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National Uranium Resource Evaluation

AERIAL GAMMA RAY AND MAGNETIC SURVEY
HELENA QUADRANGLE
ARKANSAS, MISSISSIPPI AND TENNESSEE

FINAL REPORT

EG&G GEOMETRICS
Sunnyvale, California 94086

September 1980

PREPARED FOR U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Resource Applications
Grand Junction Office, Colorado

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MISSISSIPPI AND FLORIDA AIRBORNE SURVEY
HELENA QUADRANGLE OF
ARKANSAS, MISSISSIPPI
AND TENNESSEE

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Prepared by
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Sunnyvale, California

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Under Contract No. DE-AC13-76GJ01664
and Bendix Field Engineering Corporation
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ABSTRACT

The Helena quadrangle covers a region largely within the Mississippi River flood plain in the extreme northern Gulf Coastal Province. Tertiary sediments in this area are relatively thick, and overlie a Paleozoic basin gradually shoaling to the northeast. The Ouachita Tectonic Zone strikes southeasterly through the center of the quadrangle.

The exposed sequence is almost entirely Quaternary sediments of the flood plain area. Older Cenozoic deposits crop out in upland areas on the west side of the river valley.

A search of available literature revealed no known uranium deposits.

Sixty (60) uranium anomalies were detected and discussed briefly in this report. None were considered significant, and all appeared to occur as the result of cultural and/or weather effects.

Magnetic data appear to be in agreement with existing structural interpretations of the region.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

General

The Helena quadrangle covers a 7,800 square mile area in eastern Arkansas, northwestern Mississippi, and extreme southwestern Tennessee (see Figure 1).

The geologic base map used in the interpretation was compiled by Martel Laboratories in 1980. Geologic map unit descriptions were taken directly from the Martel Laboratories map legend. Supplementary geologic information was taken from Fairbridge (ed.) 1975, Cohee and others (1962), and Antoine and others (1974). Cultural and physiographic information was taken from the 1:250,000 scale Helena topographic map (1966 version).

Radiometric and magnetic data from the Helena quadrangle were acquired in June and July of 1980, and processed in August. A detailed summary of data acquisition, processing, interpretation, and presentation methods is contained in Appendix A. Appendix B contains a flight summary report for the Helena quadrangle.

Physiography

The area covered by the Helena quadrangle lies primarily in flood plains of the Mississippi, Arkansas, and White Rivers, in the extreme northern Gulf Coastal Physiographic Province. The quadrangle is drained by these three rivers or their tributaries. The flood plains of the three rivers are separated by higher ground, and the Mississippi River flood plain narrows to a 20 mile gap near the town of Helena. Elevations range from below 150 feet in the southernmost flood plain areas, to over 350 feet in the uplands east of the Mississippi River. Higher ground to the west of the Mississippi River commonly exceeds 300 feet.

The region is only moderately developed culturally. The largest town in the area is Pine Bluff, at the western border of the quadrangle, with a population of 57,000. Several towns in the quadrangle have populations that range near 10,000. The quadrangle contains a relatively dense grid of roads and railroads, but contains no freeways.

The Mississippi River roughly divides the states of Arkansas and Mississippi, but the river has apparently shifted somewhat since the boundary was originally defined.

GEOLOGY

Structure

The area covered by the Helena quadrangle lies at the northern end

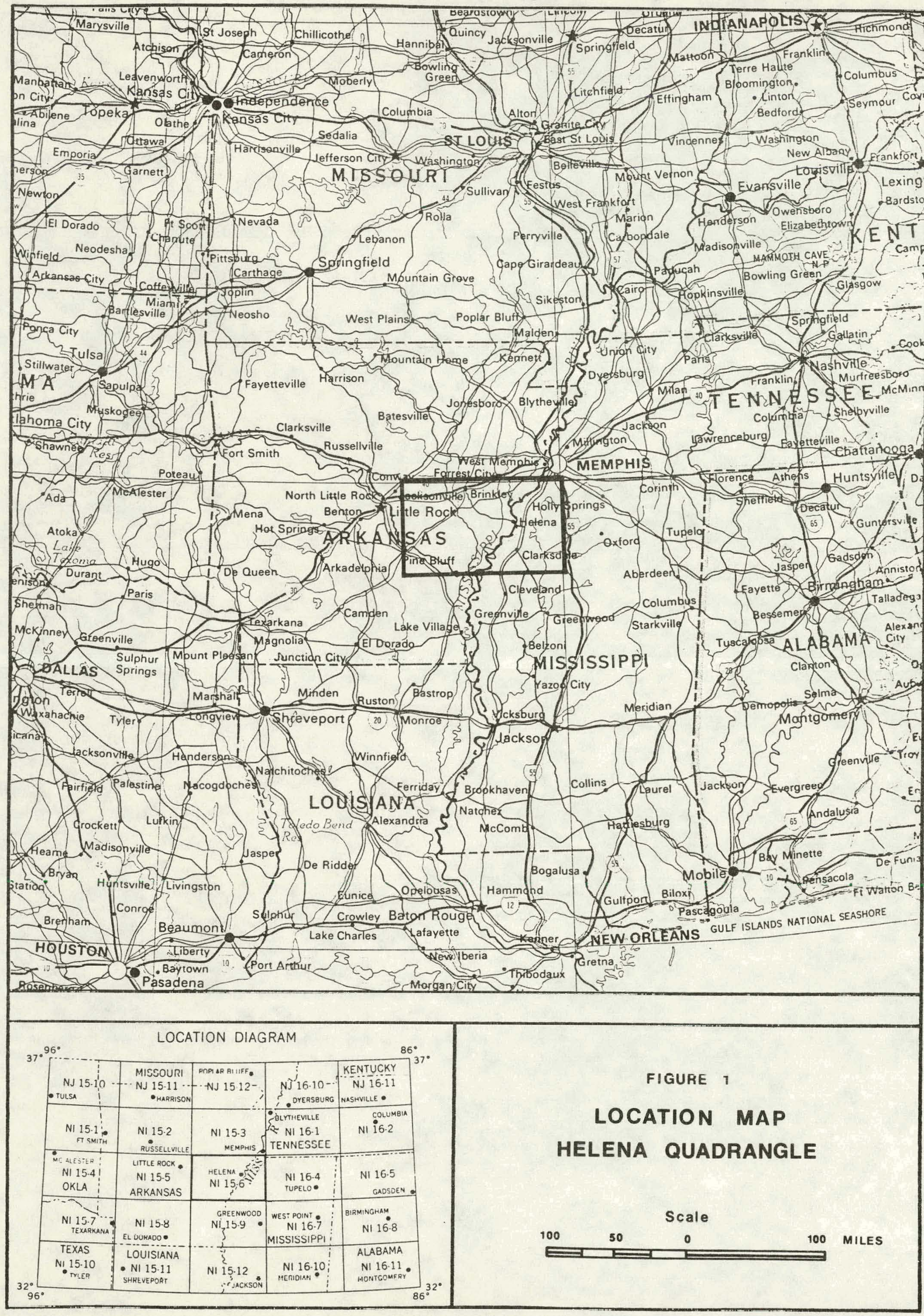


FIGURE 1

LOCATION MAP
HELENA QUADRANGLE

of the Desha Basin area of the Mississippi Embayment. Cenozoic sediment thickness in this portion of the basin range from near zero at the northeastern corner to over 3,500 feet along the central southern border. Cretaceous rocks may also attain a substantial thickness in this area. The post-Paleozoic section reaches a thickness of approximately 5,000 feet in the south (Figure 2).

Other structures are defined by the Paleozoic strata. The northern and eastern regions overlie a thick sequence of Paleozoics intermediate between the Black Warrior and Arkoma Basins. This structure shoals gradually to the northeast from thickness of 10,000 feet or more, but is abruptly terminated to the southwest by the Ouachita Tectonic Zone. This structure, which is exposed to the northwest of the quadrangle, represents Paleozoic geosynclinal sediments which were involved in a late Paleozoic orogenic event. The thickness and structural configuration of Paleozoic strata within and adjacent to the zone is still subject to some question. Sediments to the northeast of the zone are thought to overlie relatively stable Precambrian basement.

No surface faults of any kind are mapped in the Helena quadrangle.

Surface Geology

Quaternary materials dominate the Helena quadrangle. Flood plain areas are mapped as alluvium by Martel Laboratories. Regions intermediate between flood plains are mapped as Pleistocene alluvial terraces. The eastern uplands consist of Pleistocene loess deposits. Altogether the Quaternary section covers over 99 percent of the surface.

Tertiary sediments of the Jackson and Midway Groups, and the Wilcox Formation cover less than 1 percent of the surface. These sediments are largely sands and clays that are locally glauconitic and fossiliferous, and contain some lignite.

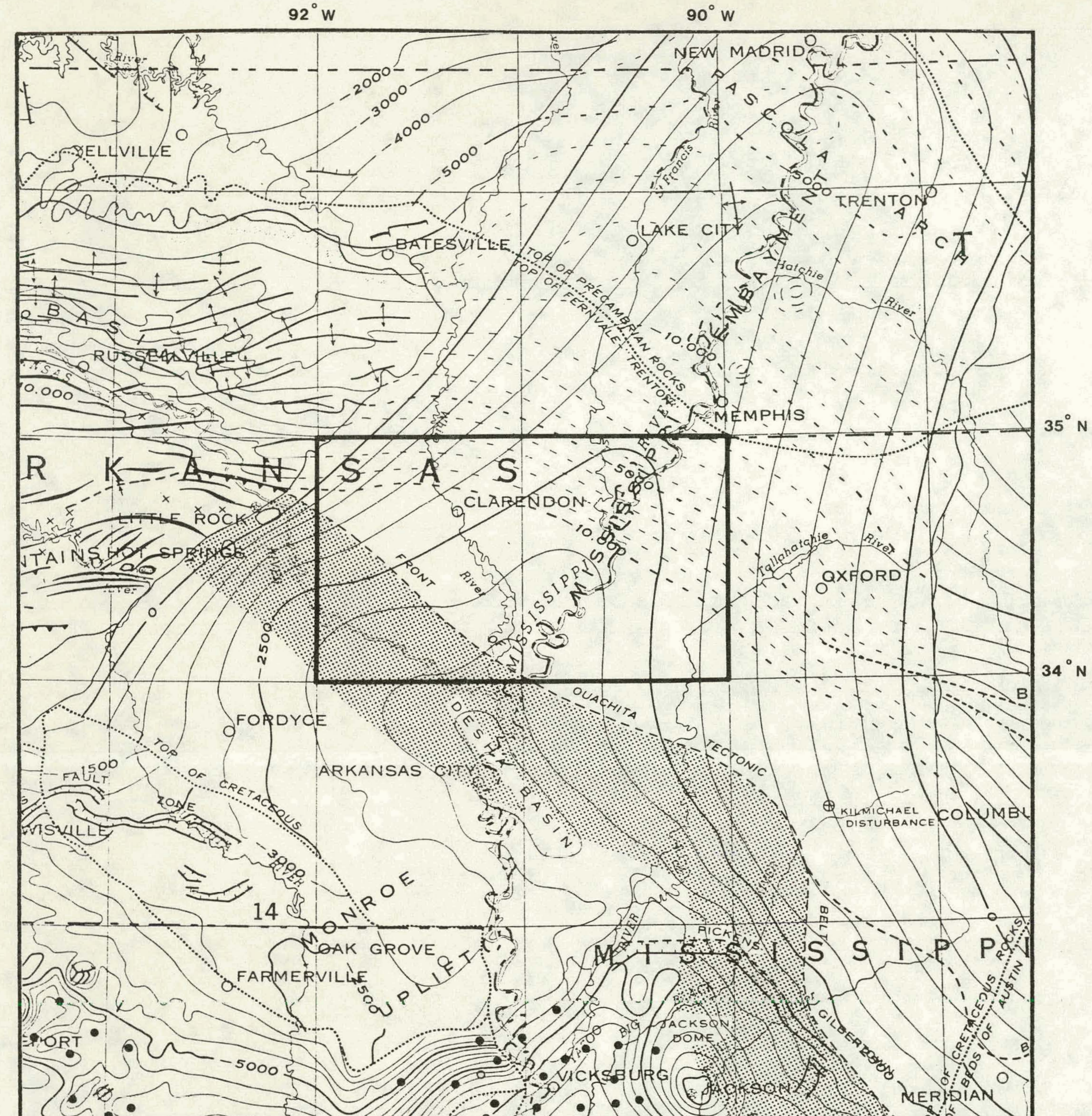
Uranium

According to available sources, there are no known uranium deposits in the Helena quadrangle.

INTERPRETATION OF GEOPHYSICAL DATA

Radiometric Data

A total of 60 groups of uranium (Bi214) samples meet the minimum statistical requirements, set forth in the data interpretation section of Appendix A, that are used to define anomalies. These are displayed, along with all other anomalous samples and pertinent data, on the Uranium Anomaly/Intepretation Map (Figure 3). The anomalies are summarized in a table in Appendix G. The potassium, uranium, thorium,



After

USGS and AAPG

Tectonic Map of the United States

by

Cohee and others (1962)

FIGURE 2

TECTONIC STRUCTURE MAP
HELENA QUADRANGLE

Scale 1:2,500,000

25 0 25 50 75 MILES

and ratio pseudo-contour maps, which reflect radiometric responses for the entire quadrangle, are found in Appendix H. Discussion of the abundances of potassium, uranium, and thorium are in terms of apparent equivalent percent and apparent equivalent ppm. These equivalent units are derived from scaling of counts per second data by the sensitivities calculated for the detection system. They do not directly correspond to real geochemical data.

The average concentrations of the three radioactive elements are higher in the Helena quadrangle relative to surrounding areas. The average uranium concentration is 2.2 ppmeU. The average potassium and thorium concentrations are 1.0 percent and 7.1 ppmeT respectively.

Highest average uranium concentrations occur in map units QS (Pleistocene loess) at 2.4 ppmeU. Map unit QT (Pleistocene terrace deposits) contains the highest average thorium concentrations. Highest average and peak concentrations of potassium occur in map unit TJ (Eocene - Jackson Group) at 1.2 and 2.3 percent respectively. Map unit QAL (Recent alluvium) contains the highest peak concentrations of both uranium and thorium (4.3 ppmeU and 16.2 ppmeT respectively).

Despite the fact that the quadrangle is mapped as more than 99 percent Quaternary surficial deposits, several large scale contrasts are evident in the radiometric data. The three radioactive elements show wide variation in their relative concentrations within the quadrangle. Uranium appears to vary almost randomly at the map scale. However both thorium and potassium concentrations are clearly higher in the flood plain areas. Potassium is higher in all flood plain areas, but thorium appears to concentrate only in the Mississippi and Arkansas Rivers. This suggests that there are inhomogeneties in the alluvium that may be related to the individual source areas of the three rivers in the Helena quadrangle.

Anomalies are scattered throughout the quadrangle, but tend to concentrate in areas of cultural activity. The peak uranium concentrations in the anomalies range as high as 4.0 ppmeU, but most anomalies have peak concentrations near 3.0 ppmeU. All the anomalies appear to have some cultural association (such as roads, railroads, pipelines, etc.).

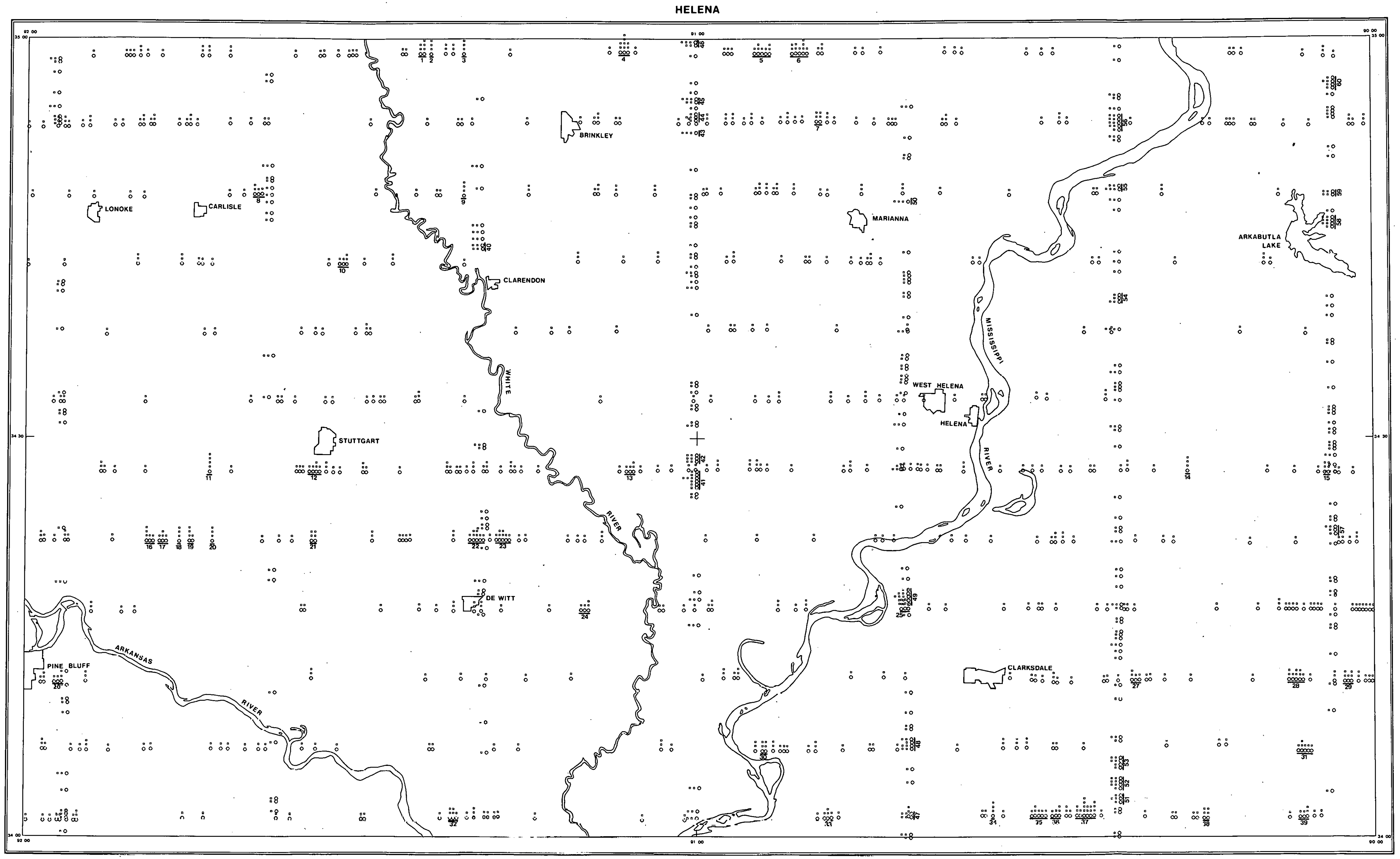
The clear association of the anomalies with cultural activity, coupled with the extreely low concentrations of uranium and the lack of bedrock units, indicate that none of the anomalies depicted in this report have any real significance.

Magnetic Data

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

The structural picture of the region is basically one of a centralized Cenozoic sedimentary basin that shoals to the northwest. These sediments overlie an extremely deep Paleozoic Basin that shoals to the northest and is abruptly terminated to the southwest by the Ouachita Tectonic Zone.

In general the magnetic data appear to be in fairly close agreement with current structural interpretations of the area. Low gradients persist throughout the region. One region of relatively higher gradients in the southeastern corner may relate to some structural and/or lithologic trend in the Ouachita Tectonic Belt.



URANIUM ANOMALY/ INTERPRETATION MAP

HELENA 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 - Helena 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. N827Q). The Queen Air 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

For the forty three quadrangles a total of 63,748 line miles, excluding reflights and overlaps and missing data, were flown by the Queen Air. The production summary presented below and the detailed daily production in Appendix B describes a portion of the total project.

Prior to the start of the survey operations, the airplane was calibrated at the DoE test pads and Dynamic Test Range in April, 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.

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

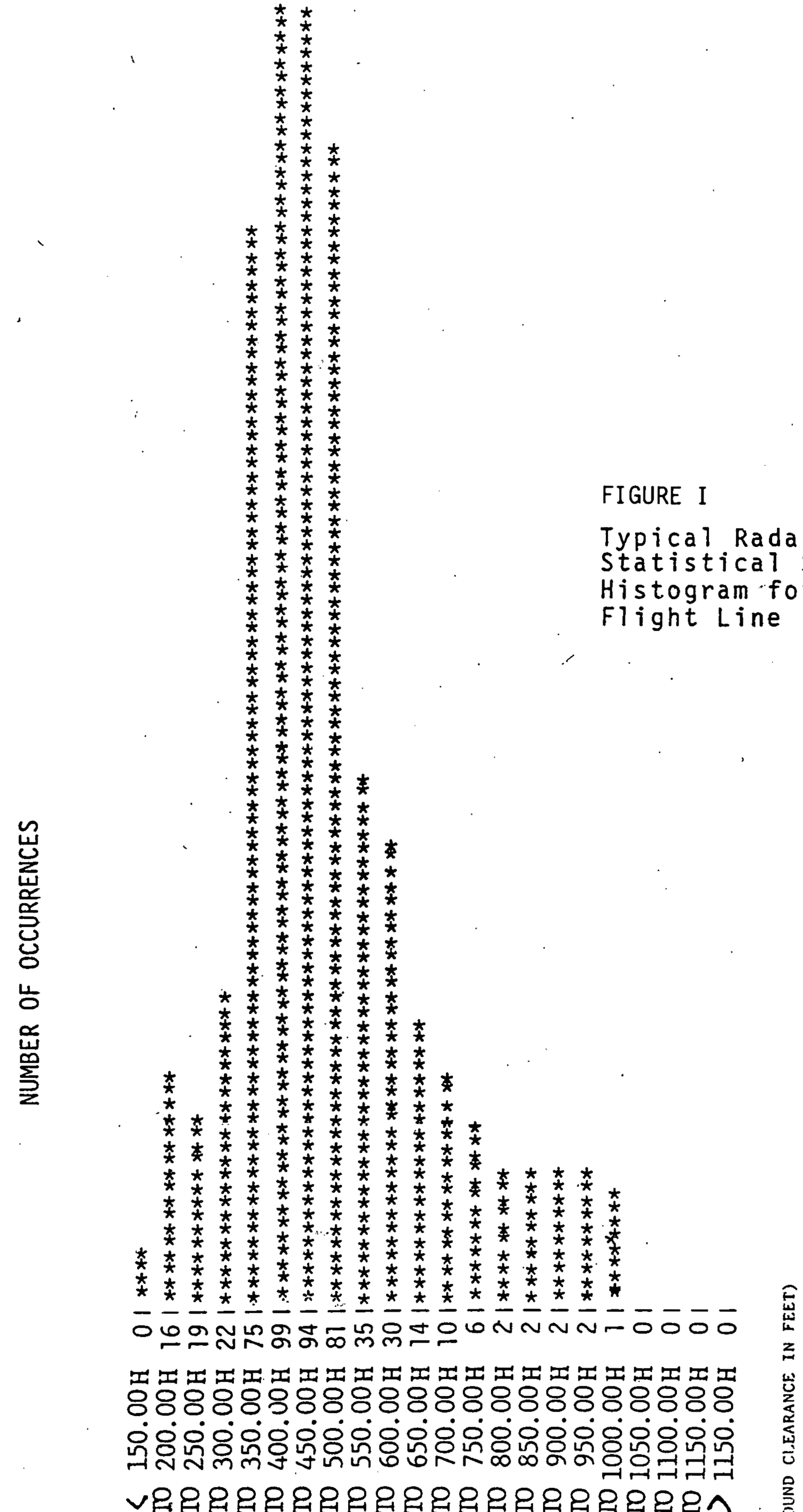
This survey was conducted using data collection parameters summarized below:

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 airplane's objective ground speed was 140 mph and was 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.



THE MINIMUM RADAR ALTMTR IS 147.500 FEET
THE MAXIMUM RADAR ALTMTR IS 975.000 FEET
THE AVERAGE RADAR ALTMTR IS 424.336 FEET
THE STANDARD DEVIATION IS 123.4900 FEET

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.

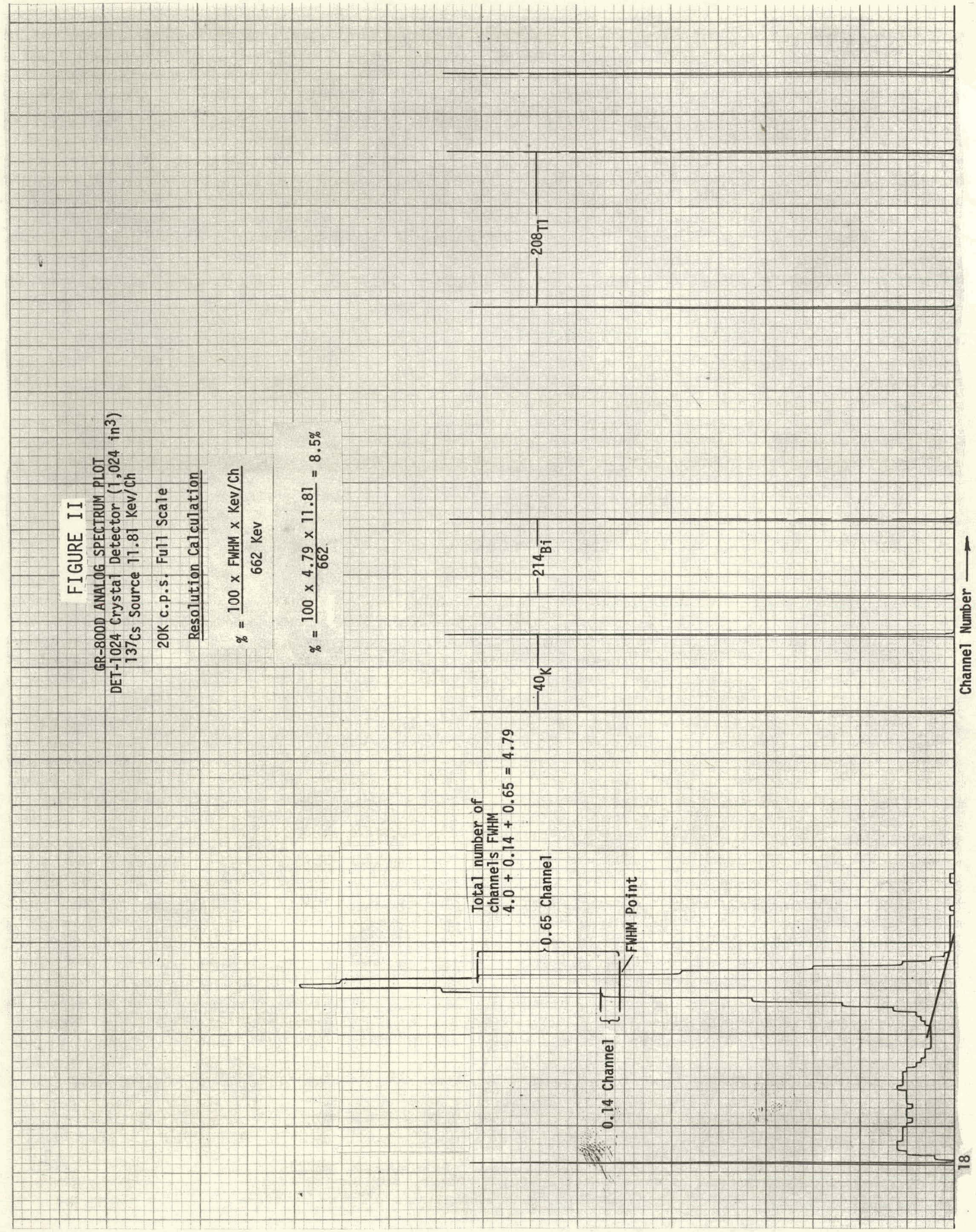
3. Finally run a full thorium analog spectrum of the down crystals and check for centering of K40 and Tl208 peaks in spectrum.

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 T1208 window.

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

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

Field Digital Data Verification

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

DATA COLLECTION SYSTEM

AIRCRAFT

The aircraft used for this survey was a Beechcraft Queen Air Model 65, U.S. Registry Number N827Q. This aircraft, being a medium twin engine aircraft, possesses overall performance and safety features which makes it ideal for low level, fixed-winged airborne geophysical survey work within areas of up to moderatly rough topographic relief. It can carry the adequate payload at the necessary lower constant airspeeds and still maintain a wide envelope of safety, all while operating economically. Performance data for the Queen Air Model 65 in its present survey configuration are give below:

Maximum Aircraft Gross Weight	7,700 lbs.
Aircraft Empty (dry)	4,640 lbs.
Max. useful load including fuel	3,060 lbs.
Geophysical Package	1,110 lbs.
Navigation Eqpt. & Extra Avionics	125 lbs.
Main Fuel Tanks	528 lbs.
Aux. Fuel Tanks	864 lbs.
Pilot	175 lbs.
Electronics Operator	175 lbs.
Total	2,977 lbs.

Minimum Control Speed	95 MPH *IAS at	Gross Weight
Safe Single Engine Speed	105 MPH IAS at	Gross Weight
Rate of climb both engines	1,300 *FPM at	Gross Weight
Rate of climb single engine	210 FPM at	Gross Weight

*IAS = Indicated Air Speed *FPM = Feet Per Minute

Avgas consumption = 36 U.S. gallons [216 lbs] per hour [at 75% power]
Endurance at 36 gallons [216 lbs.] per hour 75% power = 6 hrs. 6 mins.
Range of cruise at 75% power with 45 min. reserve = 1,200 miles

Cruise configuration stalling speed at Gross Weight [7700 lbs] at 0° Bank = 80 MPH IAS at 45° Bank = 95 MPH IAS

Electronics

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

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

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

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

   a. 512 channels of gamma ray spectrometer data

   b. Total magnetic intensity

   c. Fiducial number from data system/camera

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

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

   f. Time in days, hours, minutes and seconds

   g. Outside air temperature

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

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

6. Rosemont Barometric Altimeter with recording output and display.

7. Recording Thermometer for monitoring outside air temperature.

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

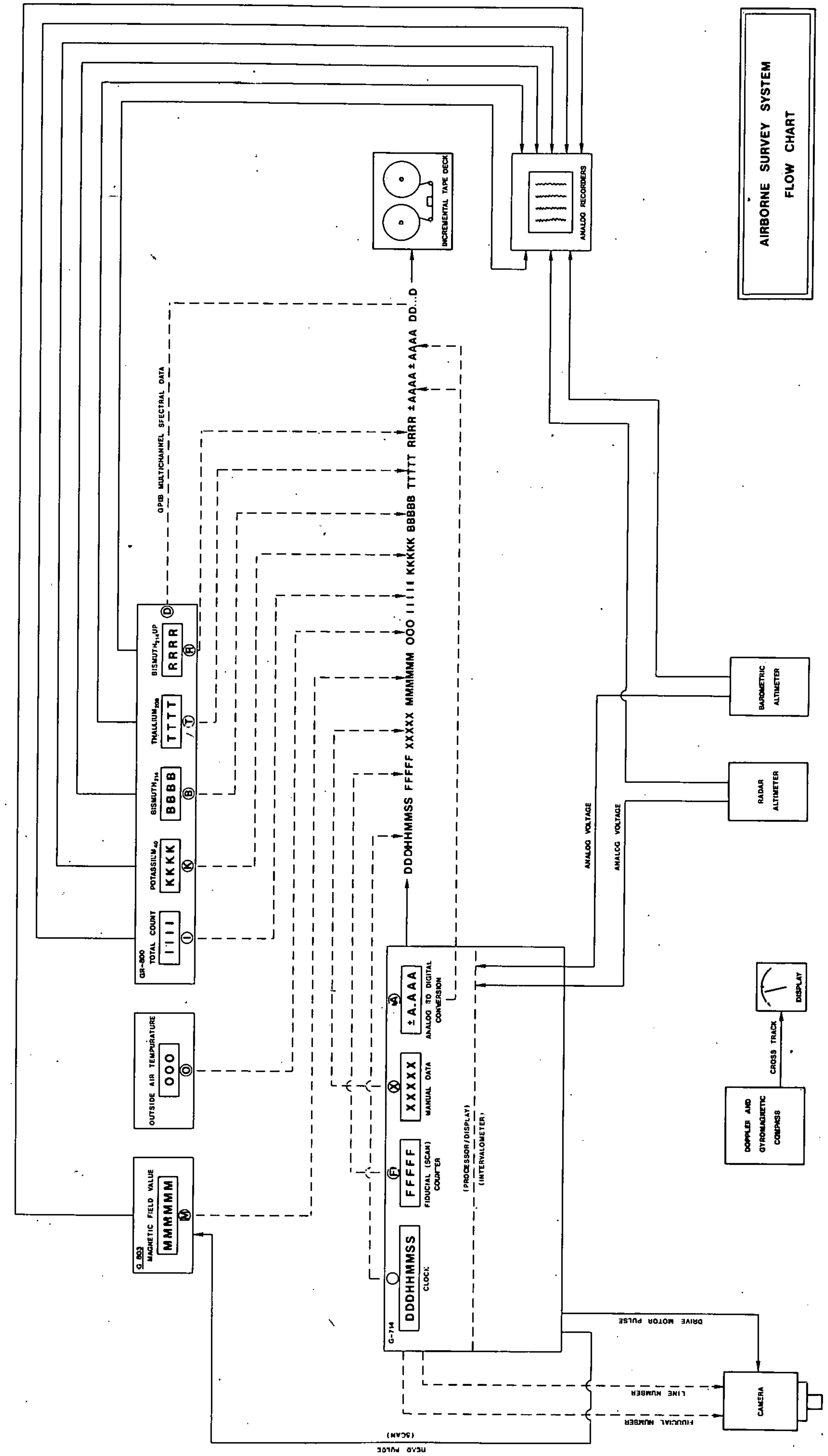


FIGURE III

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

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

   b. Bi air background from the upward looking system.

   c. Magnetometer

   d. Radar Altitude

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

   f. Barometric Altitude

   g. Time markers

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

SYSTEM CALIBRATION

AIRCRAFT AND COSMIC BACKGROUND

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

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

and

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

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

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

The aircraft background is derived as follows:

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

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

SYSTEM CONSTANTS

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

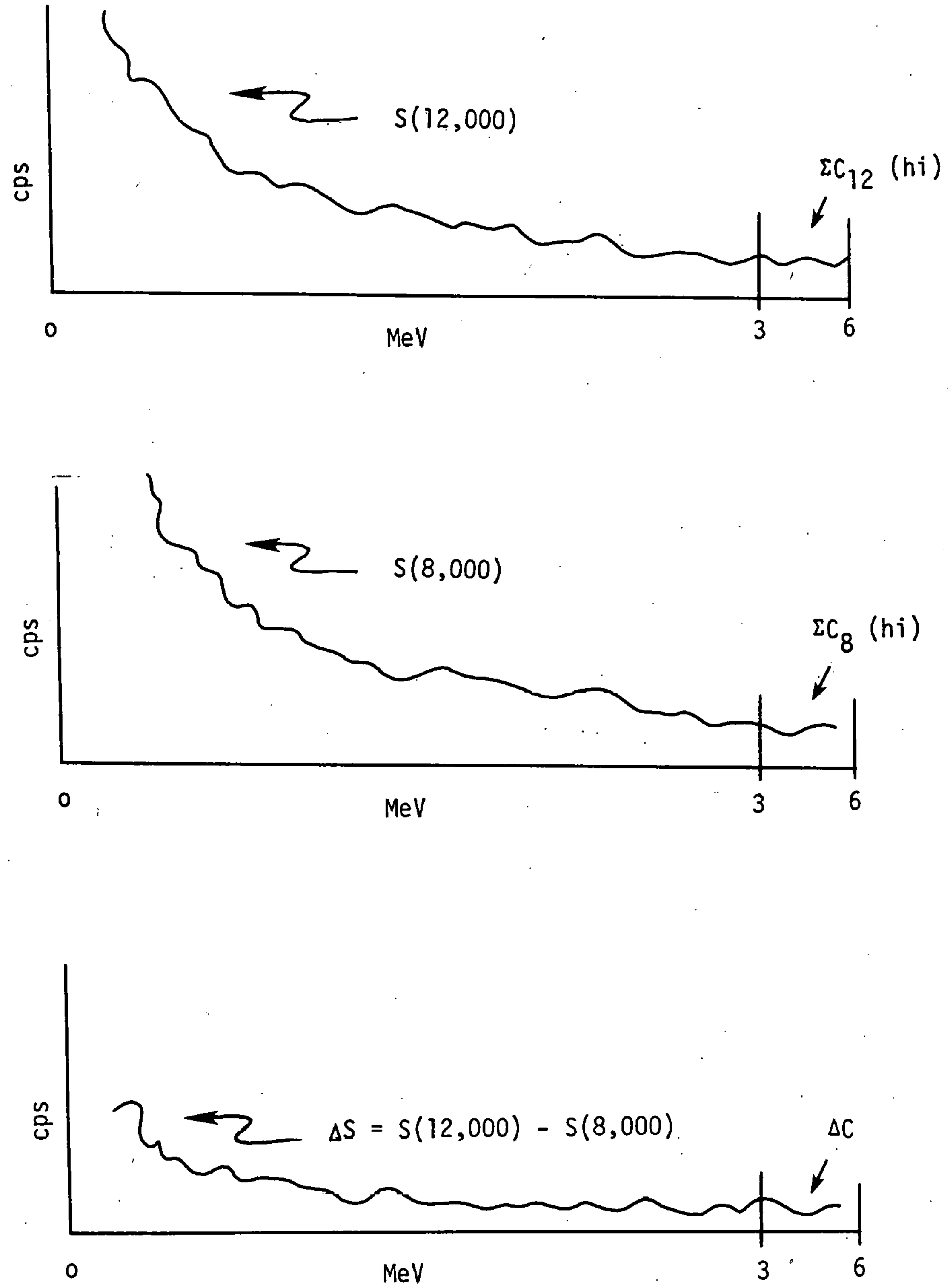


FIGURE IV - Multiple altitude spectra schematic

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

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

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

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

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

```
DERIVED AIRCRAFT BACKGROUND SPECTRUM FROM PACIFIC OCEAN DATA

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

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

AIRCRAFT BACKGROUND
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)   -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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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	(0.893 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)	11.348 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)	11.987 CPS	
CH 113	(1.336 MEV)	11.846 CPS	
CH 114	(1.347 MEV)	11.896 CPS	
CH 115	(1.359 MEV)	11.470 CPS	
CH 116	(1.371 MEV)	11.864 CPS	POTASSIUM 40
CH 117	(1.383 MEV)	10.286 CPS	
CH 118	(1.395 MEV)	10.084 CPS	
CH 119	(1.407 MEV)	9.642 CPS	
CH 120	(1.418 MEV)	11.778 CPS	
CH 121	(1.430 MEV)	12.636 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)	9.381 CPS	
CH 134	(1.584 MEV)	8.753 CPS	
CH 135	(1.596 MEV)	11.176 CPS	
CH 136	(1.608 MEV)	10.130 CPS	
CH 137	(1.619 MEV)	10.551 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)	6.488 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.

<u>K pad</u> $KC_k = \zeta_{kk}K + \zeta_{ku}U + \zeta_{kt}T$

$UC_k = \zeta_{uk}K + \zeta_{uu}U + \zeta_{ut}T$

$TC_k = \zeta_{tk}K + \zeta_{tu}U + \zeta_{tt}T$

<u>U pad</u> $KC_u = \zeta_{kk}K + \zeta_{ku}U + \zeta_{kt}T$

$UC_u = \zeta_{uk}K + \zeta_{uu}U + \zeta_{ut}T$

$TC_u = \zeta_{tk}K + \zeta_{tu}U + \zeta_{tt}T$

<u>T pad</u> $KC_t = \zeta_{kk}K + \zeta_{ku}U + \zeta_{kt}T$

$UC_t = \zeta_{uk}K + \zeta_{uu}U + \zeta_{ut}T$

$TC_t = \zeta_{tk}K + \zeta_{tu}U + \zeta_{tt}T$

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

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

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

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

The equations can be expressed in matrix notation

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

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

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

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

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

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

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

or

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

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

Rearranging the above equations we have

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

We now define

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

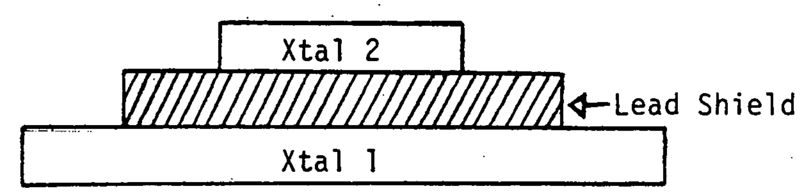
$S_{tu} = \frac{\Delta_{tu}}{\Delta_{tt}}$ (effect of uranium on thorium)

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

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

ATMOSPHERIC RADON CORRECTION

Consider the crystal configuration shown below:



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

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

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

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

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.

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

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 $\quad I_g = I_1 - I_a$

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

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

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 over these windows are as follows:

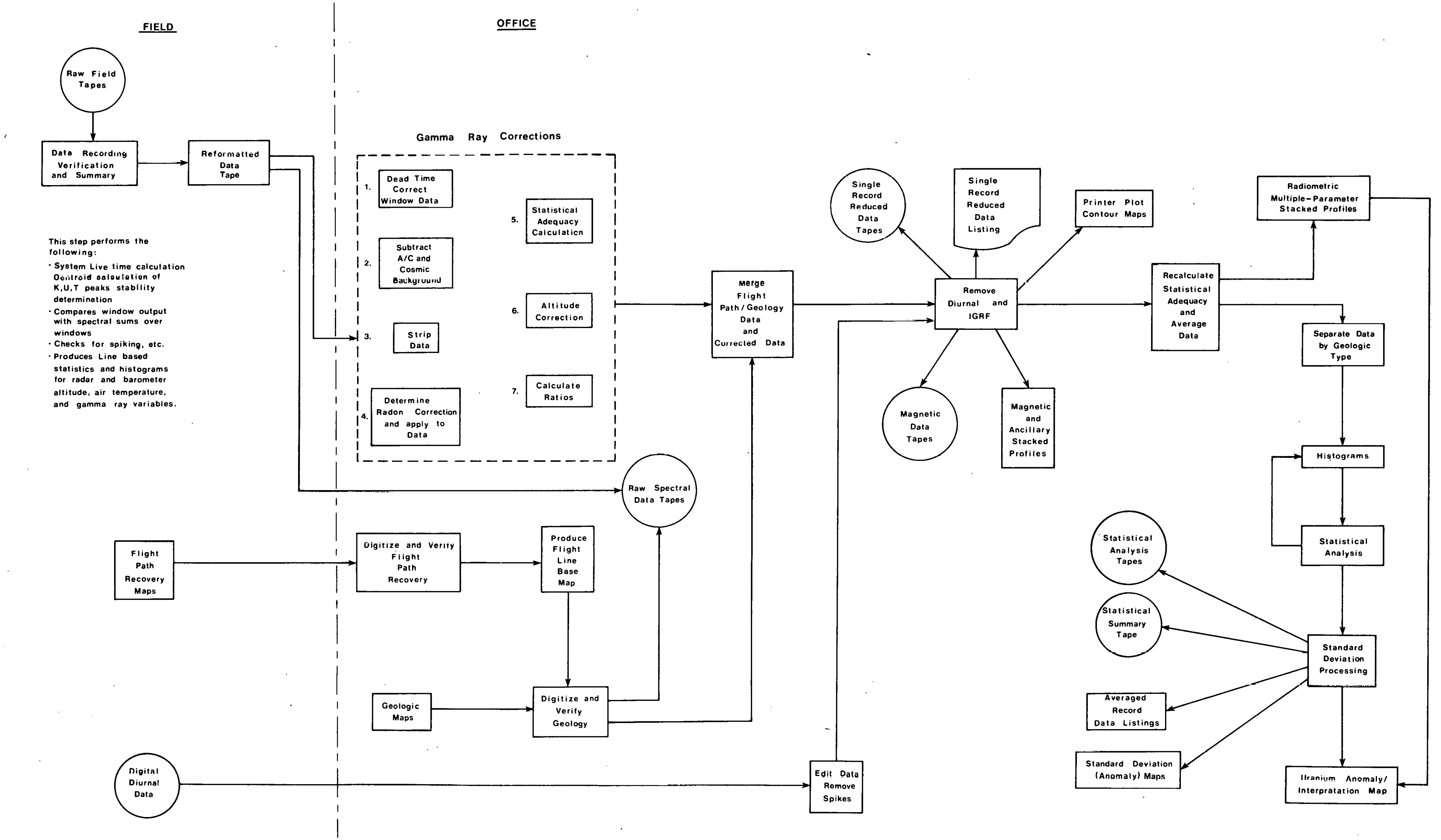
QUEEN AIR

		Aircraft	Cosmic*
TC	(cps)	152.04	2.3833
K	(cps)	16.06	0.1322
U_{dn}	(cps)	6.50	0.1098
U_{up}	(cps)	3.17	0.5540
T	(cps)	3.42	0.1503

*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
S_{ku}	0.8437
S_{kt}	0.1584
S_{ut}	0.2703
S_{uk}	0.0
S_{tu}	0.05614
S_{tk}	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
TC	(per foot)	0.002011
K	(per foot)	0.002740
U	(per foot)	0.002479
T	(per foot)	0.002048

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, u_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
ℓ	0.1101
m	0.596
C'_{uk}	.00947
C'_{uu}	.07136
C'_{ut}	.04636
$\mu\ell$	-0.000032
μm	-0.000192

$\mu\ell$ & 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
K	1%K	91.5
U	1 ppmeu	10.4
T	1 ppmeT	6.4

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.

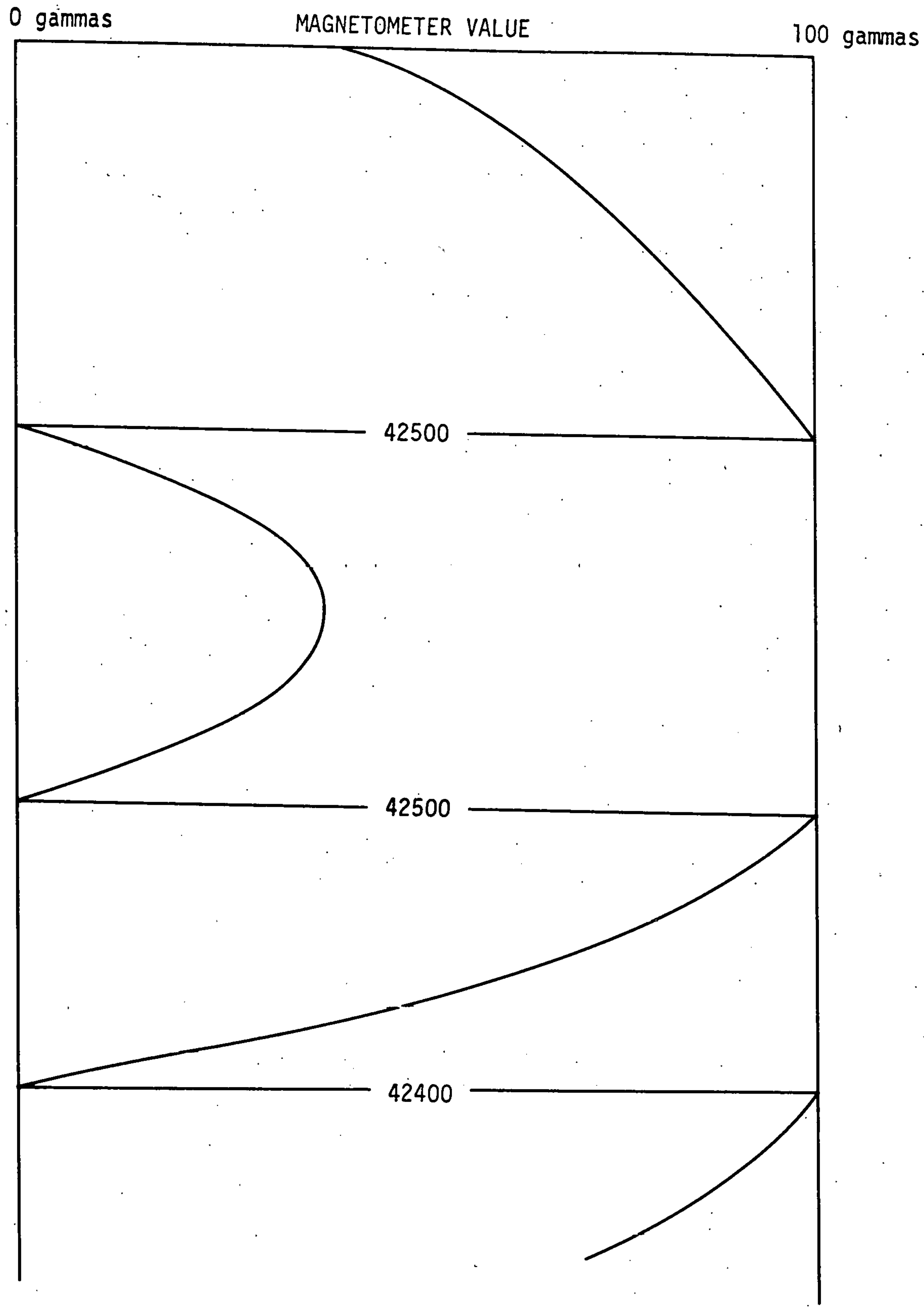


FIGURE VIII Plotter Step Value Labeling

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.

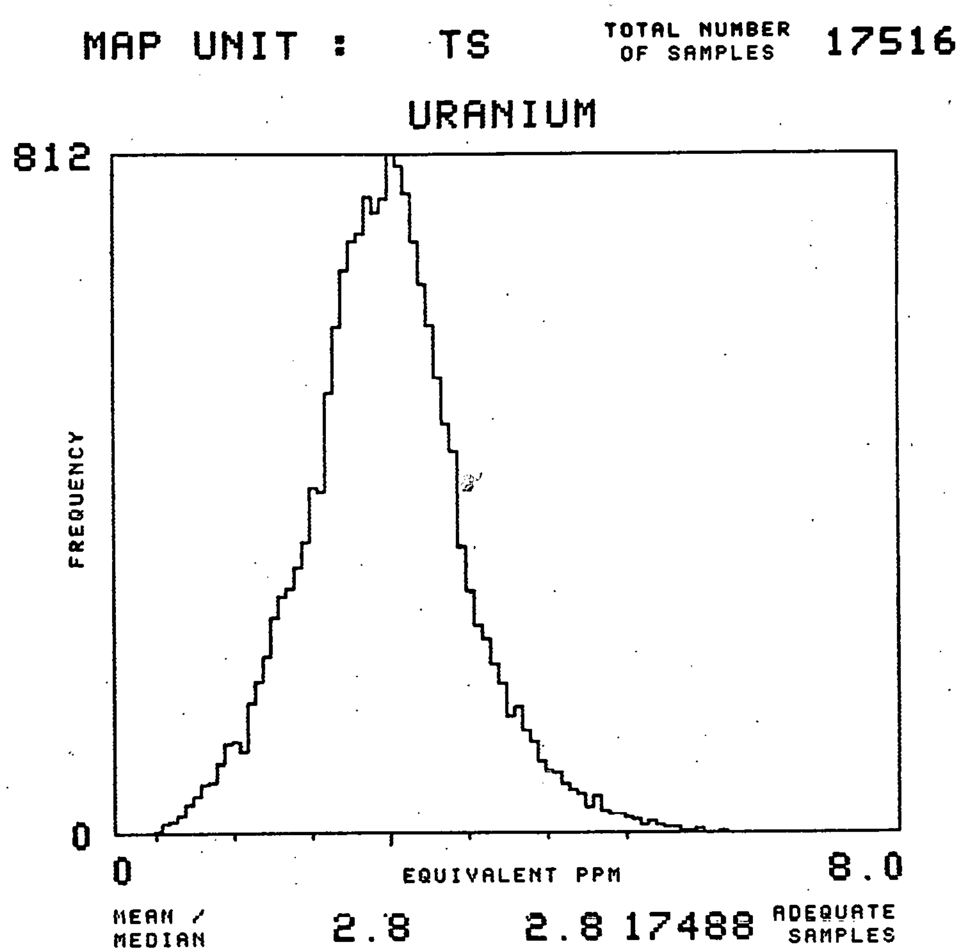


FIGURE IX Sample Computer Map Unit Histogram

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 (Tl208) has a distinct peak at 2.62 meV while uranium 238 has a daughter, bismuth 214 (Bi214) possessing a clear peak at 1.76 meV (see Figure 7 for a composite decay series spectrum). Consequently the fundamental assumption implicit to airborne uranium and thorium measurements is that the measured daughter products are in radioactive equilibrium - the number of atoms of disintegrating daughter nuclides are equal to the number being formed (see Adams and Gasparini, 1970).

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

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

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

Methodology

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

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

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

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

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

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

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

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

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

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

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

TAPE FORMATS

SINGLE RECORD REDUCED DATA TAPE

REFERENCE: Paragraphs 4.7.6 and 6.1.6, BFEC 1200-C

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

Block 1 - Format Data

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

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

SINGLE RECORD REDUCED DATA TAPE

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

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

ITEM	FORMAT	DESCRIPTION
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	AVERAGED 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 EQUIVALENT 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

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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 JUNE AND JULY, 1980

EL DORADO, GREENWOOD, WEST POINT, HELENA, MEMPHIS,

RUSSELLVILLE, AND FORTH SMITH QUADRANGLES

QUEEN AIR N9AG

6-14-80	Ferry to Greenville, Mississippi
6-15-80	755 miles El Dorado, Greenwood, West Point
6-16-80	698 miles El Dorado, Greenwood, West Point, Helena
6-17-80	698 miles " " " "
6-18-80	698 miles " " " "
6-19-80	249 miles Greenwood, Helena, West Point
6-20-80 to 6-21-80	Weather - nil production
6-22-80	607 miles Greenwood, Helena, West Point
6-23-80 to 6-24-80	Weather - nil production
6-25-80	676 miles Greenwood, El Dorado, West Point
6-26-80	902 miles El Dorado, Greenwood, West Point, Helena
6-27-80	1,025 miles Greenwood, Helena, Memphis
6-28-80	587 miles " " "
6-29-80 to 7-1-80	Ferry to Fort Smith, Arkansas
7-2-80	678 miles Fort Smith, Russellville, Memphis
7-3-80	Equipment malfunctions - nil production
7-4-80	941 miles Fort Smith, Russellville, Memphis, Helena
7-5-80	678 miles Fort Smith, Russellville, Memphis
7-6-80	1,039 miles Fort Smith, Russellville, Memphis, Helena
7-7-80	736 miles Fort Smith, Russellville, Memphis
7-8-80 to 7-10-80	Equipment Repairs - nil production
7-11-80	2645 miles Fort Smith
7-12-80	1,086 miles Fort Smith, Russellville, Memphis, Helena
7-13-80	528 miles Fort Smith, Russellville

Total for the above period - 12,825 miles as recorded by the flight crew.

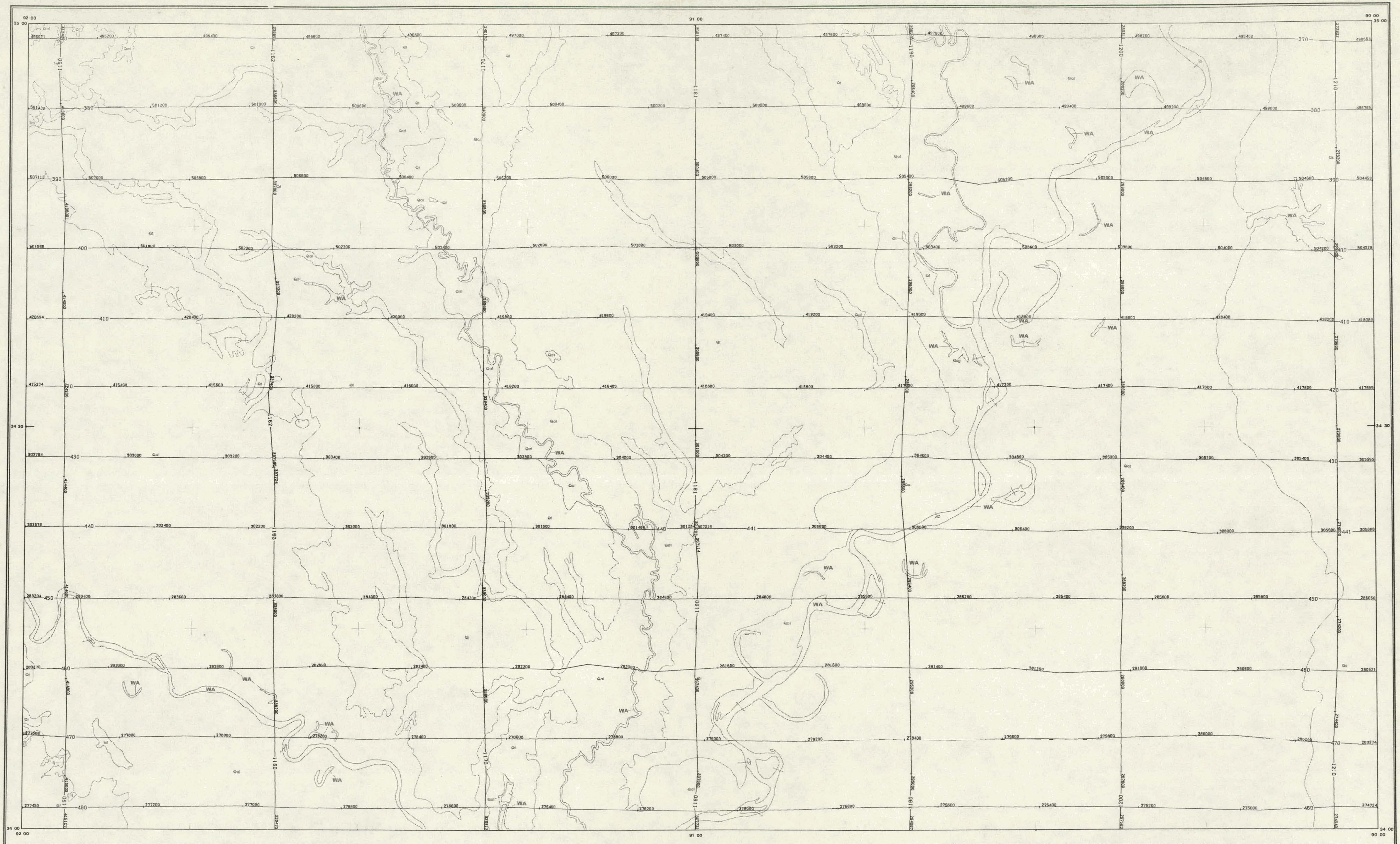
Total from May, 1980 for Russellville quadrangle - 109 miles.

Total miles for the included quadrangles:

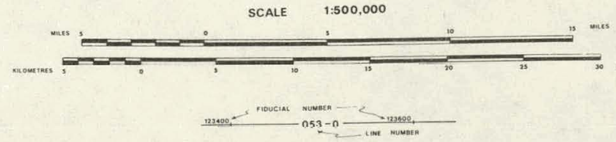
El Dorado	1,867
Greenwood	1,867
West Point	1,867
Helena	1,851
Fort Smith	1,834
Russellville	1,834
Memphis	1,834

APPENDIX C - Flight Path and Geologic Map

HELENA



SCALE 1:500,000

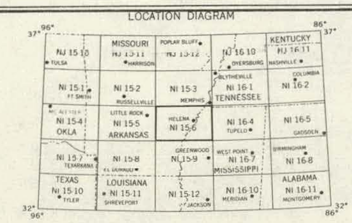


FLIGHT LINE SPACING .... 6.0 MILES
FLIGHT ALTITUDE .... 400 FEET AMT
FLOWN AND COMPILED 1980

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

LOCATION DIAGRAM



FLIGHT PATH RECOVERY

MISSISSIPPI / FLORIDA PROJECT

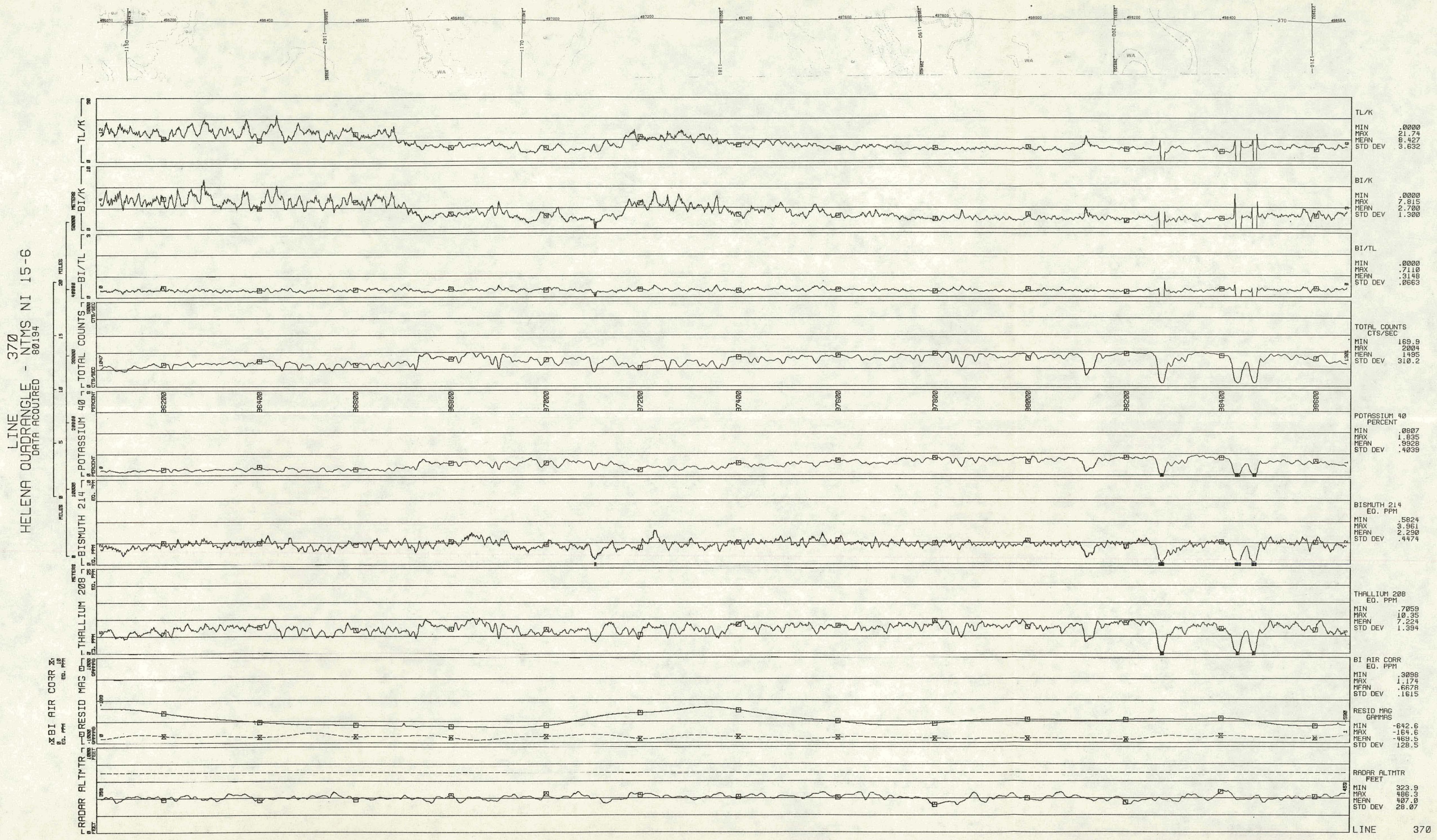
U. S. DEPARTMENT OF ENERGY

GEOLOGIC MAP EXPLANATION
HELENA QUADRANGLE
(from Martel Laboratories, 1980)

ERA		SEDIMENTARY ROCKS	EPOCH	PERIOD
CENOZOIC	Qal	**ALLUVIUM**: ALLUVIAL DEPOSITS OF PRESENT STREAMS	HOLOCENE	QUATERNARY
CENOZOIC	Qt	**PLEISTOCENE TERRACE DEPOSITS**	PLEISTOCENE	QUATERNARY
CENOZOIC	Qds	**DUNE SAND**	PLEISTOCENE	QUATERNARY
CENOZOIC	Qs	**LOESS**: GREY TO YELLOWISH-BROWN MASSIVE SILT FORMATION	PLEISTOCENE	QUATERNARY
CENOZOIC	Qsg	**SAND AND GRAVEL**	PLEISTOCENE	QUATERNARY
CENOZOIC	Tj	**JACKSON GROUP**: YAZOO CLAY AND MOODYS BRANCH FORMATION (GLAUCONITIC CLAYEY QUARTZ SAND WITH SHELLS)	EOCENE	TERTIARY
		– UNCONFORMITY –		
CENOZOIC	Tw	**WILCOX FORMATION**: IRREGULARLY BEDDED FINE TO COARSE SAND, LIGNITIC CLAY AND LIGNITE	EOCENE	TERTIARY
		– UNCONFORMITY –		
CENOZOIC	Tm	**MIDWAY GROUP**: NAHEOLA, PORTERS CREEK AND CLAYTON FORMATIONS (MOSTLY GLAUCONITIC SAND AND CLAY)	PALEOCENE	TERTIARY

APPENDIX D - Profiles

D1he


LINE 370
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DATA ACQUIRED 80194
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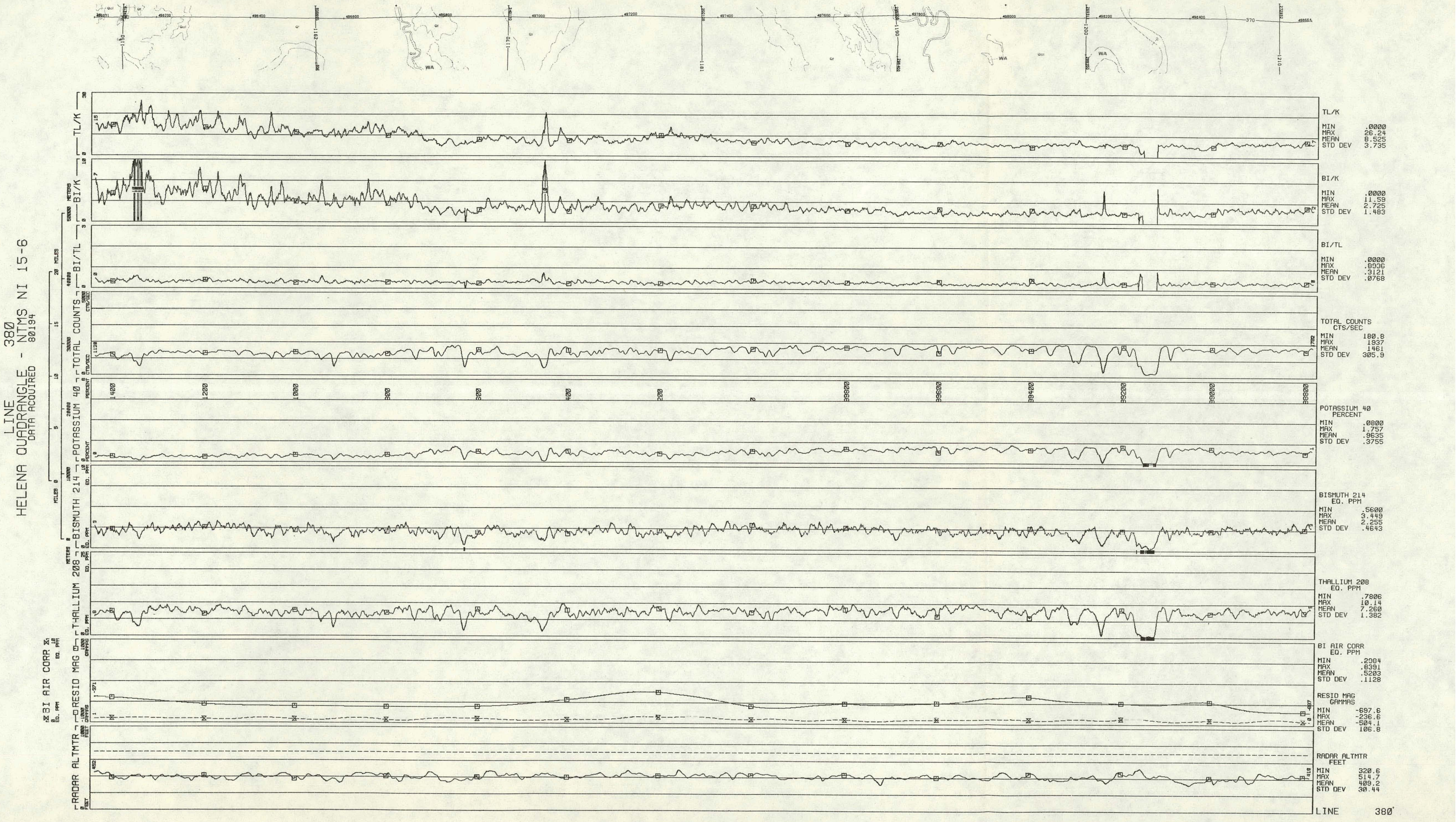
MAX 21.74
MEAN 8.427
STD DEV 3.632
BI/K
MIN .0000
MAX 7.815
MEAN 2.700
STD DEV 1.300
BI/TL
MIN .0000
MAX .7110
MEAN .3148
STD DEV .0663
TOTAL COUNTS CTS/SEC
MIN 169.9
MAX 2004
MEAN 1495
STD DEV 310.2
POTASSIUM 40 PERCENT
MIN .0807
MAX 1.835
MEAN .9928
STD DEV .4039
BISMUTH 214 EQ. PPM
MIN .5824
MAX 3.961
MEAN 2.290
STD DEV .4474
THALLIUM 208 EQ. PPM
MIN .7059
MAX 10.35
MEAN 7.224
STD DEV 1.394
BI AIR CORR EQ. PPM
MIN .3098
MAX 1.174
MFAN .6678
STD DEV .1615
RESID MAG GAMMAS
MIN -642.6
MAX -164.6
MEAN -469.5
STD DEV 128.5
RADAR ALTMTR FEET
MIN 323.9
MAX 486.3
MEAN 407.0
STD DEV 28.07
LINE 370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MAX 26.24
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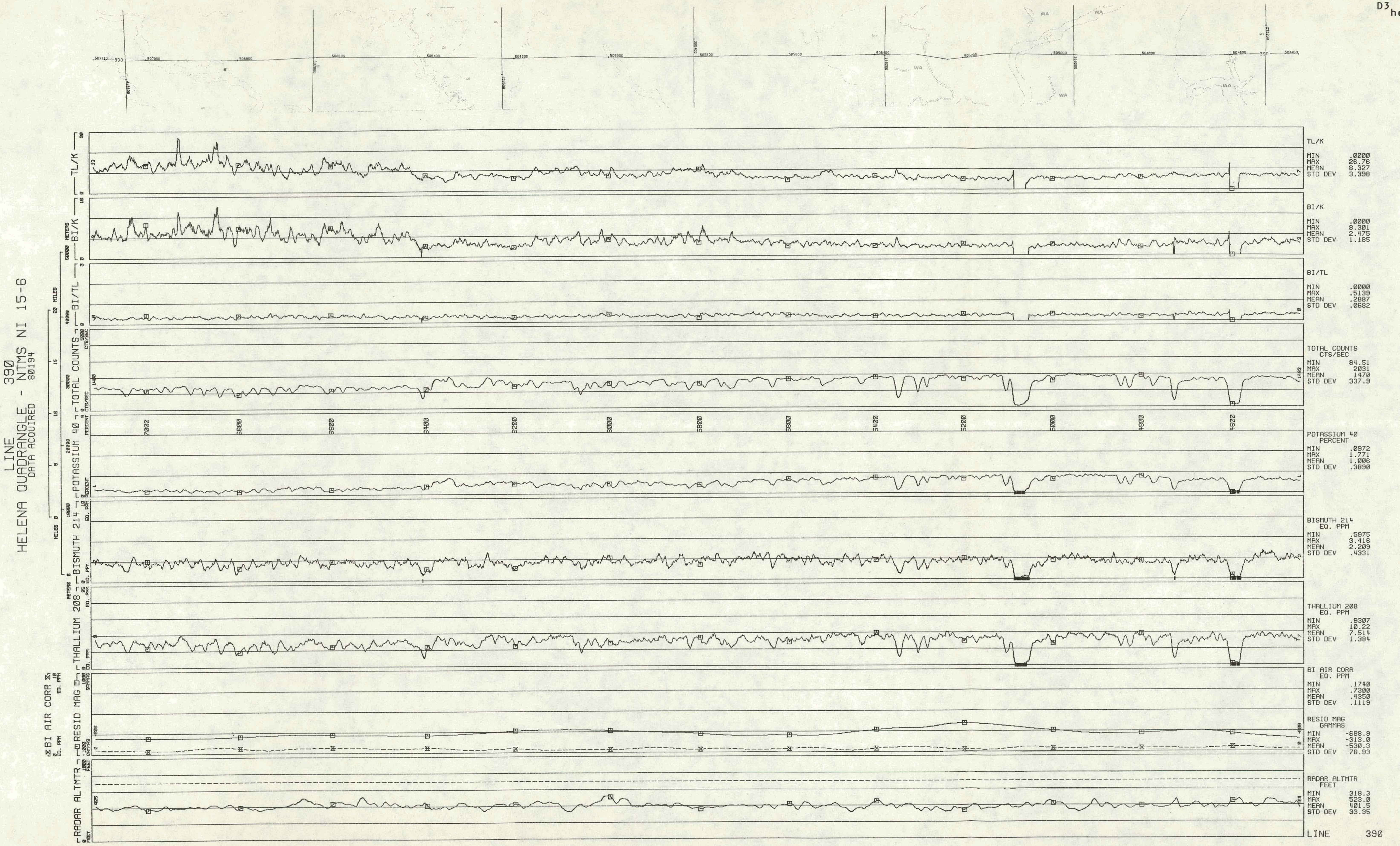
BI/K
MIN .0000
MAX 11.59
MEAN 2.725
STD DEV 1.483
BI/TL
MIN .0000
MAX .8936
MEAN .3121
STD DEV .0768
TOTAL COUNTS CTS/SEC
MIN 180.8
MAX 1937
MEAN 1461
STD DEV 305.9
POTASSIUM 40 PERCENT
MIN .0800
MAX 1.757
MEAN .9635
STD DEV .3755
BISMUTH 214 EQ. PPM
MIN .5600
MAX 3.449
MEAN 2.255
STD DEV .4643
THALLIUM 208 EQ. PPM
MIN .7806
MAX 10.14
MEAN 7.260
STD DEV 1.382
BI AIR CORR EQ. PPM
MIN .2984
MAX .8391
MEAN .5203
STD DEV .1128
RESID MAG GAMMAS
MIN -697.6
MAX -236.6
MEAN -504.1
STD DEV 106.8
RADAR ALTMTR FEET
MIN 320.6
MAX 514.7
MEAN 409.2
STD DEV 30.44
LINE 380


LINE 390
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MAX 26.76
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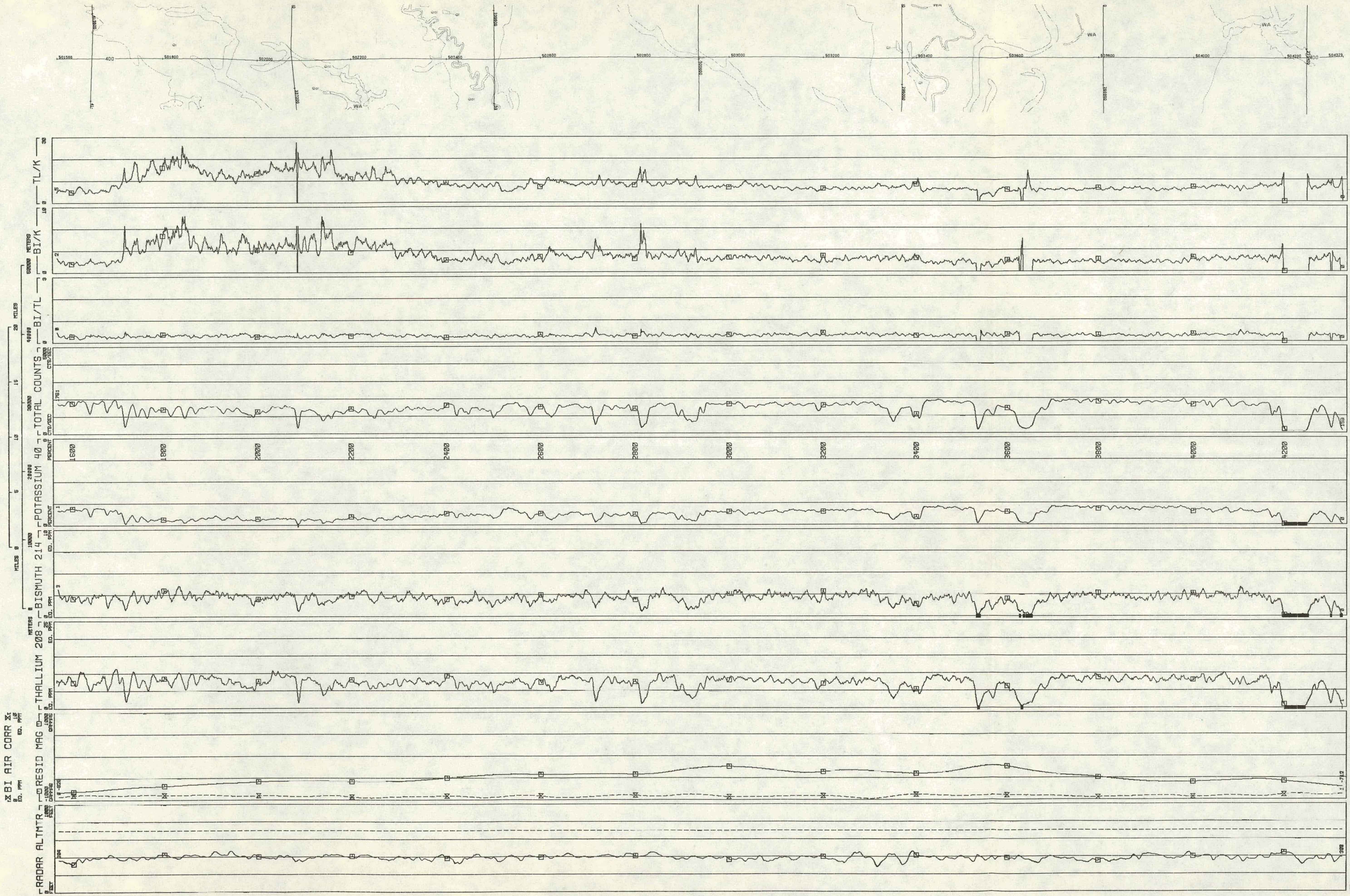
STD DEV 3.398
BI/K
MIN .0000
MAX 8.301
MEAN 2.475
STD DEV 1.185
BI/TL
MIN .0000
MAX .5139
MEAN .2887
STD DEV .0682
TOTAL COUNTS CTS/SEC
MIN 84.51
MAX 2031
MEAN 1470
STD DEV 337.9
POTASSIUM 40 PERCENT
MIN .0972
MAX 1.771
MEAN 1.006
STD DEV .3890
BISMUTH 214 EQ. PPM
MIN .5975
MAX 3.416
MEAN 2.209
STD DEV .4331
THALLIUM 208 EQ. PPM
MIN .9307
MAX 10.22
MEAN 7.514
STD DEV 1.384
BI AIR CORR EQ. PPM
MIN .1740
MAX .7300
MEAN .4350
STD DEV .1119
RESID MAG GAMMAS
MIN -688.9
MAX -313.0
MEAN -530.3
STD DEV 78.93
RADAR ALTMTR FEET
MIN 318.3
MAX 523.0
MEAN 401.5
STD DEV 33.35
LINE 390



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MEAN 8.273
STD DEV 3.966

BI/K
MIN .0000
MAX 8.606
MEAN 2.387
STD DEV 1.324

BI/TL
MIN .0000
MAX .6319
MEAN .2795
STD DEV .0755

TOTAL COUNTS
CTS/SEC
MIN 82.81
MAX 1984
MEAN 1417
STD DEV 384.5

POTASSIUM 40
PERCENT
MIN .0768
MAX 1.694
MEAN .9843
STD DEV .3989

BISMUTH 214
EQ. PPM
MIN .5506
MAX 3.516
MEAN 2.096
STD DEV .4867

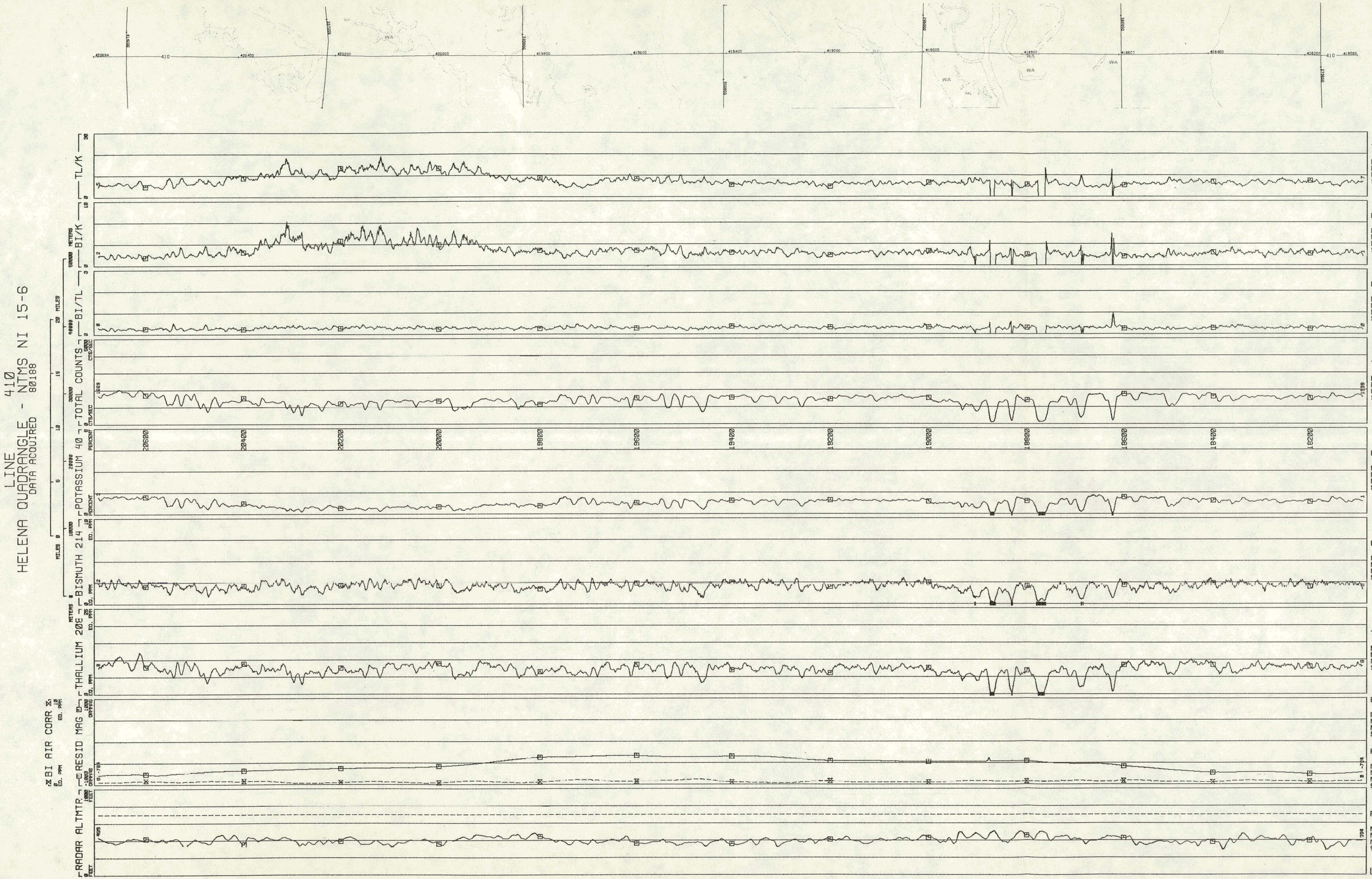
THALLIUM 208
EQ. PPM
MIN .6195
MAX 11.43
MEAN 7.221
STD DEV 1.776

BI AIR CORR
EQ. PPM
MIN .1188
MAX .6554
MEAN .4341
STD DEV .1073

RESID MAG
GAMMAS
MIN -825.9
MAX -217.3
MEAN -487.2
STD DEV 145.5

RADAR ALTMTR
FEET
MIN 284.4
MAX 466.1
MEAN 388.6
STD DEV 27.04

LINE 400



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MEAN 2.203
STD DEV .9532

BI/TL
MIN .0000
MAX .9565
MEAN .2882
STD DEV .0664

TOTAL COUNTS CTS/SEC
MIN 98.27
MAX 2037
MEAN 1388
STD DEV 299.3

POTASSIUM 40 PERCENT
MIN .0984
MAX 1.740
MEAN 1.028
STD DEV .3372

BISMUTH 214 EQ. PPM
MIN .5313
MAX 3.060
MEAN 2.084
STD DEV .4300

THALLIUM 208 EQ. PPM
MIN .7502
MAX 12.09
MEAN 7.202
STD DEV 1.467

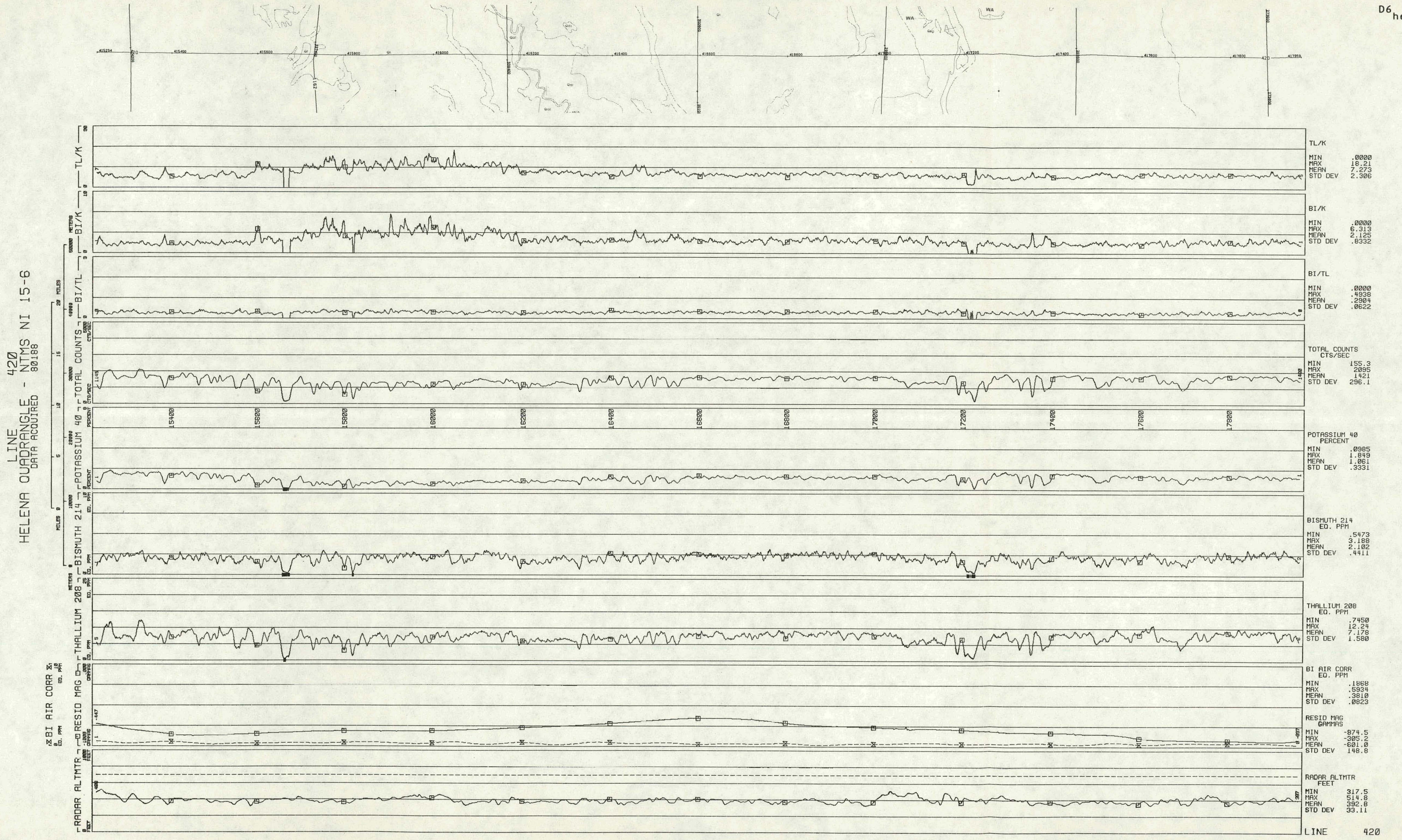
BI AIR CORR EQ. PPM
MIN .1307
MAX .5878
MEAN .3330
STD DEV .0905

RESID MAG GAMMAS
MIN -784.4
MAX -327.4
MEAN -550.4
STD DEV 144.5

RADAR ALTMTR FEET
MIN 286.9
MAX 508.8
MEAN 399.6
STD DEV 35.05

LINE 410

D6 he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HELENA QUADRANGLE - NTMS NI 15-6
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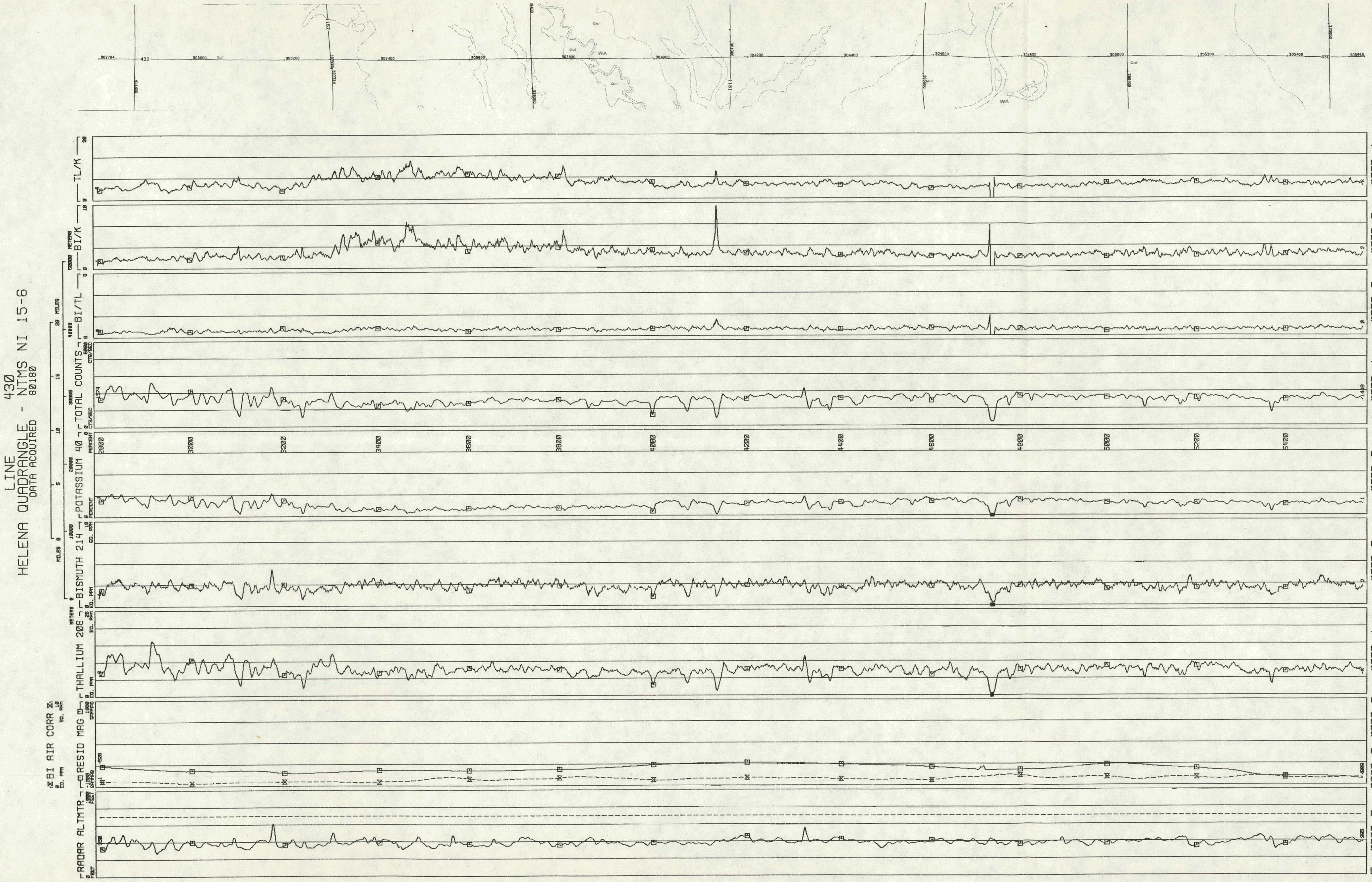
MAX 18.21
MEAN 7.273
STD DEV 2.306
BI/K
MIN .0000
MAX 6.313
MEAN 2.125
STD DEV .8332
BI/TL
MIN .0000
MAX .4938
MEAN .2904
STD DEV .0622
TOTAL COUNTS CTS/SEC
MIN 155.3
MAX 2095
MEAN 1421
STD DEV 296.1
POTASSIUM 40 PERCENT
MIN .0985
MAX 1.849
MEAN 1.061
STD DEV .3331
BISMUTH 214 EQ. PPM
MIN .5473
MAX 3.188
MEAN 2.102
STD DEV .4411
THALLIUM 208 EQ. PPM
MIN .7450
MAX 12.24
MEAN 7.176
STD DEV 1.580
BI AIR CORR EQ. PPM
MIN .1868
MAX .5934
MEAN .3610
STD DEV .0823
RESID MAG GAMMAS
MIN -874.5
MAX -305.2
MEAN -601.0
STD DEV 148.8
RADAR ALTMTR FEET
MIN 317.5
MAX 514.8
MEAN 392.8
STD DEV 33.11
LINE 420



TL/K

MIN	.0000
MAX	17.97
MEAN	7.453
STD DEV	2.342

BI/K

MIN	.0000
MAX	9.541
MEAN	2.312
STD DEV	.9322

BI/TL

MIN	.0000
MAX	.9343
MEAN	.3094
STD DEV	.0672

TOTAL COUNTS
CTS/SEC

MIN	215.6
MAX	2601
MEAN	1536
STD DEV	271.1

POTASSIUM 40
PERCENT

MIN	.1137
MAX	2.164
MEAN	1.078
STD DEV	.3367

BISMUTH 214
EQ. PPM

MIN	.7118
MAX	4.277
MEAN	2.271
STD DEV	.4332

THALLIUM 208
EQ. PPM

MIN	.7571
MAX	16.18
MEAN	7.474
STD DEV	1.538

BI AIR CORR
EQ. PPM

MIN	.3350
MAX	1.235
MEAN	.7502
STD DEV	.1934

RESID MAG
GAMMAS

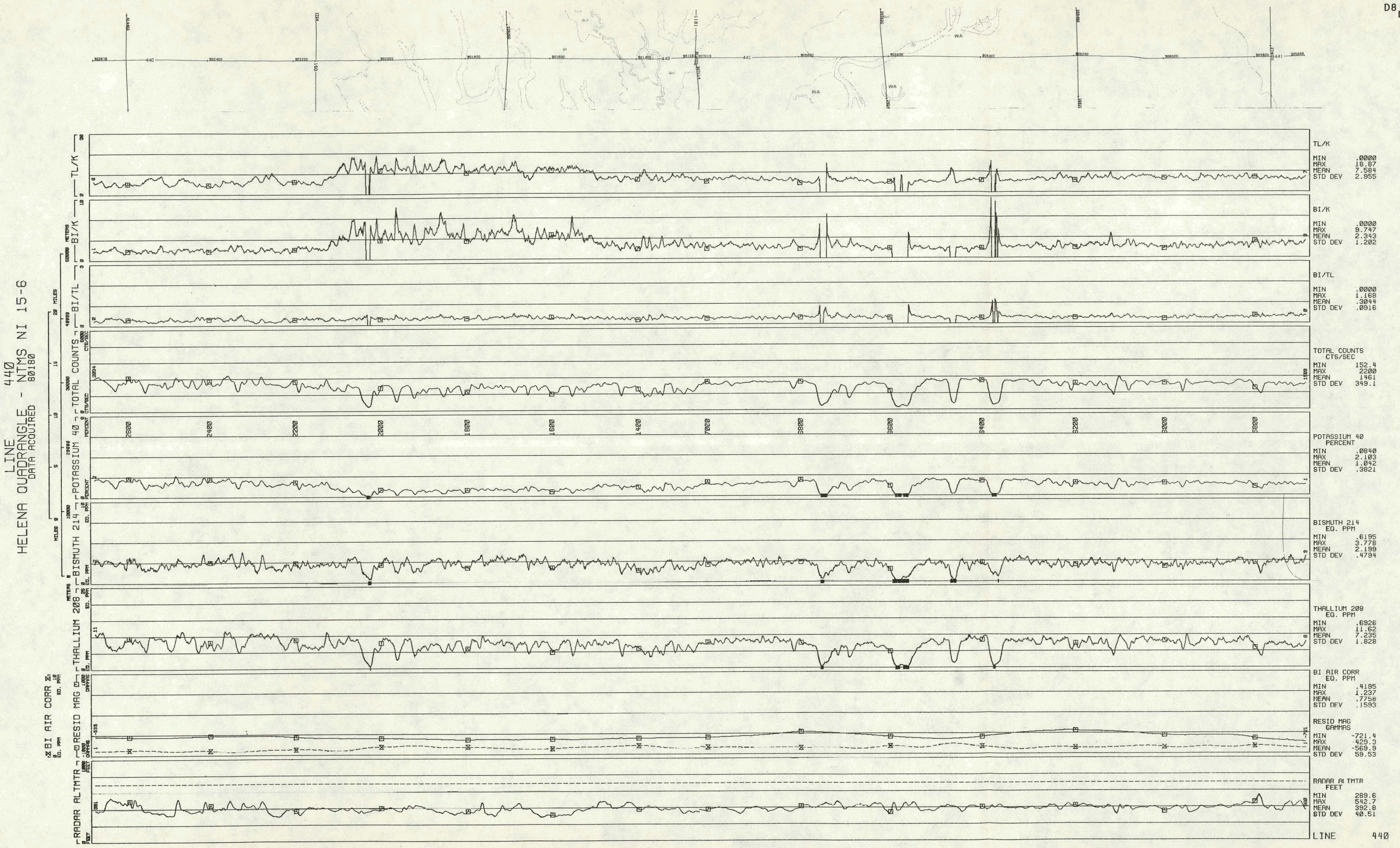
MIN	-868.2
MAX	-467.0
MEAN	-611.1
STD DEV	87.30

RADAR ALTMTR
FEET

MIN	274.9
MAX	607.9
MEAN	387.8
STD DEV	33.86

LINE 430

D8 he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DATA ACQUIRED 80180
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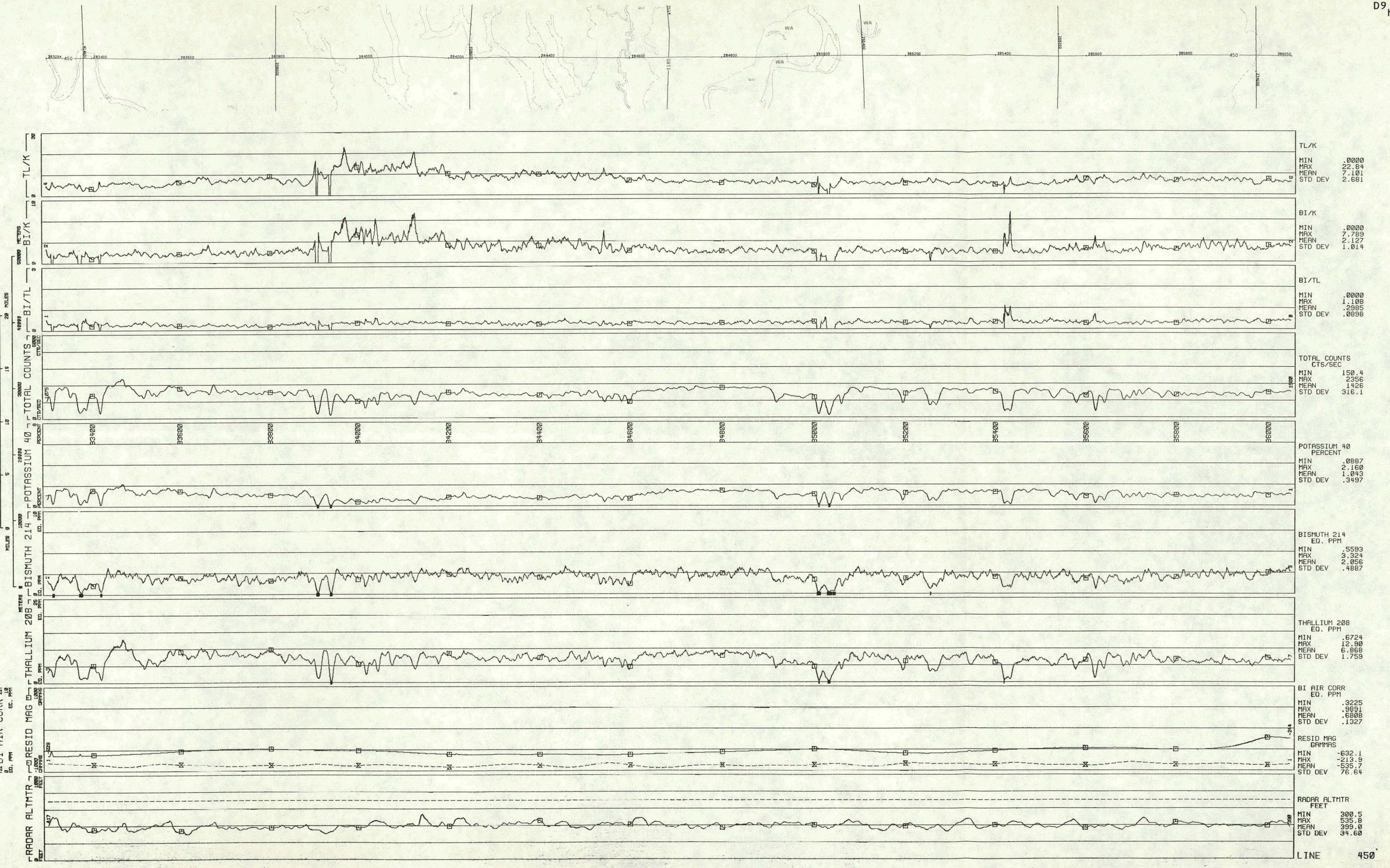
MIN .0000
MAX 18.87
MEAN 7.584
STD DEV 2.955
BI/K
MIN .0000
MAX 9.747
MEAN 2.343
STD DEV 1.202
BI/TL
MIN .0000
MAX 1.168
MEAN .3044
STD DEV .0916
TOTAL COUNTS
CTS/SEC
MIN 152.4
MAX 2200
MEAN 1461
STD DEV 349.1
POTASSIUM 40
PERCENT
MIN .0840
MAX 2.103
MEAN 1.042
STD DEV .3821
BISMUTH 214
EQ. PPM
MIN .6195
MAX 3.778
MEAN 2.199
STD DEV .4794
THALLIUM 208
EQ. PPM
MIN .6926
MAX 11.62
MEAN 7.235
STD DEV 1.828
BI AIR CORR
EQ. PPM
MIN .4195
MAX 1.237
MEAN .7758
STD DEV .1593
RESID MAG
GAMMAS
MIN -721.4
MAX 429.3
MEAN -569.9
STD DEV 59.53
RADAR ALTMTR
FEET
MIN 289.6
MAX 542.7
MEAN 392.8
STD DEV 40.51
LINE 440

LINE 450
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80179



LINE 460
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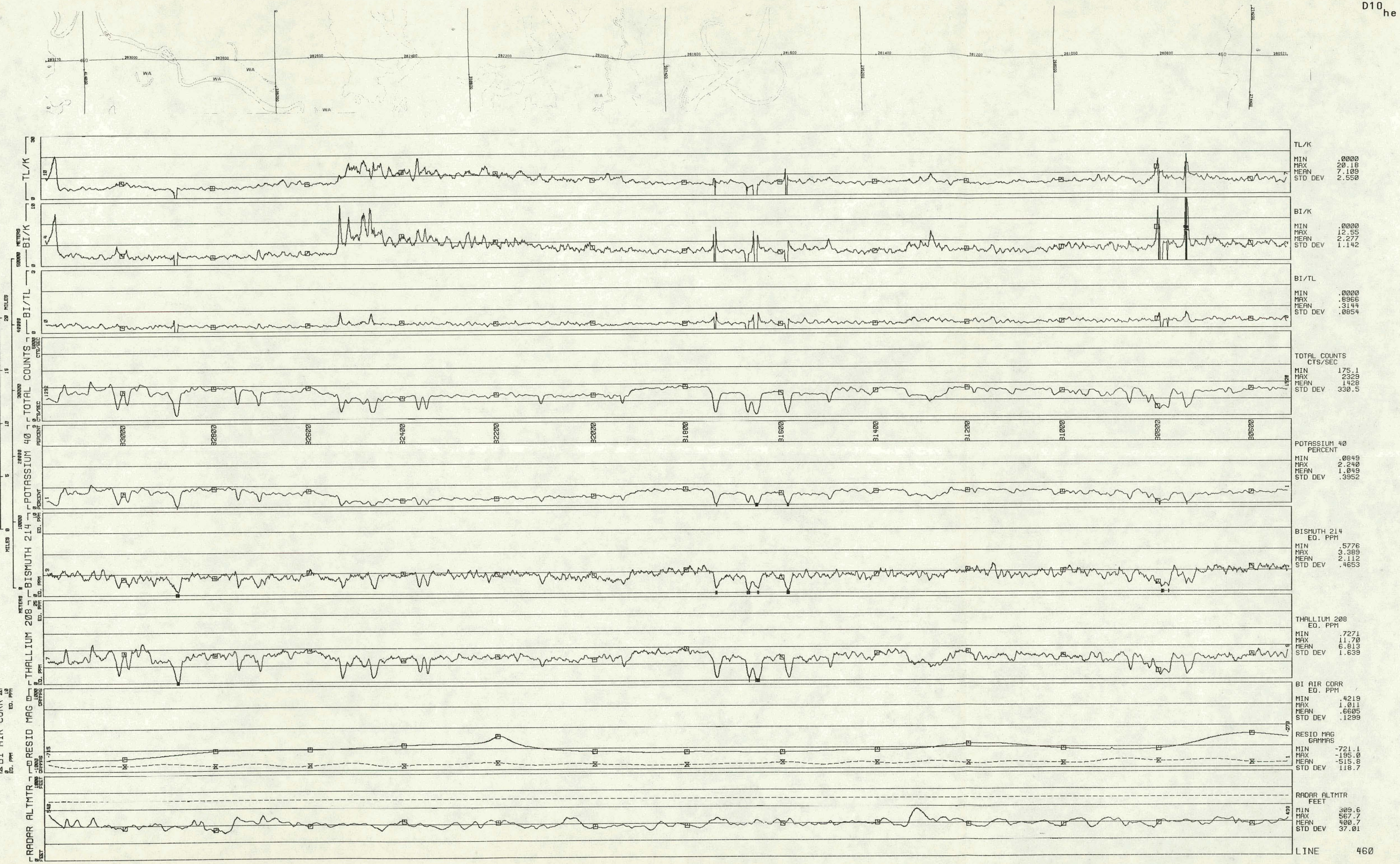

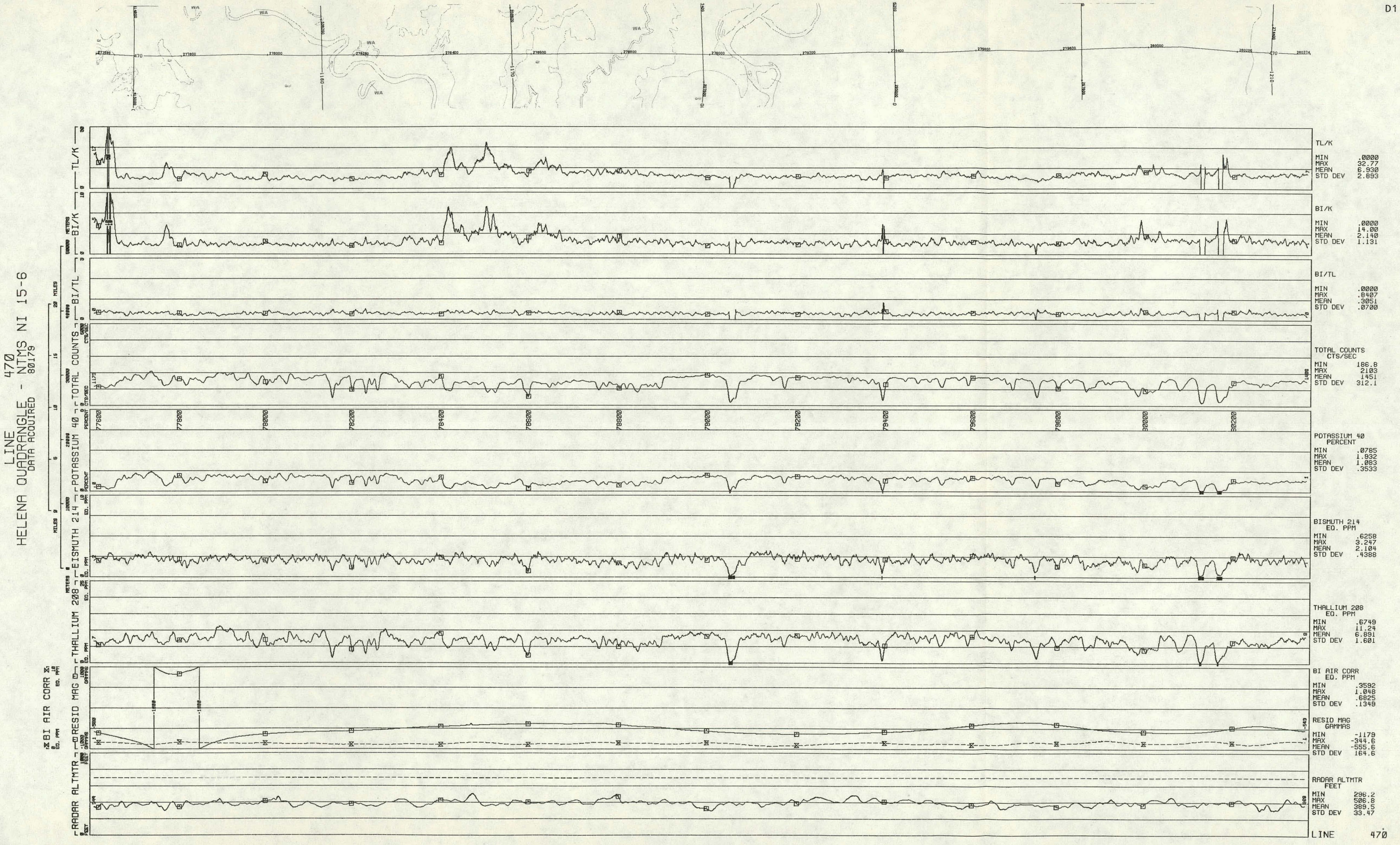
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DATA ACQUIRED 80179
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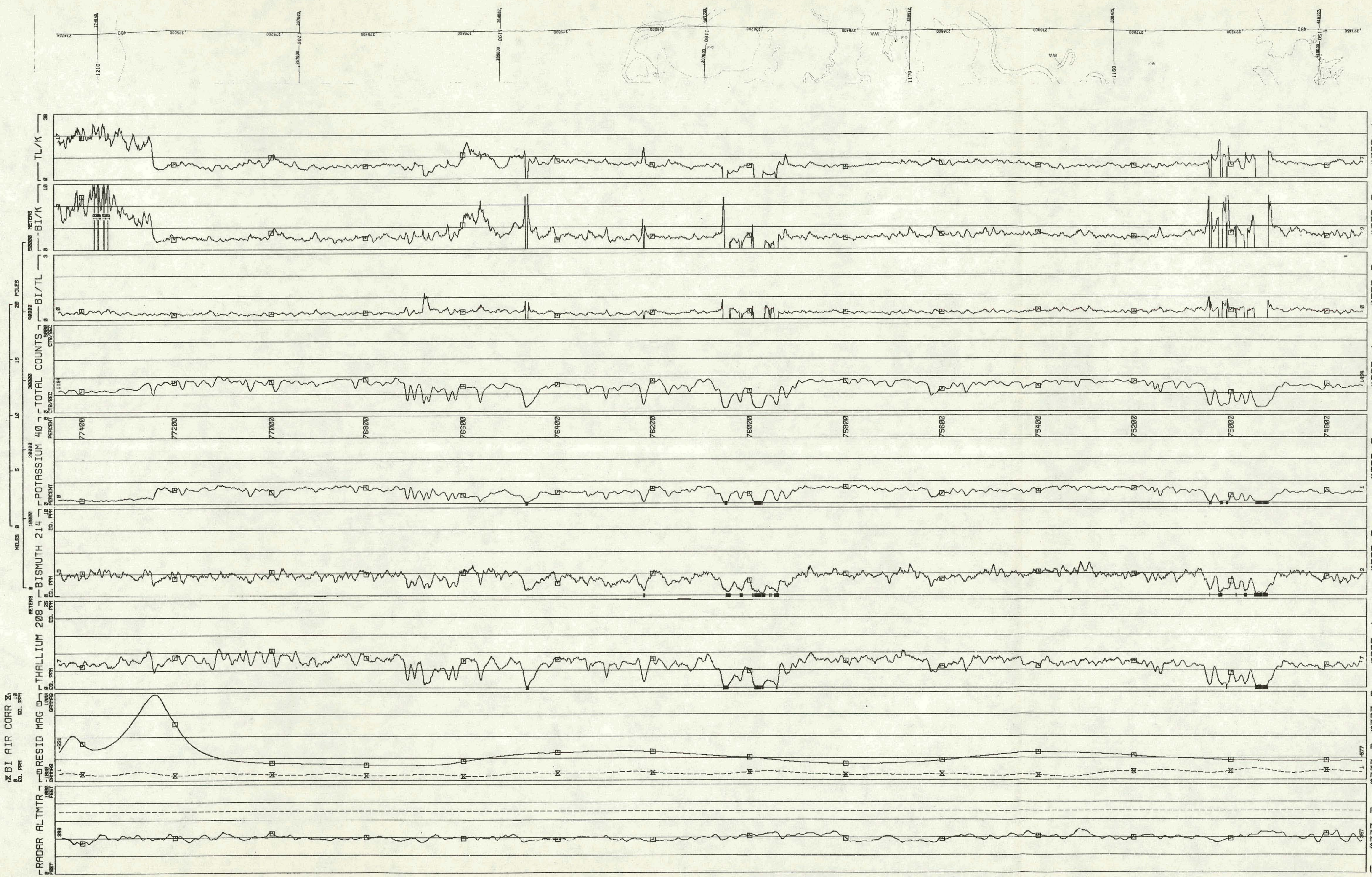
MEAN 6.930
STD DEV 2.893
BI/K
MIN .0000
MAX 14.00
MEAN 2.140
STD DEV 1.131
BI/TL
MIN .0000
MAX .8407
MEAN .3051
STD DEV .0700
TOTAL COUNTS CTS/SEC
MIN 186.8
MAX 2103
MEAN 1451
STD DEV 312.1
POTASSIUM 40 PERCENT
MIN .0785
MAX 1.932
MEAN 1.083
STD DEV .3533
BISMUTH 214 EQ. PPM
MIN .6258
MAX 3.247
MEAN 2.104
STD DEV .4388
THALLIUM 208 EQ. PPM
MIN .6749
MAX 11.24
MEAN 6.891
STD DEV 1.601
BI AIR CORR EQ. PPM
MIN .3592
MAX 1.048
MEAN .6825
STD DEV .1349
RESID MAG GAMMAS
MIN -1179
MAX -344.6
MEAN -555.6
STD DEV 164.6
RADAR ALTMTR FEET
MIN 296.2
MAX 506.8
MEAN 389.5
STD DEV 33.47
LINE 470

LINE 480
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80179



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MEAN 7.230
STD DEV 3.906

BI/K
MIN .0000
MAX 10.59
MEAN 2.319
STD DEV 1.520

BI/TL
MIN .0000
MAX 1.190
MEAN .3126
STD DEV .1118

TOTAL COUNTS
CTS/SEC
MIN 177.0
MAX 2032
MEAN 1388
STD DEV 376.8

POTASSIUM 40
PERCENT
MIN .0834
MAX 1.706
MEAN 1.023
STD DEV .3700

BISMUTH 214
EQ. PPM
MIN .5561
MAX 3.738
MEAN 2.119
STD DEV .5396

THALLIUM 208
EQ. PPM
MIN .7005
MAX 11.22
MEAN 6.748
STD DEV 1.937

BI AIR CORR
EQ. PPM
MIN .3616
MAX 1.280
MEAN .7479
STD DEV .1826

RESID MAG
GAMMAS
MIN -665.6
MAX 964.6
MEAN -439.4
STD DEV 264.5

RADAR ALTMTR
FEET
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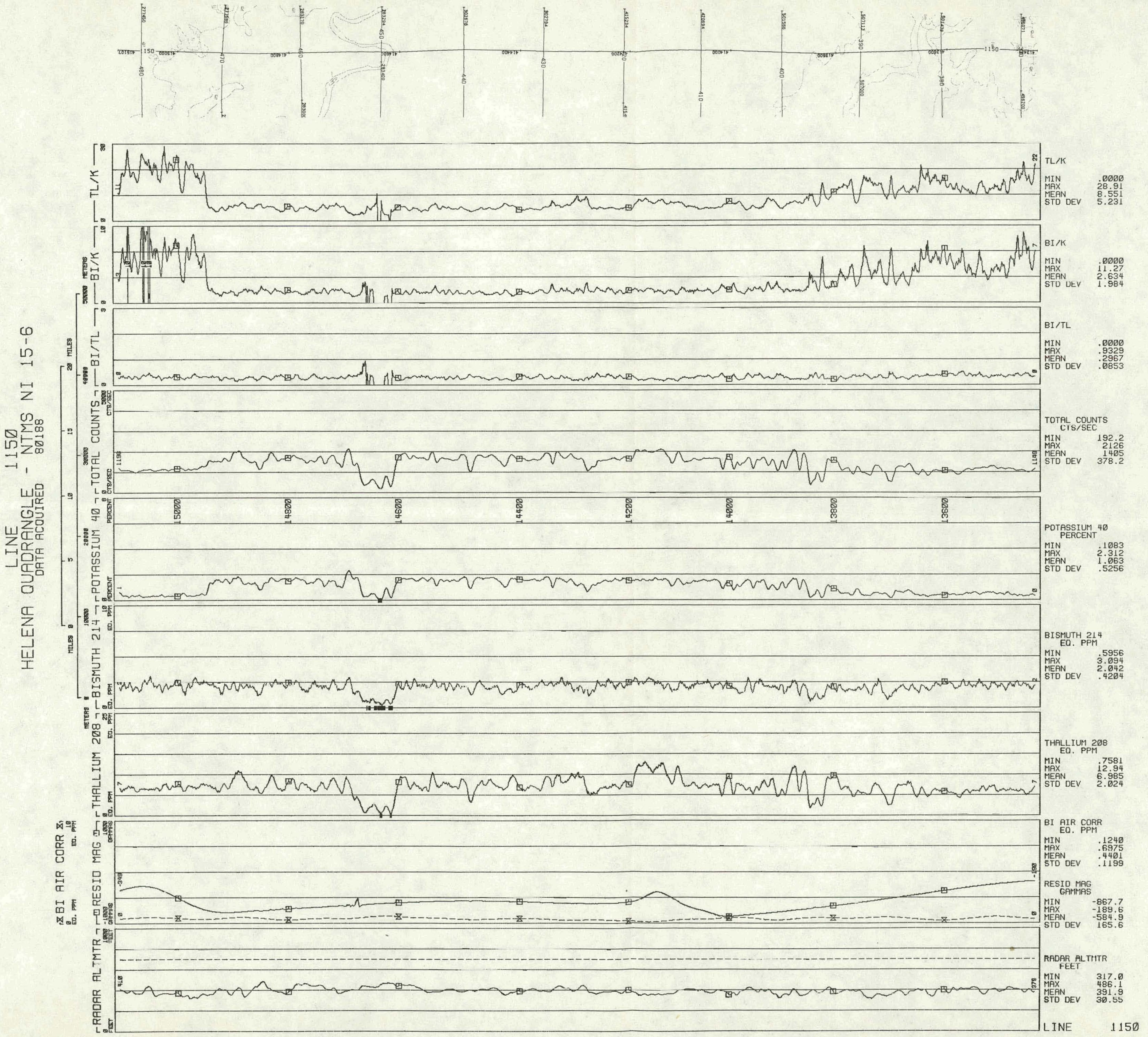
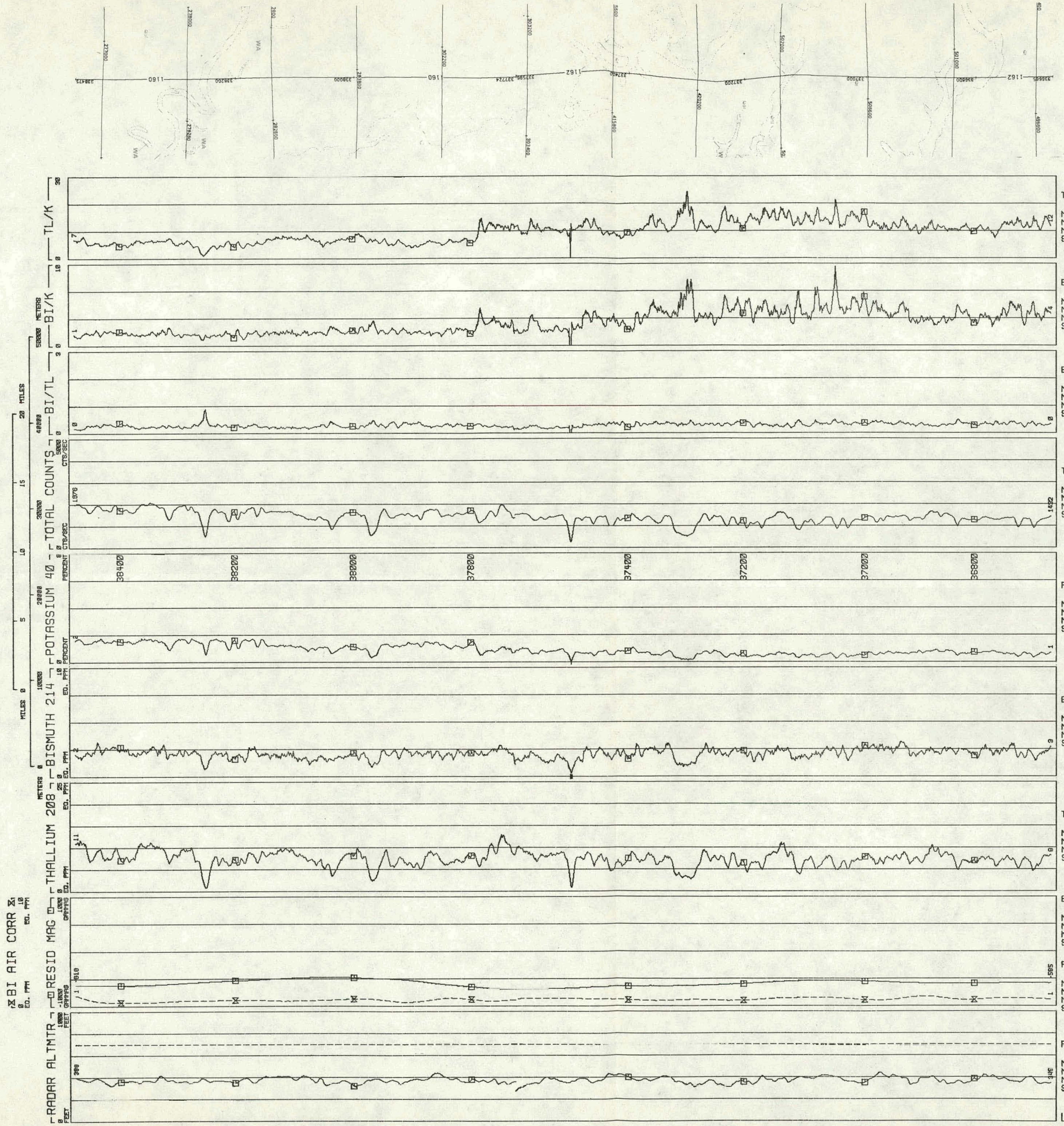
MAX 492.8
MEAN 398.1
STD DEV 27.47

LINE 480



LINE 1150
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80188
TL/K
BI/K
BI/TL
TOTAL COUNTS
POTASSIUM 40
BISMUTH 214
THALLIUM 208
BI AIR CORR
RESID MAG
RADAR ALTMTR
15000
14800
14600
14400
14200
14000
13800
13600
TL/K MIN .0000 MAX 28.91 MEAN 8.551 STD DEV 5.231
BI/K MIN .0000 MAX 11.27 MEAN 2.634 STD DEV 1.884
BI/TL MIN .0000 MAX .9329 MEAN .2967 STD DEV .0853
TOTAL COUNTS CTS/SEC MIN 192.2 MAX 2126 MEAN 1405 STD DEV 378.2
POTASSIUM 40 PERCENT MIN .1083 MAX 2.312 MEAN 1.063 STD DEV .5256
BISMUTH 214 EQ. PPM MIN .5956 MAX 3.094 MEAN 2.042 STD DEV .4204
THALLIUM 208 EQ. PPM MIN .7581 MAX 12.94 MEAN 6.985 STD DEV 2.024
BI AIR CORR EQ. PPM MIN .1240 MAX .6975 MEAN .4401 STD DEV .1199
RESID MAG GAMMAS MIN -867.7 MAX -189.6 MEAN -584.9 STD DEV 165.6
RADAR ALTMTR FEET MIN 317.0 MAX 486.1 MEAN 391.9 STD DEV 30.55
LINE 1150

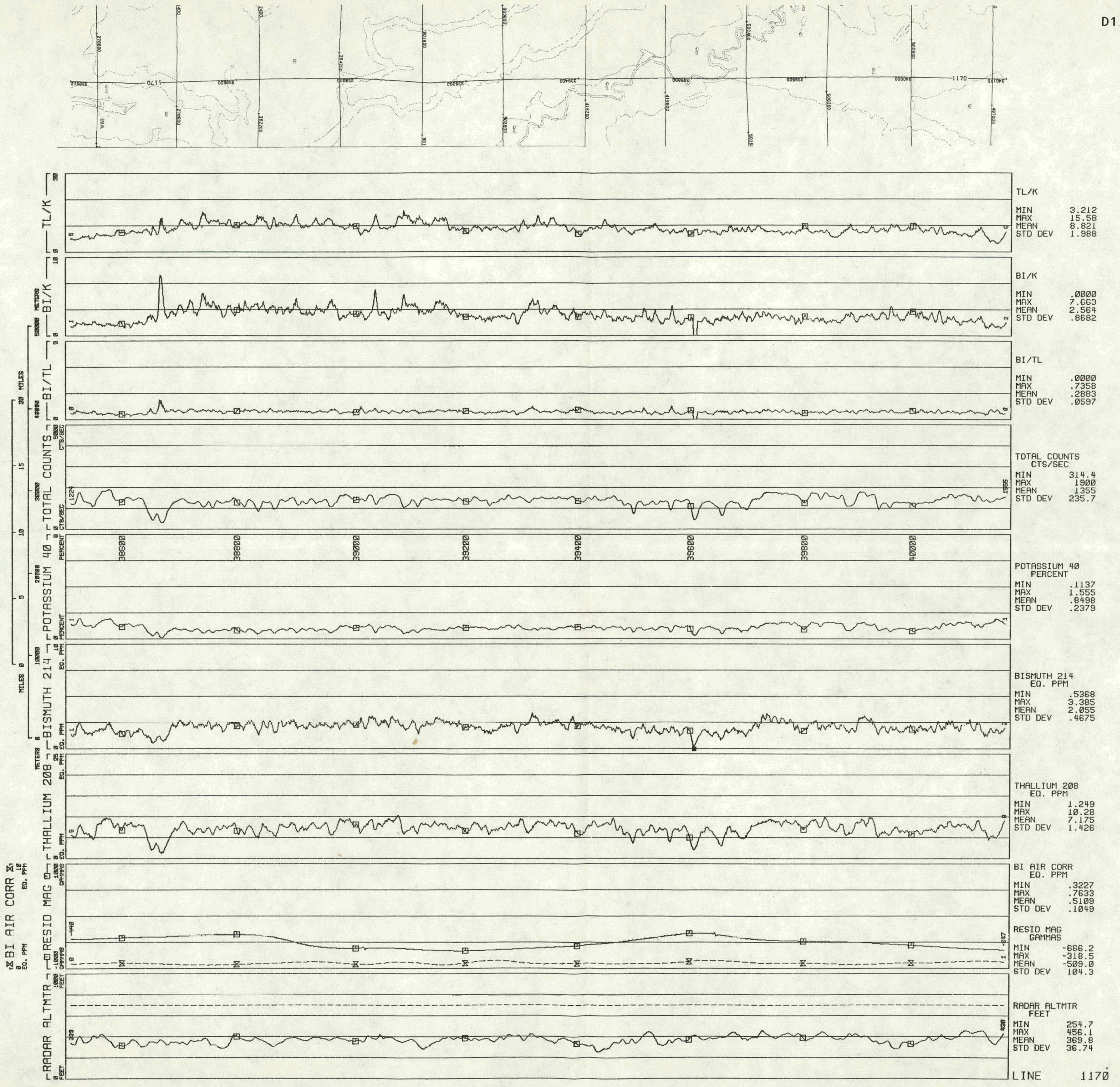
LINE 1160
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80186



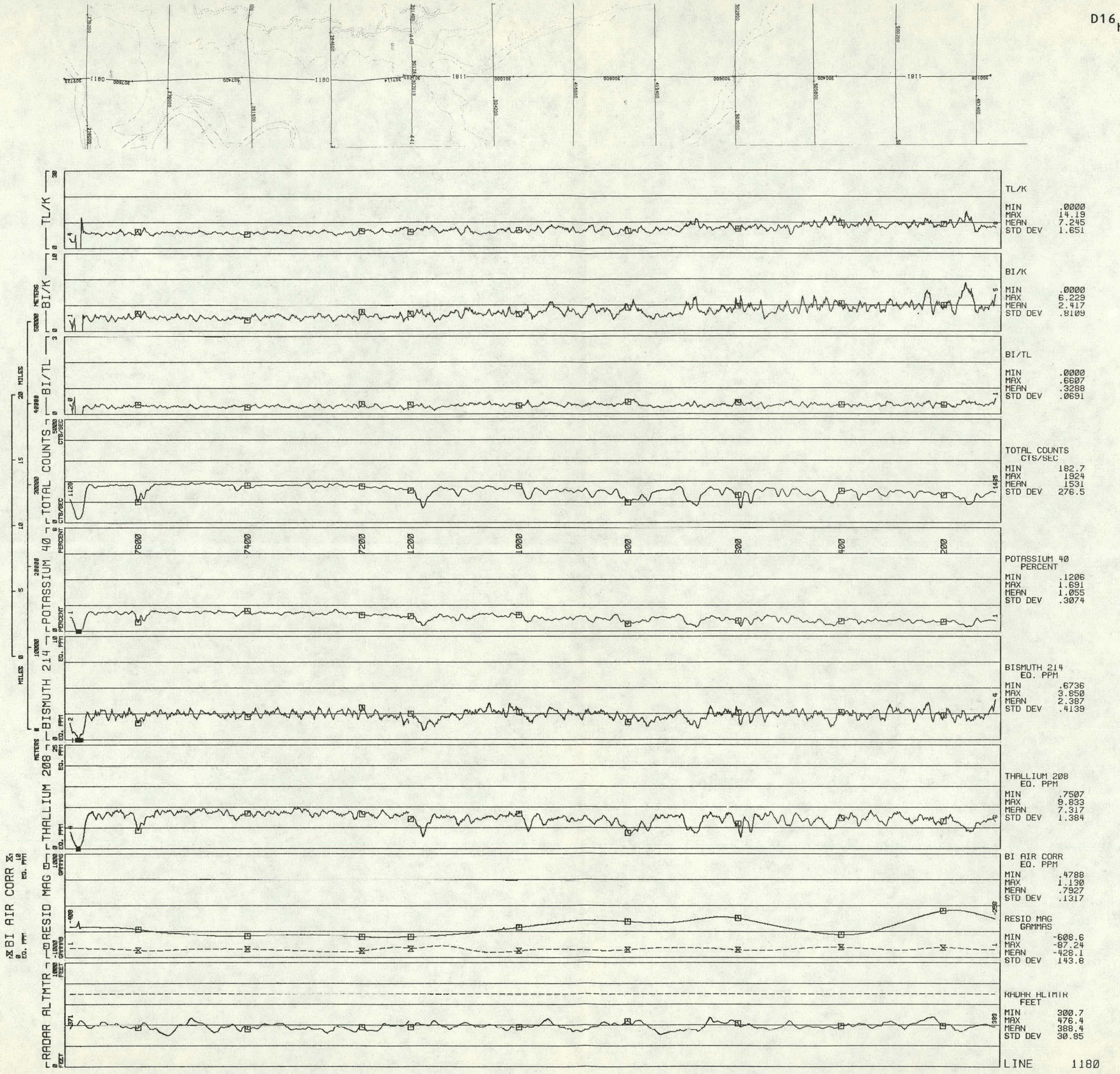
TL/K	
MIN	.0000
MAX	24.13
MEAN	9.625
STD DEV	3.680
BI/K	
MIN	.0000
MAX	9.631
MEAN	2.819
STD DEV	1.372
BI/TL	
MIN	.0000
MAX	.8776
MEAN	.2907
STD DEV	.0714
TOTAL COUNTS CTS/SEC	
MIN	267.5
MAX	2073
MEAN	1404
STD DEV	292.5
POTASSIUM 40 PERCENT	
MIN	.0885
MAX	1.753
MEAN	.8971
STD DEV	.4050
BISMUTH 214 EQ. PPM	
MIN	.6510
MAX	3.174
MEAN	2.078
STD DEV	.4229
THALLIUM 208 EQ. PPM	
MIN	.8748
MAX	12.85
MEAN	7.387
STD DEV	1.732
BI AIR CORR EQ. PPM	
MIN	.3267
MAX	.9743
MEAN	.5795
STD DEV	.1178
RESID MAG GAMMAS	
MIN	-694.9
MAX	-469.3
MEAN	-585.2
STD DEV	57.90
RADAR ALTMTR FEET	
MIN	276.5
MAX	440.8
MEAN	372.4
STD DEV	25.84

LINE 1160

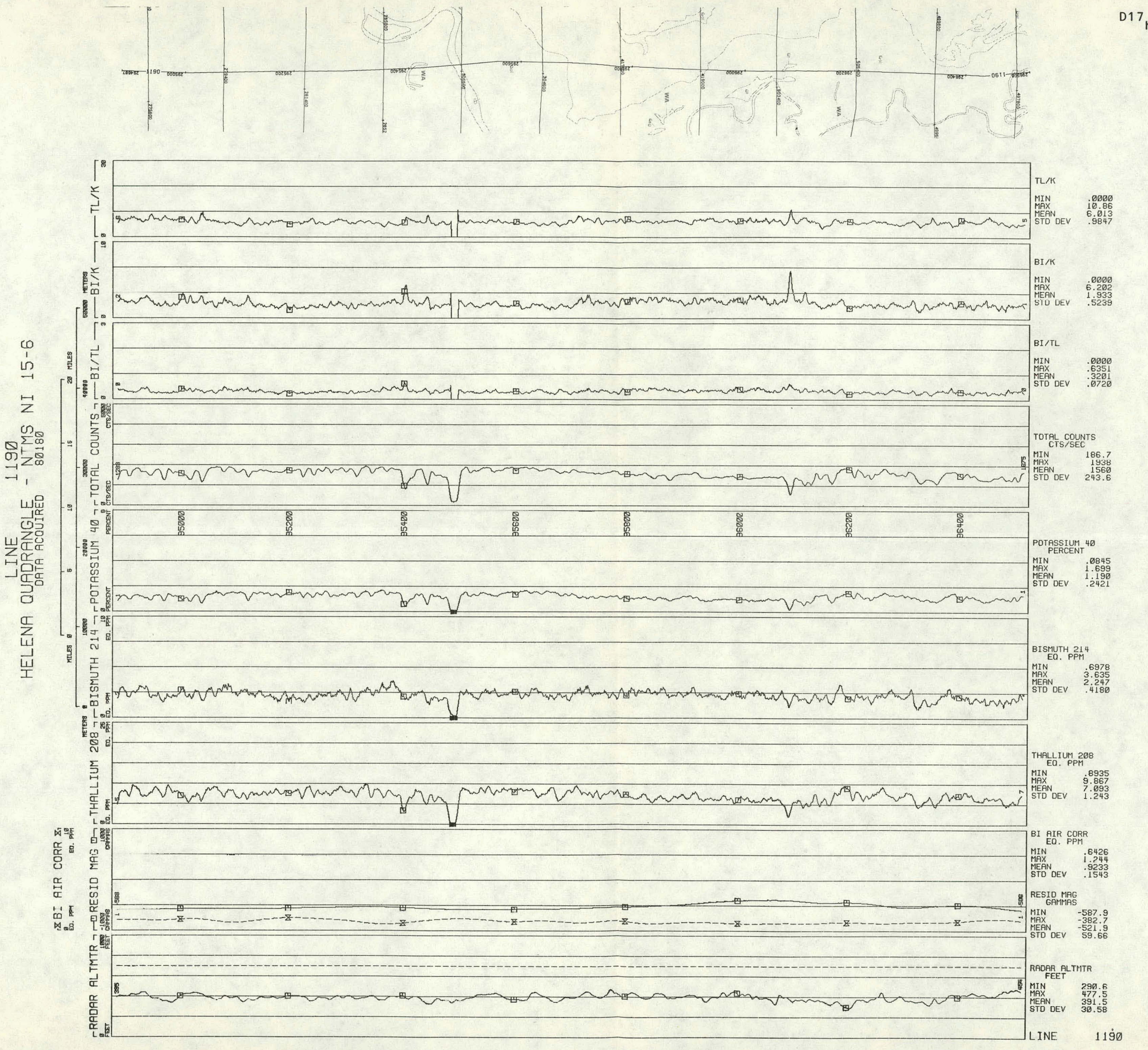
LINE 1170
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80186



LINE 1180
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED - 80180

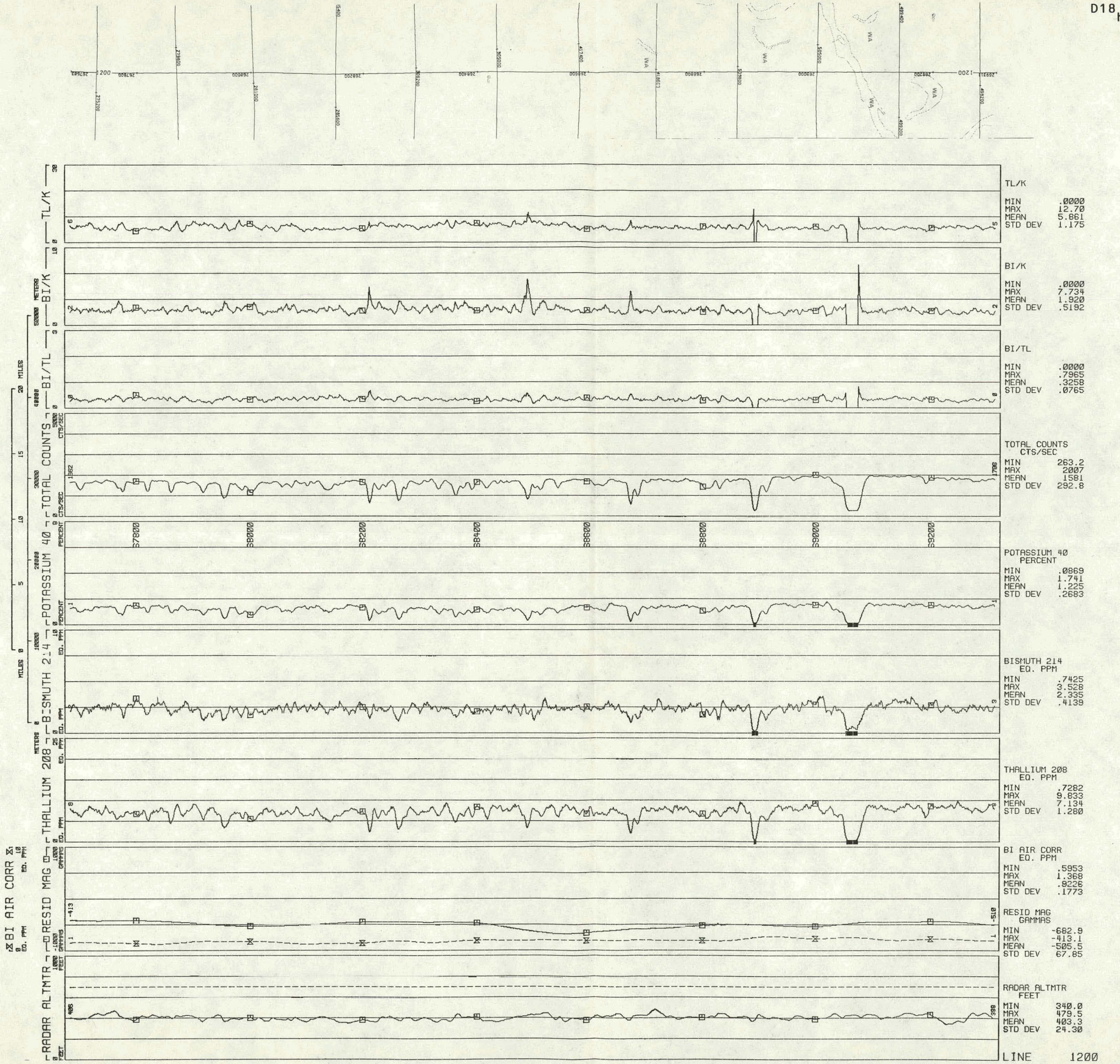


D17 he



LINE 1190
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80180
TL/K
BI/K
BI/TL
TOTAL COUNTS
POTASSIUM 40
BISMUTH 214
THALLIUM 208
BI AIR CORR
RESID MAG
RADAR ALTMTR
TL/K
MIN .0000
MAX 10.86
MEAN 6.013
STD DEV .9847
BI/K
MIN .0000
MAX 6.202
MEAN 1.933
STD DEV .5239
BI/TL
MIN .0000
MAX .6351
MEAN .3201
STD DEV .0720
TOTAL COUNTS CTS/SEC
MIN 186.7
MAX 1938
MEAN 1560
STD DEV 243.6
POTASSIUM 40 PERCENT
MIN .0845
MAX 1.699
MEAN 1.190
STD DEV .2421
BISMUTH 214 EQ. PPM
MIN .6978
MAX 3.635
MEAN 2.247
STD DEV .4180
THALLIUM 208 EQ. PPM
MIN .8935
MAX 9.867
MEAN 7.093
STD DEV 1.243
BI AIR CORR EQ. PPM
MIN .6426
MAX 1.244
MEAN .9233
STD DEV .1543
RESID MAG GAMMAS
MIN -587.9
MAX -382.7
MEAN -521.9
STD DEV 59.66
RADAR ALTMTR FEET
MIN 290.6
MAX 477.5
MEAN 391.5
STD DEV 30.58
LINE 1190

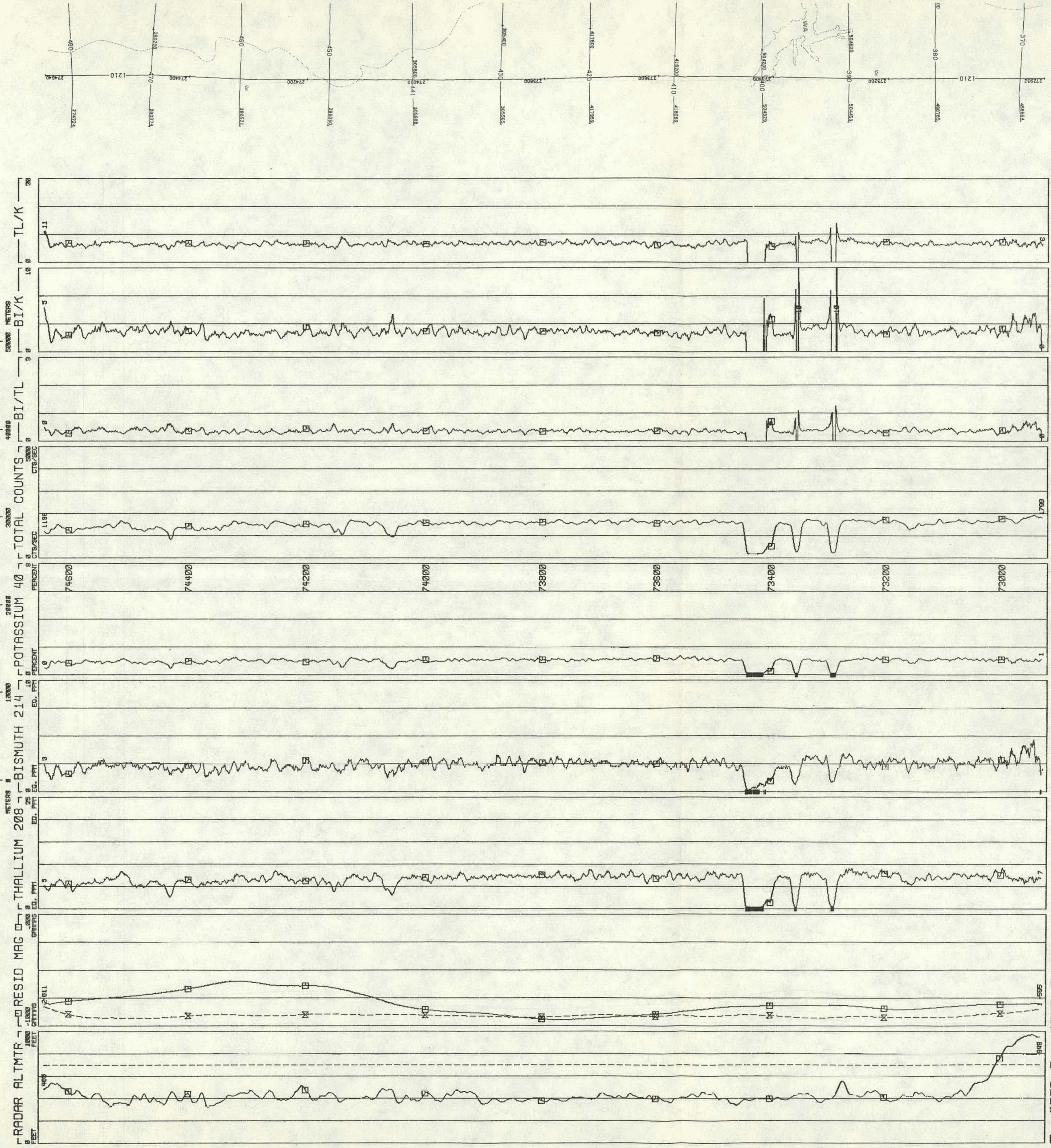
LINE 1200
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80179



LINE 1210

HELENA QUADRANGLE - NTMS NI 15-6

DATA ACQUIRED - 80179



TL/K
MIN .0000
MAX 13.81
MEAN 6.522
STD DEV 1.289

BI/K
MIN .0000
MAX 13.28
MEAN 2.384
STD DEV .7648

BI/TL
MIN .0000
MAX 1.239
MEAN .3583
STD DEV .1006

TOTAL COUNTS
CTS/SEC
MIN 171.7
MAX 1922
MEAN 1472
STD DEV 286.4

POTASSIUM 40
PERCENT
MIN .0944
MAX 1.347
MEAN 1.004
STD DEV .1704

BISMUTH 214
EQ. PPM
MIN .5980
MAX 4.645
MEAN 2.390
STD DEV .4884

THALLIUM 208
EQ. PPM
MIN .8283
MAX 9.105
MEAN 6.674
STD DEV 1.216

BI AIR CORR
EQ. PPM
MIN .6941
MAX 1.699
MEAN .9021
STD DEV .1513

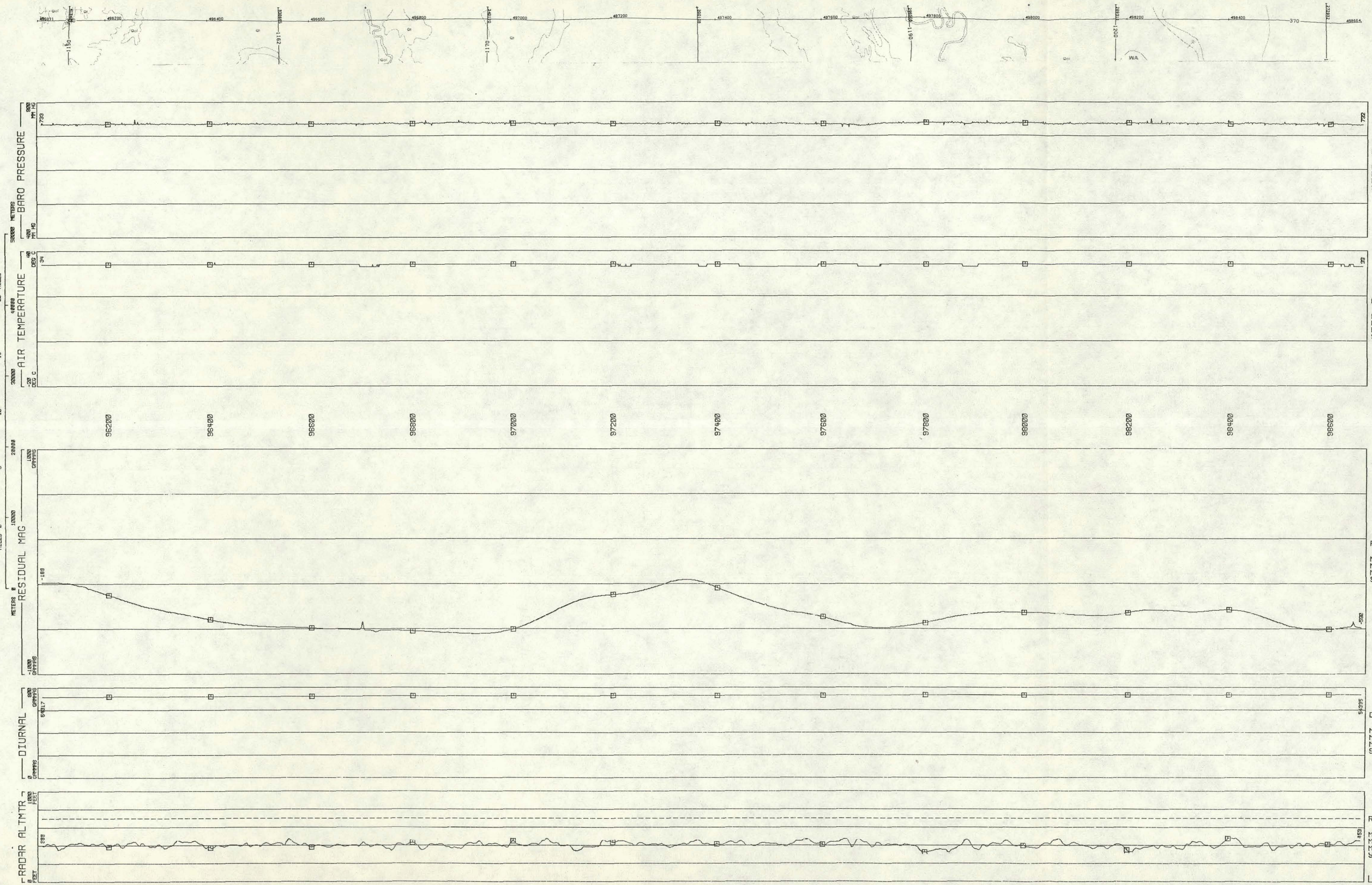
RESID MAG
GAMMAS
MIN -889.9
MAX -196.6
MEAN -605.1
STD DEV 189.3

RADAR ALTMTR
FEET
MIN 319.7
MAX 970.2
MEAN 438.3
STD DEV 108.2

LINE 1210

D20he

LINE 370
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80194



BARO PRESSURE
MM HG
MIN 726.4
MAX 749.0
MEAN 735.9
STD DEV 1.674

AIR TEMPERATURE
DEG C
MIN 33.00
MAX 35.00
MEAN 33.87
STD DEV .3345

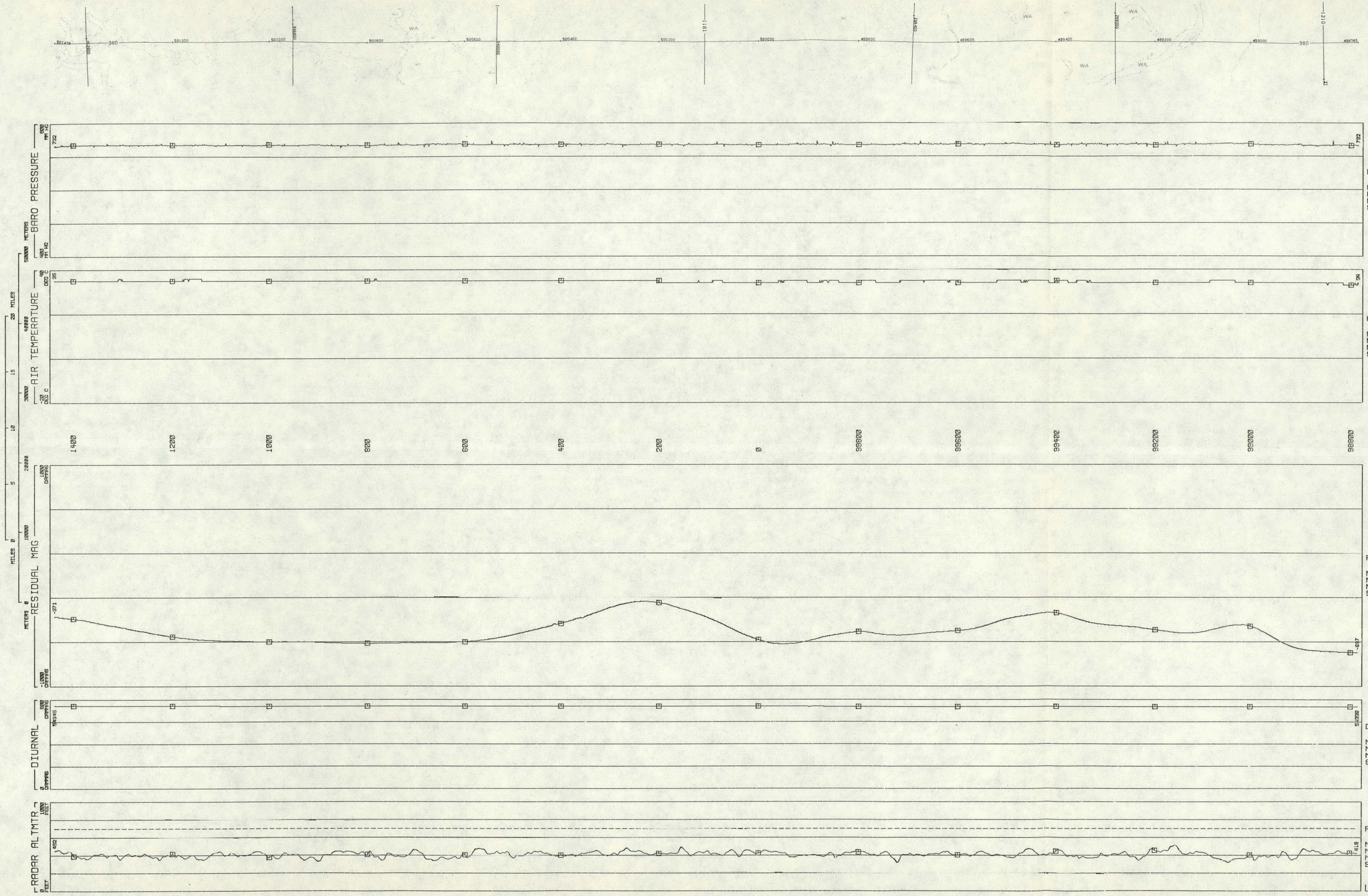
RESIDUAL MAG
GAMMAS
MIN -642.6
MAX -164.6
MEAN -469.5
STD DEV 128.5

DIURNAL
GAMMAS
MIN 54317
MAX 54335
MEAN 54319
STD DEV 9.539

RADAR ALTMTR
FEET
MIN 323.9
MAX 486.3
MEAN 407.0
STD DEV 28.07

LINE 370

LINE 380
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80194



BARO PRESSURE
MM HG

MIN	727.7
MAX	745.4
MEAN	735.4
STD DEV	1.503

AIR TEMPERATURE
DEG C

MIN	33.00
MAX	36.00
MEAN	34.64
STD DEV	.5362

RESIDUAL MAG
GAMMAS

MIN	-697.6
MAX	-236.6
MEAN	-504.1
STD DEV	106.8

DIURNAL
GAMMAS

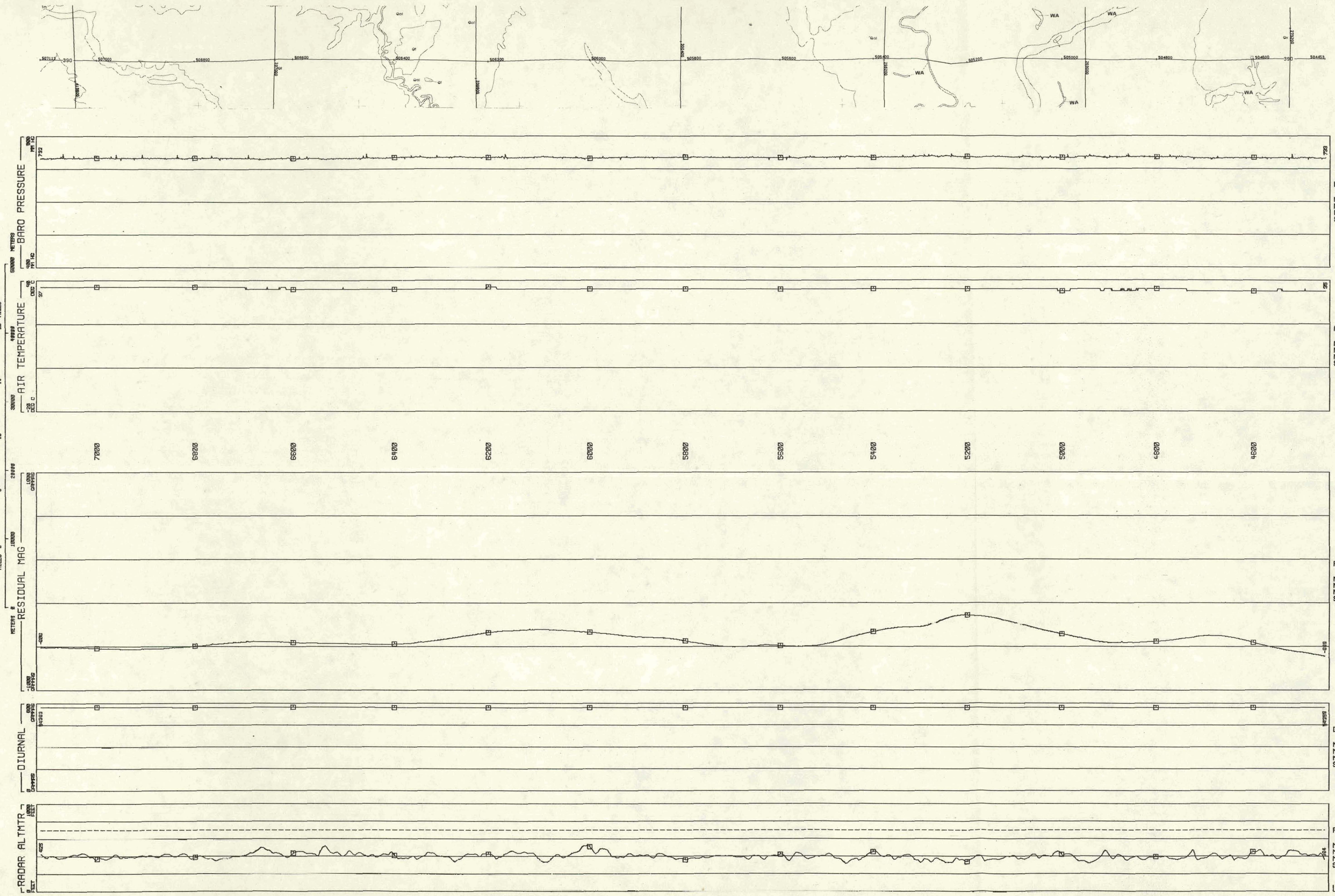
MIN	54336
MAX	54345
MEAN	54334
STD DEV	5.630

RADAR ALTMTR
FEET

MIN	320.6
MAX	514.7
MEAN	409.2
STD DEV	30.44

LINE 380

LINE 390
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80194



BARO PRESSURE
MM HG

MIN	727.4
MAX	746.0
MEAN	734.5
STD DEV	1.749

AIR TEMPERATURE
DEG C

MIN	35.00
MAX	37.00
MEAN	36.04
STD DEV	.5492

RESIDUAL MAG
GAMMAS

MIN	-688.9
MAX	-313.0
MEAN	-530.3
STD DEV	78.93

DIURNAL
GAMMAS

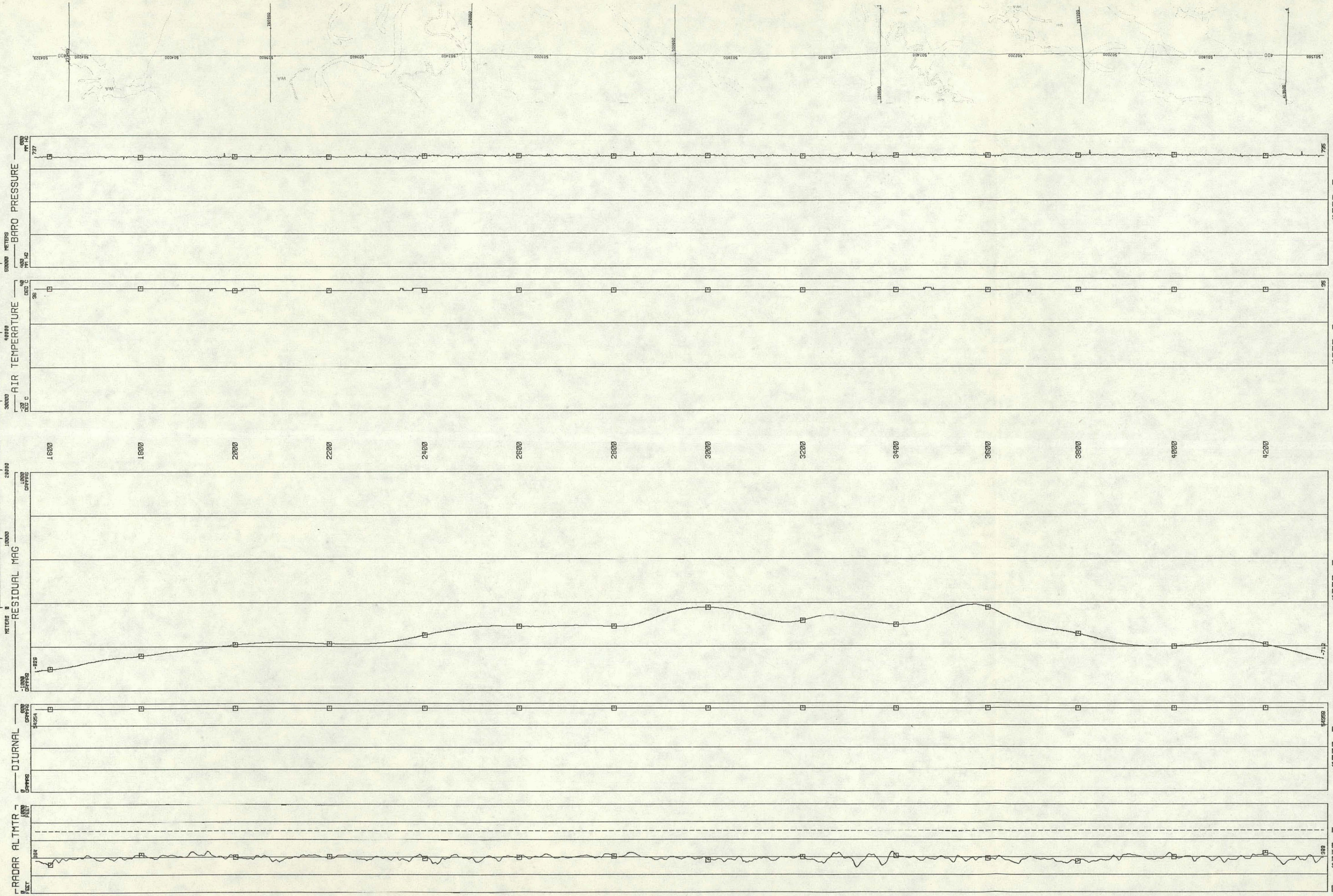
MIN	54359
MAX	54363
MEAN	54354
STD DEV	6.360

RADAR ALTMTR
FEET

MIN	318.3
MAX	523.0
MEAN	401.5
STD DEV	33.35

LINE 390

LINE 400
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80194



BARO PRESSURE
MM HG

MIN	728.3
MAX	750.6
MEAN	735.8
STD DEV	1.368

AIR TEMPERATURE
DEG C

MIN	34.00
MAX	36.00
MEAN	35.18
STD DEV	.3841

RESIDUAL MAG
GAMMAS

MIN	-825.9
MAX	-217.3
MEAN	-487.2
STD DEV	145.5

DIURNAL
GAMMAS

MIN	54354
MAX	54358
MEAN	54350
STD DEV	5.616

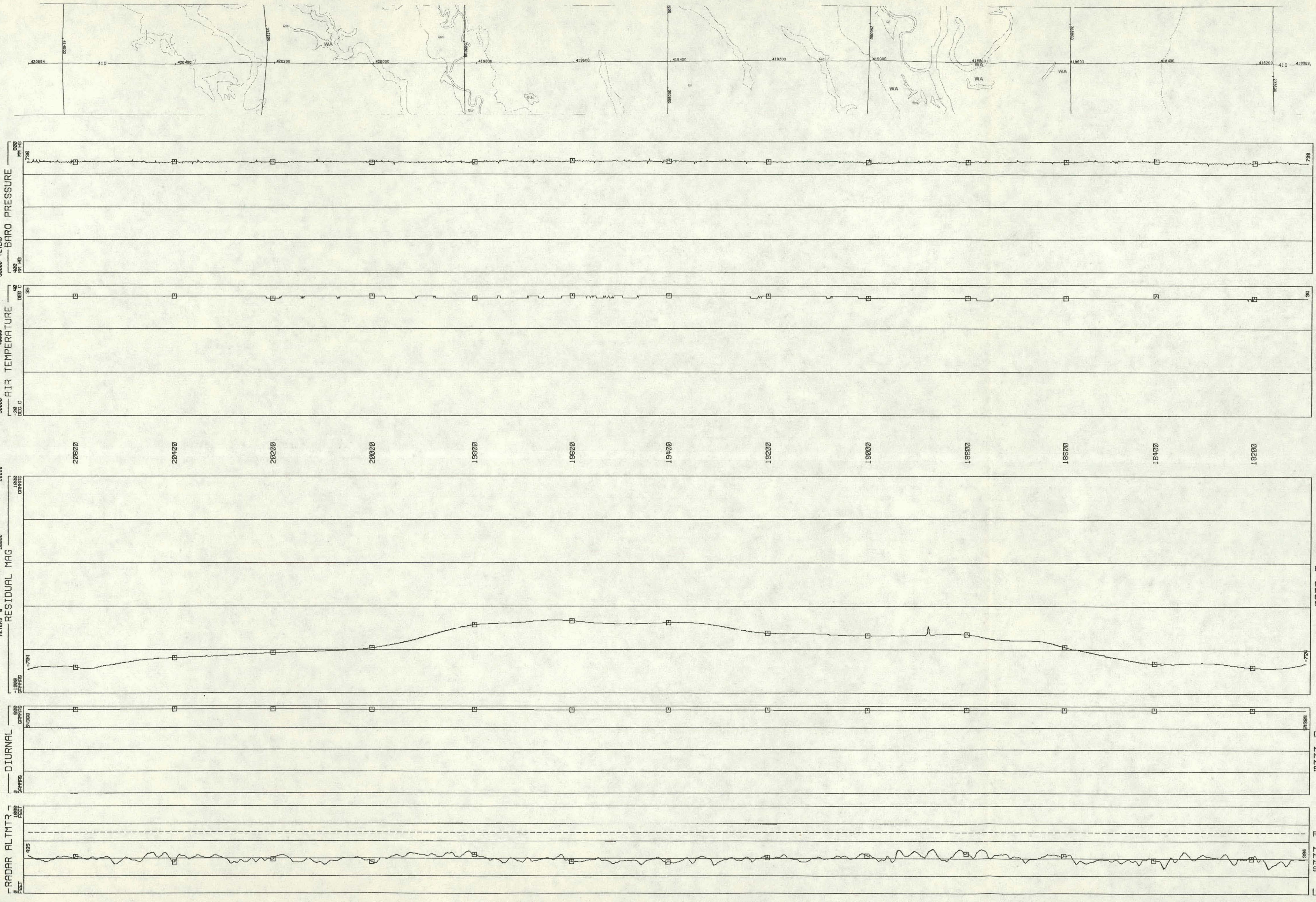
RADAR ALTMTR
FEET

MIN	284.4
MAX	466.1
MEAN	388.6
STD DEV	27.04

LINE 400

D24he

LINE 410
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80188



BARO PRESSURE
MM HG
MIN 729.6
MAX 747.6
MEAN 738.3
STD DEV 1.701

AIR TEMPERATURE
DEG C
MIN 33.00
MAX 35.00
MEAN 34.47
STD DEV .5254

RESIDUAL MAG
GAMMAS
MIN -784.4
MAX -327.4
MEAN -550.4
STD DEV 144.5

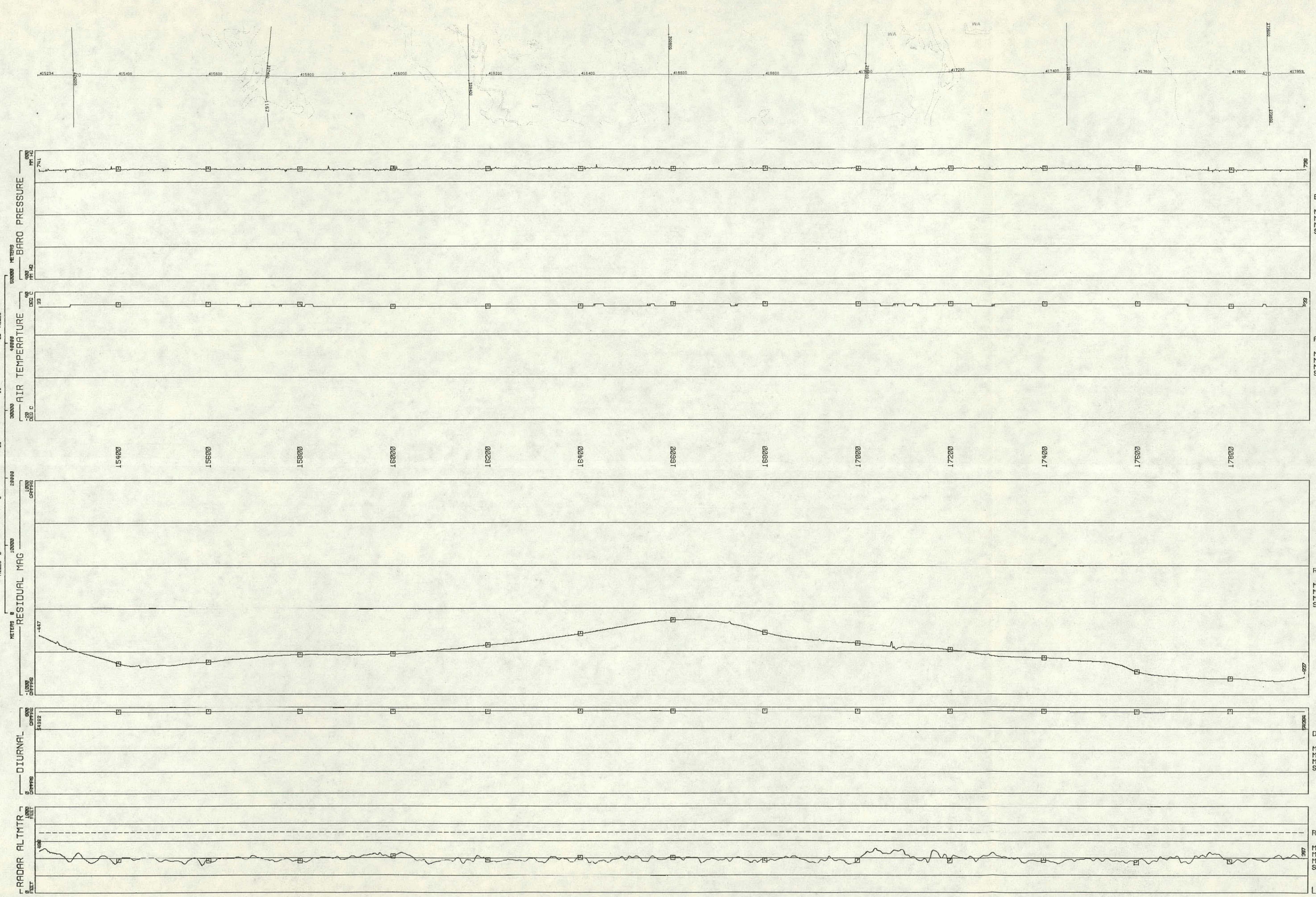
DIURNAL
GAMMAS
MIN 54361
MAX 54372
MEAN 54358
STD DEV 8.856

RADAR ALTMTR
FEET
MIN 286.9
MAX 508.8
MEAN 399.6
STD DEV 35.05

LINE 410

D25he

LINE 420
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80:88



BARO PRESSURE
MM HG
MIN 730.1
MAX 752.3
MEAN 739.2
STD DEV 1.945

AIR TEMPERATURE
DEG C
MIN 33.00
MAX 34.00
MEAN 33.55
STD DEV .4973

RESIDUAL MAG
GAMMAS
MIN -874.5
MAX -305.2
MEAN -601.0
STD DEV 148.8

DIURNAL
GAMMAS
MIN 54358
MAX 54366
MEAN 54353
STD DEV 9.128

RADAR ALTMTR
FEET
MIN 317.5
MAX 514.8
MEAN 392.8
STD DEV 33.11

LINE 420

LINE 430
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80180

BARO PRESSURE
MM HG

MIN	730.1
MAX	750.9
MEAN	738.3
STD DEV	1.648

AIR TEMPERATURE
DEG C

MIN	29.00
MAX	34.00
MEAN	31.85
STD DEV	1.425

RESIDUAL MAG
GAMMAS

MIN	-868.2
MAX	-467.0
MEAN	-611.1
STD DEV	87.30

DIURNAL
GAMMAS

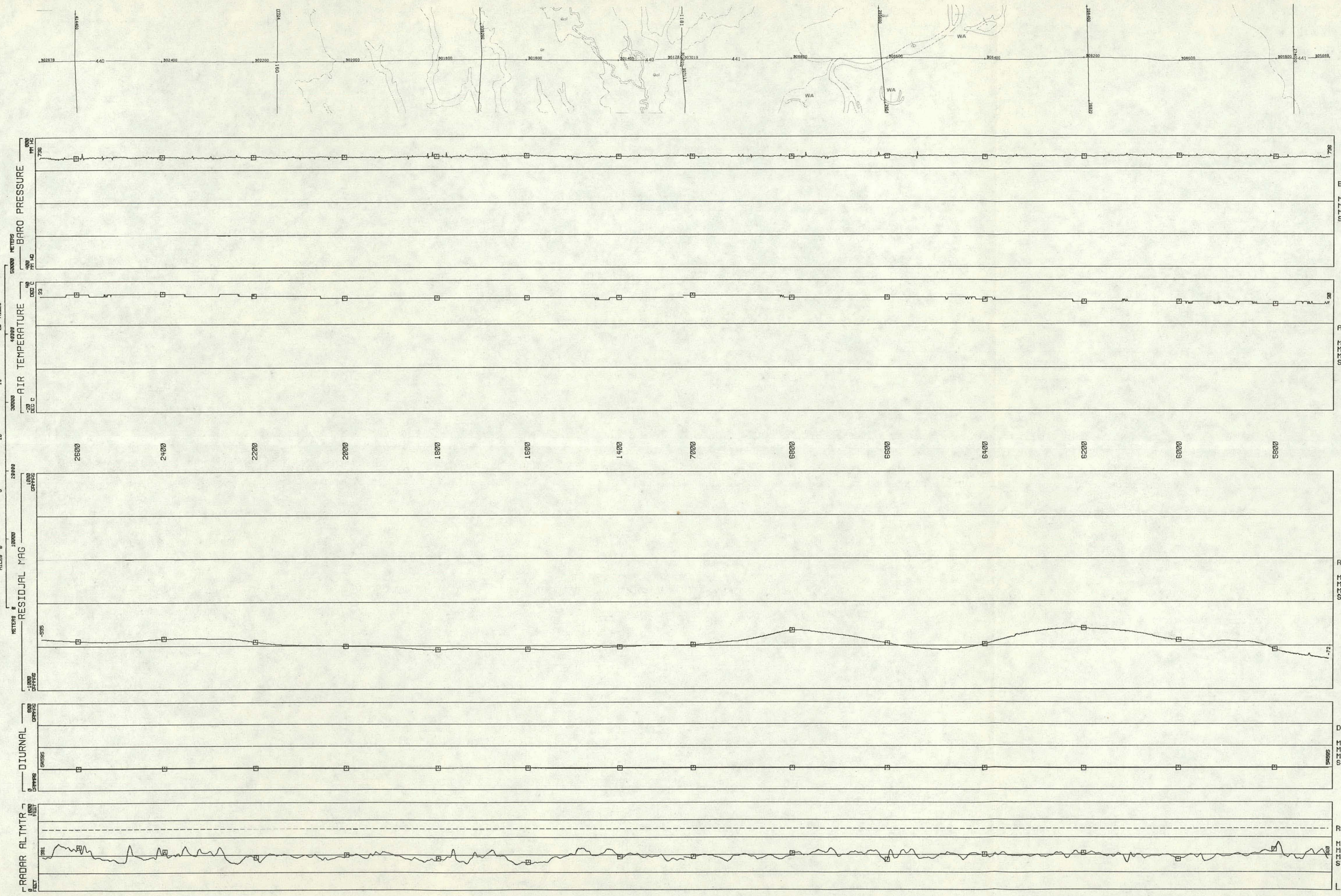
MIN	54595
MAX	54595
MEAN	54592
STD DEV	3.172

RADAR ALTMTR
FEET

MIN	274.9
MAX	607.9
MEAN	387.8
STD DEV	33.86

LINE 430

LINE 440
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80102



BARO PRESSURE
MM HG

MIN	731.0
MAX	751.5
MEAN	738.6
STD DEV	1.649

AIR TEMPERATURE
DEG C

MIN	29.00
MAX	34.00
MEAN	31.88
STD DEV	1.318

RESIDUAL MAG
GAMMAS

MIN	-721.4
MAX	-429.3
MEAN	-569.9
STD DEV	59.53

DIURNAL
GAMMAS

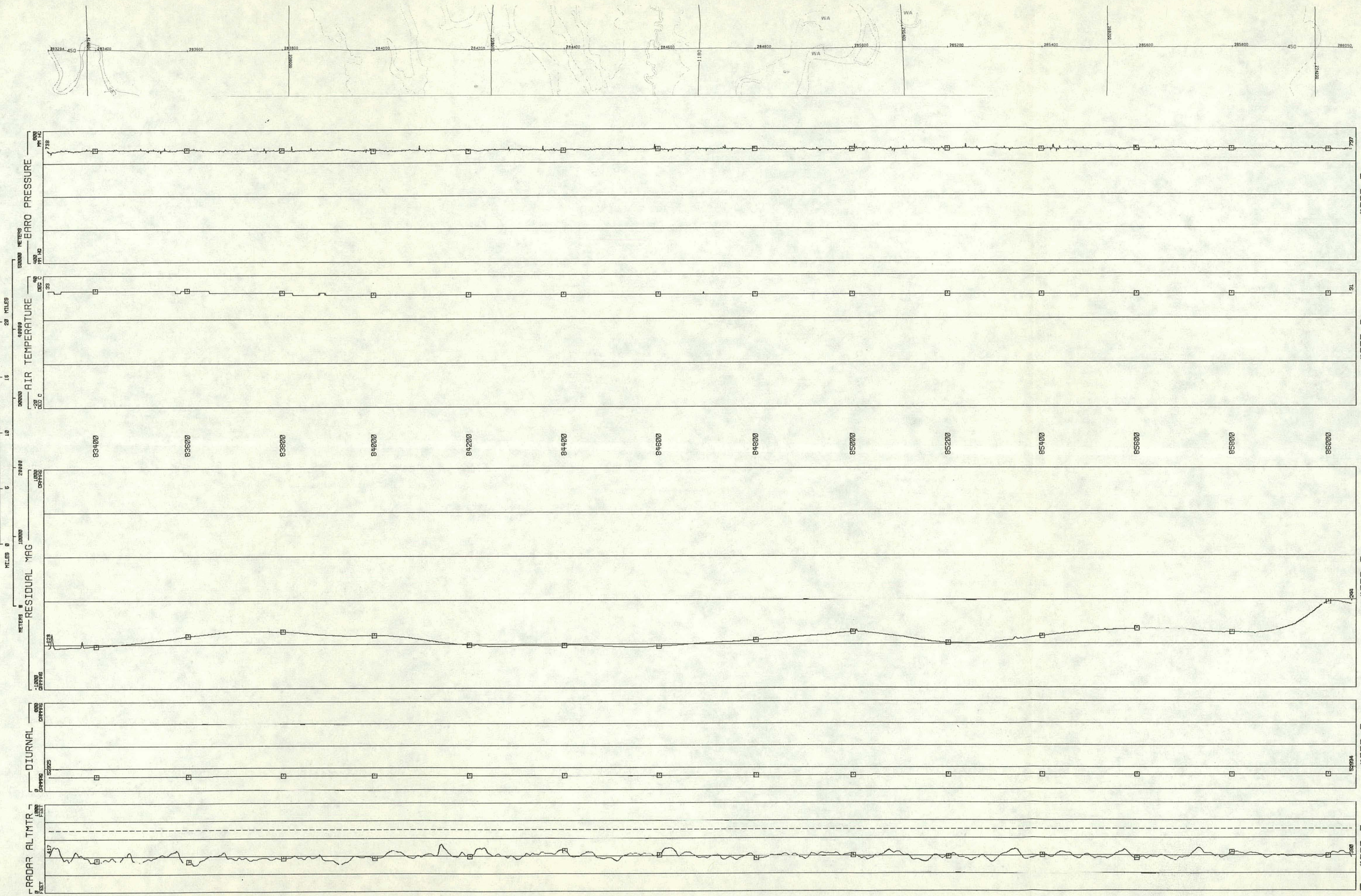
MIN	54595
MAX	54595
MEAN	54592
STD DEV	3.172

RADAR ALTMTR
FEET

MIN	289.6
MAX	542.7
MEAN	392.8
STD DEV	40.51

LINE 440

LINE 450
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80179



BARO PRESSURE
MM HG
MIN 728.5
MAX 752.3
MEAN 738.5
STD DEV 1.590

AIR TEMPERATURE
DEG C
MIN 31.00
MAX 33.00
MEAN 31.32
STD DEV .6731

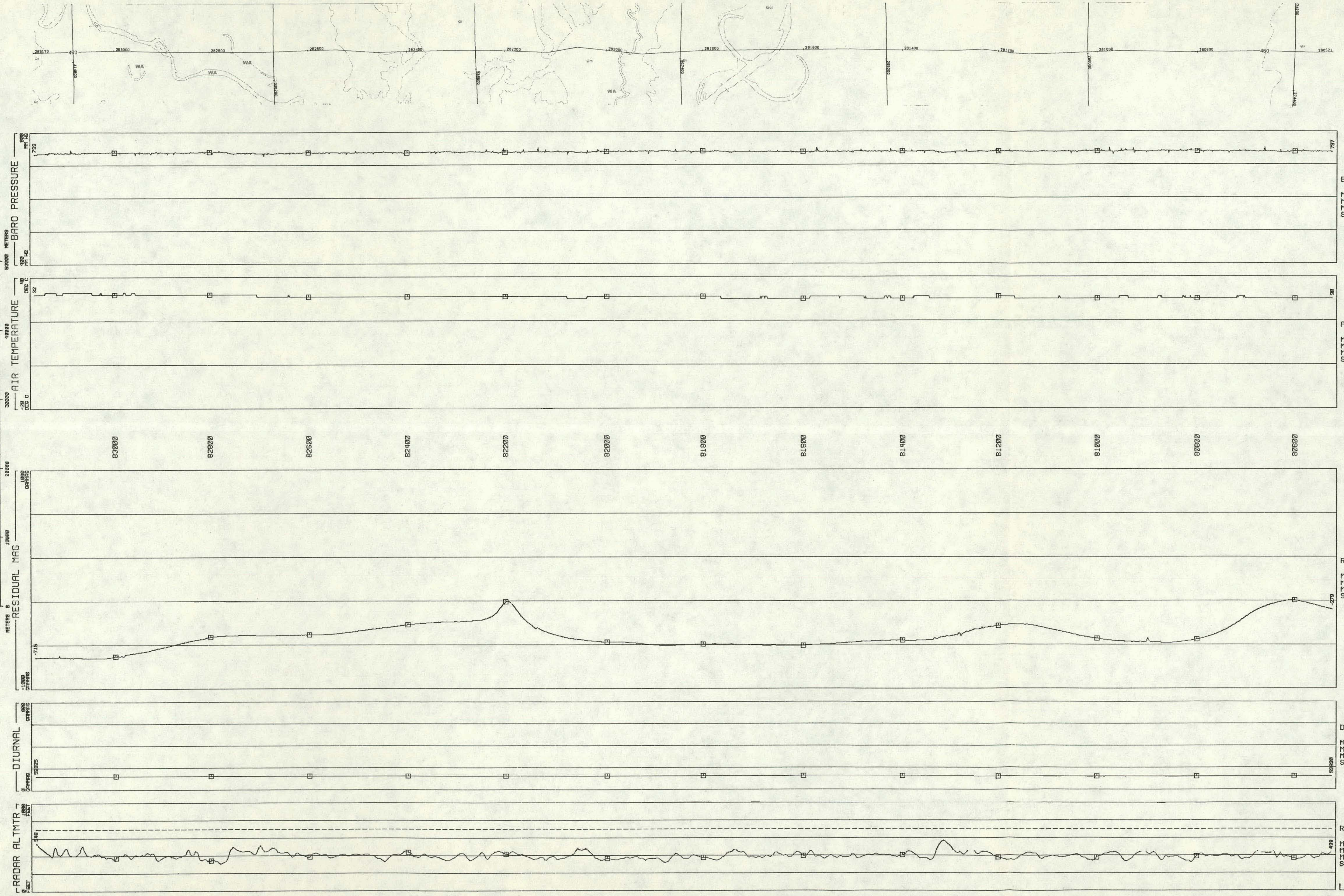
RESIDUAL MAG
GAMMAS
MIN -632.1
MAX -213.9
MEAN -535.7
STD DEV 76.64

DIURNAL
GAMMAS
MIN 52925
MAX 52934
MEAN 52926
STD DEV 4.112

RADAR ALTMTR
FEET
MIN 300.5
MAX 535.8
MEAN 399.0
STD DEV 34.60

LINE 450

LINE 460
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80179



BARO PRESSURE
MM HG

MIN	728.8
MAX	750.9
MEAN	738.8
STD DEV	1.714

AIR TEMPERATURE
DEG C

MIN	30.00
MAX	33.00
MEAN	30.82
STD DEV	.8074

RESIDUAL MAG
GAMMAS

MIN	-721.1
MAX	-195.0
MEAN	-515.8
STD DEV	118.7

DIURNAL
GAMMAS

MIN	52920
MAX	52925
MEAN	52916
STD DEV	7.188

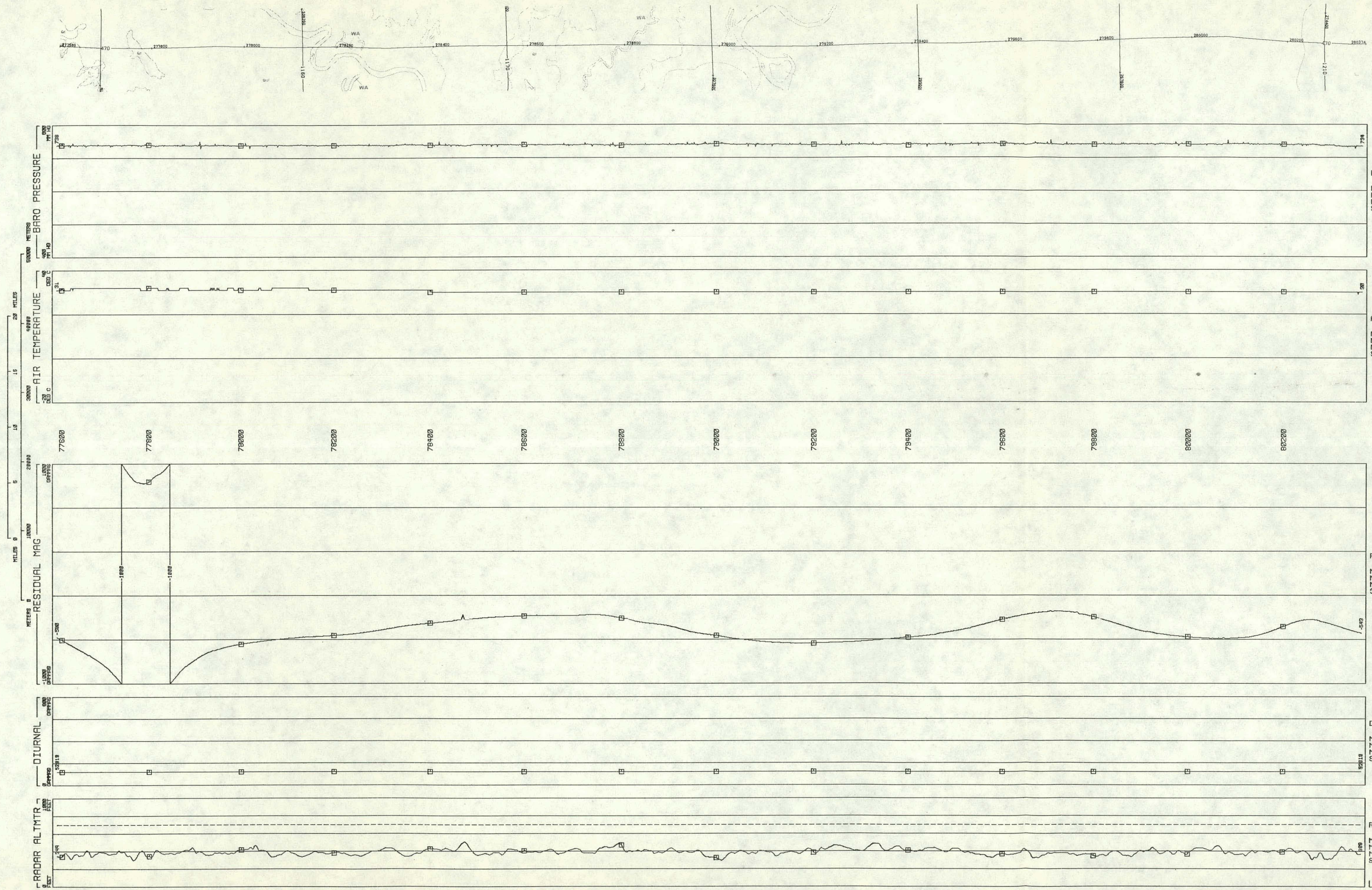
RADAR ALTMTR
FEET

MIN	309.6
MAY	567.7
MEAN	400.7
STD DEV	37.01

LINE 460

D30he

LINE 470
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80179



BARO PRESSURE
MM HG
MIN 727.4
MAX 752.0
MEAN 739.3
STD DEV 1.622

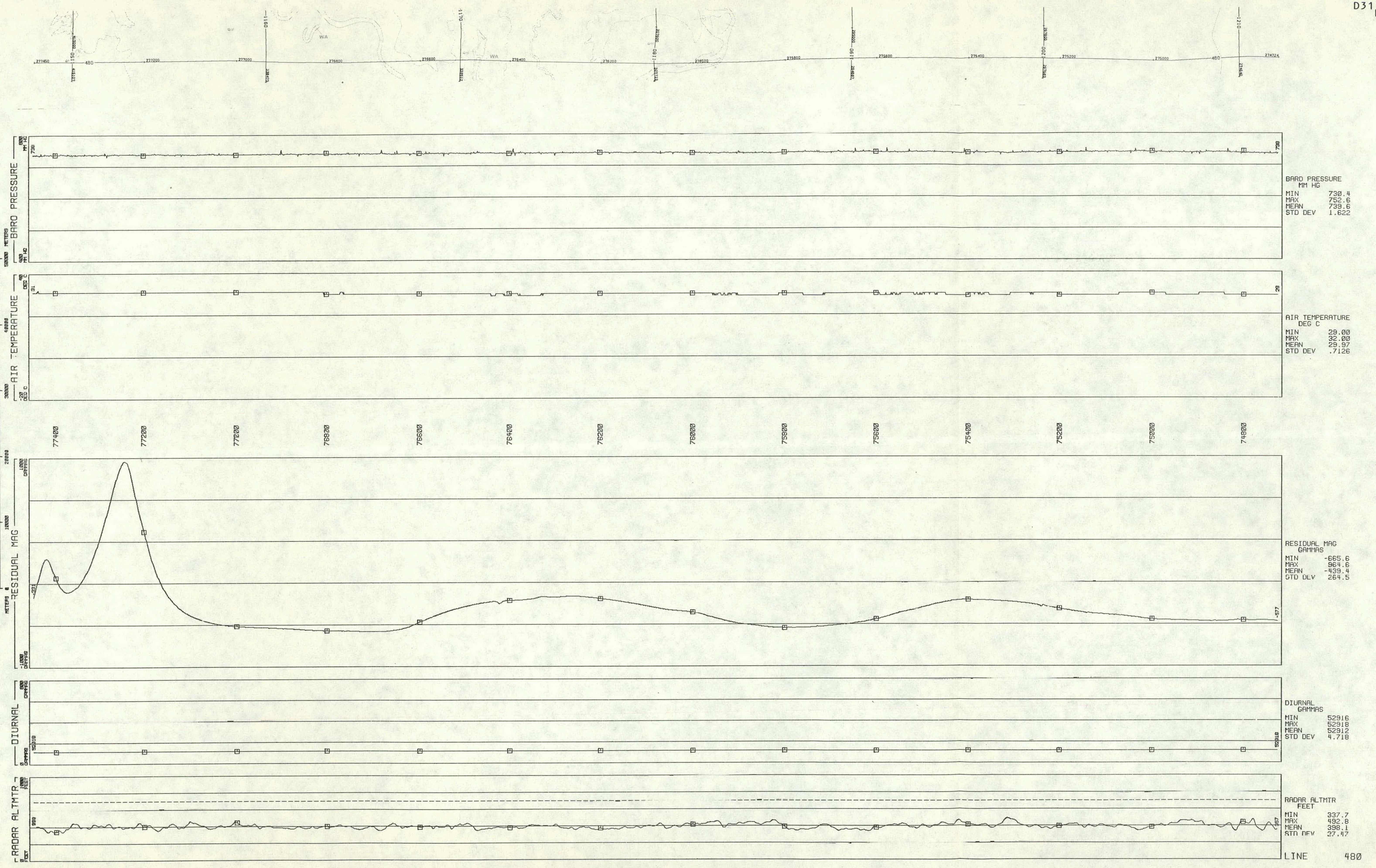
AIR TEMPERATURE
DEG C
MIN 29.00
MAX 32.00
MEAN 30.41
STD DEV .6901

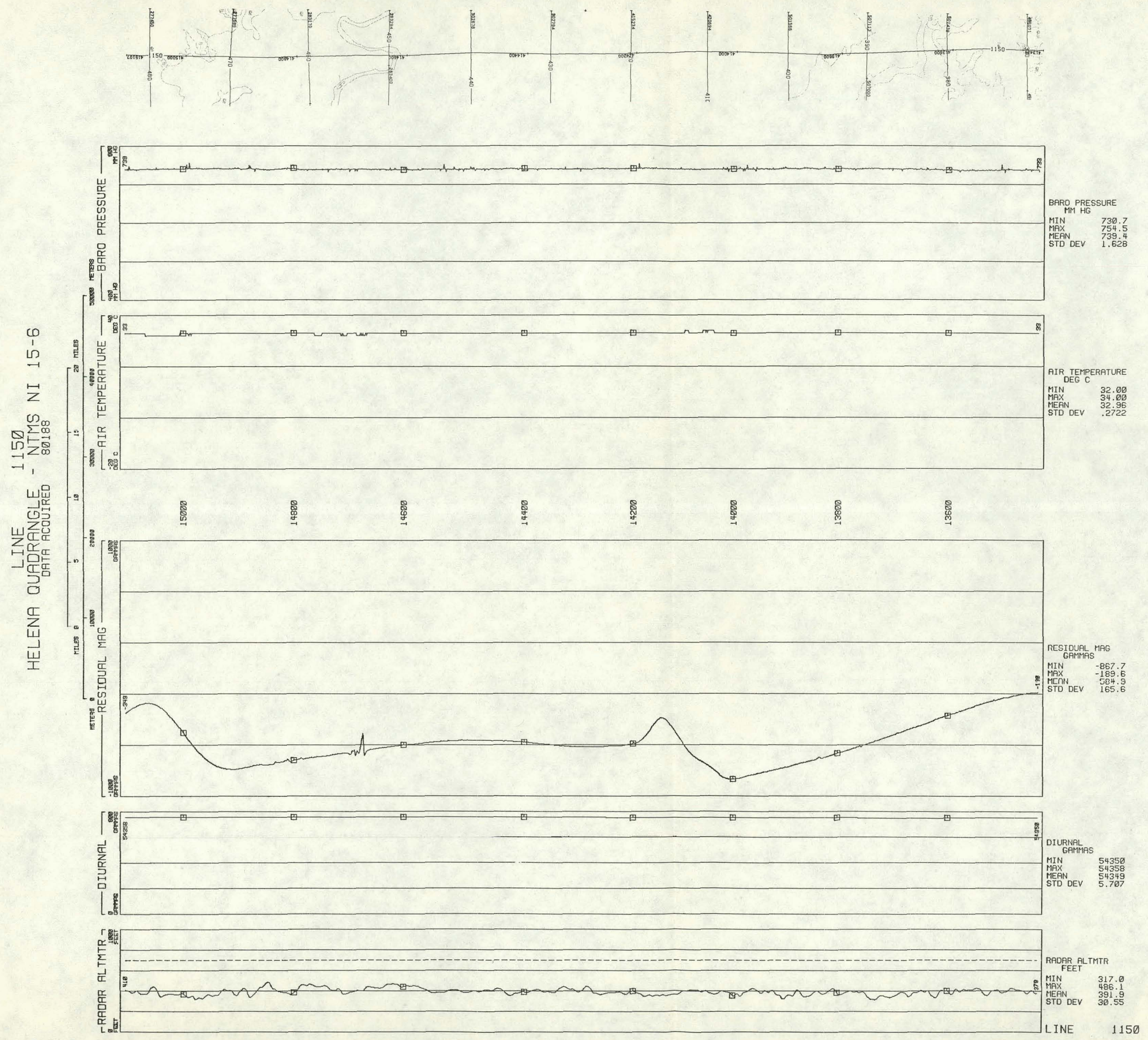
RESIDUAL MAG
GAMMAS
MIN -1179
MAX -344.6
MEAN -555.6
STD DEV 164.6

DIURNAL
GAMMAS
MIN 52919
MAX 52919
MEAN 52912
STD DEV 7.026

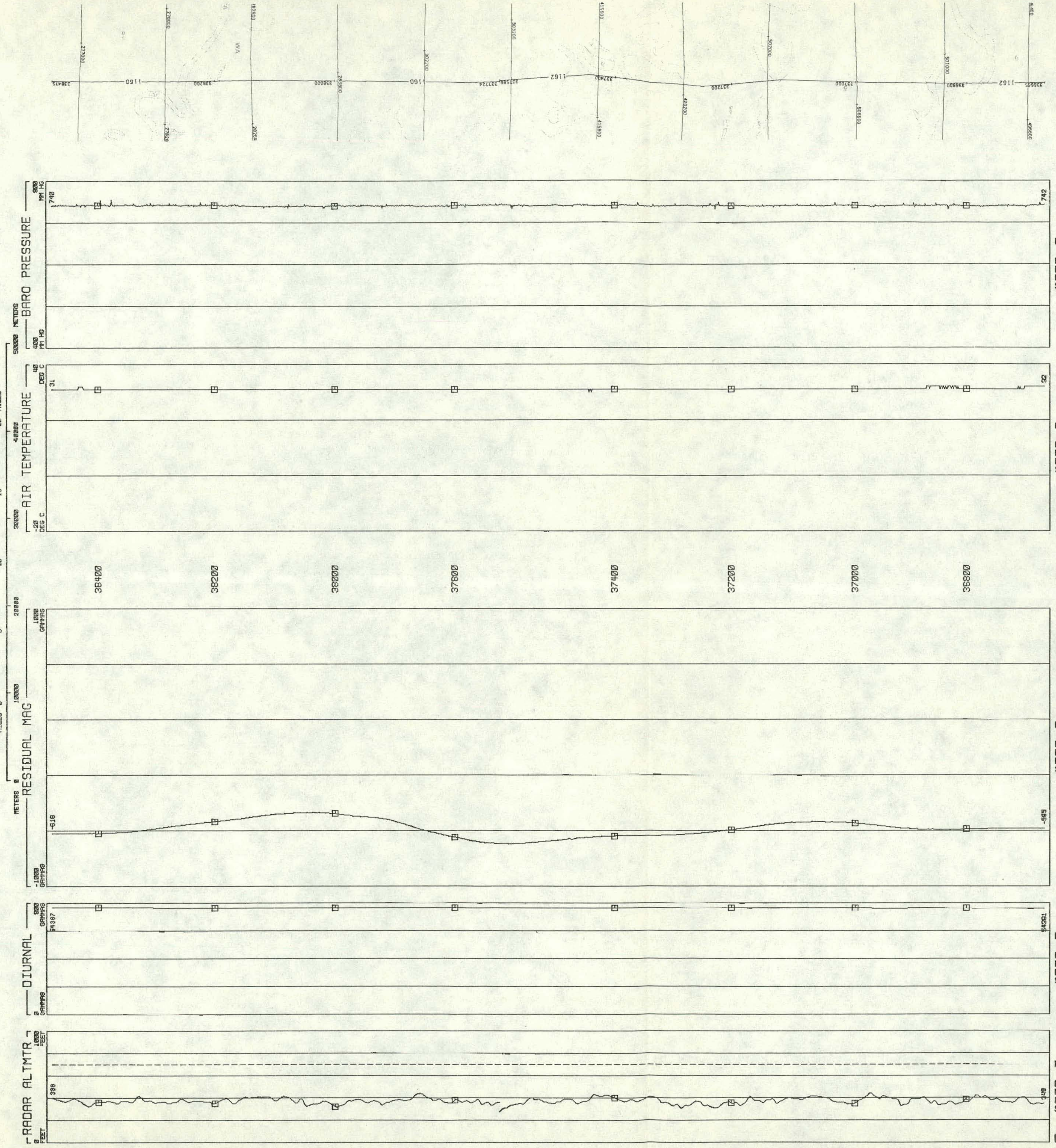
RADAR ALTMTR
FEET
MIN 296.2
MAX 506.9
MEAN 389.5
STD DEV 33.47

LINE 470


LINE 480
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80179
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
BARO PRESSURE MM HG
MIN 730.4
MAX 752.6
MEAN 739.6
STD DEV 1.622
AIR TEMPERATURE DEG C
MIN 29.00
MAX 32.00
MEAN 29.97
STD DEV .7126
RESIDUAL MAG GAMMAS
MIN -665.6
MAX 964.6
MEAN -439.4
STD DEV 264.5
DIURNAL GAMMAS
MIN 52916
MAX 52918
MEAN 52916
STD DEV 4.718
RADAR ALTMTR FEET
MIN 337.7
MAX 492.8
MEAN 398.1
STD DEV 27.47
77400
77200
77000
76800
76600
76400
76200
76000
75800
75600
75400
75200
75000
74800
LINE 480


LINE 1150
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80188
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
15000
14800
14600
14400
14200
14000
13800
13600
BARO PRESSURE
MM HG
MIN 730.7
MAX 754.5
MEAN 739.4
STD DEV 1.628
AIR TEMPERATURE
DEG C
MIN 32.00
MAX 34.00
MEAN 32.96
STD DEV .2722
RESIDUAL MAG
GAMMAS
MIN -867.7
MAX -189.6
MEAN -504.9
STD DEV 165.6
DIURNAL
GAMMAS
MIN 54350
MAX 54358
MEAN 54349
STD DEV 5.707
RADAR ALTMTR
FEET
MIN 317.0
MAX 486.1
MEAN 391.9
STD DEV 30.55
LINE 1150

LINE 1160
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80166



BARO PRESSURE
MM HG
MIN 732.3
MAX 754.2
MEAN 740.2
STD DEV 1.449

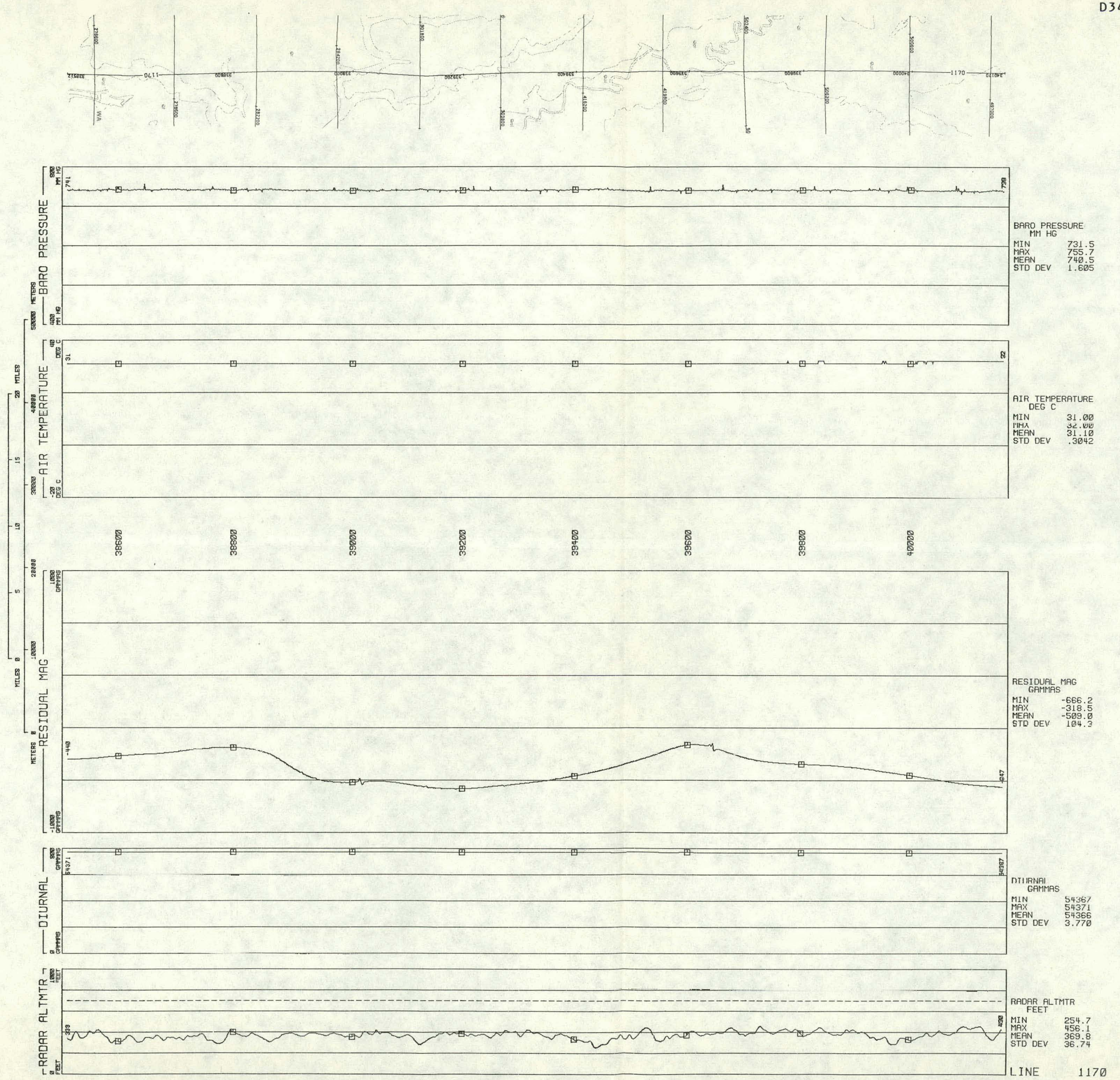
AIR TEMPERATURE
DEG C
MIN 30.00
MAX 32.00
MEAN 31.05
STD DEV .2278

RESIDUAL MAG
GAMMAS
MIN -694.9
MAX -469.3
MEAN -585.2
STD DEV 57.90

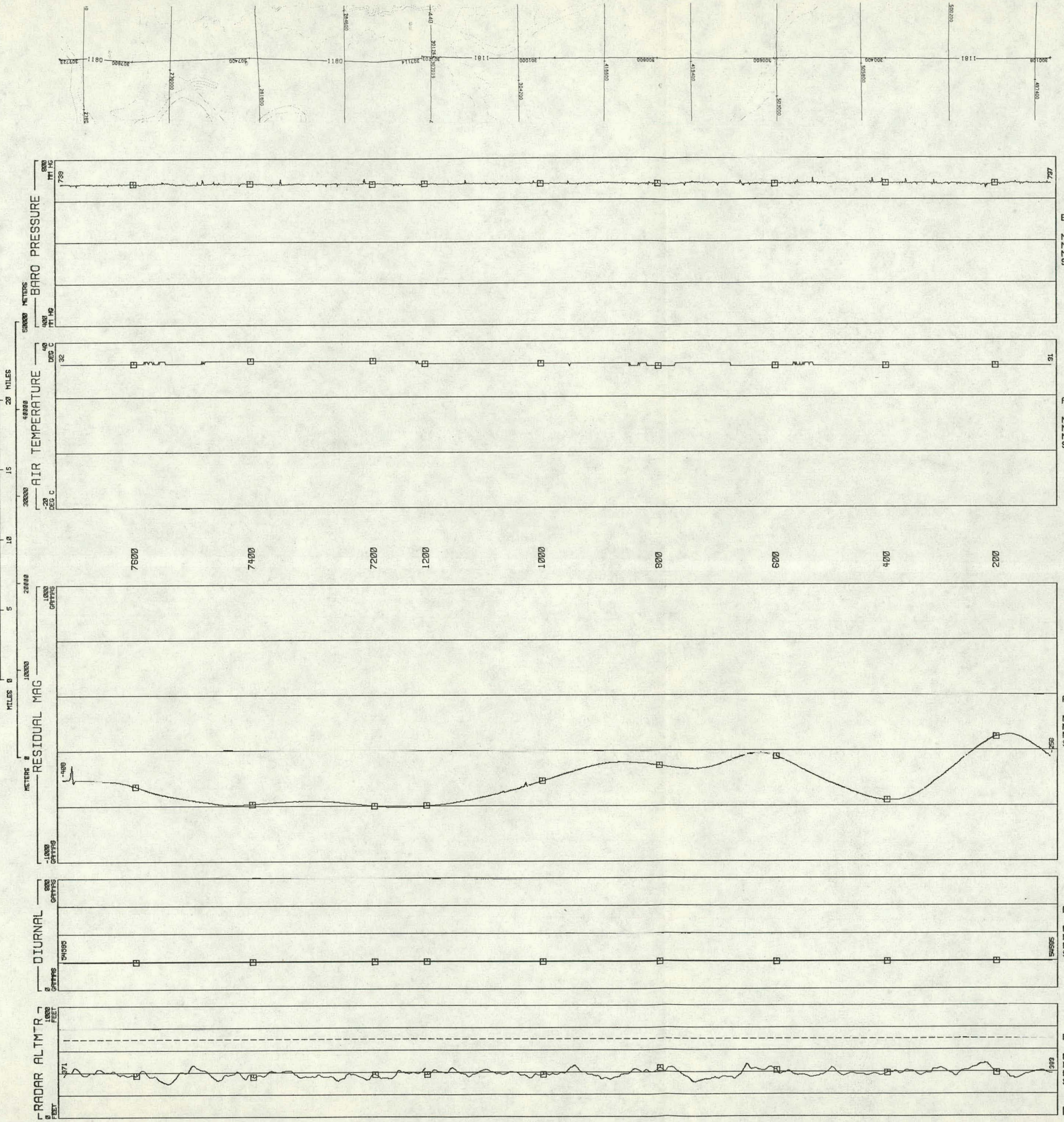
DIURNAL
GAMMAS
MIN 54361
MAX 54367
MEAN 54360
STD DEV 4.421

RADAR ALTMTR
FEET
MIN 276.5
MAX 440.8
MEAN 372.4
STD DEV 25.84

LINE 1160


LINE 1170
HELENA QUADRANGLE - NTMS N- 15-6
DATA ACQUIRED 80186
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
38600
38800
39000
39200
39400
39600
39800
40000
BARO PRESSURE
MM HG
MIN 731.5
MAX 755.7
MEAN 740.5
STD DEV 1.605
AIR TEMPERATURE
DEG C
MIN 31.00
MAX 32.00
MEAN 31.10
STD DEV .3042
RESIDUAL MAG
GAMMAS
MIN -666.2
MAX -318.5
MEAN -509.0
STD DEV 104.3
DIURNAL
GAMMAS
MIN 54367
MAX 54371
MEAN 54366
STD DEV 3.770
RADAR ALTMTR
FEET
MIN 254.7
MAX 456.1
MEAN 369.8
STD DEV 36.74
LINE 1170

LINE 1180
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80180



BARO PRESSURE
MM HG
MIN 727.4
MAX 750.6
MEAN 738.7
STD DEV 1.485

AIR TEMPERATURE
DEG C
MIN 31.00
MAX 33.00
MEAN 31.00
STD DEV .7521

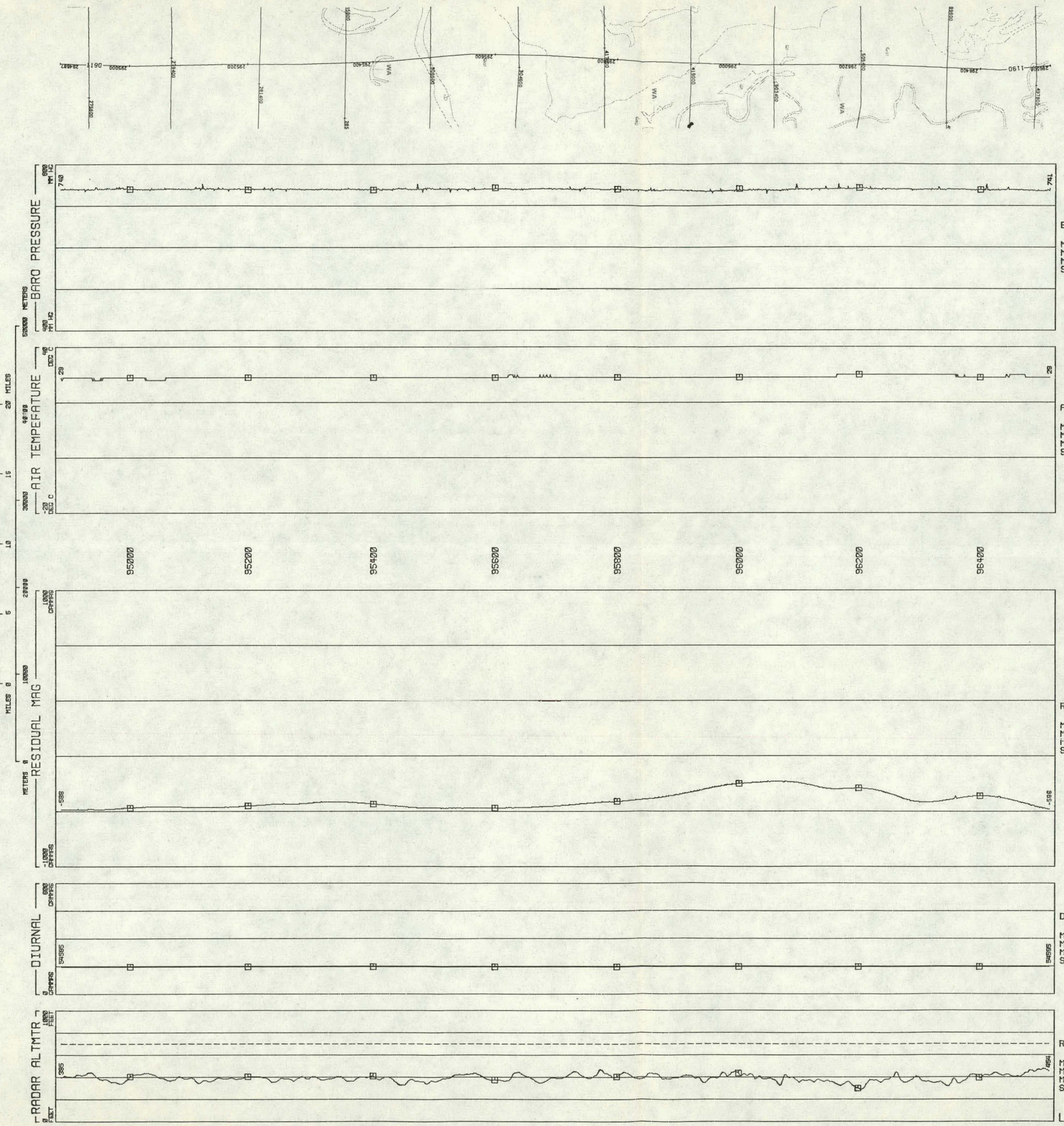
RESIDUAL MAG
GAMMAS
MIN -608.6
MAX -87.24
MEAN -428.1
STD DEV 143.8

DIURNAL
GAMMAS
MIN 54595
MAX 54595
MEAN 54592
STD DEV 3.000

RADAR ALTMTR
FEET
MIN 300.7
MAX 476.4
MEAN 388.4
STD DEV 30.85

LINE 1180

LINE 1190
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80180



BARO PRESSURE
MM HG

MIN	729.1
MAX	752.6
MEAN	739.1
STD DEV	1.843

AIR TEMPERATURE
DEG C

MIN	28.00
MAX	30.00
MEAN	29.12
STD DEV	.4069

RESIDUAL MAG
GAMMAS

MIN	-587.9
MAX	-382.7
MEAN	-521.9
STD DEV	59.66

DIURNAL
GAMMAS

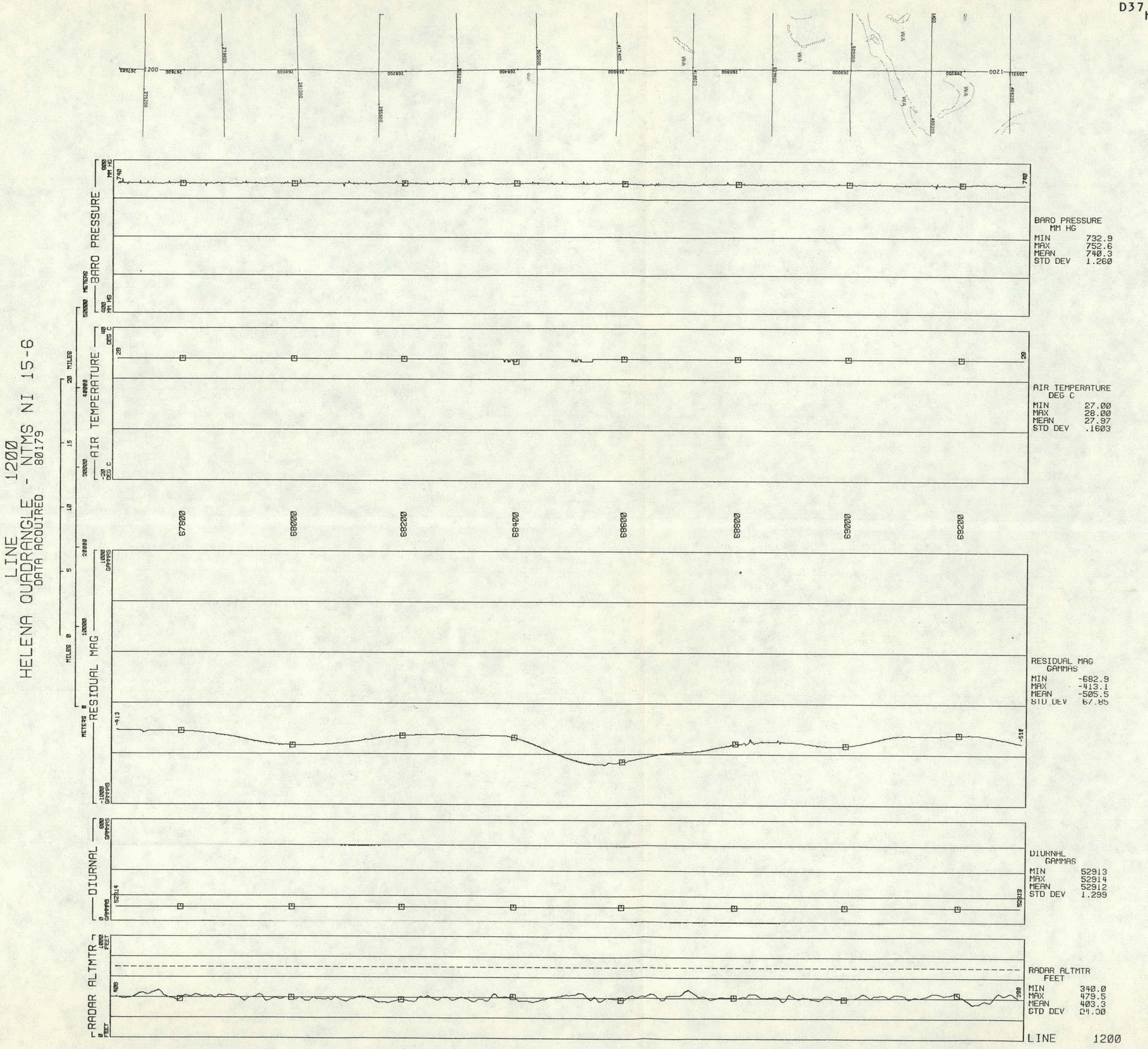
MIN	54595
MAX	54595
MEAN	54592
STD DEV	2.976

RADAR ALTMTR
FEET

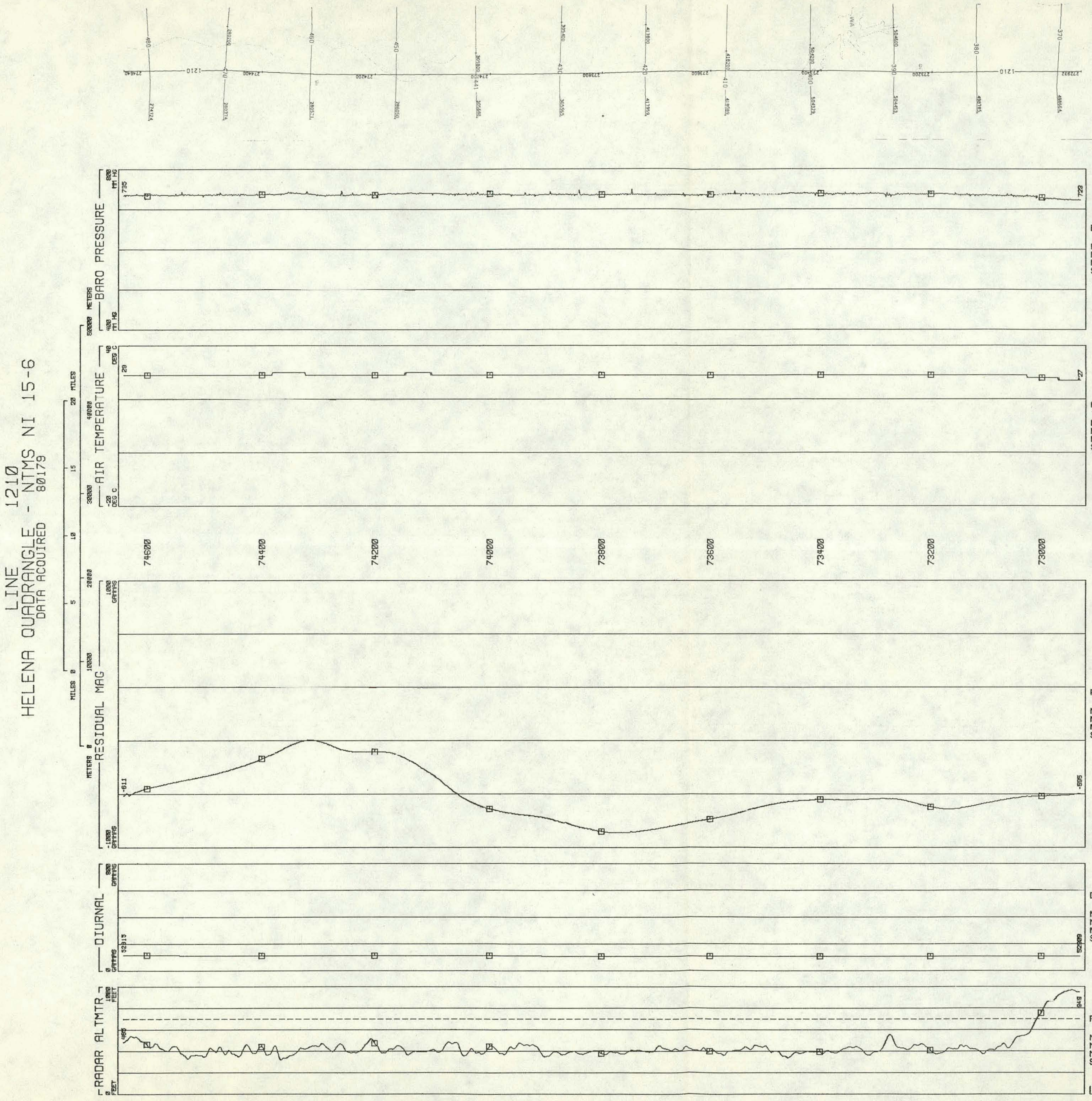
MIN	290.6
MAX	477.5
MEAN	391.5
STD DEV	30.58

LINE 1190

D37he


LINE 1200
HELENA QUADRANGLE - NTMS NI 15-6
DATA ACQUIRED 80179
BARO PRESSURE
AIR TEMPERATURE
RESIDUAL MAG
DIURNAL
RADAR ALTMTR
BARO PRESSURE
MM HG
MIN 732.9
MAX 752.6
MEAN 740.3
STD DEV 1.260
AIR TEMPERATURE
DEG C
MIN 27.00
MAX 28.00
MEAN 27.97
STD DEV .1603
RESIDUAL MAG
GAMMAS
MIN -682.9
MAX -413.1
MEAN -505.5
STD DEV 67.85
DIURNAL
GAMMAS
MIN 52913
MAX 52914
MEAN 52912
STD DEV 1.299
RADAR ALTMTR
FEET
MIN 340.0
MAX 479.5
MEAN 403.3
STD DEV 24.30
LINE 1200

D38he



BARO PRESSURE
MM HG

MIN	721.0
MAX	747.9
MEAN	736.4
STD DEV	3.060

AIR TEMPERATURE
DEG C

MIN	27.00
MAX	30.00
MEAN	28.98
STD DEV	.4262

RESIDUAL MAG
GAMMAS

MIN	-889.9
MAX	-196.6
MEAN	-605.1
STD DEV	189.3

DIURNAL
GAMMAS

MIN	52907
MAX	52915
MEAN	52905
STD DEV	5.897

RADAR ALTMTR
FEET

MIN	319.7
MAX	970.2
MEAN	438.3
STD DEV	108.2

LINE 1210

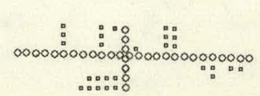
APPENDIX E - Standard Deviation Maps

HELENA

SCALE 1:500,000

MILES 5 0 5 10 15 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES



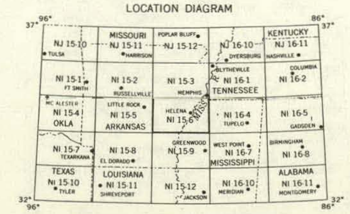
○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▫ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

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

SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

LOCATION DIAGRAM

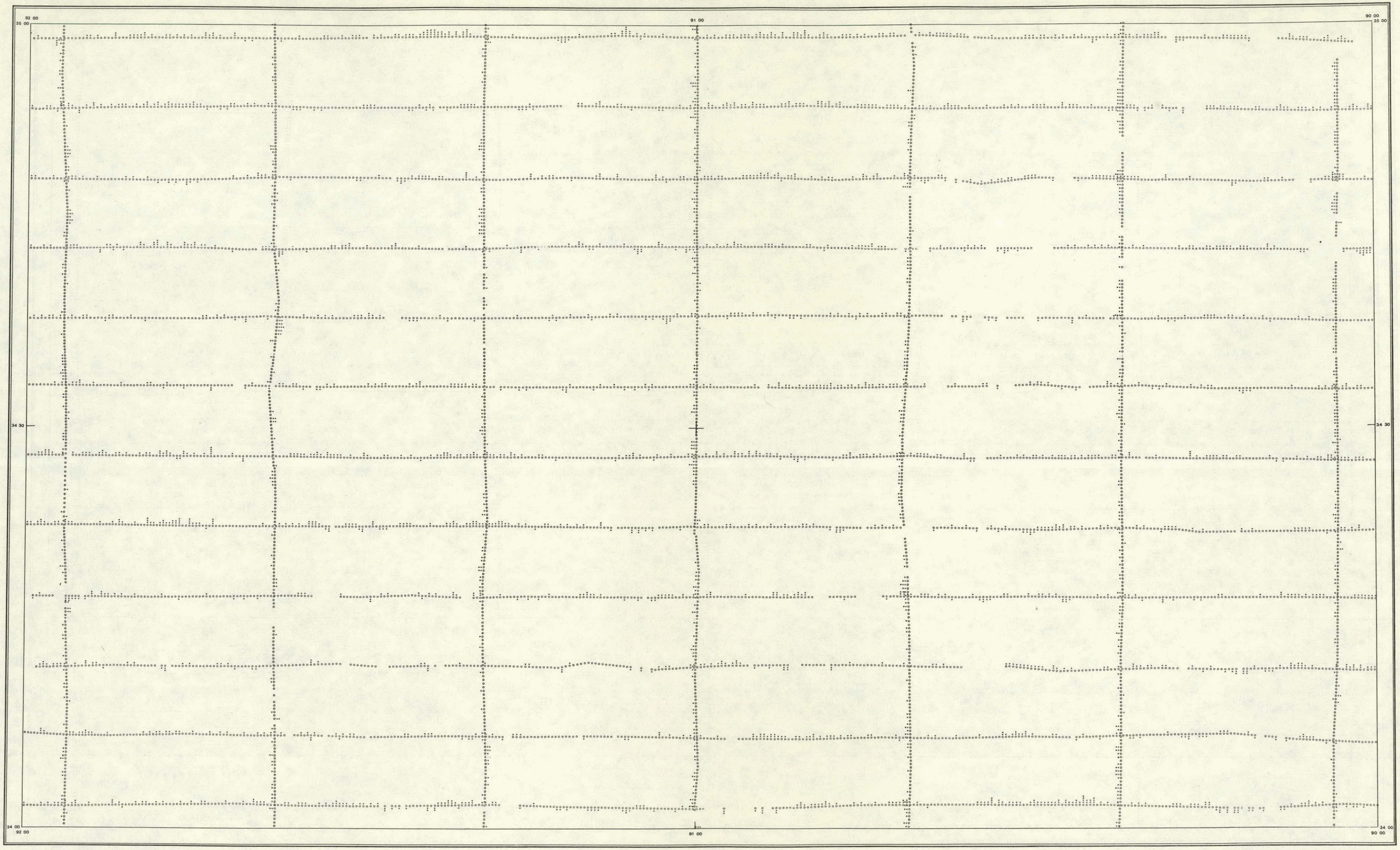


POTASSIUM STANDARD DEVIATION MAP

MISSISSIPPI / FLORIDA PROJECT

U. S. DEPARTMENT OF ENERGY

HELENA



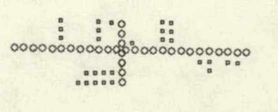
SCALE 1:500,000

MILES 5 0 5 10 15 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

SURVEY AND COMPILATION BY:

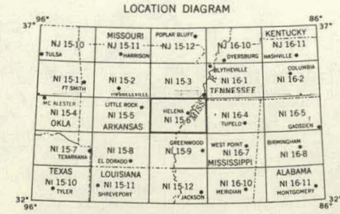
EG&G GEOMETRICS



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

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

LOCATION DIAGRAM



URANIUM STANDARD DEVIATION MAP

MISSISSIPPI / FLORIDA PROJECT

U. S. DEPARTMENT OF ENERGY

HELENA

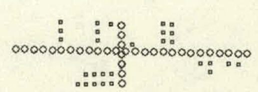
SCALE 1:500,000

MILES 5 0 5 10 15 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

SURVEY AND COMPILATION BY:

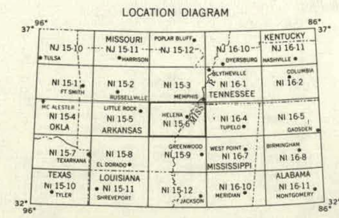
EG&G GEOMETRICS



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

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

LOCATION DIAGRAM

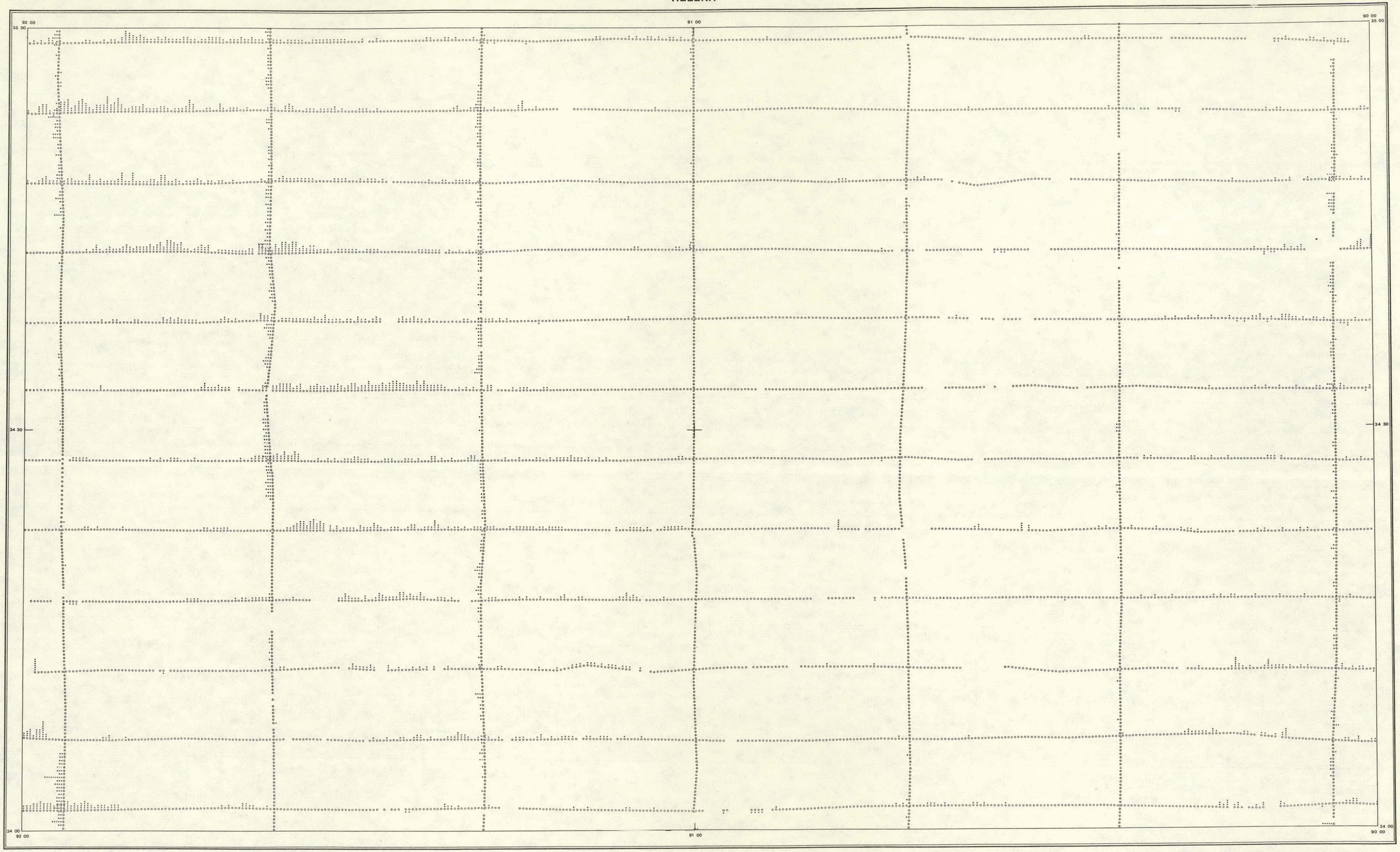


THORIUM STANDARD DEVIATION MAP

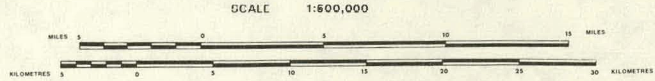
MISSISSIPPI / FLORIDA PROJECT

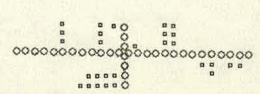
U. S. DEPARTMENT OF ENERGY

HELENA



SCALE 1:500,000

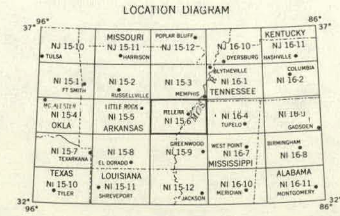




○ - DATA STATISTICALLY ADEQUATE
BLANK - DATA STATISTICALLY INADEQUATE
▫ - 1 σ ABOUT MEASURE OF CENTRAL TENDENCY

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

LOCATION DIAGRAM



THORIUM / POTASSIUM STANDARD DEVIATION MAP

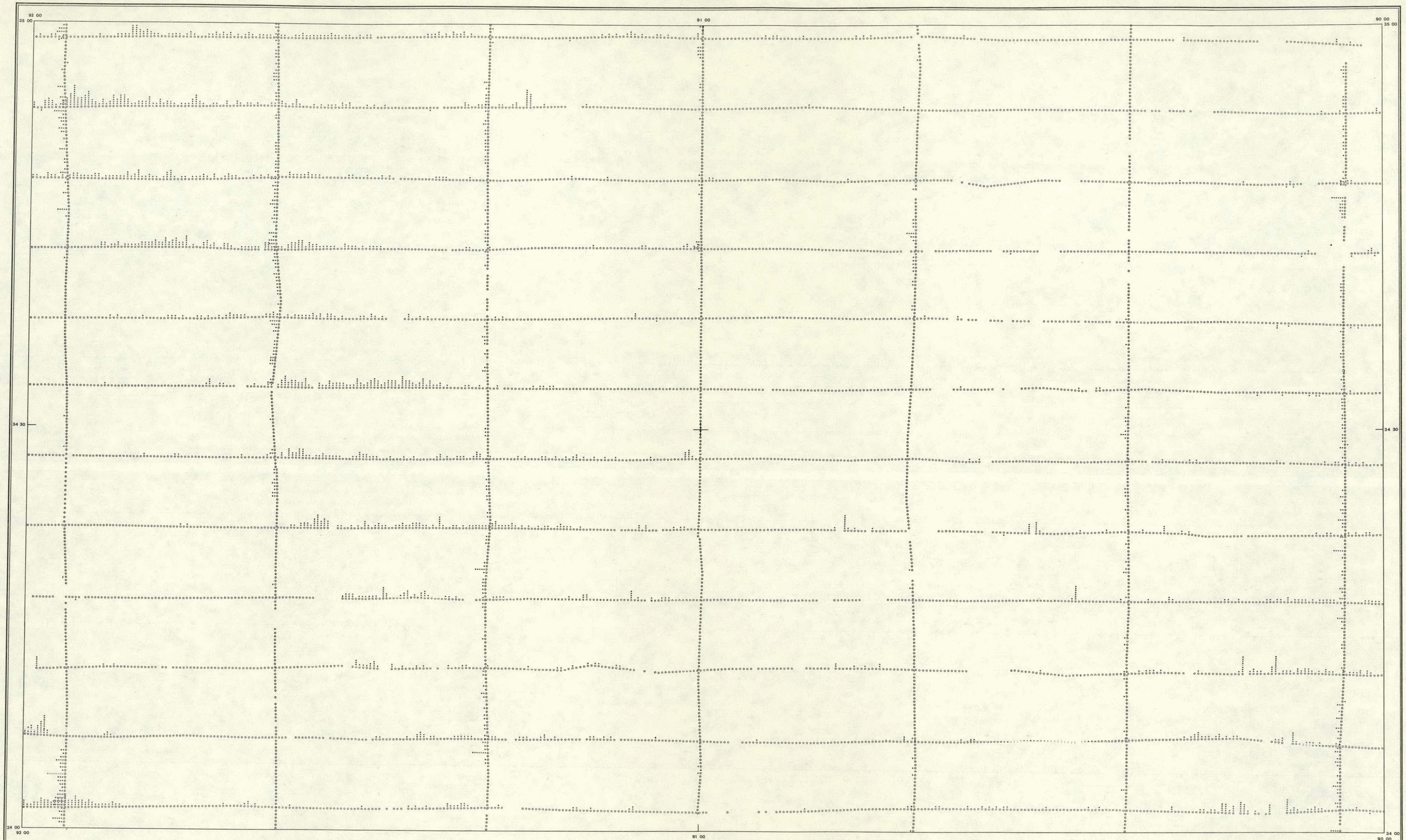
MISSISSIPPI / FLORIDA PROJECT

U. S. DEPARTMENT OF ENERGY

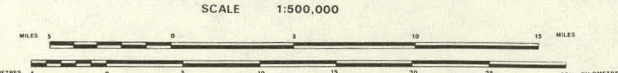
SURVEY AND COMPILATION BY:

EG&G GEOMETRICS

HELENA

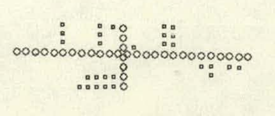


SCALE 1:500,000



SURVEY AND COMPILATION BY:

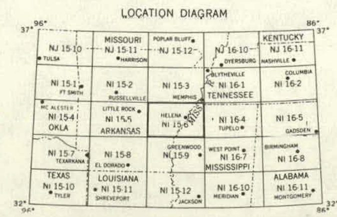
EG&G GEOMETRICS



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

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

LOCATION DIAGRAM



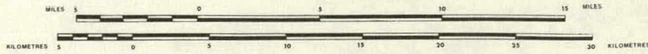
URANIUM/POTASSIUM STANDARD DEVIATION MAP

MISSISSIPPI/FLORIDA PROJECT

U. S. DEPARTMENT OF ENERGY

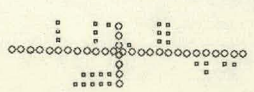
HELENA

SCALE 1:500,000



SURVEY AND COMPILATION BY:

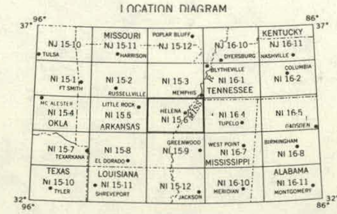
EG&G GEOMETRICS



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



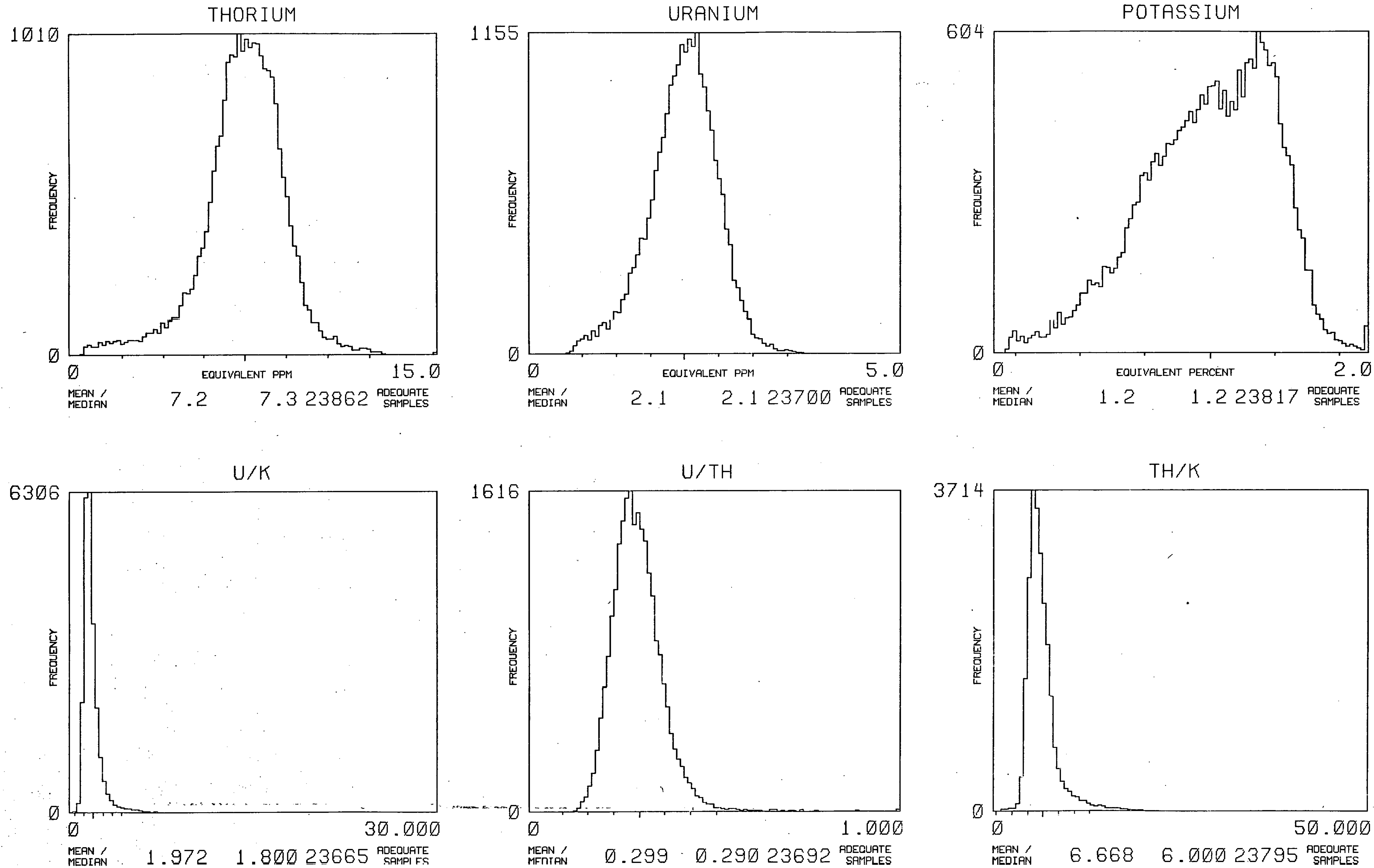
URANIUM/THORIUM STANDARD DEVIATION MAP

MISSISSIPPI/FLORIDA PROJECT

U. S. DEPARTMENT OF ENERGY

APPENDIX F - Histograms and Map Unit Conversion Table

NTMS NI 15-6 HELENA   MAP UNIT : QAL   TOTAL NUMBER OF SAMPLES 23965



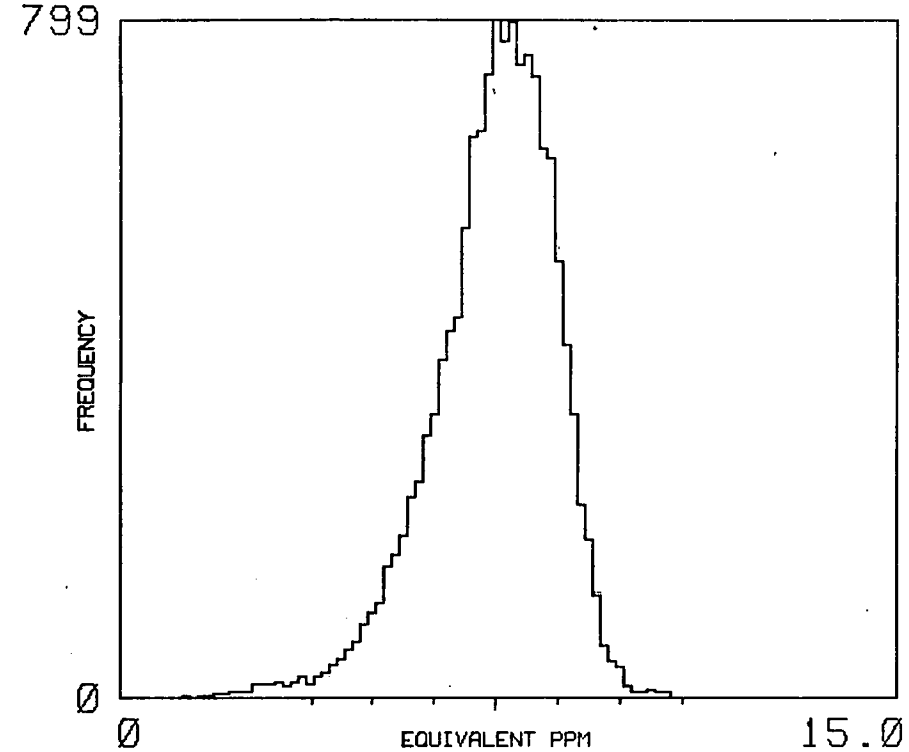
F2he

NTMS NI 15-6 HELENA

MAP UNIT : QT

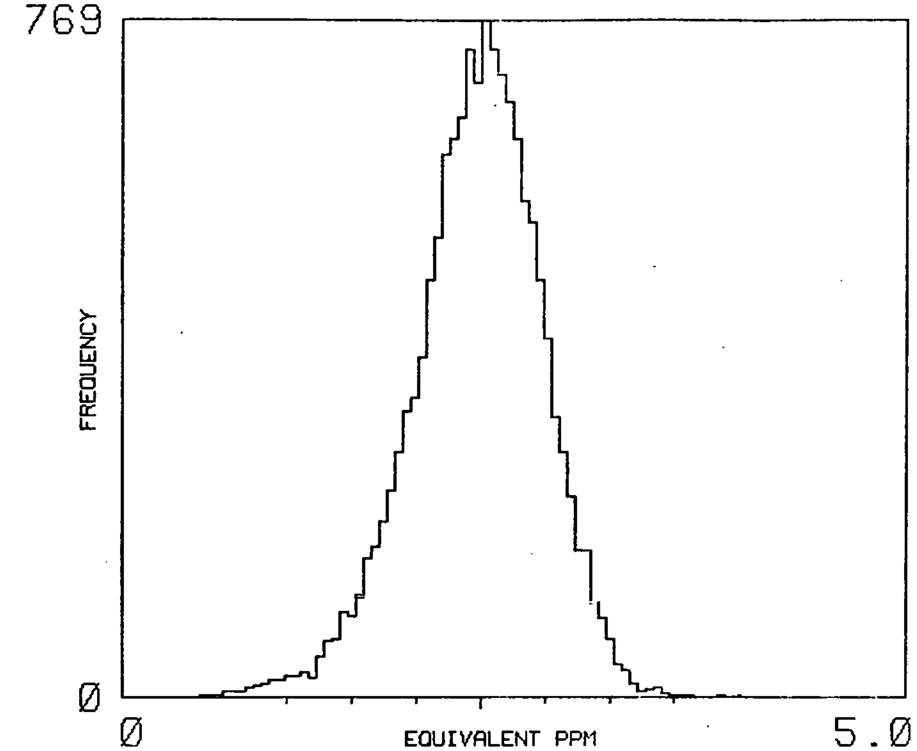
TOTAL NUMBER OF SAMPLES 14187

THORIUM



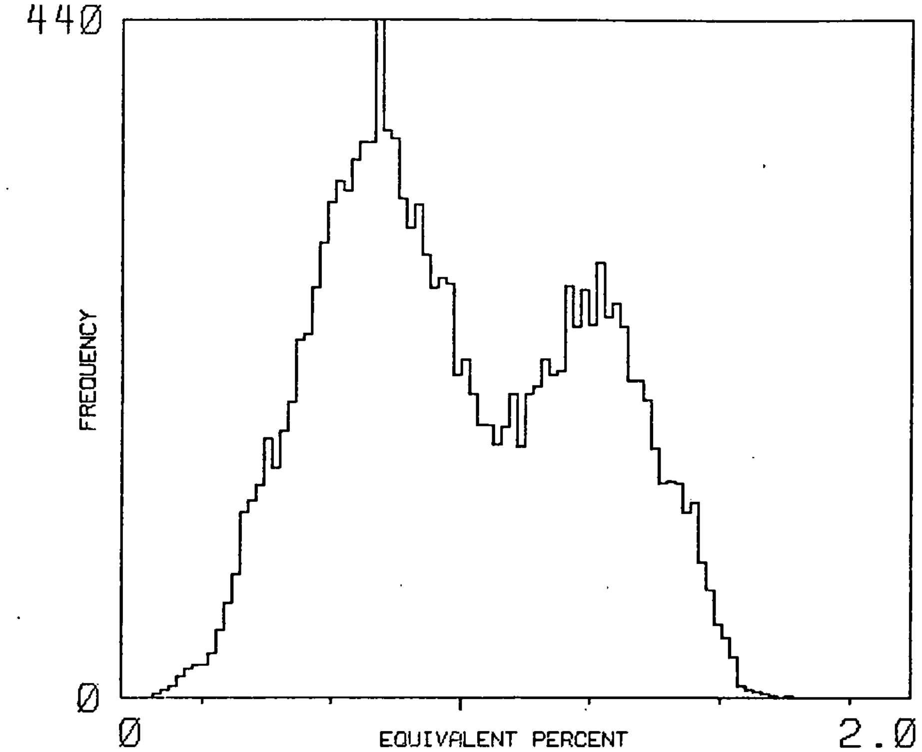
MEAN / MEDIAN 7.3 7.3 14187 ADEQUATE SAMPLES

URANIUM



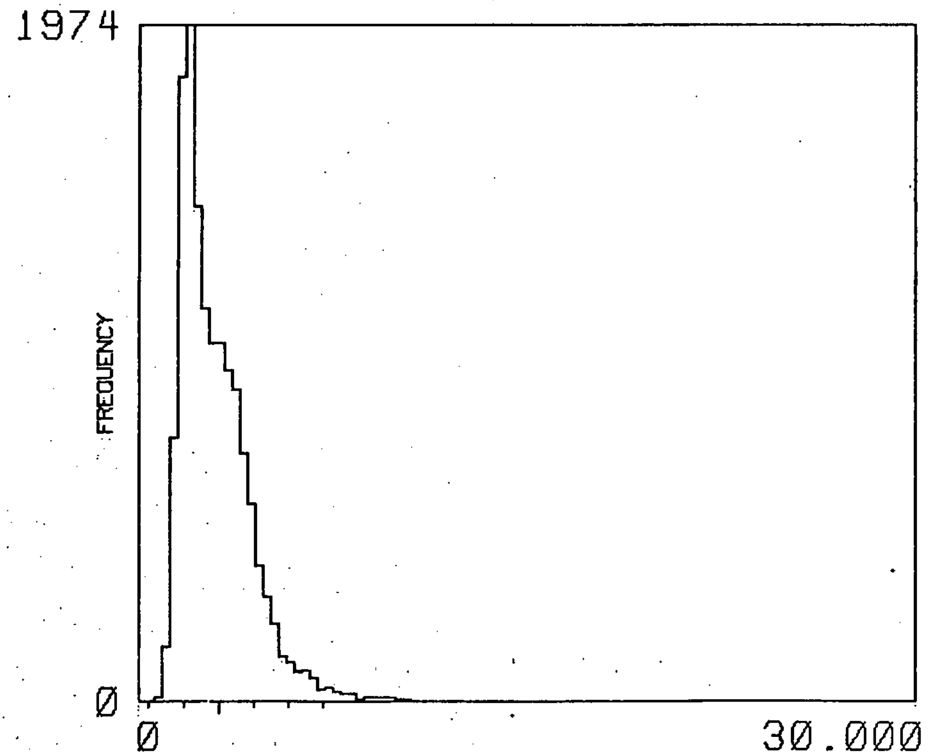
MEAN / MEDIAN 2.3 2.3 14184 ADEQUATE SAMPLES

POTASSIUM



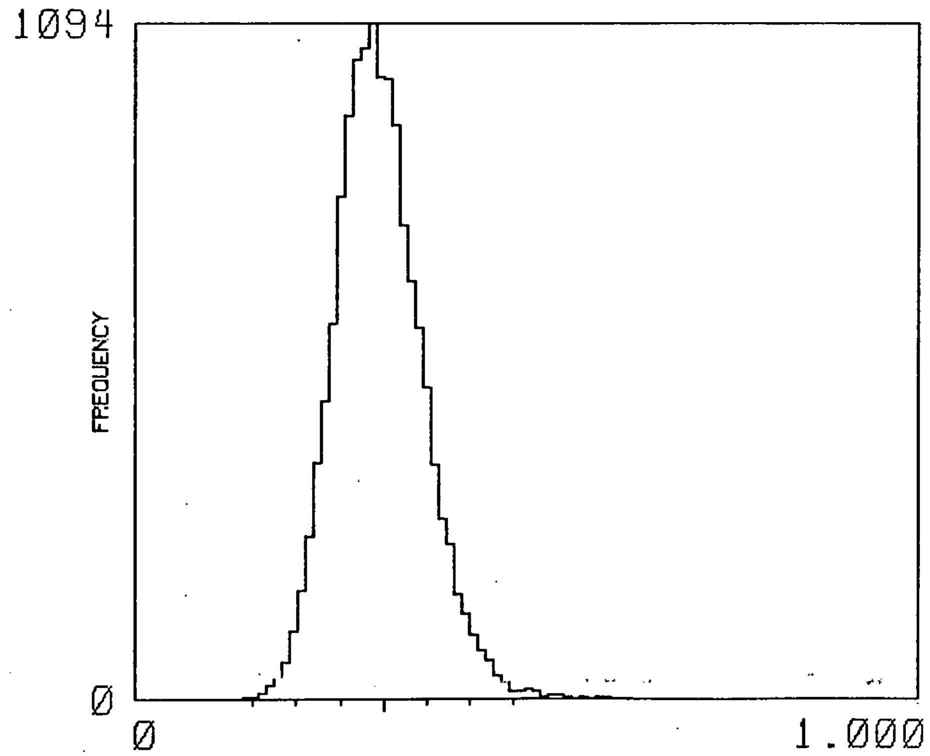
MEAN / MEDIAN 0.9 0.8 14185 ADEQUATE SAMPLES

U/K



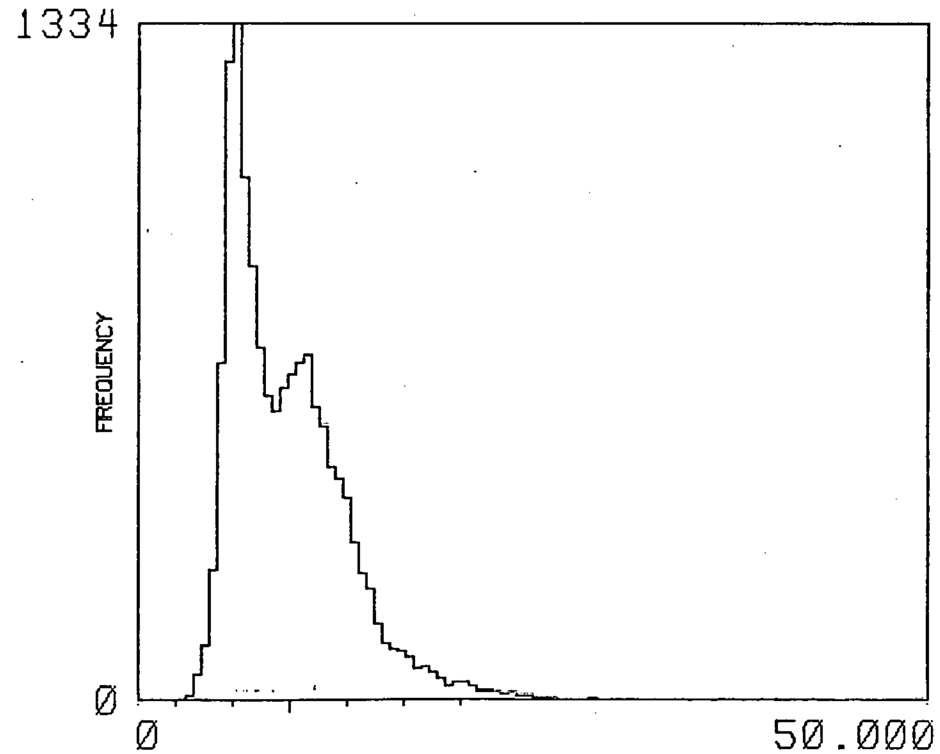
MEAN / MEDIAN 3.094 2.700 14182 ADEQUATE SAMPLES

U/TH



MEAN / MEDIAN 0.319 0.320 14184 ADEQUATE SAMPLES

TH/K



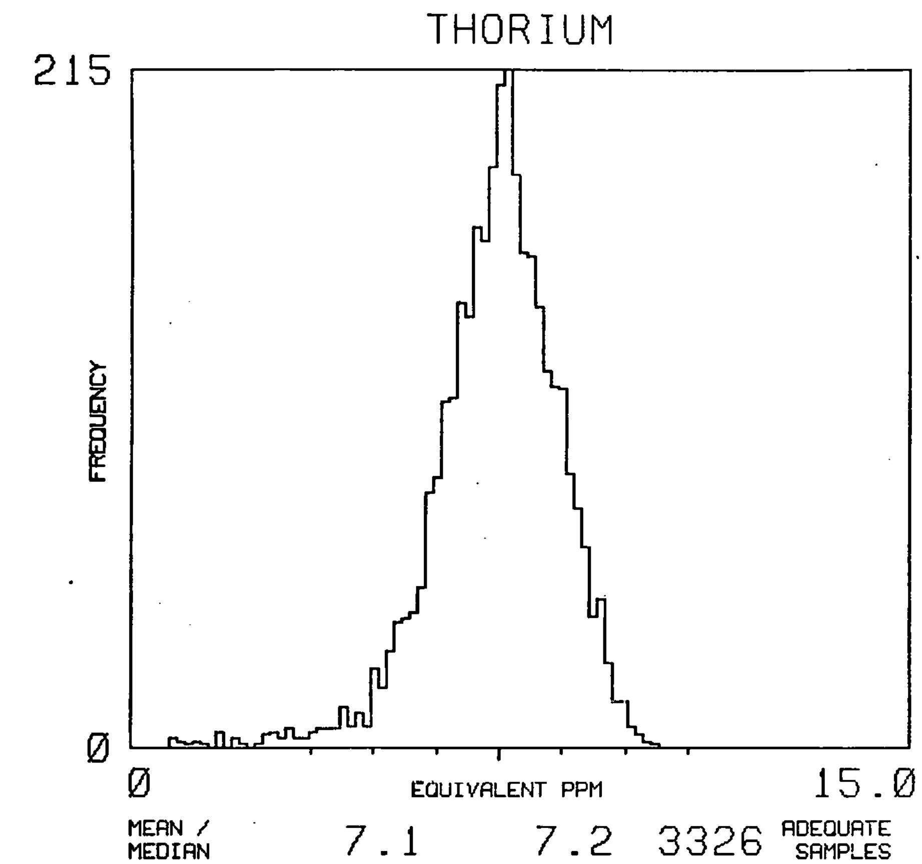
MEAN / MEDIAN 9.654 9.000 14185 ADEQUATE SAMPLES

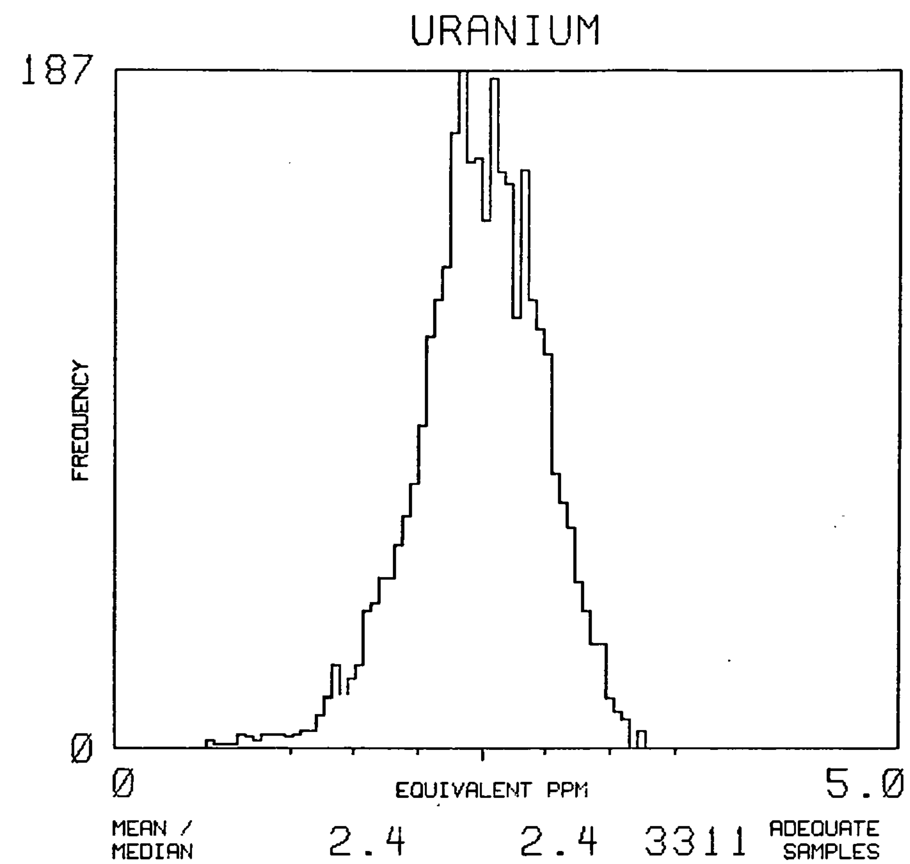
F3 he

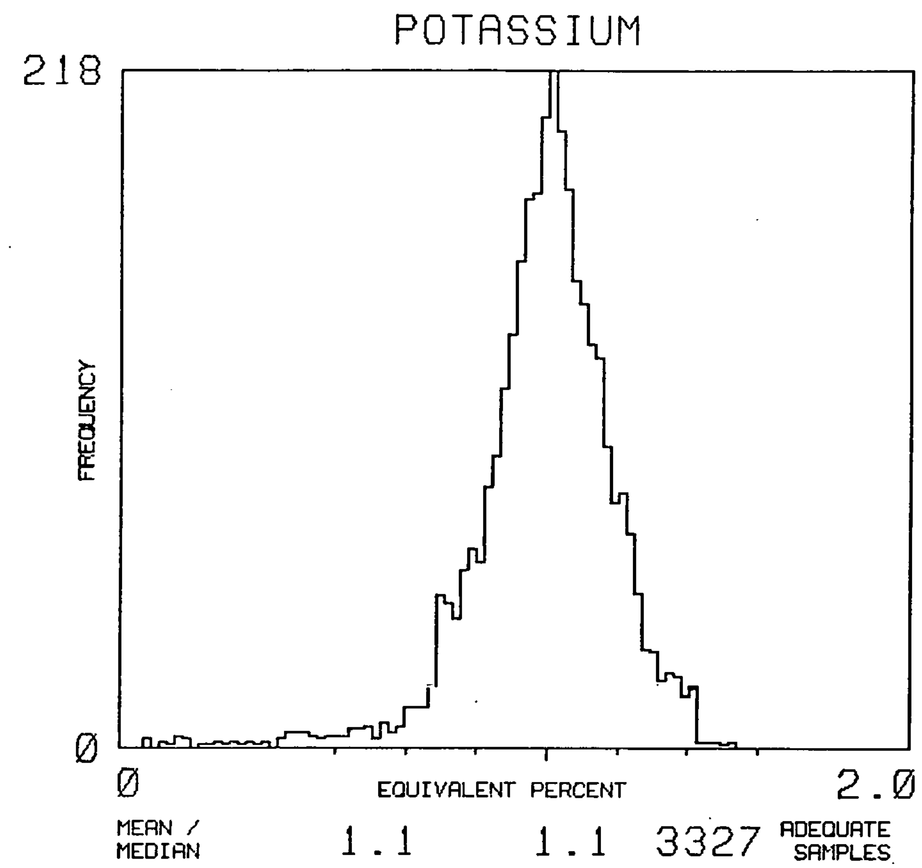
NTMS NI 15-6 HELENA

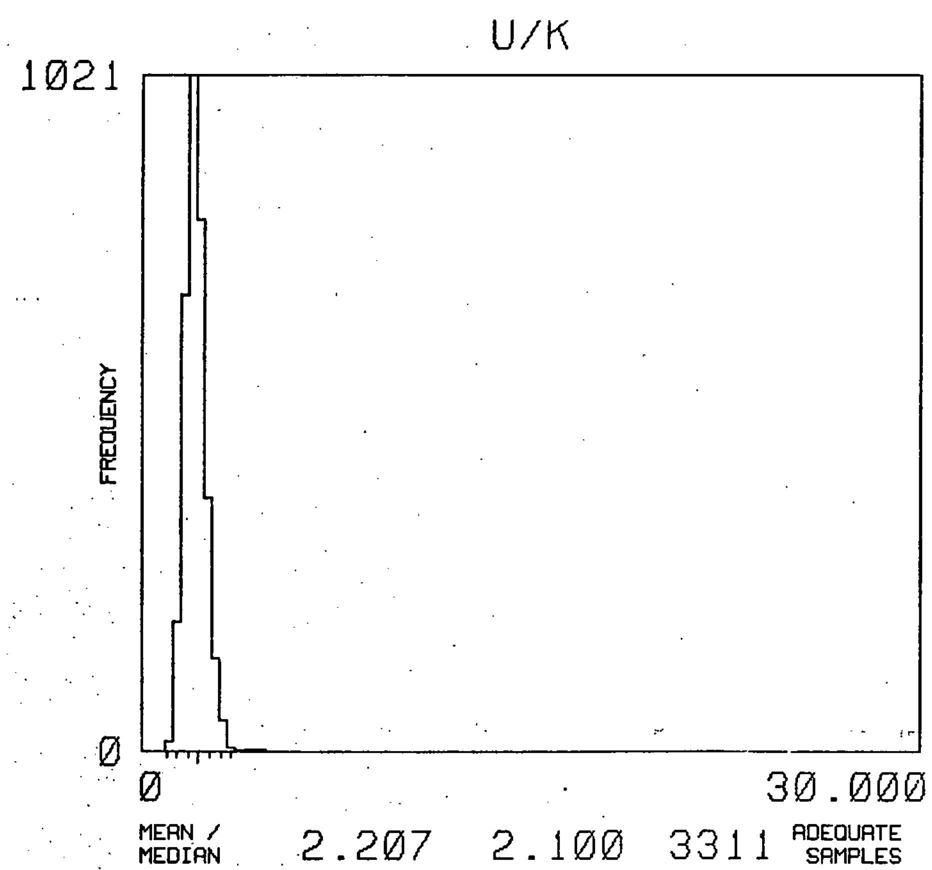
MAP UNIT : QS

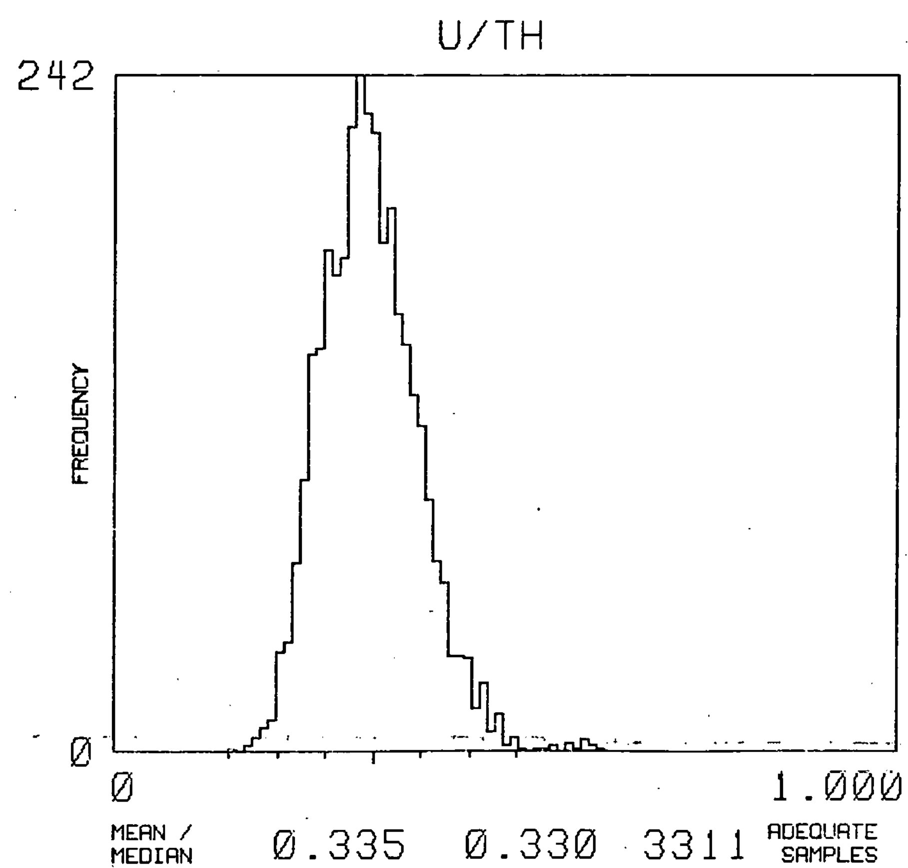
TOTAL NUMBER OF SAMPLES 3425

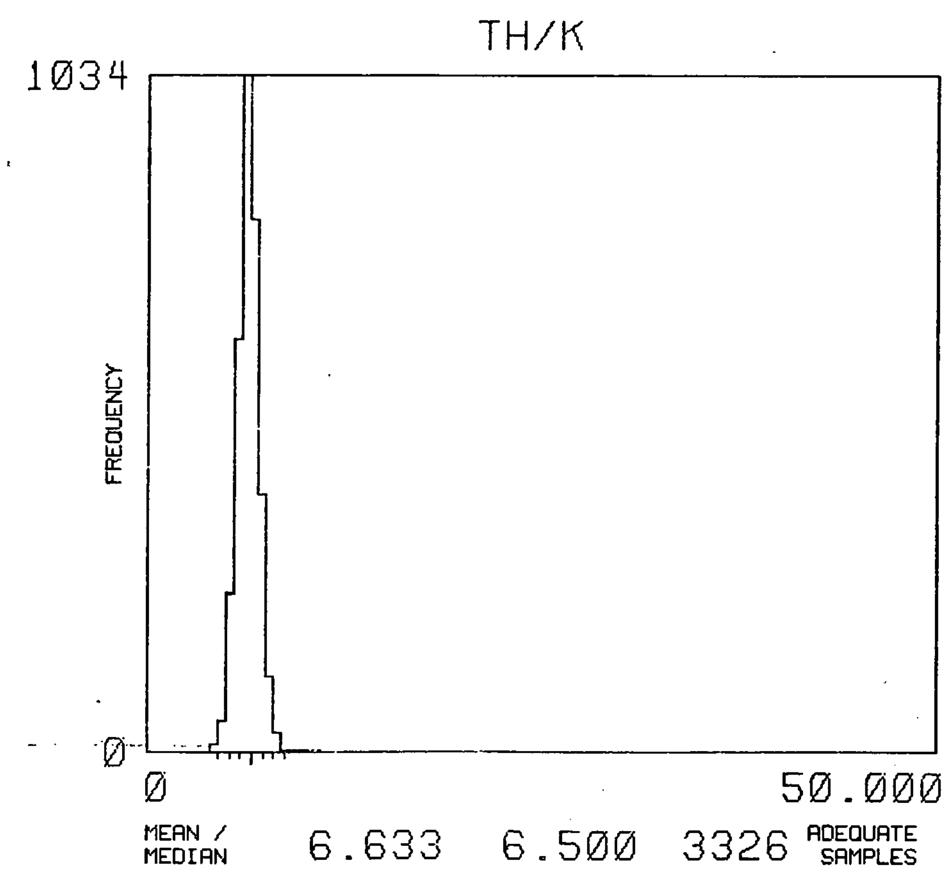




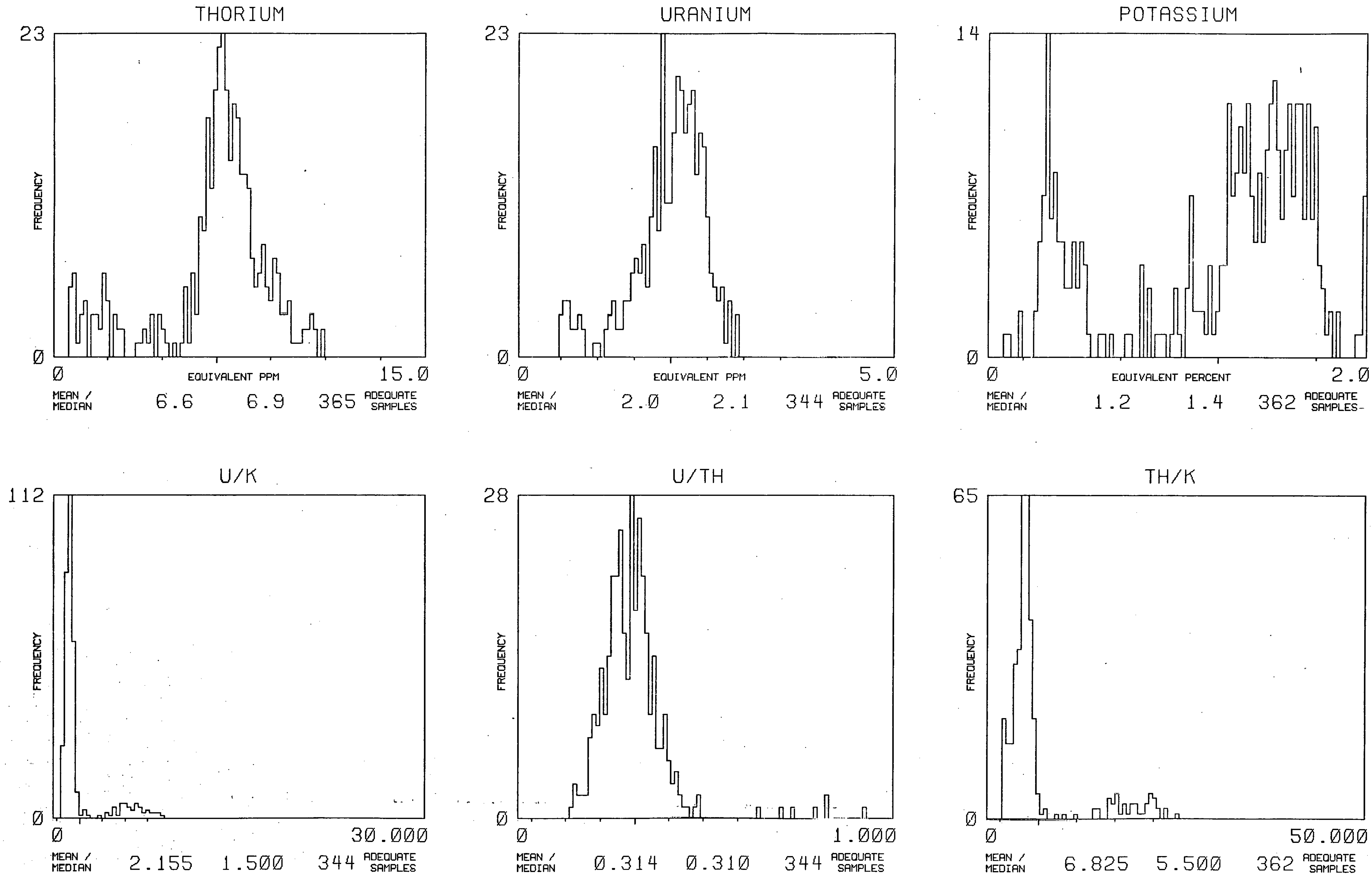








NTMS NI 15-6 HELENA MAP UNIT : TJ TOTAL NUMBER OF SAMPLES 369



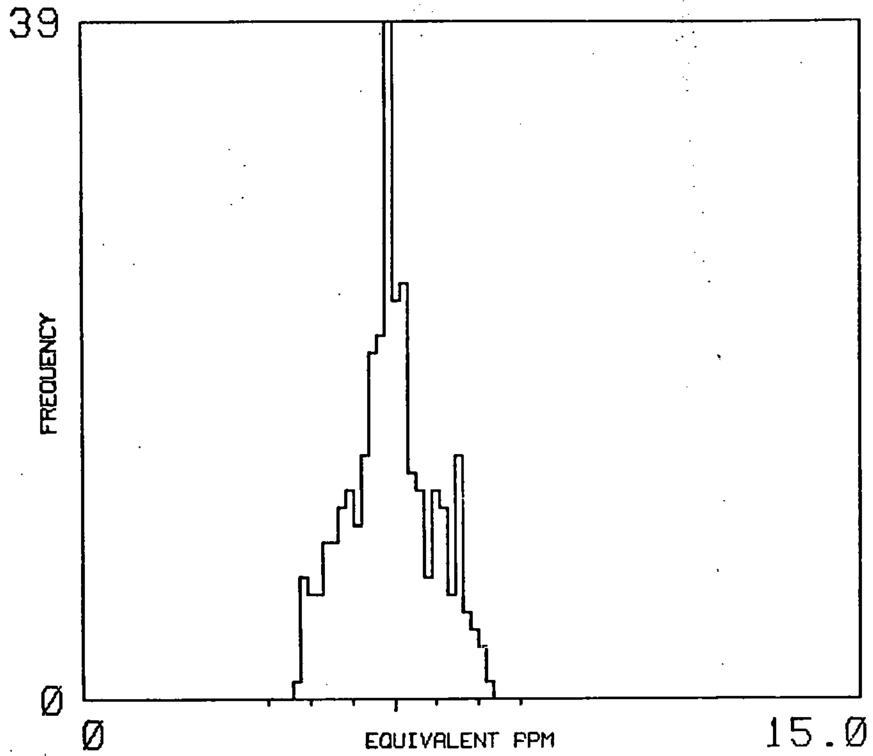
NTMS NI 15-6 HELENA

MAP UNIT : TW

TOTAL NUMBER OF SAMPLES 300

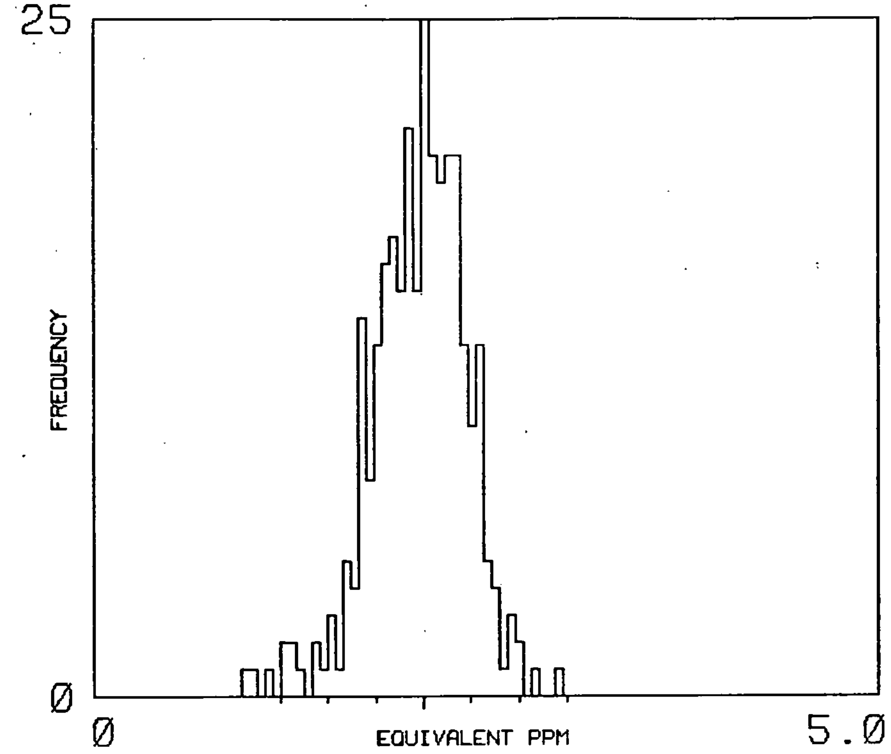
F5 he

THORIUM



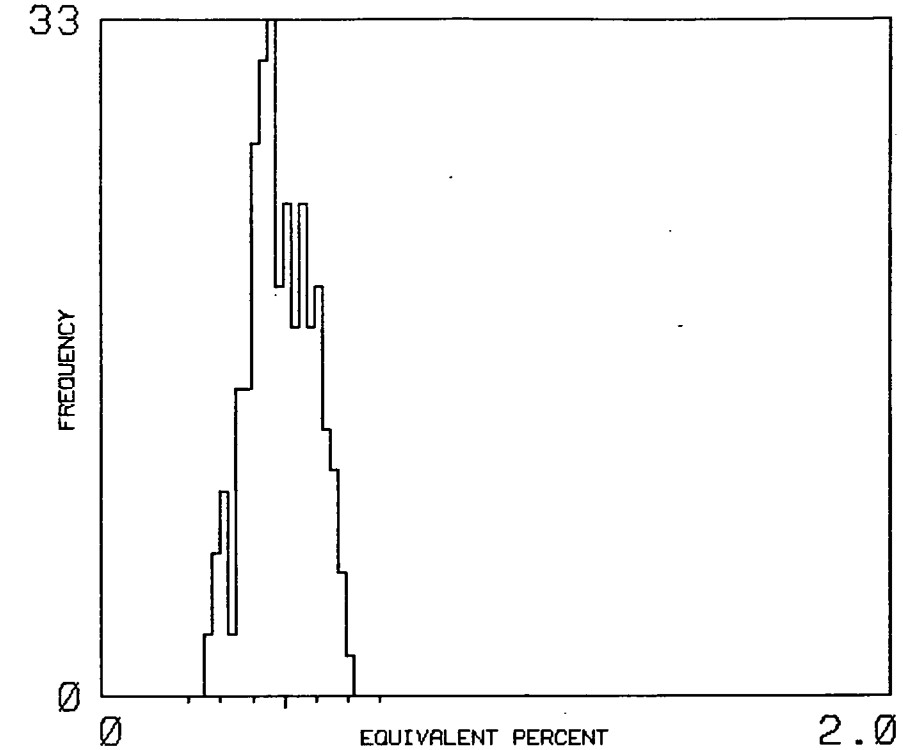
MEAN / MEDIAN 6.0 6.0 300 ADEQUATE SAMPLES

URANIUM



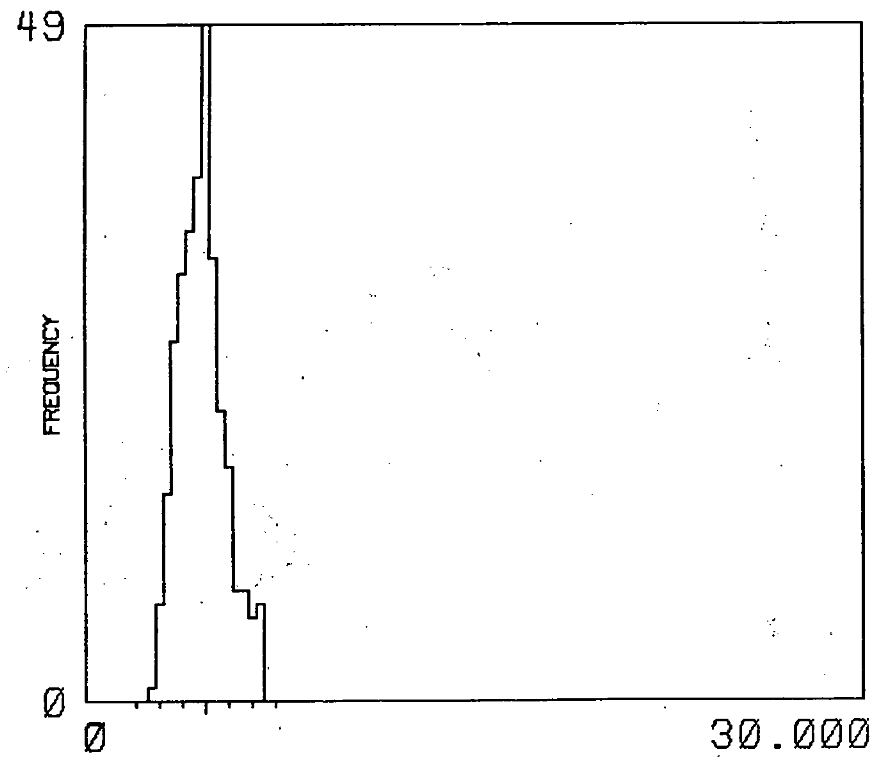
MEAN / MEDIAN 2.1 2.1 300 ADEQUATE SAMPLES

POTASSIUM



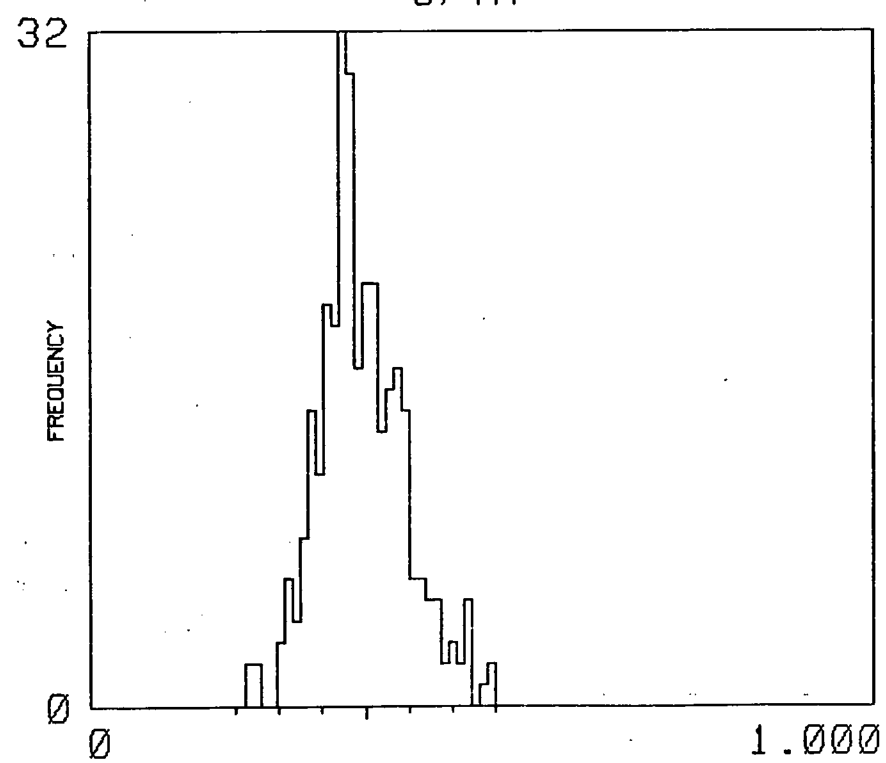
MEAN / MEDIAN 0.5 0.5 300 ADEQUATE SAMPLES

U/K



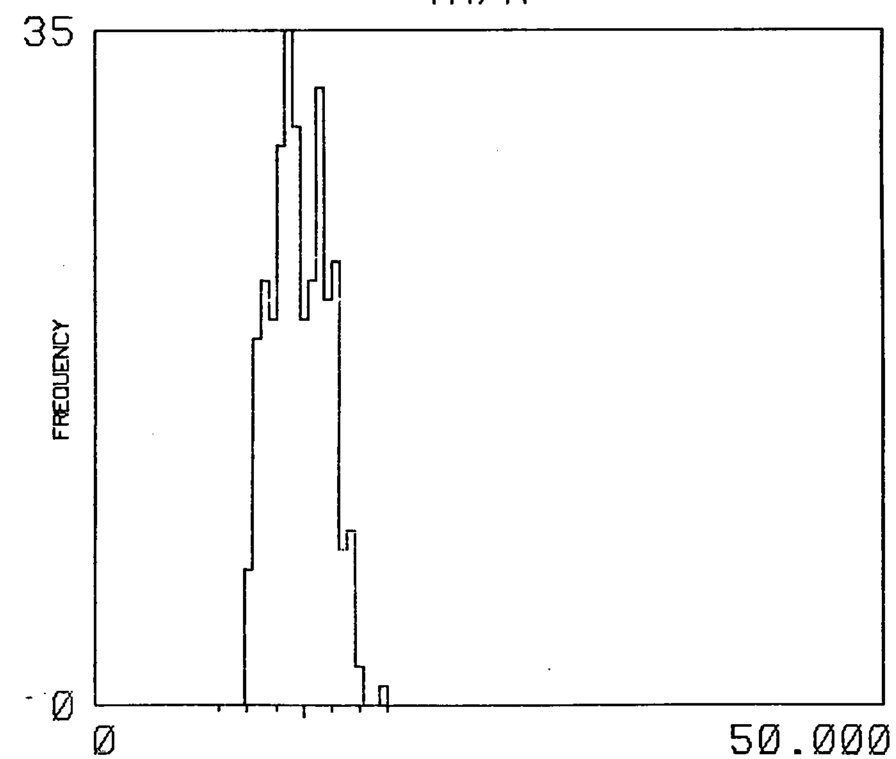
MEAN / MEDIAN 4.662 4.500 300 ADEQUATE SAMPLES

U/TH



MEAN / MEDIAN 0.354 0.350 300 ADEQUATE SAMPLES

TH/K



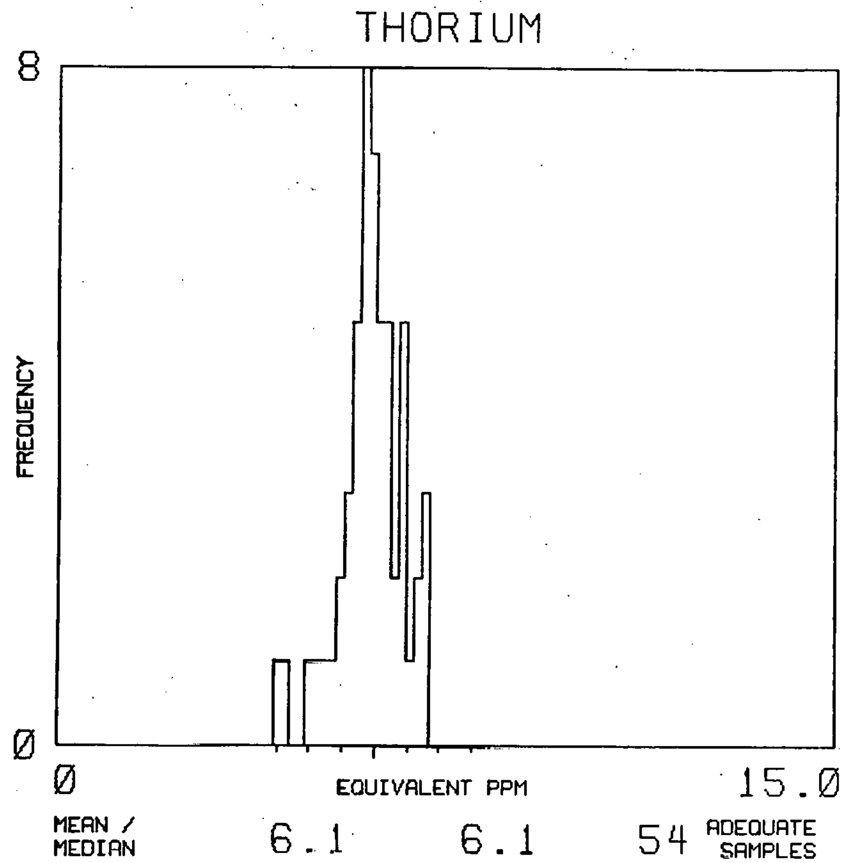
MEAN / MEDIAN 13.199 13.000 300 ADEQUATE SAMPLES

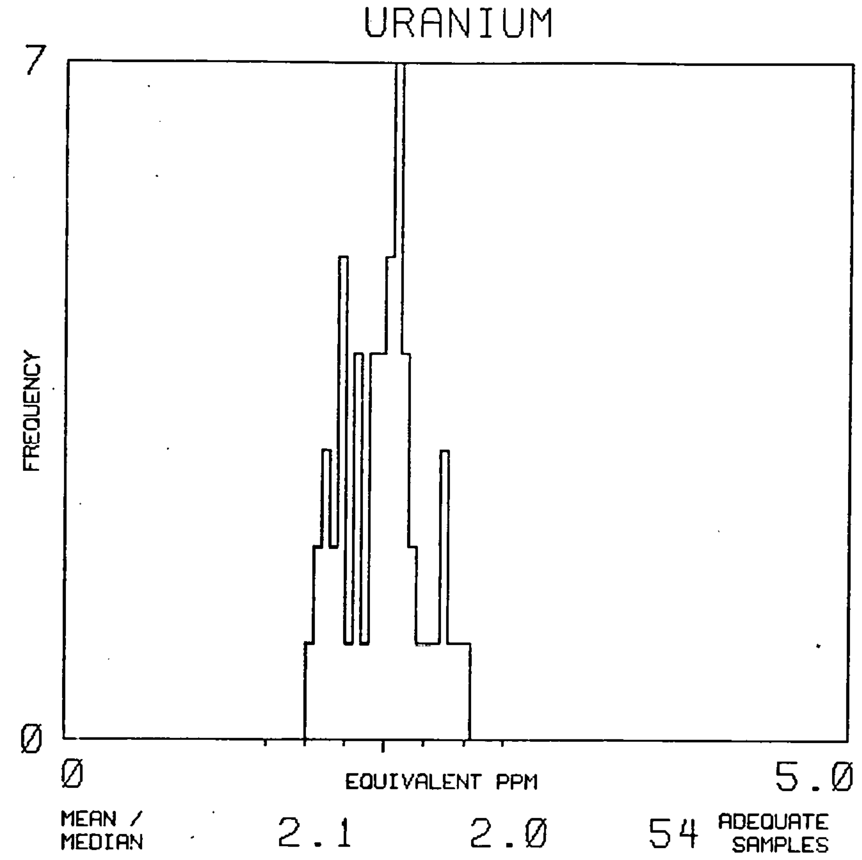
F6he

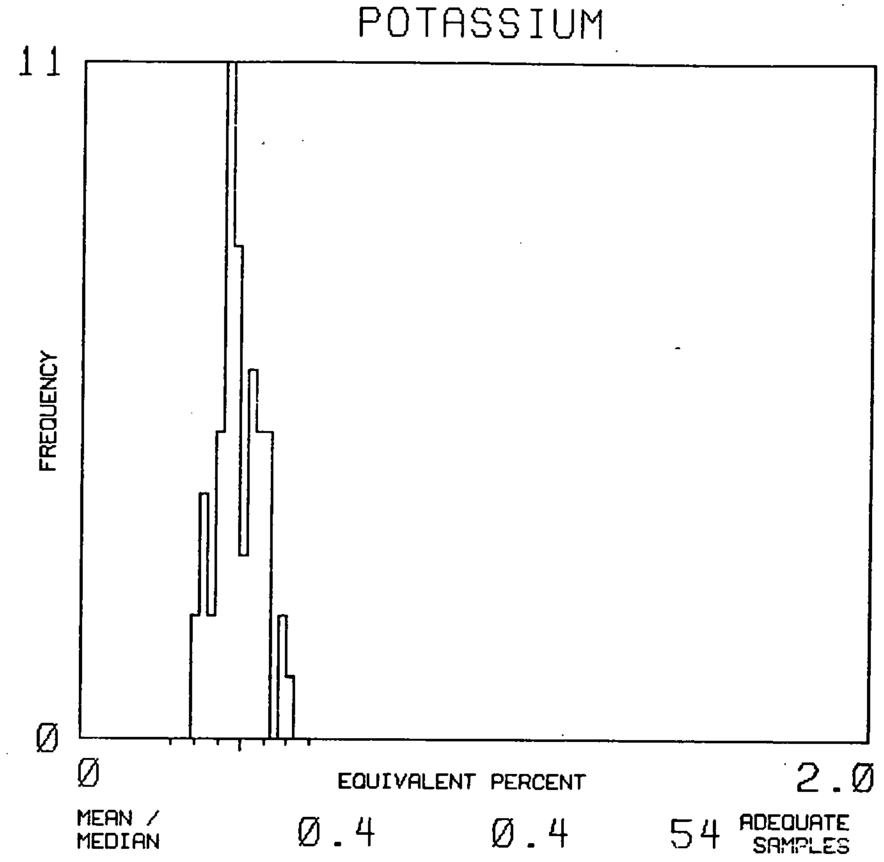
NTMS NI 15-6 HELENA

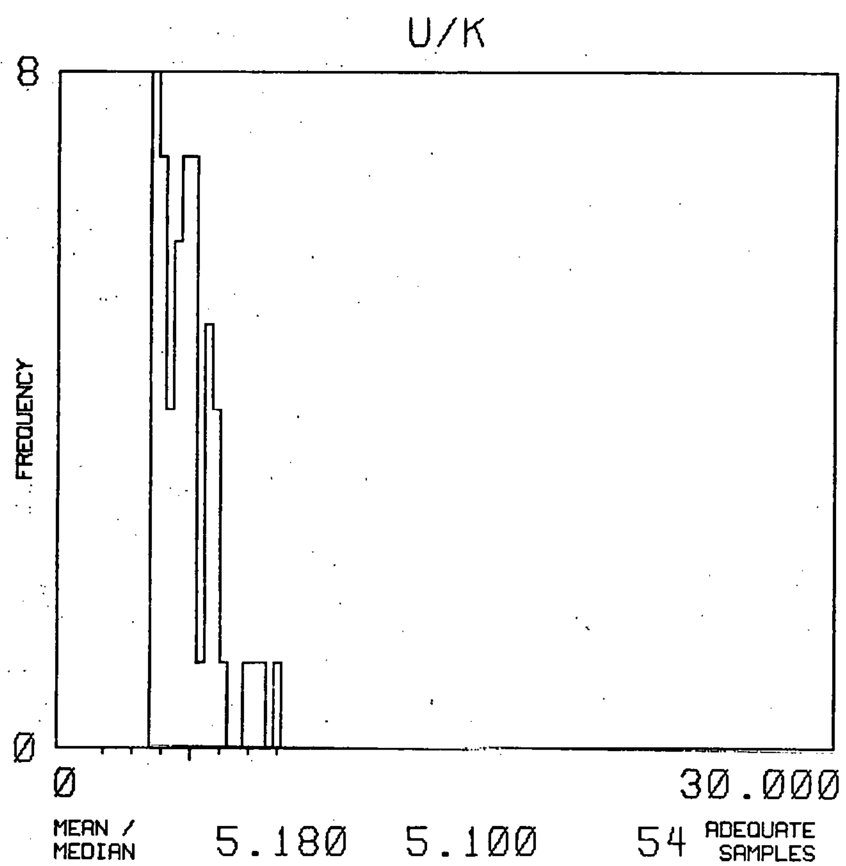
MAP UNIT : TM

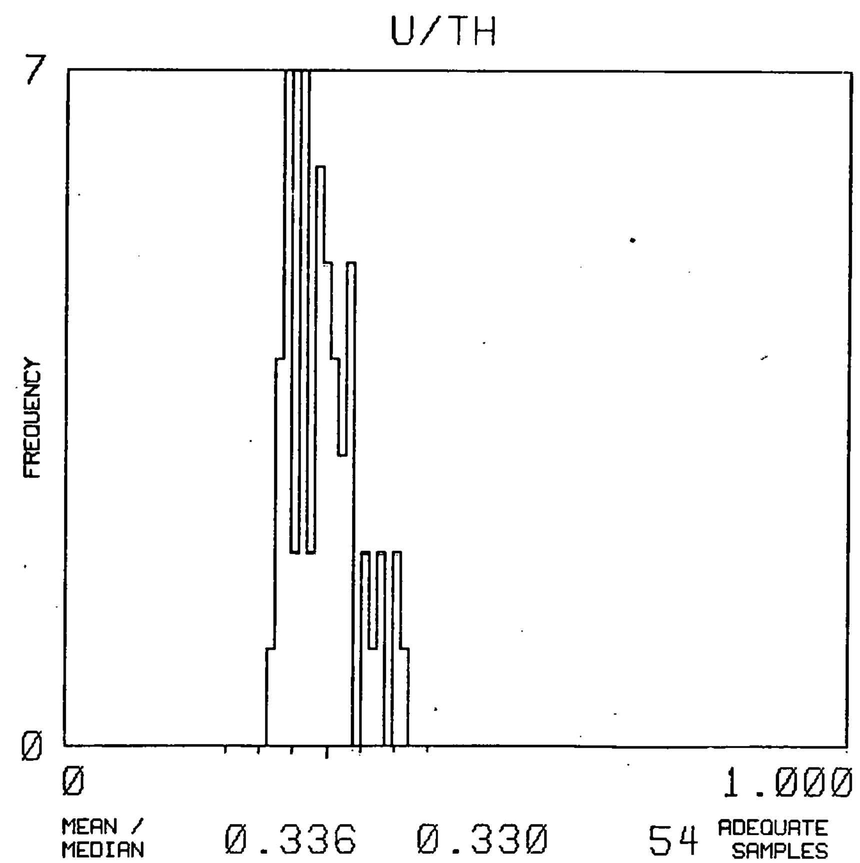
TOTAL NUMBER OF SAMPLES 54

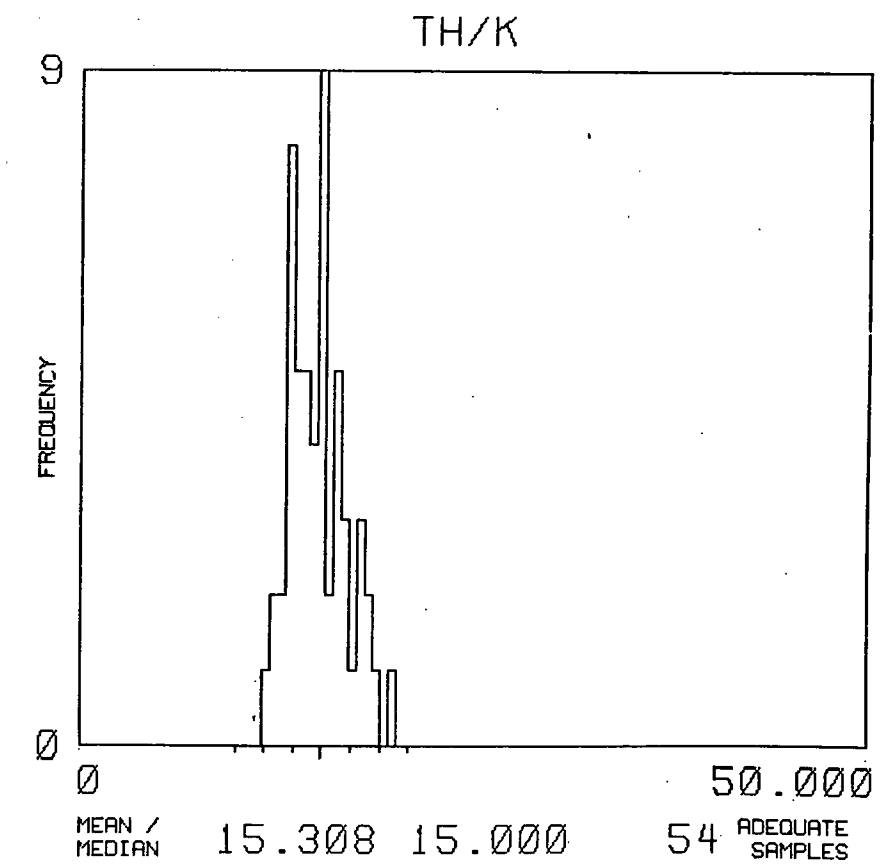












HELENA QUADRANGLE

Computer Map Unit Symbol Conversion Table

Computer Map Unit Symbol	Geologic Map Unit Symbol
QAL	Qal
QT	Qt
* QDS	Qds
QS	Qs
* QSG	Qsg
TJ	Tj
TW	Tw
TM	Tm

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 the original geologic map units are in Appendix A.

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

* A statistical analysis was not performed due to an inadequate 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	370	QAL	/ 2	/ 0	3.5	0	1	1	0	0	0	0	0
2	C	370	QAL	/ 1	/ 0	3.4	0	0	1	0	0	0	0	0
3	C	370	QAL	/ 1	/ 0	3.4	0	0	1	0	0	0	0	0
4	C	370	QT	/ 3	/ 0	3.9	0	2	0	1	0	0	0	0
5	C	370	QT	/ 3QAL	/ 2	3.2	3	2	0	0	0	0	0	0
6	C	370	QT	/ 5	/ 0	3.4	2	2	1	0	0	0	0	0
7	C	380	QT	/ 2	/ 0	3.2	0	2	0	0	0	0	0	0
8	C	390	QT	/ 3	/ 0	3.0	2	1	0	0	0	0	0	0
9	C	390	QAL	/ 1	/ 0	3.3	0	0	1	0	0	0	0	0
10	C	400	QT	/ 3	/ 0	3.0	2	1	0	0	0	0	0	0
11	C	430	QAL	/ 1	/ 0	4.0	0	0	0	1	0	0	0	0
12	C	430	QT	/ 4	/ 0	3.0	3	1	0	0	0	0	0	0
13	C	430	QT	/ 3	/ 0	3.0	2	1	0	0	0	0	0	0
14	C	430	QAL	/ 1	/ 0	3.3	0	0	1	0	0	0	0	0
15	C	430	QAL	/ 2	/ 0	3.2	0	2	0	0	0	0	0	0
16	C	440	QAL	/ 3	/ 0	3.5	2	0	1	0	0	0	0	0
17	C	440	QAL	/ 3	/ 0	3.1	2	1	0	0	0	0	0	0
18	C	440	QAL	/ 1	/ 0	3.6	0	0	1	0	0	0	0	0
19	C	440	QAL	/ 2	/ 0	3.3	1	0	1	0	0	0	0	0
20	C	440	QAL	/ 1	/ 0	3.4	0	0	1	0	0	0	0	0
21	C	440	QAL	/ 2	/ 0	3.1	0	2	0	0	0	0	0	0
22	C	440	QT	/ 5	/ 0	3.1	3	2	0	0	0	0	0	0
23	C	440	QT	/ 3QAL	/ 2	3.2	3	2	0	0	0	0	0	0
24	C	450	QAL	/ 2QT	/ 1	2.9	2	1	0	0	0	0	0	0
25	C	450	QAL	/ 3	/ 0	3.0	1	2	0	0	0	0	0	0
26	C	460	QAL	/ 3	/ 0	2.8	2	1	0	0	0	0	0	0
27	C	460	QAL	/ 5	/ 0	3.0	2	3	0	0	0	0	0	0
28	C	460	QS	/ 3	/ 0	3.2	1	2	0	0	0	0	0	0
29	C	470	QAL	/ 2	/ 0	3.0	0	2	0	0	0	0	0	0
30	C	470	QAL	/ 5	/ 0	2.9	4	1	0	0	0	0	0	0
31	C	480	QT	/ 3	/ 0	3.1	1	2	0	0	0	0	0	0
32	C	480	QAL	/ 3	/ 0	2.9	2	1	0	0	0	0	0	0
33	C	480	QAL	/ 1	/ 0	3.3	0	0	1	0	0	0	0	0
34	C	480	QAL	/ 5	/ 0	2.9	4	1	0	0	0	0	0	0
35	C	480	QAL	/ 3	/ 0	3.0	2	1	0	0	0	0	0	0
36	C	480	QAL	/ 6	/ 0	3.7	1	3	1	1	0	0	0	0
37	C	480	QAL	/ 2	/ 0	3.0	0	2	0	0	0	0	0	0
38	C	480	QAL	/ 3	/ 0	2.8	2	1	0	0	0	0	0	0
39	C	1170	QAL	/ 2	/ 0	3.1	0	2	0	0	0	0	0	0
40	C	1180	QT	/ 6	/ 0	3.5	5	0	1	0	0	0	0	0
41	C	1180	QT	/ 3	/ 0	3.1	0	3	0	0	0	0	0	0
42	C	1180	QT	/ 1	/ 0	3.4	0	0	1	0	0	0	0	0
43	C	1180	QT	/ 3	/ 0	2.9	2	1	0	0	0	0	0	0
44	C	1180	QT	/ 2	/ 0	3.5	0	1	1	0	0	0	0	0
45	C	1180	QT	/ 2	/ 0	3.6	0	1	1	0	0	0	0	0
46	C	1190	QAL	/ 2	/ 0	3.1	0	2	0	0	0	0	0	0
47	C	1190	QAL	/ 4	/ 0	3.1	1	3	0	0	0	0	0	0
48	C	1190	QAL	/ 5	/ 0	3.6	1	3	1	0	0	0	0	0
49	C	1190	QAL	/ 1	/ 0	3.3	0	0	1	0	0	0	0	0
50	C	1200	QAL	/ 3	/ 0	2.8	2	1	0	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	1200	QAL	/ 4	/ 0	3.1	1	3	0	0	0	0	0	0
52	C	1200	QAL	/ 4	/ 0	2.9	2	2	0	0	0	0	0	0
53	C	1200	QAL	/ 1	/ 0	3.3	0	0	1	0	0	0	0	0
54	C	1200	QAL	/ 3	/ 0	2.9	2	1	0	0	0	0	0	0
55	C	1200	QAL	/ 2	/ 0	3.5	0	1	1	0	0	0	0	0
56	C	1200	QAL	/ 5	/ 0	3.2	1	4	0	0	0	0	0	0
57	C	1210	QS	/ 3	/ 0	3.1	2	1	0	0	0	0	0	0
58	C	1210	QS	/ 4	/ 0	3.1	1	3	0	0	0	0	0	0
59	C	1210	QS	/ 2	/ 0	3.3	0	2	0	0	0	0	0	0
60	C	1210	QS	/ 4	/ 0	3.1	3	1	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	0.1141	0.4607	0.8073	1.1539	1.5005	1.8471	2.1937
URANIUM DIST NORMAL	0.7292	1.1882	1.6472	2.1062	2.5652	3.0242	3.4832
THORIUM DIST NORMAL	2.1670	3.8482	5.5294	7.2106	8.8918	10.5730	12.2542
U/K DIST NORMAL	-0.3561	0.4201	1.1963	1.9725	2.7487	3.5249	4.3011
U/TH DIST NORMAL	0.0895	0.1593	0.2291	0.2989	0.3687	0.4385	0.5083
TH/K DIST NORMAL	0.4269	2.5074	4.5879	6.6684	8.7489	10.8294	12.9099

MAP UNIT QT

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.1255	0.2026	0.5307	0.8588	1.1869	1.5150	1.8431
URANIUM DIST NORMAL	1.0621	1.4735	1.8849	2.2963	2.7077	3.1191	3.5305
THORIUM DIST NORMAL	3.6965	4.8916	6.0867	7.2818	8.4769	9.6720	10.8671
U/K DIST NORMAL	-0.9359	0.4075	1.7509	3.0943	4.4377	5.7811	7.1245
U/TH DIST NORMAL	0.1532	0.2085	0.2638	0.3191	0.3744	0.4297	0.4850
TH/K DIST NORMAL	-1.1934	2.4225	6.0384	9.6543	13.2702	16.8861	20.5020

MAP UNIT QS

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.5464	0.7244	0.9024	1.0804	1.2584	1.4364	1.6144
URANIUM DIST NORMAL	1.1355	1.5434	1.9513	2.3592	2.7671	3.1750	3.5829
THORIUM DIST NORMAL	3.4925	4.7047	5.9169	7.1291	8.3413	9.5535	10.7657
U/K DIST NORMAL	0.9376	1.3607	1.7838	2.2069	2.6300	3.0531	3.4762
U/TH DIST NORMAL	0.1510	0.2122	0.2734	0.3346	0.3958	0.4570	0.5182
TH/K DIST NORMAL	4.5322	5.2324	5.9326	6.6328	7.3330	8.0332	8.7334

MAP UNIT TJ

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	-0.3315	0.1846	0.7007	1.2168	1.7329	2.2490	2.7651
URANIUM DIST NORMAL	0.5751	1.0621	1.5491	2.0361	2.5231	3.0101	3.4971
THORIUM DIST NORMAL	-0.0344	2.1711	4.3766	6.5821	8.7876	10.9931	13.1986
U/K DIST NORMAL	-3.3454	-1.5121	0.3212	2.1545	3.9878	5.8211	7.6544
U/TH DIST NORMAL	0.0366	0.1290	0.2214	0.3138	0.4062	0.4986	0.5910
TH/K DIST NORMAL	-8.4566	-3.3628	1.7310	6.8248	11.9186	17.0124	22.1062

MAP UNIT TW

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.2212	0.3019	0.3826	0.4633	0.5440	0.6247	0.7054
URANIUM DIST NORMAL	1.1990	1.5033	1.8076	2.1119	2.4162	2.7205	3.0248
THORIUM DIST NORMAL	3.5743	4.3906	5.2069	6.0232	6.8395	7.6558	8.4721
U/K DIST NORMAL	1.9776	2.8724	3.7672	4.6620	5.5568	6.4516	7.3464
U/TH DIST NORMAL	0.1871	0.2428	0.2985	0.3542	0.4099	0.4656	0.5213
TH/K DIST NORMAL	7.9290	9.6856	11.4422	13.1988	14.9554	16.7120	18.4686

MAP UNIT TM

	-3	-2	-1	0	+1	+2	+3
POTASIUM DIST NORMAL	0.2320	0.2901	0.3482	0.4063	0.4644	0.5225	0.5806
URANIUM DIST NORMAL	1.3038	1.5544	1.8050	2.0556	2.3062	2.5568	2.8074
THORIUM DIST NORMAL	4.2627	4.8911	5.5195	6.1479	6.7763	7.4047	8.0331
U/K DIST NORMAL	1.8354	2.9502	4.0650	5.1798	6.2946	7.4094	8.5242
U/TH DIST NORMAL	0.2070	0.2501	0.2932	0.3363	0.3794	0.4225	0.4656
TH/K DIST NORMAL	9.8320	11.6572	13.4824	15.3076	17.1328	18.9580	20.7832

LINE BASED MEAN CONCENTRATIONS AND RATIOS PER ROCK TYPE

MAP UNIT QAL

	1200	1210	480	470	460	450	1190	1180	440	430	1160	1170	1150	420	410
POTASIUM	1.232	0.957	1.141	1.146	1.162	1.115	1.216	1.186	1.141	1.166	1.156	0.904	1.324	1.044	1.126
URANIUM	2.346	2.236	2.134	2.093	2.054	1.973	2.224	2.200	2.138	2.209	2.038	1.948	2.070	1.986	1.919
THORIUM	7.170	6.009	6.889	6.945	6.908	6.783	7.162	7.242	7.267	7.608	7.940	7.091	7.684	7.032	7.156
U/K	1.951	2.402	1.964	1.933	1.910	1.883	1.890	1.973	2.042	2.024	1.917	2.253	1.749	2.178	1.795
U/TH	0.331	0.381	0.319	0.306	0.304	0.302	0.316	0.312	0.305	0.299	0.264	0.278	0.280	0.287	0.273
TH/K	5.944	6.384	6.268	6.398	6.292	6.330	5.996	6.297	6.877	6.851	7.505	8.065	6.332	7.559	6.697

	370	380	400	390
POTASIUM	1.306	1.099	1.183	1.262
URANIUM	2.326	2.127	2.029	2.137
THORIUM	7.764	7.154	7.511	7.840
U/K	1.895	2.352	1.943	1.819
U/TH	0.302	0.306	0.275	0.275
TH/K	6.229	7.538	7.093	6.616

MAP UNIT QT

	1200	1210	480	470	460	450	1190	1180	440	430	1160	1170	1150	420	410
POTASIUM	0.000	0.000	0.653	0.813	0.872	0.928	1.128	1.043	0.837	0.916	0.567	0.762	0.428	1.072	0.933
URANIUM	0.000	0.000	2.337	2.273	2.298	2.310	2.449	2.416	2.366	2.413	2.177	2.266	1.902	2.304	2.198
THORIUM	0.000	0.000	7.235	7.125	7.297	7.644	7.127	7.372	7.314	7.288	6.916	7.435	6.154	7.577	7.232
U/K	0.000	0.000	4.479	3.658	3.089	2.920	2.200	2.500	3.268	2.905	4.065	3.154	5.002	2.219	2.665
U/TH	0.000	0.000	0.332	0.325	0.319	0.306	0.348	0.334	0.328	0.334	0.320	0.308	0.316	0.304	0.306
TH/K	0.000	0.000	13.321	10.928	9.569	9.390	6.343	7.424	9.790	8.706	12.705	10.239	15.536	7.315	8.685

	370	380	400	390
POTASIUM	0.796	0.835	0.855	0.791
URANIUM	2.314	2.340	2.236	2.249
THORIUM	7.081	7.365	7.440	7.273
U/K	3.315	3.167	3.073	3.183
U/TH	0.330	0.320	0.304	0.312
TH/K	10.102	9.816	10.088	10.245

MAP UNIT QDS

	1200	1210	480	470	460	450	1190	1180	440	430	1160	1170	1150	420	410
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	370	380	400	390
POTASIUM	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000

MAP UNIT QS

	1200	1210	480	470	460	450	1190	1180	440	430	1160	1170	1150	420	410
POTASIUM	0.000	1.020	0.954	1.006	1.050	1.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.208	1.194
URANIUM	0.000	2.403	1.954	2.111	2.646	2.568	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.260	2.296
THORIUM	0.000	6.791	6.150	6.675	6.931	6.653	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.898	7.813
U/K	0.000	2.385	2.053	2.107	2.537	2.371	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.882	1.940
U/TH	0.000	0.358	0.319	0.320	0.385	0.390	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.289	0.296
TH/K	0.000	6.681	6.500	6.629	6.633	6.134	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.534	6.597

	370	380	400	390
POTASIUM	1.182	1.200	0.990	1.189
URANIUM	2.477	2.599	2.001	2.391
THORIUM	7.645	7.858	6.559	7.983
U/K	2.114	2.176	1.964	1.991
U/TH	0.328	0.333	0.296	0.297
TH/K	6.482	6.565	6.832	6.729

MAP UNIT QSG

	1200	1210	480	470	460	450	1190	1180	440	430	1160	1170	1150	420	410
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	370	380	400	390
POTASIUM	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000

MAP UNIT TJ

	1200	1210	480	470	460	450	1190	1180	440	430	1160	1170	1150	420	410
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.217	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.036	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.582	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.155	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.314	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.825	0.000	0.000

	370	380	400	390
POTASIUM	0.000	0.000	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000
U/K	0.000	0.000	0.000	0.000
U/TH	0.000	0.000	0.000	0.000
TH/K	0.000	0.000	0.000	0.000

MAP UNIT TW

	1200	1210	480	470	460	450	1190	1180	440	430	1160	1170	1150	420	410
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.477	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.204	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.959	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.757	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.374	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.699	0.000	0.000

	370	380	400	390
POTASIUM	0.456	0.444	0.000	0.000
URANIUM	2.044	2.021	0.000	0.000
THORIUM	6.080	6.055	0.000	0.000
U/K	4.551	4.699	0.000	0.000
U/TH	0.338	0.341	0.000	0.000
TH/K	13.557	13.725	0.000	0.000

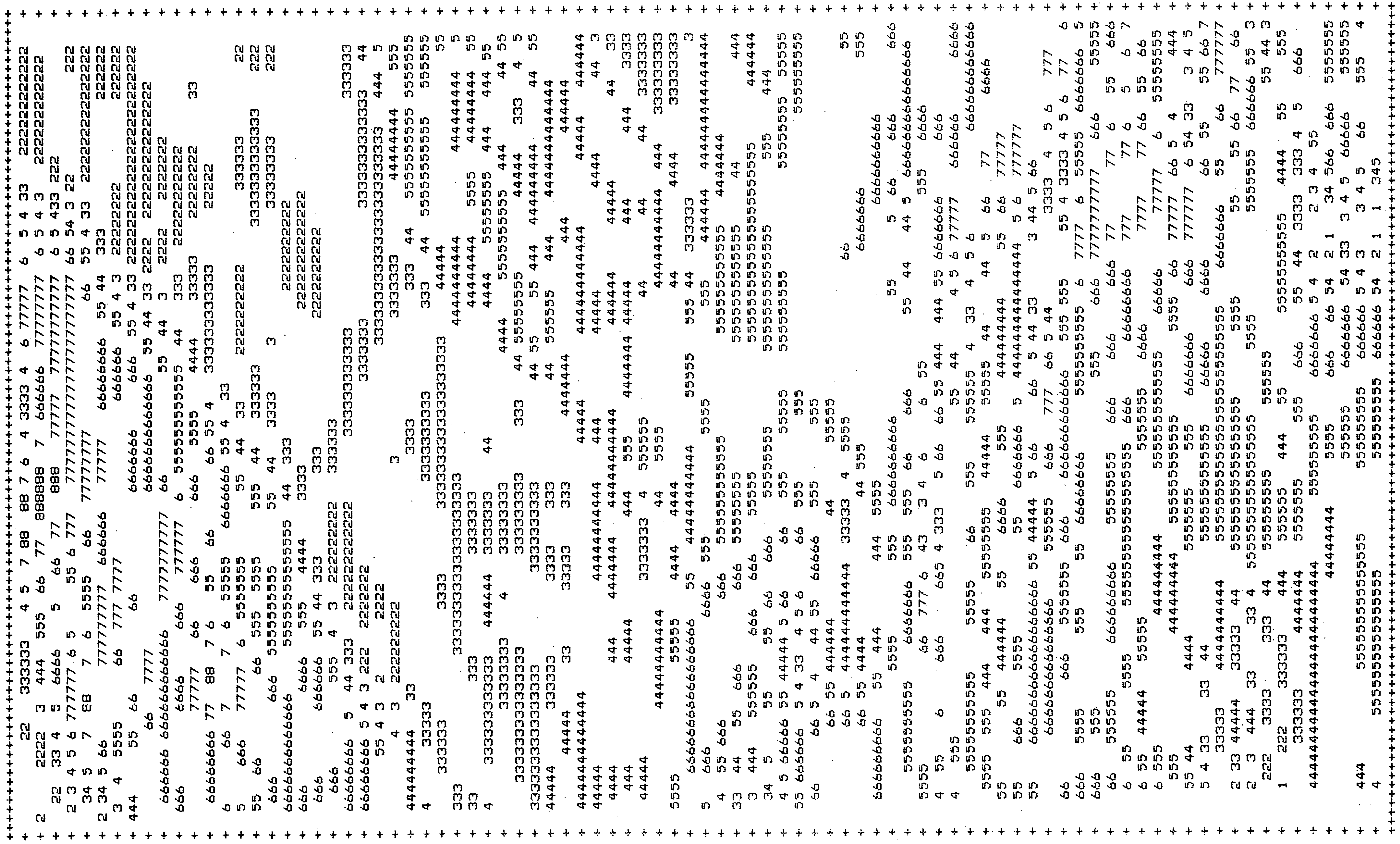
MAP UNIT TM

	1200	1210	480	470	460	450	1190	1180	440	430	1160	1170	1150	420	410
POTASIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.366	0.000	0.000
URANIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.270	0.000	0.000
THORIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.008	0.000	0.000
U/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.297	0.000	0.000
U/TH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.378	0.000	0.000
TH/K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	16.562	0.000	0.000

	370	380	400	390
POTASIUM	0.425	0.000	0.000	0.000
URANIUM	1.957	0.000	0.000	0.000
THORIUM	6.212	0.000	0.000	0.000
U/K	4.667	0.000	0.000	0.000
U/TH	0.317	0.000	0.000	0.000
TH/K	14.731	0.000	0.000	0.000

APPENDIX H - Pseudo Contour Maps

HELENA



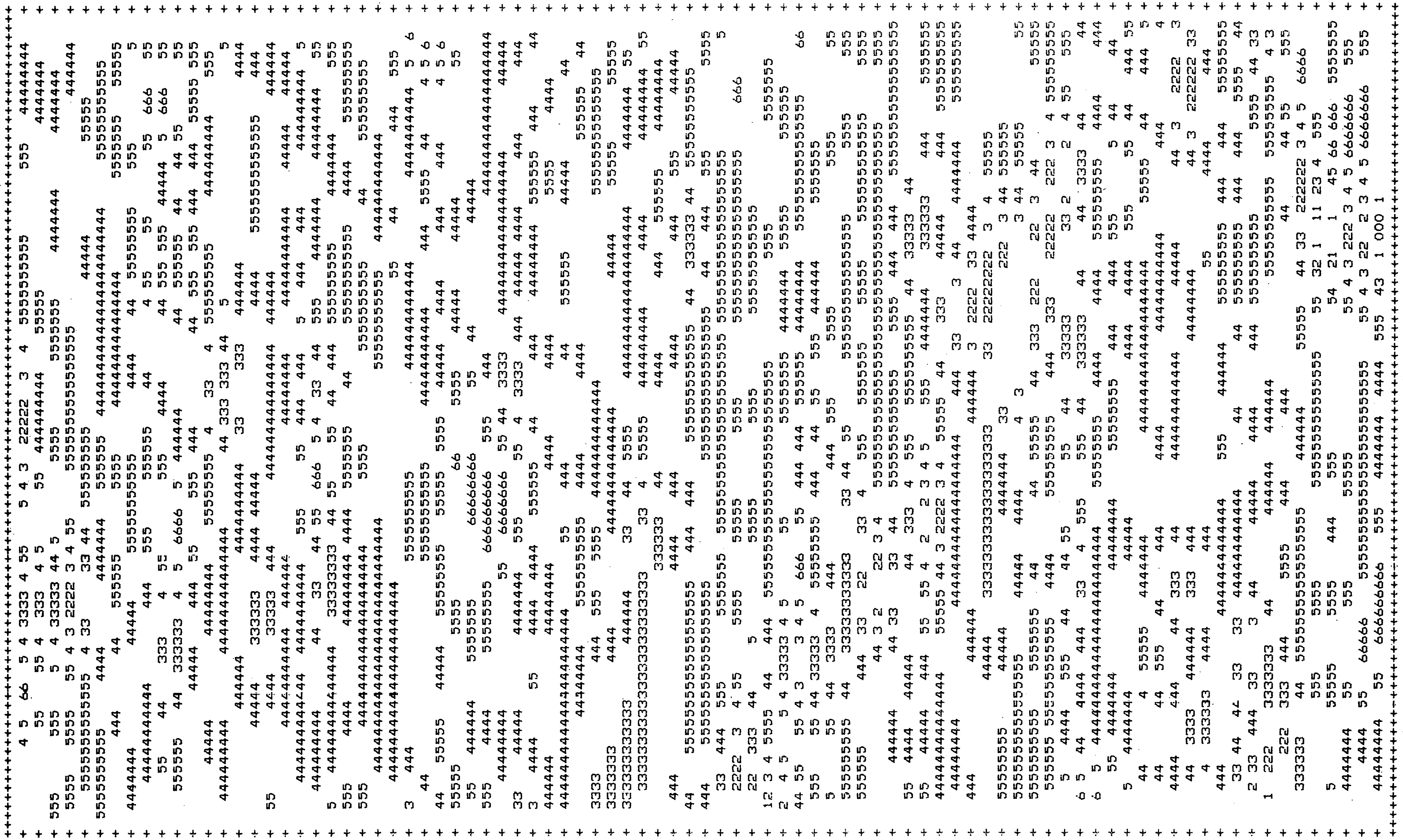
EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0750
	0.0750	0.1850
1	0.1850	0.2950
	0.2950	0.4050
2	0.4050	0.5150
	0.5150	0.6250
3	0.6250	0.7350
	0.7350	0.8450
4	0.8450	0.9550
	0.9550	1.0650
5	1.0650	1.1750
	1.1750	1.2850
6	1.2850	1.3950
	1.3950	1.5050
7	1.5050	1.6150
	1.6150	1.7250
8	1.7250	1.8350
	1.8350	1.9450
9	1.9450	2.0550
	GT	2.0550

Potassium Pseudo-Contour Map - Helena Quadrangle

SCALE IN EQUIVALENT PERCENT

HELENA



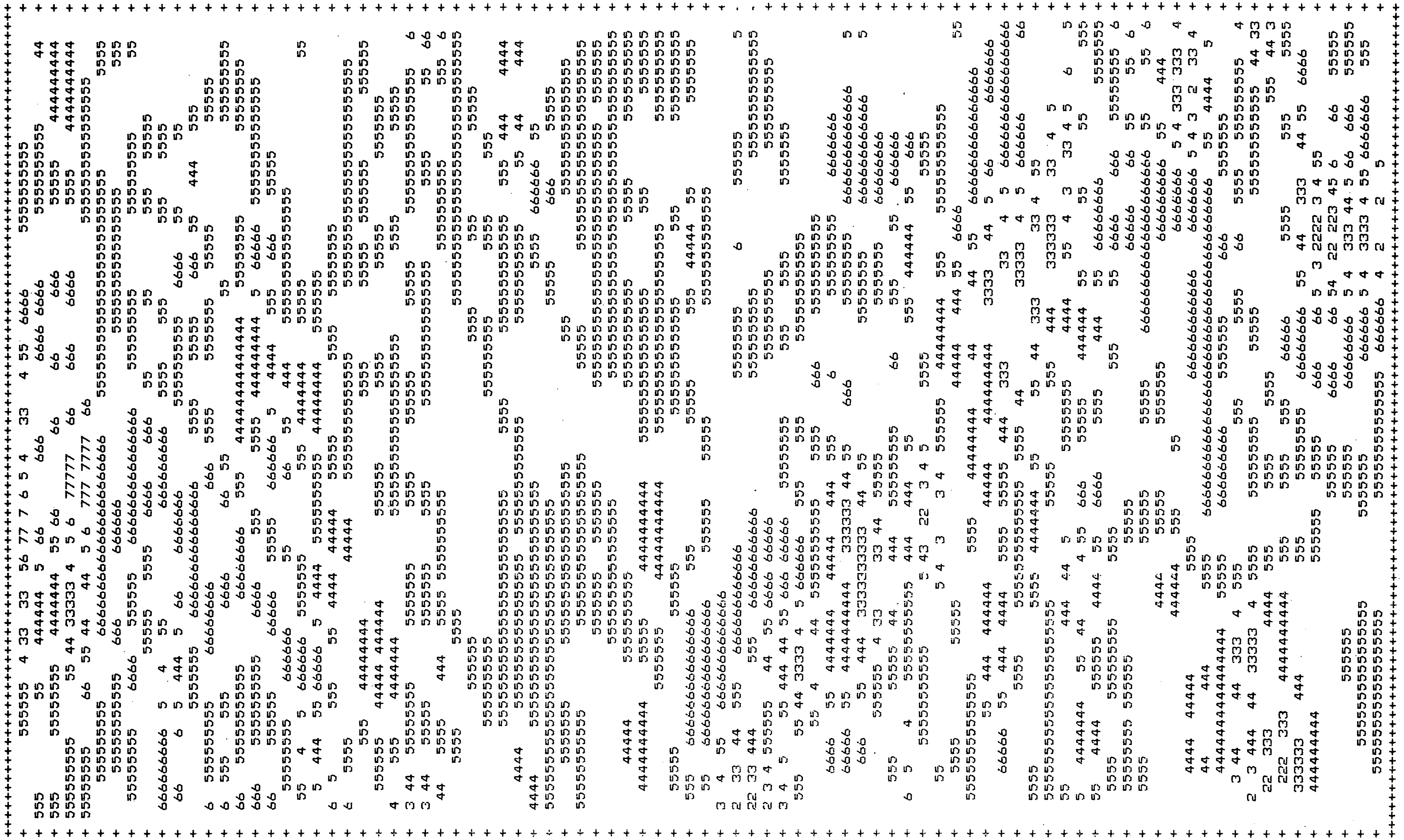
Uranium Pseudo-Contour Map - Helena Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.5000
	0.5000	0.7000
1	0.7000	0.9000
	0.9000	1.1000
2	1.1000	1.3000
	1.3000	1.5000
3	1.5000	1.7000
	1.7000	1.9000
4	1.9000	2.1000
	2.1000	2.3000
5	2.3000	2.5000
	2.5000	2.7000
6	2.7000	2.9000
	2.9000	3.1000
7	3.1000	3.3000
	3.3000	3.5000
8	3.5000	3.7000
	3.7000	3.9000
9	3.9000	4.1000
	GT	4.1000

SCALE IN EQUIVALENT PPM

HELENA



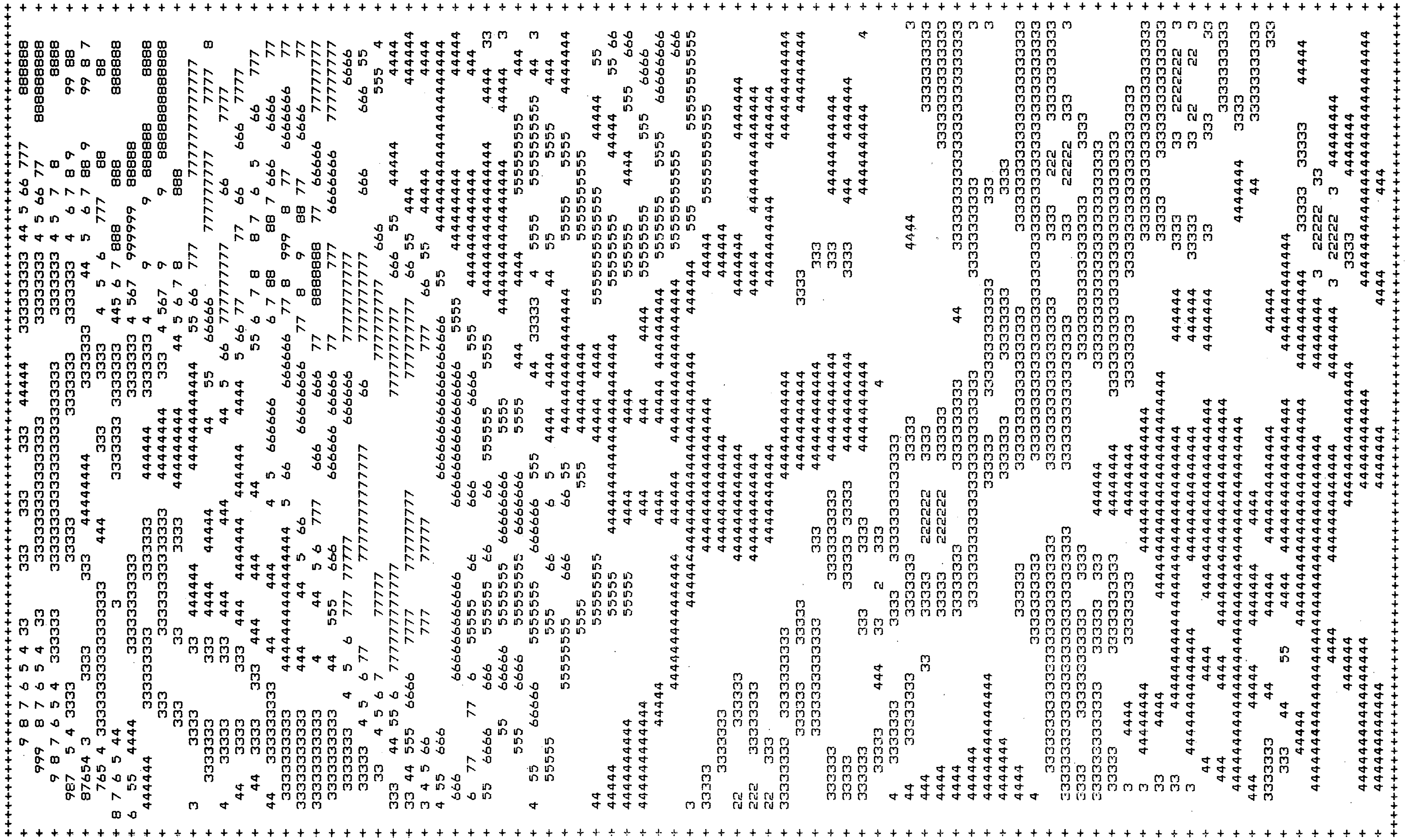
Thorium Pseudo-Contour Map - Helena Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.7500
1	0.7500	1.5000
	1.5000	2.2500
2	2.2500	3.0000
	3.0000	3.7500
3	3.7500	4.5000
	4.5000	5.2500
4	5.2500	6.0000
	6.0000	6.7500
5	6.7500	7.5000
	7.5000	8.2500
6	8.2500	9.0000
	9.0000	9.7500
7	9.7500	10.5000
	10.5000	11.2500
8	11.2500	12.0000
	12.0000	12.7500
9	12.7500	13.5000
	GT	13.5000

SCALE IN EQUIVALENT PPM

HELENA



EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.9500
1	0.9500	1.9000
	1.9000	2.8500
2	2.8500	3.8000
	3.8000	4.7500
3	4.7500	5.7000
	5.7000	6.6500
4	6.6500	7.6000
	7.6000	8.5500
5	8.5500	9.5000
	9.5000	10.4500
6	10.4500	11.4000
	11.4000	12.3500
7	12.3500	13.3000
	13.3000	14.2500
8	14.2500	15.2000
	15.2000	16.1500
9	16.1500	17.1000
	GT	17.1000

Thorium/Potassium Pseudo-Contour Map - Helena Quadrangle

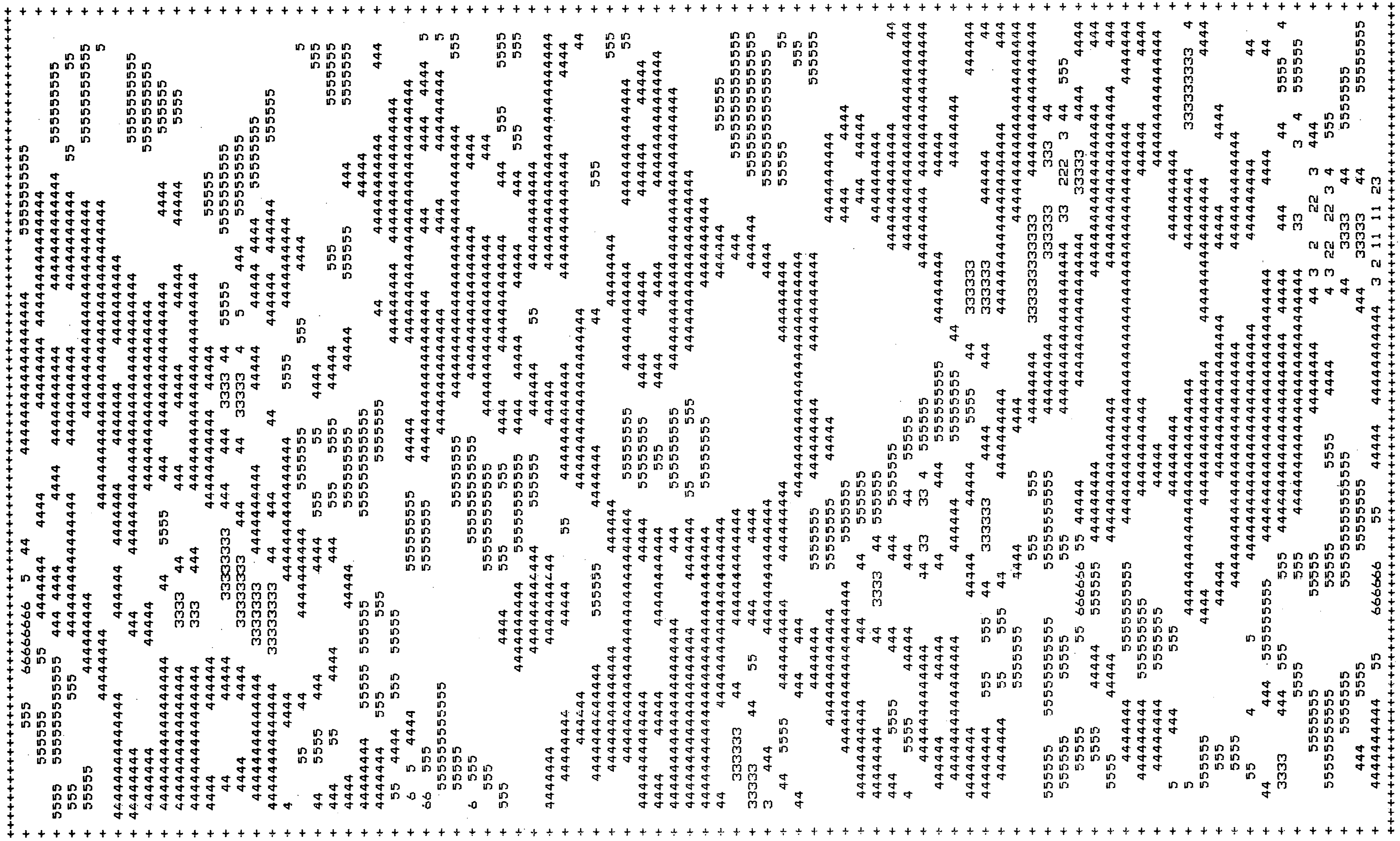
HELENA

EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.3250
1	0.3250	0.6500
	0.6500	0.9750
2	0.9750	1.3000
	1.3000	1.6250
3	1.6250	1.9500
	1.9500	2.2750
4	2.2750	2.6000
	2.6000	2.9250
5	2.9250	3.2500
	3.2500	3.5750
6	3.5750	3.9000
	3.9000	4.2250
7	4.2250	4.5500
	4.5500	4.8750
8	4.8750	5.2000
	5.2000	5.5250
9	5.5250	5.8500
	GT	5.8500

Uranium/Potassium Pseudo-Contour Map - Helena Quadrangle

HELENA

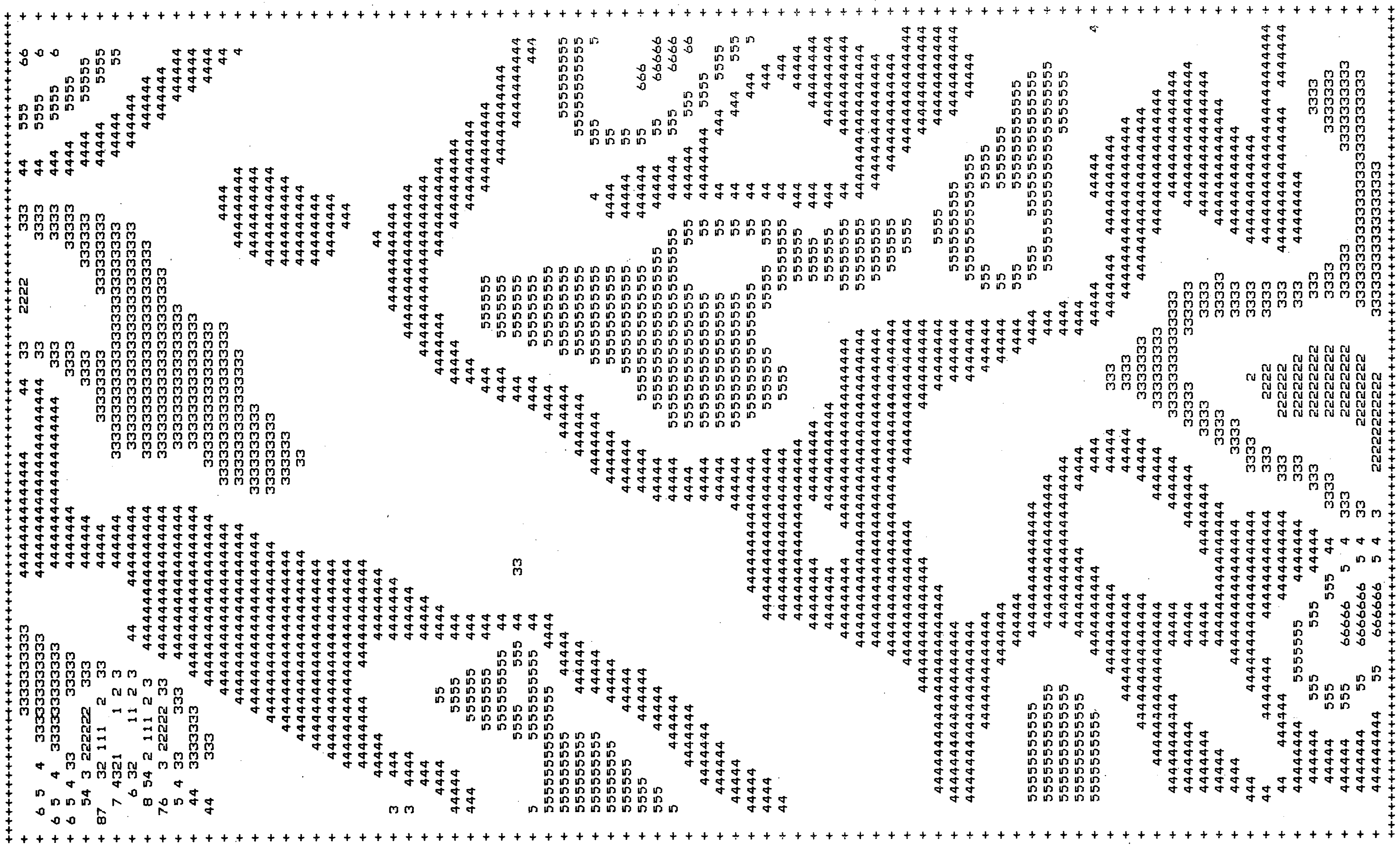


EXPLANATION

PRINT CHARACTER	VALUE	
0	LE	0.0000
	0.0000	0.0375
1	0.0375	0.0750
	0.0750	0.1125
2	0.1125	0.1500
	0.1500	0.1875
3	0.1875	0.2250
	0.2250	0.2625
4	0.2625	0.3000
	0.3000	0.3375
5	0.3375	0.3750
	0.3750	0.4125
6	0.4125	0.4500
	0.4500	0.4875
7	0.4875	0.5250
	0.5250	0.5625
8	0.5625	0.6000
	0.6000	0.6375
9	0.6375	0.6750
	GT	0.6750

Uranium/Thorium Pseudo-Contour Map - Helena Quadrangle

HELENA



Residual Magnetic Pseudo-Contour Map - Helena Quadrangle

EXPLANATION

PRINT CHARACTER	VALUE
0	LE-1200.0000
	-1200.0000-1110.0000
1	-1110.0000-1020.0000
	-1020.0000 -930.0000
2	-930.0000 -840.0000
	-840.0000 -750.0000
3	-750.0000 -660.0000
	-660.0000 -570.0000
4	-570.0000 -480.0000
	-480.0000 -390.0000
5	-390.0000 -300.0000
	-300.0000 -210.0000
6	-210.0000 -120.0000
	-120.0000 -30.0000
7	-30.0000 60.0000
	60.0000 150.0000
8	150.0000 240.0000
	240.0000 330.0000
9	330.0000 420.0000
	GT 420.0000

SCALE IN GAMMAS

HELENA QUADRANGLE - NTMS NI 15-6 LINE 370
SINGLE RECORD LISTING - GEOMETRICS DATA ACQUIRED 80194

HELENA QUADRANGLE - NTMS NI 15-6 LINE 370
AVERAGED RECORD LISTING - GEOMETRICS DATA ACQUIRED 80194