National Uranium Resource Evaluation

AERIAL GAMMA RAY AND MAGNETIC SURVEY
MARION QUADRANGLE
OHIO

FINAL REPORT

EG&G GEOMETRICS
Sunnyvale, California 94086

June 1981

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

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.

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Under Contract No. DE-AC13-76GJ01664
and Bendix Field Engineering Corporation
Subcontract No. 80-479-L

ABSTRACT

The Marion quadrangle covers a 7,200 square mile area of central Ohio located within the Midwestern Physiographic Province. Up to 5,000 feet of Paleozoic strata overlie the east dipping Precambrian basement. Flat lying Quaternary glacial sediments cover most of the surface within the quadrangle.

A search of available literature revealed no known uranium deposits.

A total of ninety-nine (99) uranium anomalies were detected and are discussed briefly in this report. Radiometric data appear to reflect a preference for uranium occurrences in glacial moraine tills, and a minimum likelihood of occurrence in Paleozoic bedrock. Some of the largest anomalies appear to be culturally induced and no anomaly was considered to represent a significant amount of naturally occurring uranium.

The magnetic data contrast somewhat with the existing structural interpretation of the area. The generally increasing magnetic gradient from west to east is interrupted by many features whose sources may be attributed to undefined lithologic and/or structural elements in the Precambrian basement.

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INTRODUCTION

General

The Marion quadrangle covers a 7,200 square mile area of central Ohio (see Figure 1).

The geologic base map used in this report was compiled at a scale of 1:250,000 by AAA Engineering and Drafting, Inc. (1980). Published sources for the base map included a 1:500,000 scale glacial map of Ohio issued by the U.S. Geological Survey (Goldthwait and others, 1967) and the 1:500,000 scale geologic map of Ohio issued by the Ohio Division of Geological Survey (Bownocker, 1965). Geologic unit descriptions in the report follow those of the base map legend and may be found in Appendix C. Suppplementary geologic information was taken from Cohee and others (1962), Flint (1959, 1971), and Weller (1975). Cultural and physiographic information came from the 1:250,000 scale Marion topographic quadrangle (rev. 1978).

Radiometric and magnetic data were acquired during the months of December 1980 and May 1981 and were processed in June, 1981. A detailed summary of data acquisition, processing, interpretation and presentation methods can be found in Appendix A. Appendix B contains a flight line summary for the Marion quadrangle.

Physiography

The area within the Marion quadrangle is part of a broad glaciated plain which is located on the northeastern edge of the Midwestern Physiographic Province. Landforms produced by repeated glaciations characterize most of the region, (although in the southeast, the undisturbed, unglaciated strata have been eroded into a maze of ridges and valleys typical of the Allegheny Plateau). Most of the area lies within the Ohio River watershed and is drained southward by tributaries of that river (see Figure 3). In the north, however, the drainage is reversed and runoff flows into Lake Erie via the Sandusky River. The drainage divide is defined by the east-west trending Fort Wayne end moraine which in itself is a topographically minor feature. Numerous glacially formed lakes and water supply reservoirs of various sizes dot the landscape.

Elevations range from a low of 734 feet, which occurs on the Dillon Reservoir in the southeast corner of the quadrangle to a high point of 1,549 feet at the headwaters of the Mad River just east of the town of Bellefontaine. Topographic relief is primarily due to stream erosion of glacial debris which nowhere exceeds more than 300 feet locally.

A part of the city of Columbus (582,000 pop.) is located within the Marion quadrangle as well as numerous smaller cities and towns (38,000 to 54,000 pop.). A highly developed network of primary and secondary roads connects population centers in a rectilinear pattern, and railroads pass through virtually all municipalities.

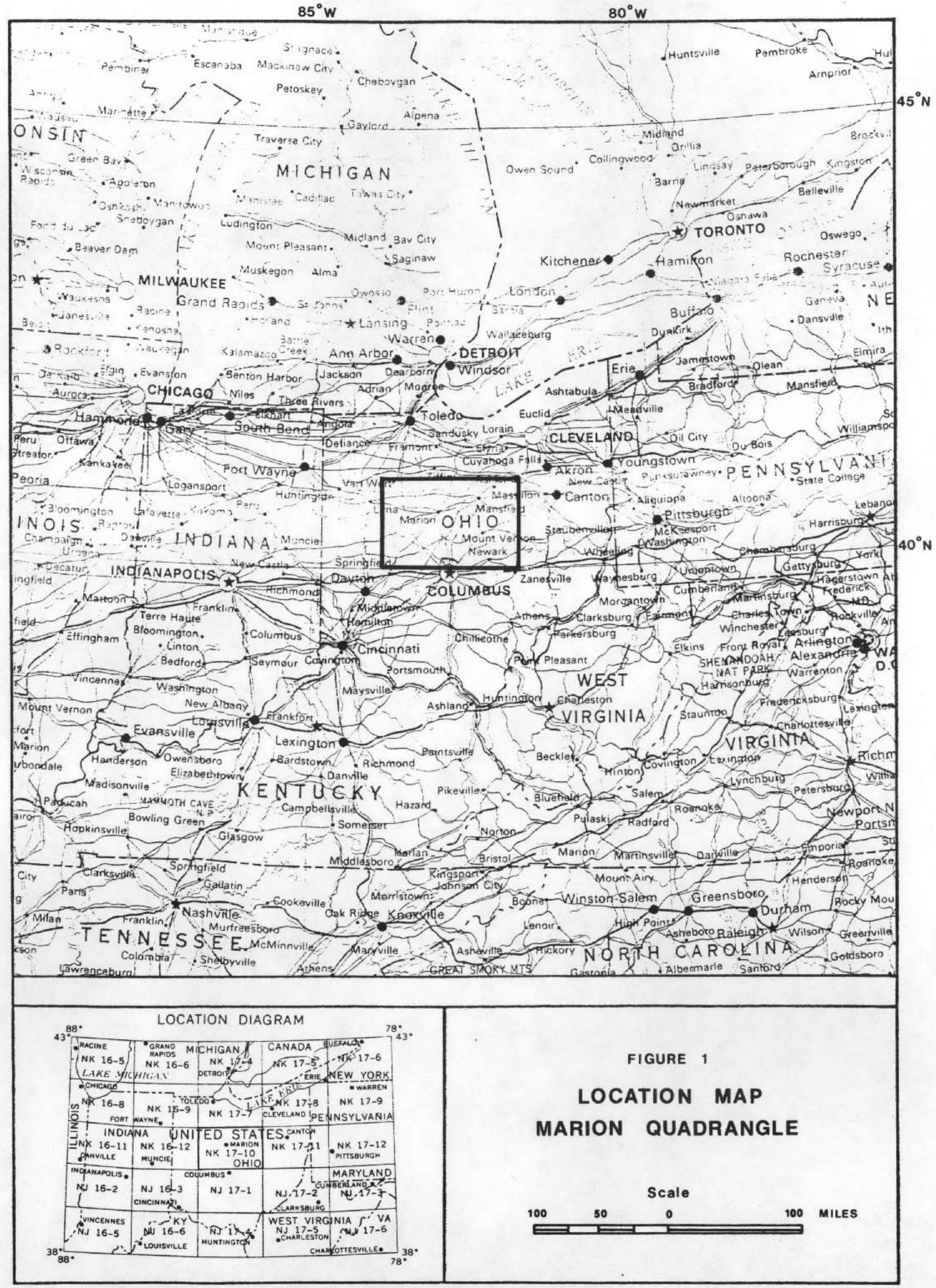


FIGURE 1

LOCATION MAP
MARION QUADRANGLE

GEOLOGY

Structure

The Marion quadrangle overlies the eastern flank of the Findlay Arch, which is a regional basement feature that trends north-northeast along the western edge of the area (see Figure 2). Throughout the quadrangle the basement displays a constant dip eastward toward the Allegheny Basin resulting in a sequence of Paleozoic sedimentary rocks that reach a maximum thickness of 5,000 feet at the southeast corner. The sedimentary cover thins to 1,500 feet on the west side of the quadrangle just over the axis of the Findlay Arch.

Mapped basement structure indicates no faults and only one area of minor local synclinal folding (Cohee and others, 1962). No faults are shown in mapped rock units or glacial cover (AAA Engr., 1980).

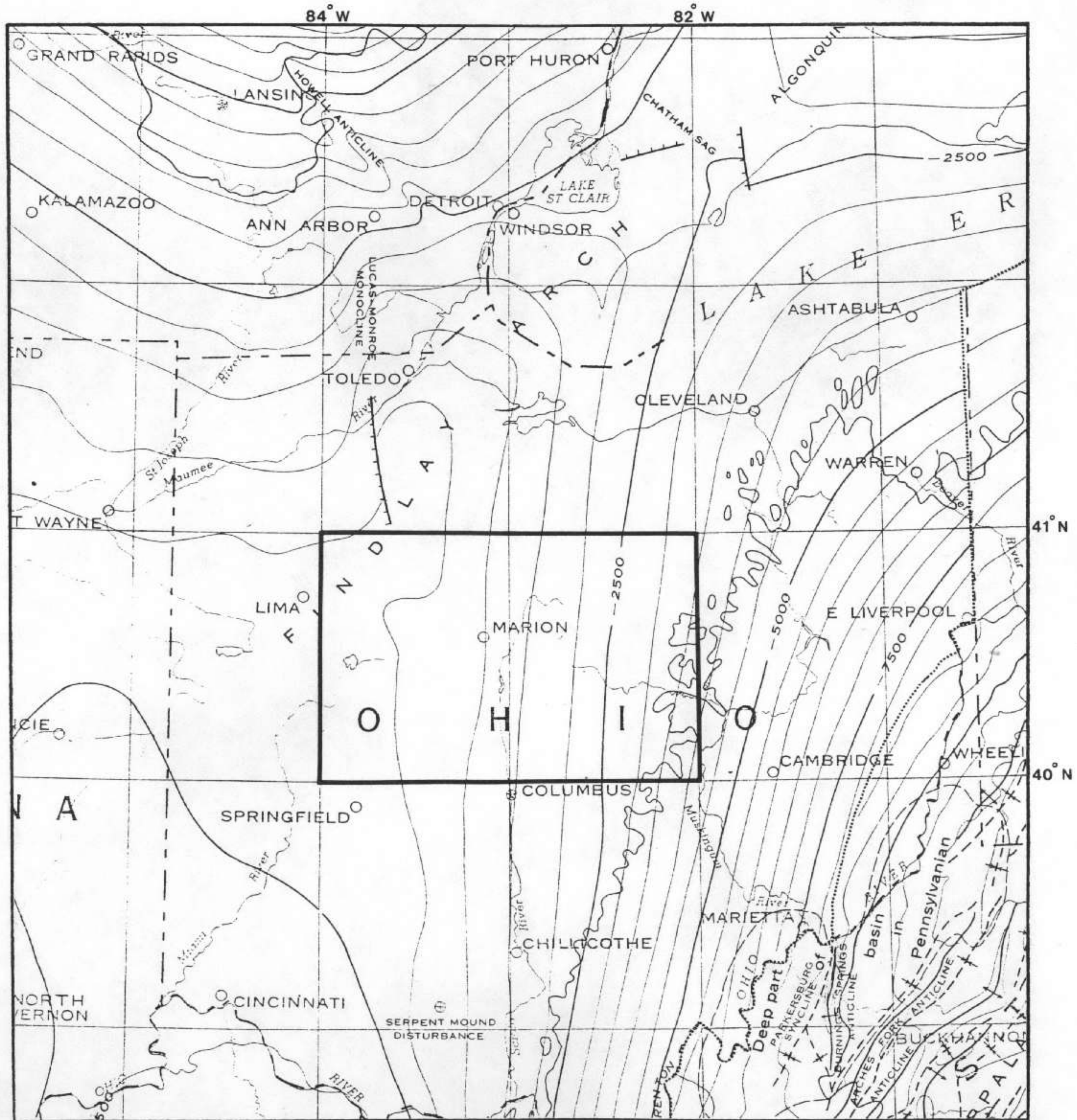
Surface Geology

Pleistocene glaciation in the Marion quadrangle left a wide variety of materials and associated landforms. These deposits represent the two most recent stages of glaciation, the Wisconsinan and Illinoian Stages, and include glacial, periglacial and post-glacial material. The small area in the east not covered by glacial debris includes exposures of Paleozoic sedimentary rocks that are unfolded and exhibit a well developed dendritic drainage pattern.

Wisconsinan drift covers most of the quadrangle (90%) and typically includes broad ground moraines composed of till which form relatively flat land surfaces. End moraines, also a till composed of an unsorted mixture of clay, silt and gravel, separate ground moraines forming narrower strips of sharply hummocky or rolling land. Eight major end moraines are mapped by Goldthwait (1961), several of which mark the limits of significant glacial advances.

Illinoian stage glacial deposits occupy less than 5% of the area and are exposed only along the east edge of younger Wisconsinan drift. The primary landform displays a rolling, smooth surface characteristic of ground moraines. Smooth surface outwash sediments and the hummocky surfaces produced by kames occur in both the Illinoian and Wisconsinan deposits.

A notable geomorphic feature is the peripheral zone along the edge of the glacial deposits. The outer limit of this zone is called the drift border, marking the farthest advance of all glaciation. Beyond the drift border, Paleozoic bedrock is exposed resulting in a dramatic contrast in soil type and vegetation.



After

USGS and AAPG

Tectonic Map of the United States

by

Cohee and others (1962)

FIGURE 2

TECTONIC STRUCTURE MAP
MARION QUADRANGLE

Scale 1:2,500,000

25 0 25 50 75 MILES

Uranium

According to available literature, there are no known uranium deposits in the Marion quadrangle (Butler and others, 1962; Schnabel, 1955).

INTERPRETATION OF GEOPHYSICAL DATA

Radiometric Data

A total of 99 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 Figure 3. 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. The abundance of potassium, uranium, and thorium is discussed in terms of apparent equivalent percent and apparent parts per million equivalent of each element (for example, ppmeU). 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.

The average uranium value for the quadrangle is 3.0 ppmeU. The highest average uranium value for any geologic unit is 3.1 ppmeU which occurs over map unit Qwe (Wisconsinan end moraine till). The peak uranium value observed was 7.4 ppmeU and this was found over map unit Qwg (Wisconsinan ground moraine till). In general, uranium values are slightly higher over Wisconsinan tills (2.8 to 3.5 ppmeU) than they are over Paleozoic bedrock and Illinoian tills (2.2 to 3.0 ppmeU). Two areas that display slightly higher values than the regional average are associated with the city of Columbus. One area includes the metropolitan and surrounding districts and the other, a linear trend, extends northwest from Columbus (see Appendix H). This linear feature follows the Powell end moraine and a major transportation corridor. Whether the higher uranium values are due to geological conditions or culture is, however, problematical.

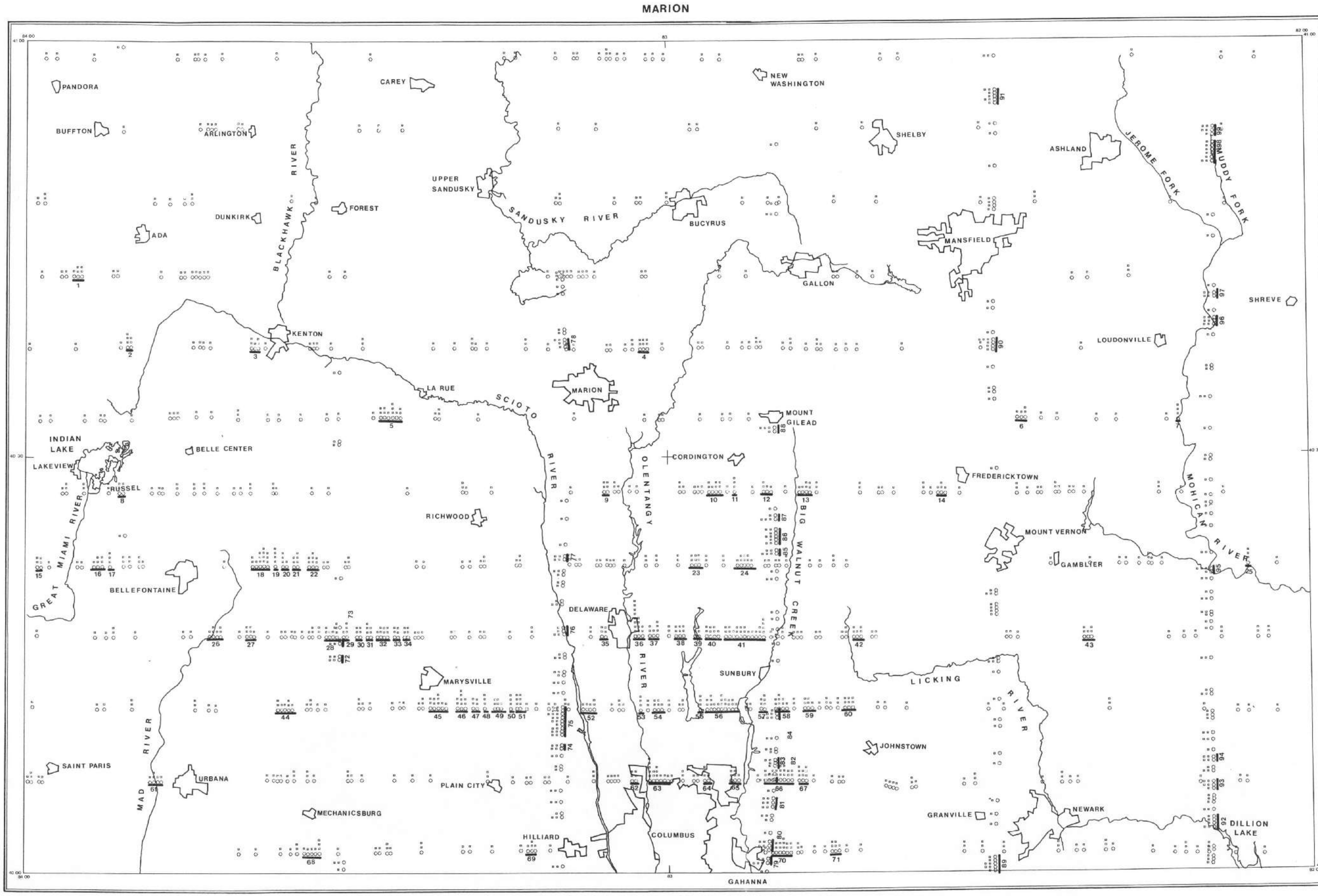
Average potassium and thorium values for the quadrangle are 1.2 percent and 5.9 ppmeT respectively. These moderate values are typical for the glaciated regions of the midwestern U.S. Tills of the Wisconsinan ground and end moraines (map units Qwg and Qwe) exhibit the greatest mean potassium value (1.2 percent) and the highest peak potassium value (2.1 percent) respectively among all the map units. Potassium values increase less than 1 percent from east to west, in broad north-south zones that seem to have little relation to geology (see Appendix H). Only a vague impression of the regional lobate end moraine northwest of Columbus is seen on the potassium pseudo-contour map. Thorium values, on the other hand, are at a maximum in Illinoian outwash deposits and Mississippian bedrock units. The highest mean thorium value is 6.4 ppmeT over map unit Qio (Illinoian outwash deposits), while the highest peak thorium value occurs over map unit Mmw (Mississippian Maxville Limestone and Waverly Group) at 6.4 ppmeT. The thorium pseudo-contour map displays almost as much heterogeny as that of uranium and a slightly larger range of values (4.5 to 7 ppmeT). Correlation between the thorium pseudo-contour map and the geologic base is only slightly better than non-existant. Higher values seem to be associated with bedrock units and some Illinoian drift. These higher values also occur over Wisconsinan deposits in the west, but show trends that cross map unit contacts and do not seem to be controlled by the geology. Some of the lowest values for both potassium and thorium are located in and around Columbus.

Examination of the gamma ray profiles (Appendix D) shows several lines that have significantly higher uranium and BiAir concentrations. These peculiar radiometric signatures have been encountered in previous surveys nearby and are considered to be weather phenomena that are not easily corrected by the present radon correction scheme which is based upon the assumption of uniform, homogenous radon distribution. An adjustment of the uranium and affected ratios was made, assuming that the absolute ground uranium concentrations in these areas are actually similar to those of adjacent and crossing lines. Statistical analyses were done using the corrected values.

Uranium anomalies are found primarily in the southern part of the quadrangle along a broad zone between the east and west map borders. Anomalies generally range from 3.5 to 5.0 ppmeU, with anomaly number 36 containing a peak value of 7.4 ppmeU. Most of the larger anomalies are located around Columbus and this association, as well as the generally low values throughout the quadrangle, suggest a lack of significant occurrences of natural in-situ uranium.

Magnetic Data

The magnetic data as displayed by the pseudo-contour map (Appendix H) exhibit a wide variety of features in apparent contrast to the interpretation of the basement structure, as shown in Figure 2. Only in the west is the long wavelength magnetic signature uninterrupted. Elsewhere lithologic and structural elements in the underlying rock units are represented by magnetic features with various shapes and sizes that show no dominate trend.



URANIUM ANOMALY/ INTERPRETATION MAP

MARION QUADRANGLE

U.S. DEPARTMENT OF ENERGY

APPROXIMATE SCALE 1:500,000

EXPLANATION

□ – CITY OR TOWN

– URANIUM SAMPLE MEETING FOLLOWING CRITERIA:

(1) $1.0 \le U \le \infty$

(2) $-1.0 \le T \le \infty$

(3) $1.0 \le U/T \le \infty$

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, $4.0 \le \text{sum} \le \infty$, WITH AT LEAST ONE SAMPLE OF 2 OR MORE STANDARD DEVIATIONS.

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

Figure 3 - Uranium Anomaly/Interpretation Map - Marion Quadrangle

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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.

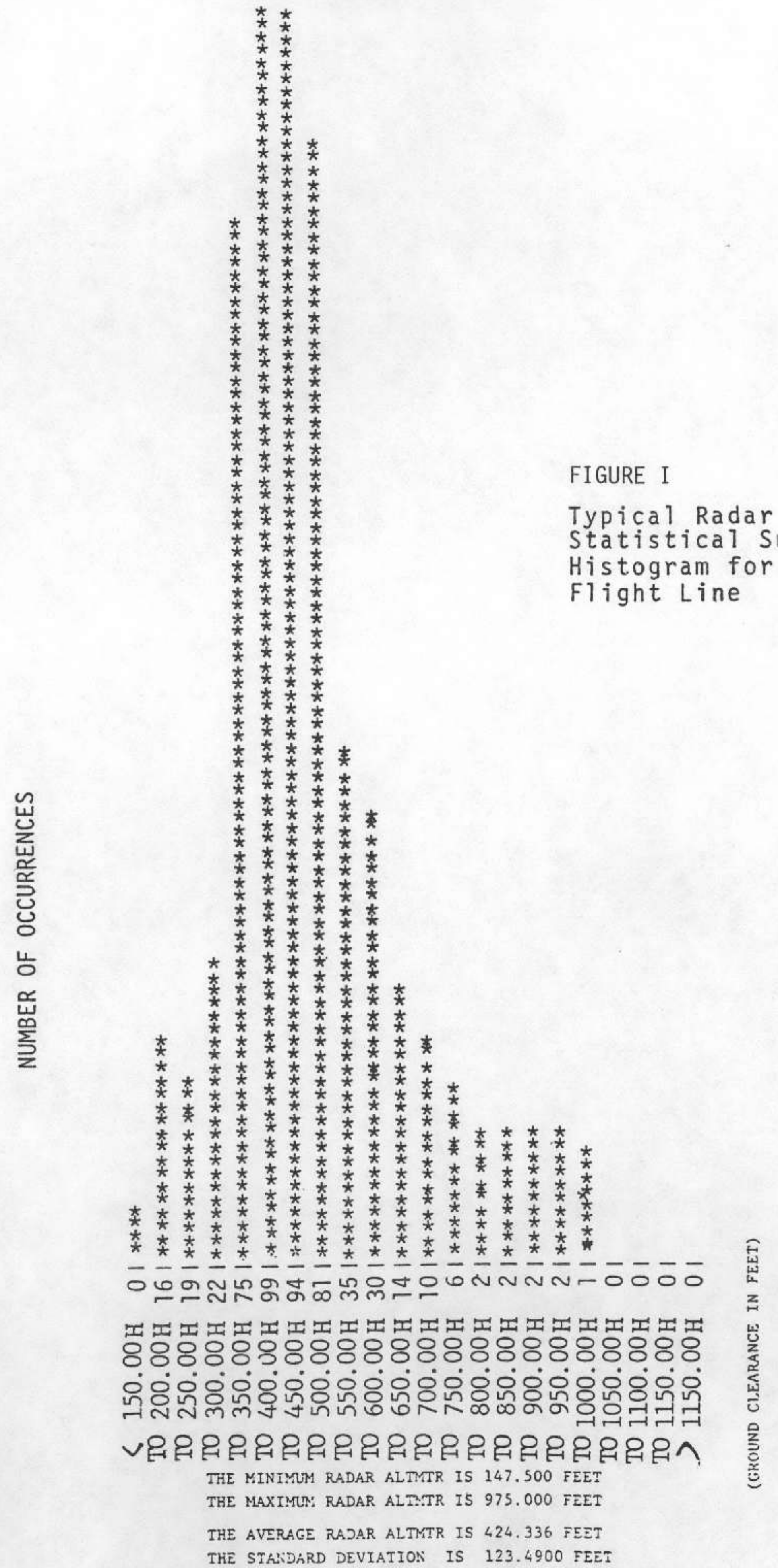


FIGURE I

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.

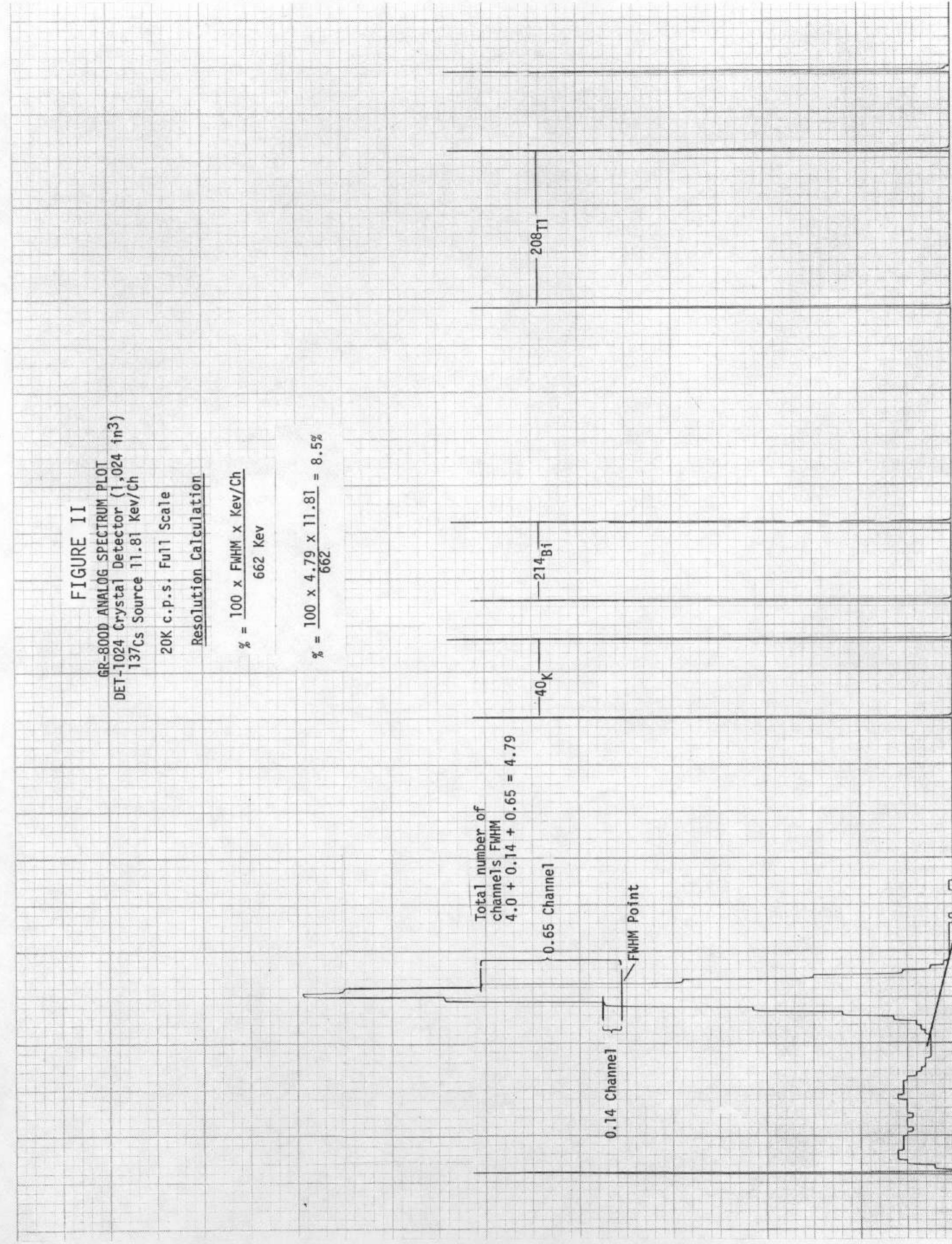
3. Finally run a full thorium analog spectrum of the down crystals and check for centering of K40 and Tl208 peaks in spectrum.

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.



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.

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	528 lbs.	1,338 lbs
Pilot & Electronics Operator	350 lbs.	350 lbs.
Total	2,113 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

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.

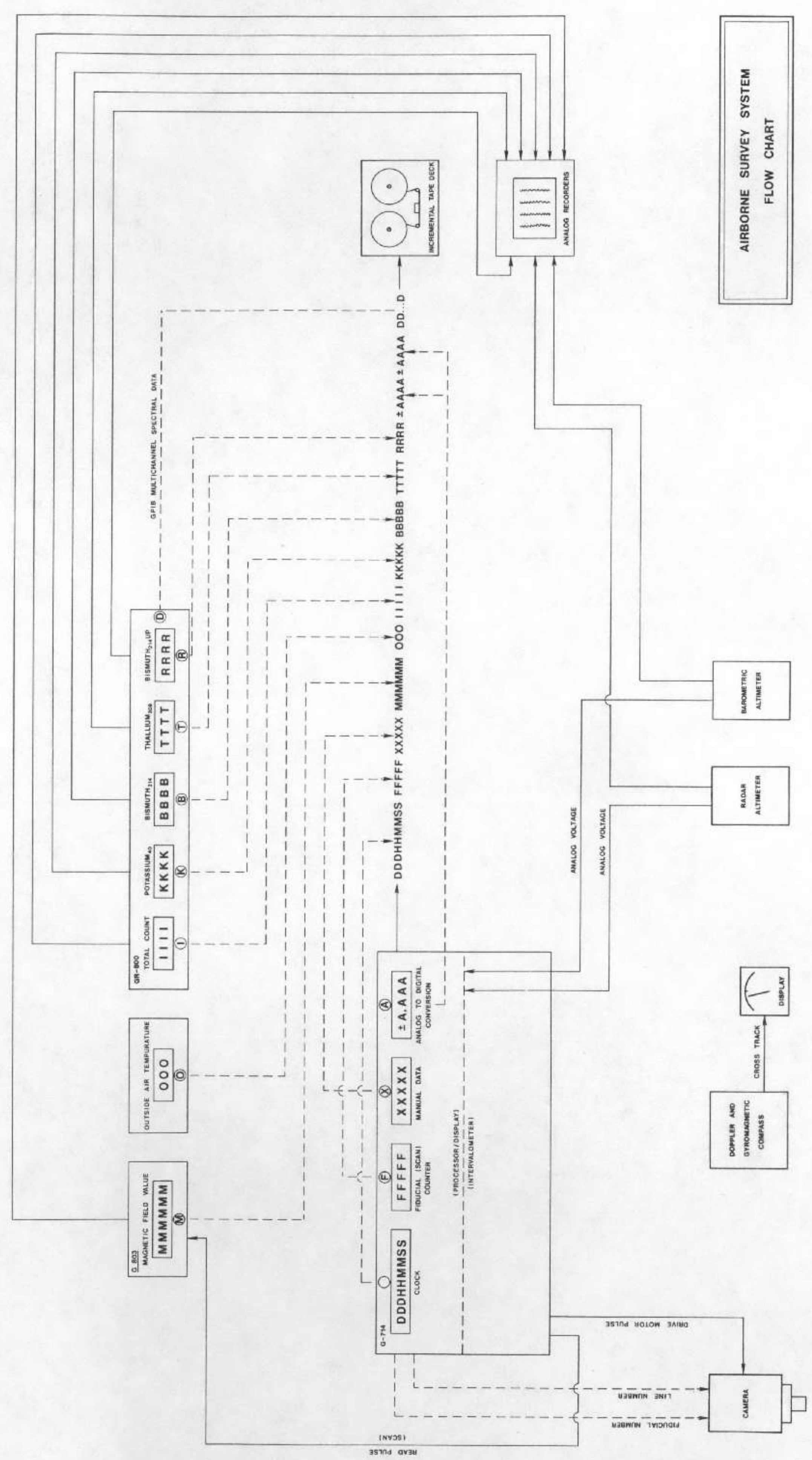


FIGURE III

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:

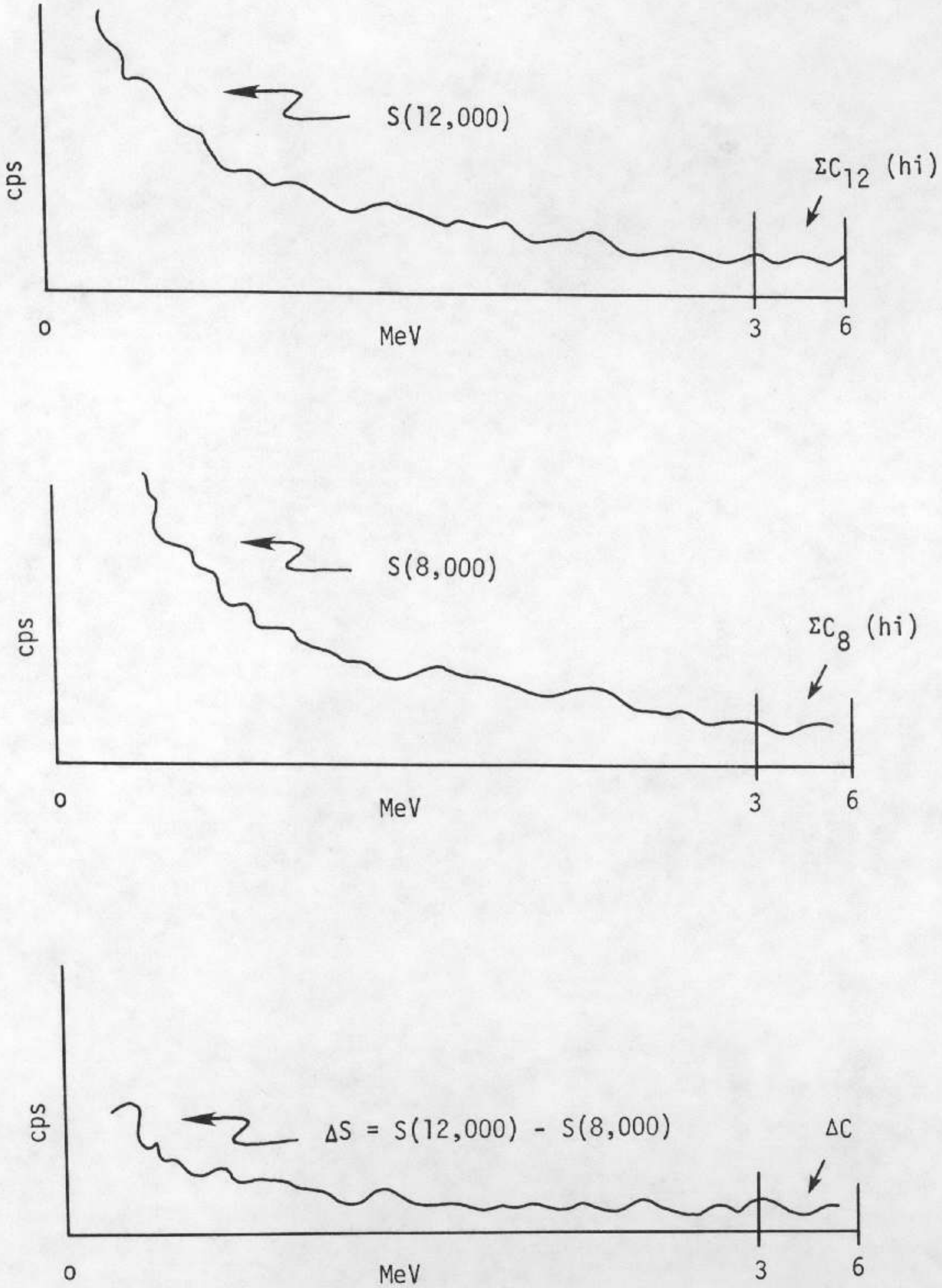


FIGURE IV - Multiple altitude spectra schematic

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).

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DERIVED AIRCRAFT BACKGROUND SPECTRUM FROM PACIFIC OCEAN DATA

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

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

CH   0 (0.000 MEV)   0.000 CPS *
CH   1 (0.012 MEV)   0.000 CPS *
CH   2 (0.024 MEV)   0.000 CPS *
CH   3 (0.035 MEV)   0.000 CPS *
CH   4 (0.047 MEV)   0.000 CPS *
CH   5 (0.059 MEV)   0.000 CPS *
CH   6 (0.071 MEV)   0.000 CPS *
CH   7 (0.083 MEV)   0.000 CPS *
CH   8 (0.095 MEV)   0.000 CPS *
CH   9 (0.106 MEV)   0.000 CPS *
CH  10 (0.118 MEV)   0.000 CPS *
CH  11 (0.130 MEV)   0.000 CPS *
CH  12 (0.142 MEV)   0.000 CPS *
CH  13 (0.154 MEV)   0.000 CPS *
CH  14 (0.165 MEV)   0.000 CPS *
CH  15 (0.177 MEV)   0.000 CPS *
CH  16 (0.189 MEV)   0.000 CPS *
CH  17 (0.201 MEV)   0.000 CPS *
CH  18 (0.213 MEV)  -0.025 CPS *
CH  19 (0.225 MEV)  -0.020 CPS *
CH  20 (0.236 MEV)   0.080 CPS *
CH  21 (0.248 MEV)   1.401 CPS *****
CH  22 (0.260 MEV)   3.792 CPS ************
CH  23 (0.272 MEV)   4.280 CPS **************
CH  24 (0.284 MEV)   4.334 CPS **************
CH  25 (0.295 MEV)   3.748 CPS ************
CH  26 (0.307 MEV)   3.897 CPS *************
CH  27 (0.319 MEV)   3.818 CPS ************
CH  28 (0.331 MEV)   4.236 CPS **************
CH  29 (0.343 MEV)   3.433 CPS ***********
CH  30 (0.355 MEV)   2.996 CPS **********
CH  31 (0.366 MEV)   2.559 CPS *********
CH  32 (0.378 MEV)   2.269 CPS ********
CH  33 (0.390 MEV)   2.102 CPS *******
CH  34 (0.402 MEV)   2.081 CPS ******* TOTAL COUNT
CH  35 (0.414 MEV)   2.121 CPS *******
CH  36 (0.426 MEV)   2.114 CPS *******
CH  37 (0.437 MEV)   1.976 CPS *******
CH  38 (0.449 MEV)   2.290 CPS ********
CH  39 (0.461 MEV)   2.188 CPS ********
CH  40 (0.473 MEV)   2.226 CPS ********
CH  41 (0.485 MEV)   1.983 CPS *******
CH  42 (0.496 MEV)   2.165 CPS *******
CH  43 (0.508 MEV)   2.158 CPS *******
CH  44 (0.520 MEV)   2.267 CPS ********
CH  45 (0.532 MEV)   2.217 CPS ********
CH  46 (0.544 MEV)   1.997 CPS *******
CH  47 (0.556 MEV)   2.447 CPS ********
CH  48 (0.567 MEV)   2.540 CPS *********
CH  49 (0.579 MEV)   2.586 CPS *********
CH  50 (0.591 MEV)   2.708 CPS *********
CH  51 (0.603 MEV)   2.481 CPS ********
CH  52 (0.615 MEV)   2.372 CPS ********
CH  53 (0.626 MEV)   1.866 CPS *******
CH  54 (0.638 MEV)   1.682 CPS ******
CH  55 (0.650 MEV)   1.661 CPS ******
CH  56 (0.662 MEV)   1.480 CPS *****
CH  57 (0.674 MEV)   1.474 CPS *****
CH  58 (0.686 MEV)   1.447 CPS *****
CH  59 (0.697 MEV)   1.431 CPS *****
CH  60 (0.709 MEV)   1.476 CPS *****
CH  61 (0.721 MEV)   1.453 CPS *****
CH  62 (0.733 MEV)   1.467 CPS *****
CH  63 (0.745 MEV)   1.579 CPS ******
CH  64 (0.756 MEV)   1.497 CPS *****
CH  65 (0.768 MEV)   1.548 CPS ******
CH  66 (0.780 MEV)   1.421 CPS *****
CH  67 (0.792 MEV)   1.282 CPS *****
CH  68 (0.804 MEV)   1.155 CPS ****
CH  69 (0.816 MEV)   1.246 CPS *****
CH  70 (0.827 MEV)   1.245 CPS *****
CH  71 (0.839 MEV)   1.161 CPS ****
CH  72 (0.851 MEV)   1.253 CPS *****
CH  73 (0.863 MEV)   1.231 CPS *****
CH  74 (0.875 MEV)   1.425 CPS *****
CH  75 (0.887 MEV)   1.452 CPS *****
CH  76 (0.898 MEV)   1.543 CPS ******
CH  77 (0.910 MEV)   1.444 CPS *****
CH  78 (0.922 MEV)   1.364 CPS *****
CH  79 (0.934 MEV)   1.289 CPS *****
CH  80 (0.946 MEV)   1.150 CPS ****
CH  81 (0.957 MEV)   1.144 CPS ****
CH  82 (0.969 MEV)   1.085 CPS ****
CH  83 (0.981 MEV)   1.061 CPS ****
CH  84 (0.993 MEV)   0.941 CPS ****
CH  85 (1.005 MEV)   0.919 CPS ****
CH  86 (1.017 MEV)   0.822 CPS ***
CH  87 (1.028 MEV)   0.816 CPS ***
CH  88 (1.040 MEV)   0.853 CPS ****
CH  89 (1.052 MEV)   0.901 CPS **** BISMUTH 214
CH  90 (1.064 MEV)   0.822 CPS ***
CH  91 (1.076 MEV)   0.867 CPS ****
CH  92 (1.087 MEV)   0.968 CPS ****
CH  93 (1.099 MEV)   0.851 CPS ****
CH  94 (1.111 MEV)   0.905 CPS ****
CH  95 (1.123 MEV)   0.847 CPS ****
CH  96 (1.135 MEV)   0.861 CPS ****
CH  97 (1.147 MEV)   0.800 CPS ***
CH  98 (1.158 MEV)   0.727 CPS ***
CH  99 (1.170 MEV)   0.751 CPS ***
CH 100 (1.182 MEV)   0.607 CPS *** BISMUTH 214
CH 101 (1.194 MEV)   0.663 CPS ***
CH 102 (1.206 MEV)   0.657 CPS ***
CH 103 (1.217 MEV)   0.633 CPS ***
CH 104 (1.229 MEV)   0.719 CPS ***
CH 105 (1.241 MEV)   0.671 CPS ***
CH 106 (1.253 MEV)   0.475 CPS **
CH 107 (1.265 MEV)   0.601 CPS ***
CH 108 (1.277 MEV)   0.661 CPS ***
CH 109 (1.288 MEV)   0.669 CPS ***
CH 110 (1.300 MEV)   0.606 CPS ***
CH 111 (1.312 MEV)   0.630 CPS ***
CH 112 (1.324 MEV)   0.652 CPS ***
CH 113 (1.336 MEV)   0.644 CPS ***
CH 114 (1.347 MEV)   0.652 CPS ***
CH 115 (1.359 MEV)   0.791 CPS ***
CH 116 (1.371 MEV)   0.787 CPS *** POTASSIUM 40
CH 117 (1.383 MEV)   0.834 CPS ****
CH 118 (1.395 MEV)   0.984 CPS ****
CH 119 (1.407 MEV)   1.072 CPS ****
CH 120 (1.418 MEV)   1.124 CPS ****
CH 121 (1.430 MEV)   1.088 CPS ****
CH 122 (1.442 MEV)   1.210 CPS *****
CH 123 (1.454 MEV)   1.231 CPS *****
CH 124 (1.466 MEV)   1.207 CPS *****
CH 125 (1.477 MEV)   0.995 CPS ****
CH 126 (1.489 MEV)   0.967 CPS ****
CH 127 (1.501 MEV)   0.624 CPS ***
CH 128 (1.513 MEV)   0.635 CPS ***
CH 129 (1.525 MEV)   0.512 CPS ***
CH 130 (1.537 MEV)   0.488 CPS **
CH 131 (1.548 MEV)   0.409 CPS **
CH 132 (1.560 MEV)   0.369 CPS ** POTASSIUM 40
CH 133 (1.572 MEV)   0.339 CPS **
CH 134 (1.584 MEV)   0.438 CPS **
CH 135 (1.596 MEV)   0.310 CPS **
CH 136 (1.608 MEV)   0.259 CPS **
CH 137 (1.619 MEV)   0.250 CPS **
CH 138 (1.631 MEV)   0.353 CPS **
CH 139 (1.643 MEV)   0.323 CPS **
CH 140 (1.655 MEV)   0.332 CPS **
CH 141 (1.667 MEV)   0.326 CPS ** BISMUTH 214
CH 142 (1.678 MEV)   0.267 CPS **
CH 143 (1.690 MEV)   0.275 CPS **
CH 144 (1.702 MEV)   0.245 CPS **
CH 145 (1.714 MEV)   0.347 CPS **
CH 146 (1.726 MEV)   0.352 CPS **
CH 147 (1.738 MEV)   0.293 CPS **
CH 148 (1.749 MEV)   0.359 CPS **
CH 149 (1.761 MEV)   0.270 CPS **
CH 150 (1.773 MEV)   0.334 CPS **
CH 151 (1.785 MEV)   0.245 CPS **
CH 152 (1.797 MEV)   0.255 CPS **
CH 153 (1.808 MEV)   0.174 CPS **
CH 154 (1.820 MEV)   0.228 CPS **
CH 155 (1.832 MEV)   0.188 CPS **
CH 156 (1.844 MEV)   0.115 CPS *
CH 157 (1.856 MEV)   0.084 CPS * BISMUTH 214
CH 158 (1.868 MEV)   0.147 CPS *
CH 159 (1.879 MEV)   0.147 CPS *
CH 160 (1.891 MEV)   0.139 CPS *
CH 161 (1.903 MEV)   0.109 CPS *
CH 162 (1.915 MEV)   0.091 CPS *
CH 163 (1.927 MEV)   0.151 CPS *
CH 164 (1.938 MEV)   0.088 CPS *
CH 165 (1.950 MEV)   0.136 CPS *
CH 166 (1.962 MEV)   0.157 CPS *
CH 167 (1.974 MEV)   0.119 CPS *
CH 168 (1.986 MEV)   0.109 CPS *
CH 169 (1.998 MEV)   0.113 CPS *
CH 170 (2.009 MEV)   0.106 CPS *
CH 171 (2.021 MEV)   0.147 CPS *
CH 172 (2.033 MEV)   0.137 CPS *
CH 173 (2.045 MEV)   0.171 CPS **
CH 174 (2.057 MEV)   0.154 CPS *
CH 175 (2.068 MEV)   0.108 CPS *
CH 176 (2.080 MEV)   0.162 CPS *
CH 177 (2.092 MEV)   0.104 CPS *
CH 178 (2.104 MEV)   0.138 CPS *
CH 179 (2.116 MEV)   0.137 CPS *
CH 180 (2.128 MEV)   0.119 CPS *
CH 181 (2.139 MEV)   0.169 CPS **
CH 182 (2.151 MEV)   0.148 CPS *
CH 183 (2.163 MEV)   0.101 CPS *
CH 184 (2.175 MEV)   0.114 CPS *
CH 185 (2.187 MEV)   0.088 CPS *
CH 186 (2.199 MEV)   0.101 CPS *
CH 187 (2.210 MEV)   0.085 CPS *
CH 188 (2.222 MEV)   0.130 CPS *
CH 189 (2.234 MEV)   0.117 CPS *
CH 190 (2.246 MEV)   0.113 CPS *
CH 191 (2.258 MEV)   0.116 CPS *
CH 192 (2.269 MEV)   0.088 CPS *
CH 193 (2.281 MEV)   0.097 CPS *
CH 194 (2.293 MEV)   0.095 CPS *
CH 195 (2.305 MEV)   0.087 CPS *
CH 196 (2.317 MEV)   0.059 CPS *
CH 197 (2.329 MEV)   0.015 CPS *
CH 198 (2.340 MEV)   0.041 CPS *
CH 199 (2.352 MEV)   0.070 CPS *
CH 200 (2.364 MEV)   0.087 CPS *
CH 201 (2.376 MEV)   0.085 CPS *
CH 202 (2.388 MEV)   0.084 CPS *
CH 203 (2.399 MEV)   0.064 CPS *
CH 204 (2.411 MEV)   0.123 CPS * THALLIUM 208
CH 205 (2.423 MEV)   0.076 CPS *
CH 206 (2.435 MEV)   0.116 CPS *
CH 207 (2.447 MEV)   0.147 CPS *
CH 208 (2.459 MEV)   0.108 CPS *
CH 209 (2.470 MEV)   0.120 CPS *
CH 210 (2.482 MEV)   0.092 CPS *
CH 211 (2.494 MEV)   0.127 CPS *
CH 212 (2.506 MEV)   0.169 CPS **
CH 213 (2.518 MEV)   0.206 CPS **
CH 214 (2.529 MEV)   0.262 CPS **
CH 215 (2.541 MEV)   0.184 CPS **
CH 216 (2.553 MEV)   0.206 CPS **
CH 217 (2.565 MEV)   0.195 CPS **
CH 218 (2.577 MEV)   0.173 CPS **
CH 219 (2.589 MEV)   0.201 CPS **
CH 220 (2.600 MEV)   0.329 CPS **
CH 221 (2.612 MEV)   0.232 CPS **
CH 222 (2.624 MEV)   0.187 CPS **
CH 223 (2.636 MEV)   0.171 CPS **
CH 224 (2.648 MEV)   0.177 CPS **
CH 225 (2.660 MEV)   0.089 CPS *
CH 226 (2.671 MEV)   0.122 CPS *
CH 227 (2.683 MEV)   0.124 CPS *
CH 228 (2.695 MEV)   0.131 CPS *
CH 229 (2.707 MEV)   0.090 CPS *
CH 230 (2.719 MEV)   0.027 CPS *
CH 231 (2.730 MEV)   0.012 CPS *
CH 232 (2.742 MEV)  -0.026 CPS *
CH 233 (2.754 MEV)  -0.024 CPS *
CH 234 (2.766 MEV)   0.038 CPS *
CH 235 (2.778 MEV)   0.003 CPS *
CH 236 (2.790 MEV)   0.060 CPS *
CH 237 (2.801 MEV)   0.038 CPS * THALLIUM 208
CH 238 (2.813 MEV)   0.023 CPS *
CH 239 (2.825 MEV)   0.008 CPS *
CH 240 (2.837 MEV)   0.078 CPS *
CH 241 (2.849 MEV)   0.027 CPS *
CH 242 (2.860 MEV)   0.047 CPS *
CH 243 (2.872 MEV)   0.039 CPS *
CH 244 (2.884 MEV)   0.084 CPS *
CH 245 (2.896 MEV)   0.025 CPS *
CH 246 (2.908 MEV)   0.025 CPS *
CH 247 (2.920 MEV)  -0.015 CPS *
CH 248 (2.931 MEV)   0.037 CPS *
CH 249 (2.943 MEV)  -0.005 CPS *
CH 250 (2.955 MEV)   0.042 CPS *
CH 251 (2.967 MEV)   0.002 CPS *
CH 252 (2.979 MEV)  -0.018 CPS *
CH 253 (2.990 MEV)   0.031 CPS *
CH 254 (3.002 MEV)  -0.106 CPS * TOTAL COUNT
CH 255 (3.014 MEV)   0.000 CPS *
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AIRCRAFT BACKGROUND
ROTARY WING AIRCRAFT
DOWNWARD LOOKING CRYSTAL
2048 CUBIC INCHES
DATE: 25 JULY 1977

FIGURE V

DERIVED COSMIC SPECTRUM FROM PACIFIC OCEAN DATA

DOWNWARD-LOOKING CRYSTAL SPECTRUM FOR LINE COSMIC, DATED 072577

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

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

CH 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)	12.084 CPS	
CH 119	(1.407 MEV)	9.642 CPS	
CH 120	(1.418 MEV)	11.778 CPS	
CH 121	(1.430 MEV)	12.635 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)	9.250 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)	9.361 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)	10.551 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)	8.425 CPS	
CH 147	(1.738 MEV)	9.263 CPS	
CH 148	(1.749 MEV)	9.653 CPS	
CH 149	(1.761 MEV)	9.412 CPS	
CH 150	(1.773 MEV)	9.019 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)	9.602 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)	8.235 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)	7.110 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)	7.050 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)	6.852 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)	5.845 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)	6.670 CPS	
CH 219	(2.589 MEV)	6.808 CPS	
CH 220	(2.600 MEV)	5.940 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.

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

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

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

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

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

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

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

The equations can be expressed in matrix notation

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

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

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

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

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

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

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

or

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

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

Rearranging the above equations we have

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

We now define

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

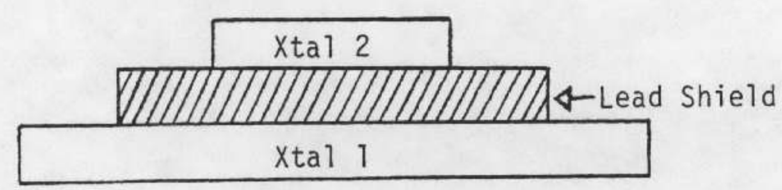
$S_{tu} = \frac{\Delta_{tu}}{\Delta_{tt}}$ (effect of uranium on thorium)

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

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

ATMOSPHERIC RADON CORRECTION

Consider the crystal configuration shown below:



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

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

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

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

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

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

Therefore $$I_1 = I_g$$

$$I_2 = \ell I_g$$

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

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

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

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

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

Consider the equations for I_1 and I_2 again

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

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

Over water $I_g = 0$

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

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

$$I_1 = I_a$$

$$I_2 = mI_a$$

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

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

$$I_1 = I_g + I_a$$

$$I_2 = \ell I_g + mI_a$$

$$mI_a = I_2 - \ell I_g$$

but $$I_g = I_1 - I_a$$

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

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

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

DATA PROCESSING

DATA PREPARATION

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

Field Tape Verification and Edit

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

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

Flight Line Location

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

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

RADIOMETRIC DATA REDUCTION

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

Total count - 0.4 to 3.0 MeV

K - 1.37 to 1.57 MeV

U - 1.66 to 1.87 MeV (downward looking system)

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

T - 2.41 to 2.81 MeV

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

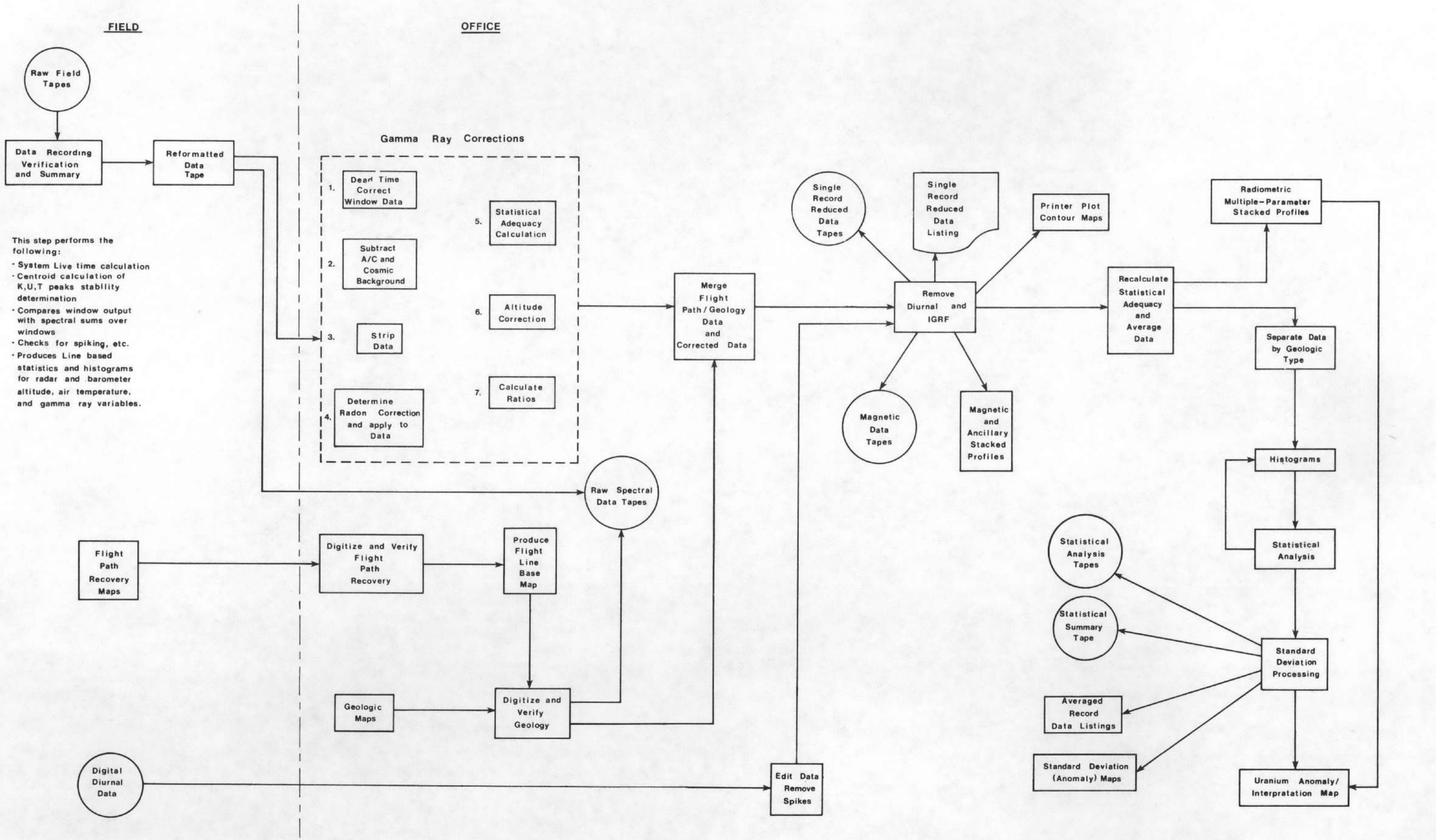
Aircraft and Cosmic background for the Queen Air/Aero Commander over these windows are as follows:

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

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

DATA PROCESSING FLOW DIAGRAM

FIGURE VII



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

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

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

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

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

Altitude attenuation coefficients used are defined as follows:

ALTITUDE ATTENUATION COEFFICIENTS

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

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

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

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

Bi Air calculations are made using the following expressions:

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

Where U_{up} = count rate from upward detectors

ℓ = crystal coupling constant

m = crystal geometric factor

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

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

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

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

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

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

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

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

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

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

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

Statistical Adequacy Test

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

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

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

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

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

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

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

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

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

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

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

Conversion to Equivalent ppm and Percent

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

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

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.

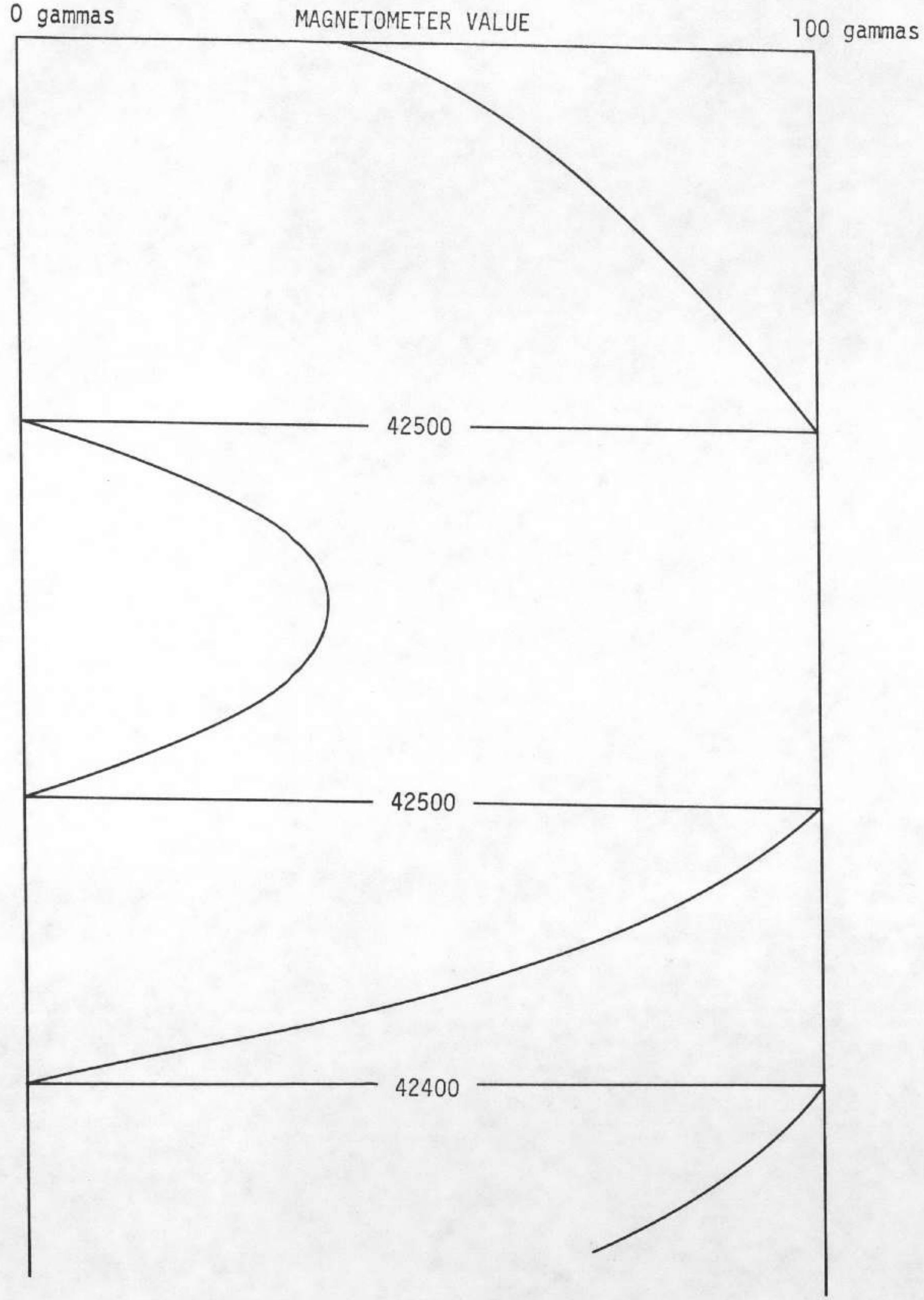


FIGURE VIII Plotter Step Value Labeling

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.

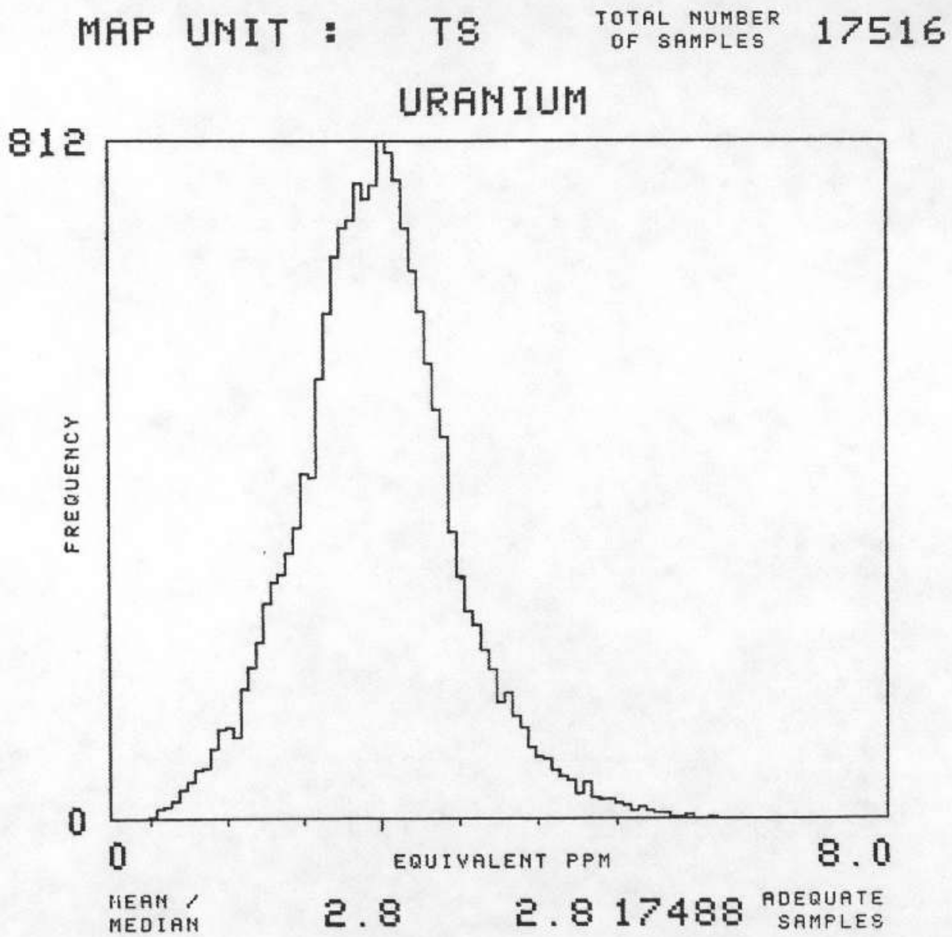


FIGURE IX Sample Computer Map Unit Histogram

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 (±) standard deviations from the mean

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

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

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

10. Uair - atmospheric Bi-214 in equivalent ppm

DATA TAPES

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

DATA INTERPRETATION METHODS

General

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

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

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

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

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

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

Methodology

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

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

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

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

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

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

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

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

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

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

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

TAPE FORMATS

SINGLE RECORD REDUCED DATA TAPE

REFERENCE: Paragraphs 4.7.6 and 6.1.6, BFEC 1200-C

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

Block 1 - Format Data

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

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

SINGLE RECORD REDUCED DATA TAPE

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

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

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

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

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

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

Block 2 - Single Record Reduced Identification Data

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

Block 3 - Single Record Reduced Data

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

STATISTICAL ANALYSIS TAPE

REFERENCE: Paragraphs 4.7.7 and 6.1.6, BFEC 1200-C

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

Block 1 - Format Description Data

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

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

STATISTICAL ANALYSIS DATA TAPE

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

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

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

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

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

The remaining 440 characters in this block are blanks.

Block 2 - Statistical Analysis Identification Data

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

Block 3 - Statistical Analysis Data

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

MAGNETIC DATA TAPE

REFERENCE: Paragraphs 4.7.8 and 6.1.6, BFEC 1200-C

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

Block 1 - Tape Format Description

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

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

MAGNETIC DATA TAPE

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

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

FORMAT FOR MAGNETIC DATA RECORD (THIRD THRU LAST BLOCK)

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

The remaining 4616 characters in this block are blanks.

Block 2 - Magnetic Tape Identification Data

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

Block 3 - Magnetic Data

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

STATISTIC ANALYSIS SUMMARY TAPE

REFERENCE: Paragraphs 4.7.9, BFEC 1200-C

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

Block 1 - Format Description Data

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

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

STATISTICAL ANALYSIS SUMMARY TAPE (OR FILE)

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

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

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

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

The remaining 2680 characters on this block shall be blanks.

Block 2 - Statistical Analysis Identification Data

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

Block 3 - Statistical Analysis Summary Data

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

BIBLIOGRAPHY

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

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

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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

DECEMBER, 1980

Dec. 12	630 line miles, Marion
13	630 line miles, Marion
14	671 line miles, Marion, Toledo

MAY, 1981

May 17-19	Base Mobilization
20	550 line miles, Toledo
21	701 line miles, Toledo, Marion, Columbus
22	Base Mobilization - nil production
23	500 line miles, Toledo, Marion, Columbus
24	763.8 line miles, Columbus

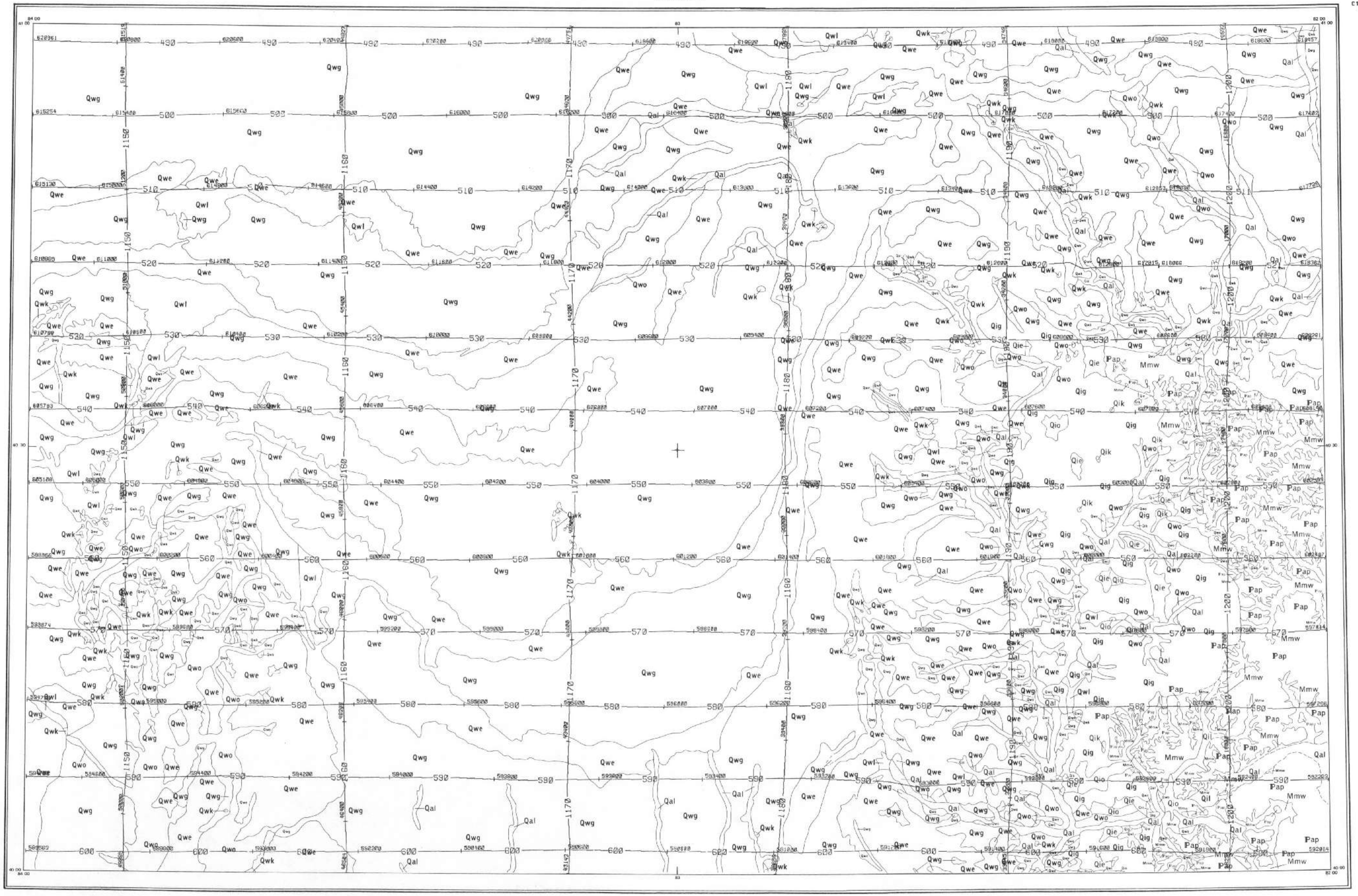
Total miles for the above periods = 4,445.8 line miles

Total miles for the included quadrangles:

Marion	1,675.8
Toledo	1,076.2
Columbus	1,693.8

APPENDIX C - Flight Path and Geologic Map

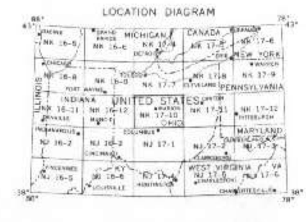
MARION



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

MARION QUADRANGLE
GEOLOGIC MAP EXPLANATION
(Martel Laboratories, 1981)

SEDIMENTARY

CENOZOIC	Qal	ALLUVIUM	Sand, silt, and minor peat.		HOLOCENE	QUATERNARY
CENOZOIC	Qwo	OUTWASH	Sand and gravel.	WISCONSINAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qwk	KAMES AND ESKERS	Sand and gravel.	WISCONSINAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qwl	LAKE DEPOSITS	Silt and clay.	WISCONSINAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qwg	GROUND MORAINE	Clay, silt, sand, and gravel.	WISCONSINAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qwe	END MORAINE	Clay, silt, sand, and gravel.	WISCONSINAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qio	OUTWASH	Sand and gravel.	ILLINOIAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qik	KAMES	Sand and gravel.	ILLINOIAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qig	GROUND MORAINE	Clay, silt, sand, gravel, and boulders.	ILLINOIAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qie	END MORAINE	Clay, silt, sand, and gravel.	ILLINOIAN	PLEISTOCENE	QUATERNARY
CENOZOIC	Qil	LAKE DEPOSITS	Silt and clay.	ILLINOIAN	PLEISTOCENE	QUATERNARY
PALEOZOIC	IPap	UNDIVIDED ALLEGHENY AND POTTSVILLE FORMATIONS	Coal, sandstone, shale, and limestone.			PENNSYLVANIAN
PALEOZOIC	Mmw	UNDIVIDED MAXVILLE LIMESTONE AND WAVERLY GROUP	Shale, sandstone, and limestone.			MISSISSIPPIAN

STRATIGRAPHIC LEGEND

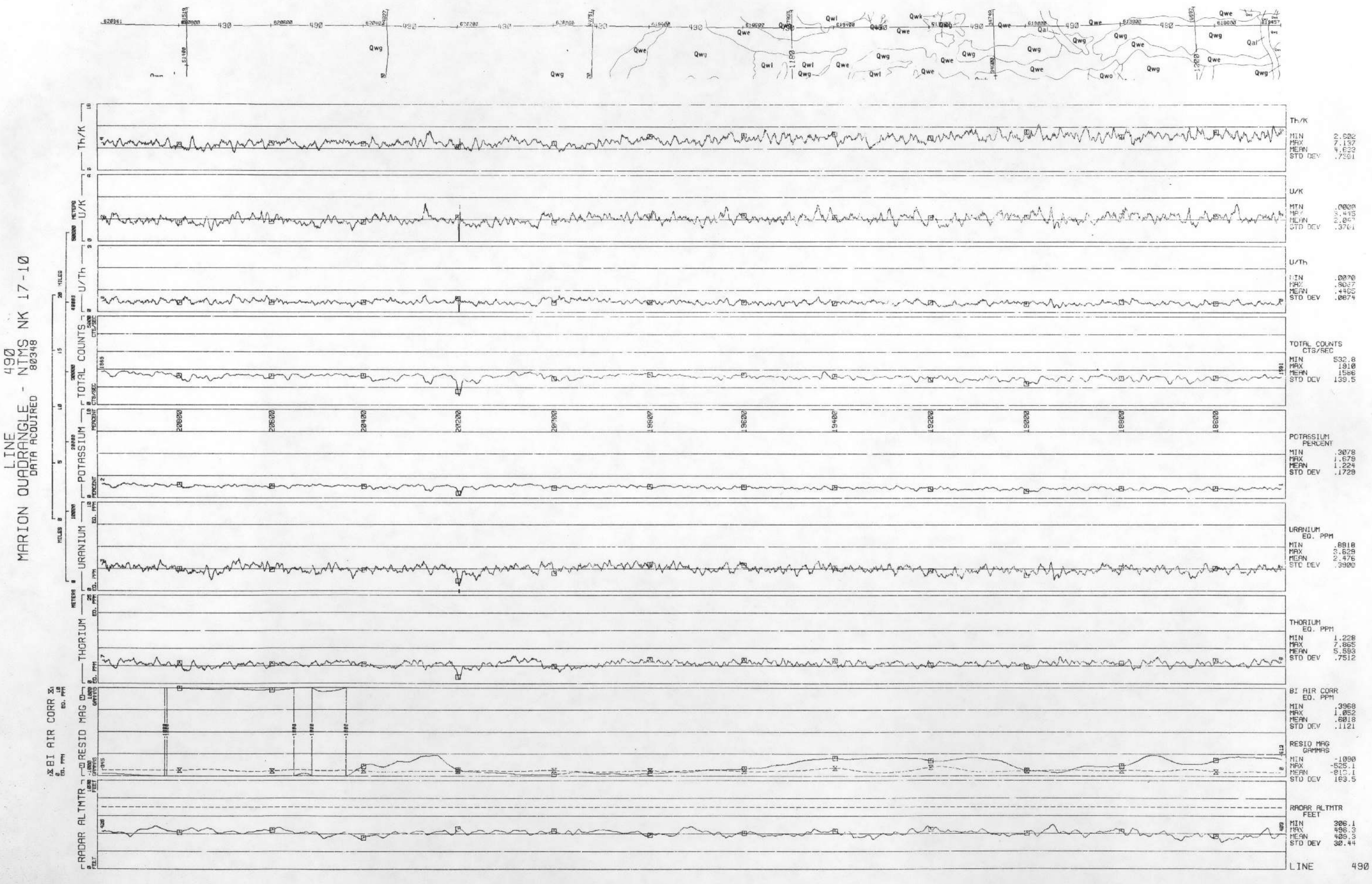
QUATERNARY	Qal	Sand, silt, and peat
QUATERNARY	Qwo	Sand and gravel
QUATERNARY	Qwk	Sand and gravel
QUATERNARY	Qwl	Silt and clay
QUATERNARY	Qwg	Clay, silt, sand, and gravel
QUATERNARY	Qwe	Clay, silt, sand, and gravel
QUATERNARY	Qio	Sand and gravel
QUATERNARY	Qik	Sand and gravel
QUATERNARY	Qig	Clay, silt, sand, gravel, and boulders
QUATERNARY	Qie	Clay, silt, sand, and gravel
QUATERNARY	Qil	Silt and clay
PENNSYLVANIAN	IPap	Coal, sandstone, shale, and limestone
MISSISSIPPIAN	Mmw	Shale, sandstone, and limestone

GEOLOGIC SYMBOLS

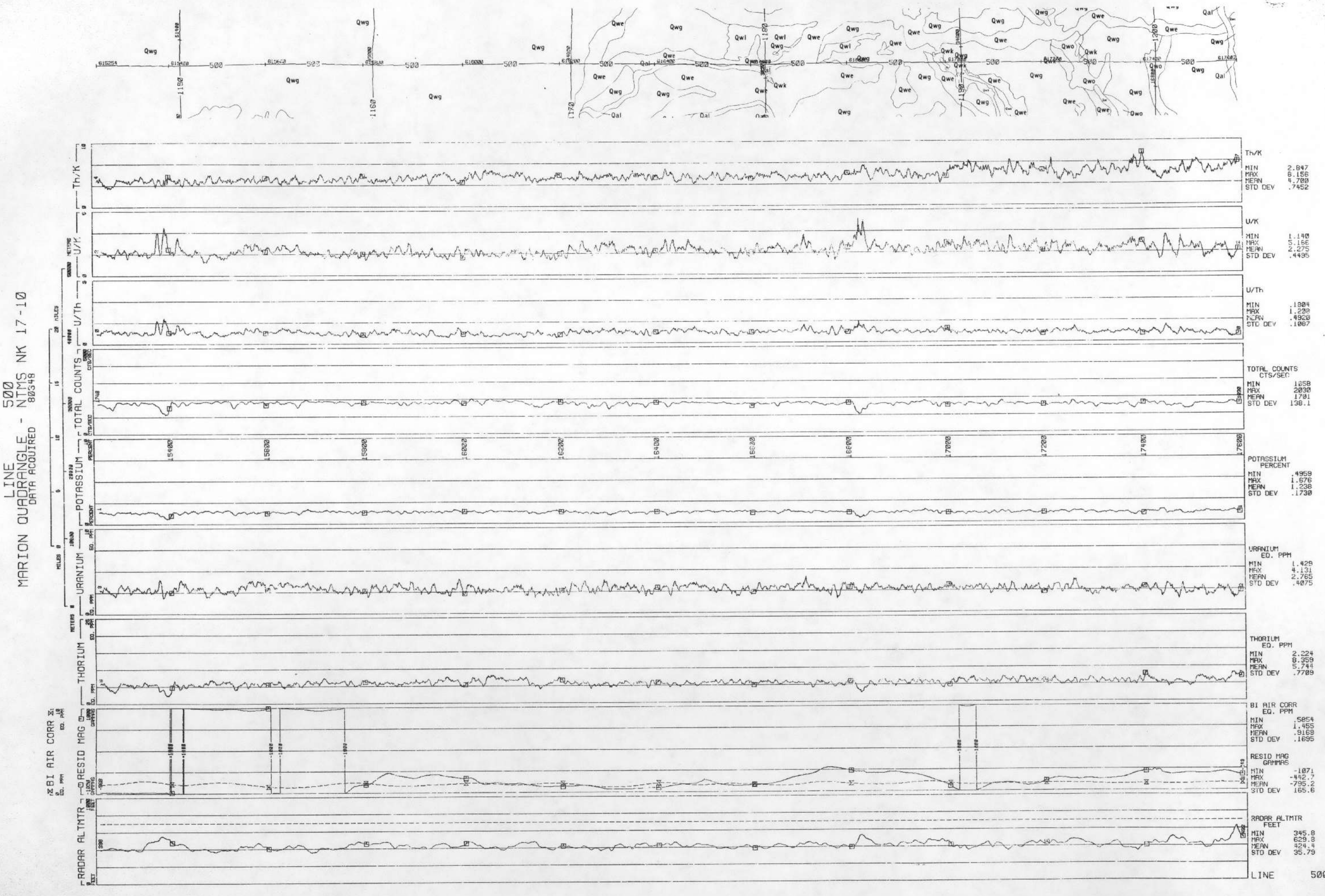
——————— – – – Contact, dashed where approximate.

C2

APPENDIX D - Profiles


LINE 490
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80348
Th/K
MIN 2.602
MAX 7.137
MEAN 4.623
STD DEV .7391
U/K
MIN .0000
STD DEV .3701
U/Th
MIN .0070
MAX .8027
MEAN .4405
STD DEV .0874
TOTAL COUNTS CTS/SEC
MIN 532.8
MAX 1910
MEAN 1586
STD DEV 139.5
POTASSIUM PERCENT
MIN .3078
MAX 1.679
MEAN 1.224
STD DEV .1729
URANIUM EQ. PPM
MIN .8818
MAX 3.629
MEAN 2.476
STD DEV .3900
THORIUM EQ. PPM
MIN 1.228
MAX 7.865
MEAN 5.593
STD DEV .7512
BI AIR CORR EQ. PPM
MIN .3968
MAX 1.052
MEAN .6018
STD DEV .1121
RESID MAG GAMMAS
MIN -1090
MAX -525.1
STD DEV 163.5
RADAR ALTMTR FEET
MIN 306.1
MAX 498.3
MEAN 409.3
STD DEV 30.44
LINE 490

D2 ma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MEAN 4.700
STD DEV .7452
U/K
MIN 1.140
MAX 5.166
MEAN 2.275
STD DEV .4495
U/Th
MIN .1804
MAX 1.220
MEAN .4920
STD DEV .1087
TOTAL COUNTS CTS/SEC
MIN 1058
MAX 2030
MEAN 1701
STD DEV 138.1
POTASSIUM PERCENT
MIN .4959
MAX 1.676
MEAN 1.238
STD DEV .1730
URANIUM EQ. PPM
MIN 1.429
MAX 4.131
MEAN 2.765
STD DEV .4075
THORIUM EQ. PPM
MIN 2.224
MAX 8.359
MEAN 5.744
STD DEV .7709
BI AIR CORR EQ. PPM
MIN .5854
MAX 1.455
MEAN .9169
STD DEV .1695
RESID MAG GAMMAS
MIN -1071
MAX -442.7
MEAN -795.2
STD DEV 165.6
RADAR ALTMTR FEET
MIN 345.8
MAX 629.8
MEAN 424.4
STD DEV 35.79
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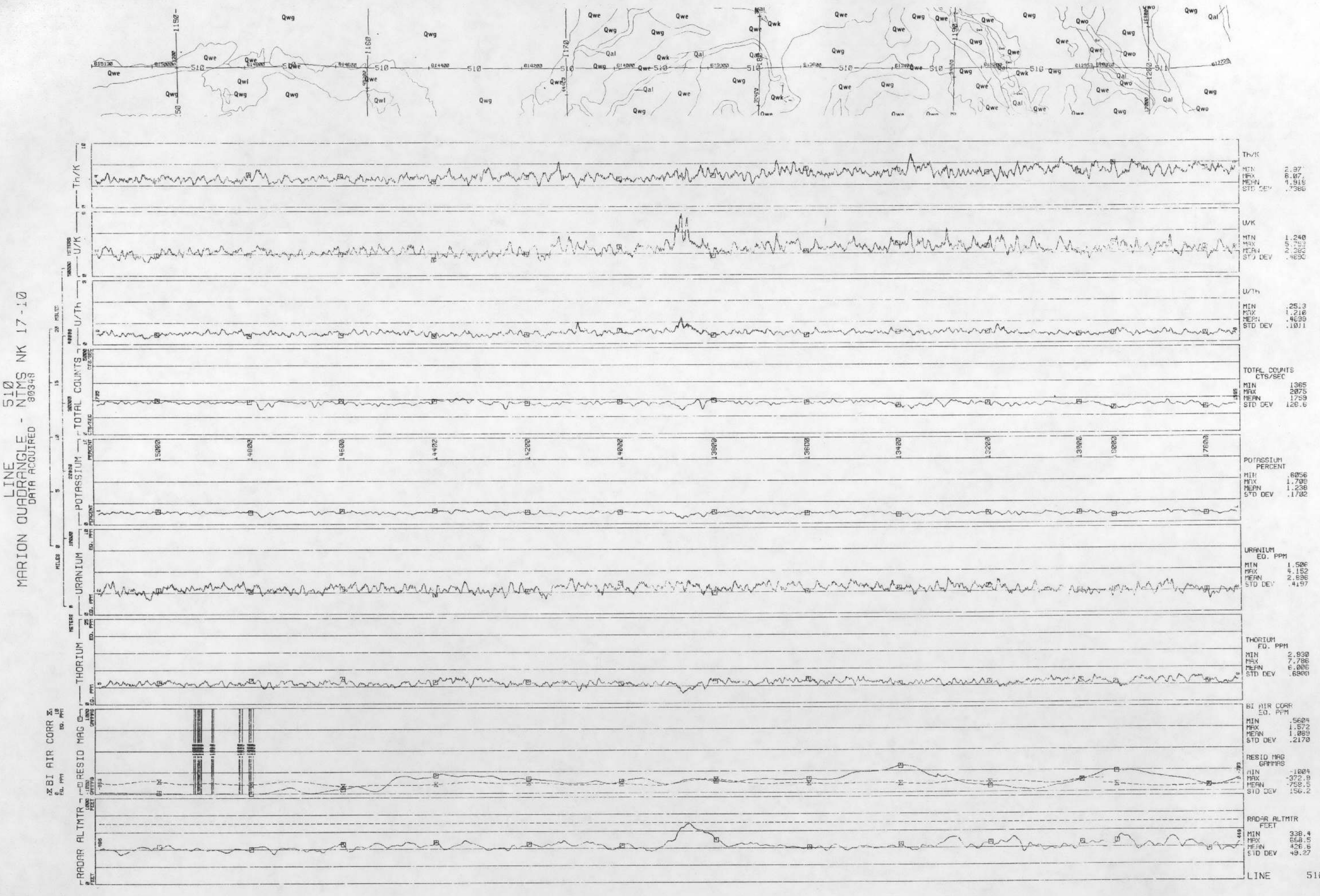
D3 ma



LINE 510
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80348
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MAX 6.07
MEAN 4.918
STD DEV .7380
U/K
MIN 1.240
MAX 5.793
MEAN 2.383
STD DEV .4890
U/Th
MIN .2513
MAX 1.210
MEAN .4839
STD DEV .1011
TOTAL COUNTS CTS/SEC
MIN 1365
MAX 2075
MEAN 1759
STD DEV 120.6
POTASSIUM PERCENT
MIN .6056
MAX 1.709
MEAN 1.238
STD DEV .1702
URANIUM EQ. PPM
MIN 1.506
MAX 4.152
MEAN 2.886
STD DEV .4197
THORIUM EQ. PPM
MIN 2.930
MAX 7.786
MEAN 6.006
STD DEV .6900
BI AIR CORR EQ. PPM
MIN .5604
MAX 1.572
MEAN 1.089
STD DEV .2170
RESID MAG GAMMAS
MIN -1004
MAX -372.9
MEAN -759.5
STD DEV 156.2
RADAR ALTMTR FEET
MIN 338.4
MAX 668.5
MEAN 426.6
STD DEV 49.27
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LINE 520
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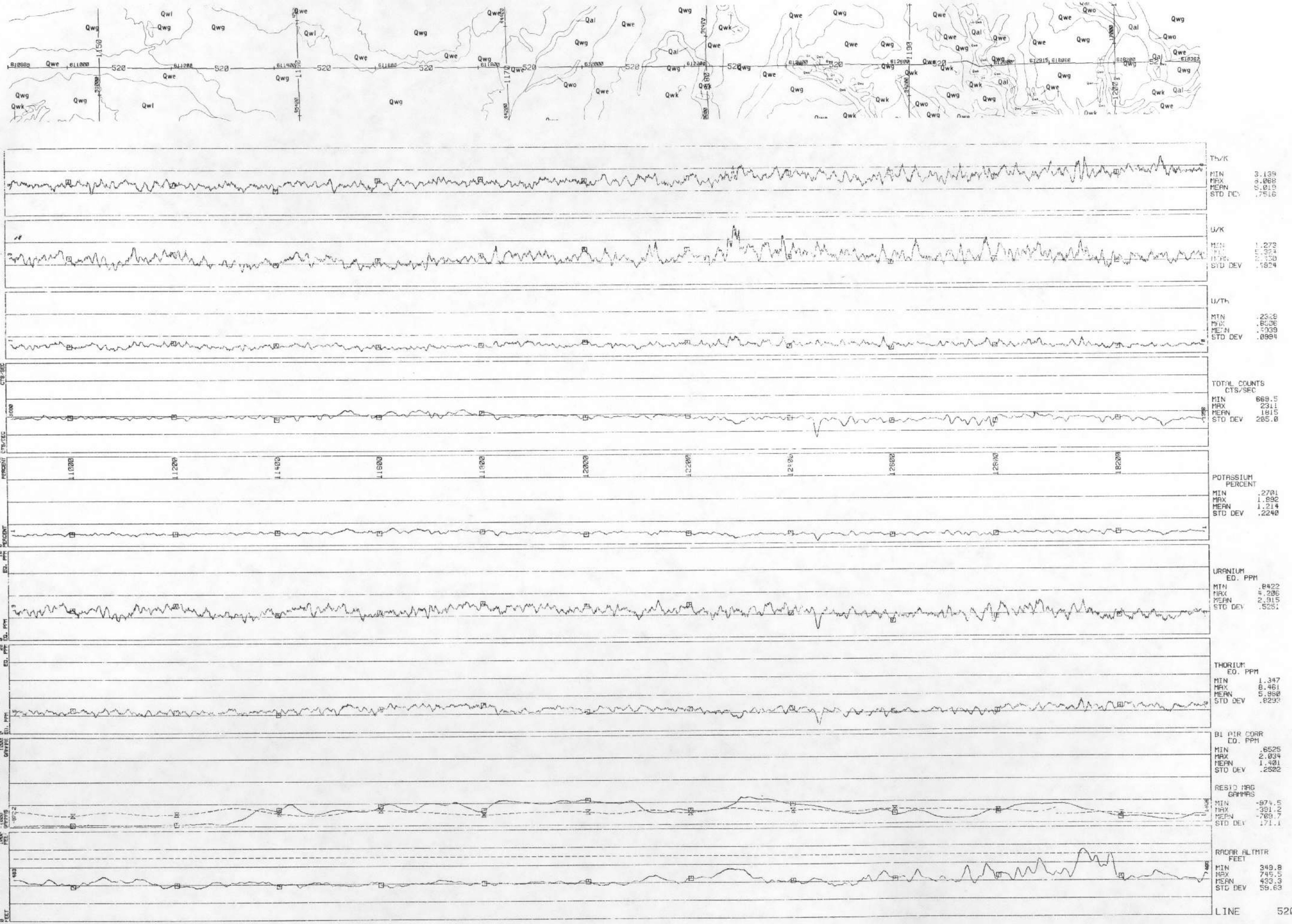
DATA ACQUIRED 80348



LINE 530
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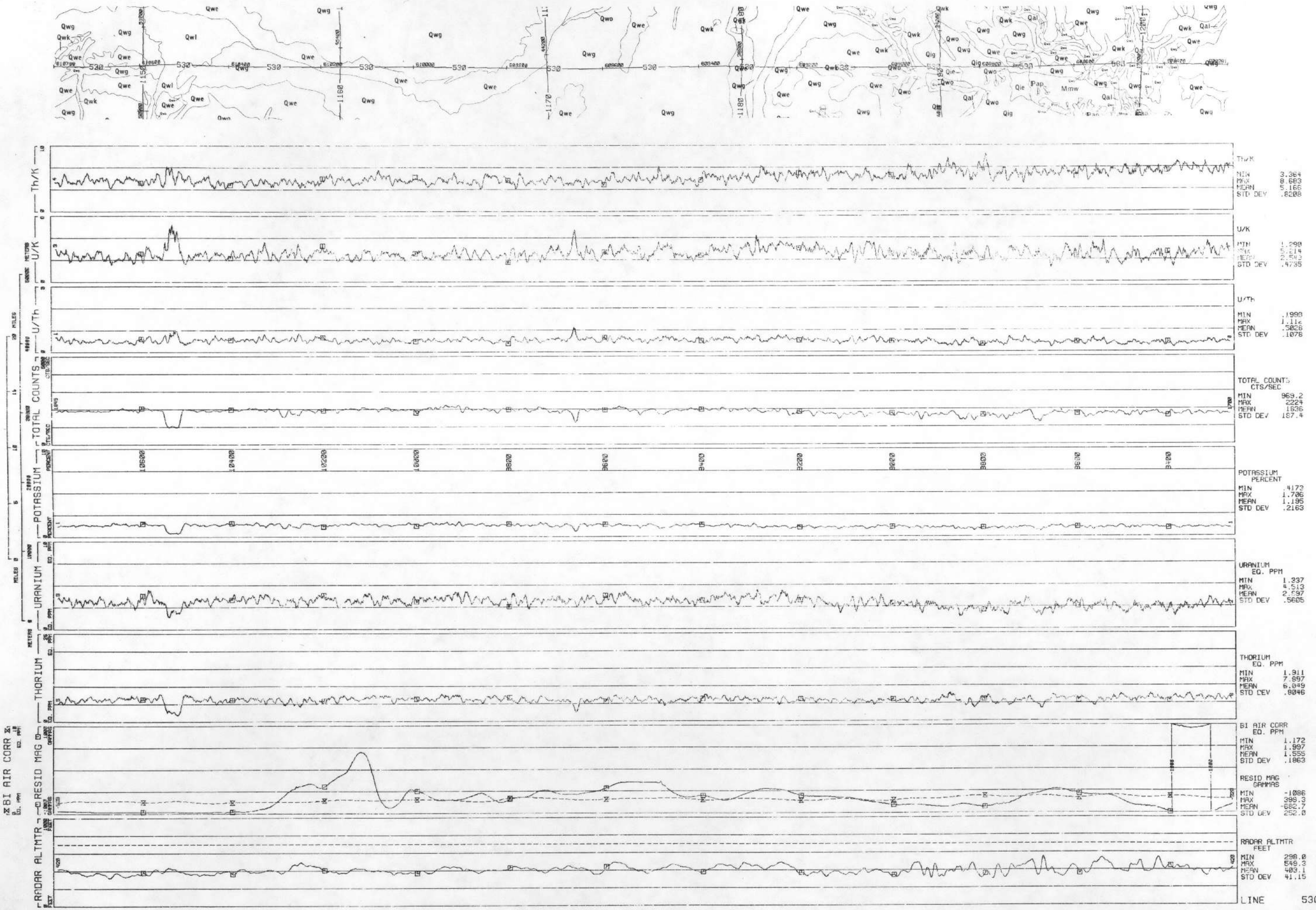
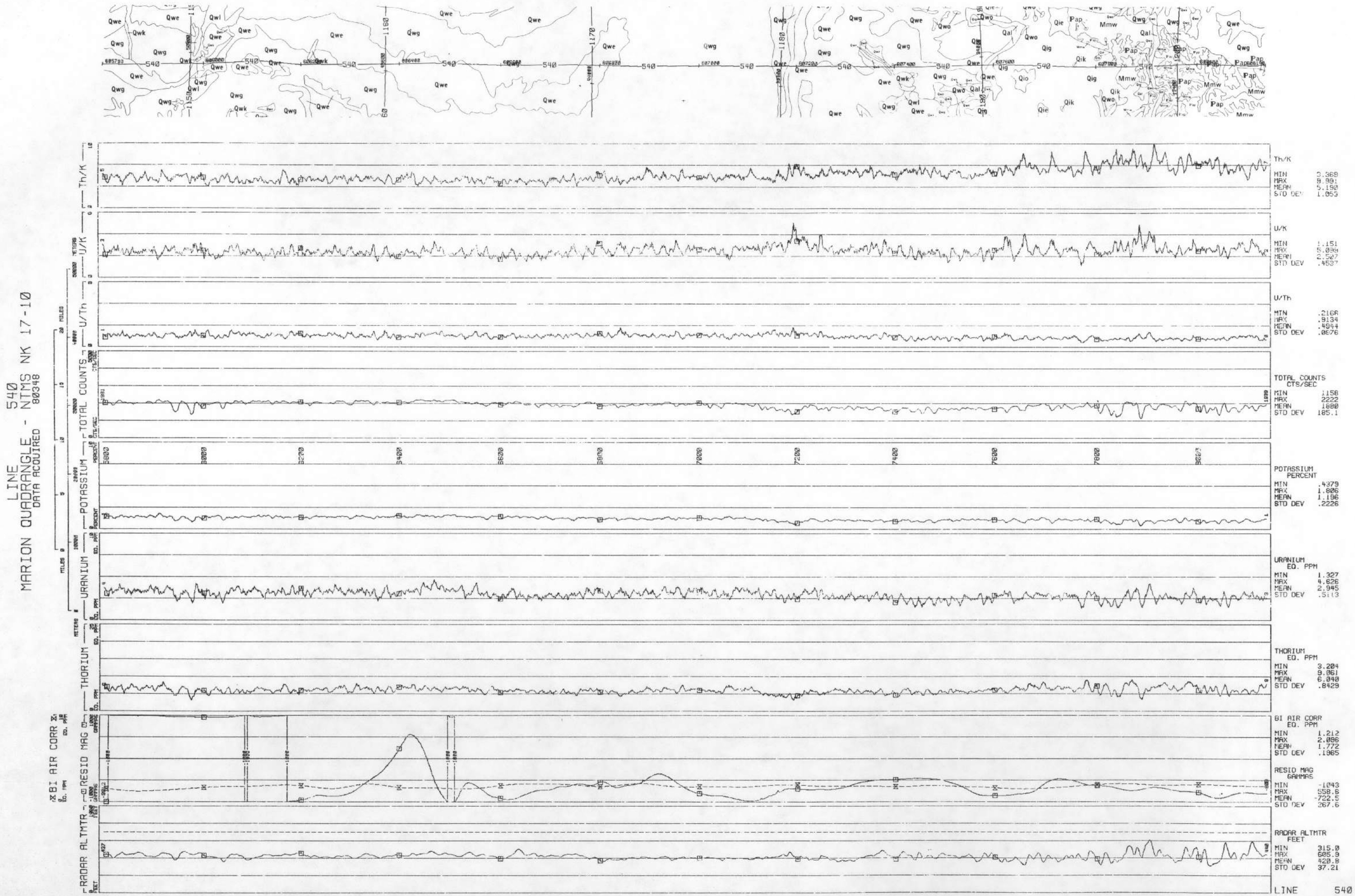
DATA ACQUIRED 80348

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DATA ACQUIRED 80348
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MIN 3.369
MAX 9.991
MEAN 5.190
STD DEV 1.053
U/K
MIN 1.151
MAX 5.099
MEAN 2.507
STD DEV .4537
U/Th
MIN .2168
MAX .9134
MEAN .4944
STD DEV .0976
TOTAL COUNTS CTS/SEC
MIN 1158
MAX 2222
MEAN 1880
STD DEV 185.1
POTASSIUM PERCENT
MIN .4379
MAX 1.806
MEAN 1.196
STD DEV .2226
URANIUM EQ. PPM
MIN 1.327
MAX 4.626
MEAN 2.945
STD DEV .5113
THORIUM EQ. PPM
MIN 3.204
MAX 9.061
MEAN 6.040
STD DEV .8429
BI AIR CORR EQ. PPM
MIN 1.212
MAX 2.096
MEAN 1.772
STD DEV .1965
RESID MAG GAMMAS
MIN -1043
MAX 558.6
MEAN -722.5
STD DEV 267.6
RADAR ALTMTR FEET
MIN 315.0
MAX 605.9
MEAN 420.8
STD DEV 37.21
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LINE 550
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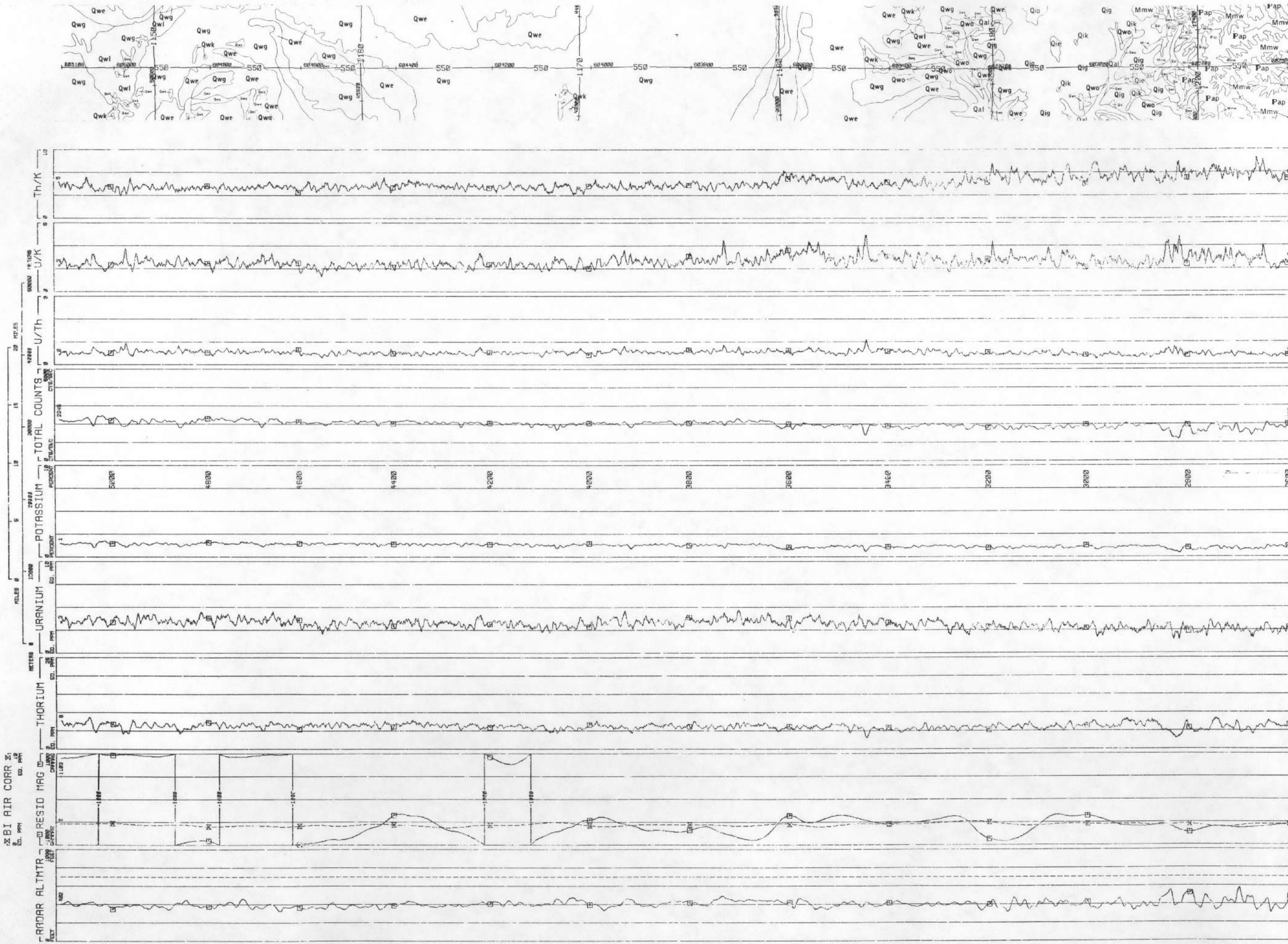
80347
DATA ACQUIRED



Th/K

MIN	3.284
MAX	8.729
MEAN	5.113
STD DEV	.8808

U/K

MIN	1.234
MAX	4.915
MEAN	2.621
STD DEV	.4694

U/Th

MIN	.2634
MAX	1.092
MEAN	.5204
STD DEV	.0958

TOTAL COUNTS CTS/SEC

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MAX	2469
MEAN	1955
STD DEV	187.5

POTASSIUM PERCENT

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MEAN	1.235
STD DEV	.2231

URANIUM EQ. PPM

MIN	1.472
MAX	4.678
MEAN	3.171
STD DEV	.5027

THORIUM EQ. PPM

MIN	2.895
MAX	8.675
MEAN	6.166
STD DEV	.7777

BI AIR CORR EQ. PPM

MIN	1.863
MAX	2.614
MEAN	2.188
STD DEV	.1440

RESID MAG GAMMAS

MIN	-1236
MAX	-316.3
MEAN	-708.1
STD DEV	242.4

RADAR ALTMTR FEET

MIN	311.7
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STD DEV	35.60

LINE 550

D8 ma

LINE 560
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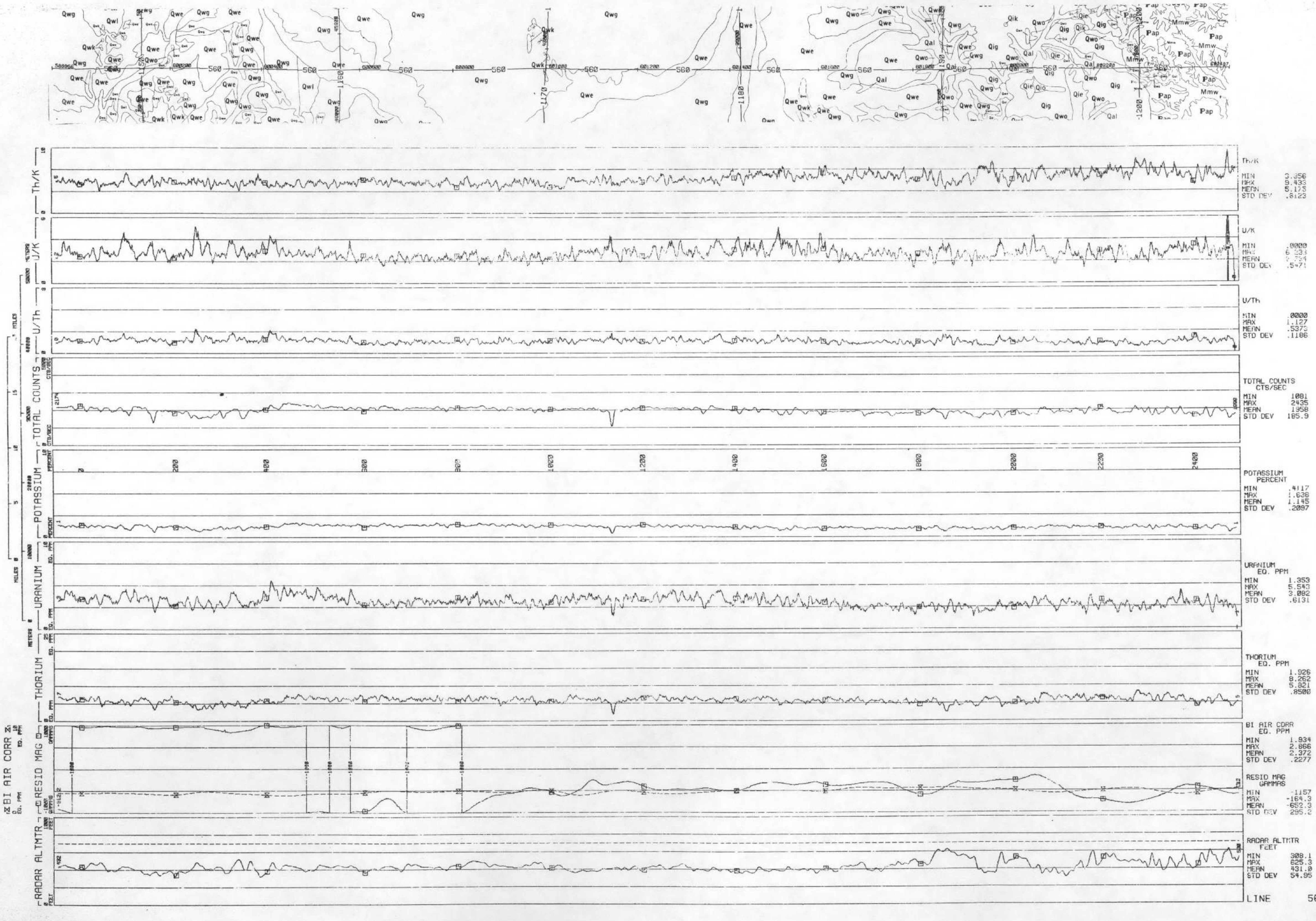
DATA ACQUIRED 80347



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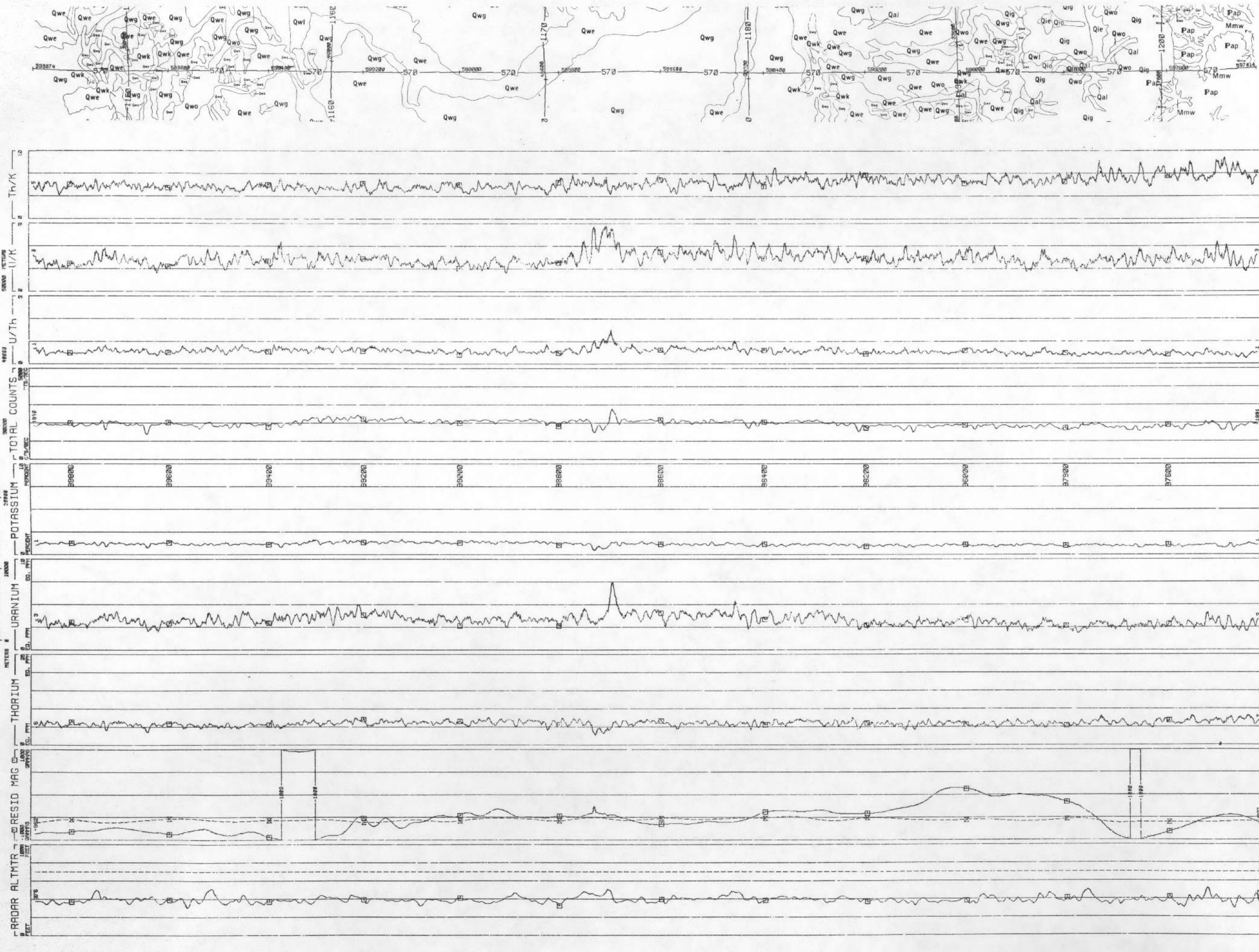
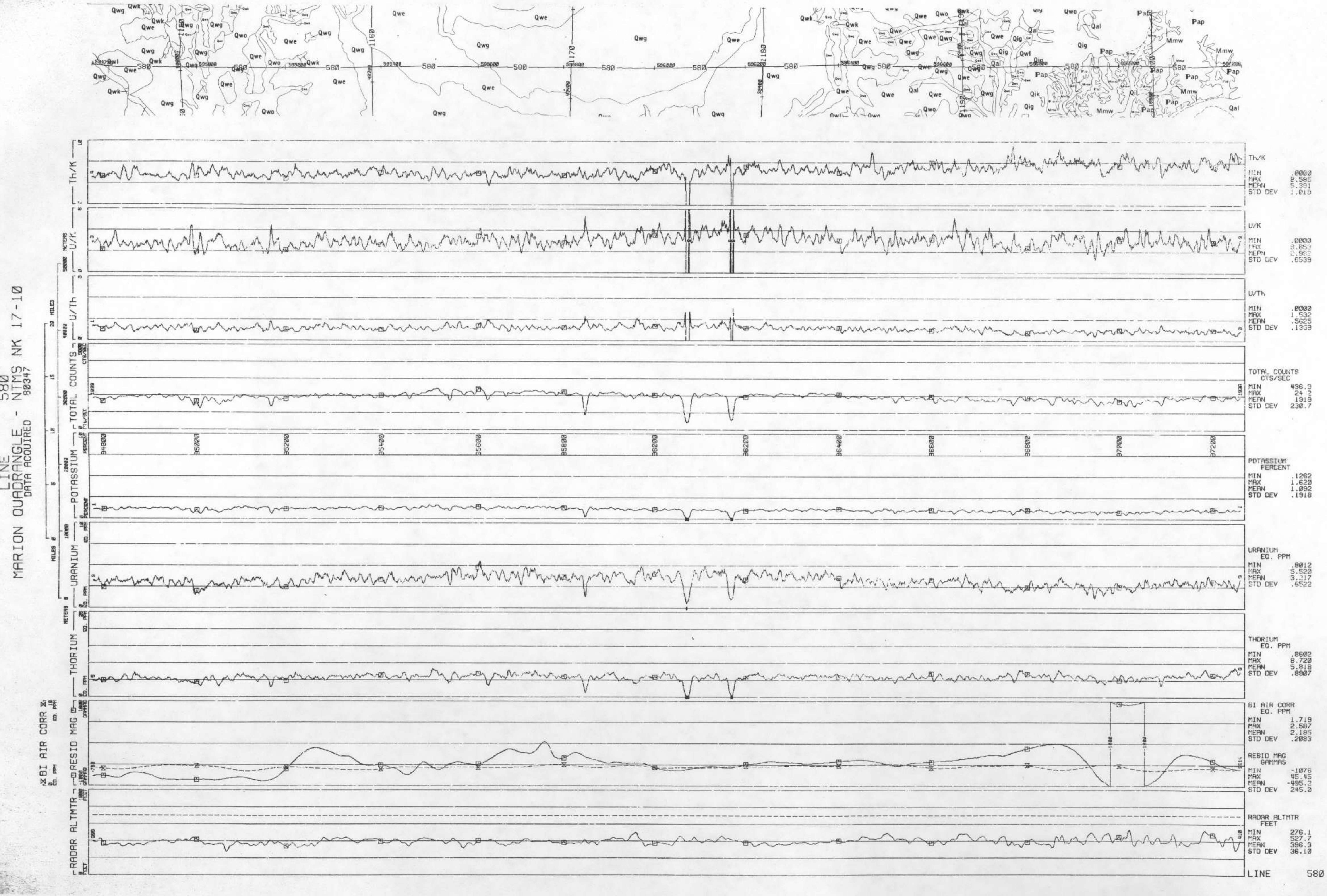
DATA ACQUIRED 80347

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MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80347
Th/K
U/K
U/Th
TOTAL COUNTS
POTASSIUM
URANIUM
THORIUM
BI AIR CORR
RESID MAG
RADAR ALTMTR
94800
95000
95200
95400
95600
95800
96000
96200
96400
96600
96800
97000
97200
Th/K
MIN .0000
MAX 8.585
MEAN 5.391
STD DEV 1.019
U/K
MIN .0000
MAX 8.653
STD DEV .6539
U/Th
MIN .0000
MAX 1.532
MEAN .5625
STD DEV .1359
TOTAL COUNTS CTS/SEC
MIN 436.9
MEAN 1919
STD DEV 230.7
POTASSIUM PERCENT
MIN .1262
MAX 1.620
MEAN 1.092
STD DEV .1918
URANIUM EQ. PPM
MIN .8012
MAX 5.520
MEAN 3.217
STD DEV .6522
THORIUM EQ. PPM
MIN .8602
MAX 8.720
MEAN 5.818
STD DEV .8907
BI AIR CORR EQ. PPM
MIN 1.719
MAX 2.587
MEAN 2.195
STD DEV .2083
RESID MAG GAMMAS
MIN -1076
MAX 45.45
MEAN -495.2
STD DEV 245.0
RADAR ALTMTR FEET
MIN 276.1
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MEAN 396.3
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LINE 580

LINE 590
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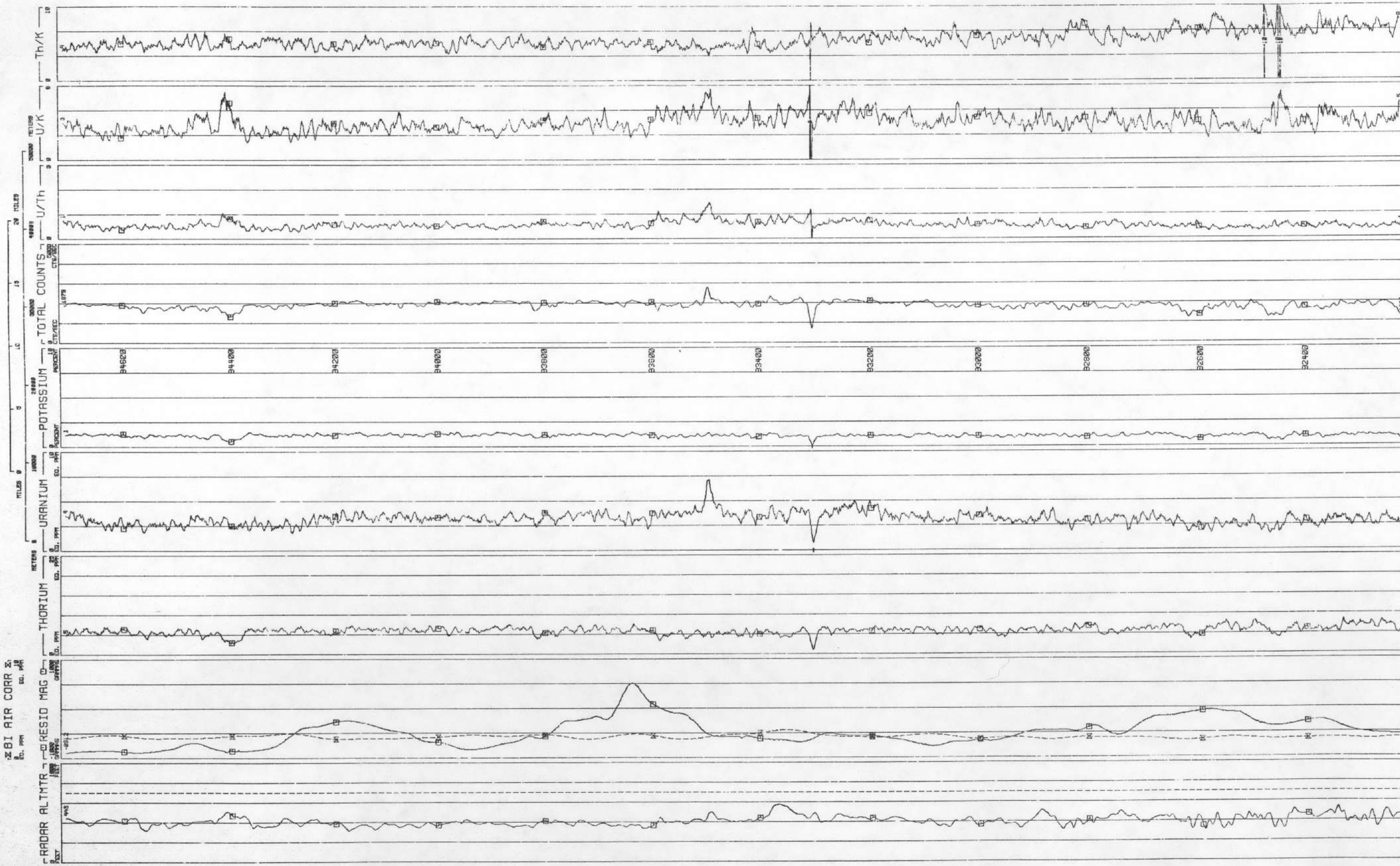
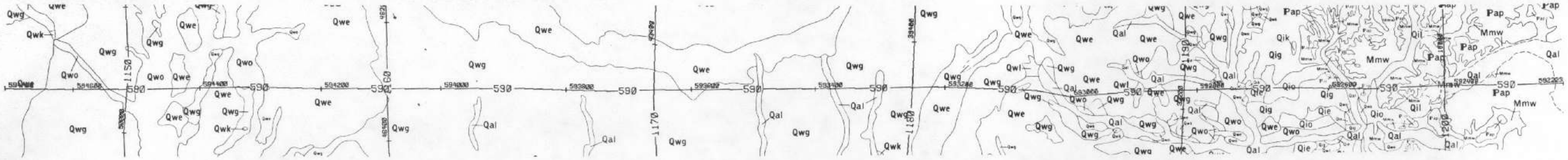
DATA ACQUIRED 80347





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U/Th
MIN .0000
MAX 1.486
MEAN .5524
STD DEV .1486

TOTAL COUNTS CTS/SEC
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MAX 2781
MEAN 1878
STD DEV 191.0

POTASSIUM PERCENT
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MEAN 1.077
STD DEV .1818

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MAX 7.139
MEAN 3.139
STD DEV .6299

THORIUM EQ. PPM
MIN .9518
MAX 8.448
MEAN 5.817
STD DEV .8800

BI AIR CORR EQ. PPM
MIN 1.640
MAX 2.798
MEAN 2.071
STD DEV .2185

RESID MAG GAMMAS
MIN -894.8
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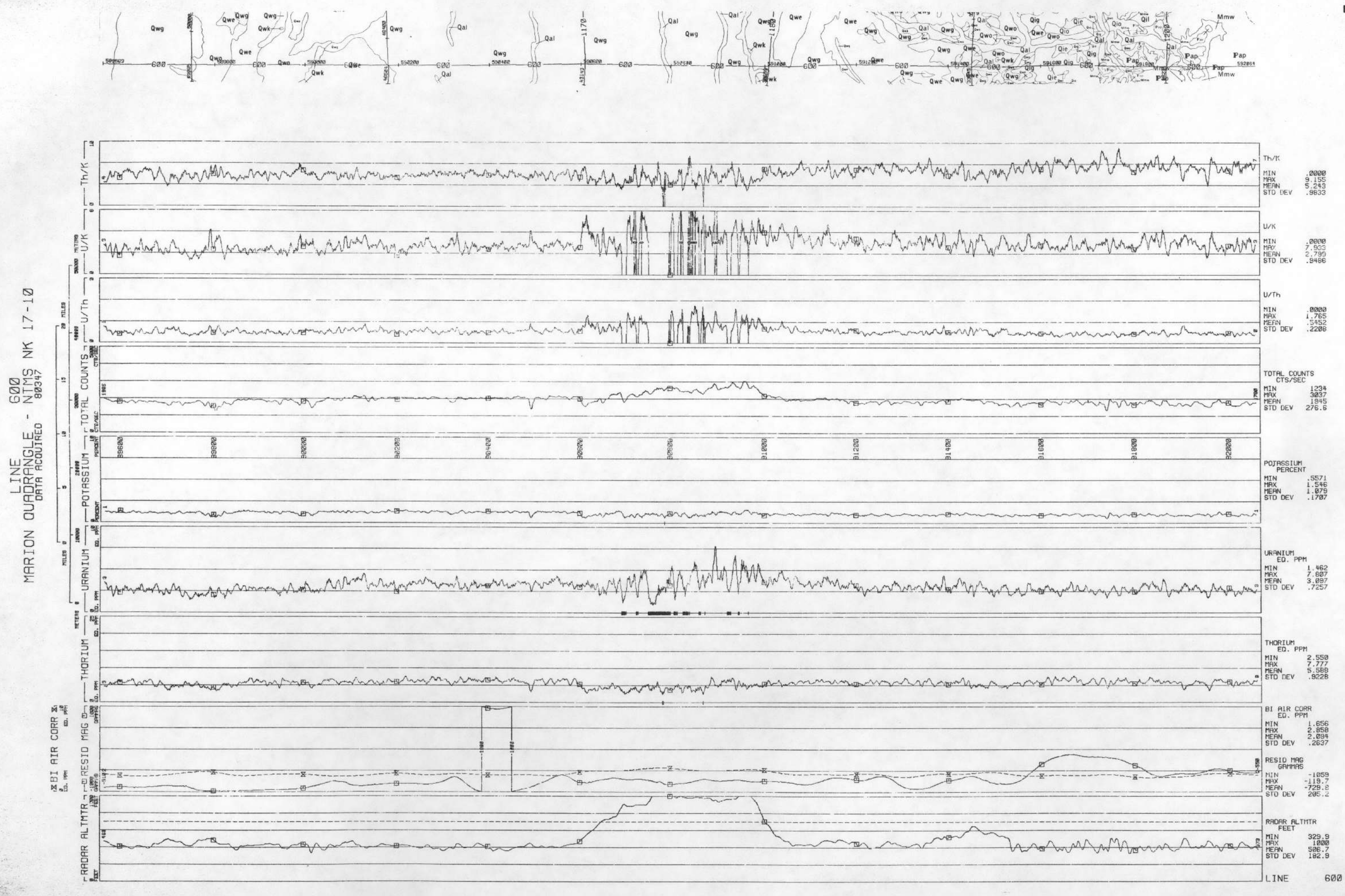
LINE 590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MIN .0000
MAX 7.933
MEAN 2.799
STD DEV .9486
U/Th
MIN .0000
MAX 1.765
MEAN .5452
STD DEV .2208
TOTAL COUNTS CTS/SEC
MIN 1234
MAX 3037
MEAN 1945
STD DEV 276.6
POTASSIUM PERCENT
MIN .5571
MAX 1.546
MEAN 1.079
STD DEV .1707
URANIUM EQ. PPM
MIN 1.462
MAX 7.807
MEAN 3.097
STD DEV .7257
THORIUM EQ. PPM
MIN 2.550
MAX 7.777
MEAN 5.588
STD DEV .9228
BI AIR CORR EQ. PPM
MIN 1.656
MAX 2.858
MEAN 2.094
STD DEV .2637
RESID MAG GAMMAS
MIN -1059
MAX -119.7
MEAN -729.8
STD DEV 205.2
RADAR ALTMTR FEET
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MAX 1000
MEAN 506.7
STD DEV 182.9
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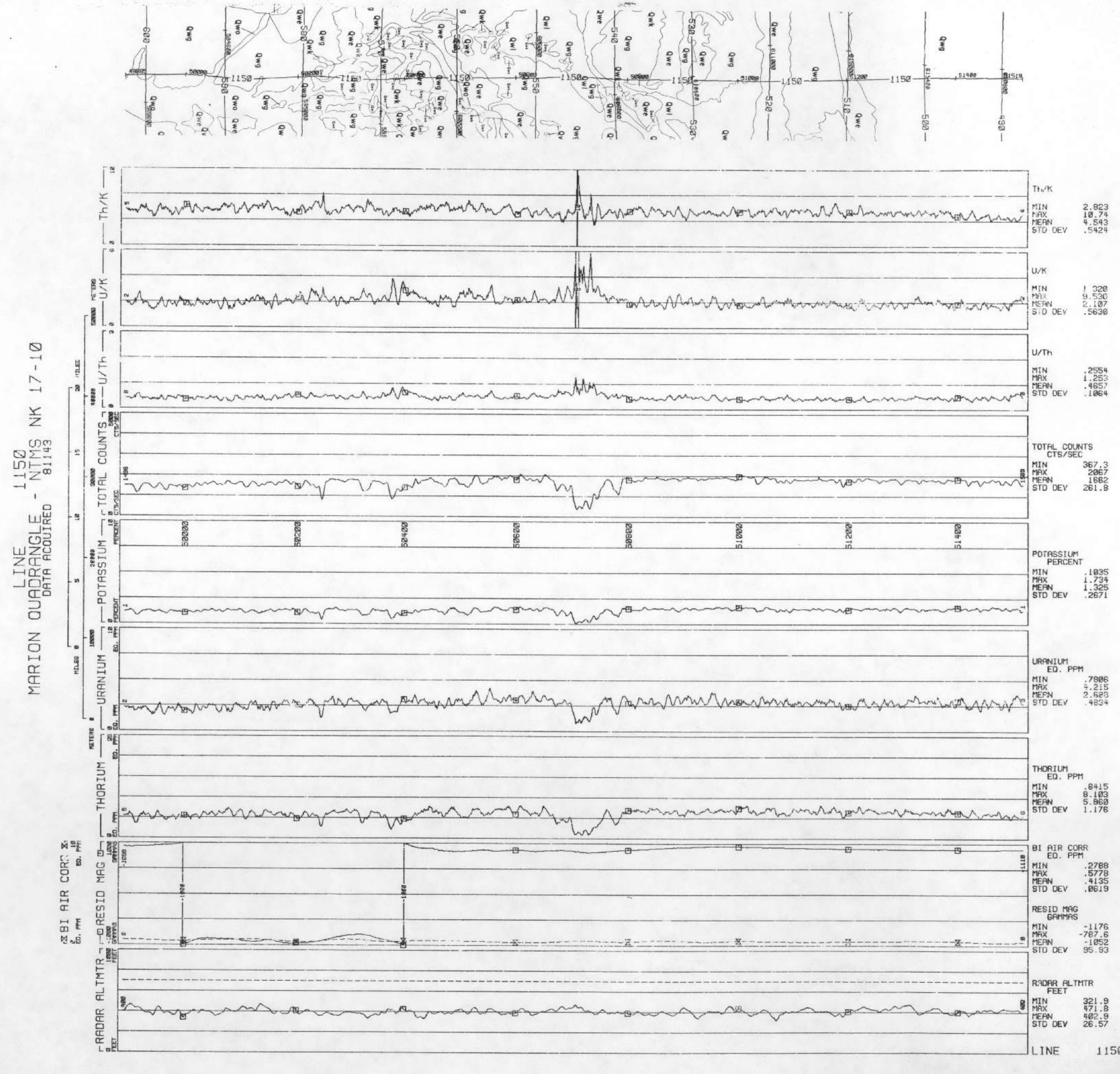
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DATA ACQUIRED 81143
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MEAN 4.543
STD DEV .5424
U/K
MIN 1.320
MAX 9.530
MEAN 2.107
STD DEV .5630
U/Th
MIN .2554
MAX 1.253
MEAN .4657
STD DEV .1064
TOTAL COUNTS CTS/SEC
MIN 367.3
MAX 2067
MEAN 1662
STD DEV 261.8
POTASSIUM PERCENT
MIN .1035
MAX 1.734
MEAN 1.325
STD DEV .2671
URANIUM EQ. PPM
MIN .7806
MAX 4.215
MEAN 2.603
STD DEV .4834
THORIUM EQ. PPM
MIN .8415
MAX 8.103
MEAN 5.960
STD DEV 1.176
BI AIR CORR EQ. PPM
MIN .2708
MAX .5778
MEAN .4135
STD DEV .0619
RESID MAG GAMMAS
MIN -1176
MAX -787.6
MEAN -1052
STD DEV 95.93
RADAR ALTMTR FEET
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MAX 471.8
MEAN 402.9
STD DEV 26.57
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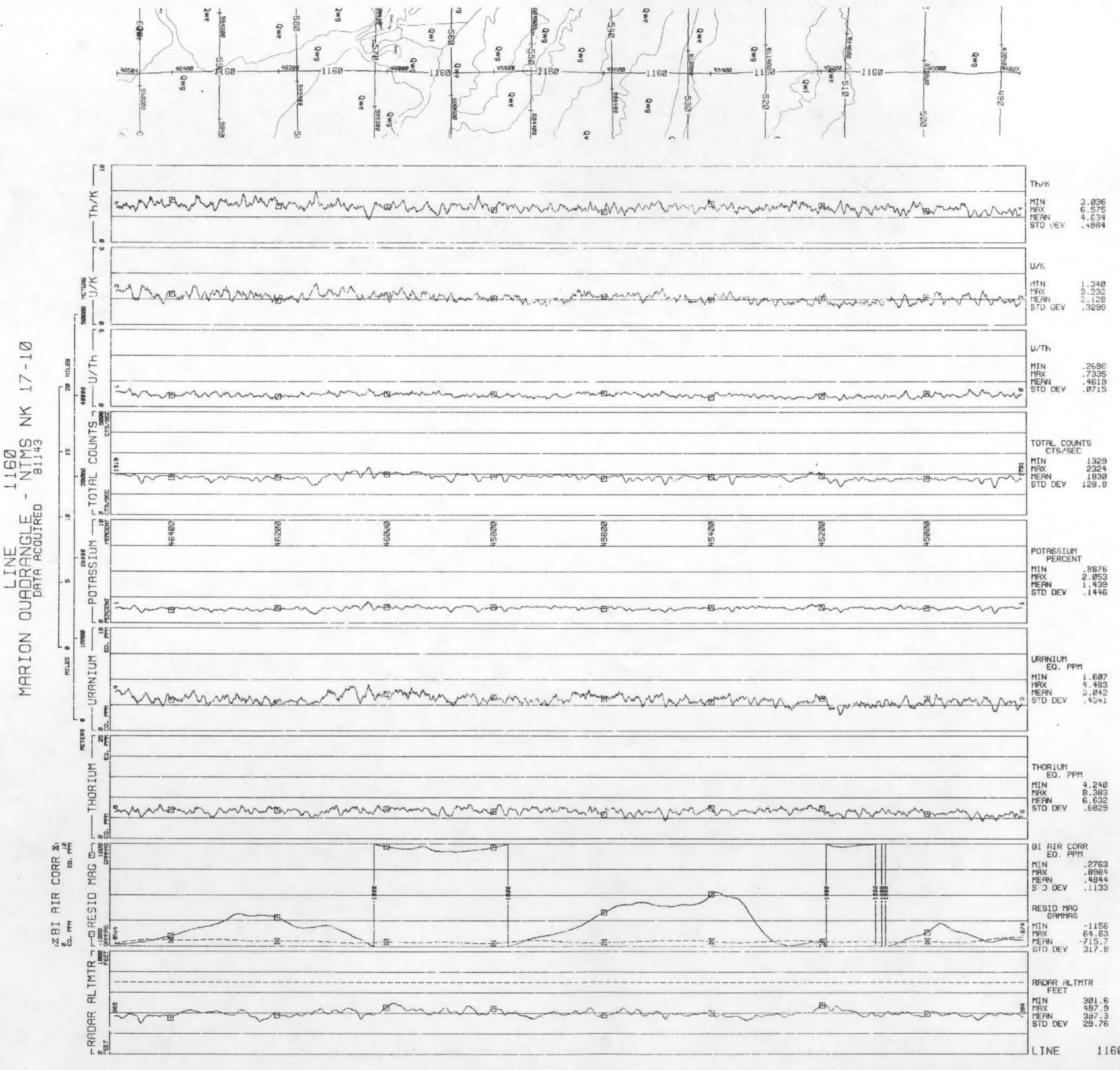
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MEAN 4.634
STD DEV .4884
U/K
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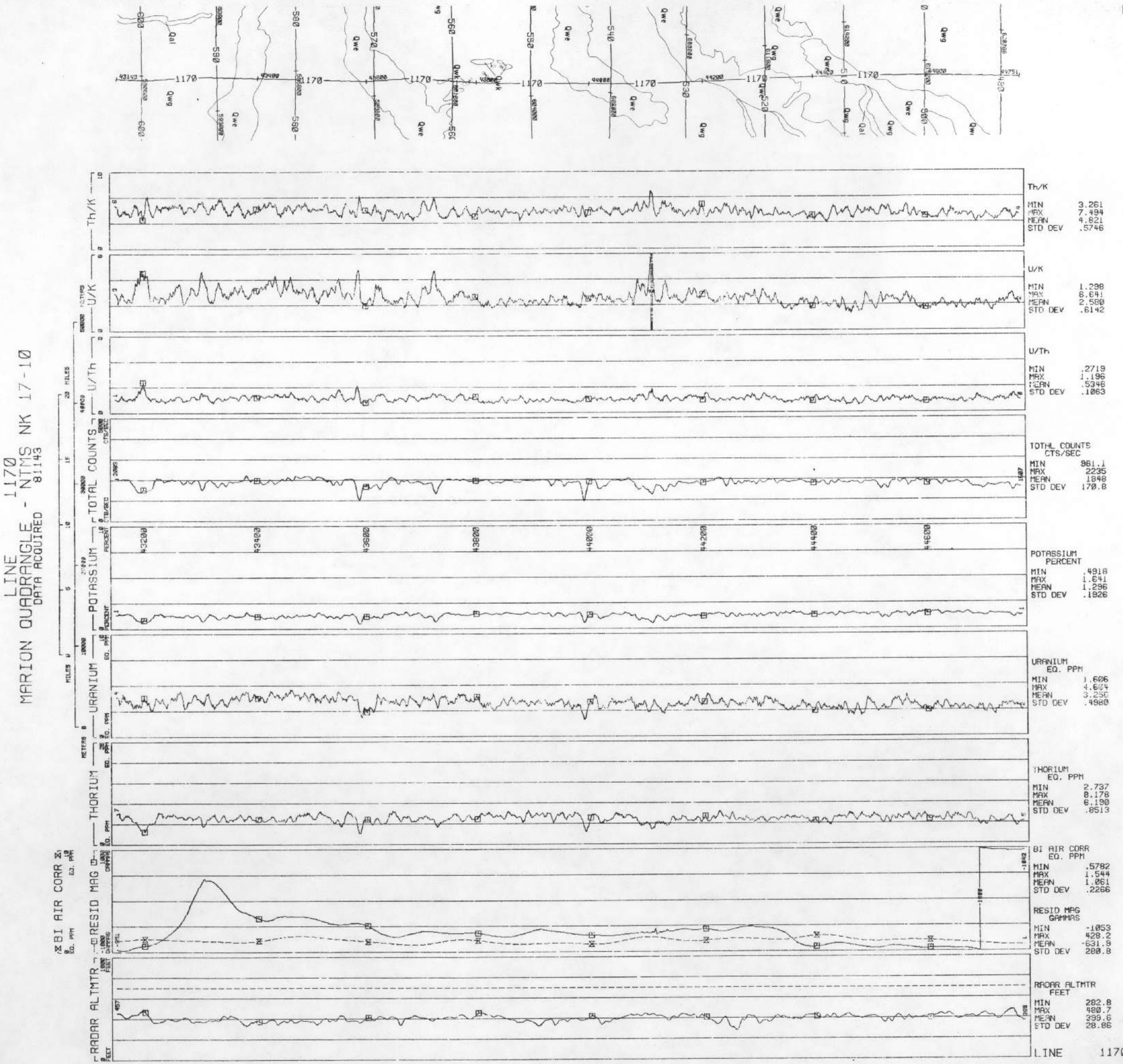
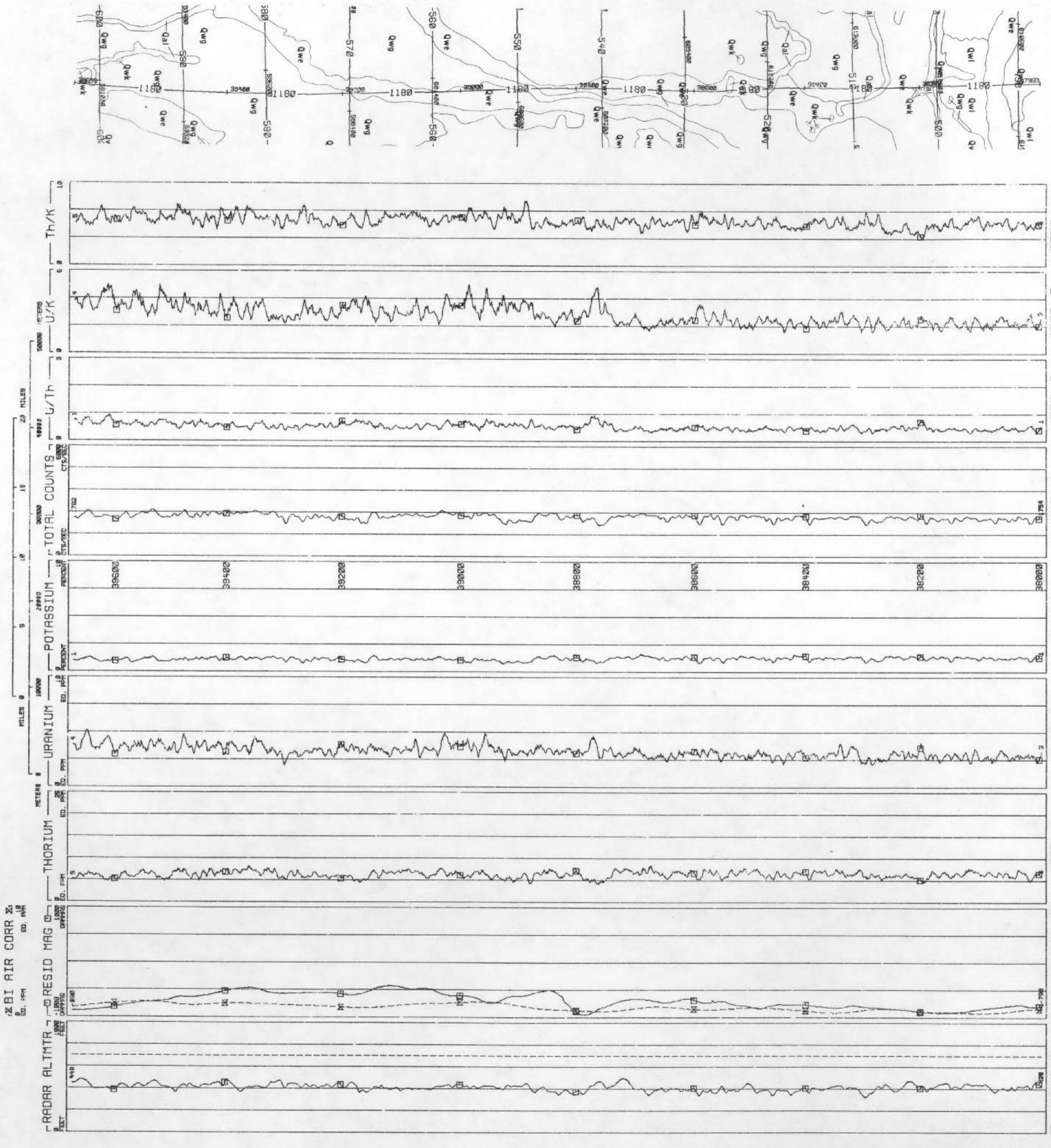
MAX 3.232
MEAN 2.128
STD DEV .3299
U/Th
MIN .2690
MAX .7335
MEAN .4619
STD DEV .0715
TOTAL COUNTS CTS/SEC
MIN 1329
MAX 2324
MEAN 1830
STD DEV 128.8
POTASSIUM PERCENT
MIN .8876
MAX 2.053
MEAN 1.439
STD DEV .1446
URANIUM EQ. PPM
MIN 1.607
MAX 4.403
MEAN 3.042
STD DEV .4341
THORIUM EQ. PPM
MIN 4.240
MAX 8.383
MEAN 6.632
STD DEV .6829
BI AIR CORR EQ. PPM
MIN .2763
MAX .8984
MEAN .4844
STD DEV .1133
RESID MAG GAMMAS
MIN -1156
MAX 64.63
MEAN -715.7
STD DEV 317.8
RADAR ALTMTR FEET
MIN 301.6
MAX 497.9
MEAN 397.3
STD DEV 29.76
LINE 1160

D15 ma


LINE 1170
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 81143
Th/K
MIN 3.261
MAX 7.494
MEAN 4.821
STD DEV .5746
U/K
MIN 1.298
MAX 6.641
MEAN 2.580
STD DEV .6142
U/Th
MIN .2719
MAX 1.196
MEAN .5346
STD DEV .1063
TOTAL COUNTS CTS/SEC
MIN 961.1
MAX 2235
MEAN 1848
STD DEV 170.8
POTASSIUM PERCENT
MIN .4918
MAX 1.641
MEAN 1.296
STD DEV .1826
URANIUM EQ. PPM
MIN 1.606
MAX 4.624
MEAN 3.256
STD DEV .4980
THORIUM EQ. PPM
MIN 2.737
MAX 8.178
MEAN 6.190
STD DEV .8513
BI AIR CORR EQ. PPM
MIN .5782
MAX 1.544
MEAN 1.061
STD DEV .2266
RESID MAG GAMMAS
MIN -1053
MAX 428.2
MEAN -631.5
STD DEV 280.8
RADAR ALTMTR FEET
MIN 282.8
MAX 480.7
MEAN 399.6
STD DEV 28.86
LINE 1170

LINE 1180
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 81143



Th/K
MIN 3.405
MAX 7.884
MEAN 5.?04
STD DEV .6554

U/K
MIN 1.570
MAX 4.994
MEAN 2.815
STD DEV .6754

U/Th
MIN .2927
MA- .8376
MEAN .5206
STD DEV .1064

TOTAL COUNTS CTS/SEC
MIN 1436
MAX 2109
MEAN 1791
STD DEV 127.6

POTASSIUM PERCENT
MIN .7348
MAX 1.597
MEAN 1.178
STD DEV .1651

URANIUM EQ. PPM
MIN 1.958
MAX 5.129
MEAN 3.231
STD DEV .50?1

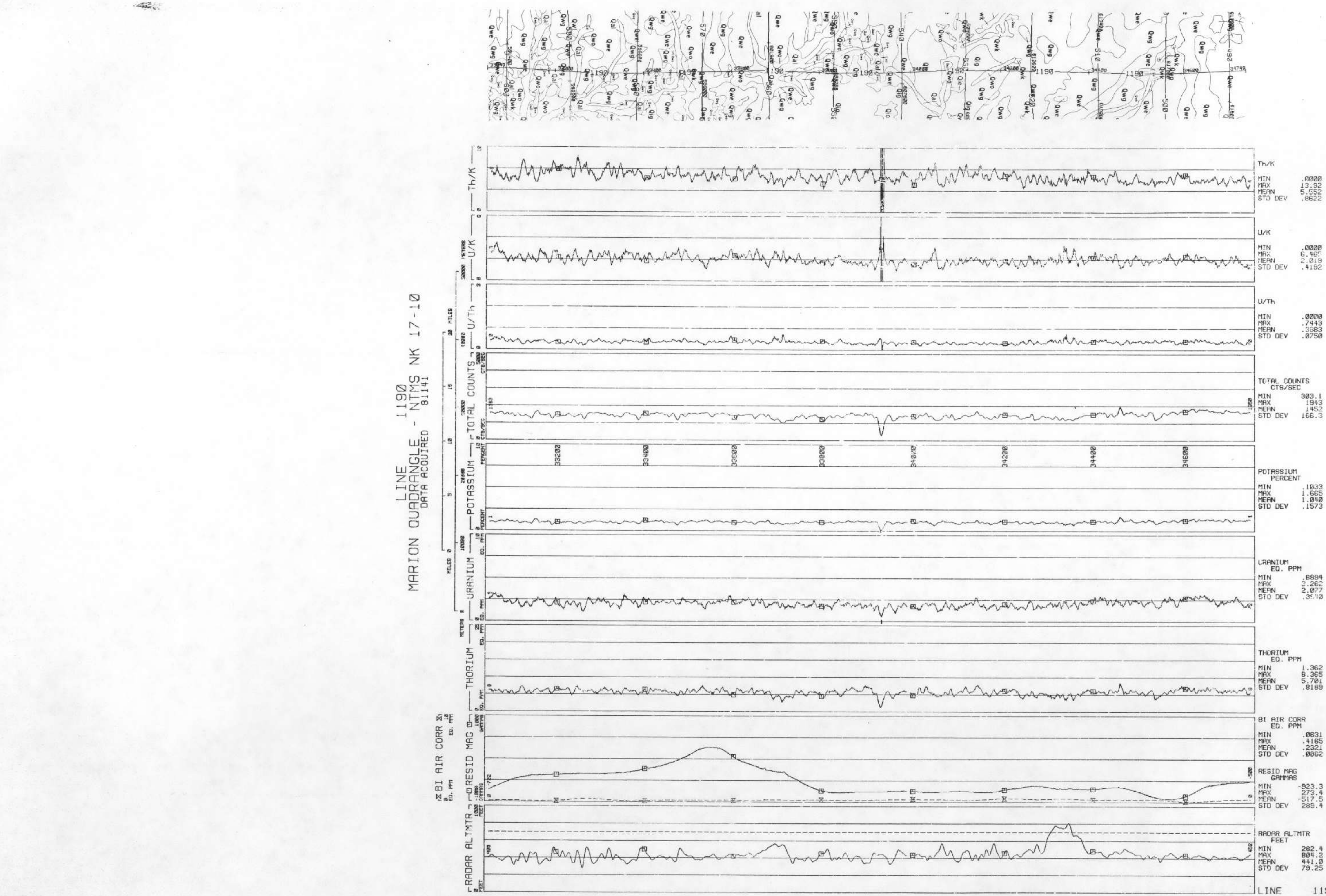
THORIUM EQ. PPM
MIN 4.191
MAX 8.382
MEAN 6.301
STD DEV .7353

BI AIR CORR EQ. PPM
MIN .4070
MAX 1.426
MEAN .8993
STD DEV .2837

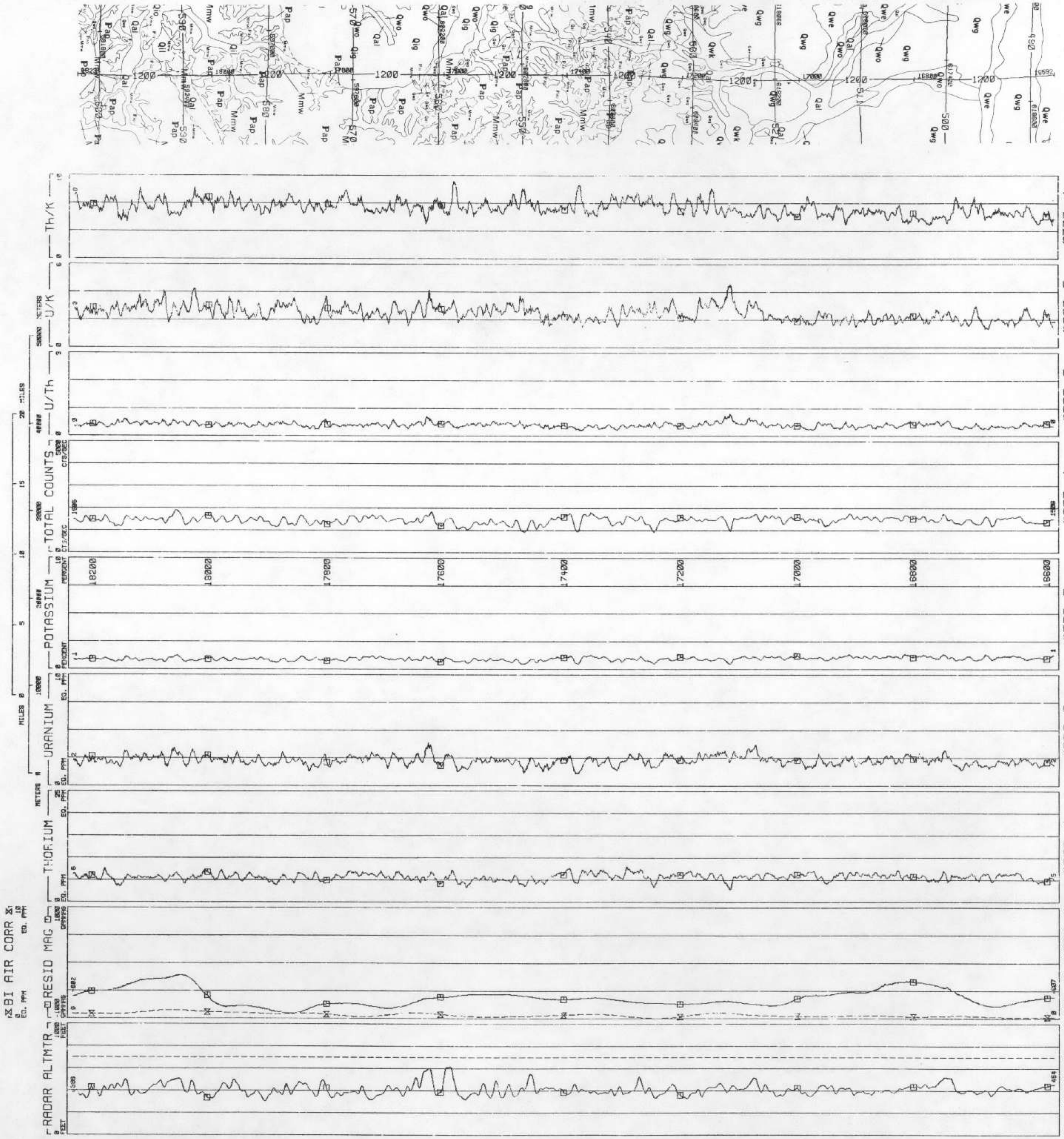
RESID MAG GAMMAS
MIN -950.9
MAX -431.9
MEAN -700.6
STD DEV 132.9

RADAR ALTMTR FEET
MIN 324.4
MAX 496.4
MEAN 411.1
STD DEV 28.38

LINE 1180


LINE 1190
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 81141
Th/K
MIN .0000
MAX 13.92
MEAN 5.552
STD DEV .8622
U/K
MIN .0000
MAX 6.465
MEAN 2.019
STD DEV .4192
U/Th
MIN .0000
MAX .7443
MEAN .3683
STD DEV .0750
TOTAL COUNTS CTS/SEC
MIN 303.1
MAX 1943
MEAN 1452
STD DEV 166.3
POTASSIUM PERCENT
MIN .1033
MAX 1.665
MEAN 1.090
STD DEV .1573
URANIUM EQ. PPM
MIN .6894
MAX 3.262
MEAN 2.077
STD DEV .3540
THORIUM EQ. PPM
MIN 1.362
MAX 8.365
MEAN 5.701
STD DEV .8189
BI AIR CORR EQ. PPM
MIN .0631
MAX .4165
MEAN .2321
STD DEV .0862
RESID MAG GAMMAS
MIN -923.3
MAX 273.4
MEAN -517.5
STD DEV 289.4
RADAR ALTMTR FEET
MIN 282.4
MAX 804.2
MEAN 441.0
STD DEV 79.25
LINE 1190

LINE 1200
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 81141



Th/K	
MIN	4.039
MAX	9.279
MEAN	6.108
STD DEV	.8455

U/K	
MIN	1.324
MAX	4.549
MEAN	2.465
STD DEV	.5137

U/Th	
MIN	.2171
MAX	.7931
MEAN	.4065
STD DEV	.0796

TOTAL COUNTS CTS/SEC	
MIN	929.4
MAX	1894
MEAN	1455
STD DEV	158.4

POTASSIUM PERCENT	
MIN	.4818
MAX	1.344
MEAN	.9426
STD DEV	.1640

URANIUM EQ. PPM	
MIN	1.087
MAX	3.869
MEAN	2.276
STD DEV	.4090

THORIUM EQ. PPM	
MIN	2.873
MAX	7.960
MEAN	5.667
STD DEV	.7747

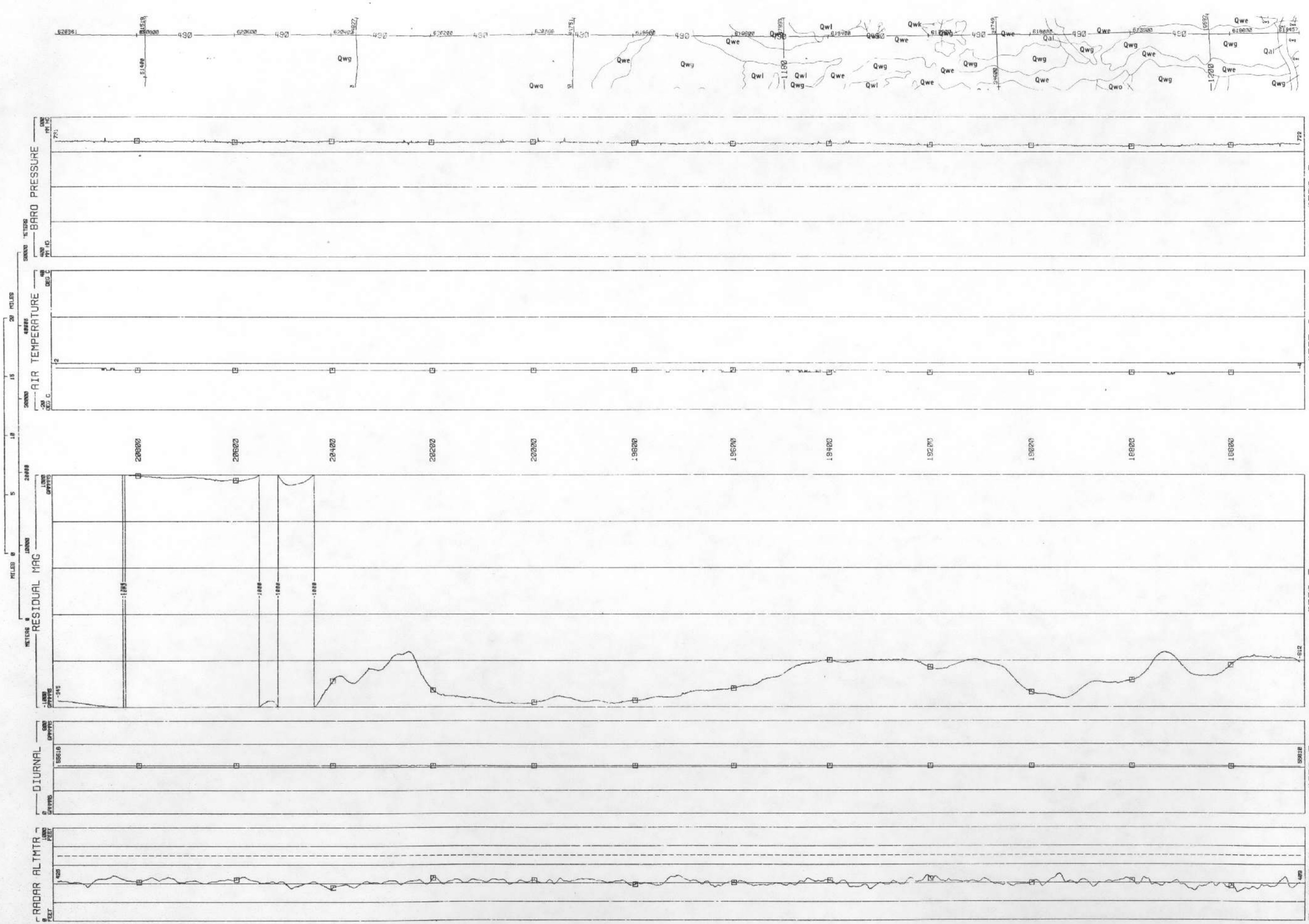
BI AIR CORR EQ. PPM	
MIN	.0155
MAX	.7130
MEAN	.3103
STD DEV	.1546

RESID MAG GAMMAS	
MIN	-910.4
MAX	-222.4
MEAN	-624.0
STD DEV	155.2

RADAR ALTMTR FEET	
MIN	307.5
MAX	614.7
MEAN	410.3
STD DEV	48.87

LINE 1200

LINE 490
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 90348



BARO PRESSURE
MM HG
MIN 715.1
MAX 739.4
MEAN 724.6
STD DEV 4.510

AIR TEMPERATURE
DEG C
MIN -5.000
MAX -2.000
MEAN -3.329
STD DEV .5557

RESIDUAL MAG
GAMMAS
MIN -1090
MAX -525.1
MEAN -813.1
STD DEV 163.5

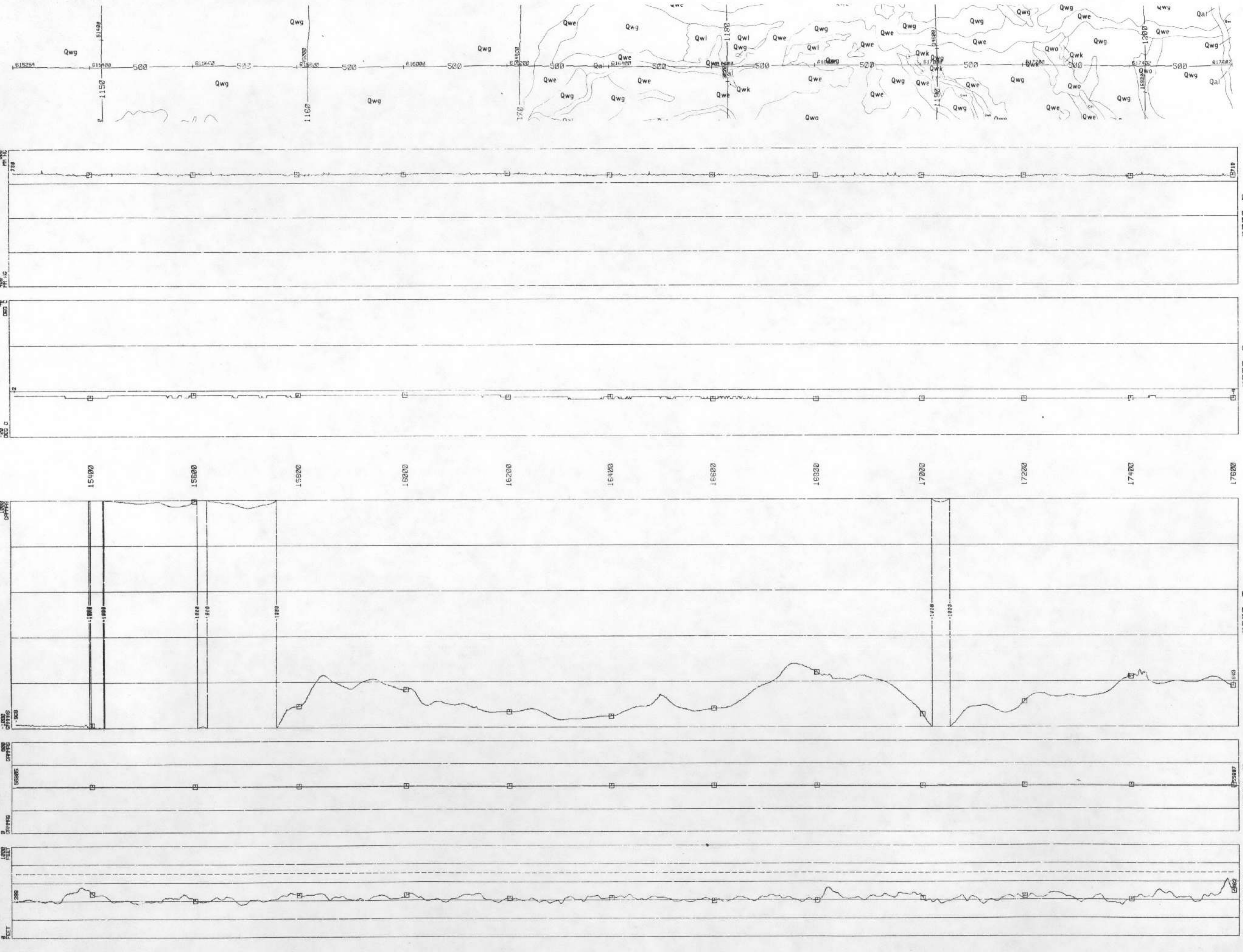
DIURNAL
GAMMAS
MIN 55609
MAX 55616
MEAN 55605
STD DEV 8.371

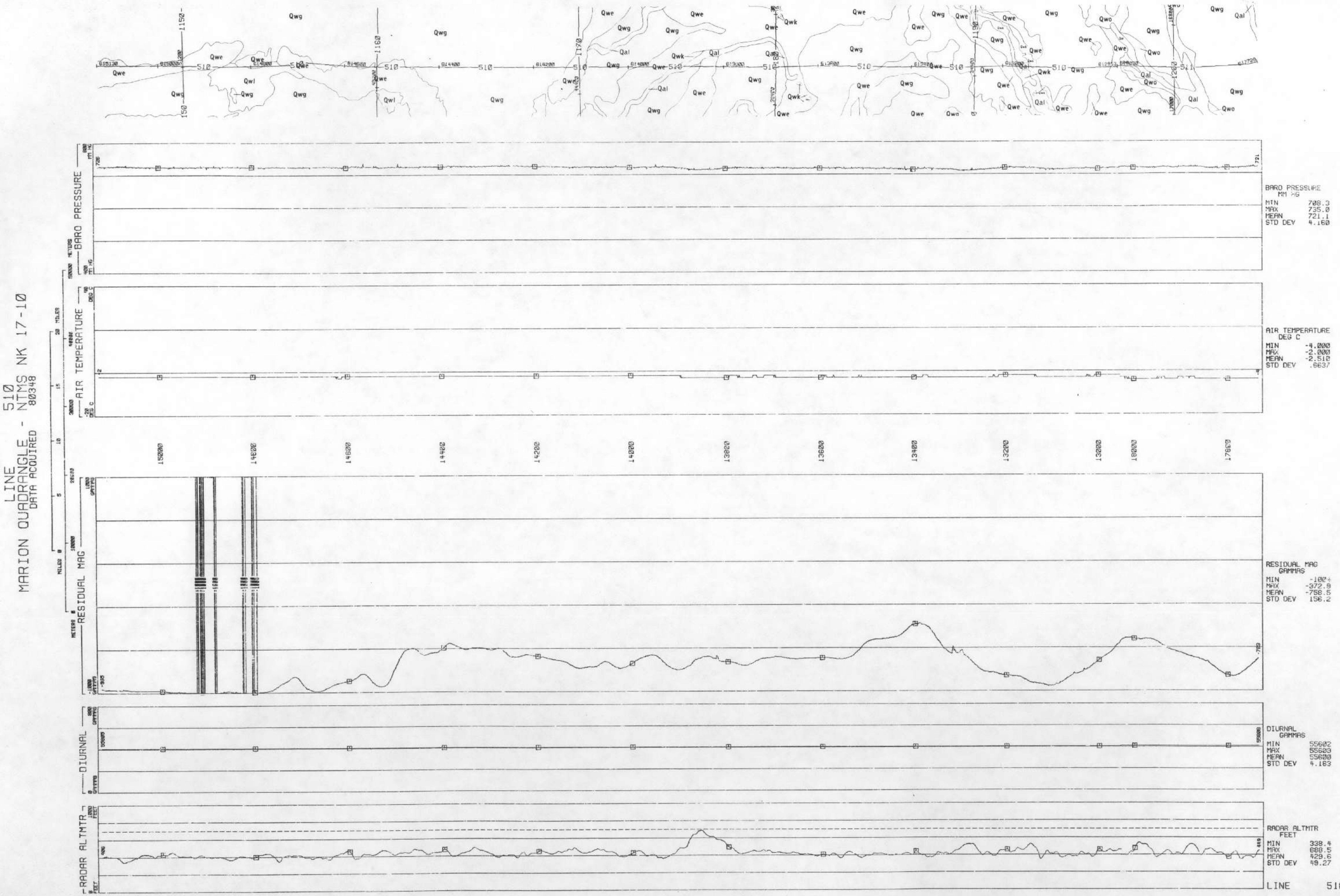
RADAR ALTMTR
FEET
MIN 306.1
MAX 498.3
MEAN 409.3
STD DEV 30.44

LINE 490

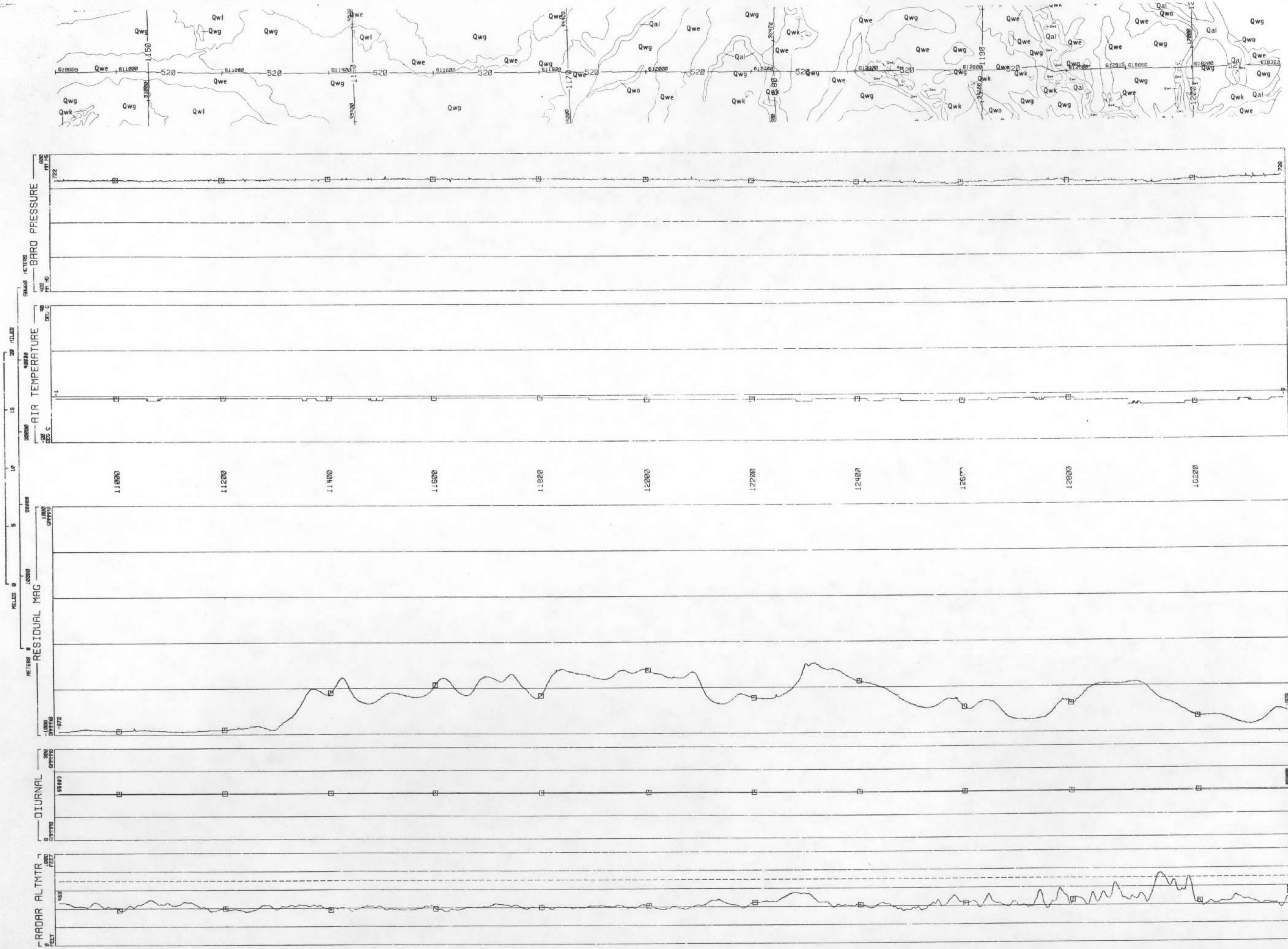
D20 ma

LINE 500
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80348




LINE 510
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80348
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
BARO PRESSURE MM HG
MIN 708.3
MAX 735.0
MEAN 721.1
STD DEV 4.160
AIR TEMPERATURE DEG C
MIN -4.000
MAX -2.000
MEAN -2.510
STD DEV .6637
RESIDUAL MAG GAMMAS
MIN -1004
MAX -372.9
MEAN -758.5
STD DEV 156.2
DIURNAL GAMMAS
MIN 55602
MAX 55603
MEAN 55600
STD DEV 4.163
RADAR ALTMTR FEET
MIN 338.4
MAX 688.5
MEAN 429.6
STD DEV 49.27
LINE 510

LINE 520
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80348



BARO PRESSURE
MM HG
MIN 704.8
MAX 735.0
MEAN 719.6
STD DEV 5.311

AIR TEMPERATURE
DEG C
MIN -5.000
MAX -1.000
MEAN -2.032
STD DEV 1.110

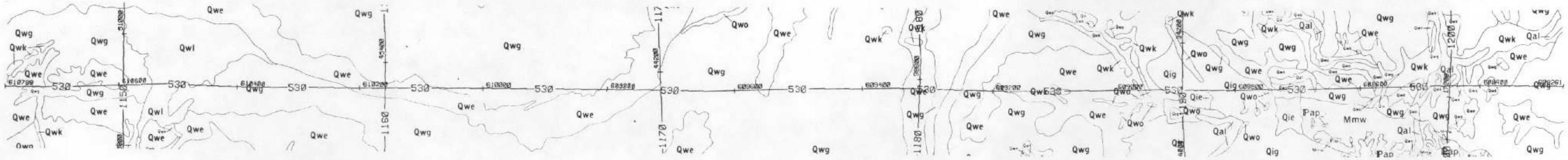
RESIDUAL MAG
GAMMAS
MIN -974.5
MAX -391.2
MEAN -709.7
STD DEV 171.1

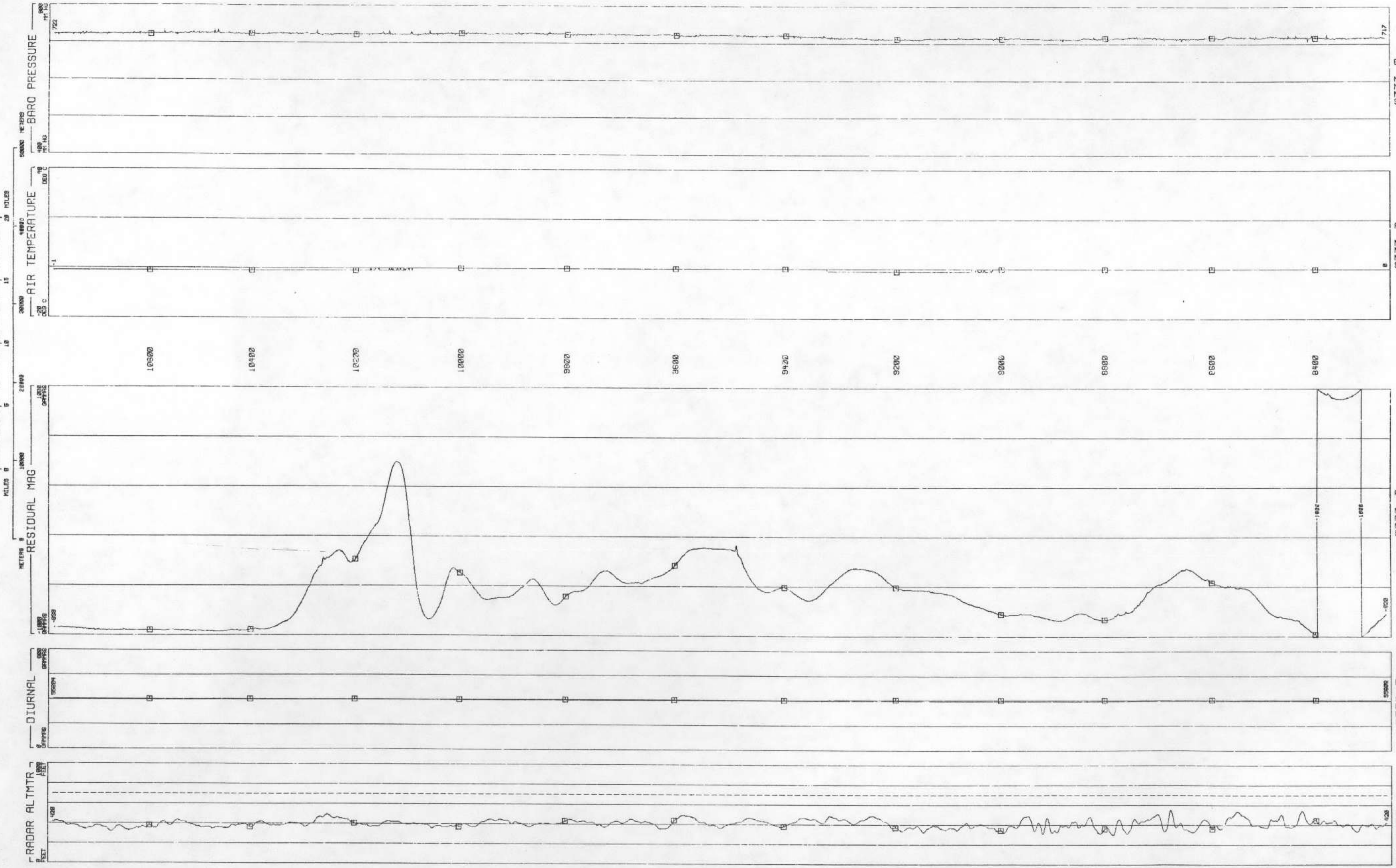
DIURNAL
GAMMAS
MIN 55602
MAX 55609
MEAN 55601
STD DEV 3.832

RADAR ALTMTR
FEET
MIN 349.8
MAX 749.5
MEAN 433.3
STD DEV 59.69

LINE 520

LINE 530
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80348





BARO PRESSURE
MM HG

MIN	708.3
MAX	734.0
MEAN	719.6
STD DEV	4.325

AIR TEMPERATURE
DEG C

MIN	-1.000
MAX	.0000
MEAN	-.3815
STD DEV	.4857

RESIDUAL MAG
GAMMAS

MIN	-1086
MAX	398.3
MEAN	-682.7
STD DEV	252.0

DIURNAL
GAMMAS

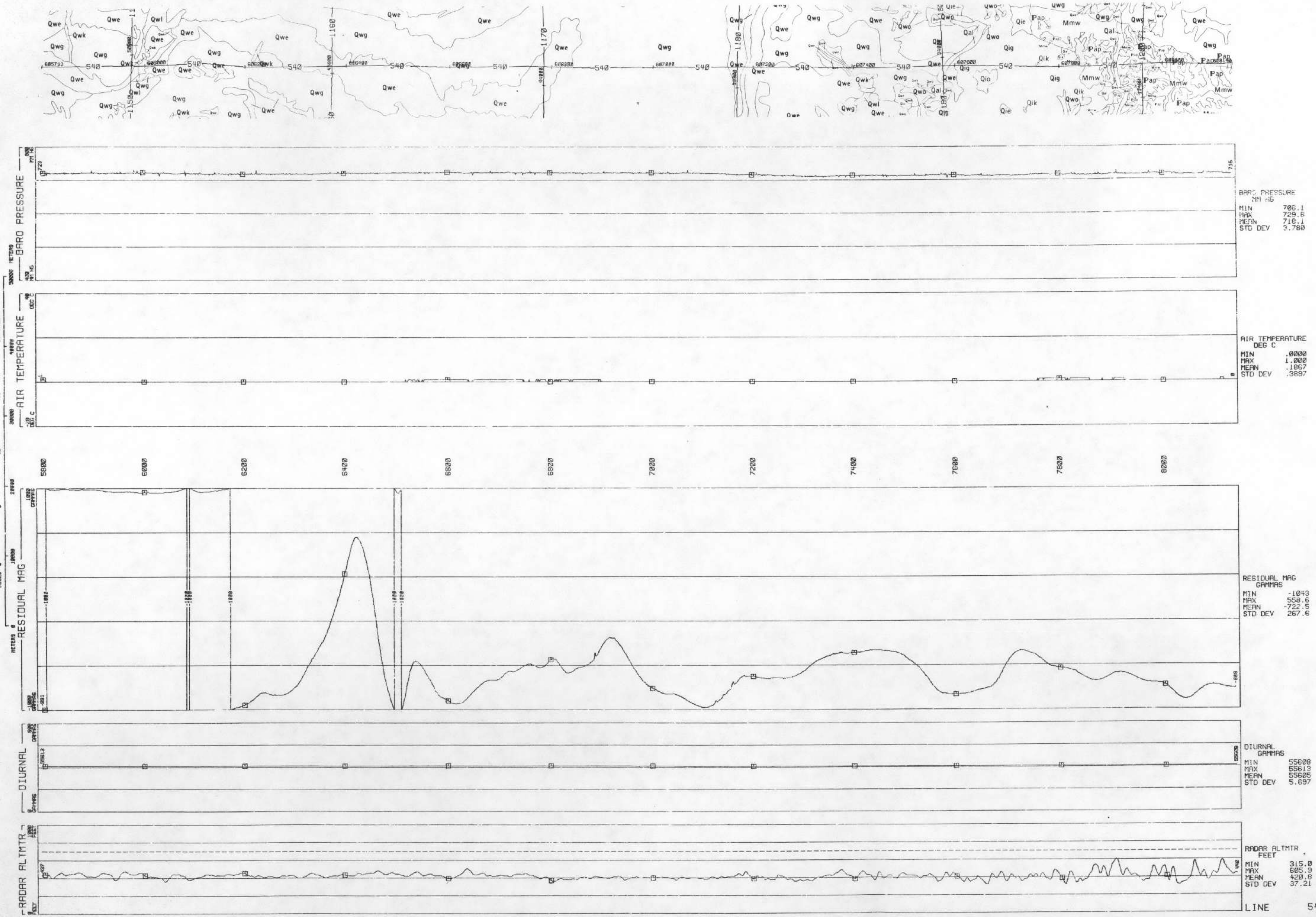
MIN	55604
MAX	55608
MEAN	55600
STD DEV	5.890

RADAR ALTMTR
FEET

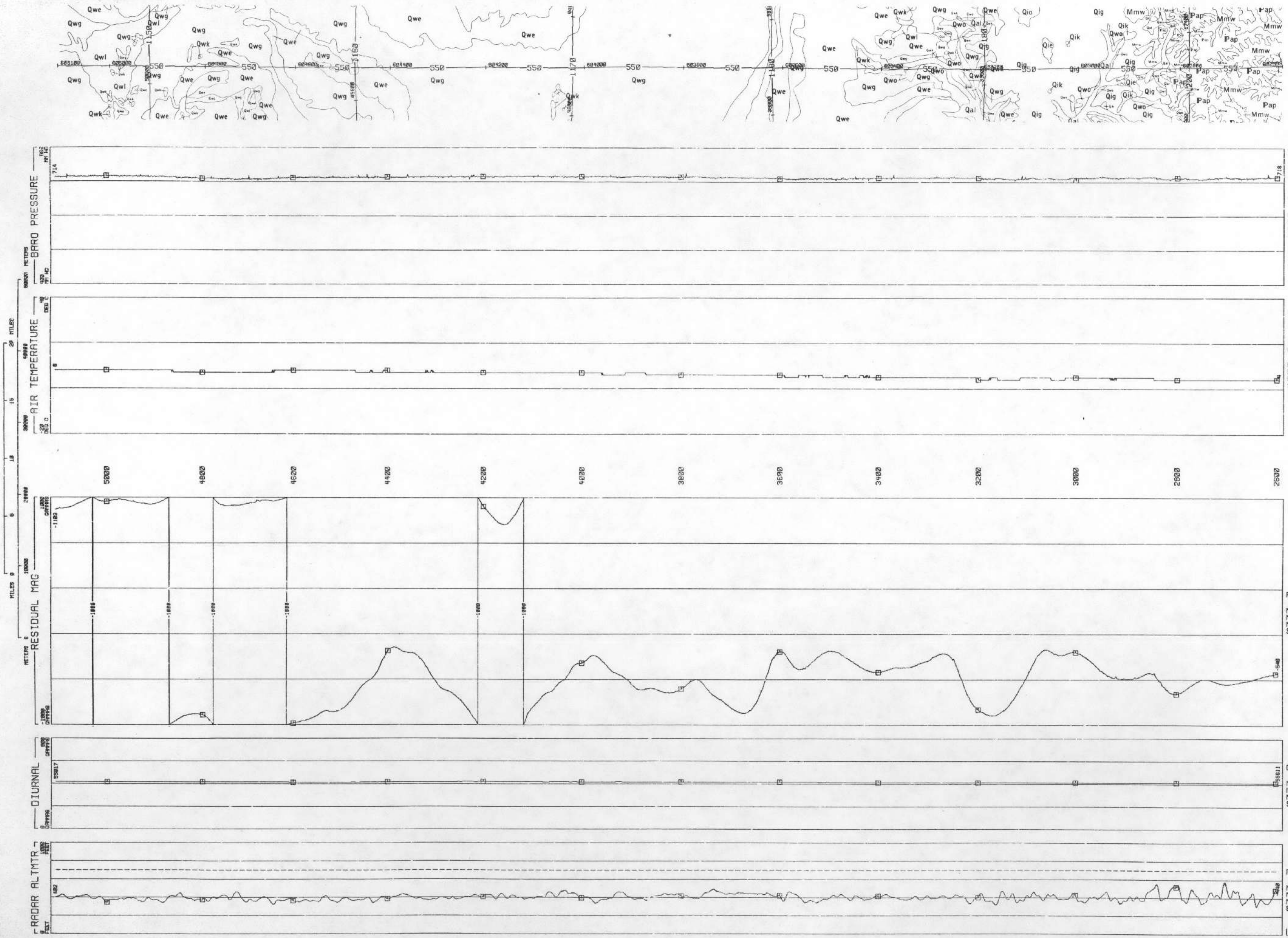
MIN	298.0
MAX	549.3
MEAN	403.1
STD DEV	41.15

LINE 530

LINE 540
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80348



LINE 550
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80347



BARO PRESSURE
MM HG

MIN	704.5
MAX	724.8
MEAN	712.6
STD DEV	2.447

AIR TEMPERATURE
DEG C

MIN	4.000
MAX	8.000
MEAN	6.138
STD DEV	1.334

RESIDUAL MAG
GAMMAS

MIN	-1236
MAX	-316.3
MEAN	-709.1
STD DEV	242.4

DIURNAL
GAMMAS

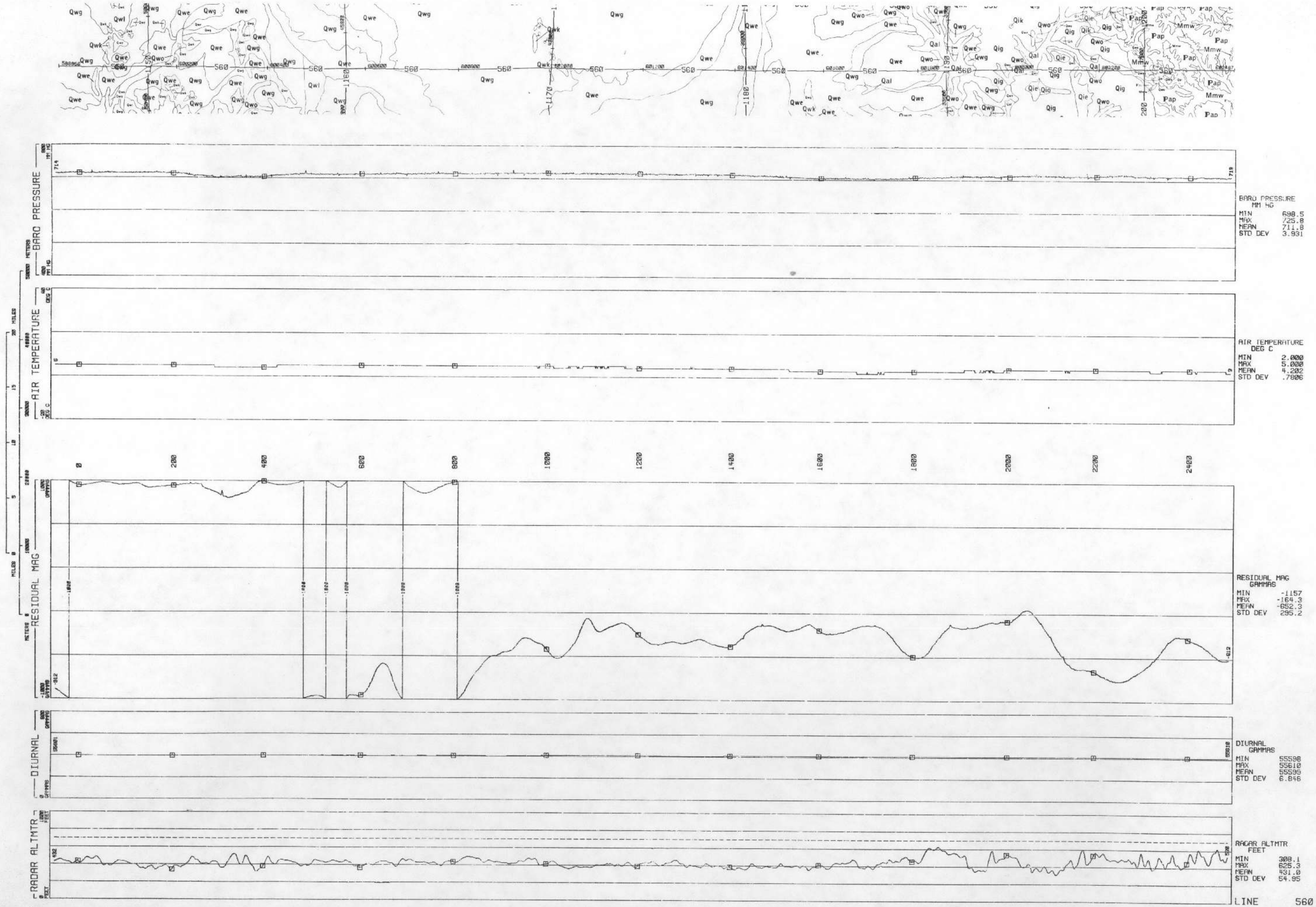
MIN	55611
MAX	55619
MEAN	55607
STD DEV	8.003

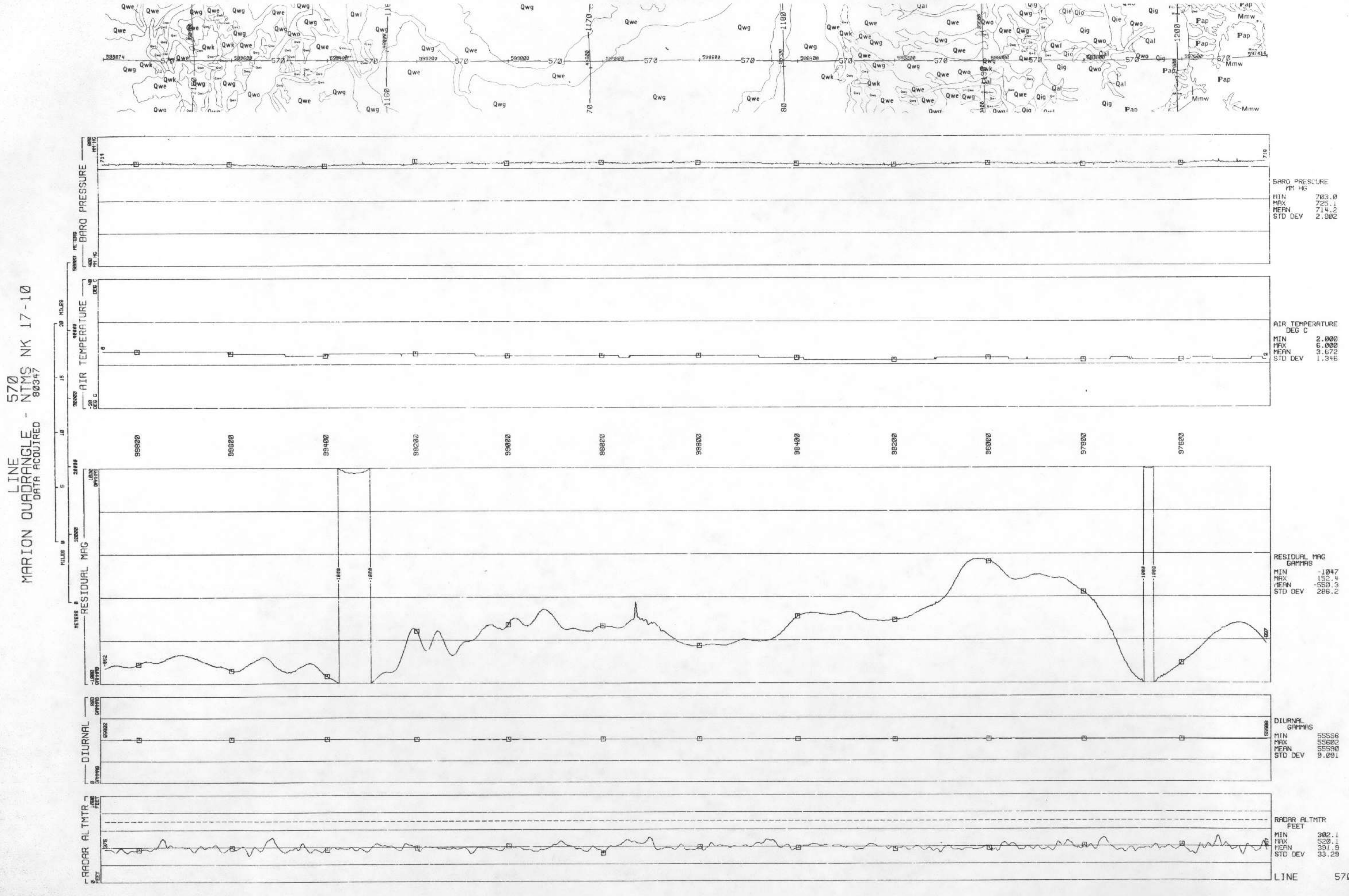
RADAR ALTMTR
FEET

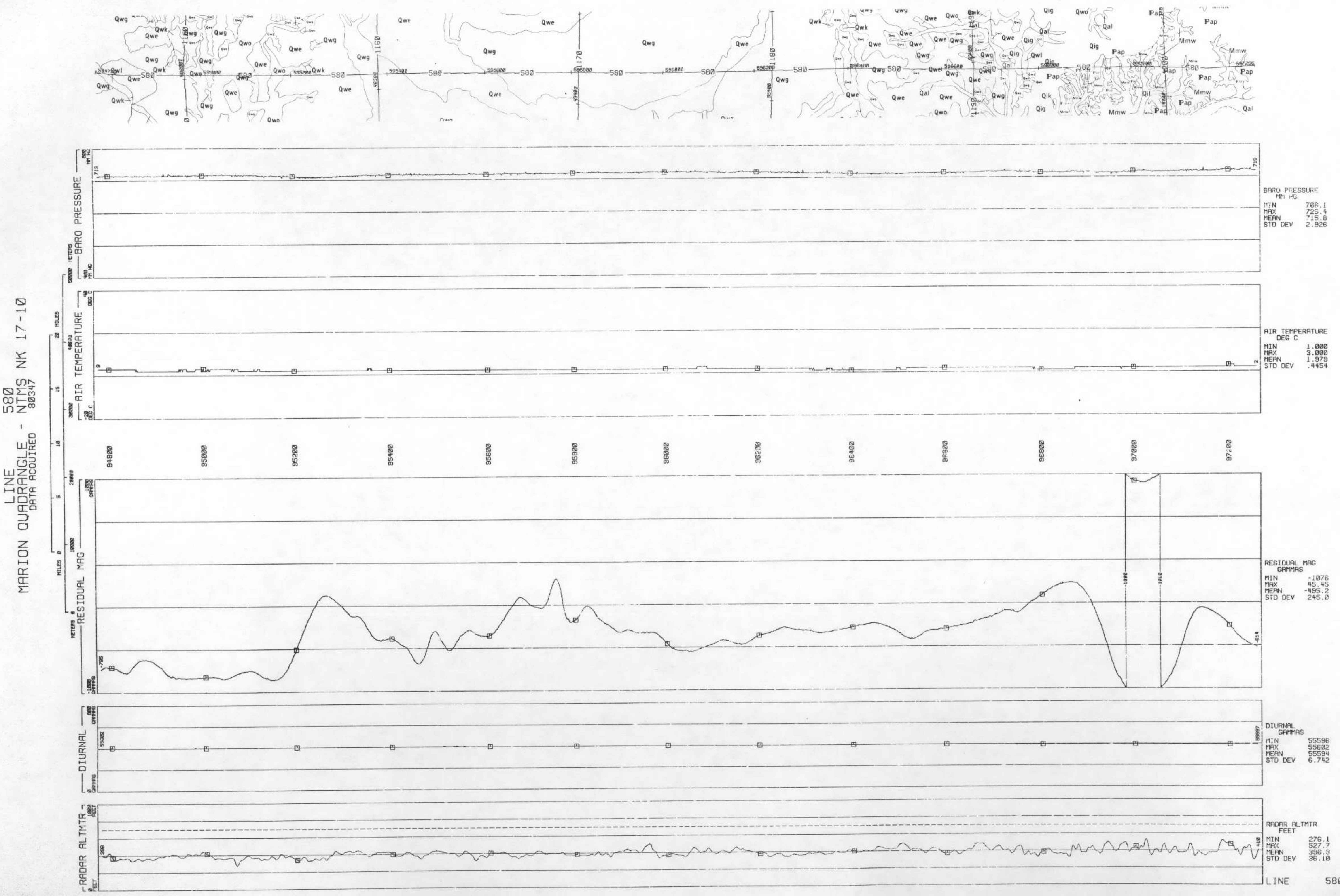
MIN	311.7
MAX	576.3
MEAN	401.8
STD DEV	35.60

LINE 550

LINE 560
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80347

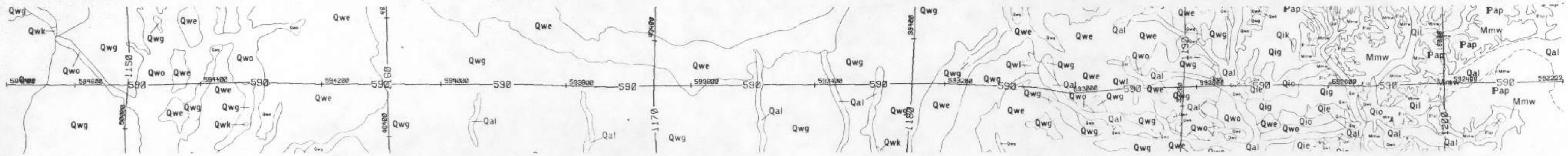


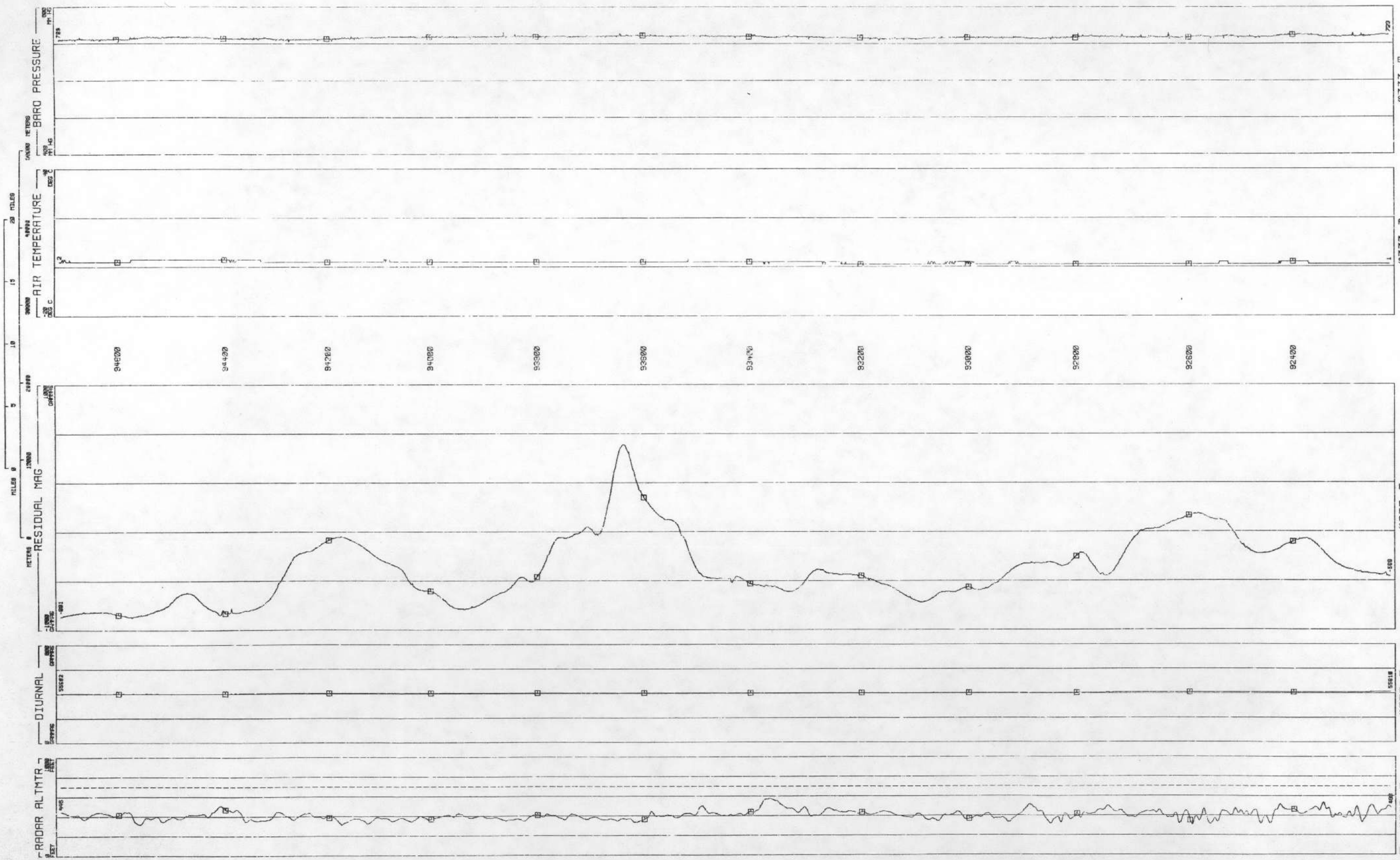

LINE 570
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80347
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
99800 99600 99400 99200 99000 98800 98600 98400 98200 98000 97800 97600
BARO PRESSURE MM HG
MIN 703.0
MAX 725.1
MEAN 714.2
STD DEV 2.902
AIR TEMPERATURE DEG C
MIN 2.000
MAX 6.000
MEAN 3.672
STD DEV 1.346
RESIDUAL MAG GAMMAS
MIN -1047
MAX 152.4
MEAN -550.3
STD DEV 286.2
DIURNAL GAMMAS
MIN 55566
MAX 55602
MEAN 55580
STD DEV 9.091
RADAR ALTMTR FEET
MIN 302.1
MAX 520.1
MEAN 391.9
STD DEV 33.29
LINE 570


LINE 580
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80347
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
94800
95000
95200
95400
95600
95800
96000
96200
96400
96600
96800
97000
97200
BARO PRESSURE MM HG
MIN 708.1
MAX 725.4
MEAN 715.8
STD DEV 2.926
AIR TEMPERATURE DEG C
MIN 1.000
MAX 3.000
MEAN 1.979
STD DEV .4454
RESIDUAL MAG GAMMAS
MIN -1076
MAX 45.45
MEAN -495.2
STD DEV 245.0
DIURNAL GAMMAS
MIN 55596
MAX 55602
MEAN 55594
STD DEV 6.742
RADAR ALTMTR FEET
MIN 276.1
MAX 527.7
MEAN 396.3
STD DEV 36.10
LINE 580

D29 ma

LINE 590
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80347





BARO PRESSURE
MM HG
MIN 705.3
MAX 730.7
MEAN 717.2
STD DEV 3.410

AIR TEMPERATURE
DEG C
MIN 1.000
MAX 3.000
MEAN 1.748
STD DEV .6291

RESIDUAL MAG
GAMMAS
MIN -894.6
MAX 508.7
MEAN -500.5
STD DEV 265.5

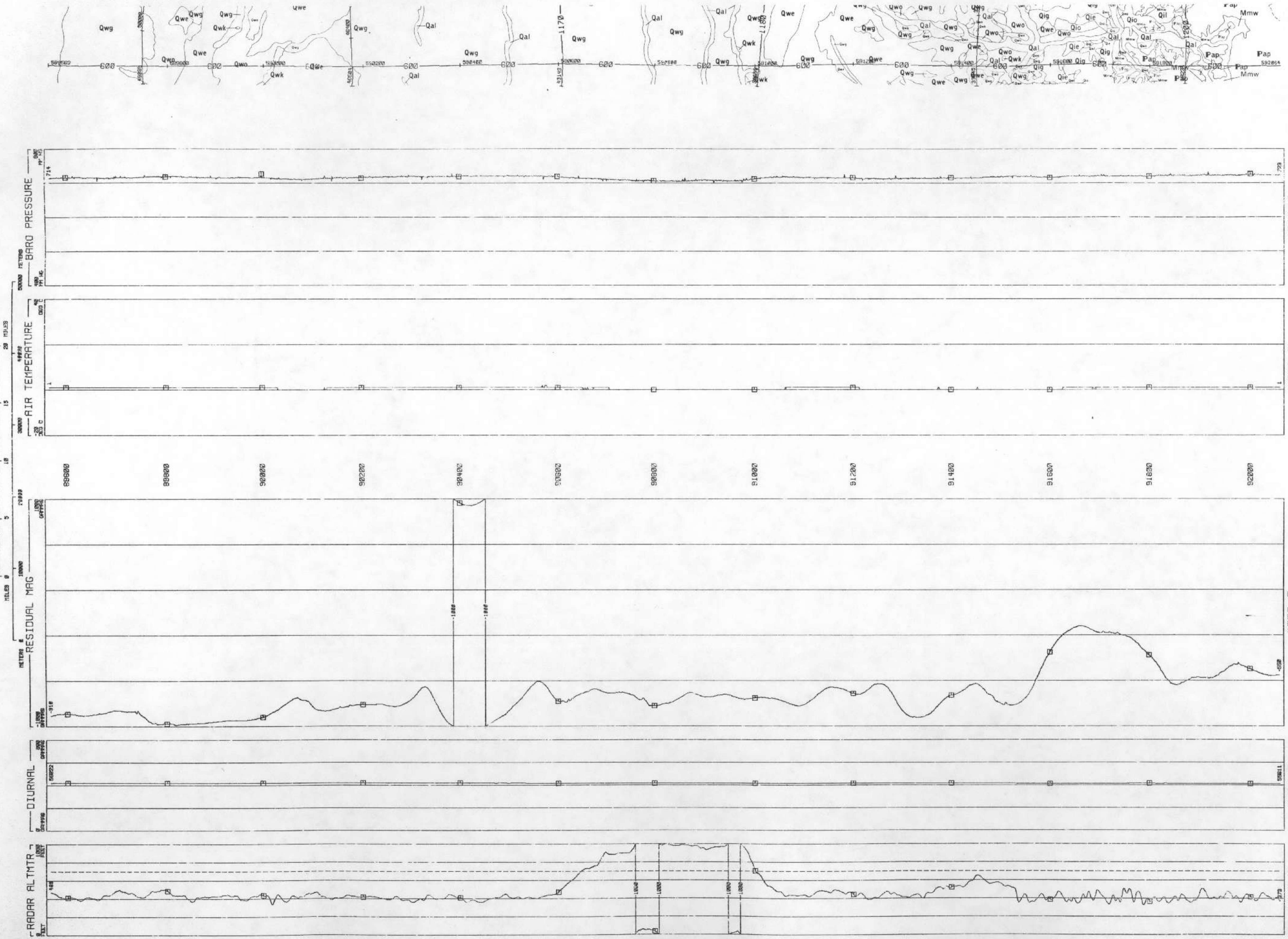
DIURNAL
GAMMAS
MIN 55602
MAX 55611
MEAN 55600
STD DEV 4.932

RADAR ALTMTR
FEET
MIN 312.1
MAX 575.1
MEAN 408.0
STD DEV 43.77

LINE 590

D30 ma

LINE 600
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 80347



BARO PRESSURE
MM HG
MIN 700.9
MAX 731.7
MEAN 715.9
STD DEV 4.520

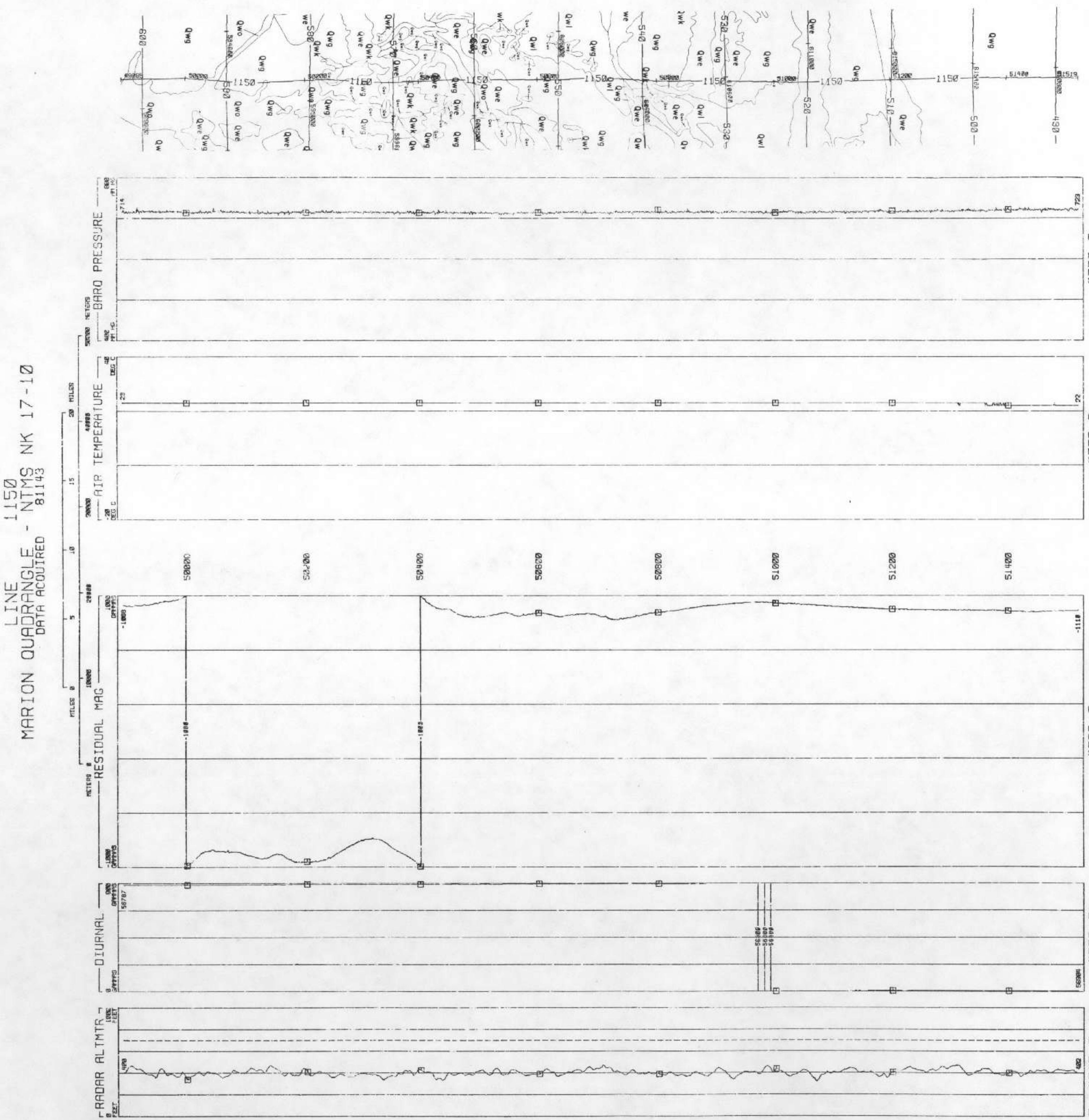
AIR TEMPERATURE
DEG C
MIN .0000
MAX 2.000
MEAN .6503
STD DEV .4810

RESIDUAL MAG
GAMMAS
MIN -1059
MAX -119.7
MEAN -729.8
STD DEV 205.2

DIURNAL
GAMMAS
MIN 55611
MAX 55622
MEAN 55618
STD DEV 7.670

RADAR ALTMTR
FEET
MIN 329.9
MAX 1060
MEAN 507.7
STD DEV 185.6

LINE 600



BARO PRESSURE
MM HG
MIN 708.0
MAX 727.2
MEAN 715.5
STD DEV 2.664

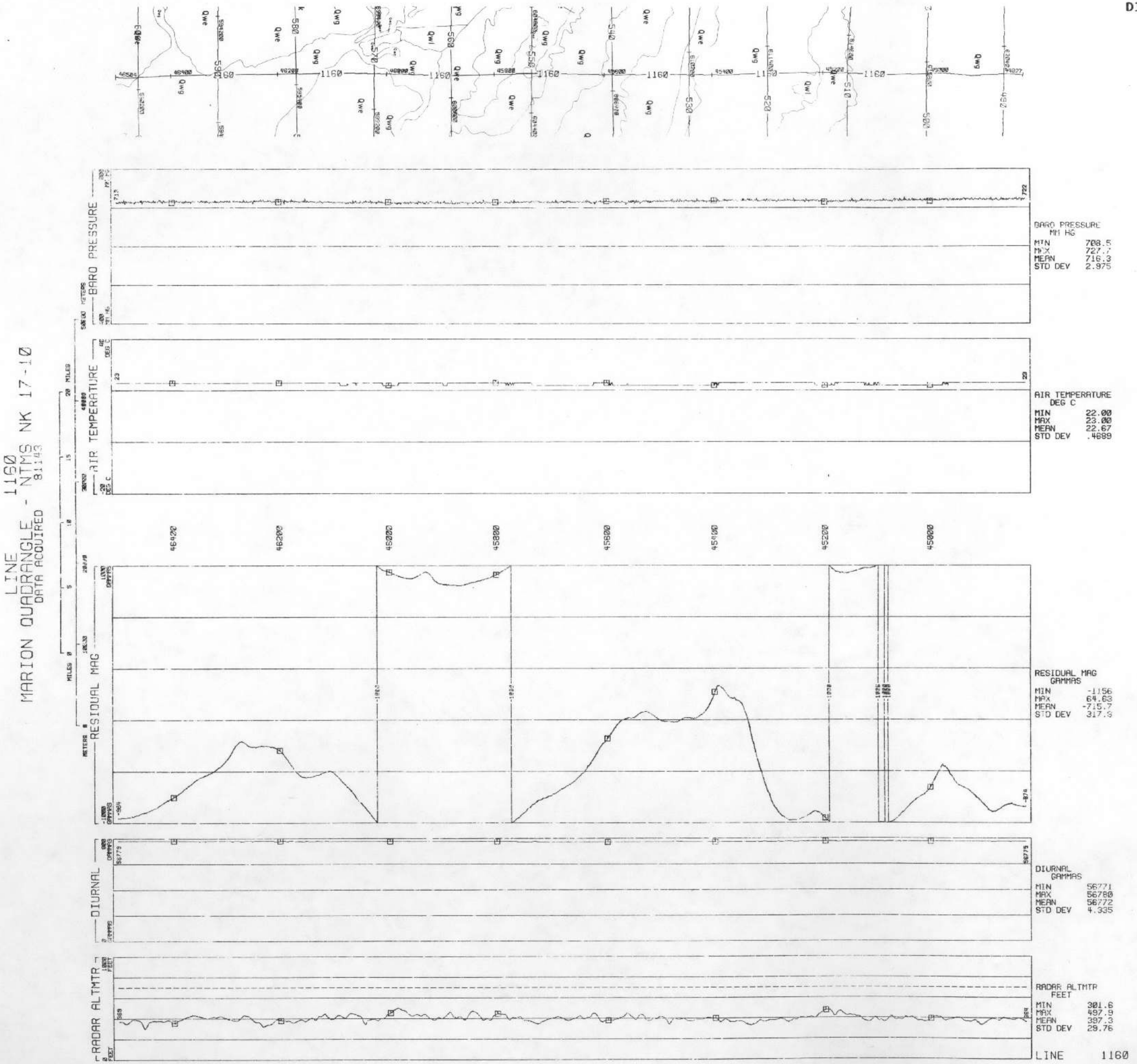
AIR TEMPERATURE
DEG C
MIN 22.00
MAX 23.00
MEAN 22.91
STD DEV .2865

RESIDUAL MAG
GAMMAS
MIN -1176
MAX -787.6
MEAN -1052
STD DEV 95.93

DIURNAL
GAMMAS
MIN 56786
MAX 56805
MEAN 56793
STD DEV 6.137

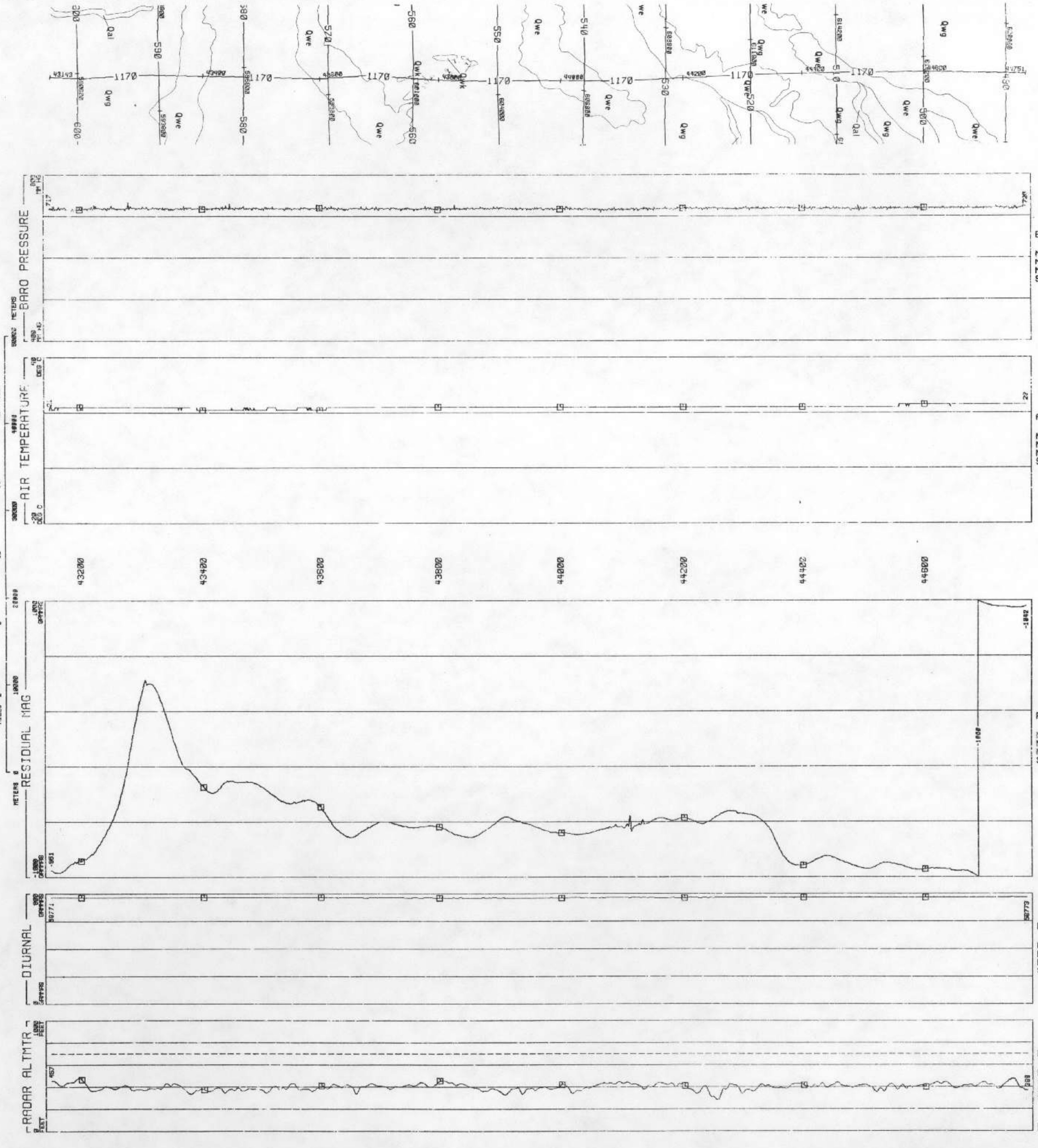
RADAR ALTMTR
FEET
MIN 321.9
MAX 471.8
MEAN 402.9
STD DEV 26.57

LINE 1150


LINE 1160
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 81143
BARO PRESSURE
MM HG
MIN 708.5
MAX 727.7
MEAN 716.3
STD DEV 2.975
AIR TEMPERATURE
DEG C
MIN 22.00
MAX 23.00
MEAN 22.67
STD DEV .4689
RESIDUAL MAG
GAMMAS
MIN -1156
MAX 64.63
MEAN -715.7
STD DEV 317.9
DIURNAL
GAMMAS
MIN 56771
MAX 56780
MEAN 56772
STD DEV 4.335
RADAR ALTMTR
FEET
MIN 301.6
MAX 497.9
MEAN 397.3
STD DEV 29.76
LINE 1160

D33 ma

LINE 1170
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 81143



BARO PRESSURE
MM HG
MIN 710.6
MAX 734.0
MEAN 713.4
STD DEV 1.833

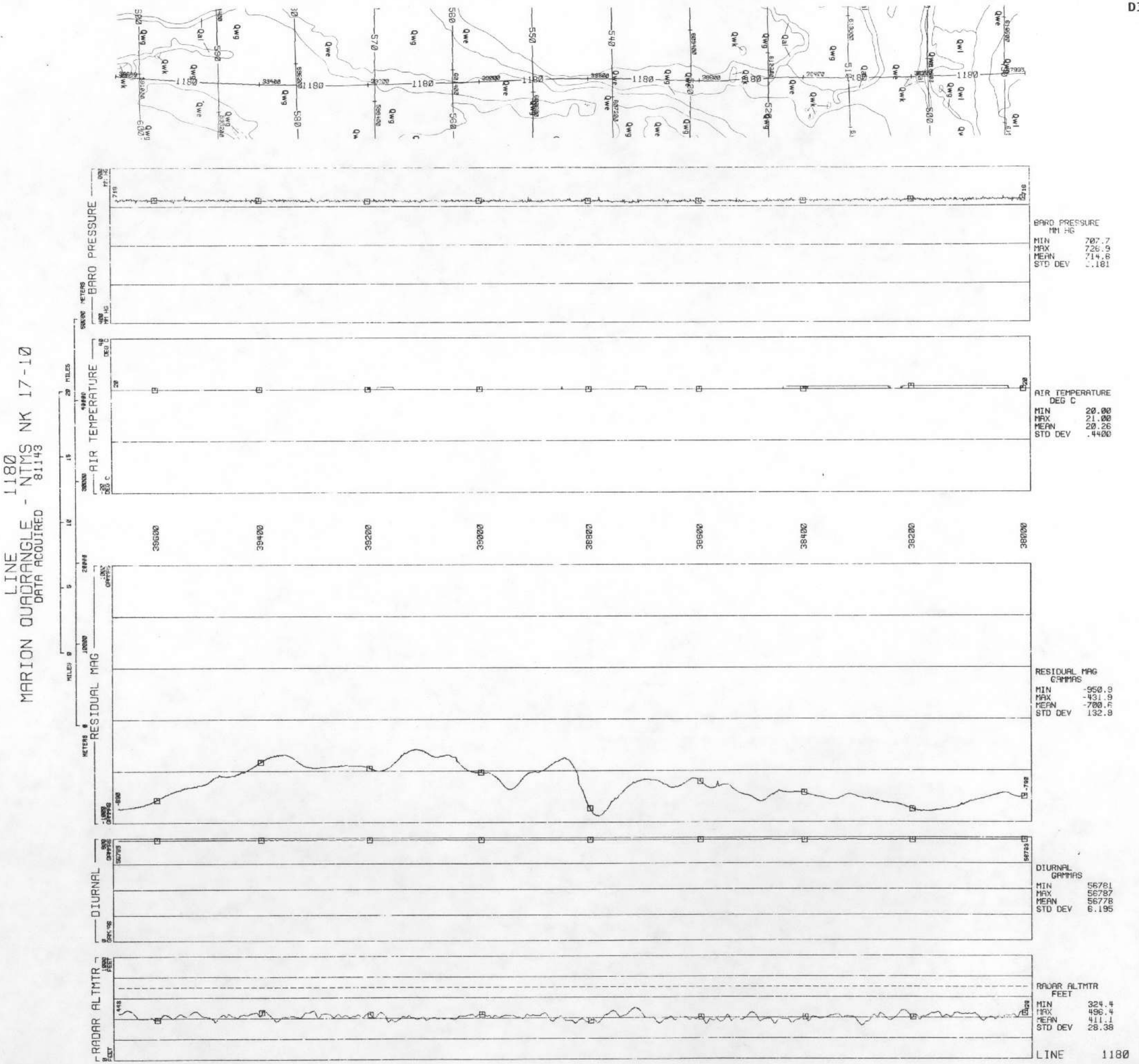
AIR TEMPERATURE
DEG C
MIN 21.00
MAX 23.00
MEAN 22.00
STD DEV .4853

RESIDUAL MAG
GAMMAS
MIN -1053
MAX 429.2
MEAN -631.9
STD DEV 280.8

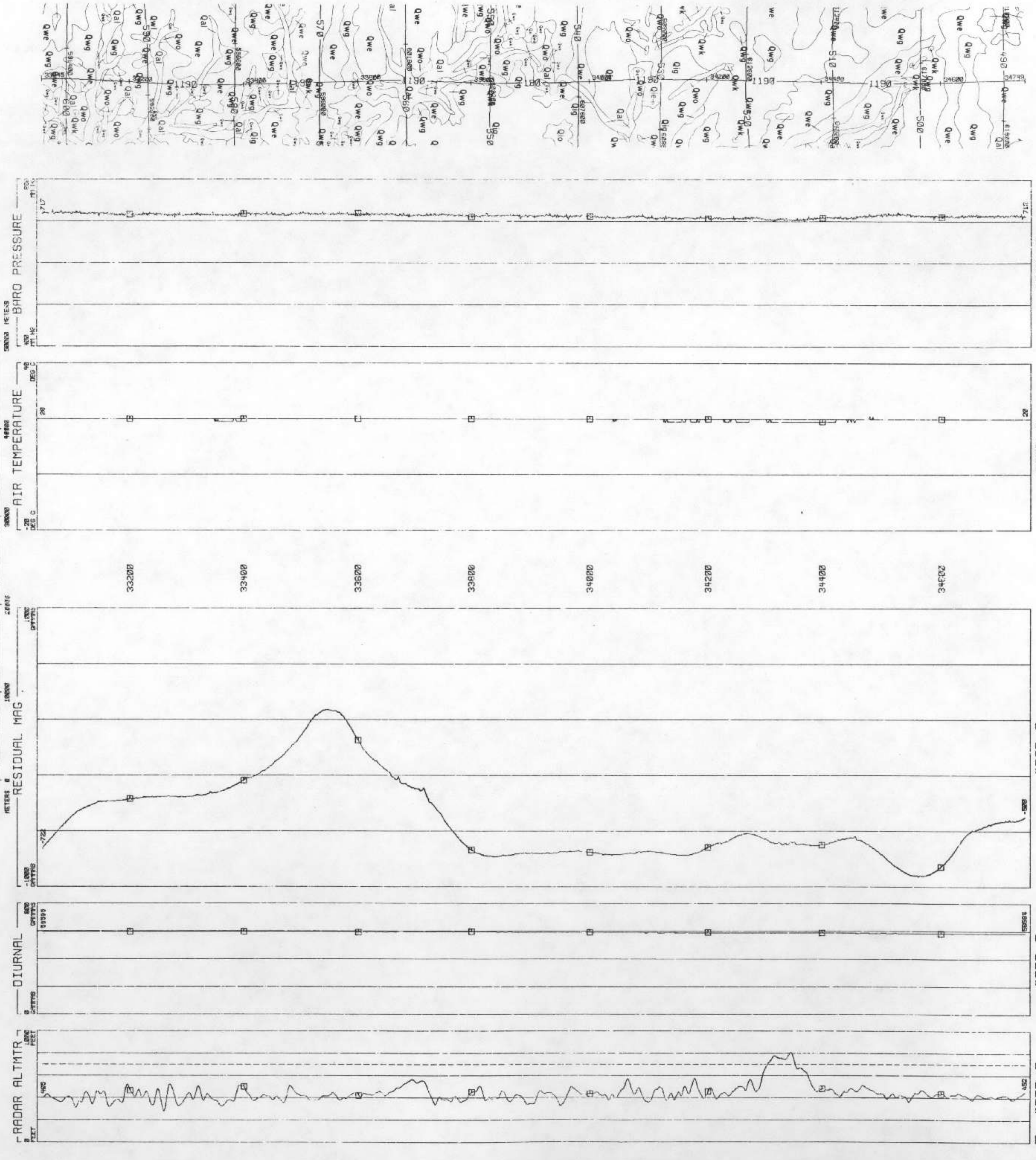
DIURNAL
GAMMAS
MIN 56769
MAX 56774
MEAN 56769
STD DEV 2.800

RADAR ALTMTR
FEET
MIN 282.6
MAX 480.7
MEAN 390.6
STD DEV 28.86

LINE 1170


LINE 1180
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 81143
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
BARO PRESSURE MM HG
MIN 707.7
MAX 726.9
MEAN 714.6
STD DEV .181
AIR TEMPERATURE DEG C
MIN 20.00
MAX 21.00
MEAN 20.26
STD DEV .4400
RESIDUAL MAG GAMMAS
MIN -950.9
MAX -431.9
MEAN -700.6
STD DEV 132.9
DIURNAL GAMMAS
MIN 56781
MAX 56787
MEAN 56778
STD DEV 6.195
RADAR ALTMTR FEET
MIN 324.4
MAX 496.4
MEAN 411.1
STD DEV 28.38
LINE 1180

LINE 1190
MARION QUADRANGLE - NTMS NK 17-10
DATA ACQUIRED 81141



BARO PRESSURE
MM HG
MIN 700.1
MAX 726.7
MEAN 712.9
STD DEV 4.071

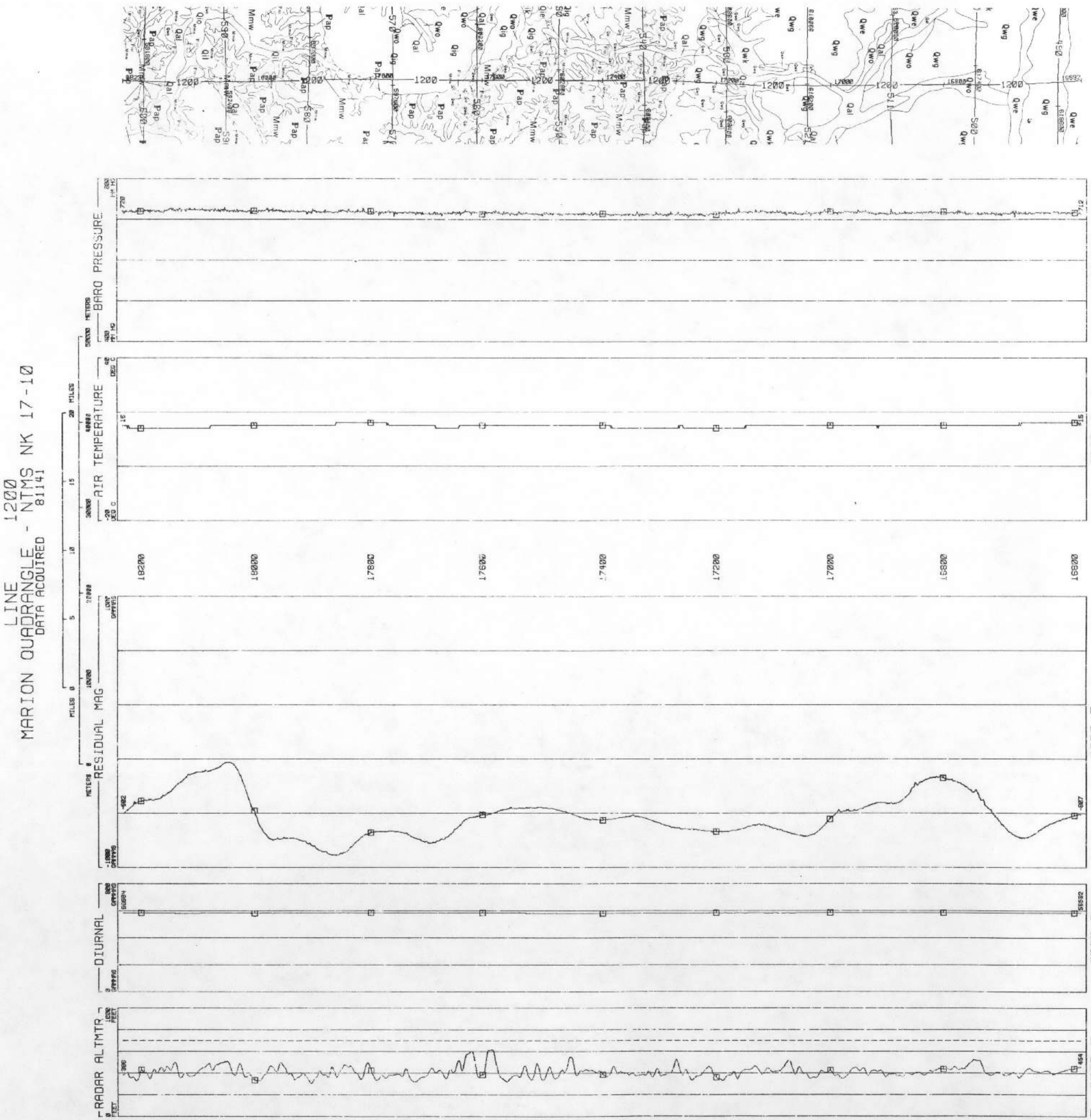
AIR TEMPERATURE
DEG C
MIN 19.00
MAX 21.00
MEAN 19.86
STD DEV .3547

RESIDUAL MAG
GAMMAS
MIN -923.3
MAX 273.4
MEAN -517.5
STD DEV 289.4

DIURNAL
GAMMAS
MIN 56584
MAX 56597
MEAN 56586
STD DEV 6.459

RADAR ALTMTR
FEET
MIN 282.4
MAX 804.2
MEAN 441.0
STD DEV 79.25

LINE 1190



BARO PRESSURE
MM HG
MIN 705.6
MAX 728.6
MEAN 716.8
STD DEV 3.618

AIR TEMPERATURE
DEG C
MIN 14.00
MAX 16.00
MEAN 14.84
STD DEV .5786

RESIDUAL MAG
GAMMAS
MIN -910.4
MAX -222.4
MEAN -624.0
STD DEV 155.2

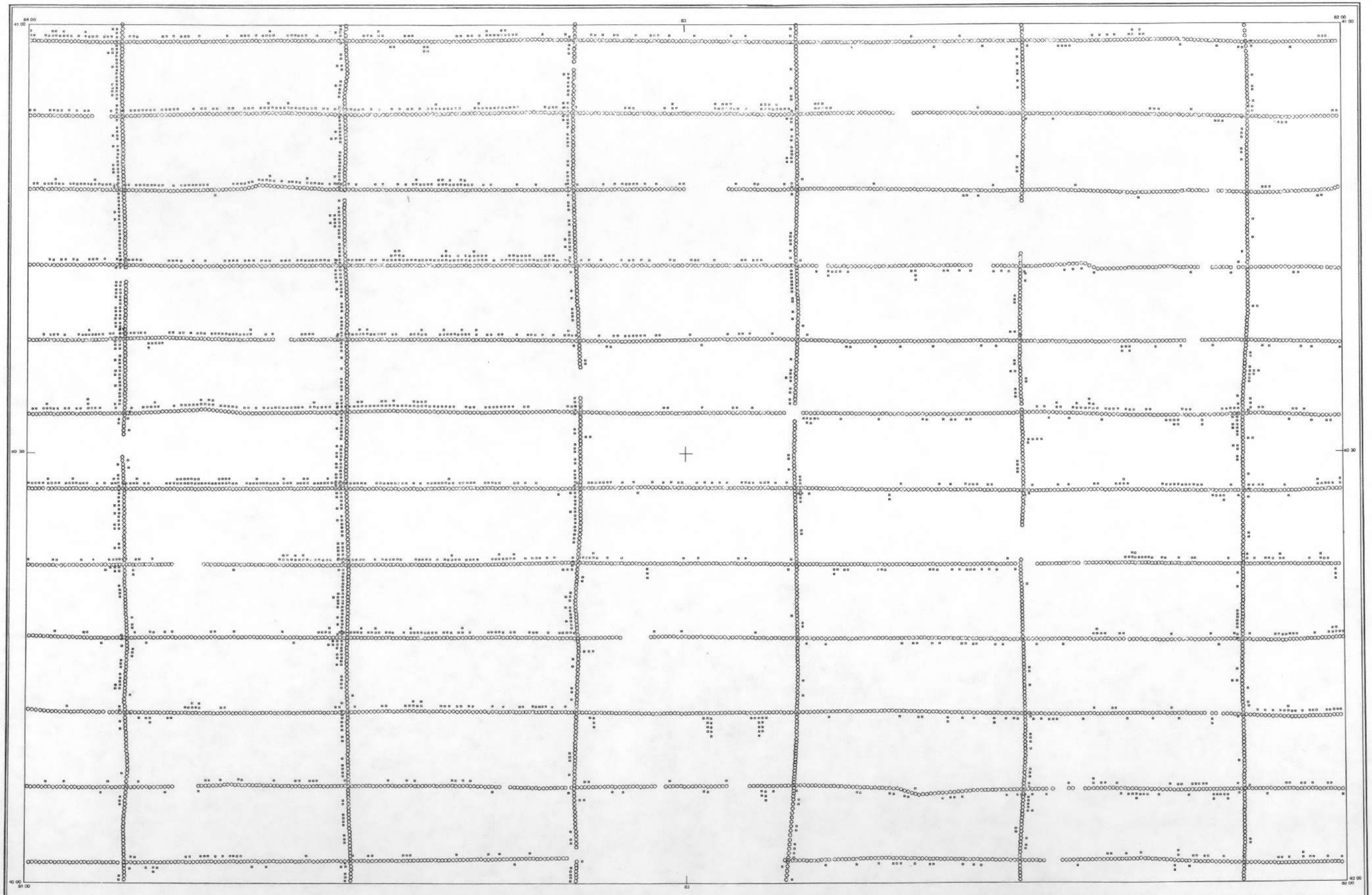
DIURNAL
GAMMAS
MIN 56570
MAX 56586
MEAN 56578
STD DEV 4.642

RADAR ALTMTR
FEET
MIN 307.5
MAX 614.7
MEAN 410.3
STD DEV 48.87

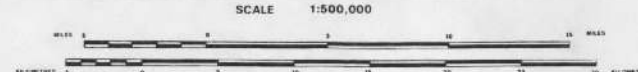
LINE 1200

APPENDIX E - Standard Deviation Maps

MARION



SCALE 1:500,000

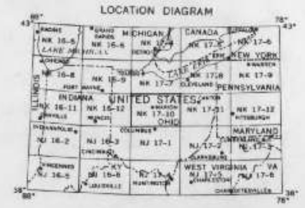


O - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▫ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY
NOTE: ON E-W LINES, +σ TO NORTH, -σ TO SOUTH.
ON N-S LINES, +σ TO WEST, -σ TO EAST.

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

LOCATION DIAGRAM

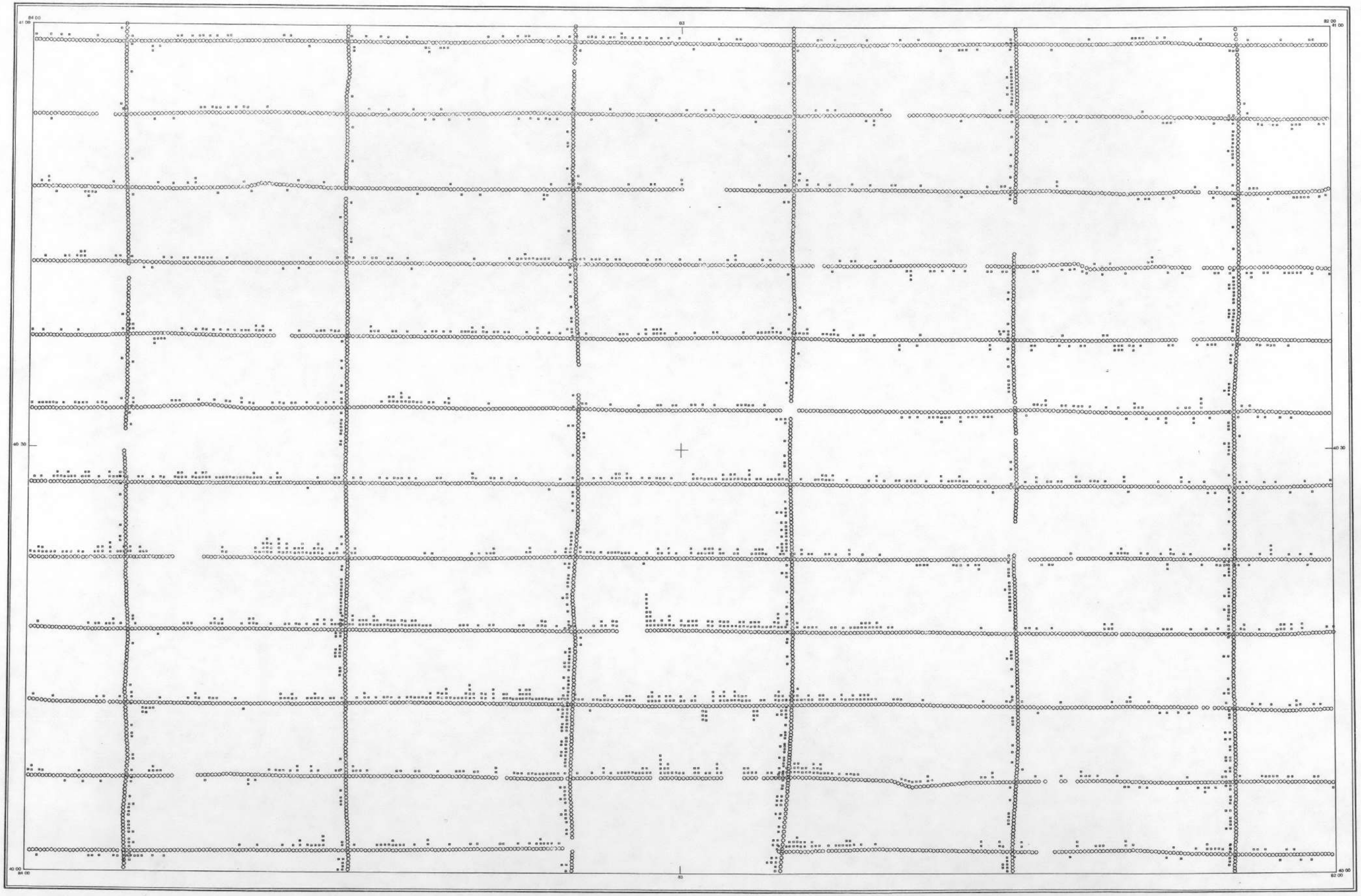


POTASSIUM STANDARD DEVIATION MAP

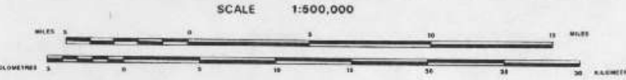
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

MARION

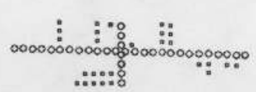


SCALE 1:500,000



SURVEY AND COMPILATION BY:

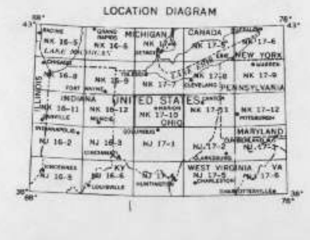
EG&G GEOMETRICS



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

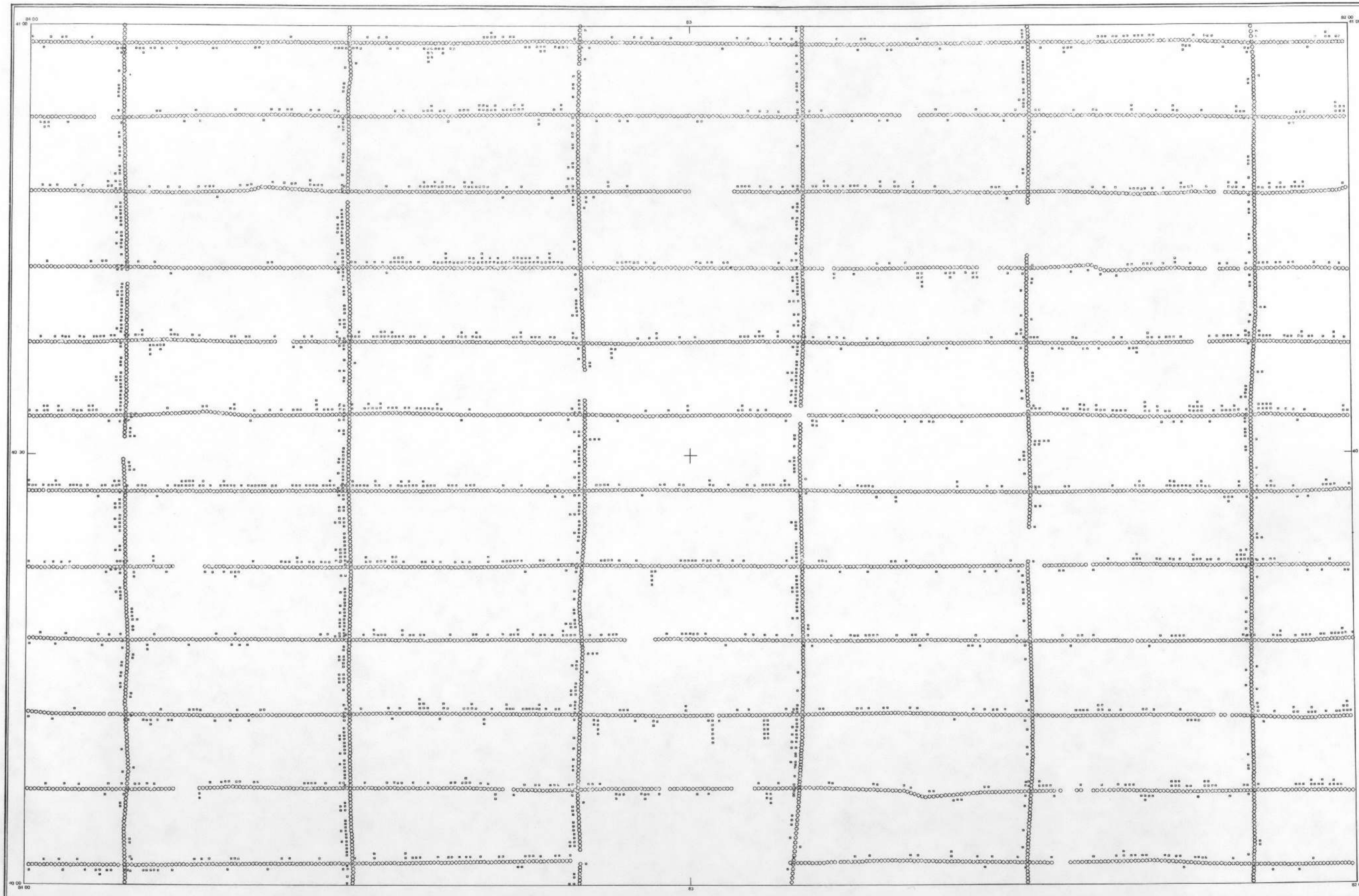


URANIUM STANDARD DEVIATION MAP

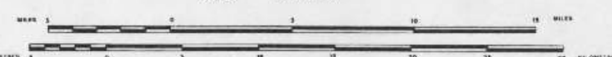
GREAT LAKES PROJECT

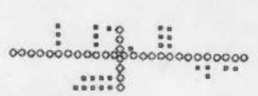
U. S. DEPARTMENT OF ENERGY

MARION



SCALE 1:500,000





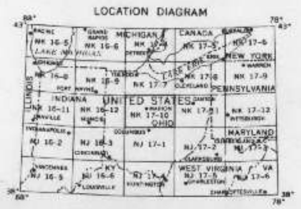
O - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
■ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

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

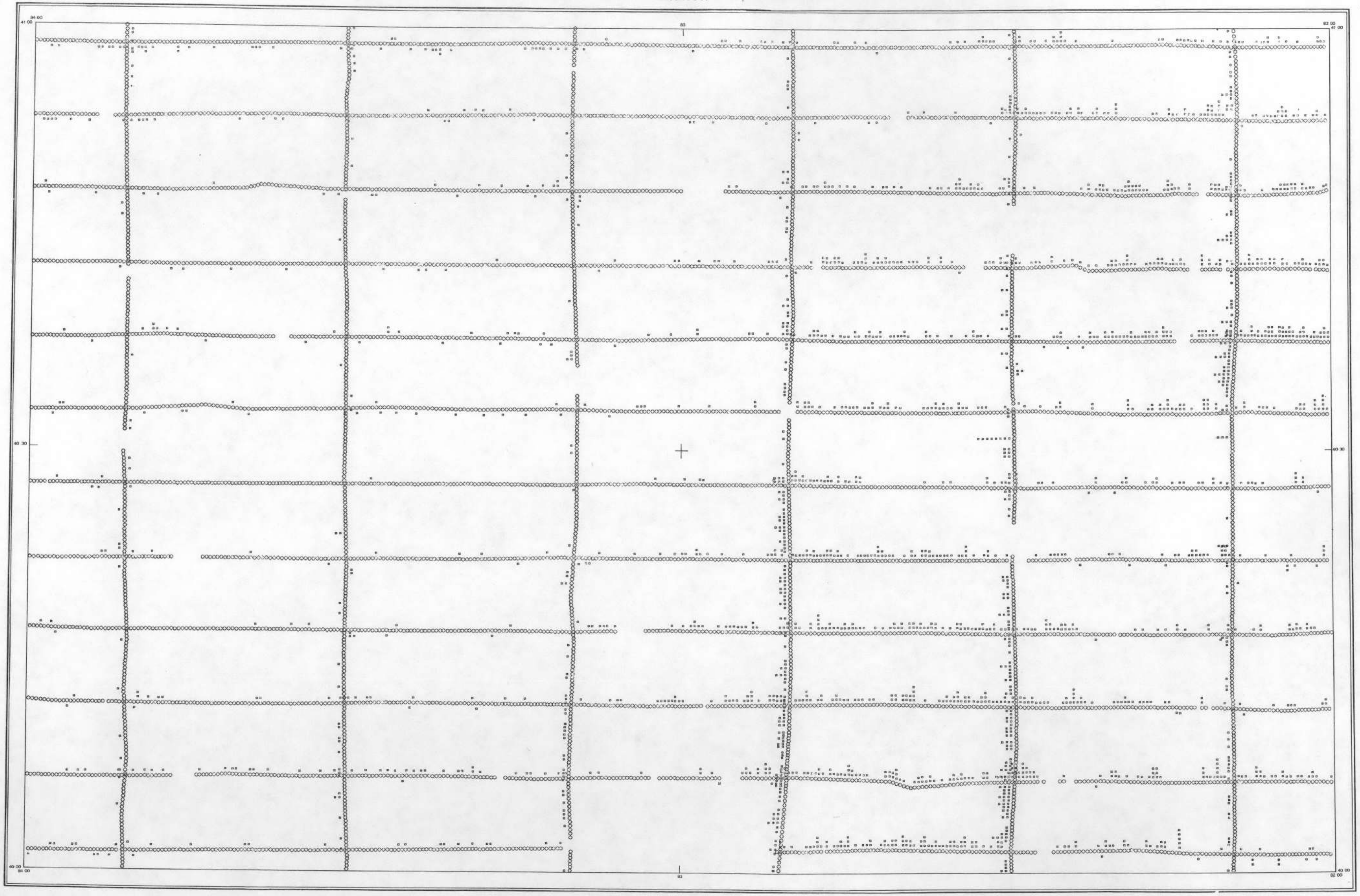


THORIUM STANDARD DEVIATION MAP

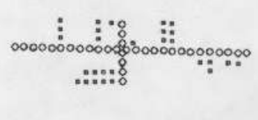
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

MARION



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

THORIUM / POTASSIUM STANDARD DEVIATION MAP

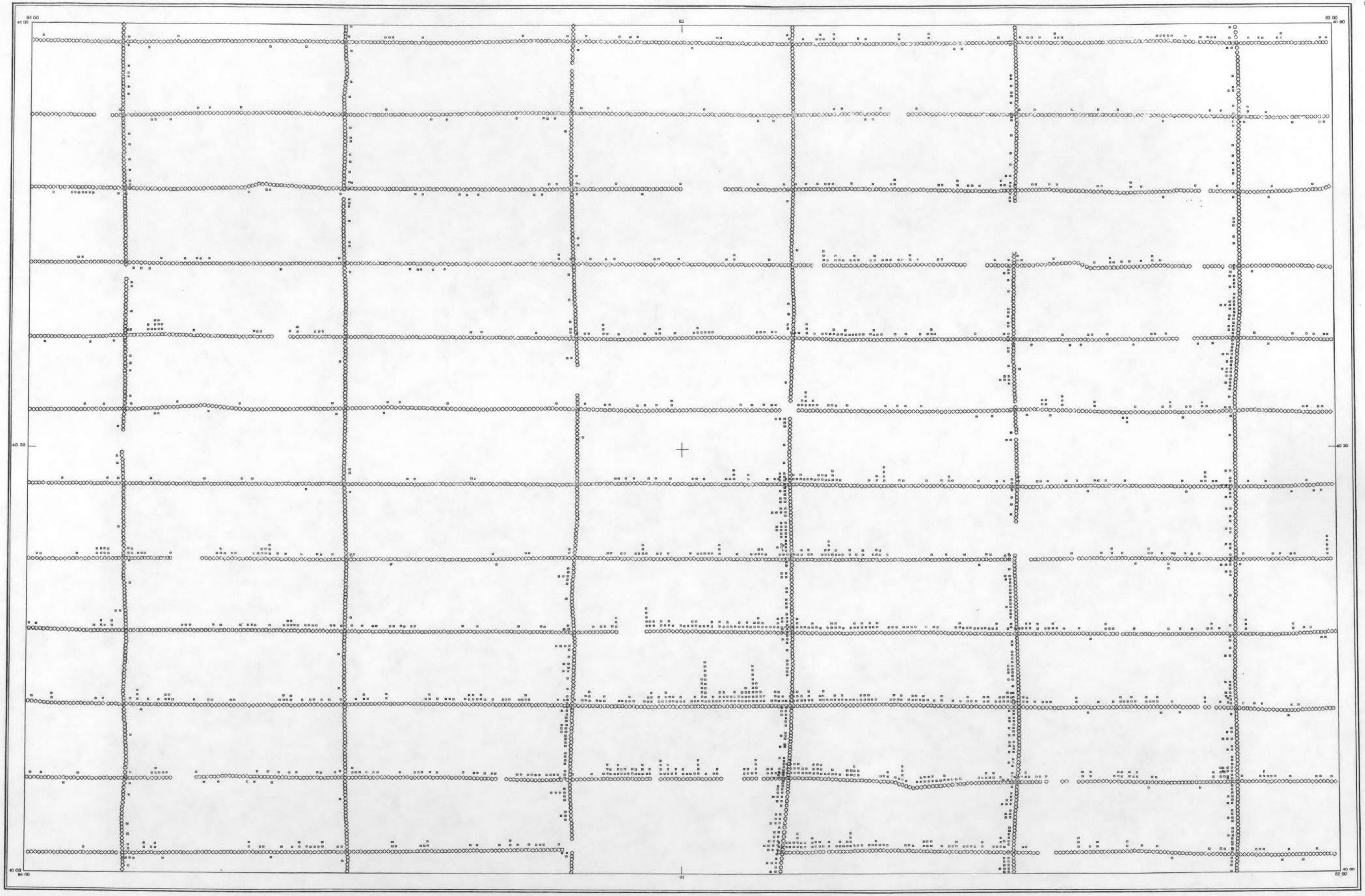
GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

SURVEY AND COMPILATION BY

EG&G GEOMETRICS

MARION



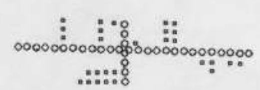
SCALE 1:500,000

MILES 5 0 5 10 15 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS



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

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

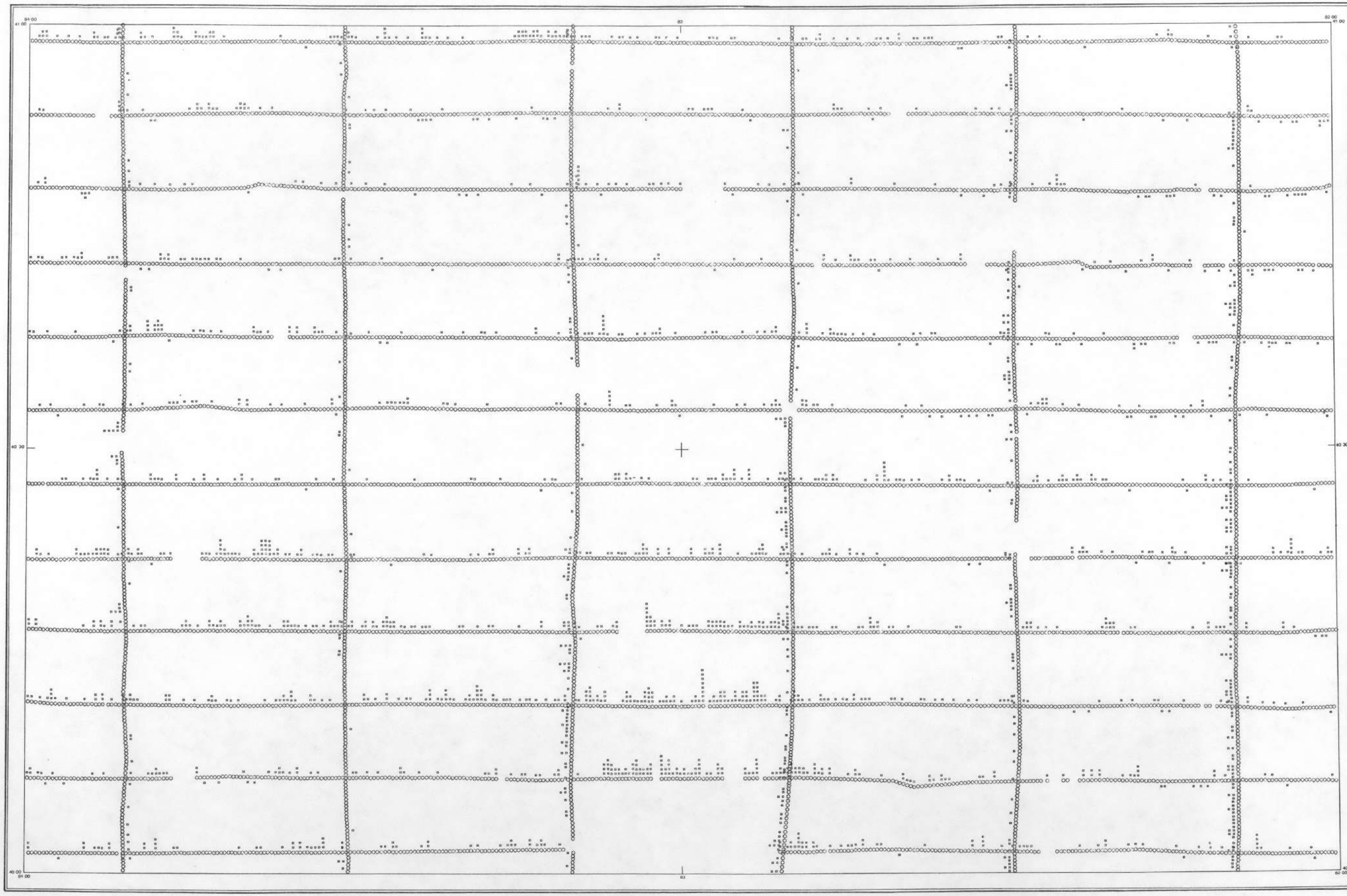
URANIUM / POTASSIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

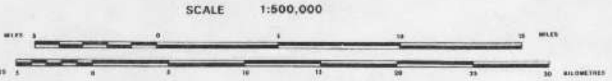
U. S. DEPARTMENT OF ENERGY

MARION

E6

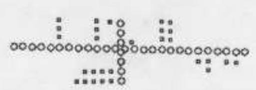


SCALE 1:500,000



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

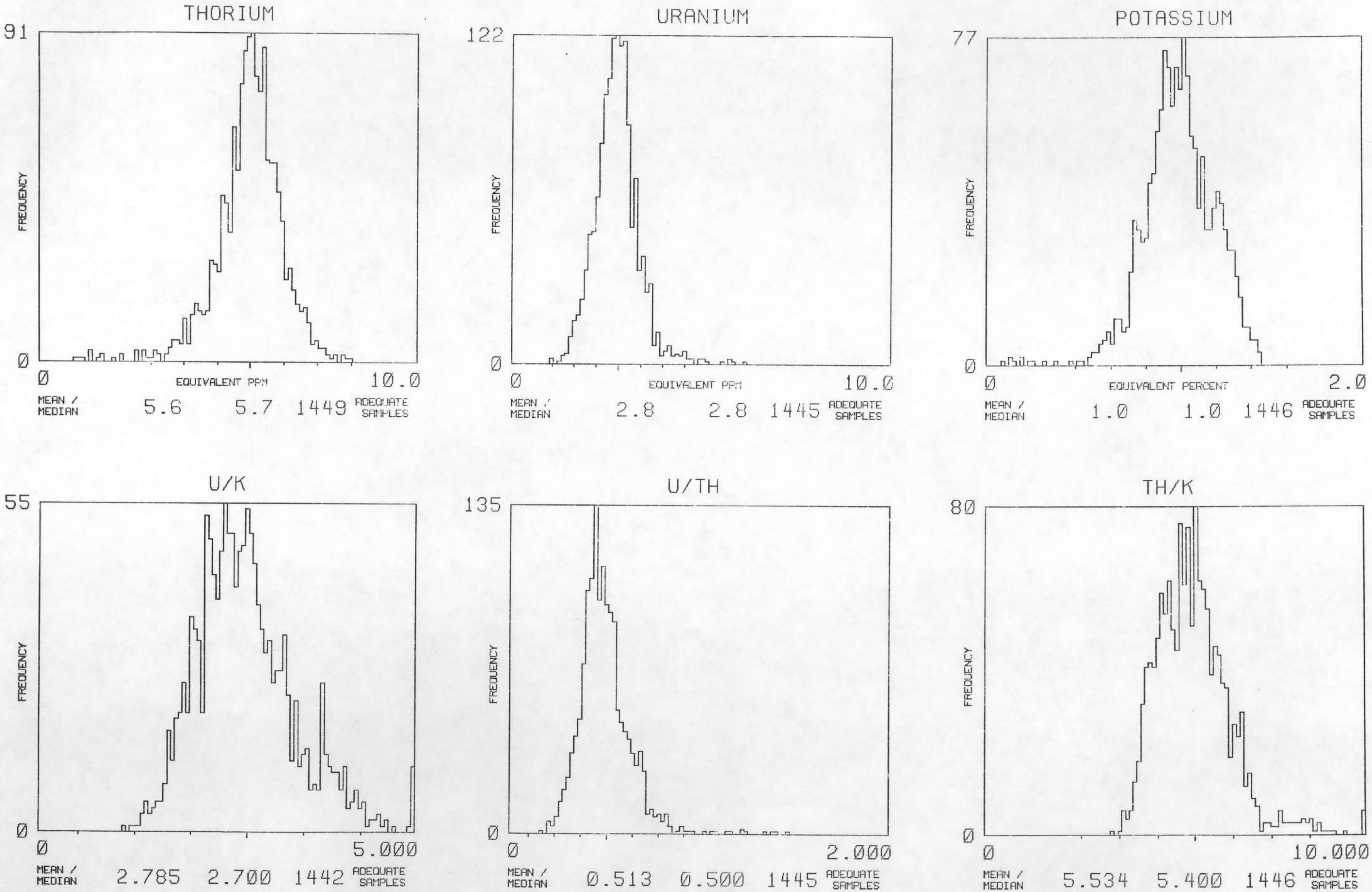
URANIUM / THORIUM STANDARD DEVIATION MAP

GREAT LAKES PROJECT

U. S. DEPARTMENT OF ENERGY

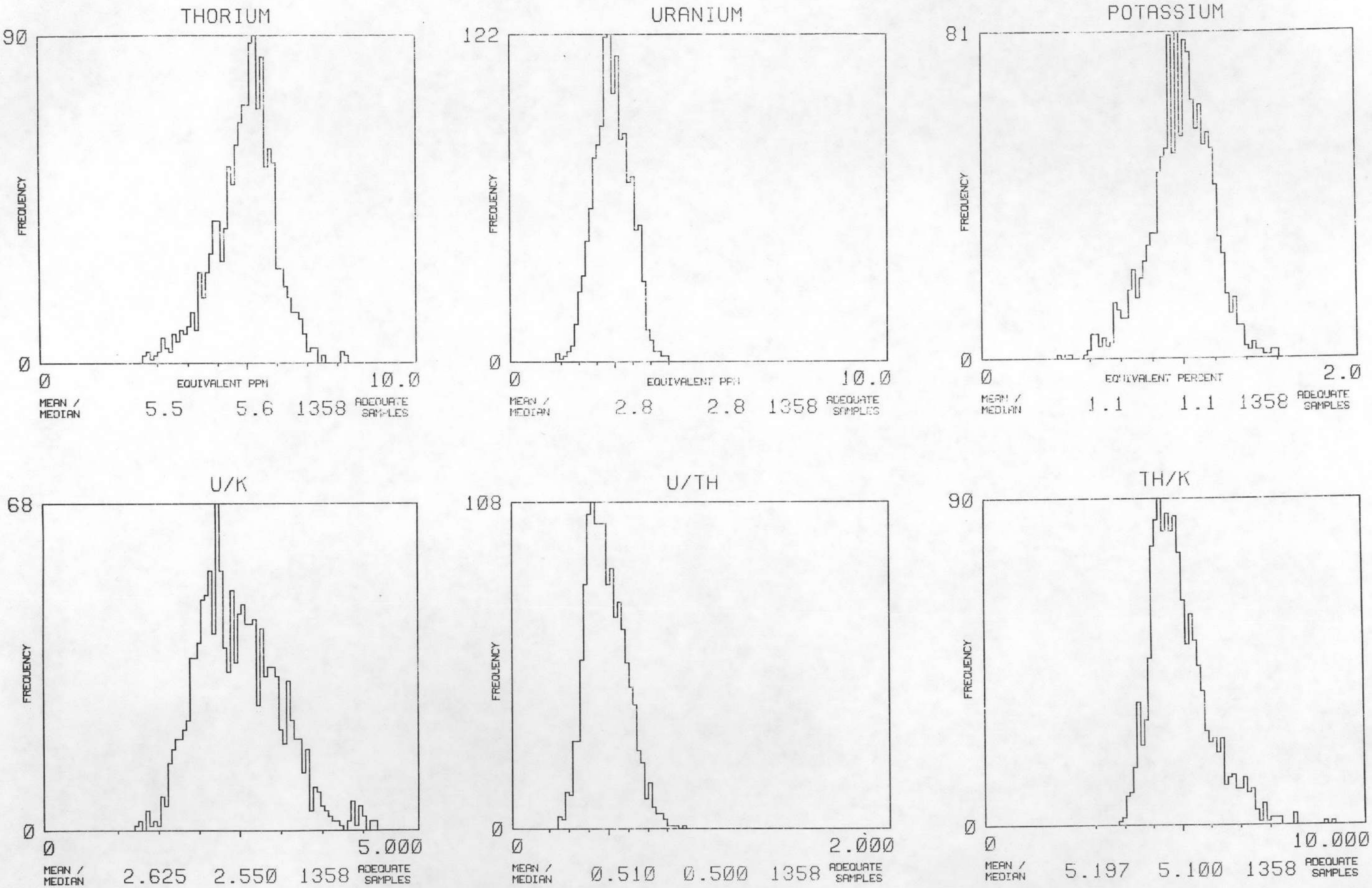
APPENDIX F - Histograms and Map Unit Conversion Table

NK 17-10 MAP UNIT : QAL TOTAL NUMBER OF SAMPLES 1458

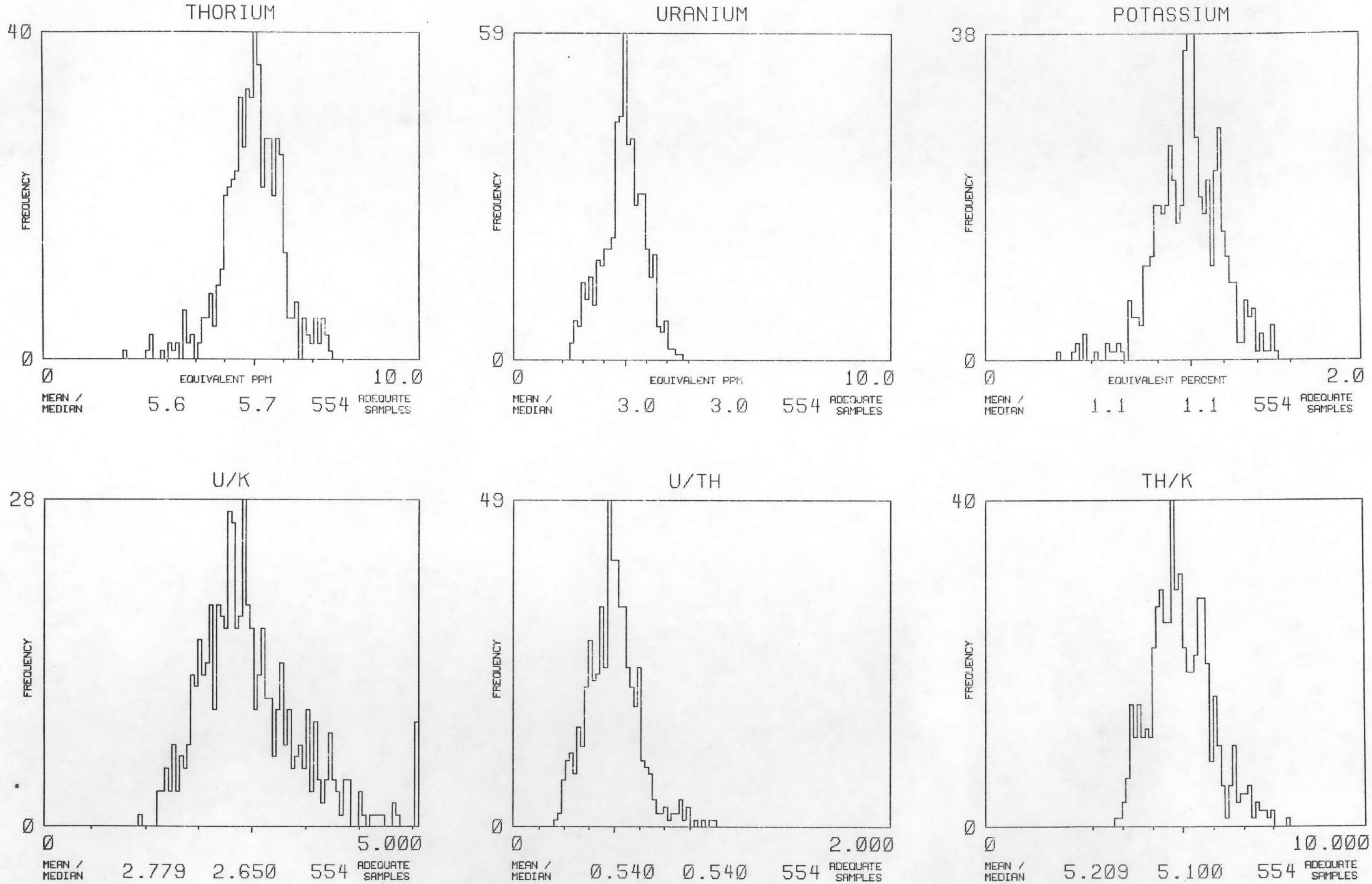


F2 ma

NK 17-10   MAP UNIT : QWO   TOTAL NUMBER OF SAMPLES 1358

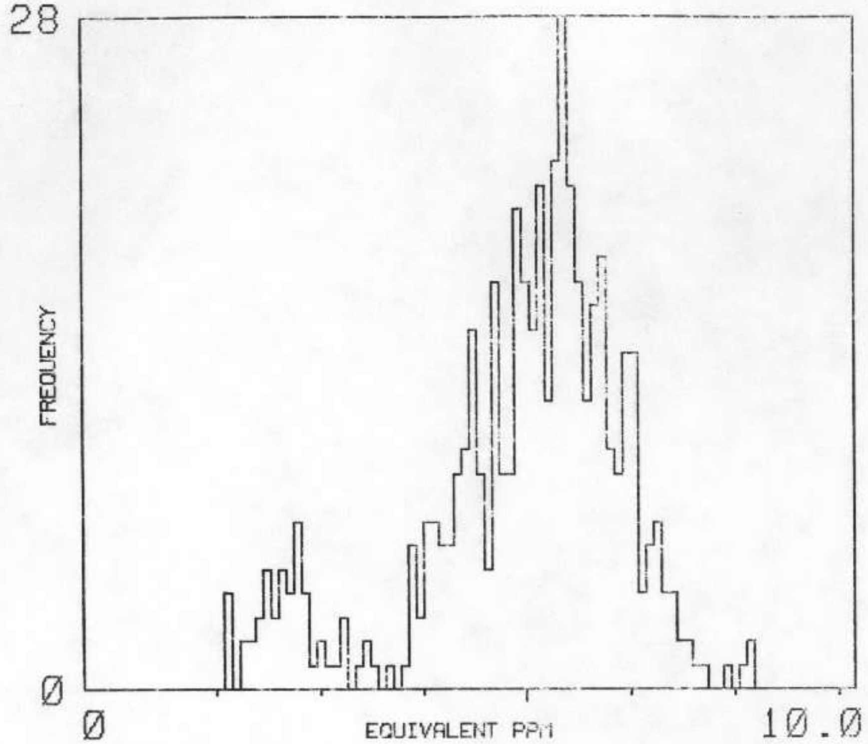


NK 17-10 MAP UNIT : QWK TOTAL NUMBER OF SAMPLES 557



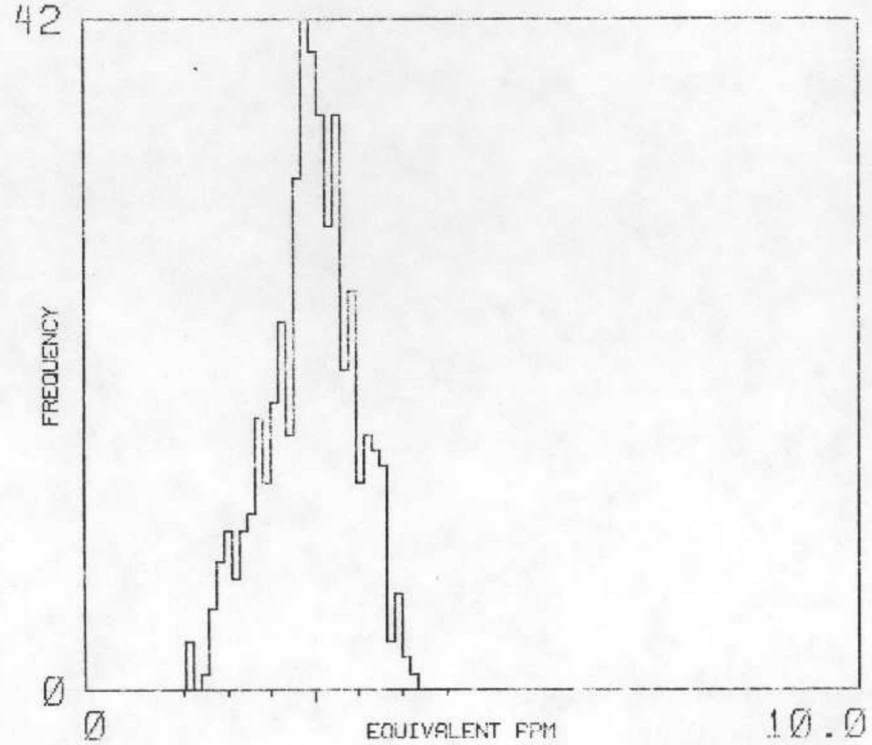
NK 17-10 MAP UNIT : QWL TOTAL NUMBER OF SAMPLES 472

THORIUM



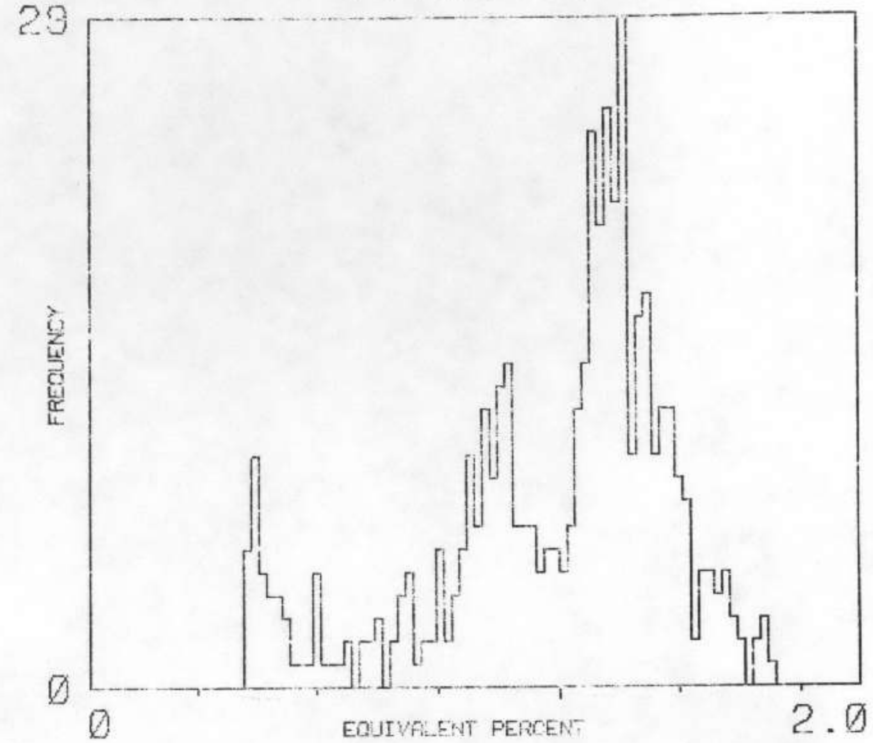
MEAN / MEDIAN 5.7 6.0 472 ADEQUATE SAMPLES

URANIUM



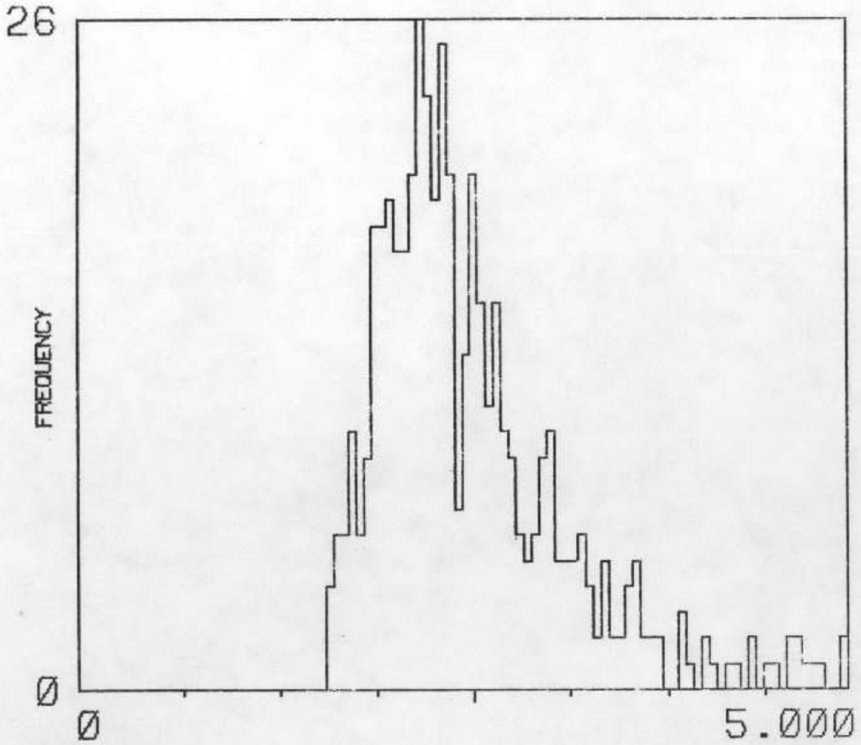
MEAN / MEDIAN 3.0 3.0 472 ADEQUATE SAMPLES

POTASSIUM



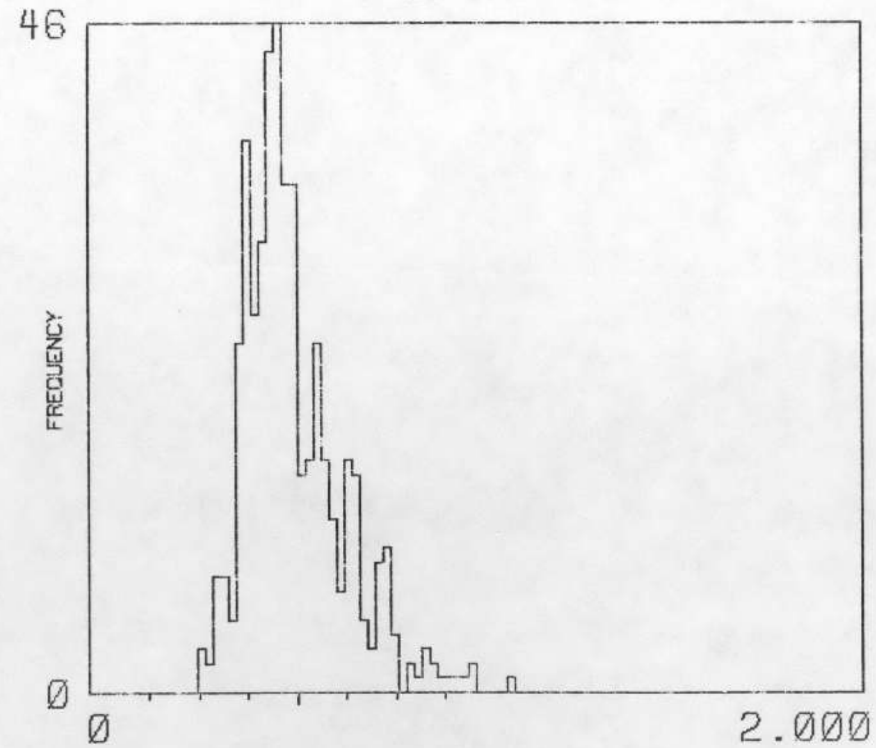
MEAN / MEDIAN 1.2 1.3 472 ADEQUATE SAMPLES

U/K



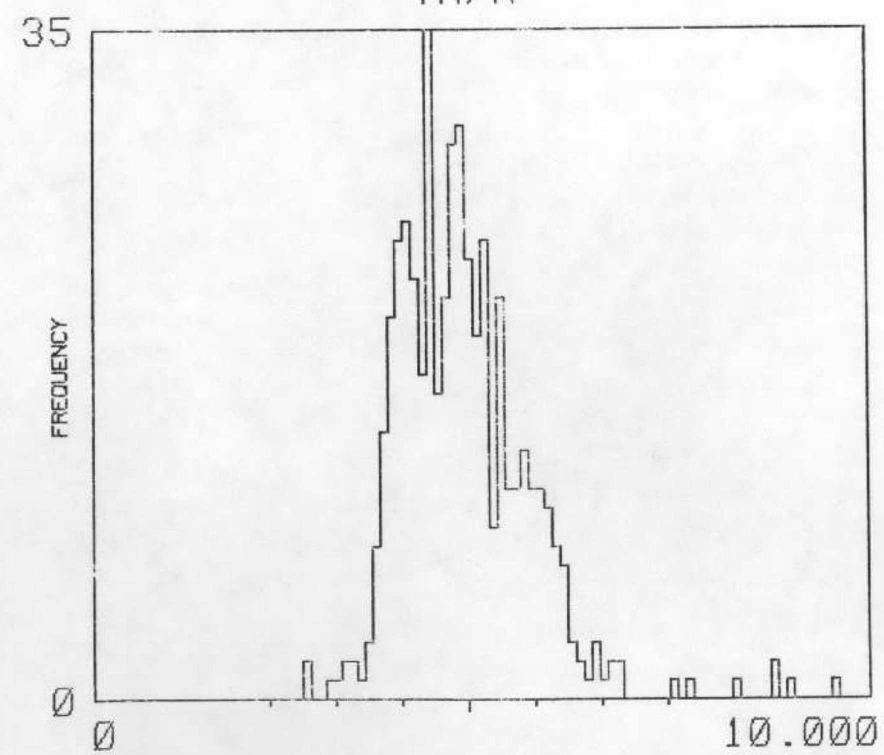
MEAN / MEDIAN 2.569 2.400 472 ADEQUATE SAMPLES

U/TH



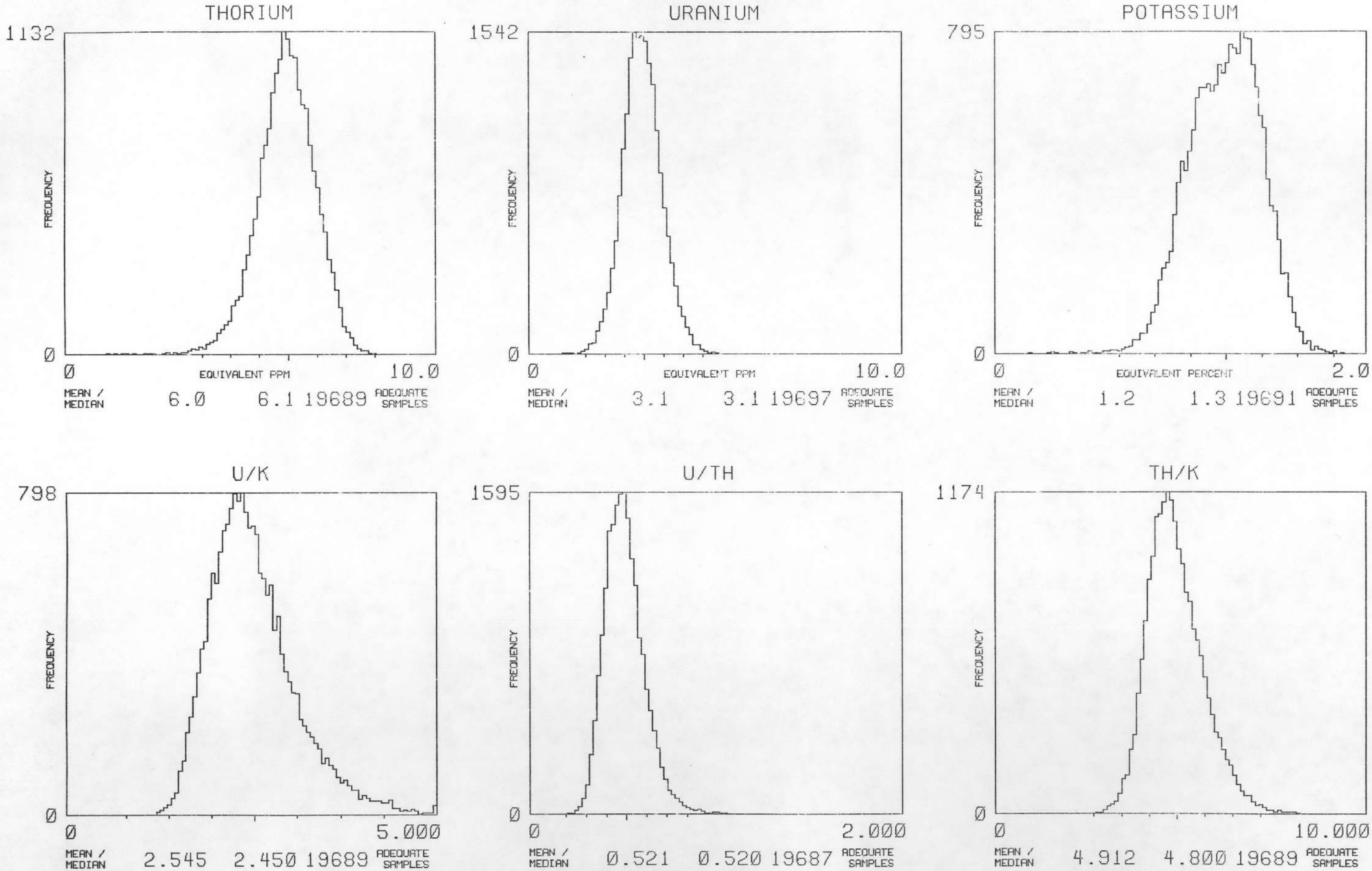
MEAN / MEDIAN 0.540 0.520 472 ADEQUATE SAMPLES

TH/K

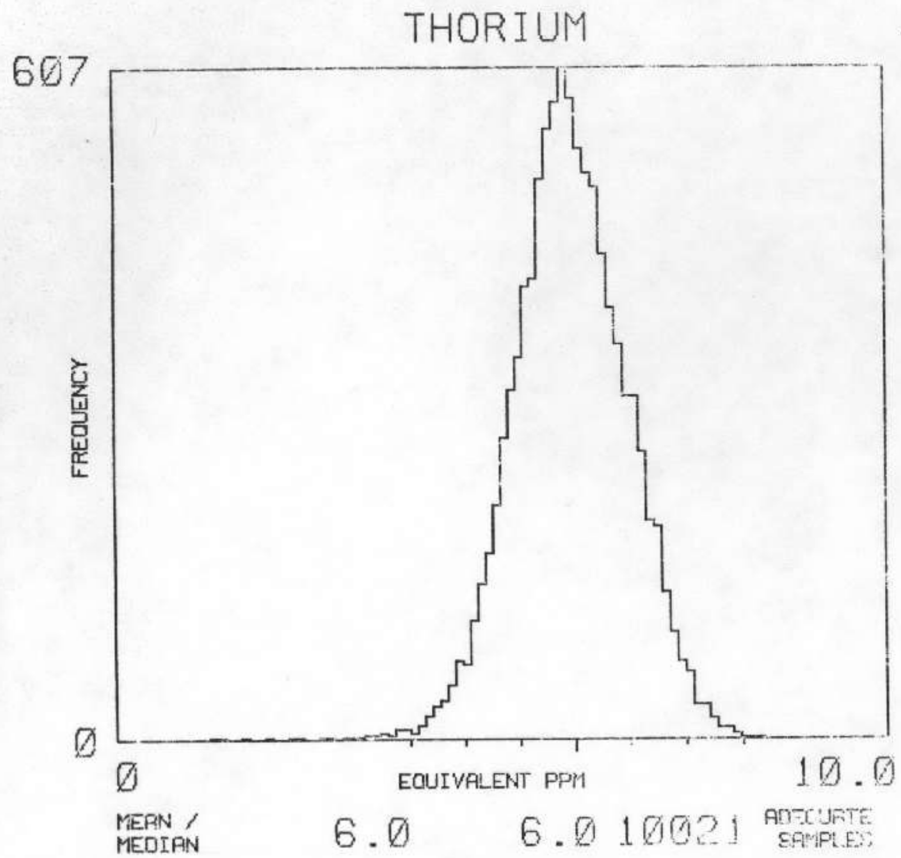


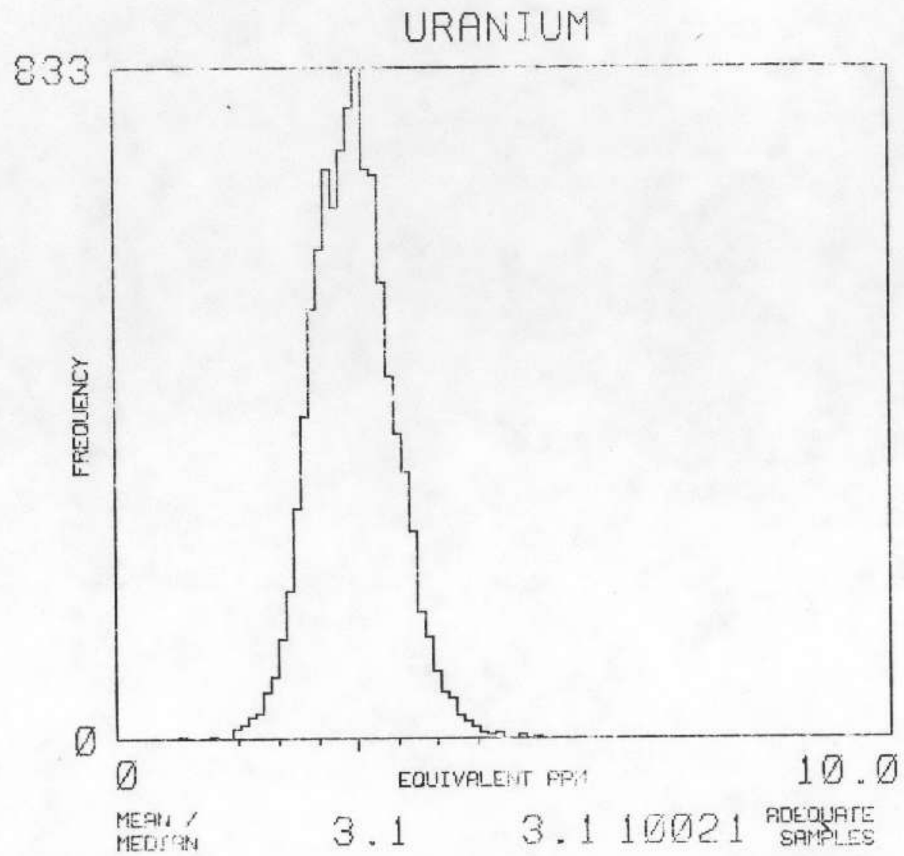
MEAN / MEDIAN 4.823 4.700 472 ADEQUATE SAMPLES

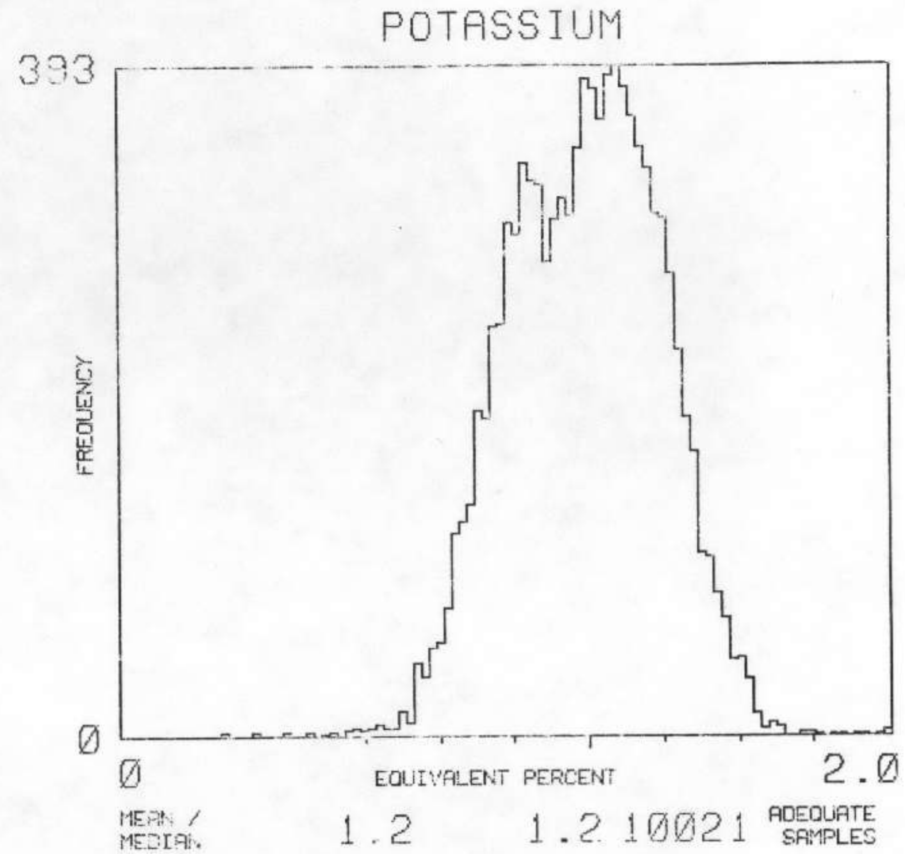
NK 17-10 MAP UNIT : QWG TOTAL NUMBER OF SAMPLES 19803

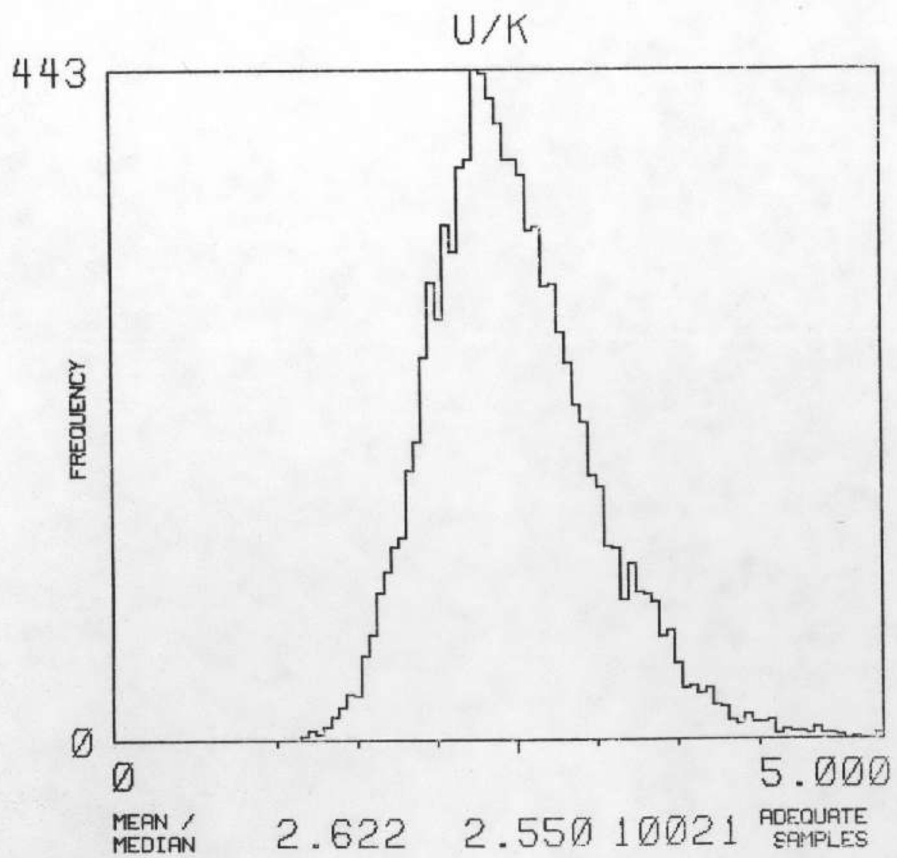


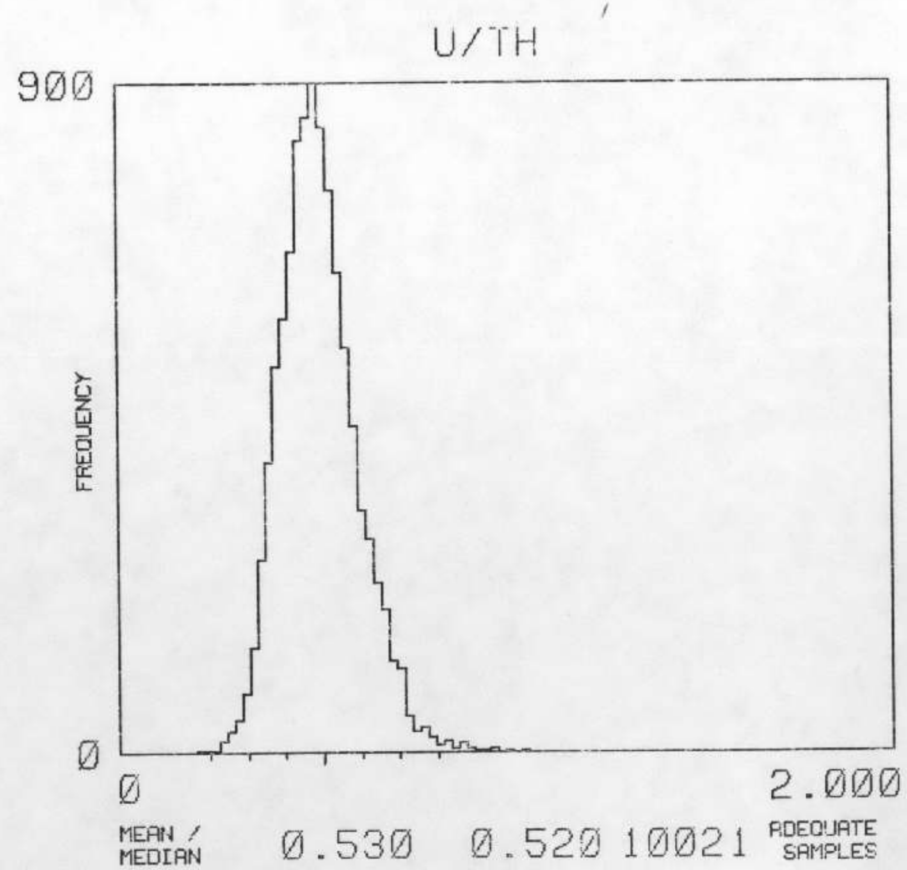
NK 17-10 MAP UNIT : QWE TOTAL NUMBER OF SAMPLES 10021

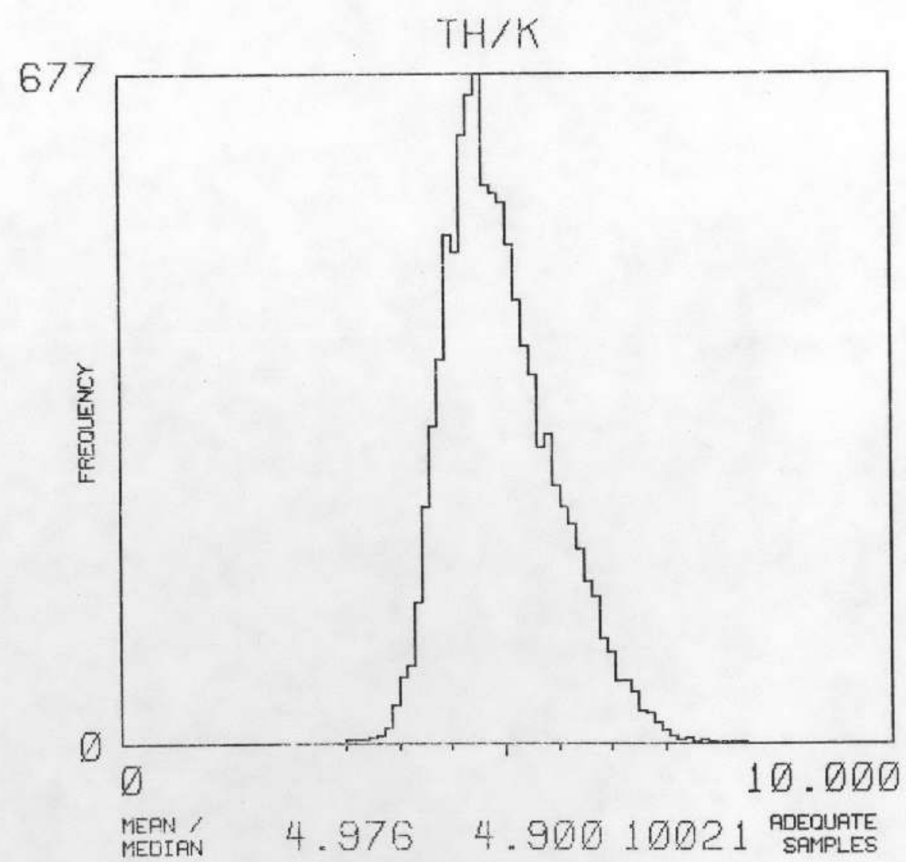






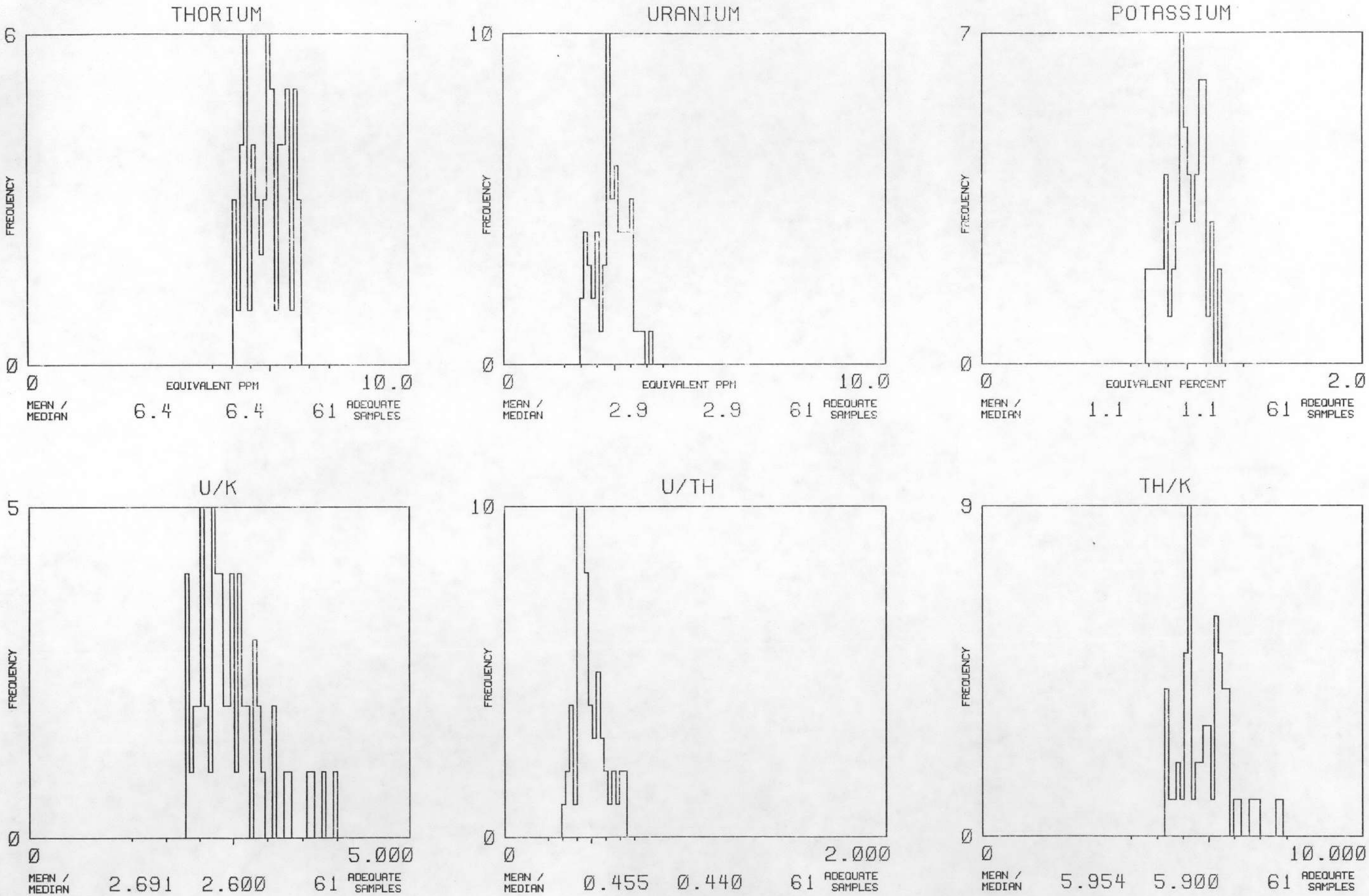






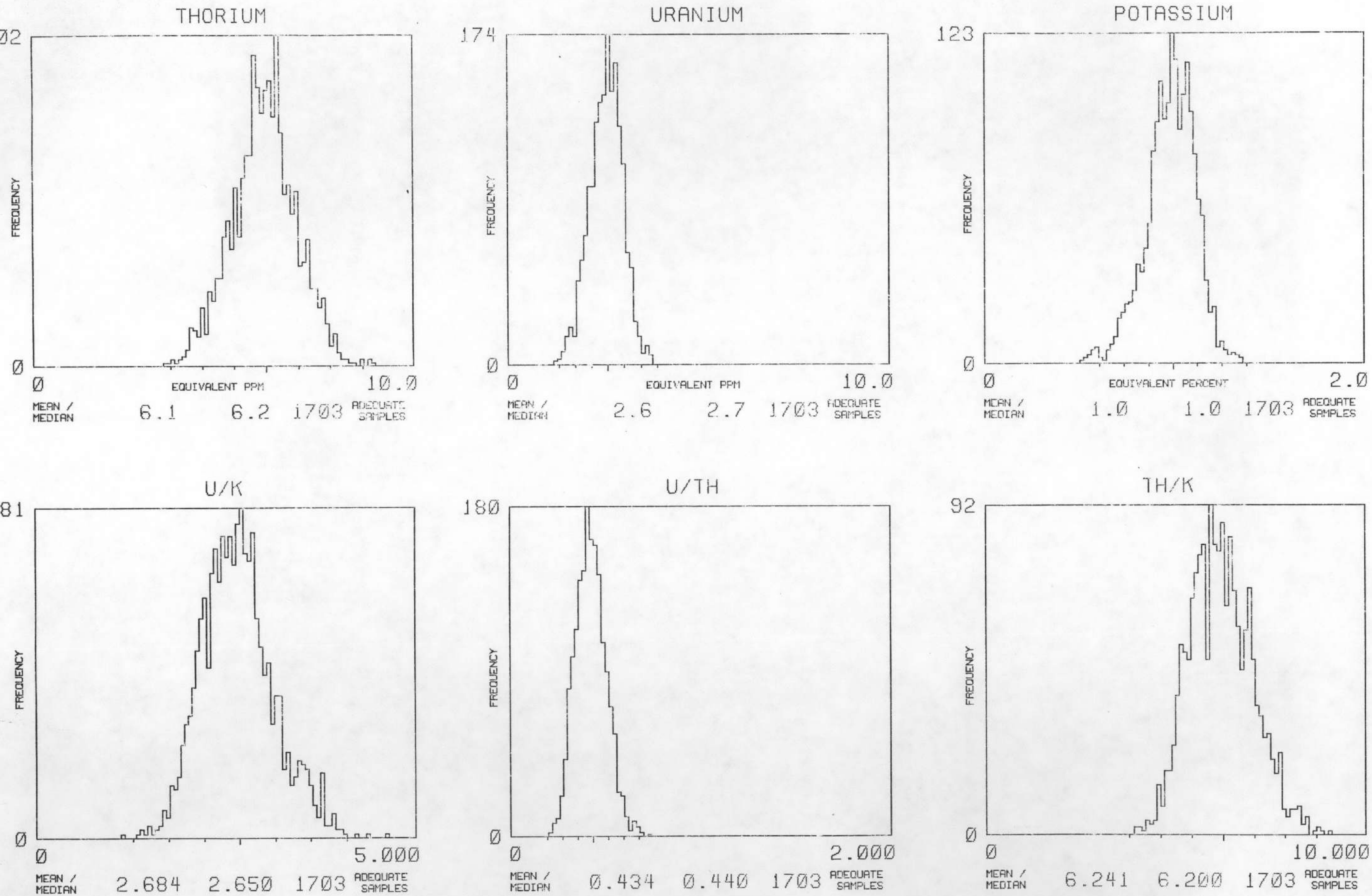
F7 ma

NK 17-10 MAP UNIT : QIO TOTAL NUMBER OF SAMPLES 61



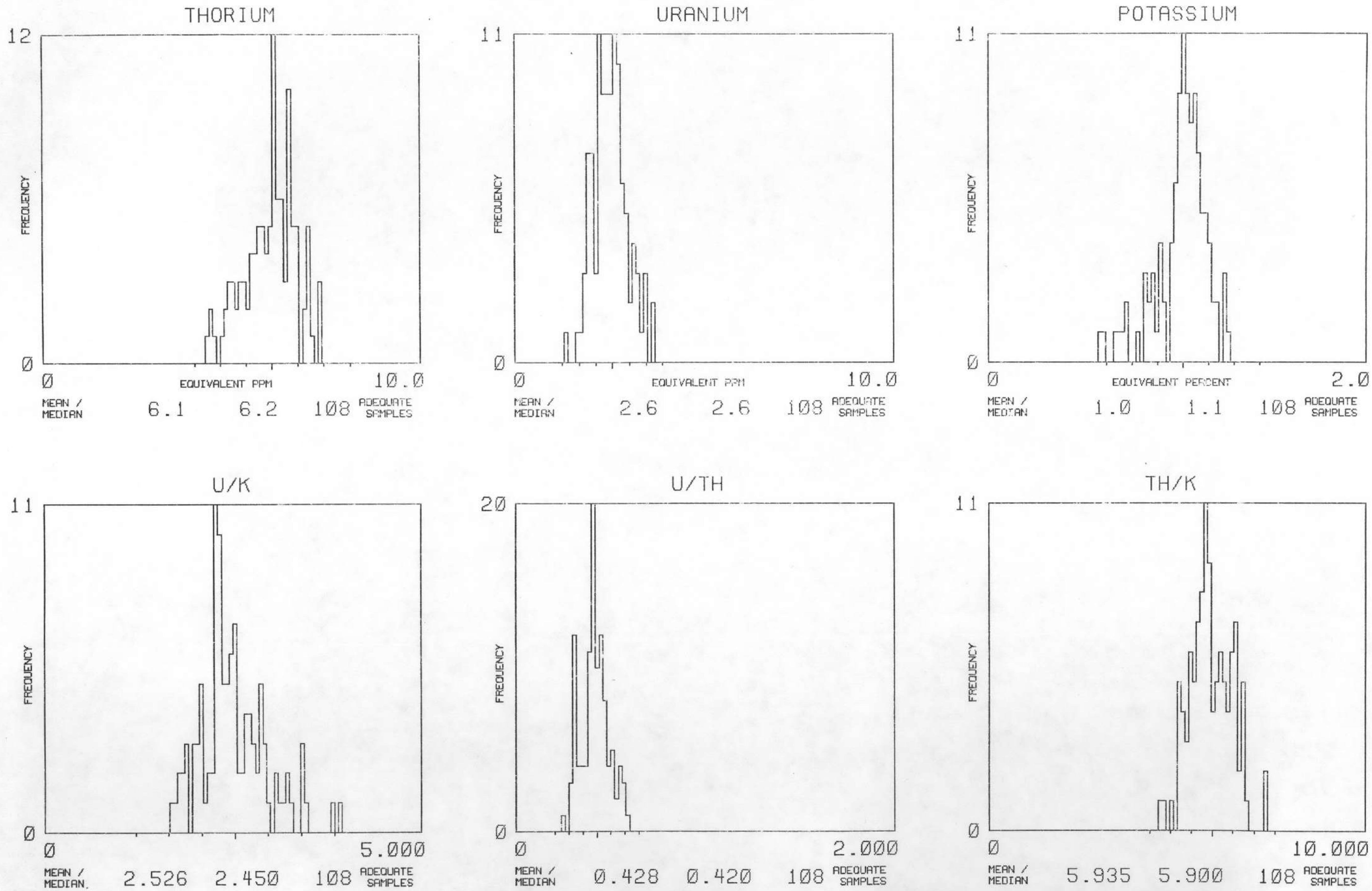
F8 ma

NK 17-10 MAP UNIT : QIG TOTAL NUMBER OF SAMPLES 1703

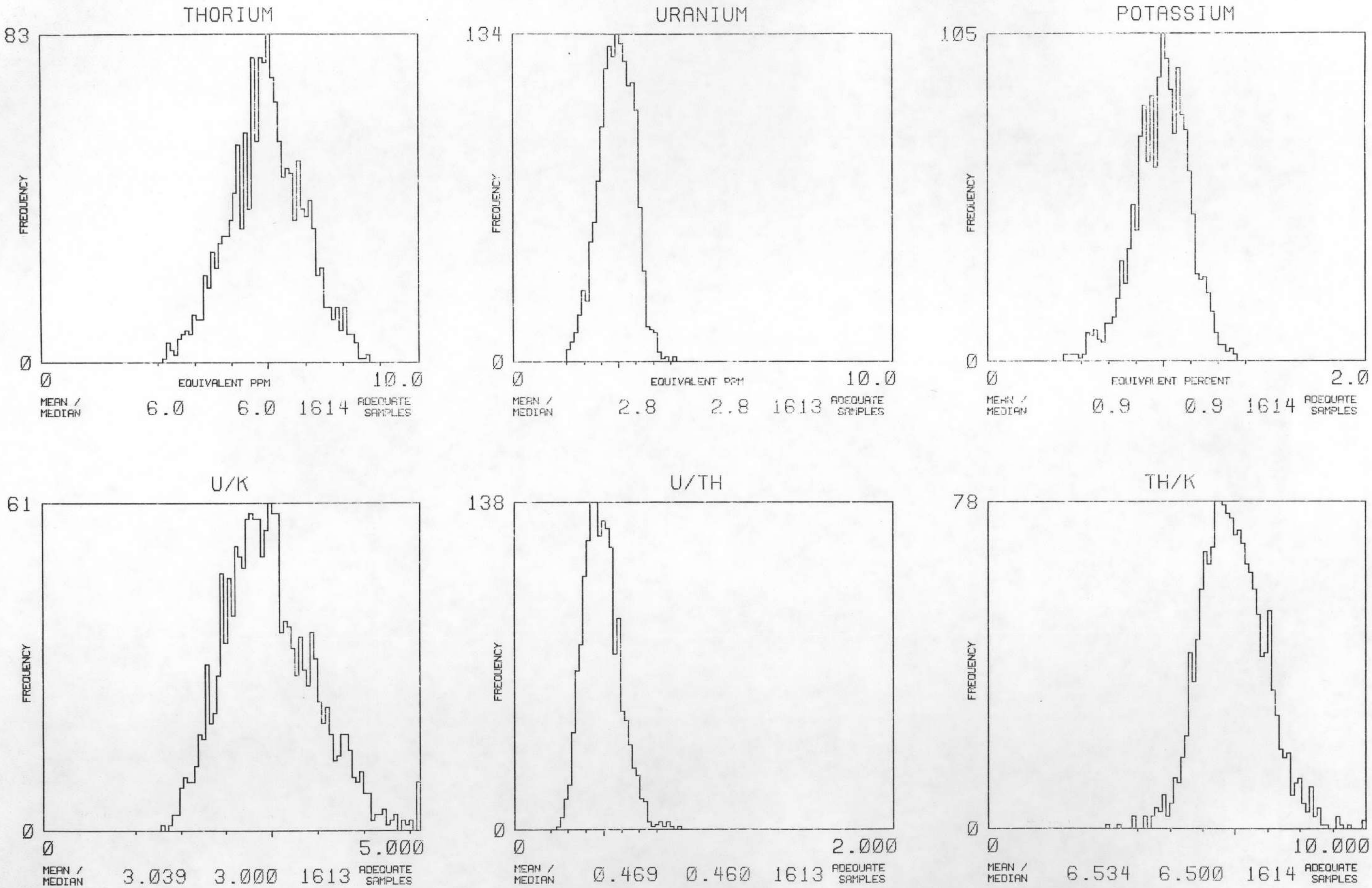


F9 ma

NK 17-10 MAP UNIT : QIE TOTAL NUMBER OF SAMPLES 108

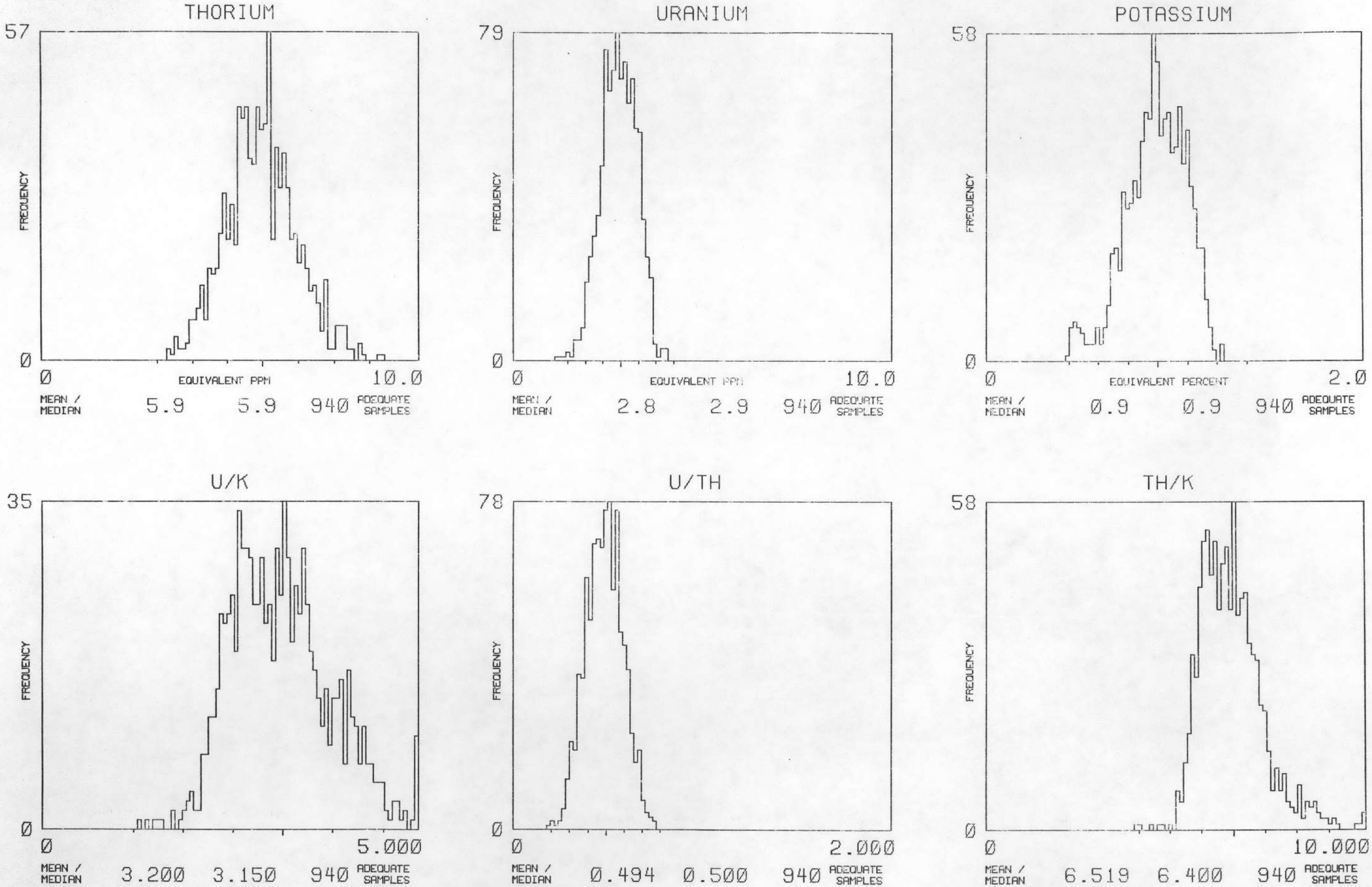


NK 17-10 MAP UNIT : PAP TOTAL NUMBER OF SAMPLES 1614



F11 ma

NK 17-10 MAP UNIT : MMW TOTAL NUMBER OF SAMPLES 940



MARION QUADRANGLE

Computer Map Unit Symbol Conversion Table

Computer Map Unit Symbol	Geologic Map Unit Symbol
QAL	Qal
QWO	Qwo
QWK	Qwk
QWL	Qwl
QWG	Qwg
QWE	Qwe
QIO	Qio
* QIK	Qik
QIG	Qig
QIE	Qie
* QIL	Qil
PAP	Pap
MMW	Mmw

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.

*Statistical analysis was not performed on these units due to there being an inadaquate number of samples.

APPENDIX G - Uranium Anomaly Summary and Statistical Tables

ANOMALY SUMMARY TABLE

ANOMALY	FLIGHT	COMPUTER MAP UNIT AND NO. ANOMALOUS SAMPLES IN UNIT			PEAK PPM	NUMBER OF SAMPLES WITH A STANDARD DEVIATION OF : 1	2	3	4	5	6	7	GT7
1 C	520	QWE / 3	/ 0	/ 0	4.0	1	2	0	0	0	0	0	0
2 C	530	QWE / 1QWG	/ 1	/ 0	4.5	0	1	1	0	0	0	0	0
3 C	530	QWG / 3	/ 0	/ 0	3.9	1	2	0	0	0	0	0	0
4 C	530	QWG / 2QWE	/ 1	/ 0	4.2	0	3	0	0	0	0	0	0
5 C	540	QWE / 6	/ 0	/ 0	4.5	2	3	1	0	0	0	0	0
6 C	540	QIG / 3	/ 0	/ 0	3.3	2	1	0	0	0	0	0	0
7 C	540	MMW / 1	/ 0	/ 0	4.1	0	0	1	0	0	0	0	0
8 C	550	QWG / 2	/ 0	/ 0	4.2	0	2	0	0	0	0	0	0
9 C	550	QWG / 2	/ 0	/ 0	4.0	0	2	0	0	0	0	0	0
10 C	550	QWG / 4	/ 0	/ 0	4.1	1	3	0	0	0	0	0	0
11 C	550	QWG / 1	/ 0	/ 0	4.7	0	0	1	0	0	0	0	0
12 C	550	QWE / 2QWG	/ 1	/ 0	4.1	2	1	0	0	0	0	0	0
13 C	550	QWG / 4	/ 0	/ 0	4.0	2	2	0	0	0	0	0	0
14 C	550	QWG / 1QWO	/ 2	/ 0	3.5	2	1	0	0	0	0	0	0
15 C	560	QWG / 2	/ 0	/ 0	4.3	0	2	0	0	0	0	0	0
16 C	560	QWG / 3	/ 0	/ 0	4.4	1	2	0	0	0	0	0	0
17 C	560	QWE / 1	/ 0	/ 0	4.6	0	0	1	0	0	0	0	0
18 C	560	QWG / 3QWE	/ 2	/ 0	5.0	1	1	2	1	0	0	0	0
19 C	560	QWG / 1	/ 0	/ 0	5.0	0	0	0	1	0	0	0	0
20 C	560	QWG / 2	/ 0	/ 0	4.5	1	0	1	0	0	0	0	0
21 C	560	QWG / 2	/ 0	/ 0	4.5	0	1	1	0	0	0	0	0
22 C	560	QWG / 1QWE	/ 2	/ 0	4.5	0	2	1	0	0	0	0	0
23 C	560	QWG / 2QWE	/ 1	/ 0	4.3	0	3	0	0	0	0	0	0
24 C	560	QWG / 5	/ 0	/ 0	4.4	2	3	0	0	0	0	0	0
25 C	560	PAP / 1	/ 0	/ 0	4.3	0	0	1	0	0	0	0	0
26 C	570	QWO / 4	/ 0	/ 0	3.9	2	2	0	0	0	0	0	0
27 C	570	QWE / 2QWG	/ 1	/ 0	4.1	1	2	0	0	0	0	0	0
28 C	570	QWG / 2QWE	/ 2	/ 0	4.7	2	1	1	0	0	0	0	0
29 C	570	QWE / 2	/ 0	/ 0	4.4	1	0	1	0	0	0	0	0
30 C	570	QWE / 2	/ 0	/ 0	4.2	0	2	0	0	0	0	0	0
31 C	570	QWE / 2	/ 0	/ 0	4.9	0	1	1	0	0	0	0	0
32 C	570	QWE / 4	/ 0	/ 0	4.2	1	3	0	0	0	0	0	0
33 C	570	QWE / 2	/ 0	/ 0	4.2	0	2	0	0	0	0	0	0
34 C	570	QWE / 2	/ 0	/ 0	4.2	0	2	0	0	0	0	0	0
35 C	570	QWG / 2	/ 0	/ 0	4.4	0	2	0	0	0	0	0	0
36 C	570	QWG / 3	/ 0	/ 0	7.4	0	1	0	1	0	0	0	1
37 C	570	QWG / 3	/ 0	/ 0	4.4	1	1	1	0	0	0	0	0
38 C	570	QWG / 3	/ 0	/ 0	4.3	0	3	0	0	0	0	0	0
39 C	570	QWG / 2	/ 0	/ 0	4.0	0	2	0	0	0	0	0	0
40 C	570	QWG / 4	/ 0	/ 0	4.4	1	3	0	0	0	0	0	0
41 C	570	QWG /11	/ 0	/ 0	5.2	4	6	0	1	0	0	0	0
42 C	570	QWG / 1QWE	/ 2	/ 0	4.3	1	2	0	0	0	0	0	0
43 C	570	QIG / 3	/ 0	/ 0	3.5	1	2	0	0	0	0	0	0
44 C	580	QWE / 5	/ 0	/ 0	4.1	3	2	0	0	0	0	0	0
45 C	580	QWE / 5	/ 0	/ 0	4.5	2	2	1	0	0	0	0	0
46 C	580	QWE / 3	/ 0	/ 0	5.0	0	2	0	1	0	0	0	0
47 C	580	QWG / 2	/ 0	/ 0	4.4	0	2	0	0	0	0	0	0
48 C	580	QWG / 1	/ 0	/ 0	4.4	0	0	1	0	0	0	0	0
49 C	580	QWG / 3	/ 0	/ 0	4.1	1	2	0	0	0	0	0	0
50 C	580	QWG / 1	/ 0	/ 0	4.6	0	0	1	0	0	0	0	0

ANOMALY SUMMARY TABLE

ANOMALY	FLIGHT	COMPUTER MAP UNIT AND NO. ANOMALOUS SAMPLES IN UNIT			PEAK PPM	NUMBER OF SAMPLES WITH A STANDARD DEVIATION OF : 1	2	3	4	5	6	7	GT7
51 C	580	QWG / 2	/ 0	/ 0	4.5	0	0	2	0	0	0	0	0
52 C	580	QWG / 4	/ 0	/ 0	4.3	3	1	0	0	0	0	0	0
53 C	580	QWG / 1	/ 0	/ 0	4.8	0	0	1	0	0	0	0	0
54 C	580	QWG / 3	/ 0	/ 0	4.4	1	2	0	0	0	0	0	0
55 C	580	QWG / 1	/ 0	/ 0	4.5	0	0	1	0	0	0	0	0
56 C	580	QWG / 5QWE	/ 4	/ 0	4.6	3	4	2	0	0	0	0	0
57 C	580	QWG / 2	/ 0	/ 0	4.5	0	1	1	0	0	0	0	0
58 C	580	QWG / 4	/ 0	/ 0	4.6	1	2	1	0	0	0	0	0
59 C	580	QWG / 3	/ 0	/ 0	4.1	1	2	0	0	0	0	0	0
60 C	580	QWG / 1QWE	/ 2	/ 0	4.0	0	3	0	0	0	0	0	0
61 C	590	QWO / 4	/ 0	/ 0	3.5	3	1	0	0	0	0	0	0
62 C	590	QWG / 2	/ 0	/ 0	4.4	0	2	0	0	0	0	0	0
63 C	590	QAL / 2QWG	/ 5	/ 0	5.6	4	1	1	0	1	0	0	0
64 C	590	QWG / 1QAL	/ 1	/ 0	4.5	1	0	1	0	0	0	0	0
65 C	590	QWG / 3	/ 0	/ 0	4.2	1	2	0	0	0	0	0	0
66 C	590	QWG / 7QWE	/ 1	/ 0	4.6	1	5	2	0	0	0	0	0
67 C	590	QWE / 3	/ 0	/ 0	4.7	0	1	2	0	0	0	0	0
68 C	600	QWE / 5	/ 0	/ 0	4.5	4	0	1	0	0	0	0	0
69 C	600	QWG / 3	/ 0	/ 0	4.1	2	1	0	0	0	0	0	0
70 C	600	QWG / 6	/ 0	/ 0	4.8	1	4	1	0	0	0	0	0
71 C	600	QWG / 3	/ 0	/ 0	4.1	1	2	0	0	0	0	0	0
72 C	1160	QWE / 2	/ 0	/ 0	4.3	0	2	0	0	0	0	0	0
73 C	1160	QWE / 2	/ 0	/ 0	4.2	0	2	0	0	0	0	0	0
74 C	1170	QWE / 2	/ 0	/ 0	3.9	0	2	0	0	0	0	0	0
75 C	1170	QWG / 9	/ 0	/ 0	4.6	1	7	1	0	0	0	0	0
76 C	1170	QWE / 3	/ 0	/ 0	4.0	2	1	0	0	0	0	0	0
77 C	1170	QWG / 2	/ 0	/ 0	4.0	0	2	0	0	0	0	0	0
78 C	1170	QWG / 3	/ 0	/ 0	3.9	2	1	0	0	0	0	0	0
79 C	1180	QWG / 1QAL	/ 1	/ 0	4.9	0	1	1	0	0	0	0	0
80 C	1180	QWG / 3	/ 0	/ 0	4.4	1	2	0	0	0	0	0	0
81 C	1180	QWG / 3	/ 0	/ 0	4.2	0	3	0	0	0	0	0	0
82 C	1180	QWG / 1	/ 0	/ 0	4.6	0	0	1	0	0	0	0	0
83 C	1180	QWG / 3	/ 0	/ 0	4.1	2	1	0	0	0	0	0	0
84 C	1180	QWG / 3	/ 0	/ 0	4.4	1	1	1	0	0	0	0	0
85 C	1180	QWE / 2	/ 0	/ 0	4.7	0	1	1	0	0	0	0	0
86 C	1180	QWE / 5	/ 0	/ 0	4.2	2	3	0	0	0	0	0	0
87 C	1180	QWE / 2	/ 0	/ 0	4.8	1	0	1	0	0	0	0	0
88 C	1180	QWE / 2	/ 0	/ 0	4.5	1	0	1	0	0	0	0	0
89 C	1190	QWE / 5	/ 0	/ 0	4.0	3	2	0	0	0	0	0	0
90 C	1190	QIG / 4	/ 0	/ 0	3.8	3	0	1	0	0	0	0	0
91 C	1190	QWE / 5	/ 0	/ 0	4.1	3	2	0	0	0	0	0	0
92 C	1200	QAL / 1MMW	/ 3	/ 0	3.8	3	1	0	0	0	0	0	0
93 C	1200	QAL / 3	/ 0	/ 0	4.1	1	2	0	0	0	0	0	0
94 C	1200	PAP / 2	/ 0	/ 0	3.5	0	2	0	0	0	0	0	0
95 C	1200	QAL / 2	/ 0	/ 0	4.7	1	0	1	0	0	0	0	0
96 C	1200	QAL / 1QWK	/ 2	/ 0	3.8	0	3	0	0	0	0	0	0
97 C	1200	QWK / 2	/ 0	/ 0	4.1	0	2	0	0	0	0	0	0
98 C	1200	QWO / 6	/ 0	/ 0	3.7	5	1	0	0	0	0	0	0
99 C	1200	QWO / 3	/ 0	/ 0	3.9	1	2	0	0	0	0	0	0

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

C INDICATES THAT THE ANOMALY LIES OVER A CULTURAL FEATURE.

W INDICATES POSSIBLE INTERFERENCE BY WEATHER PHENOMENA.

MAP UNIT QAL

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.4771	0.6631	0.8491	1.0351	1.2211	1.4071	1.5931
URANIUM	DIST NORMAL	1.0648	1.6462	2.2276	2.8090	3.3904	3.9718	4.5532
THORIUM	DIST NORMAL	2.9382	3.8263	4.7144	5.6025	6.4906	7.3787	8.2668
U/K	DIST NORMAL	0.5235	1.2773	2.0311	2.7849	3.5387	4.2925	5.0463
U/TH	DIST NORMAL	0.1047	0.2408	0.3769	0.5130	0.6491	0.7852	0.9213
TH/K	DIST NORMAL	2.5479	3.5433	4.5387	5.5341	6.5295	7.5249	8.5203

MAP UNIT QWO

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.5734	0.7407	0.9080	1.0753	1.2426	1.4099	1.5772
URANIUM	DIST NORMAL	1.3450	1.8192	2.2934	2.7676	3.2418	3.7160	4.1902
THORIUM	DIST NORMAL	3.1088	3.9135	4.7182	5.5229	6.3276	7.1323	7.9370
U/K	DIST NORMAL	0.9811	1.5290	2.0769	2.6248	3.1727	3.7206	4.2685
U/TH	DIST NORMAL	0.1971	0.3013	0.4055	0.5097	0.6139	0.7181	0.8223
TH/K	DIST NORMAL	2.9060	3.6698	4.4336	5.1974	5.9612	6.7250	7.4888

MAP UNIT QWK

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.5659	0.7423	0.9187	1.0951	1.2715	1.4479	1.6243
URANIUM	DIST NORMAL	1.2906	1.8499	2.4092	2.9685	3.5278	4.0871	4.6464
THORIUM	DIST NORMAL	3.2693	4.0529	4.8365	5.6201	6.4037	7.1873	7.9709
U/K	DIST NORMAL	0.6309	1.3469	2.0629	2.7789	3.4949	4.2109	4.9269
U/TH	DIST NORMAL	0.1407	0.2738	0.4069	0.5400	0.6731	0.8062	0.9393
TH/K	DIST NORMAL	2.8344	3.6260	4.4176	5.2092	6.0008	6.7924	7.5840

MAP UNIT QWL

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.2779	0.5911	0.9043	1.2175	1.5307	1.8439	2.1571
URANIUM	DIST NORMAL	1.2753	1.8401	2.4049	2.9697	3.5345	4.0993	4.6641
THORIUM	DIST NORMAL	1.6915	3.0415	4.3915	5.7415	7.0915	8.4415	9.7915
U/K	DIST NORMAL	0.6715	1.3040	1.9365	2.5690	3.2015	3.8340	4.4665
U/TH	DIST NORMAL	0.1569	0.2845	0.4121	0.5397	0.6673	0.7949	0.9225
TH/K	DIST NORMAL	2.2774	3.1260	3.9746	4.8232	5.6718	6.5204	7.3690

MAP UNIT QWG

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.6691	0.8616	1.0541	1.2466	1.4391	1.6316	1.8241
URANIUM	DIST NORMAL	1.5225	2.0491	2.5757	3.1023	3.6289	4.1555	4.6821
THORIUM	DIST NORMAL	3.6963	4.4768	5.2573	6.0378	6.8183	7.5988	8.3793
U/K	DIST NORMAL	0.7964	1.3792	1.9620	2.5448	3.1276	3.7104	4.2932
U/TH	DIST NORMAL	0.1974	0.3054	0.4134	0.5214	0.6294	0.7374	0.8454
TH/K	DIST NORMAL	2.6612	3.4114	4.1616	4.9118	5.6620	6.4122	7.1624

MAP UNIT QWE

		-3	-2	-1	0	+1	+2	+3
POTASIUM	DIST NORMAL	0.6349	0.8286	1.0223	1.2160	1.4097	1.6034	1.7971
URANIUM	DIST NORMAL	1.5816	2.0973	2.6130	3.1287	3.6444	4.1601	4.6758
THORIUM	DIST NORMAL	3.7904	4.5146	5.2388	5.9630	6.6872	7.4114	8.1356
U/K	DIST NORMAL	1.0457	1.5710	2.0963	2.6216	3.1469	3.6722	4.1975
U/TH	DIST NORMAL	0.2349	0.3333	0.4317	0.5301	0.6285	0.7269	0.8253
TH/K	DIST NORMAL	2.8972	3.5902	4.2832	4.9762	5.6692	6.3622	7.0552

MAP UNIT QIO

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.7835	0.8823	0.9811	1.0799	1.1787	1.2775	1.3763
URANIUM DIST NORMAL	1.5988	2.0289	2.4590	2.8891	3.3192	3.7493	4.1794
THORIUM DIST NORMAL	4.8542	5.3640	5.8738	6.3836	6.8934	7.4032	7.9130
U/K DIST NORMAL	1.3355	1.7873	2.2391	2.6909	3.1427	3.5945	4.0463
U/TH DIST NORMAL	0.2283	0.3038	0.3793	0.4548	0.5303	0.6058	0.6813
TH/K DIST NORMAL	3.9194	4.5976	5.2758	5.9540	6.6322	7.3104	7.9886

MAP UNIT QIG

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.6047	0.7340	0.8633	0.9926	1.1219	1.2512	1.3805
URANIUM DIST NORMAL	1.3566	1.7828	2.2090	2.6352	3.0614	3.4876	3.9138
THORIUM DIST NORMAL	3.6103	4.4556	5.3009	6.1462	6.9915	7.8368	8.6821
U/K DIST NORMAL	1.2652	1.7380	2.2108	2.6836	3.1564	3.6292	4.1020
U/TH DIST NORMAL	0.1952	0.2749	0.3546	0.4343	0.5140	0.5937	0.6734
TH/K DIST NORMAL	3.7761	4.5979	5.4197	6.2415	7.0633	7.8851	8.7069

MAP UNIT QIE

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.6269	0.7620	0.8971	1.0322	1.1673	1.3024	1.4375
URANIUM DIST NORMAL	1.2547	1.6974	2.1401	2.5828	3.0255	3.4682	3.9109
THORIUM DIST NORMAL	4.0144	4.7035	5.3926	6.0817	6.7708	7.4599	8.1490
U/K DIST NORMAL	1.1977	1.6405	2.0833	2.5261	2.9689	3.4117	3.8545
U/TH DIST NORMAL	0.2051	0.2793	0.3535	0.4277	0.5019	0.5761	0.6503
TH/K DIST NORMAL	4.2809	4.8323	5.3837	5.9351	6.4865	7.0379	7.5893

MAP UNIT PAP

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.4953	0.6406	0.7859	0.9312	1.0765	1.2218	1.3671
URANIUM DIST NORMAL	1.4114	1.8671	2.3228	2.7785	3.2342	3.6899	4.1456
THORIUM DIST NORMAL	3.0843	4.0681	5.0519	6.0357	7.0195	8.0033	8.9871
U/K DIST NORMAL	1.2137	1.8223	2.4309	3.0395	3.6481	4.2567	4.8653
U/TH DIST NORMAL	0.1879	0.2817	0.3755	0.4693	0.5631	0.6569	0.7507
TH/K DIST NORMAL	3.9545	4.8143	5.6741	6.5339	7.3937	8.2535	9.1133

MAP UNIT MMW

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.4401	0.5974	0.7547	0.9120	1.0693	1.2266	1.3839
URANIUM DIST NORMAL	1.4521	1.9177	2.3833	2.8489	3.3145	3.7801	4.2457
THORIUM DIST NORMAL	3.0506	3.9935	4.9364	5.8793	6.8222	7.7651	8.7080
U/K DIST NORMAL	1.1953	1.8635	2.5317	3.1999	3.8681	4.5363	5.2045
U/TH DIST NORMAL	0.2055	0.3016	0.3977	0.4938	0.5899	0.6860	0.7821
TH/K DIST NORMAL	4.0189	4.8523	5.6857	6.5191	7.3525	8.1859	9.0193

LINE BASED MEAN CONCENTRATIONS
AND RATIOS PER ROCK TYPE

MAP UNIT QAL

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	1.124	1.255	1.111	0.921	0.961	0.974	0.991	0.951	1.115	1.033	0.961	0.960	0.000	0.000	0.000
URANIUM	2.871	2.699	2.916	2.249	2.372	2.497	2.797	2.511	2.903	2.821	3.000	2.770	0.000	0.000	0.000
THURIUM	6.036	5.809	5.915	5.559	5.655	6.413	5.237	5.381	6.510	6.045	5.687	5.146	0.000	0.000	0.000
U/K	2.575	2.168	2.666	2.484	2.474	2.661	2.846	2.682	2.604	2.726	3.127	2.913	0.000	0.000	0.000
U/TH	0.479	0.472	0.498	0.414	0.419	0.390	0.543	0.480	0.447	0.468	0.548	0.548	0.000	0.000	0.000
TH/K	5.413	4.665	5.366	6.083	5.908	6.865	5.319	5.659	5.840	5.850	6.135	5.398	0.000	0.000	0.000

	1180	1190	1200
POTASIUM	1.245	0.914	0.954
URANIUM	3.004	2.801	3.368
THURIUM	6.099	4.953	5.455
U/K	2.430	3.244	3.590
U/TH	0.492	0.588	0.624
TH/K	4.936	5.715	5.791

MAP UNIT QWO

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	0.000	1.153	0.999	1.242	1.024	0.982	1.079	1.022	1.138	1.035	1.114	1.054	1.166	0.000	0.000
URANIUM	0.000	2.573	2.426	3.060	2.639	3.207	2.893	2.806	2.959	2.767	2.747	2.503	2.423	0.000	0.000
THURIUM	0.000	5.577	5.693	6.018	5.455	6.063	5.604	5.688	5.427	5.044	5.801	5.277	5.540	0.000	0.000
U/K	0.000	2.275	2.440	2.469	2.587	3.279	2.735	2.774	2.606	2.753	2.509	2.443	2.126	0.000	0.000
U/TH	0.000	0.470	0.434	0.509	0.489	0.529	0.523	0.514	0.550	0.561	0.484	0.484	0.442	0.000	0.000
TH/K	0.000	4.872	5.717	4.849	5.348	6.204	5.262	5.633	4.775	4.934	5.232	5.078	4.806	0.000	0.000

	1180	1190	1200
POTASIUM	0.000	1.002	1.099
URANIUM	0.000	3.047	3.140
THURIUM	0.000	5.771	5.635
U/K	0.000	3.072	2.879
U/TH	0.000	0.530	0.565
TH/K	0.000	5.821	5.176

MAP UNIT QWK

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	1.083	1.157	0.941	1.020	1.025	0.901	1.095	1.339	1.130	0.000	0.000	0.000	1.337	0.000	1.507
URANIUM	2.899	2.863	3.062	2.551	2.460	2.988	3.195	3.220	2.935	0.000	0.000	0.000	2.948	0.000	3.593
THORIUM	4.947	5.706	4.874	5.443	6.033	4.703	5.467	5.275	5.311	0.000	0.000	0.000	5.856	0.000	6.062
U/K	2.680	2.475	3.263	2.537	2.412	3.323	2.955	2.408	2.611	0.000	0.000	0.000	2.210	0.000	2.389
U/TH	0.587	0.508	0.632	0.474	0.413	0.637	0.592	0.612	0.557	0.000	0.000	0.000	0.507	0.000	0.595
TH/K	4.569	4.939	5.227	5.381	5.938	5.222	5.079	3.944	4.707	0.000	0.000	0.000	4.376	0.000	4.021

	1180	1190	1200
POTASIUM	1.259	0.996	0.966
URANIUM	3.027	3.196	3.686
THORIUM	6.628	5.403	5.350
U/K	2.415	3.311	3.960
U/TH	0.462	0.606	0.709
TH/K	5.266	5.463	5.576

MAP UNIT QWL

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	1.231	0.000	1.370	0.000	0.786	0.000	1.464	0.000	1.225	0.905	1.013	0.000	0.784	0.000	0.000
URANIUM	3.267	0.000	2.987	0.000	2.238	0.000	3.505	0.000	3.668	2.457	3.129	0.000	2.164	0.000	0.000
THORIUM	6.258	0.000	5.841	0.000	4.187	0.000	6.529	0.000	5.627	5.108	5.457	0.000	3.259	0.000	0.000
U/K	2.699	0.000	2.196	0.000	3.450	0.000	2.424	0.000	3.044	2.779	3.107	0.000	2.891	0.000	0.000
U/TH	0.527	0.000	0.517	0.000	0.628	0.000	0.550	0.000	0.663	0.487	0.580	0.000	0.693	0.000	0.000
TH/K	5.099	0.000	4.284	0.000	5.518	0.000	4.469	0.000	4.608	5.969	5.399	0.000	4.250	0.000	0.000

	1180	1190	1200
POTASIUM	1.284	1.082	0.000
URANIUM	2.809	3.238	0.000
THORIUM	6.628	5.992	0.000
U/K	2.204	3.007	0.000
U/TH	0.426	0.546	0.000
TH/K	5.189	5.539	0.000

MAP UNIT QWG

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	1.255	1.263	1.237	1.272	1.258	1.244	1.340	1.265	1.164	1.124	1.138	1.182	1.372	1.428	1.312
URANIUM	3.002	2.765	2.867	2.947	3.133	3.006	3.339	3.352	3.413	3.471	3.292	3.191	2.709	2.982	3.311
THORIUM	5.539	5.888	6.190	6.273	6.180	5.862	6.218	6.065	5.922	5.800	5.866	5.955	6.116	6.601	6.282
U/K	2.423	2.223	2.345	2.365	2.525	2.445	2.525	2.692	2.971	3.182	2.943	2.736	1.996	2.106	2.579
U/TH	0.551	0.477	0.468	0.475	0.514	0.518	0.543	0.559	0.582	0.615	0.572	0.541	0.449	0.455	0.533
TH/K	4.461	4.740	5.059	5.026	4.999	4.782	4.662	4.845	5.153	5.201	5.201	5.069	4.484	4.647	4.828

	1180	1190	1200
POTASIUM	1.133	1.065	1.018
URANIUM	3.303	3.181	3.017
THORIUM	6.252	6.062	5.947
U/K	2.980	3.027	3.022
U/TH	0.535	0.531	0.512
TH/K	5.570	5.776	5.913

MAP UNIT QWE

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	1.103	1.212	1.280	1.196	1.205	1.275	1.298	1.142	1.244	1.175	1.134	1.104	1.373	1.481	1.315
URANIUM	2.869	2.841	2.933	2.976	3.092	3.089	3.379	3.113	3.432	3.364	3.229	3.056	2.905	3.279	3.161
THORIUM	5.655	5.462	5.922	5.715	6.079	6.040	6.324	5.745	6.052	5.806	5.815	5.732	6.327	6.762	6.221
U/K	2.633	2.358	2.330	2.516	2.595	2.468	2.656	2.756	2.782	2.903	2.903	2.800	2.148	2.224	2.444
U/TH	0.512	0.525	0.500	0.525	0.512	0.516	0.538	0.545	0.571	0.587	0.563	0.538	0.466	0.488	0.515
TH/K	5.177	4.519	4.699	4.849	5.117	4.820	4.960	5.107	4.925	4.998	5.191	5.266	4.623	4.589	4.763

	1180	1190	1200
POTASIUM	1.208	1.089	1.044
URANIUM	3.226	3.160	2.755
THORIUM	6.363	5.718	5.674
U/K	2.745	2.945	2.664
U/TH	0.515	0.556	0.497
TH/K	5.328	5.321	5.468

MAP UNIT QIO

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.080	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	2.889	0.000	0.000	0.000	0.000
THURIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.384	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	2.691	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	0.455	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	5.954	0.000	0.000	0.000	0.000

	1180	1190	1200
POTASIUM	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000
THURIUM	0.000	0.000	0.000
U/K	0.000	0.000	0.000
U/TH	0.000	0.000	0.000
TH/K	0.000	0.000	0.000

MAP UNIT QIG

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	0.000	0.000	0.000	0.000	0.938	1.016	1.043	1.034	0.991	0.940	0.781	0.968	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	2.185	2.607	2.771	2.630	2.711	2.605	2.328	2.711	0.000	0.000	0.000
THURIUM	0.000	0.000	0.000	0.000	5.698	6.435	6.382	6.192	5.992	6.362	5.306	6.299	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	2.346	2.611	2.678	2.551	2.757	2.815	3.036	2.811	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.393	0.409	0.440	0.428	0.457	0.414	0.449	0.434	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	6.082	6.429	6.156	6.033	6.082	6.798	6.791	6.523	0.000	0.000	0.000

	1180	1190	1200
POTASIUM	0.000	1.040	0.000
URANIUM	0.000	2.852	0.000
THURIUM	0.000	5.971	0.000
U/K	0.000	2.774	0.000
U/TH	0.000	0.483	0.000
TH/K	0.000	5.774	0.000

MAP UNIT QIE

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	1.116	1.115	0.973	0.749	1.103	1.084	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	2.362	2.809	2.220	2.159	3.107	2.801	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	6.916	6.542	5.807	4.848	6.176	5.978	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	2.126	2.526	2.297	2.963	2.834	2.588	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.343	0.430	0.385	0.451	0.504	0.473	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	6.199	5.885	5.989	6.541	5.620	5.532	0.000	0.000	0.000

	1180	1190	1200
POTASIUM	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000
U/K	0.000	0.000	0.000
U/TH	0.000	0.000	0.000
TH/K	0.000	0.000	0.000

MAP UNIT PAP

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.917	0.922	0.941	1.006	0.957	0.898	0.948	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	2.434	2.564	2.803	2.816	2.713	2.682	2.689	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	6.253	6.021	5.537	6.741	6.104	6.332	5.889	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	2.705	2.830	3.042	2.836	2.871	3.040	2.868	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.396	0.432	0.518	0.421	0.454	0.430	0.461	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	6.879	6.562	5.950	6.790	6.387	7.119	6.272	0.000	0.000	0.000

	1180	1190	1200
POTASIUM	0.000	0.000	0.899
URANIUM	0.000	0.000	3.058
THORIUM	0.000	0.000	5.772
U/K	0.000	0.000	3.471
U/TH	0.000	0.000	0.538
TH/K	0.000	0.000	6.470

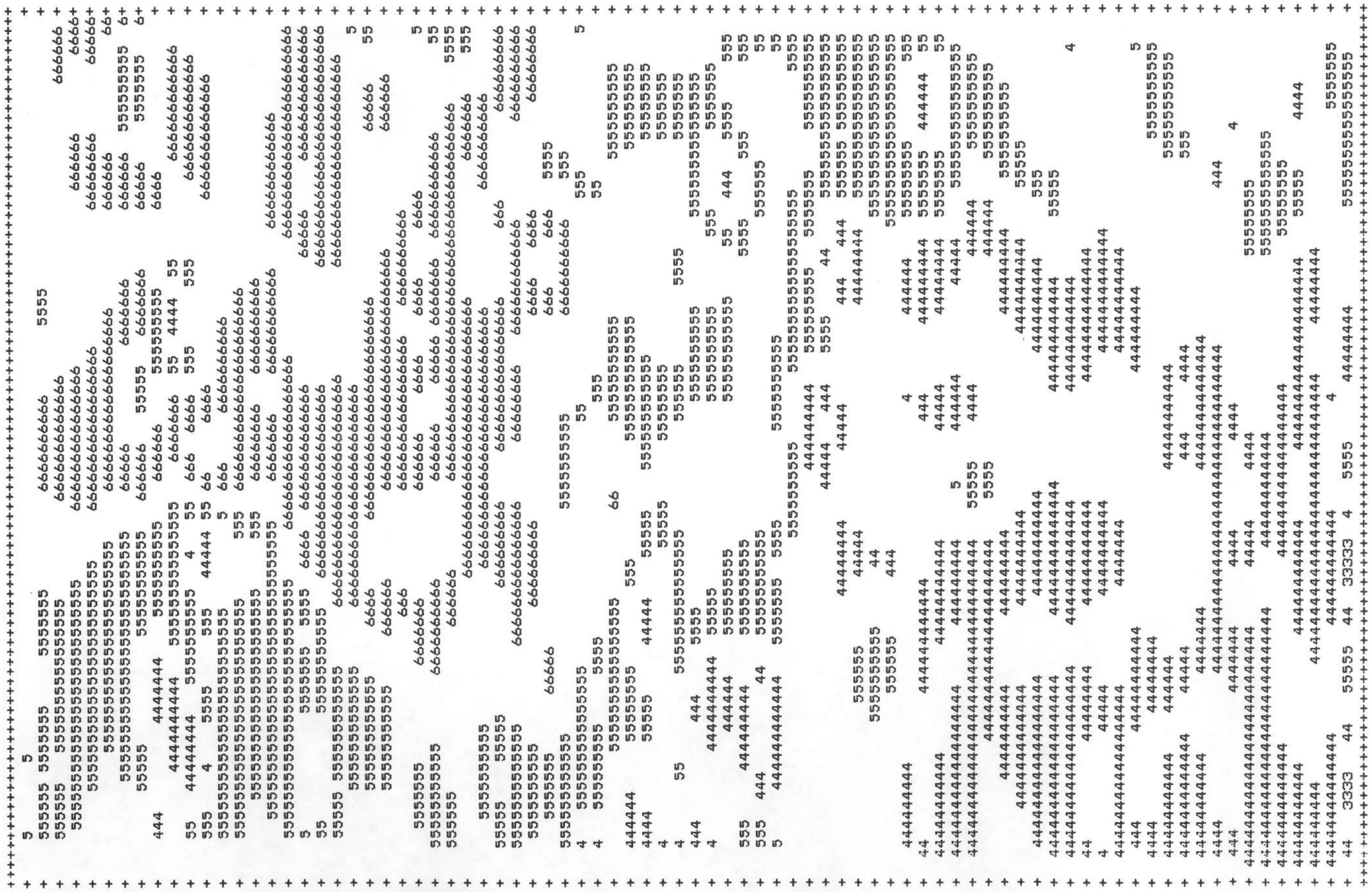
MAP UNIT MMW

	490	500	510	520	530	540	550	560	570	580	590	600	1150	1160	1170
POTASIUM	0.000	0.000	0.000	0.000	0.000	1.030	0.885	0.962	1.081	0.947	0.934	0.971	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	2.780	2.526	2.714	3.399	2.714	2.745	2.635	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	7.042	5.624	5.901	6.445	6.076	6.450	5.897	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	2.710	2.955	2.879	3.137	2.888	3.085	2.733	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.398	0.458	0.468	0.531	0.448	0.433	0.450	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	6.875	6.450	6.222	5.969	6.475	7.085	6.128	0.000	0.000	0.000

	1180	1190	1200
POTASIUM	0.000	0.000	0.855
URANIUM	0.000	0.000	2.989
THORIUM	0.000	0.000	5.487
U/K	0.000	0.000	3.554
U/TH	0.000	0.000	0.549
TH/K	0.000	0.000	6.494

APPENDIX H - Pseudo Contour Maps

MARION



EXPLANATION

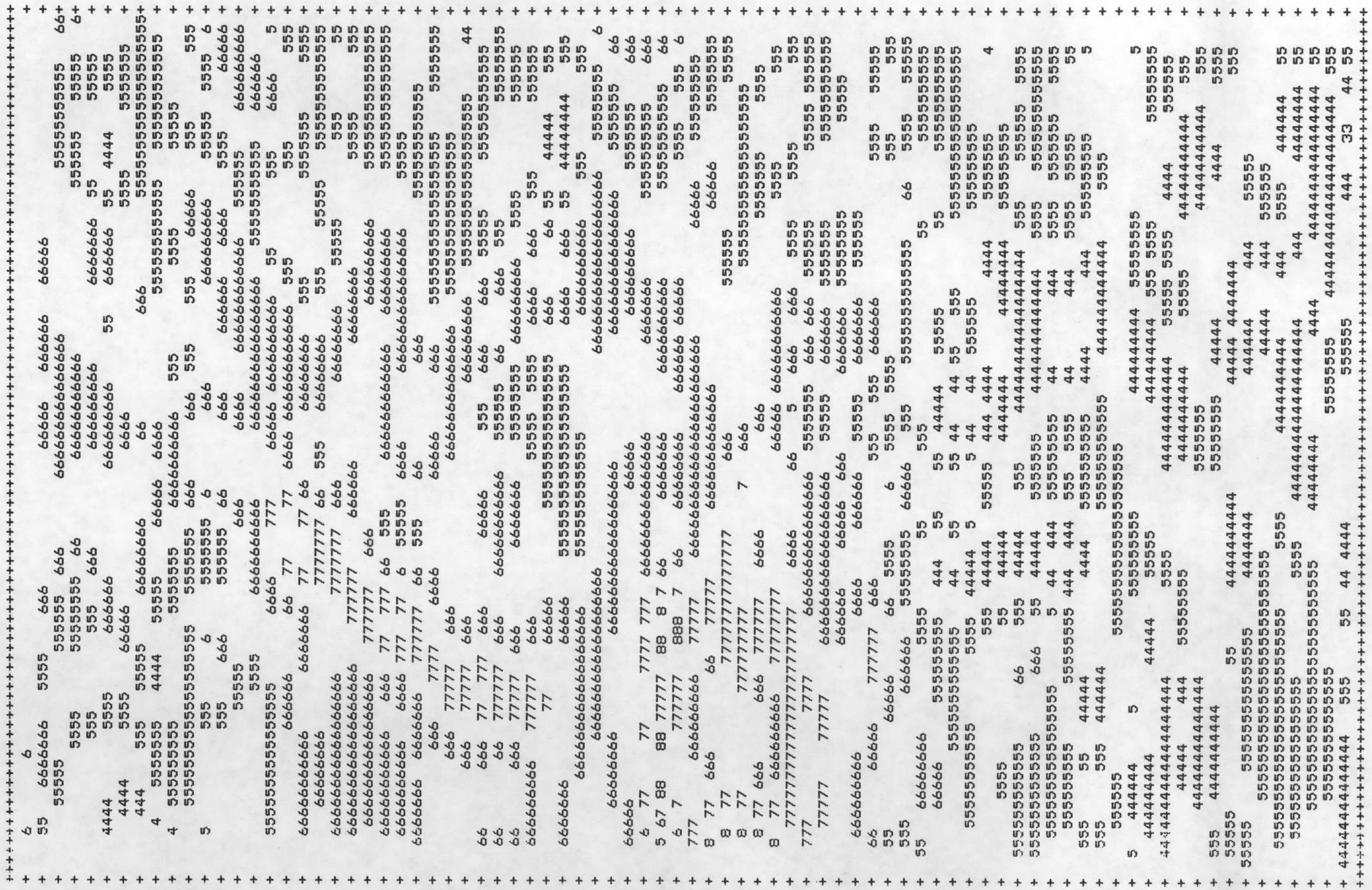
PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.1250
1	0.1250	0.2500
	0.2500	0.3750
2	0.3750	0.5000
	0.5000	0.6250
3	0.6250	0.7500
	0.7500	0.8750
4	0.8750	1.0000
	1.0000	1.1250
5	1.1250	1.2500
	1.2500	1.3750
6	1.3750	1.5000
	1.5000	1.6250
7	1.6250	1.7500
	1.7500	1.8750
8	1.8750	2.0000
	2.0000	2.1250
9	2.1250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

Potassium Pseudo-Contour Map - Marion Quadrangle

SCALE IN EQUIVALENT PERCENT

H2 ma

MARION



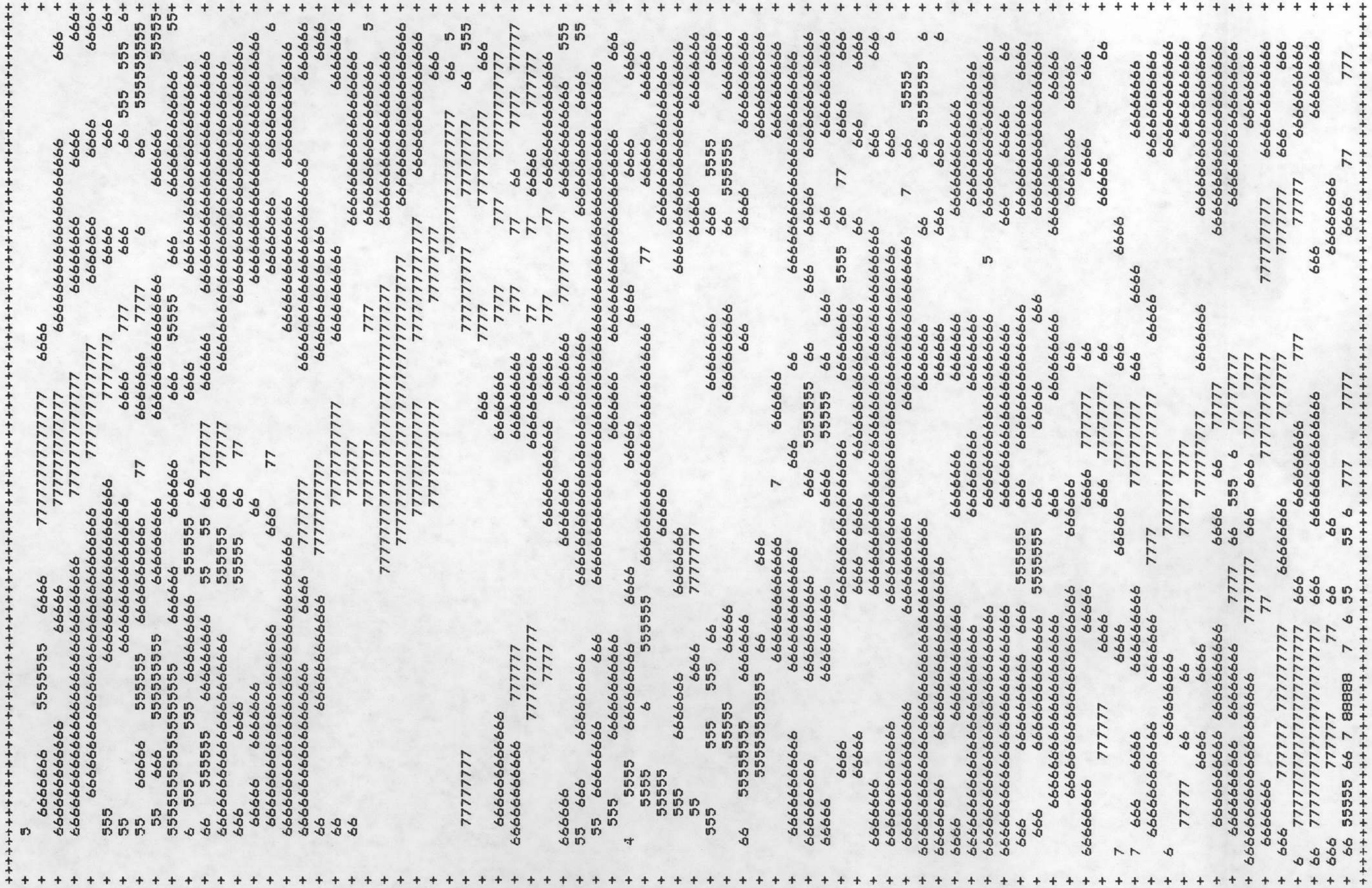
Uranium Pseudo-Contour Map - Marion Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.5000
	0.5000	0.7500
1	0.7500	1.0000
	1.0000	1.2500
2	1.2500	1.5000
	1.5000	1.7500
3	1.7500	2.0000
	2.0000	2.2500
4	2.2500	2.5000
	2.5000	2.7500
5	2.7500	3.0000
	3.0000	3.2500
6	3.2500	3.5000
	3.5000	3.7500
7	3.7500	4.0000
	4.0000	4.2500
8	4.2500	4.5000
	4.5000	4.7500
9	4.7500	5.0000
	GT	5.0000

SCALE IN EQUIVALENT PPM

MARION



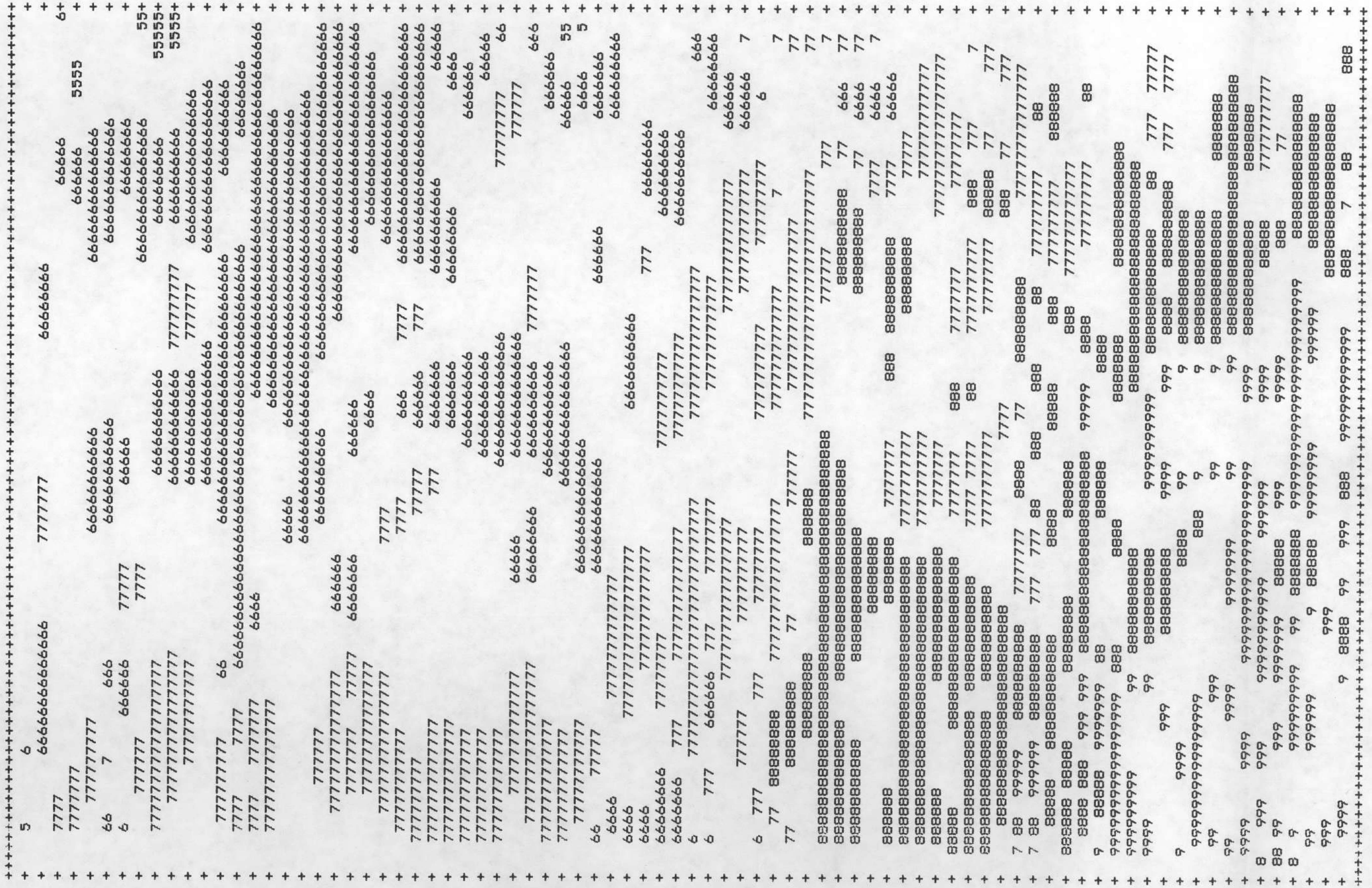
Thorium Pseudo-Contour Map - Marion Quadrangle

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

MARION

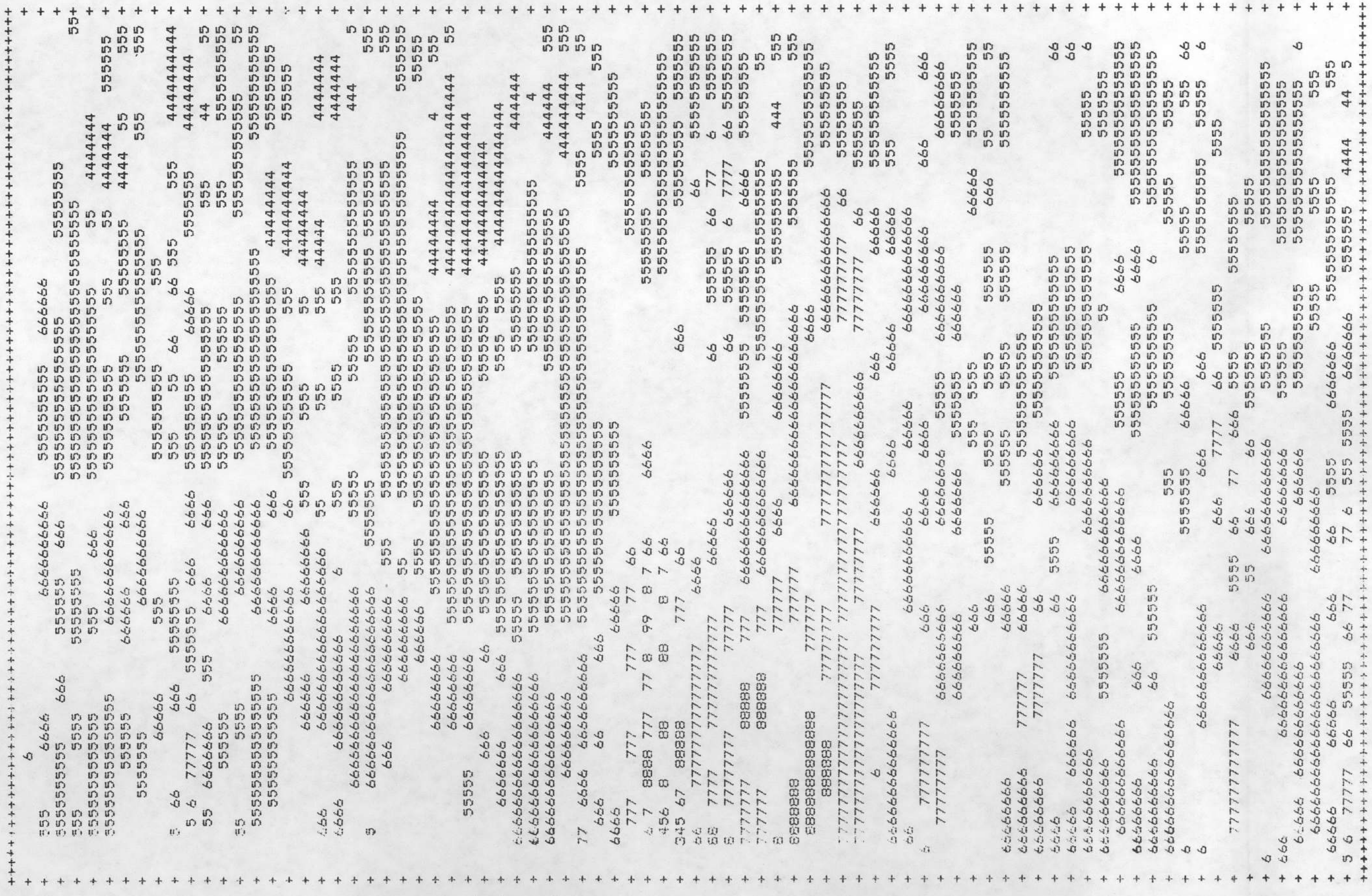


Thorium/Potassium Pseudo-Contour Map - Marion Quadrangle

EXPLANATION

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

MARION

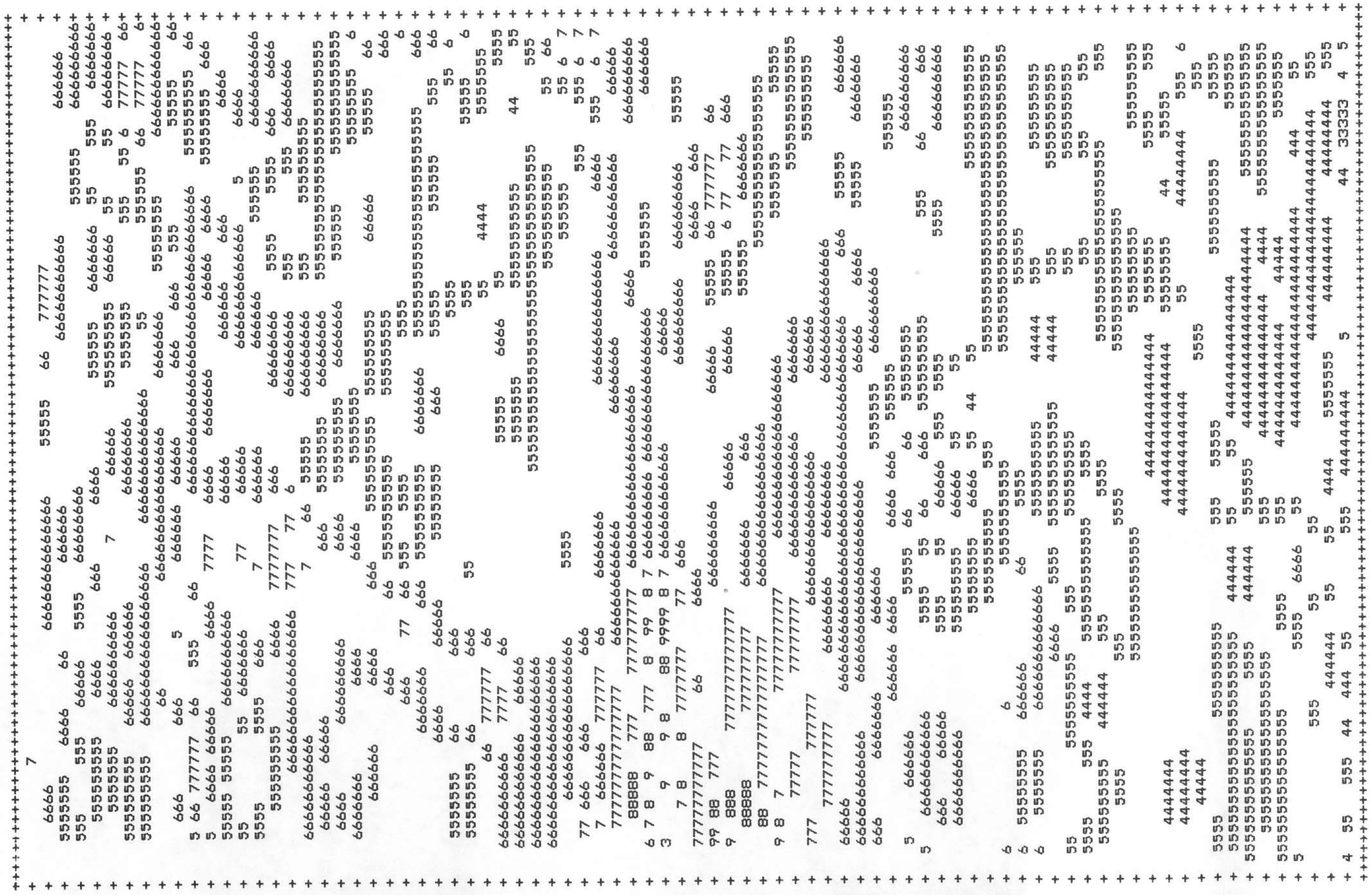


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.2500
1	0.2500	0.5000
	0.5000	0.7500
2	0.7500	1.0000
	1.0000	1.2500
3	1.2500	1.5000
	1.5000	1.7500
4	1.7500	2.0000
	2.0000	2.2500
5	2.2500	2.5000
	2.5000	2.7500
6	2.7500	3.0000
	3.0000	3.2500
7	3.2500	3.5000
	3.5000	3.7500
8	3.7500	4.0000
	4.0000	4.2500
9	4.2500	4.5000
	GT	4.5000

Uranium/Potassim Pseudo-Contour Map - Marion Quadrangle

MARION

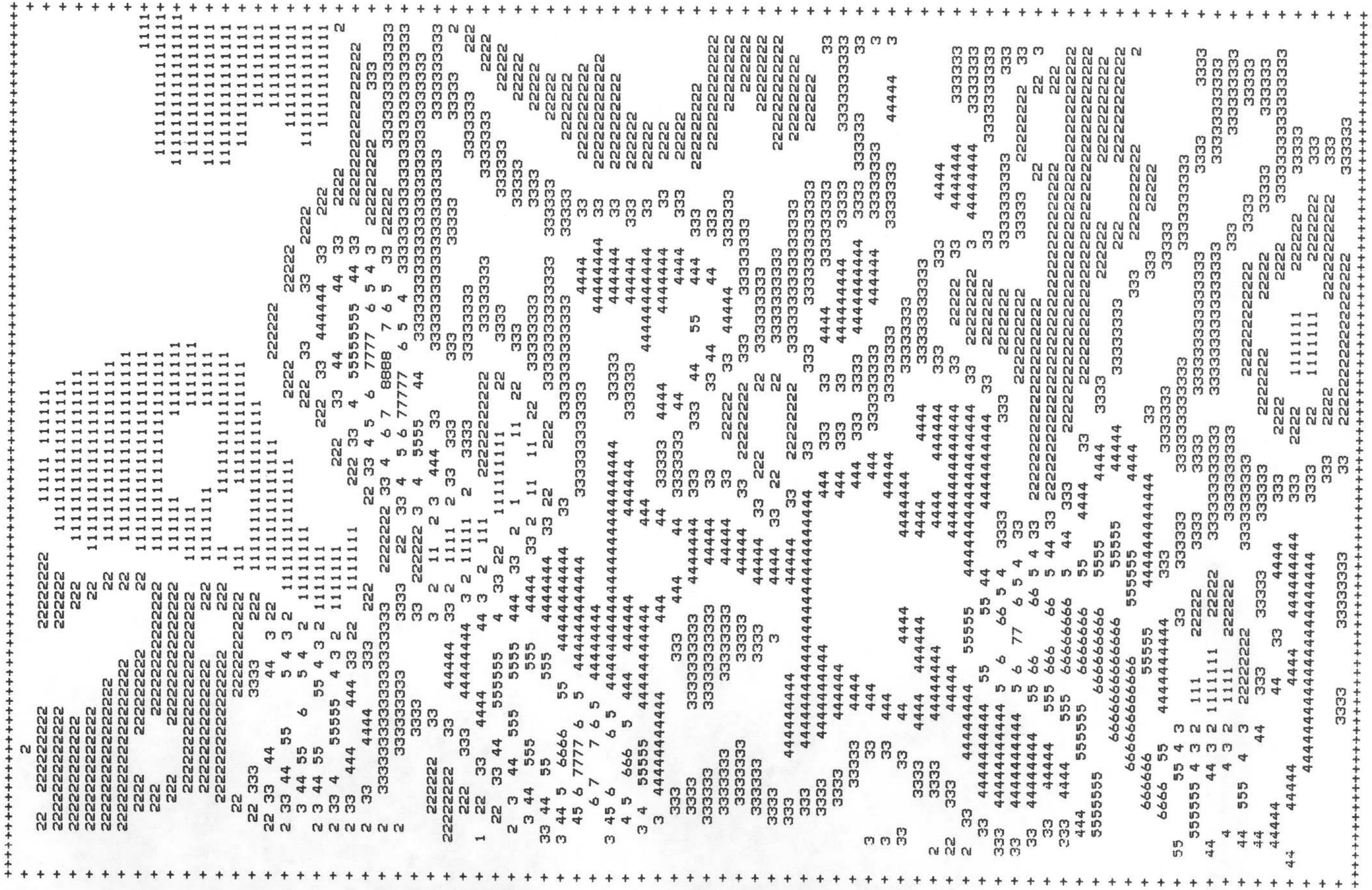


EXPLANATION

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 - Marion Quadrangle

MARION



Residual Magnetic Pseudo-Contour Map - Marion Quadrangle

EXPLANATION

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

SCALE IN GAMMAS