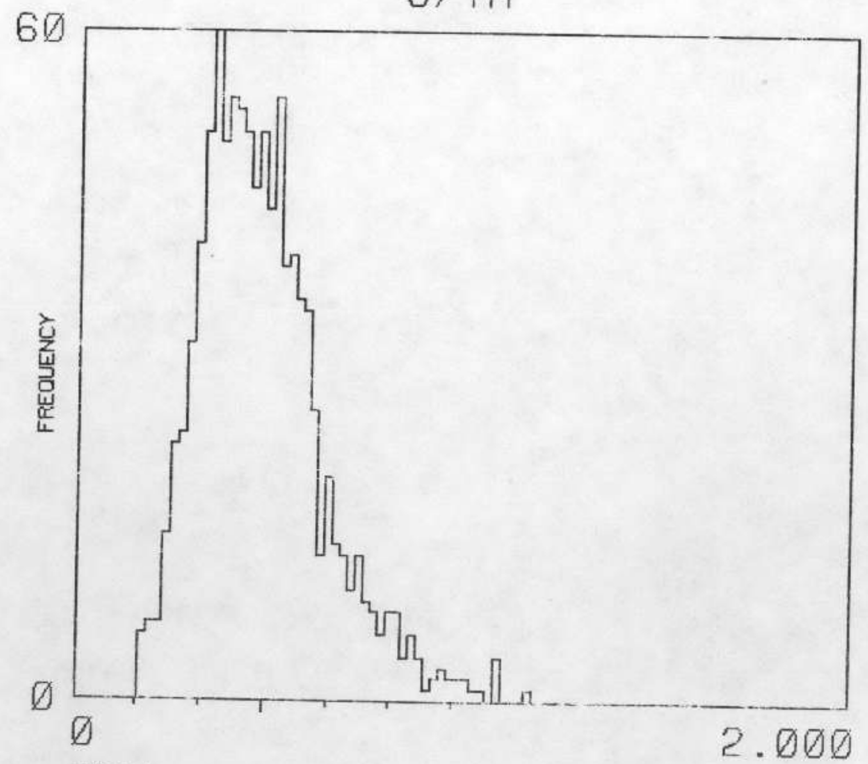
MEAN / MEDIAN 0.6 0.6 2263 ADEQUATE SAMPLES

U/K



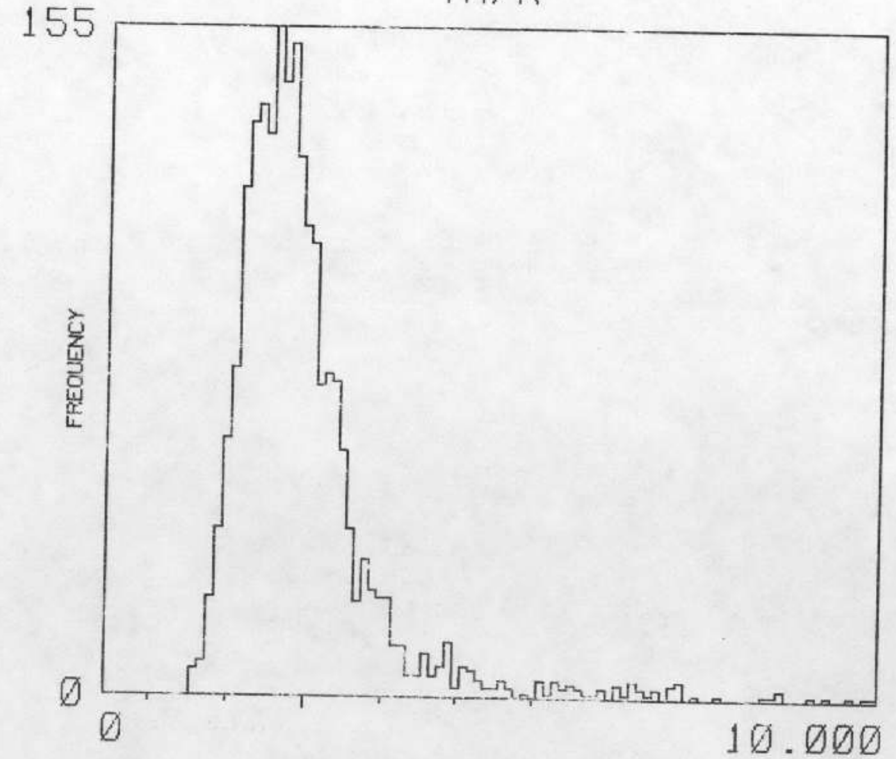
MEAN / MEDIAN 1.237 1.100 1017 ADEQUATE SAMPLES

U/TH



MEAN / MEDIAN 0.484 0.460 1000 ADEQUATE SAMPLES

TH/K

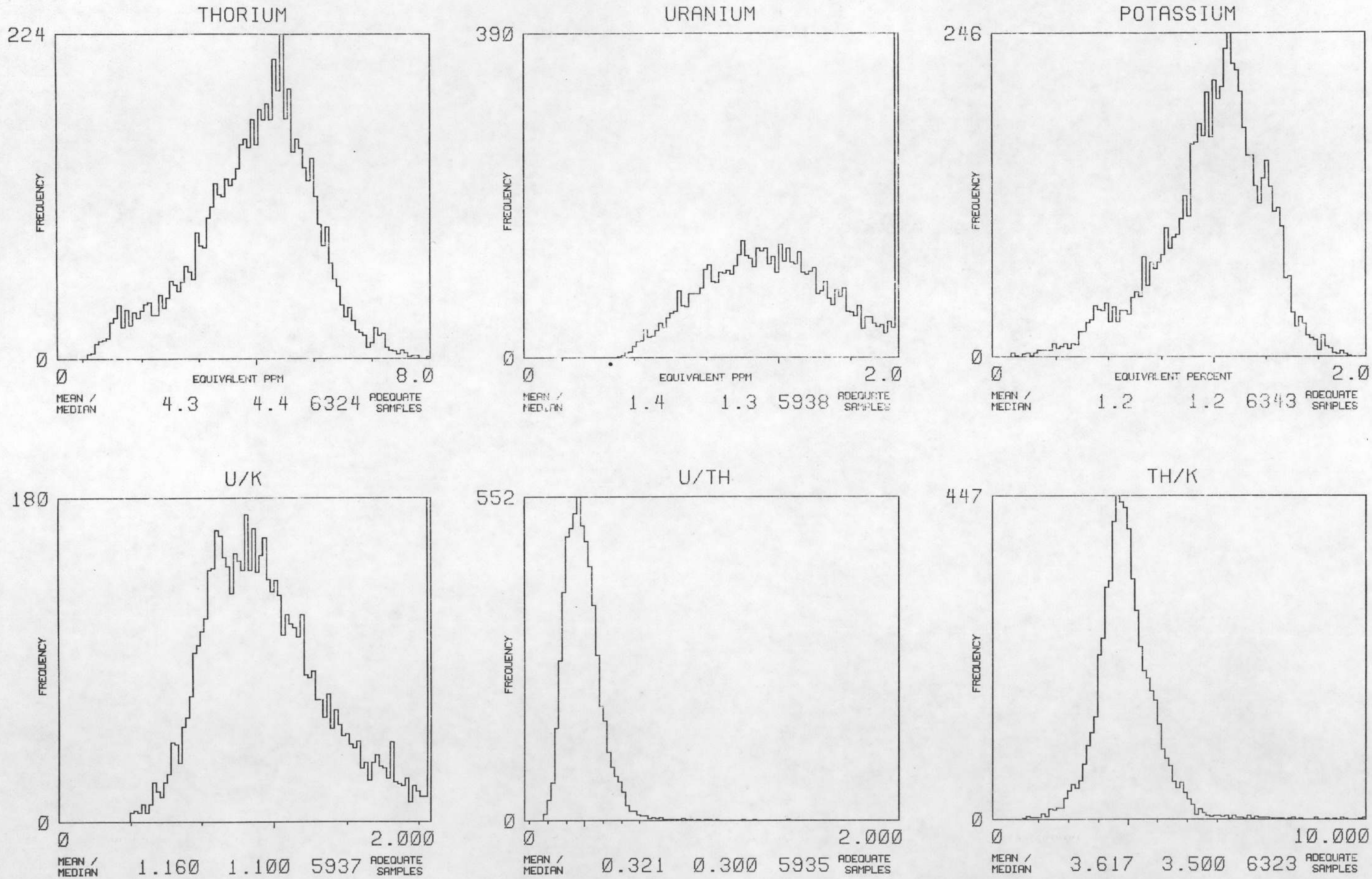


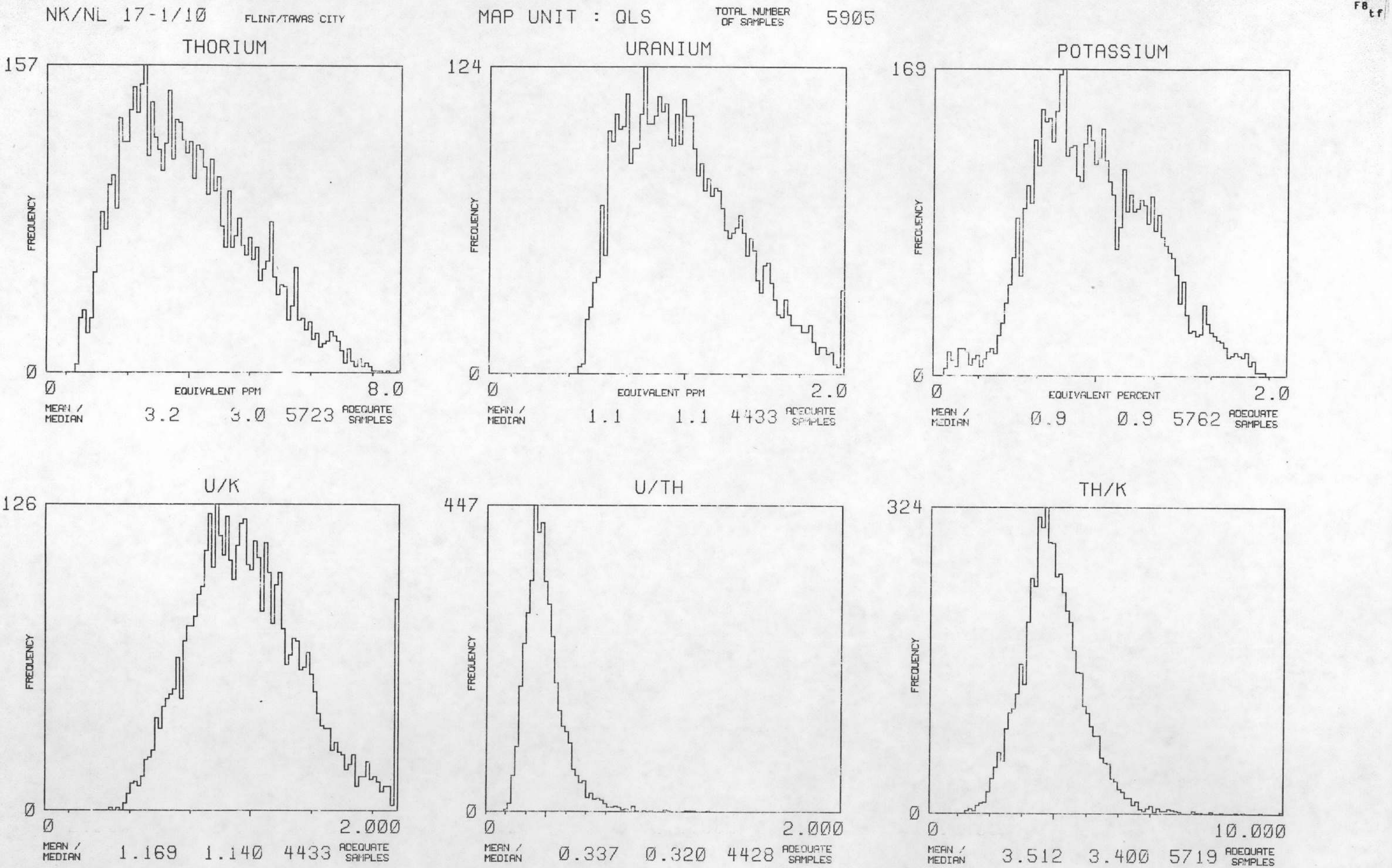
MEAN / MEDIAN 2.574 2.400 2108 ADEQUATE SAMPLES

F7tf

NK/NL 17-1/10 FLINT/TAVAS CITY

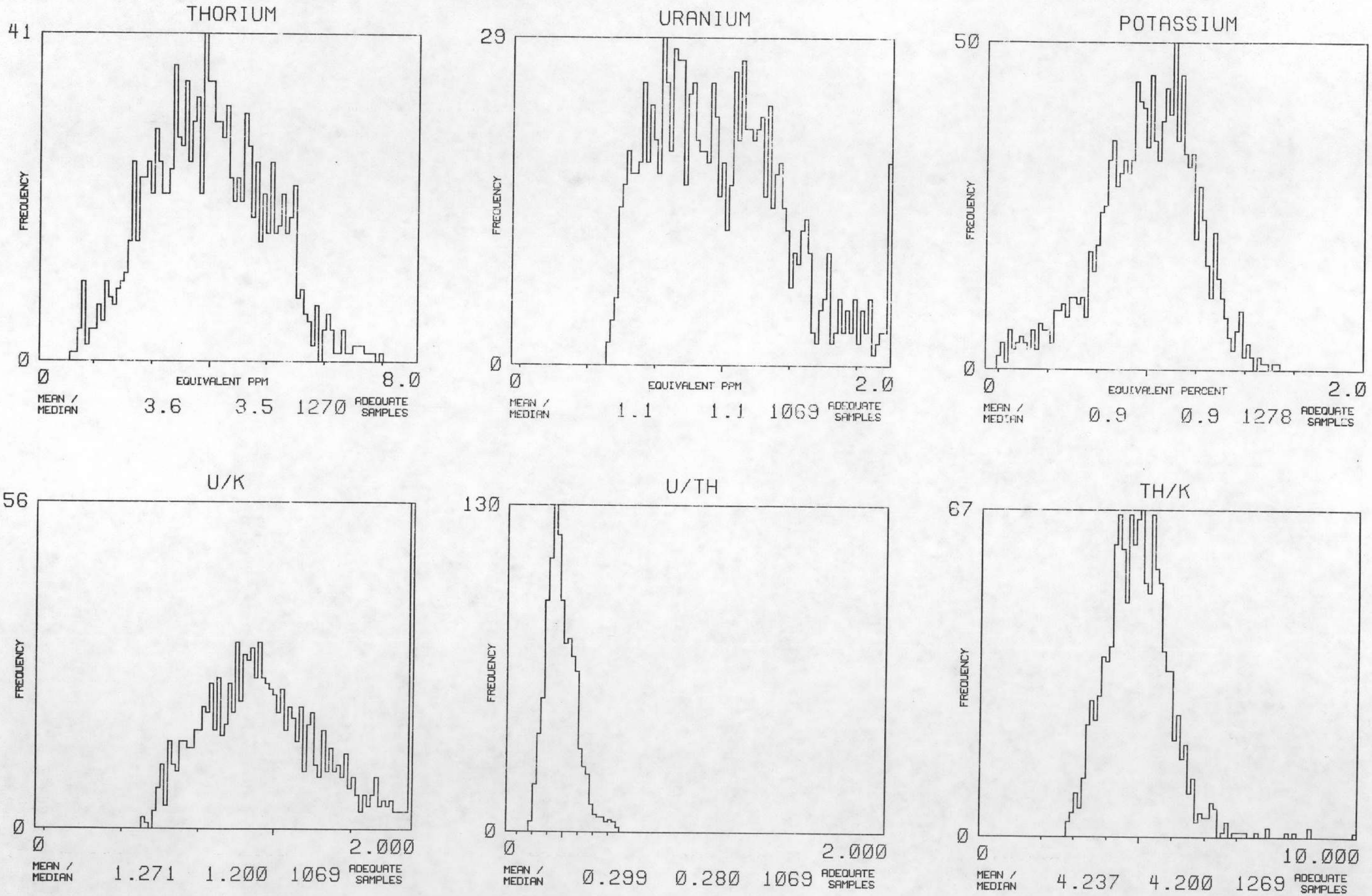
MAP UNIT : QLC TOTAL NUMBER OF SAMPLES 6359




NK/NL 17-1/10
FLINT/TAWAS CITY
MAP UNIT : QLS
TOTAL NUMBER OF SAMPLES 5905
F8tf
THORIUM
157
0
FREQUENCY
0
EQUIVALENT PPM
8.0
MEAN / MEDIAN 3.2 3.0 5723 ADEQUATE SAMPLES
URANIUM
124
0
FREQUENCY
0
EQUIVALENT PPM
2.0
MEAN / MEDIAN 1.1 1.1 4433 ADEQUATE SAMPLES
POTASSIUM
169
0
FREQUENCY
0
EQUIVALENT PERCENT
2.0
MEAN / MEDIAN 0.9 0.9 5762 ADEQUATE SAMPLES
U/K
126
0
FREQUENCY
0
2.000
MEAN / MEDIAN 1.169 1.140 4433 ADEQUATE SAMPLES
U/TH
447
0
FREQUENCY
0
2.000
MEAN / MEDIAN 0.337 0.320 4428 ADEQUATE SAMPLES
TH/K
324
0
FREQUENCY
0
10.000
MEAN / MEDIAN 3.512 3.400 5719 ADEQUATE SAMPLES

NK/NL 17-1/10 FLINT/TAVAS CITY MAP UNIT : QO TOTAL NUMBER OF SAMPLES 1309

F9tf



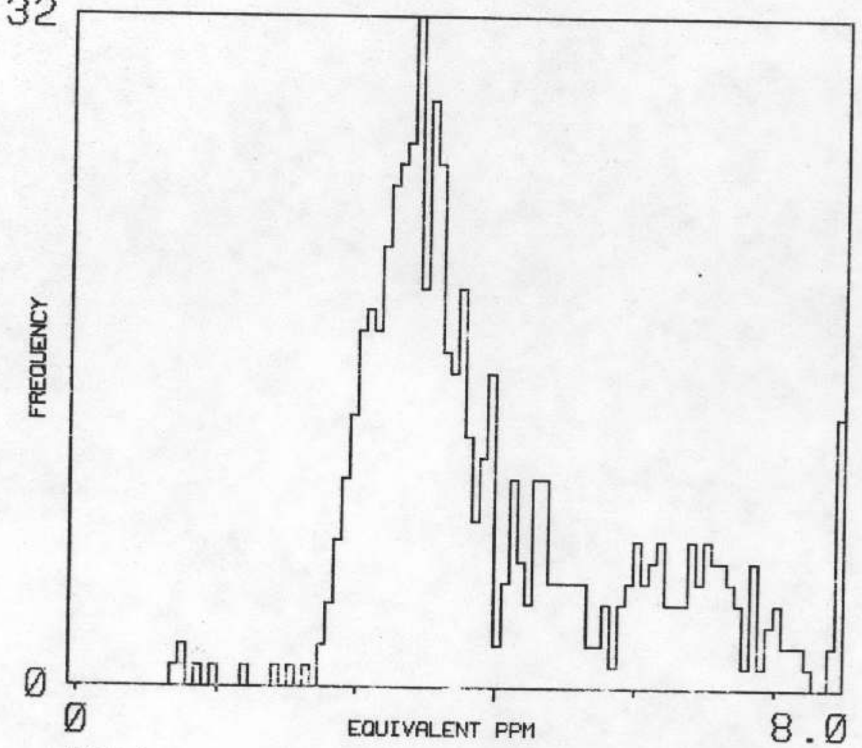
NK/NL 17-1/10 FLINT/TAVAS CITY

MAP UNIT : QP

TOTAL NUMBER OF SAMPLES 662

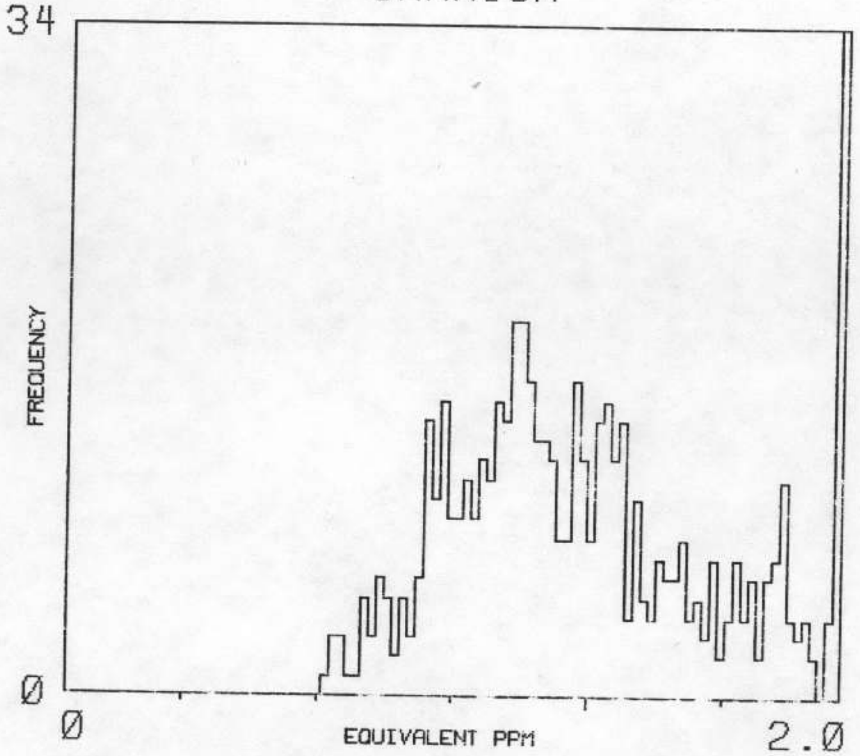
F10tf

THORIUM



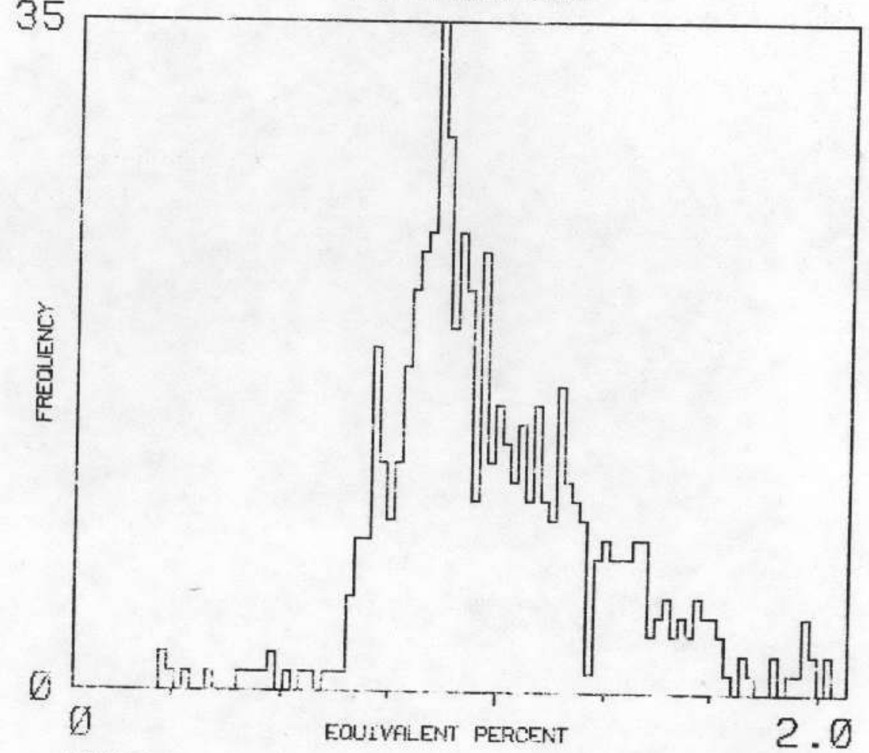
MEAN / MEDIAN 4.4 3.9 597 ADEQUATE SAMPLES

URANIUM



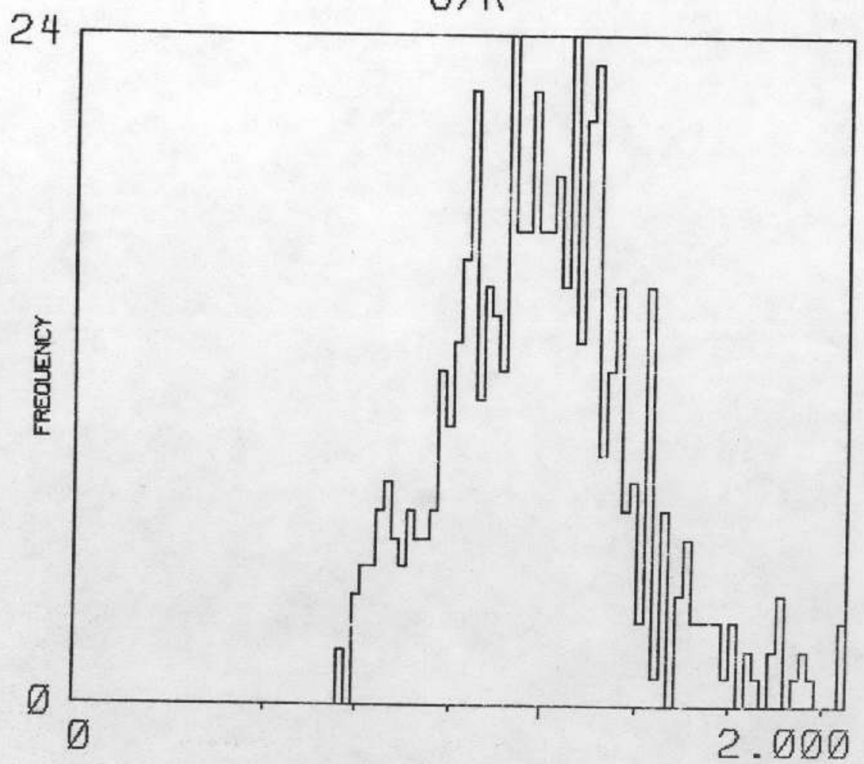
MEAN / MEDIAN 1.3 1.3 541 ADEQUATE SAMPLES

POTASSIUM



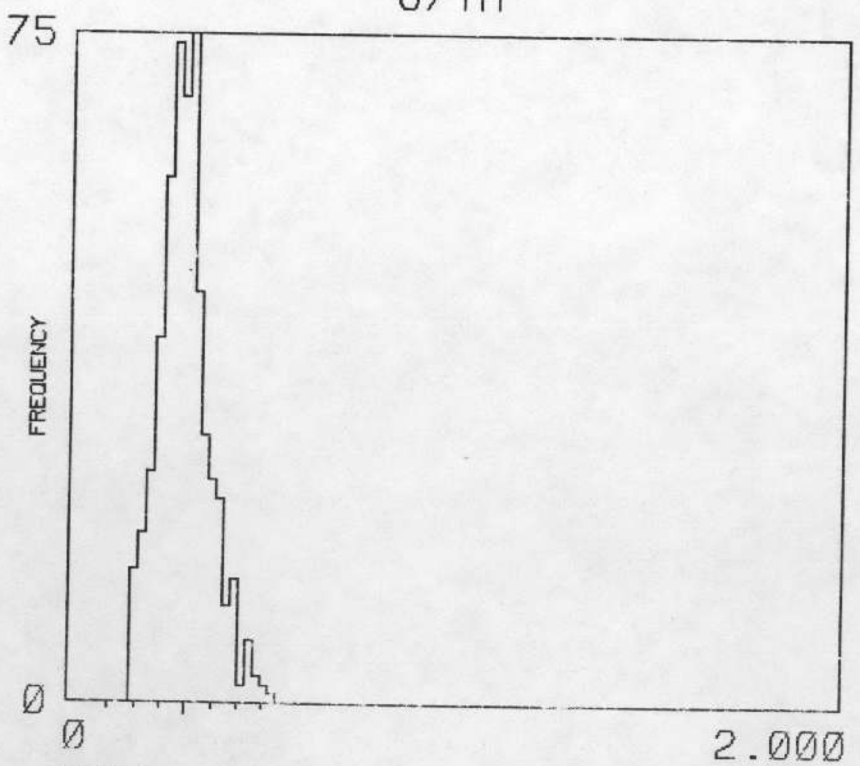
MEAN / MEDIAN 1.1 1.0 597 ADEQUATE SAMPLES

U/K



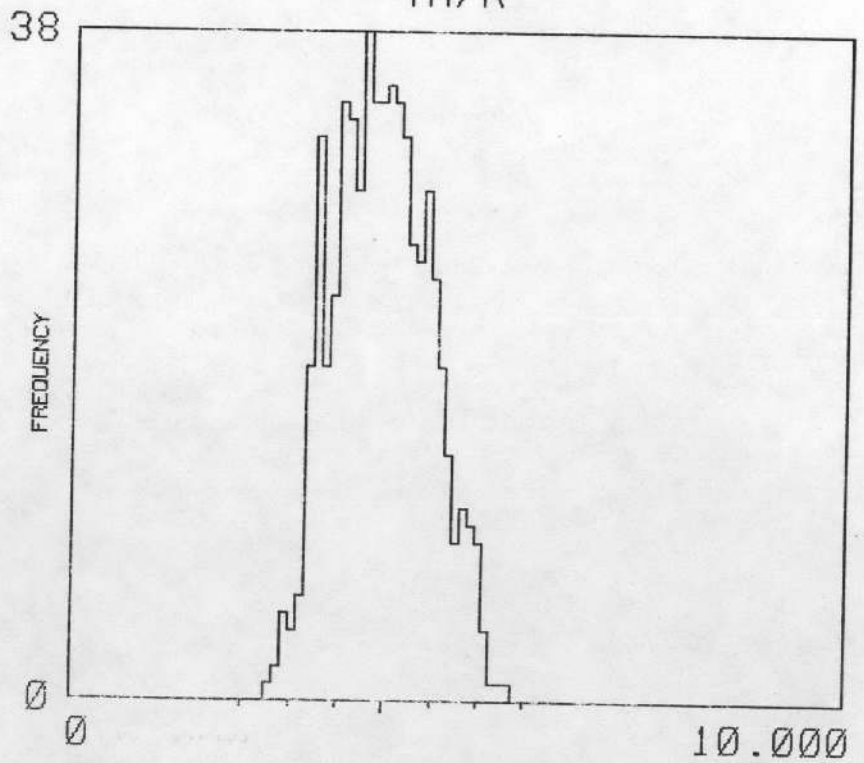
MEAN / MEDIAN 1.216 1.200 541 ADEQUATE SAMPLES

U/TH



MEAN / MEDIAN 0.307 0.300 541 ADEQUATE SAMPLES

TH/K



MEAN / MEDIAN 4.034 4.000 597 ADEQUATE SAMPLES

TAWAS CITY AND FLINT QUADRANGLES

Computer Map Unit Symbol Conversion Table

Computer Map Unit Symbol	Geologic Map Unit Symbol
QM	Qm
QGM	Qgm
QWM	Qwm
QPW	Qpw
QLP	Qlp
QOS	Qos
QLC	Qlc
QLS	Qls
QO	Qo
QP	Qp

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	1	2	3	4	5	6	7	GT7
								NUMBER OF SAMPLES WITH A STANDARD DEVIATION OF :							
1	C	10	QPW	/ 1	/ 0	/ 0	1.2	0	0	1	0	0	0	0	0
2	C	10	QPW	/ 1	/ 0	/ 0	1.1	0	0	1	0	0	0	0	0
3	C	10	QLP	/ 2	/ 0	/ 0	2.4	0	1	0	1	0	0	0	0
4	C	20	QPW	/ 1	/ 0	/ 0	1.1	0	0	1	0	0	0	0	0
5	C	90	QM	/ 2	/ 0	/ 0	1.8	0	2	0	0	0	0	0	0
6	C	140	QLC	/ 2	/ 0	/ 0	2.2	0	2	0	0	0	0	0	0
7	C	160	QLC	/ 3	/ 0	/ 0	2.0	2	1	0	0	0	0	0	0
8	C	210	QGM	/ 3	/ 0	/ 0	2.2	0	3	0	0	0	0	0	0
9	C	210	QLC	/ 2	/ 0	/ 0	2.1	0	2	0	0	0	0	0	0
10	C	210	QLC	/ 6	/ 0	/ 0	2.2	2	4	0	0	0	0	0	0
11	C	220	QO	/ 3	/ 0	/ 0	1.7	1	2	0	0	0	0	0	0
12	C	220	QGM	/ 1	/ 0	/ 0	2.6	0	0	0	1	0	0	0	0
13	C	220	QGM	/ 1QO	/ 1	/ 0	2.3	0	1	1	0	0	0	0	0
14	C	220	QO	/ 1	/ 0	/ 0	2.1	0	0	1	0	0	0	0	0
15	C	220	QLC	/ 7	/ 0	/ 0	2.4	1	5	1	0	0	0	0	0
16	C	220	QLC	/ 4	/ 0	/ 0	2.5	0	3	1	0	0	0	0	0
17	C	220	QLC	/ 5	/ 0	/ 0	2.4	1	3	1	0	0	0	0	0
18	C	220	QLC	/ 3	/ 0	/ 0	2.3	1	1	1	0	0	0	0	0
19	C	220	QM	/ 1	/ 0	/ 0	2.3	0	0	1	0	0	0	0	0
20	C	230	QGM	/ 1QLC	/ 1	/ 0	2.5	0	0	2	0	0	0	0	0
21	C	230	QLC	/ 4	/ 0	/ 0	2.5	1	1	2	0	0	0	0	0
22	C	230	QLC	/ 2	/ 0	/ 0	2.3	0	1	1	0	0	0	0	0
23	C	240	QLC	/ 7	/ 0	/ 0	2.4	0	5	2	0	0	0	0	0
24	C	240	QLC	/ 3QGM	/ 3	/ 0	2.0	4	2	0	0	0	0	0	0
25	C	240	QGM	/ 3	/ 0	/ 0	1.9	2	1	0	0	0	0	0	0
26	C	240	QWM	/ 1	/ 0	/ 0	2.1	0	0	1	0	0	0	0	0
27	C	1150	QGM	/ 2	/ 0	/ 0	2.1	0	2	0	0	0	0	0	0
28	C	1150	QGM	/ 3	/ 0	/ 0	2.4	0	2	1	0	0	0	0	0
29	C	1150	QLS	/ 2QLC	/ 2	/ 0	2.1	1	3	0	0	0	0	0	0
30	C	1160	QLS	/ 1	/ 0	/ 0	2.0	0	0	1	0	0	0	0	0
31	C	1160	QLS	/ 1	/ 0	/ 0	2.1	0	0	1	0	0	0	0	0
32	C	1160	QLS	/ 1	/ 0	/ 0	2.3	0	0	0	1	0	0	0	0
33	C	1180	QLC	/ 3	/ 0	/ 0	2.3	1	1	1	0	0	0	0	0
34	C	1180	QLC	/ 4	/ 0	/ 0	2.3	1	3	0	0	0	0	0	0
35	C	1180	QGM	/ 3	/ 0	/ 0	2.2	1	1	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 QM

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.0058	0.3178	0.6298	0.9418	1.2538	1.5658	1.8778
URANIUM DIST NORMAL	0.0750	0.4223	0.7696	1.1169	1.4642	1.8115	2.1588
THORIUM DIST NORMAL	-1.3310	0.1537	1.6384	3.1231	4.6078	6.0925	7.5772
U/K DIST NORMAL	0.0494	0.4092	0.7690	1.1288	1.4886	1.8484	2.2082
U/TH DIST NORMAL	-0.0169	0.1062	0.2293	0.3524	0.4755	0.5986	0.7217
TH/K DIST NORMAL	0.3712	1.3118	2.2524	3.1930	4.1336	5.0742	6.0148

MAP UNIT QGM

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.2324	0.5114	0.7904	1.0694	1.3484	1.6274	1.9064
URANIUM DIST NORMAL	0.2097	0.5696	0.9295	1.2894	1.6493	2.0092	2.3691
THORIUM DIST NORMAL	-0.2055	1.2404	2.6863	4.1322	5.5781	7.0240	8.4699
U/K DIST NORMAL	0.1334	0.4869	0.8404	1.1939	1.5474	1.9009	2.2544
U/TH DIST NORMAL	0.0069	0.1103	0.2137	0.3171	0.4205	0.5239	0.6273
TH/K DIST NORMAL	1.0207	1.9551	2.8895	3.8239	4.7583	5.6927	6.6271

MAP UNIT QWM

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.5225	0.7600	0.9975	1.2350	1.4725	1.7100	1.9475
URANIUM DIST NORMAL	0.2366	0.5737	0.9108	1.2479	1.5850	1.9221	2.2592
THORIUM DIST NORMAL	0.9555	1.9597	2.9639	3.9681	4.9723	5.9765	6.9807
U/K DIST NORMAL	0.2041	0.4737	0.7433	1.0129	1.2825	1.5521	1.8217
U/TH DIST NORMAL	0.0577	0.1448	0.2319	0.3190	0.4061	0.4932	0.5803
TH/K DIST NORMAL	1.5594	2.1098	2.6602	3.2106	3.7610	4.3114	4.8618

MAP UNIT QPW

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.1418	0.3165	0.4912	0.6659	0.8406	1.0153	1.1900
URANIUM DIST NORMAL	0.2695	0.4200	0.5705	0.7210	0.8715	1.0220	1.1725
THORIUM DIST NORMAL	0.3223	0.6795	1.0367	1.3939	1.7511	2.1083	2.4655
U/K DIST NORMAL	0.1100	0.4109	0.7118	1.0127	1.3136	1.6145	1.9154
U/TH DIST NORMAL	0.0655	0.2158	0.3661	0.5164	0.6667	0.8170	0.9673
TH/K DIST NORMAL	0.5767	1.0824	1.5881	2.0938	2.5995	3.1052	3.6109

MAP UNIT QLP

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.3979	-0.0075	0.3829	0.7733	1.1637	1.5541	1.9445
URANIUM DIST NORMAL	0.0164	0.3385	0.6606	0.9827	1.3048	1.6269	1.9490
THORIUM DIST NORMAL	-1.3502	-0.1738	1.0026	2.1790	3.3554	4.5318	5.7082
U/K DIST NORMAL	-0.5701	0.0029	0.5759	1.1489	1.7219	2.2949	2.8679
U/TH DIST NORMAL	-0.0815	0.0867	0.2549	0.4231	0.5913	0.7595	0.9277
TH/K DIST NORMAL	-0.2273	0.7835	1.7943	2.8051	3.8159	4.8267	5.8375

MAP UNIT QOS

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	-0.1870	0.0839	0.3548	0.6257	0.8966	1.1675	1.4384
URANIUM	DIST NORMAL	0.1360	0.3498	0.5636	0.7774	0.9912	1.2050	1.4188
THORIUM	DIST NORMAL	-0.6828	0.0759	0.8346	1.5933	2.3520	3.1107	3.8694
U/K	DIST NORMAL	-0.7719	-0.1024	0.5671	1.2366	1.9061	2.5756	3.2451
U/TH	DIST NORMAL	-0.0065	0.1571	0.3207	0.4843	0.6479	0.8115	0.9751
TH/K	DIST NORMAL	-0.4066	0.5869	1.5804	2.5739	3.5674	4.5609	5.5544

MAP UNIT QLC

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.3408	0.6219	0.9030	1.1841	1.4652	1.7463	2.0274
URANIUM	DIST NORMAL	0.2072	0.5913	0.9754	1.3595	1.7436	2.1277	2.5118
THORIUM	DIST NORMAL	0.5472	1.7911	3.0350	4.2789	5.5228	6.7667	8.0106
U/K	DIST NORMAL	-0.0047	0.3837	0.7721	1.1605	1.5489	1.9373	2.3257
U/TH	DIST NORMAL	0.0262	0.1245	0.2228	0.3211	0.4194	0.5177	0.6160
TH/K	DIST NORMAL	1.2325	2.0272	2.8219	3.6166	4.4113	5.2060	6.0007

MAP UNIT QLS

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	-0.0730	0.2560	0.5850	0.9140	1.2430	1.5720	1.9010
URANIUM	DIST NORMAL	0.1249	0.4502	0.7755	1.1008	1.4261	1.7514	2.0767
THORIUM	DIST NORMAL	-0.9490	0.4377	1.8244	3.2111	4.5978	5.9845	7.3712
U/K	DIST NORMAL	0.1368	0.4810	0.8252	1.1694	1.5136	1.8578	2.2020
U/TH	DIST NORMAL	0.0002	0.1123	0.2244	0.3365	0.4486	0.5607	0.6728
TH/K	DIST NORMAL	0.8072	1.7089	2.6106	3.5123	4.4140	5.3157	6.2174

MAP UNIT QO

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.0703	0.3311	0.5919	0.8527	1.1135	1.3743	1.6351
URANIUM	DIST NORMAL	0.0472	0.4018	0.7564	1.1110	1.4656	1.8202	2.1748
THORIUM	DIST NORMAL	-0.0841	1.1406	2.3653	3.5900	4.8147	6.0394	7.2641
U/K	DIST NORMAL	0.0476	0.4553	0.8630	1.2707	1.6784	2.0861	2.4938
U/TH	DIST NORMAL	0.0590	0.1389	0.2188	0.2987	0.3786	0.4585	0.5384
TH/K	DIST NORMAL	1.6477	2.5108	3.3739	4.2370	5.1001	5.9632	6.8263

MAP UNIT QP

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.2553	0.5335	0.8117	1.0899	1.3681	1.6463	1.9245
URANIUM	DIST NORMAL	0.3003	0.6484	0.9965	1.3446	1.6927	2.0408	2.3889
THORIUM	DIST NORMAL	0.0714	1.5186	2.9658	4.4130	5.8602	7.3074	8.7546
U/K	DIST NORMAL	0.4895	0.7316	0.9737	1.2158	1.4579	1.7000	1.9421
U/TH	DIST NORMAL	0.1070	0.1736	0.2402	0.3068	0.3734	0.4400	0.5066
TH/K	DIST NORMAL	2.2074	2.8162	3.4250	4.0338	4.6426	5.2514	5.8602

LINE BASED MEAN CONCENTRATIONS
AND RATIOS PER ROCK TYPE

MAP UNIT QM

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASSIUM	0.871	0.796	0.724	0.733	0.726	0.710	0.729	0.662	1.091	0.925	0.699	0.000	0.000	0.000	0.982
URANIUM	1.019	0.845	0.711	0.717	0.736	0.746	0.917	0.983	1.163	1.251	0.995	0.000	0.000	0.000	0.975
THORIUM	2.168	1.698	1.553	1.662	1.651	1.927	2.170	1.942	3.004	3.180	2.415	0.000	0.000	0.000	3.075
U/K	1.199	1.125	0.922	0.927	0.973	1.055	1.279	1.284	1.069	1.155	1.111	0.000	0.000	0.000	1.059
U/TH	0.465	0.526	0.442	0.433	0.441	0.417	0.439	0.440	0.398	0.358	0.348	0.000	0.000	0.000	0.330
TH/K	2.553	2.119	2.181	2.208	2.277	2.733	3.001	2.802	2.728	3.150	3.306	0.000	0.000	0.000	3.204

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASSIUM	1.268	1.241	1.283	1.218	1.051	1.080	0.973	0.905	0.996	0.768	0.823	1.029	1.148	0.000
URANIUM	1.231	1.106	1.184	1.147	1.208	1.431	1.404	1.043	1.250	0.851	0.971	1.268	1.505	0.000
THORIUM	4.013	4.760	4.641	4.328	4.250	4.425	4.076	3.424	3.788	2.162	2.331	3.854	4.762	0.000
U/K	0.976	0.906	0.931	0.924	1.179	1.390	1.418	1.127	1.272	1.024	1.092	1.261	1.318	0.000
U/TH	0.311	0.236	0.255	0.262	0.291	0.342	0.345	0.302	0.358	0.387	0.408	0.338	0.320	0.000
TH/K	3.178	3.917	3.643	3.584	4.079	4.129	4.087	3.758	3.701	2.745	2.725	3.798	4.146	0.000

MAP UNIT QGM

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASSIUM	1.038	1.080	0.000	0.000	0.000	0.809	0.836	0.838	1.078	0.508	0.000	0.000	0.000	0.000	1.053
URANIUM	1.091	1.215	0.000	0.000	0.000	0.770	1.233	0.873	1.293	1.131	0.000	0.000	0.000	0.000	0.929
THORIUM	2.983	2.673	0.000	0.000	0.000	2.041	2.785	2.098	3.220	1.968	0.000	0.000	0.000	0.000	2.988
U/K	1.033	1.138	0.000	0.000	0.000	0.945	1.571	1.048	1.232	2.285	0.000	0.000	0.000	0.000	0.882
U/TH	0.383	0.470	0.000	0.000	0.000	0.360	0.467	0.417	0.425	0.509	0.000	0.000	0.000	0.000	0.305
TH/K	2.886	2.517	0.000	0.000	0.000	2.542	3.374	2.505	2 971	3.844	0.000	0.000	0.000	0.000	2.861

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASSIUM	1.332	1.260	1.121	1.184	1.205	1.147	1.028	1.170	1.140	1.004	0.914	0.941	1.052	0.000
URANIUM	1.166	1.041	1.022	1.241	1.435	1.509	1.437	1.456	1.429	1.393	1.118	1.437	1.329	0.000
THORIUM	4.339	4.546	4.199	5.022	5.343	5.179	4.395	5.068	4.766	3.518	3.060	4.324	4.345	0.000
U/K	0.880	0.858	0.971	1.058	1.206	1.313	1.371	1.246	1.267	1.383	1.192	1.227	1.227	0.000
U/TH	0.274	0.234	0.248	0.248	0.272	0.291	0.328	0.295	0.308	0.392	0.366	0.282	0.300	0.000
TH/K	3.256	3.674	3.926	4.336	4.463	4.551	4.219	4.306	4.186	3.503	3.279	4.366	4.041	0.000

MAP UNIT QWM

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.202	0.000	0.000	1.314	1.234
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.012	0.000	0.000	1.231	1.172
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.158	0.000	0.000	4.090	2.934
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.847	0.000	0.000	0.908	0.923
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.328	0.000	0.000	0.293	0.393
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.624	0.000	0.000	3.105	2.354

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASIUM	1.334	1.407	0.000	1.333	1.067	0.000	0.000	1.332	1.075	1.050	0.000	1.502	0.000	0.000
URANIUM	1.188	1.078	0.000	1.296	1.009	0.000	0.000	1.246	1.547	1.231	0.000	1.790	0.000	0.000
THORIUM	4.150	3.948	0.000	4.428	3.648	0.000	0.000	4.764	3.836	3.377	0.000	4.940	0.000	0.000
U/K	0.877	0.776	0.000	0.978	0.906	0.000	0.000	0.946	1.420	1.195	0.000	1.197	0.000	0.000
U/TH	0.287	0.276	0.000	0.298	0.277	0.000	0.000	0.265	0.403	0.374	0.000	0.363	0.000	0.000
TH/K	3.064	2.844	0.000	3.386	3.328	0.000	0.000	3.586	3.530	3.208	0.000	3.293	0.000	0.000

MAP UNIT QPW

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASIUM	0.694	0.572	0.680	0.738	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.919	0.832	0.643	0.678	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
THORIUM	1.613	1.493	1.218	1.726	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/K	1.193	1.109	0.897	0.900	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.557	0.562	0.472	0.416	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	2.219	2.095	1.898	2.341	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.644	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.679	0.000	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.304	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.010	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.544	0.000	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.065	0.000	0.000	0.000	0.000

MAP UNIT QLP

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASIUM	0.461	0.272	0.552	0.862	1.157	0.536	0.602	0.477	0.637	0.856	1.032	0.843	0.000	0.000	0.000
URANIUM	1.190	0.803	0.632	0.828	1.065	0.747	0.879	0.872	1.051	1.033	1.030	1.025	0.000	0.000	0.000
THORIUM	1.545	1.354	1.512	2.065	3.000	1.634	1.450	1.436	2.240	2.550	2.972	2.129	0.000	0.000	0.000
U/K	2.148	3.894	1.370	0.927	0.847	1.373	1.506	1.774	1.304	1.133	0.974	1.044	0.000	0.000	0.000
U/TH	0.664	0.571	0.528	0.408	0.348	0.442	0.635	0.568	0.458	0.392	0.354	0.397	0.000	0.000	0.000
TH/K	2.979	4.506	2.697	2.248	2.522	3.095	2.288	3.418	2.721	3.161	2.907	2.446	0.000	0.000	0.000

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.835	0.685	0.000	1.147	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.946	0.885	0.000	1.238	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.018	1.835	0.000	4.068	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.038	1.081	0.000	1.080	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.475	0.402	0.000	0.305	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.405	2.723	0.000	3.546	0.000

MAP UNIT QOS

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASIUM	0.000	0.274	0.703	0.719	0.763	0.628	0.480	0.545	0.000	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.662	0.721	0.955	0.708	0.775	0.737	0.000	0.000	0.000	0.000	0.000	0.000	0.000
THORIUM	0.000	1.182	1.514	1.710	1.997	1.524	1.432	1.257	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.827	0.991	0.987	1.119	1.656	1.330	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.404	0.450	0.419	0.456	0.558	0.609	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	0.000	3.609	2.107	2.424	2.504	2.447	3.190	2.354	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.660	0.627	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.720	0.803	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.597	1.542	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.168	1.244	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.439	0.464	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.486	2.405	0.000	0.000	0.000

MAP UNIT QLC

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.014	1.176	1.181
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.229	1.363	1.291
THURIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.636	3.994	3.974
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.188	1.131	1.119
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.337	0.328	0.337
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.560	3.394	3.373

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASIUM	1.286	1.297	1.388	1.253	1.351	1.092	1.085	1.100	1.065	1.103	1.320	1.179	1.152	0.000
URANIUM	1.387	1.128	1.118	1.147	1.301	1.577	1.695	1.524	1.603	1.223	1.394	1.327	1.404	0.000
THURIUM	4.338	4.655	4.524	4.472	5.221	4.573	4.405	4.521	4.499	3.507	4.500	3.839	4.349	0.000
U/K	1.060	0.891	0.798	0.931	1.008	1.427	1.566	1.399	1.482	1.021	1.065	1.086	1.249	0.000
U/TH	0.316	0.235	0.241	0.265	0.259	0.343	0.391	0.354	0.358	0.328	0.322	0.354	0.327	0.000
TH/K	3.360	3.749	3.247	3.577	3.911	4.183	4.001	4.069	4.208	3.139	3.382	3.103	3.800	0.000

MAP UNIT QLS

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.861	1.120	0.833
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.044	0.998	1.076
THURIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.247	3.512	2.448
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.071	0.892	1.268
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.412	0.285	0.451
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.542	3.128	2.944

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASIUM	0.916	0.974	1.143	1.137	0.824	0.818	0.886	0.896	0.609	0.801	0.922	0.988	0.892	0.558
URANIUM	1.075	0.905	1.021	1.214	0.957	1.056	1.063	1.182	1.009	1.126	1.146	1.057	1.449	1.119
THURIUM	2.848	3.103	3.987	4.381	2.930	2.837	3.216	3.673	1.949	2.791	2.909	3.390	4.094	1.580
U/K	1.096	0.867	0.895	1.041	1.088	1.272	1.218	1.300	1.473	1.348	1.189	1.083	1.432	1.781
U/TH	0.353	0.273	0.251	0.275	0.315	0.374	0.343	0.323	0.424	0.397	0.364	0.317	0.327	0.565
TH/K	3.203	3.336	3.525	3.902	3.492	3.421	3.607	4.105	3.196	3.465	3.185	3.419	4.676	2.845

MAP UNIT QO

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASIUM	0.000	0.839	0.837	0.842	0.798	0.970	0.929	0.867	0.000	0.000	0.000	0.811	0.000	0.000
URANIUM	0.000	0.965	0.900	0.990	1.027	1.353	1.419	1.122	0.000	0.000	0.000	1.109	0.000	0.000
THORIUM	0.000	3.329	3.617	3 576	3.215	4.036	4.134	3.639	0.000	0.000	0.000	3.288	0.000	0.000
U/K	0.000	1.005	1.038	1.053	1.318	1.412	1.516	1.309	0.000	0.000	0.000	1.360	0.000	0.000
U/TH	0.000	0.252	0.238	0.247	0.307	0.344	0.339	0.313	0.000	0.000	0.000	0.333	0.000	0.000
TH/K	0.000	4.527	4.298	4.212	4.194	4.152	4.439	4.181	0.000	0.000	0.000	3.998	0.000	0.000

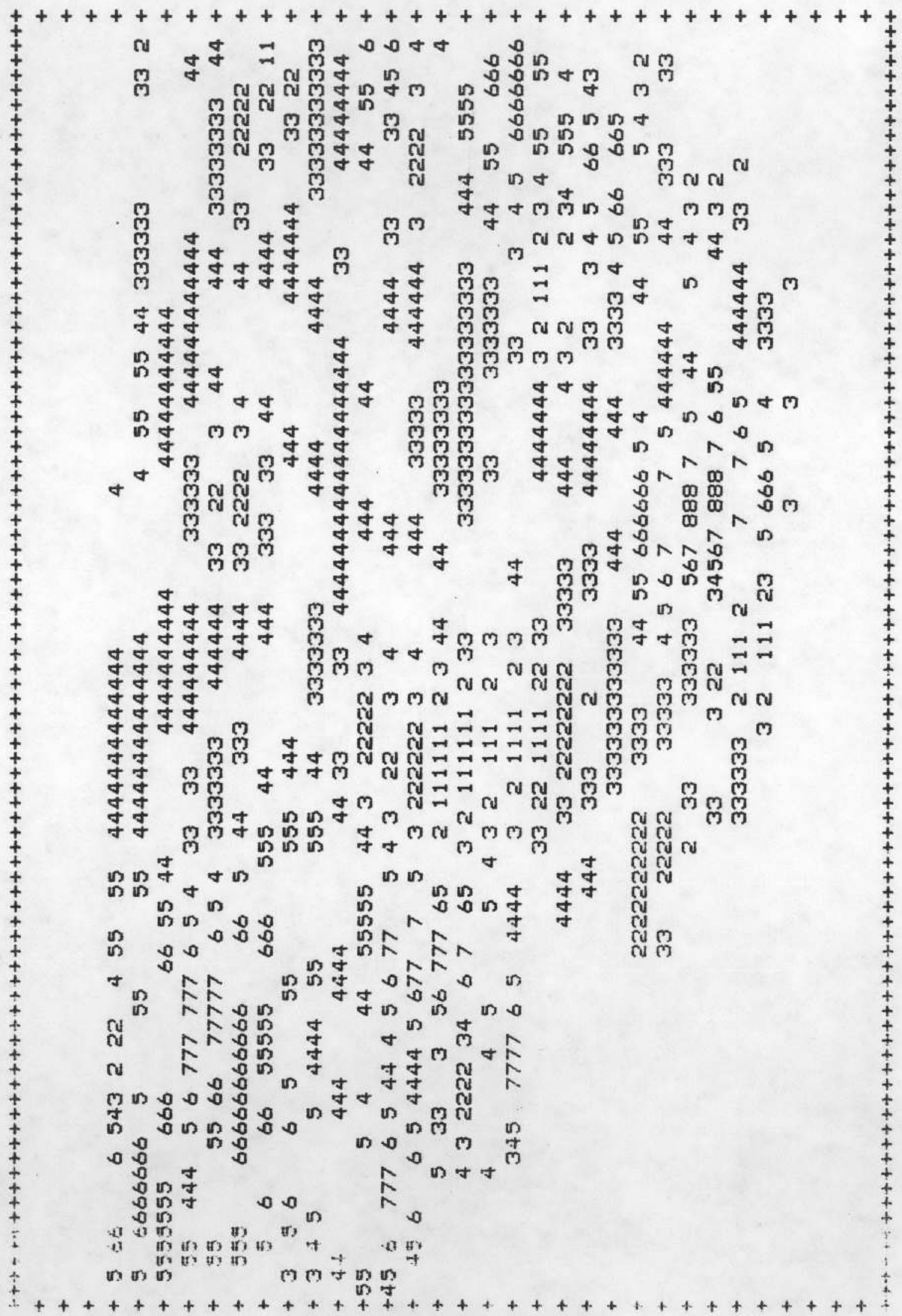
MAP UNIT QP

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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	0.000	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	0.000	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	0.000	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	0.000	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	160	170	180	190	200	210	220	230	240	1150	1160	1170	1180	1190
POTASIUM	0.000	0.000	0.000	0.000	0.000	1.364	0.000	1.069	0.981	0.000	0.962	0.982	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	1.636	0.000	1.198	1.264	0.000	1.288	1.064	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	6.071	0.000	4.064	3.794	0.000	4.357	3.647	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	1.201	0.000	1.120	1.266	0.000	1.338	1.072	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.275	0.000	0.298	0.330	0.000	0.294	0.295	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	4.431	0.000	3.790	3.914	0.000	4.557	3.757	0.000	0.000

APPENDIX H - Pseudo Contour Maps

TAWAS CITY



Potassium Pseudo-Contour Map - Tawas City Quadrangle

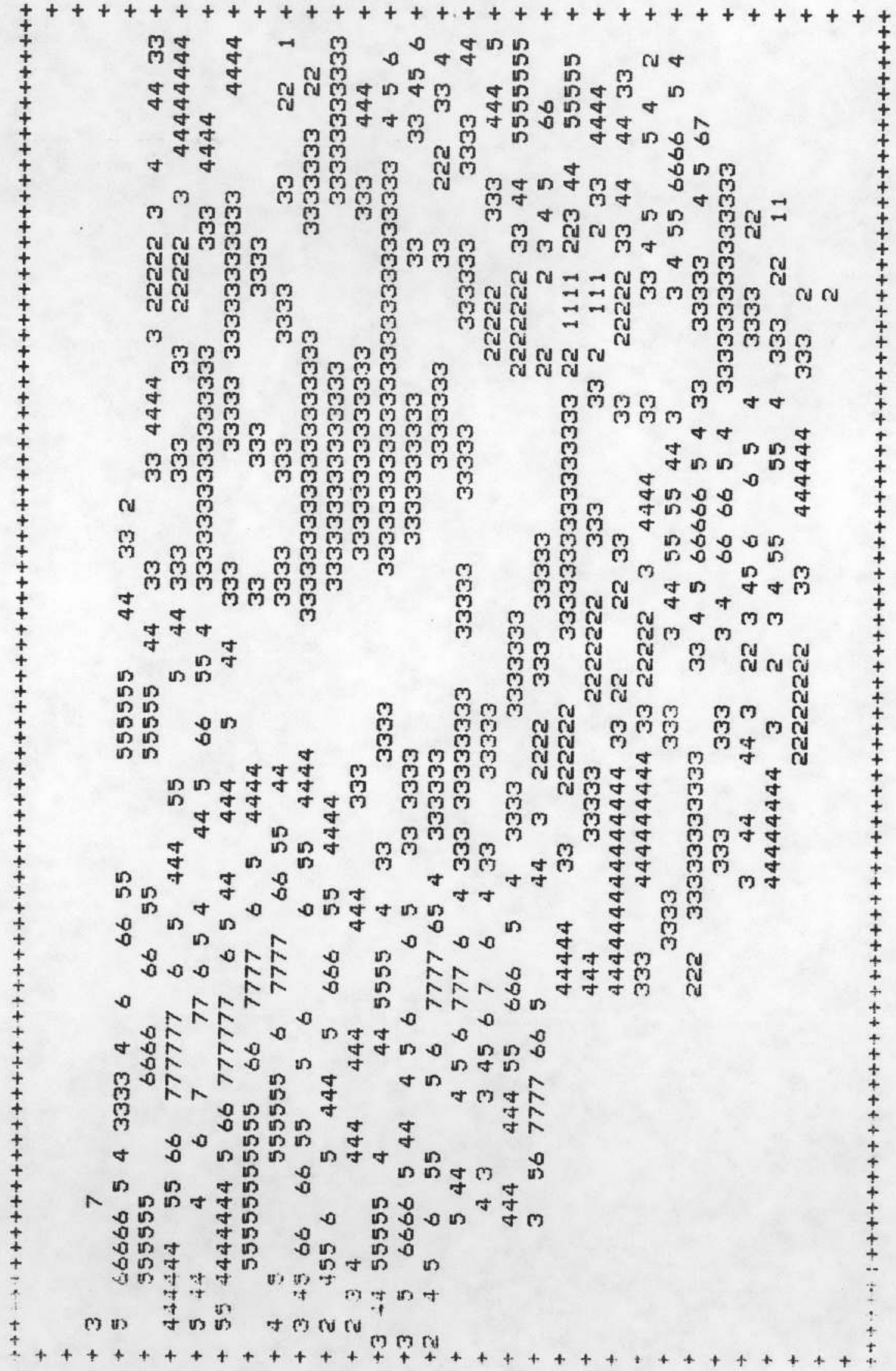
EXPLANATION

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 PERCENT

H2 tf

TAWAS CITY



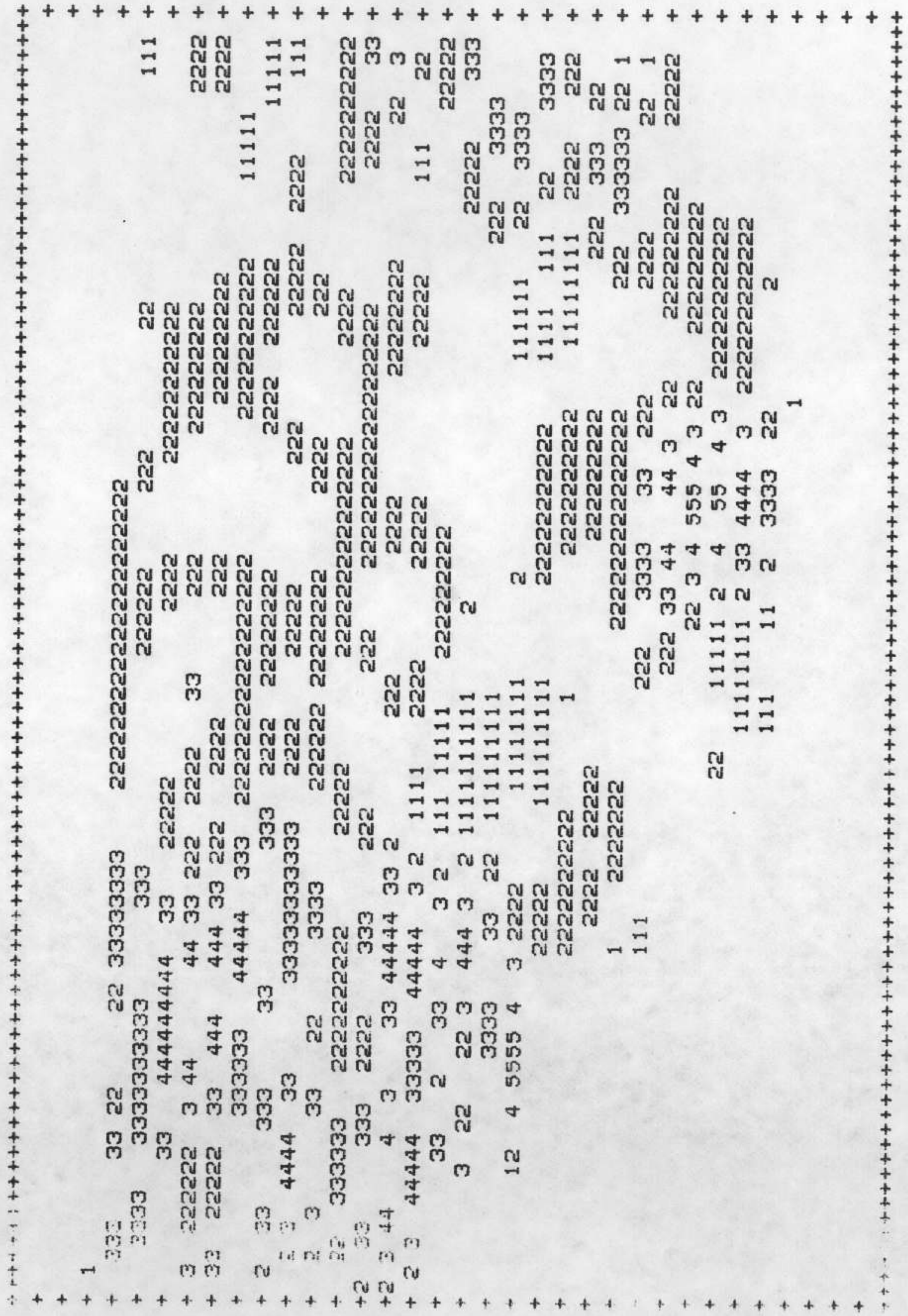
Uranium Pseudo-Contour Map - Tawas City Quadrangle

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

TAWAS CITY



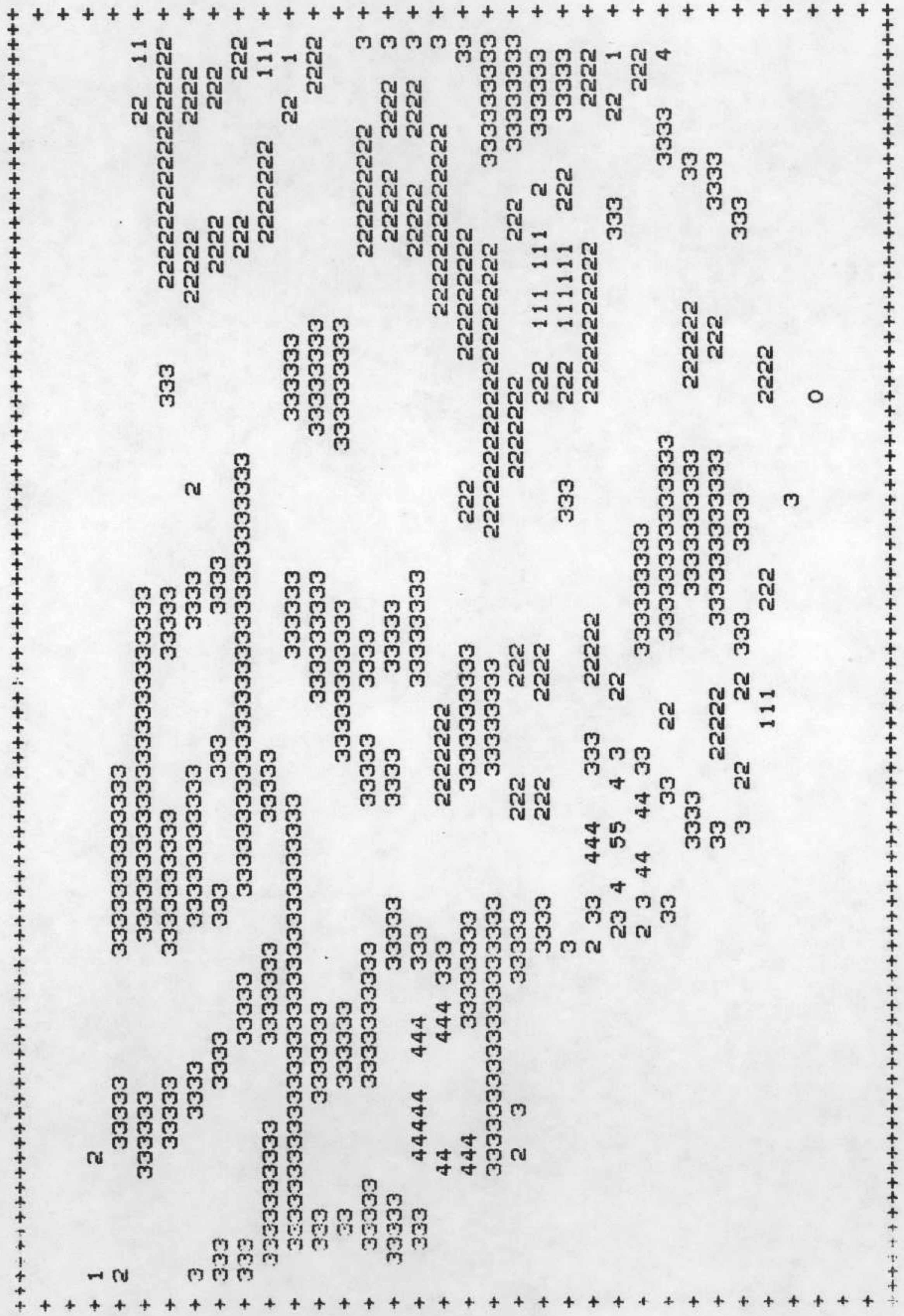
Thorium Pseudo-Contour Map - Tawas City Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.5000
1	0.5000	1.0000
	1.0000	1.5000
2	1.5000	2.0000
	2.0000	2.5000
3	2.5000	3.0000
	3.0000	3.5000
4	3.5000	4.0000
	4.0000	4.5000
5	4.5000	5.0000
	5.0000	5.5000
6	5.5000	6.0000
	6.0000	6.5000
7	6.5000	7.0000
	7.0000	7.5000
8	7.5000	8.0000
	8.0000	8.5000
9	8.5000	9.0000
	GT	9.0000

SCALE IN EQUIVALENT PPM

TAWAS CITY

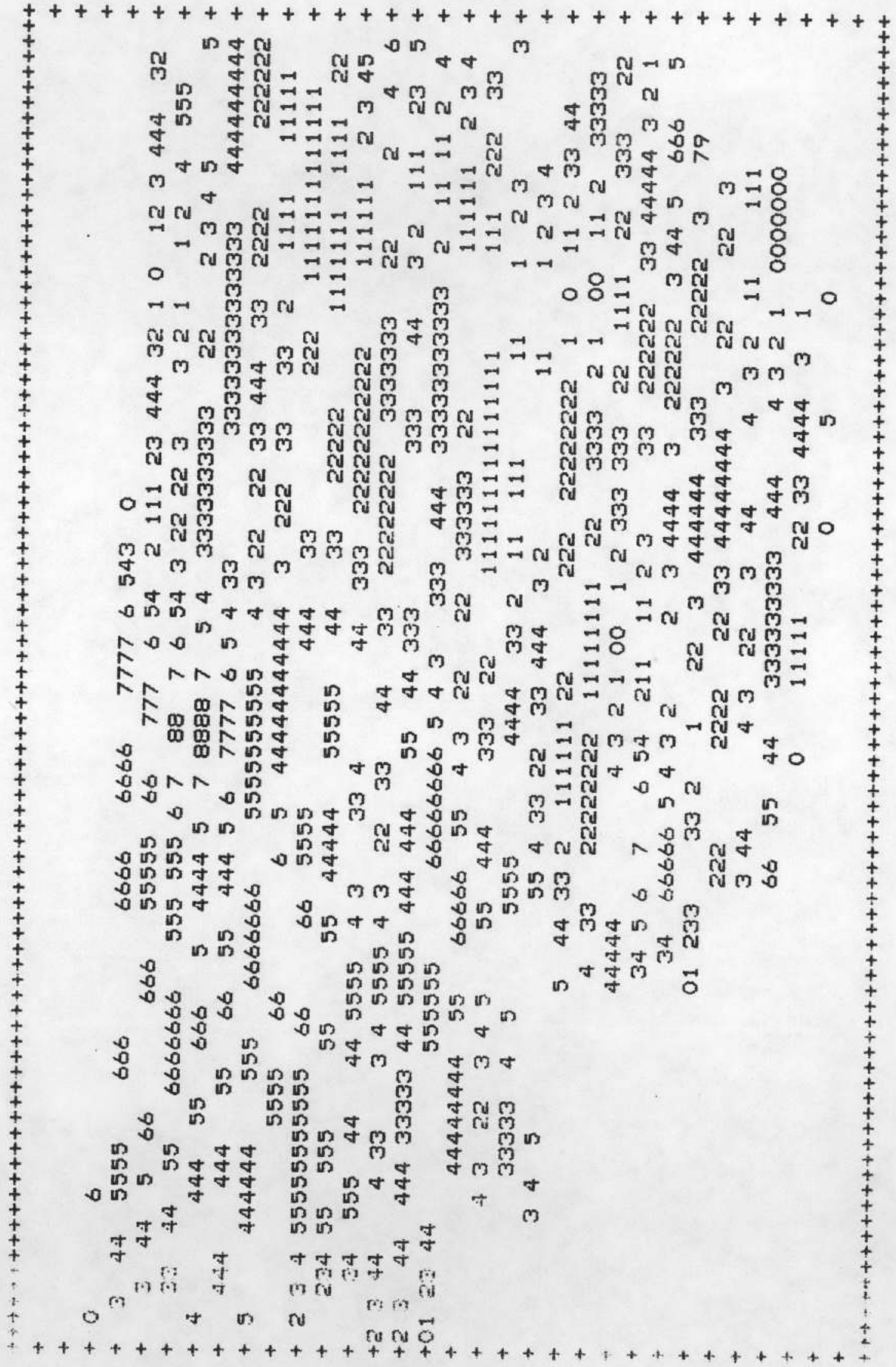


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.5000
1	0.5000	1.0000
	1.0000	1.5000
2	1.5000	2.0000
	2.0000	2.5000
3	2.5000	3.0000
	3.0000	3.5000
4	3.5000	4.0000
	4.0000	4.5000
5	4.5000	5.0000
	5.0000	5.5000
6	5.5000	6.0000
	6.0000	6.5000
7	6.5000	7.0000
	7.0000	7.5000
8	7.5000	8.0000
	8.0000	8.5000
9	8.5000	9.0000
	GT	9.0000

Thorium/Potassium Pseudo-Contour Map - Tawas City Quadrangle

TAWAS CITY

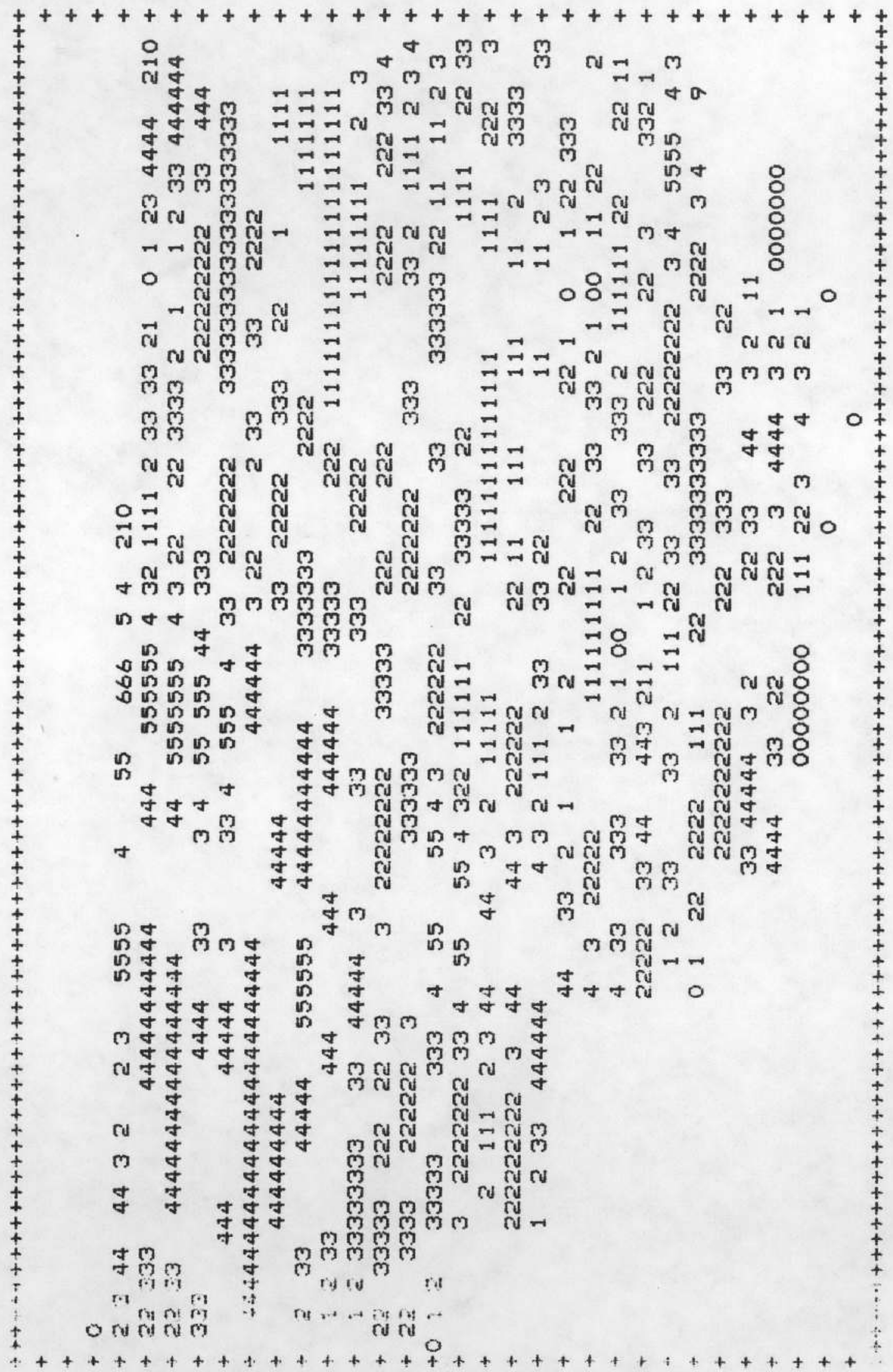


Uranium/Potassium Pseudo-Contour Map - Tawas City Quadrangle

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

TAWAS CITY

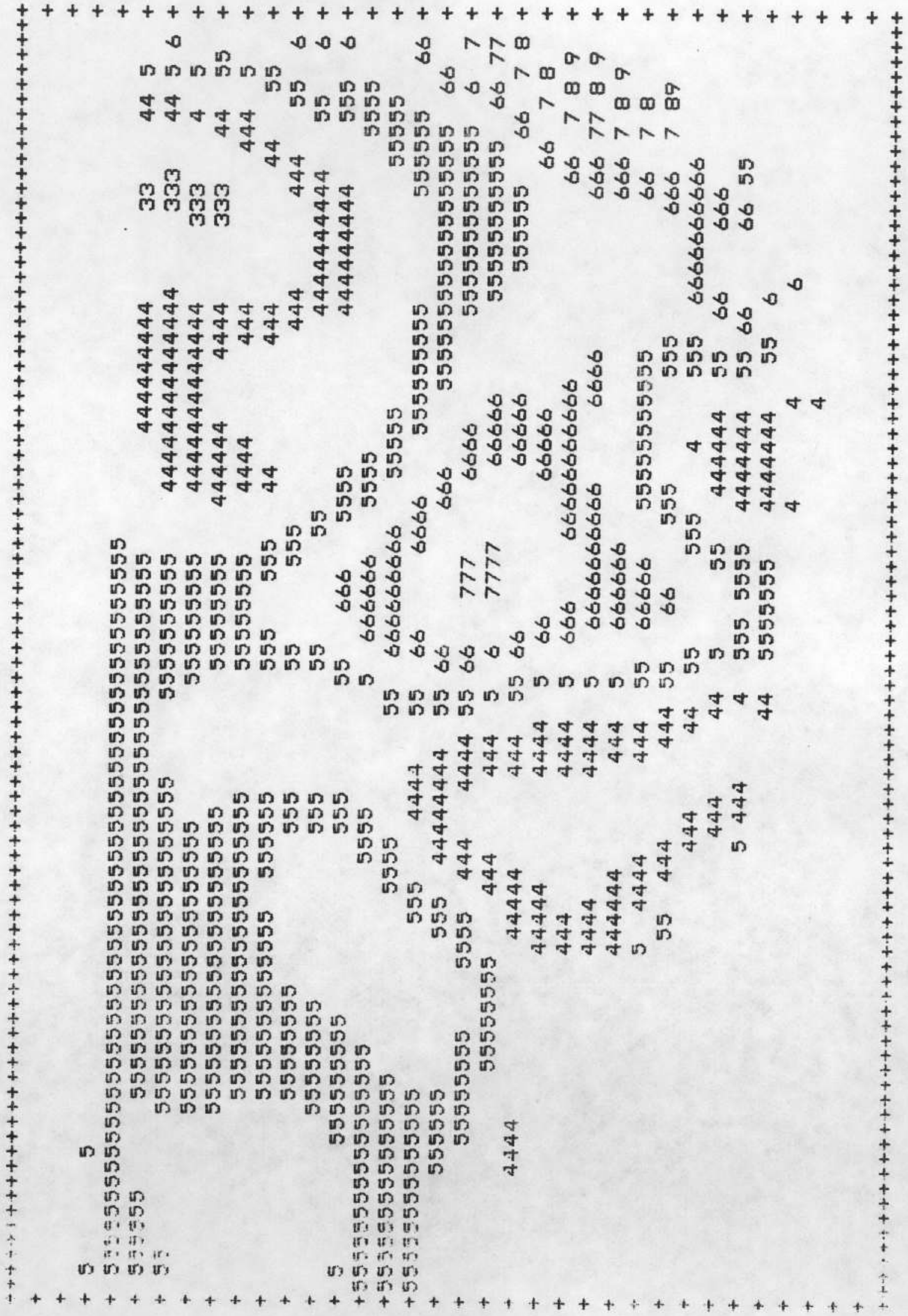


Uranium/Thorium Pseudo-Contour Map - Tawas City Quadrangle

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

TAWAS CITY



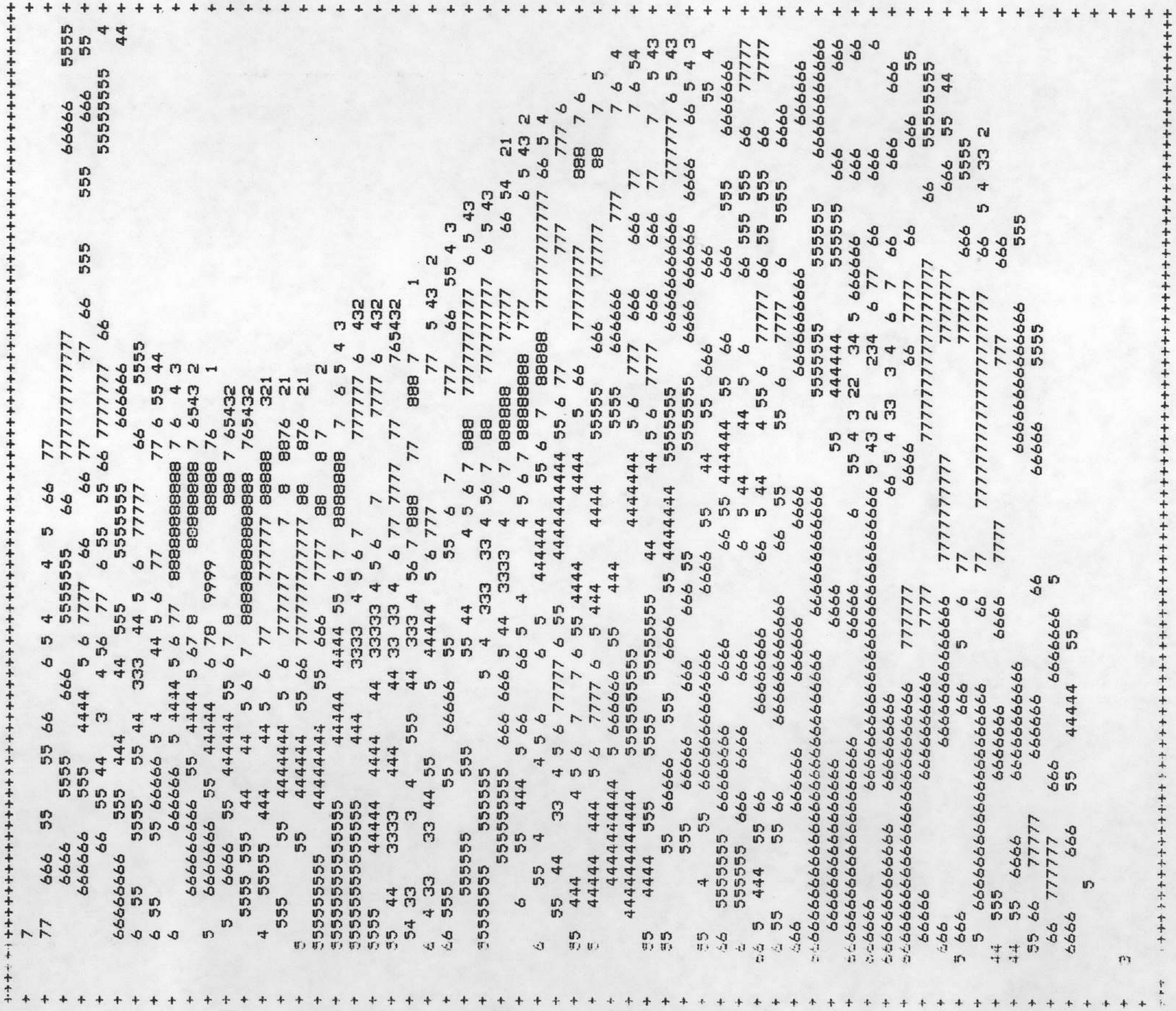
EXPLANATION

PRINT CHARACTER	VALUE
0	LE-1200.0000
	-1200.0000-1125.0000
1	-1125.0000-1050.0000
	-1050.0000 -975.0000
2	-975.0000 -900.0000
	-900.0000 -825.0000
3	-825.0000 -750.0000
	-750.0000 -675.0000
4	-675.0000 -600.0000
	-600.0000 -525.0000
5	-525.0000 -450.0000
	-450.0000 -375.0000
6	-375.0000 -300.0000
	-300.0000 -225.0000
7	-225.0000 -150.0000
	-150.0000 -75.0000
8	-75.0000 0.0000
	0.0000 75.0000
9	75.0000 150.0000
	GT 150.0000

Residual Magnetic Pseudo-Contour Map - Tawas City Quadrangle

SCALE IN GAMMAS

FLINT



Potassium Pseudo-Contour Map - Flint Quadrangle

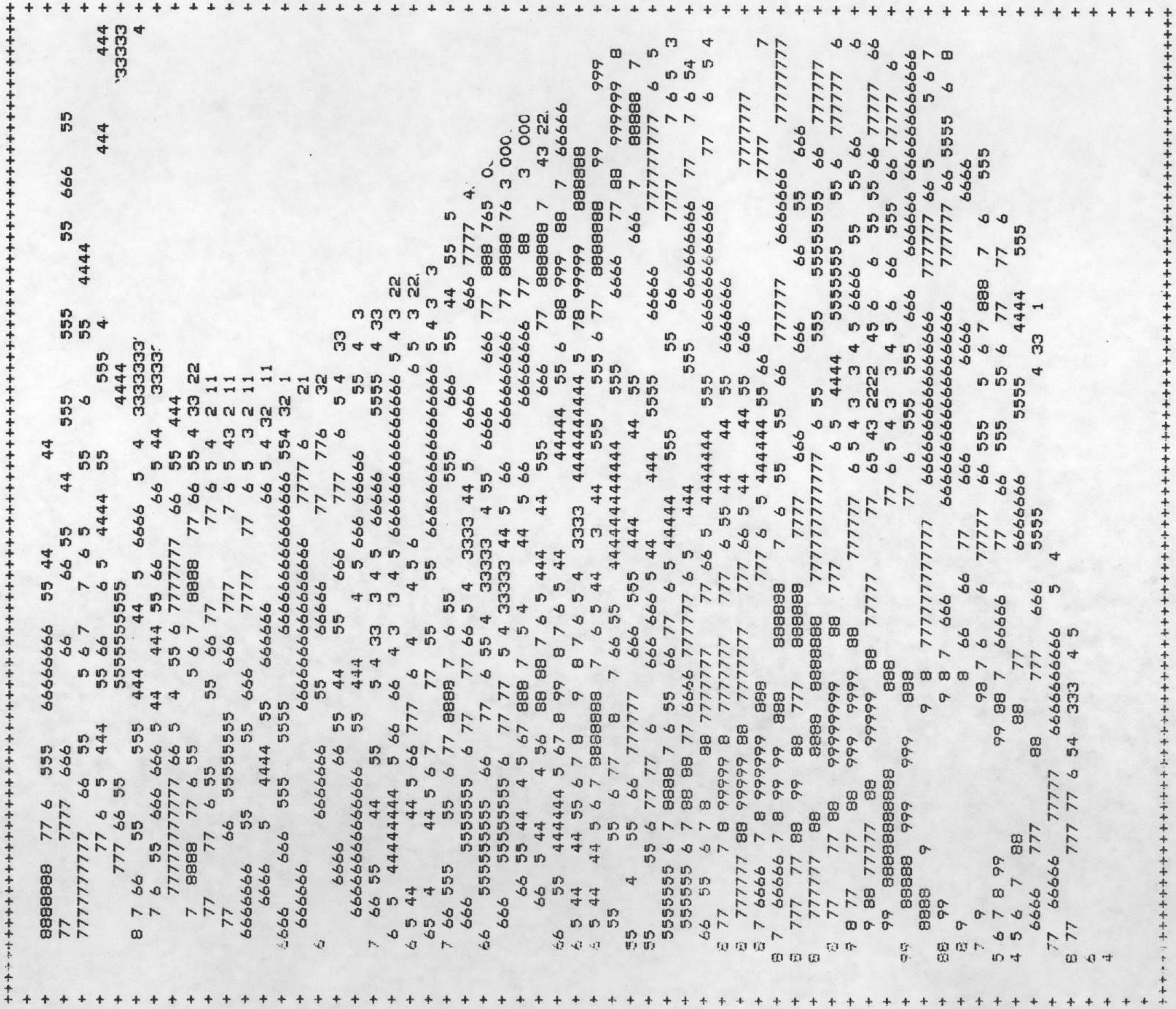
EXPLANATION

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 PERCENT

H9 tf

FLINT



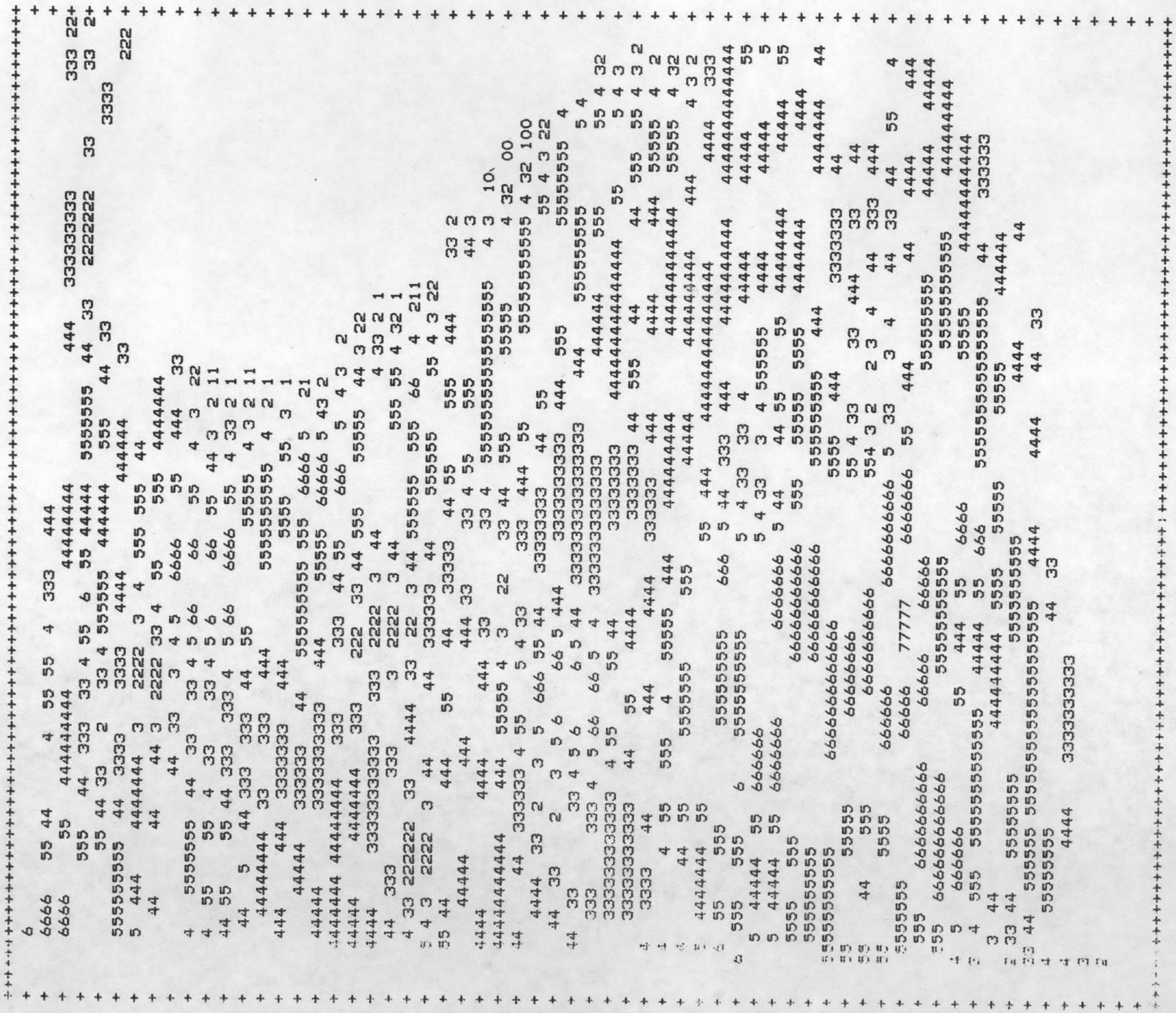
Uranium Pseudo-Contour Map - Flint Quadrangle

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

FLINT



Thorium Pseudo-Contour Map - Flint Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.5000
1	0.5000	1.0000
	1.0000	1.5000
2	1.5000	2.0000
	2.0000	2.5000
3	2.5000	3.0000
	3.0000	3.5000
4	3.5000	4.0000
	4.0000	4.5000
5	4.5000	5.0000
	5.0000	5.5000
6	5.5000	6.0000
	6.0000	6.5000
7	6.5000	7.0000
	7.0000	7.5000
8	7.5000	8.0000
	8.0000	8.5000
9	8.5000	9.0000
	GT	9.0000

SCALE IN EQUIVALENT PPM

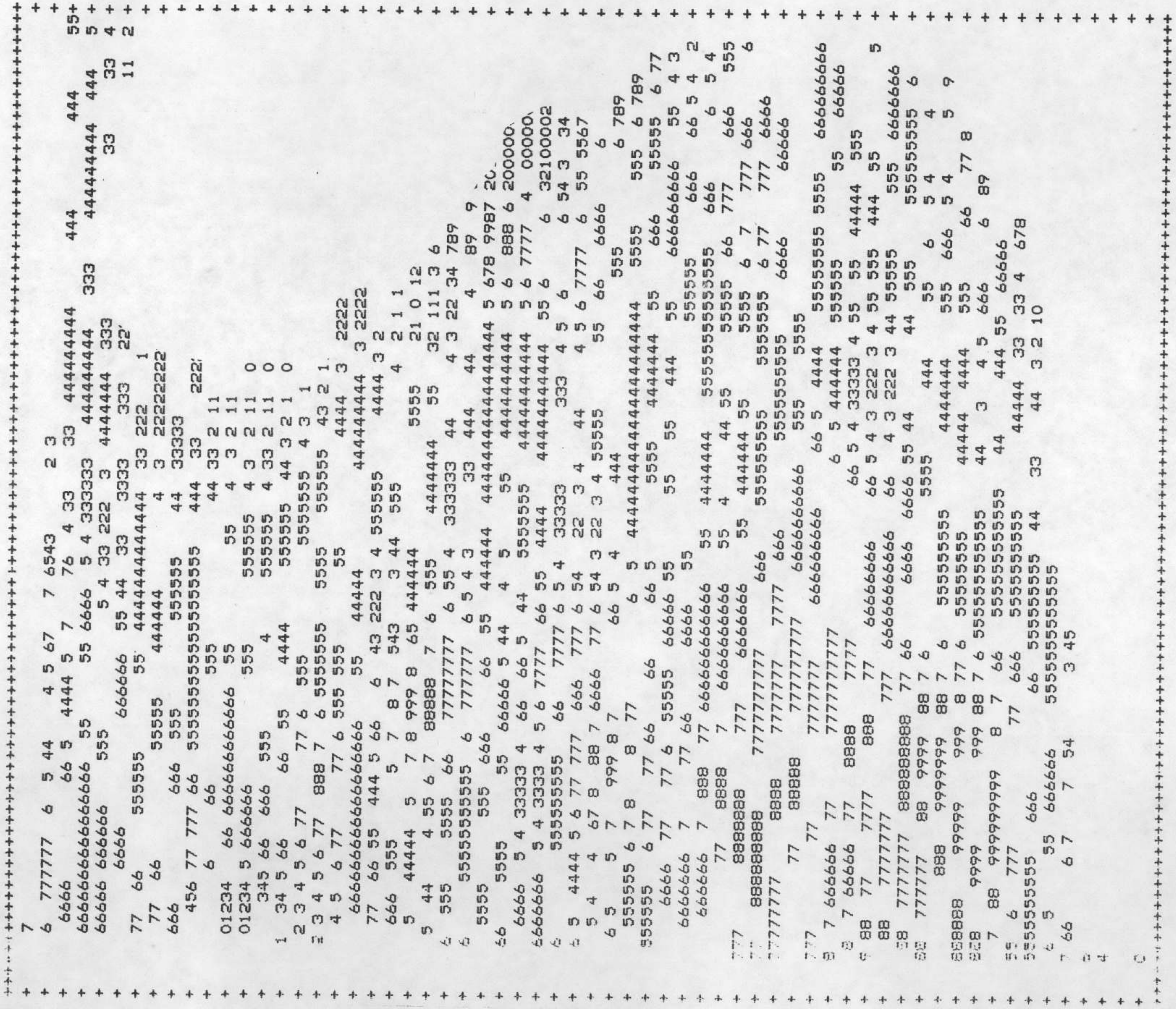
FLINT

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.5000
1	0.5000	1.0000
	1.0000	1.5000
2	1.5000	2.0000
	2.0000	2.5000
3	2.5000	3.0000
	3.0000	3.5000
4	3.5000	4.0000
	4.0000	4.5000
5	4.5000	5.0000
	5.0000	5.5000
6	5.5000	6.0000
	6.0000	6.5000
7	6.5000	7.0000
	7.0000	7.5000
8	7.5000	8.0000
	8.0000	8.5000
9	8.5000	9.0000
	GT	9.0000

Thorium/Potassium Pseudo-Contour Map - Flint Quadrangle

FLINT



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/Potassium Pseudo-Contour Map - Flint Quadrangle

H13 tf

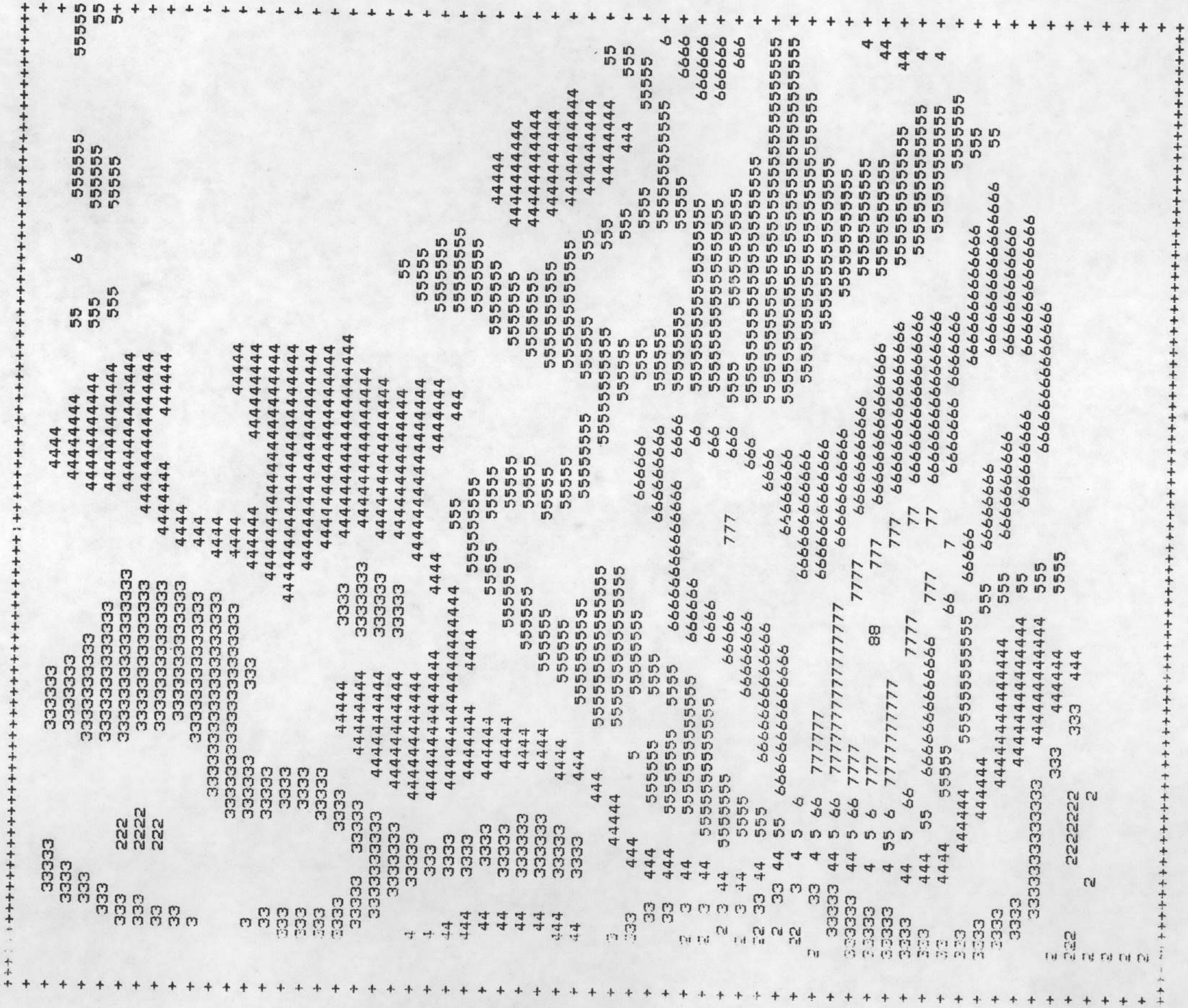
FLINT

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 - Flint Quadrangle

FLINT



Residual Magnetic Pseudo-Contour Map - Flint Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE-1200.0000	
	-1200.0000	-1125.0000
1	-1125.0000	-1050.0000
	-1050.0000	-975.0000
2	-975.0000	-900.0000
	-900.0000	-825.0000
3	-825.0000	-750.0000
	-750.0000	-675.0000
4	-675.0000	-600.0000
	-600.0000	-525.0000
5	-525.0000	-450.0000
	-450.0000	-375.0000
6	-375.0000	-300.0000
	-300.0000	-225.0000
7	-225.0000	-150.0000
	-150.0000	-75.0000
8	-75.0000	0.0000
	0.0000	75.0000
9	75.0000	150.0000
	GT	150.0000

SCALE IN GAMMAS