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AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY OF BALTIMORE, WASHINGTON, AND RICHMOND QUADRANGLES

RICHMOND QUADRANGLE

VOLUME 2-C

TEXAS INSTRUMENTS INCORPORATED
Dallas, Texas

September 1978

WORK PERFORMED UNDER
BENDIX FIELD ENGINEERING CORPORATION
GRAND JUNCTION OPERATIONS, GRAND JUNCTION, COLORADO
Subcontract No. 78-092-L and Bendix Contract EY-76-C-13-1664

PREPARED FOR THE
DEPARTMENT OF ENERGY
Grand Junction, Colorado 81501

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ABSTRACT

The results of a high-sensitivity aerial gamma-ray spectrometer and magnetometer survey of the eastern portion of the Richmond Quadrangle, Virginia are presented. Instrumentation and methods are described in Volume 1 of this final report. This work was done by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-092-L as part of the U.S. Department of Energy National Uranium Resource Evaluation (NURE) Program.

Statistical and geological analysis of the radiometric data revealed five uranium anomalies worthy of field checking as possible prospects. They are located over Tertiary sediments that may have long-range future potential for low-grade sedimentary uranium deposits. The Richmond Quadrangle does not appear to have appreciable potential for economic uranium deposits under current conditions.

NARRATIVE

NARRATIVE

SECTION I

INTRODUCTION

A. GENERAL

This volume contains information and survey results pertaining specifically to the Richmond NTMS 1:250,000 scale quadrangle, Virginia, one of a group of three such quadrangles between 37° and 40° north latitude, included in an aerial radiometric and magnetic reconnaissance survey. General information concerning the instrumentation and methods used in data acquisition, processing, and interpretation is presented in Volume 1 of this final report.

This survey was conducted by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-092-L as part of the U.S. Department of Energy National Uranium Resource Evaluation (NURE) Program.

B. URANIUM GEOLOGY AND OCCURRENCES

1. Uranium Occurrences

There is no reported uranium deposit or production in the Richmond Quadrangle (LeVan and Harris, 1971; Butler et al., 1962; and Gifford and Eppelsheimer, 1969).

2. Geologic Mapping

The geologic map used for the survey of the Richmond Quadrangle was prepared by LKB Resources (1978). Table T-1 (TABLES section) is a listing of the mapped geologic units.

3. Potential Uranium-Bearing Units

Brown (1962) describes uranium-bearing pegmatites in the Amelia, Powhatan, Gootchland, Hanover and Louisa-Spotsylvania areas of the Richmond Quadrangle (see Volume 1); however, these areas were not sampled during this survey. The surveyed portion is restricted to the Coastal Plain province, and only the fluvial and tidal sandstones of the Late Cretaceous Black Creek Formation that are exposed south of this quadrangle have been suggested as having some potential for uranium mineralization. This formation may underlie the Yorktown Formation (Ty) in the southeastern part of the Richmond Quadrangle.

SECTION II

RADIOMETRIC DATA INTERPRETATION

A. SELECTION OF URANIUM ANOMALIES

1. Statistical Considerations

Each of the eU,* eTh,* and eU/K* data sets was computer-processed to identify and outline all individual or groups of statistically high data points on the following basis. If a single statistically high point is considered in terms of multiples of the standard deviation above the mean (i.e., significance factor), the probability that its value was caused by random variation of the background is shown in Table 2-1.

Table 2-1

Probability that a Single Statistically High Point is Caused by Random Deviations**

Point Value	Probability
Mean + 1 standard deviation	0.1587 or 1:6.3
Mean + 2 standard deviations	0.0228 or 1:44
Mean + 3 standard deviations	0.0013 or 1:768

**A probability is determined as the area under the standardized normal distribution curve above the indicated value.

The maximum probability of 1:768 was used to judge the reliability of single, isolated, statistically high points in the data interpretation.

Spatial groupings of statistically high values are less probable than is a scattering of the same values over the map unit. If a spatial grouping consists of adjacent statistically high points, the probability (P) that all the points were caused by random fluctuations is:

$$P = P_1 \cdot P_2 \cdot P_3 \ldots P_n$$

where

$P_1, P_2, \ldots P_n$ represent the single-point probabilities for n points.

Assuming the same certainty criterion of 1:768, Table 2-2 gives the minimum requirements for all adjacent points in a reliable anomaly. This allows groupings of statistically high (or low) points more than 0.87 standard deviation from the mean to be evaluated.

Table 2-2

Minimum Deviation from the Mean for all Points for Limiting Probability of 1:768 (Elkins, 1940)

Number of Points Supporting Anomaly	Minimum Deviation
1	3.00 standard deviations
2	1.79 standard deviations
3	1.22 standard deviations
4	0.87 standard deviation

2. Uranium Anomalies

Data for the Richmond Quadrangle, including eU, eU/eTh, and eU/K, were searched by the computer and all acceptable significnt anomalies were identified. These were printed out on the "preferred-anomaly" map (Figure 2-1) as asterisk symbols for each data point constituting a valid anomaly. The eU anomalies are indicated by asterisks along the flight line, and eU/eTh anomalies are shown by asterisks north of E-W flight lines and east of N-S flight lines. The eU/K anomalies are indicated by asterisks south of E-W flight lines and west of N-S flight lines.

Next, eU anomalies showing a geochemical enrichment of eU over the eTh and/or K present were identified. First-priority anomalies are those that show simultaneous, statisticaly valid eU, eU/eTh, and eU/K anomalies. The preferred-anomaly map (Figure 2-1) has been marked to indicate the locations of all first-priority anomalies, and they are described in Table 2-3.

* eU = Equivalent uranium measured by bismuth-214.
eTh = Equivalent thorium measured by thallium-208.
K = Potassium measured by potassium-40.

Table 2-3

Preferred eU Anomalies - Richmond Quadrangle

Anomaly No.	Line No.	Geologic Unit(s)	Highest eU S.F.*	No. of Averaged Records	Remarks
①	202	Ts/Tv	1.0	2	Possible U prospect
②	203	Tv	2.0	2	Possible U prospect
③	51	Tv	2.0	3	Possible U prospect
④	51	Tv	4.0	8	Possible U prospect
⑤	52	Tv	2.0	1	Swampy, possible U prospect

*Significance Factor (from eU profile map, M-2; recorded to nearest 0.5 unit)

○= Possible uranium prospect

The data user can outline these anomalies on the appropriate profile maps to evaluate more quantitatively the relative magnitudes of the anomalies. The profile maps also are useful in delineating areas whose uranium has been concentrated in nearby deposits by geochemical activity. Recent study has shown that the Gas Hills and Shirley Basin uranium districts are accompanied by uranium-barren altered areas detectable by aerial gamma-ray spectrometry (Texas Instruments, 1977).

Second-priority anomalies that under special circumstances may indicate potential uranium prospects are those showing only a combination of two statistically valid anomalies out of the three parameters, eU, eU/eTh, and eU/K. These are easily identifiable on the preferred-anomaly map. Examples of special situations where second-priority anomalies can be important indicators of uranium prospects are given in Table 2-4.

B. DATA TABLES AND HISTOGRAMS

1. General

Microfiche copies of the single-record and averaged-record data listings are included in Volume 1 of this report. Statistical summary tables, flight-line mean values, and histograms for the gamma-ray parameters are presented by geologic unit in this volume. Further explanatory details are given in Volume 1.

Table 2-4

Examples of Potentially Important Second-Priority Anomalies
(Texas Instruments, 1977)

Valid Anomalies	No Anomaly	Locality Description
eU + eU/K	eU/eTh	Shirley Basin, Wyoming; high thorium due to surface layer of monazite yields normal eU/eTh even in areas where eU is anomalously high.
eU + eU/eTh	eU/K	Regions with surface evaporite deposits rich in potash yield normal eU/K even when eU is anomalously high.
eU/eTh + eU/K	eU	Areas of water-saturated surface material or heavy vegetation can shield eU, eTh, and K radiations simultaneously, but the ratios will still reflect the hidden relative eU enrichment.

Table 2-5

Calibration Constants*

Element	Constant
eU	15.5 cps/ppm
eTh	7.9 cps/ppm
K	134.0 cps/%

*Based on Lake Mead Test Strip calibration of 5 April 1977.

2. Statistical Summary Tables

Tables showing the distribution types, statistical parameters and number of samples for each geologic formation are presented for eU, eTh, K, eU/eTh, eU/K, and eTh/K in the TABLES section. These are useful in studying the magnitudes and variations of the radioactivity of the formations relative to one another and to the normal U, Th, and K abundances in the lithologic types represented. Approximate conversion factors from counts per second to concentration units are given in Table 2-5.

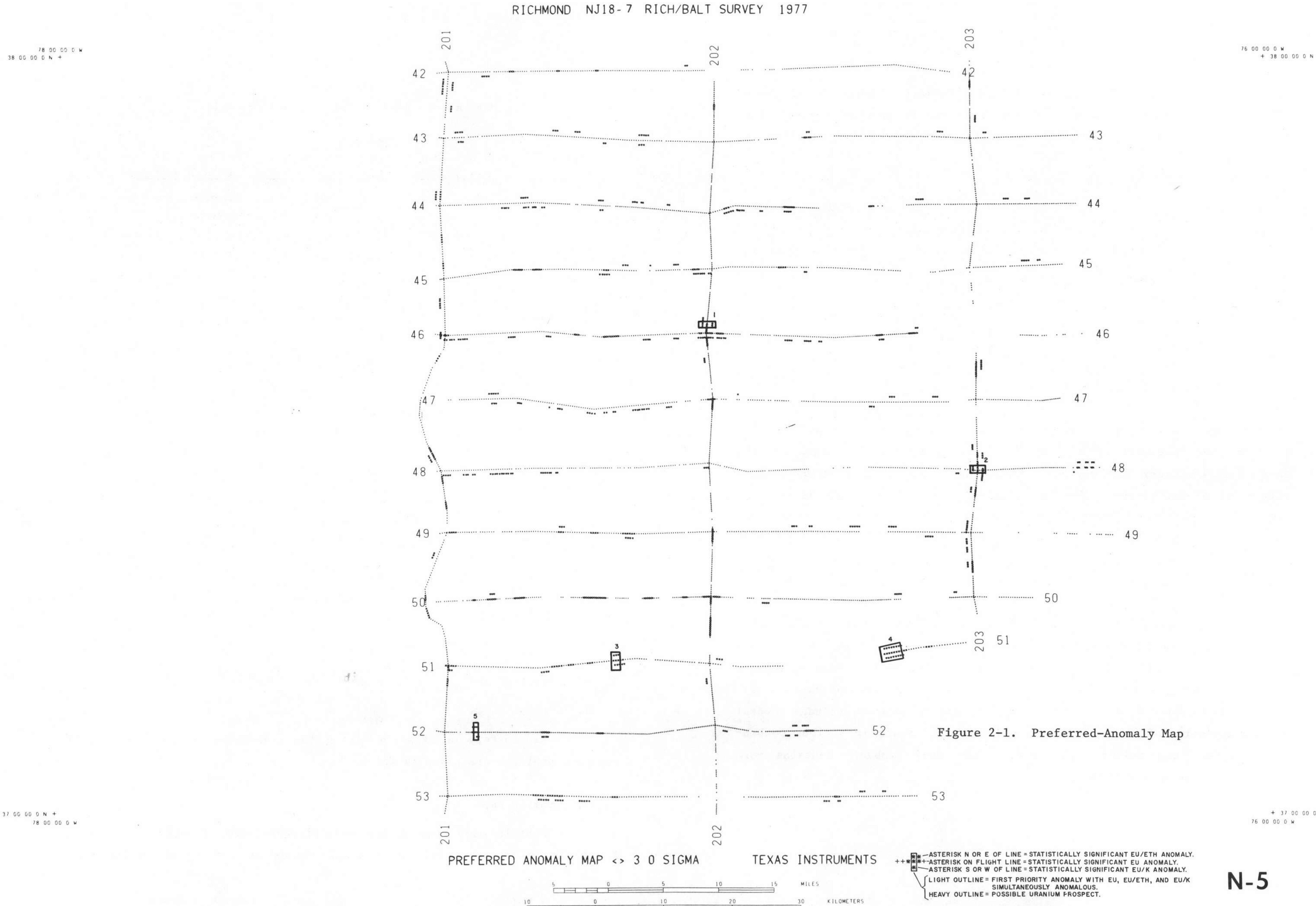

Figure 2-1. Preferred-Anomaly Map

Examination of the Statistical Summary Tables shows Kptx-2 (Cretaceous Patuxent Formation) to have the highest mean eU content; however, it is not abnormally high for its lithlogy.

3. Flight-Line Averages

Mean values for eU, eTh, K, eU/eTh, eU/K, and eTh/K by geologic unit for each flight line in the Richmond Quadrangle are given in the TABLES section. These may be used to study the variation in gamma-ray parameters within a formation as one crosses the quadrangle from north to south or from east to west.

4. Histograms

Histograms for each radiometric parameter are presented for each geologic unit in the HISTOGRAMS section. Two map units showed multimodal distributions indicating the presence of more than one distinct lithology in that geologic unit. Each of these units was divided into two populations by splitting the histogram based on eTh or K but not eU. For example, in the case of Tn (Tertiary Nanjemoy Formation), the K histogram could be reasonably split at two points. The distribution of the unsplit unit is shown in H-6, and the distributions after splitting are shown in H-7 and H-8. New means and standard deviations were calculated before computerized geologic analysis of the data. Table 2-6 summarizes all the histogram splits for the quadrangle. The eU, eTh, and K medians for the resulting subunits are given in concentration units computed from the Statistical Summary Tables and the calibration constants in Table 2-5. Comparing the values in Table 2-6 with the estimated crustal averages for various rock types (Table 2-7) compiled by Kogan et al. (1971; also see Saunders and Potts, 1978) allows at least a reasonable guess as to the probable average lithology of the units. For example, the geologic unit Tn (Tertiary Nanjemoy Formation) includes several sedimentary units of clay, sand, silt and limestone which in various combinations affect the values determined. Unit Tn-1 probably contains more limestone and less clay than unit Tn-2.

Table 2-6

Radiometric Analysis of Selected Map Units

Geologic Unit	Split On (cps)	Median Values: eU (ppm)	eTh (ppm)	K (%)	eTh/eU	Probable Lithology
Tn-1	K=110	1.4	4.5	0.42	3.2	Calcareous sandstone
Tn-2		2.0	6.1	1.01	3.1	Sandstone
Kptx-1	Th=45	1.3	3.9	0.62	3.0	Calcareous sandstone
Kptx-2		1.8	6.8	0.77	3.8	Sandstone

Table 2-7

Average U, Th, K Content of Rocks
(after Kogan et al., 1971)

Rock Type	Average Values: U (ppm)	Th (ppm)	K (%)	Th/U
Continental Crust	2.5	13.0	2.5	5.2
Igneous Rocks				
Acidic (granites)	3.5	18.0	3.34	5.1
Intermediate (diorites)	1.8	7.0	2.31	4.0
Basic (basalt-gabbro)	0.5	3.0	0.83	6.0
Ultrabasic (dunite-peridotite)	0.003	0.005	0.03	1.7
Sediments				
Shale, clay	4.0	11.0	3.2	2.8
Sandstone	3.0	10.0	1.2	3.3
Limestone	1.4	1.8	0.3	1.3
Evaporite	0.1	0.4	0.1	4.0

C. MAPS AND PROFILES

1. General

Explanatory details concerning the generation and presentation of maps and profiles are given in Volume 1.

2. Profile Maps

Profile maps showing the significance-factor levels for eU, eTh, K, eU/eTh, eU/K, and eTh/K on geologic bases are presented in the MAPS section, along with a map showing the record locations and geology (M-1 through M-7). These may be compared directly with the preferred-anomaly map (Figure 2-1) to determine the relative strengths of the eU, eU/eTh, and eU/K anomalies and their geologic locations. They are also useful in studying geographic variations in the other radiometric parameters.

3. Radiometric Stacked Profiles

Stacked profiles showing the variation in absolute magnitudes of eU, eTh, K, eU/eTh, eU/K, and eTh/K, as well as gross count, residual magnetic field, terrain clearance, eU-air values, and geology along each flight line are presented in the PROFILES Section (P-1 through P-15). This presentation provides a convenient way of examining simultaneously all the data at each averaged-record location. The data as shown are not corrected for geology (as is the case with the profile maps) and provide an opportunity to study the relative differences in counting rates among the geologic units.

The altitude (terrain-clearance) trace permits identifying portions of flight lines where terrain-clearance requirements were exceeded and the data were discarded in the statistical processing. The averaged-record locations are flagged along the baseline. The eU, eTh, and K traces are similarly flagged for data discarded for failing the Currie significance test. The discarded data points are included in the stacked profiles, although they are generally statistically unreliable. If the rock types are sufficiently radioactive, normal terrain clearance may be exceeded somewhat with reasonably reliable data statistics, and the added information may be useful.

4. Magnetic Stacked Profiles

The single-record (unaveraged) data on flight-level air temperature, flight-level barometric pressure, average terrain clearance, diurnal magnetics, residual total magnetic field, and geology are shown for each flight line in the PROFILES Section (P-16 through P30).

D. CONCLUSIONS

1. General

Table 2-8 lists the number of first-priority anomalies and the total number of eU records in each formation. The unit Ty (Yorktown Formation) has the greatest number of records and anomalies. It was previously noted (paragraph I.B.3) that this formation in places may overlie the Black Creek Formation, which is believed to have potential for sedimentary uranium deposits.

The five first-priority anomalies in this quadrangle, are classified as possible U prospects based on their geologic location and eU-anomaly characteristics (see Table 2-3).

Table 2-8

Geologic Units with eU Anomalies

Geologic Unit	Number of First-Priority Anomalies	Total Number of eU Records in Unit
Qsg	-	1050
Qtu	-	467
Ty	5	7493
Ts	1	5325
Tc	-	2366
Tn	-	494
Ta	-	409
Kptx	-	195

2. Uraniferous Provinces

There are no readily apparent uraniferous provinces in this quadrangle.

3. Suggestions for Further Work

Follow-up studies should include a ground check of the most promising eU anomalies.

If the ground checks prove fruitful, it could be advantageous to fly detailed aerial radiometric surveys over the areas surrounding the most promising anomalies (in areas considered as uraniferous geochemical provinces). This survey covered only a small percentage of the surface, and closer line spacing would delineate all anomalies that might represent potential uranium deposits.

Summary discussions of possible follow-up exploration methods are presented by Saunders and Potts (1978).

SECTION III
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TABLES

TABLES

TABLE T-1. GEOLOGIC MAP UNITS — RICHMOND QUADRANGLE

Computer Symbol	Map Symbol	Description
QUATERNARY		
QDU	Qdu	Undivided Deposits: Intercalated fluvial sands and marsh muds; shell-bearing estuarine clays and silts; sand dunes, beach sands, and subsurface gravels.
QSG	Qsg	Lower Terrace Sand and Gravel: Organic, poorly sorted sand, gravel, and clay.
QTU	QTu	Upper Terrace Sand and Gravel: Mainly sand and gravel with some clay; dominantly fluvial deposition. Covers Tertiary outcrops from westernmost exposure, mapped as Tu, up to and including the easternmost Tertiary outcrop, mapped as TY; does not occur adjacent to rivers.
TERTIARY		
TU	Tu	Undivided Formations
TY	Ty	Yorktown Formation: Tan to reddish-brown, cross-bedded Coquina; buff colored sand and dark blue to gray clay.
TS	Ts	Saint Marys Formation: Fine-grained argillaceous sand, gray to yellow or brown and locally glauconitic; blue to gray unconsolidated clay.
TCH	Tch	Choptank Formation: Dark brown, fossiliferous sand.
TC	Tc	Calvert Formation: Drab gray, bluish-gray, and greenish-gray silts, clays, and silty clays with minor glauconite, plant fragments and shell beds. Fairhaven Member: Diatomaceous silty clay which weathers yellowish-buff; overlies a well-sorted medium-to-coarse-grained basal sand, locally fossiliferous; mollusks, whale bones, and plant fossils.
TN	Tn	Nanjemoy Formation: Grayish-green, glauconitic, argillaceous silt and quartz sand; fossiliferous and locally gypsiferous. Some thin limestone beds are present, and large concretions are common. Includes Marlboro Clay Member: Generally pure, impermeable, pink to light gray clay, interlaminated with very fine-grained glauconite at base of Nanjemoy Formation.
TA	Ta	Aquia Formation: Fine- to medium-grained, silty, glauconitic and fossiliferous sand.
CRETACEOUS		
KPTX	Kptx	Patuxent Formation: Buff to gray, cross-bedded, arkosic sandstone and gravel, interbedded with red, purple, gray, green, and yellow clay beds; plant fragments and phosphatic boulders in lower part.
TRIASSIC		
TRN	TRn	Newark Group: Mostly indunated, poorly sorted sandstones and mudstones, generally red with variegated clay interbeds.
TRO	TRo	Otterdale Sandstone
TRV	TRv	Vinta Formation
TRCM	TRcm	Coal Measures: Sandstone and shale in Richmond Basin.
TRD	TRd	Igneous Rocks: Sills and dikes, diabase and gabbro.

Computer Symbol	Map Symbol	Description
PALEOZOIC-PRECAMBRIAN		
PZPB	Pzpb	Petersburg Granite: Medium-grained, pink to gray, biotite-microcline granite; quartz monzonite; quartz-biotite gneiss and chloritic granodiorite; weathers to a saprolite that is a red, clayey, medium-grained sand.
UNCERTAIN AGE		
GR	gr	Granite: Biotite-muscovite granite; granodiorite and quartz manzonite. Includes Columbia granite and some mica schist and gneiss.
GRGN	grgn	Granite Gneiss: Biotite-muscovite granite gneiss and granodiorite gneiss.
GHGN	ghgn	Granite and Hornblende Gneiss: Interlayered mica-quartz-feldspar gneiss and hornblende-feldspar-mica gneiss.
HGB	hgb	Hornblende Gabbro and Gneiss: Talc-amphibole-chlorite schist; chlorite-hornblende gneiss; some amphibolite, chloritic dionite and hornblende diorite. Also kyanite schist and kyanite quartzite.
V	v	Metamorphosed Volcanic and Sedimentary Rocks: Extrusive igneous rocks and interlayered sedimentary rocks; includes Peters Creek quartzite from Prince William to Buckingham Counties.
MGN	mgn	Metamorphosed Sedimentary Rocks: Includes metamorphosed sedimentary and interlayered igneous rocks that overlie Blue Ridge complex; previously mapped as Wissahickon schist and Wissahickon granite gneiss. mgn-gneiss.
MP	mp	Phyllite: Associated with mgn.
MSCH	msch	Schist: Associated with mgn and mp.

TABLE T-2. STATISTICAL SUMMARIES

DISTRIBUTION TYPES OF GAMMA-RAY PARAMETERS

GEOL UNIT	TH	U	K	U/K	U/TH	TH/K
QSG	N	LN	LN	LN	LN	LN
QTU	LN	N	LN	LN	N	LN
TY	N	LN	LN	LN	LN	LN
TS	N	LN	LN	LN	LN	LN
TC	N	N	LN	LN	LN	LN
TN-1	N	LN	LN	LN	LN	LN
TN-2	LN	N	N	N	LN	LN
TA	N	LN	LN	LN	N	LN
KPTX-1	N	N	LN	LN	LN	LN
KPTX-2	LN	N	N	LN	LN	LN

GEOLOGIC UNITS ARE ABBREVIATIONS. FOR ACTUAL NAMES AND DESCRIPTIONS SEE TEXT.

N=NORMAL; LN=LOGNORMAL. (LN) INDICATES ASSUMED DISTRIBUTION TYPE: INSUFFICIENT DATA AVAILABLE FOR VALID STATISTICAL TEST

STATISTICAL SUMMARY FOR THORIUM

GEOL UNIT	NUM. SAMPLES	-3 S.D.	-2 S.D.	-1 S.D.	MEDIAN	+1 S.D.	+2 S.D.	+3 S.D.
QSG	1094.	5.792	13.805	21.819	29.832	37.845	45.859	53.872
QTU	475.	16.490	20.570	25.660	32.009	39.929	49.808	62.132
TY	7861.	5.406	13.954	22.503	31.052	39.601	48.150	56.699
TS	5770.	-4.563	7.047	18.657	30.267	41.876	53.486	65.096
TC	2502.	0.584	12.176	23.769	35.362	46.954	58.547	70.139
TN-1	441.	5.675	15.704	25.734	35.763	45.793	55.822	65.852
TN-2	56.	27.867	33.466	40.190	48.264	57.961	69.606	83.591
TA	408.	3.985	17.071	30.157	43.243	56.330	69.416	82.502
KPTX-1	158.	9.157	16.484	23.812	31.139	38.467	45.794	53.122
KPTX-2	56.	40.651	44.525	48.769	53.417	58.508	64.084	70.192

STATISTICAL SUMMARY FOR URANIUM

GEOL UNIT	NUM. SAMPLES	-3 S.D.	-2 S.D.	-1 S.D.	MEDIAN	+1 S.D.	+2 S.D.	+3 S.D.
QSG	1050.	6.274	9.323	13.854	20.588	30.593	45.462	67.556
QTU	467.	0.521	7.748	14.975	22.202	29.429	36.656	43.882
TY	7493.	6.015	8.690	12.553	18.134	26.195	37.841	54.665
TS	5325.	5.788	8.512	12.519	18.412	27.079	39.825	58.572
TC	2366.	-0.884	6.370	13.625	20.879	28.133	35.388	42.642
TN-1	438.	8.964	12.041	16.176	21.729	29.189	39.210	52.671
TN-2	56.	6.845	15.127	23.408	31.690	39.971	48.253	56.535
TA	409.	8.007	11.533	16.611	23.925	34.461	49.635	71.492
KPTX-1	142.	-0.079	6.613	13.304	19.995	26.687	33.378	40.069
KPTX-2	53.	10.784	16.294	21.804	27.315	32.825	38.336	43.846

VALUES LISTED ARE STATISTICALLY DERIVED ABSOLUTE COUNTING RATES AT 1,2, AND 3 STD. DEVIATIONS ABOVE AND BELOW THE RESPECTIVE MEANS. ANY NEGATIVE VALUES ARE THE RESULT OF STATISTICS ONLY AND HAVE NO REAL MEANING. RELATIVE MAGNITUDES OF THE LISTED MEDIAN VALUES ARE INDICATORS OF RELATIVE CONCENTRATIONS OF THE ELEMENTS IN THE VARIOUS GEOLOGIC ROCK UNITS.

STATISTICAL SUMMARY FOR POTASSIUM

GEOL UNIT	NUM. SAMPLES	-3 S.D.	-2 S.D.	-1 S.D.	MEDIAN	+1 S.D.	+2 S.D.	+3 S.D.
QSG	1053.	17.069	23.431	32.163	44.150	60.604	83.190	114.193
QTU	475.	16.709	22.795	31.098	42.425	57.878	78.960	107.720
TY	7778.	9.925	14.841	22.194	33.189	49.630	74.217	110.984
TS	5746.	9.064	14.982	24.764	40.933	67.658	111.833	184.851
TC	2465.	9.600	15.568	25.248	40.947	66.406	107.695	174.656
TN-1	441.	21.210	29.412	40.785	56.557	78.428	108.755	150.811
TN-2	56.	83.324	100.835	118.345	135.856	153.367	170.877	188.388
TA	409.	22.411	34.783	53.986	83.791	130.050	201.849	313.285
KPTX-1	158.	24.489	36.780	55.240	82.966	124.607	187.149	281.082
KPTX-2	53.	-15.011	24.373	63.756	103.139	142.522	181.905	221.288

STATISTICAL SUMMARY FOR THOR./POT.

GEOL UNIT	NUM. SAMPLES	-3 S.D.	-2 S.D.	-1 S.D.	MEDIAN	+1 S.D.	+2 S.D.	+3 S.D.
QSG	1053.	0.274	0.368	0.494	0.664	0.892	1.199	1.611
QTU	475.	0.199	0.310	0.484	0.754	1.177	1.836	2.863
TY	7769.	0.262	0.395	0.596	0.898	1.353	2.039	3.073
TS	5732.	0.223	0.324	0.472	0.687	0.999	1.453	2.115
TC	2458.	0.236	0.356	0.538	0.813	1.228	1.855	2.801
TN-1	441.	0.241	0.328	0.446	0.607	0.825	1.123	1.527
TN-2	56.	0.168	0.216	0.278	0.358	0.461	0.594	0.766
TA	408.	0.181	0.252	0.350	0.486	0.676	0.940	1.307
KPTX-1	158.	0.112	0.166	0.246	0.364	0.540	0.802	1.189
KPTX-2	53.	0.154	0.238	0.367	0.567	0.875	1.351	2.085

STATISTICAL SUMMARY FOR URAN./THOR.

GEOL UNIT	NUM. SAMPLES	-3 S.D.	-2 S.D.	-1 S.D.	MEDIAN	+1 S.D.	+2 S.D.	+3 S.D.
QSG	1050.	0.177	0.281	0.446	0.710	1.128	1.794	2.851
QTU	467.	0.139	0.320	0.501	0.682	0.862	1.043	1.224
TY	7488.	0.225	0.311	0.430	0.594	0.820	1.133	1.564
TS	5322.	0.252	0.341	0.461	0.625	0.845	1.144	1.548
TC	2366.	0.223	0.306	0.421	0.578	0.795	1.092	1.501
TN-1	438.	0.278	0.366	0.481	0.633	0.833	1.095	1.441
TN-2	56.	0.297	0.382	0.492	0.632	0.814	1.047	1.347
TA	408.	0.129	0.288	0.447	0.607	0.766	0.926	1.085
KPTX-1	142.	0.239	0.325	0.441	0.600	0.817	1.111	1.510
KPTX-2	53.	0.270	0.333	0.410	0.506	0.623	0.768	0.947

STATISTICAL SUMMARY FOR URAN./POT.

GEOL UNIT	NUM. SAMPLES	-3 S.D.	-2 S.D.	-1 S.D.	MEDIAN	+1 S.D.	+2 S.D.	+3 S.D.
QSG	1010.	0.112	0.178	0.284	0.452	0.719	1.144	1.820
QTU	467.	0.089	0.158	0.281	0.498	0.885	1.570	2.787
TY	7413.	0.120	0.198	0.327	0.539	0.890	1.470	2.428
TS	5307.	0.104	0.168	0.270	0.436	0.703	1.133	1.826
TC	2335.	0.104	0.173	0.286	0.476	0.790	1.312	2.178
TN-1	438.	0.143	0.199	0.277	0.385	0.534	0.742	1.031
TN-2	56.	-0.015	0.070	0.156	0.242	0.328	0.414	0.500
TA	408.	0.086	0.128	0.191	0.285	0.425	0.635	0.948
KPTX-1	142.	0.049	0.081	0.134	0.221	0.366	0.606	1.002
KPTX-2	50.	0.086	0.126	0.186	0.274	0.405	0.597	0.881

TABLE T-3. FLIGHT-LINE AVERAGES

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 42

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	37.6	35.	17.1	35.	69.8	35.	0.26	35.	0.45	35.	0.55	35.
QTU	32.9	470.	22.0	470.	44.5	470.	0.58	470.	0.67	470.	0.84	470.
TS	31.3	330.	18.2	330.	50.2	330.	0.40	330.	0.60	330.	0.65	330.
TC	23.7	225.	14.0	225.	42.1	225.	0.33	225.	0.53	225.	0.68	225.
TN-1	37.6	20.	22.3	20.	54.8	20.	0.43	20.	0.60	20.	0.71	20.
TA	34.1	20.	23.7	20.	61.6	20.	0.38	20.	0.69	20.	0.56	20.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 43

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	36.5	40.	19.2	40.	60.5	40.	0.33	40.	0.53	40.	0.62	40.
QTU	21.5	5.	16.8	5.	37.1	5.	0.45	5.	0.78	5.	0.58	5.
TS	27.4	890.	17.2	890.	47.2	890.	0.40	890.	0.64	890.	0.62	890.
TC	23.4	215.	15.6	215.	39.9	215.	0.44	215.	0.71	215.	0.62	215.
TN-1	36.1	195.	22.7	195.	62.1	195.	0.38	195.	0.65	195.	0.58	195.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 44

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	30.5	20.	17.8	20.	76.0	20.	0.24	20.	0.60	20.	0.40	20.
TY	27.9	305.	17.4	305.	48.3	305.	0.39	305.	0.65	305.	0.59	305.
TS	29.2	625.	19.5	625.	39.6	625.	0.54	625.	0.69	625.	0.80	625.
TC	31.6	330.	17.3	330.	29.6	330.	0.68	330.	0.56	330.	1.19	330.
TN-1	27.7	60.	22.4	60.	44.5	60.	0.51	60.	0.83	60.	0.63	60.
TA	25.8	15.	15.8	15.	65.4	15.	0.26	15.	0.61	15.	0.42	15.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 45

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	28.9	35.	17.8	35.	53.6	35.	0.34	35.	0.62	35.	0.55	35.
TY	32.7	335.	20.6	335.	39.4	335.	0.58	335.	0.65	335.	0.91	335.
TS	26.5	575.	17.6	575.	34.2	575.	0.66	575.	0.67	575.	0.92	575.
TC	36.8	245.	22.0	245.	48.6	245.	0.62	245.	0.63	245.	0.92	245.
TN-1	54.2	19.	39.0	19.	95.3	19.	0.41	19.	0.72	19.	0.57	19.
TN-2	51.0	36.	30.8	36.	142.3	36.	0.23	36.	0.61	36.	0.37	36.
TA	52.3	40.	30.6	40.	112.6	40.	0.28	40.	0.59	40.	0.48	40.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 46

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	25.5	55.	14.5	55.	44.8	55.	0.34	55.	0.60	55.	0.57	55.
TY	38.9	330.	22.6	330.	34.1	330.	0.75	330.	0.59	330.	1.23	330.
TS	34.0	635.	20.5	635.	40.5	635.	0.58	635.	0.60	635.	0.95	635.
TC	38.3	190.	22.8	190.	40.4	190.	0.64	190.	0.60	190.	1.06	190.
TN-1	31.5	15.	21.6	15.	61.1	15.	0.35	15.	0.70	15.	0.51	15.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 47

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	33.6	15.	17.6	15.	61.0	15.	0.29	15.	0.52	15.	0.55	15.
TY	31.7	610.	18.7	610.	34.1	610.	0.65	610.	0.61	610.	1.07	610.
TS	27.6	490.	17.5	490.	40.1	490.	0.59	490.	0.64	490.	0.85	490.
TC	37.0	165.	16.7	165.	38.4	165.	0.56	165.	0.48	165.	1.19	165.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 48

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	31.3	260.	22.6	260.	38.4	260.	0.70	260.	0.90	260.	0.84	260.
TY	26.3	820.	13.6	820.	23.1	820.	0.76	820.	0.53	820.	1.38	820.
TS	21.5	275.	11.0	275.	25.6	275.	0.55	275.	0.52	275.	0.97	275.
TC	39.0	75.	20.5	75.	36.6	75.	0.64	75.	0.52	75.	1.15	75.
TN-1	42.5	30.	17.7	30.	31.2	30.	0.59	30.	0.42	30.	1.40	30.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 49

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	23.1	130.	20.4	130.	35.5	130.	0.61	130.	0.89	130.	0.69	130.
TY	30.2	745.	19.9	745.	32.0	745.	0.68	745.	0.68	745.	1.02	745.
TS	36.1	160.	21.2	160.	59.9	160.	0.38	160.	0.64	160.	0.60	160.
TC	27.9	5.	18.1	5.	60.1	5.	0.30	5.	0.65	5.	0.46	5.
TN-1	23.3	8.	14.2	8.	70.2	8.	0.22	8.	0.67	8.	0.33	8.
TN-2	52.9	2.	24.9	2.	120.2	2.	0.21	2.	0.47	2.	0.44	2.
TA	30.5	80.	19.8	80.	77.4	80.	0.29	80.	0.72	80.	0.41	80.
KPTX-1	35.7	54.	23.6	54.	93.8	54.	0.26	54.	0.67	54.	0.39	54.
KPTX-2	50.7	6.	[illegible]	6.	73.1	6.	0.39	6.	0.56	6.	0.69	6.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 50

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	27.7	150.	15.6	150.	43.5	150.	0.37	150.	0.57	150.	0.66	150.
TY	27.9	405.	16.9	405.	40.5	405.	0.63	405.	0.70	405.	0.80	405.
TS	37.4	465.	22.4	465.	71.7	465.	0.36	465.	0.59	465.	0.60	465.
TC	48.7	75.	25.0	75.	105.2	75.	0.32	75.	0.52	75.	0.58	75.
TN-1	38.0	44.	22.2	44.	77.5	44.	0.28	44.	0.58	44.	0.50	44.
TN-2	45.7	26.	30.7	26.	121.3	26.	0.26	26.	0.68	26.	0.38	26.
TA	51.6	10.	32.4	10.	120.0	10.	0.27	10.	0.65	10.	0.43	10.
KPTX-1	26.7	20.	12.4	20.	61.1	20.	0.24	20.	0.47	20.	0.48	20.
KPTX-2	56.0	30.	21.4	30.	59.7	30.	1.23	30.	0.39	30.	2.35	30.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 51

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
TY	35.8	805.	23.3	805.	43.1	805.	0.62	805.	0.67	805.	0.93	805.
TS	17.5	95.	7.3	95.	30.2	95.	0.23	95.	0.39	95.	0.61	95.
TC	46.4	10.	29.2	10.	58.7	10.	0.64	10.	0.64	10.	0.96	10.

TABLE T-3. FLIGHT-LINE AVERAGES (Continued)

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 52

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
TY	31.6	1085.	18.2	1085.	32.9	1085.	0.63	1085.	0.58	1085.	1.07	1085.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 53

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
TY	28.0	1025.	16.9	1025.	29.7	1025.	0.80	1025.	0.58	1025.	1.22	1025.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 201

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
TY	37.0	330.	19.9	330.	55.6	330.	0.41	330.	0.54	330.	0.75	330.
TC	38.9	915.	21.8	915.	47.6	915.	0.54	915.	0.58	915.	0.91	915.
TN-1	33.6	50.	21.1	50.	55.2	50.	0.41	50.	0.64	50.	0.63	50.
TA	47.1	245.	26.9	245.	95.8	245.	0.32	245.	0.58	245.	0.56	245.
KPTX-1	29.3	84.	16.6	84.	94.4	84.	0.21	84.	0.56	84.	0.38	84.
KPTX-2	53.3	26.	29.8	26.	136.7	26.	0.22	26.	0.56	26.	0.40	26.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 202

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
TY	29.8	680.	15.1	680.	34.4	680.	0.48	680.	0.49	680.	0.92	680.
TS	34.9	965.	20.0	965.	56.0	965.	0.42	965.	0.59	965.	0.70	965.
TC	32.8	85.	21.7	85.	59.1	85.	0.40	85.	0.68	85.	0.58	85.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

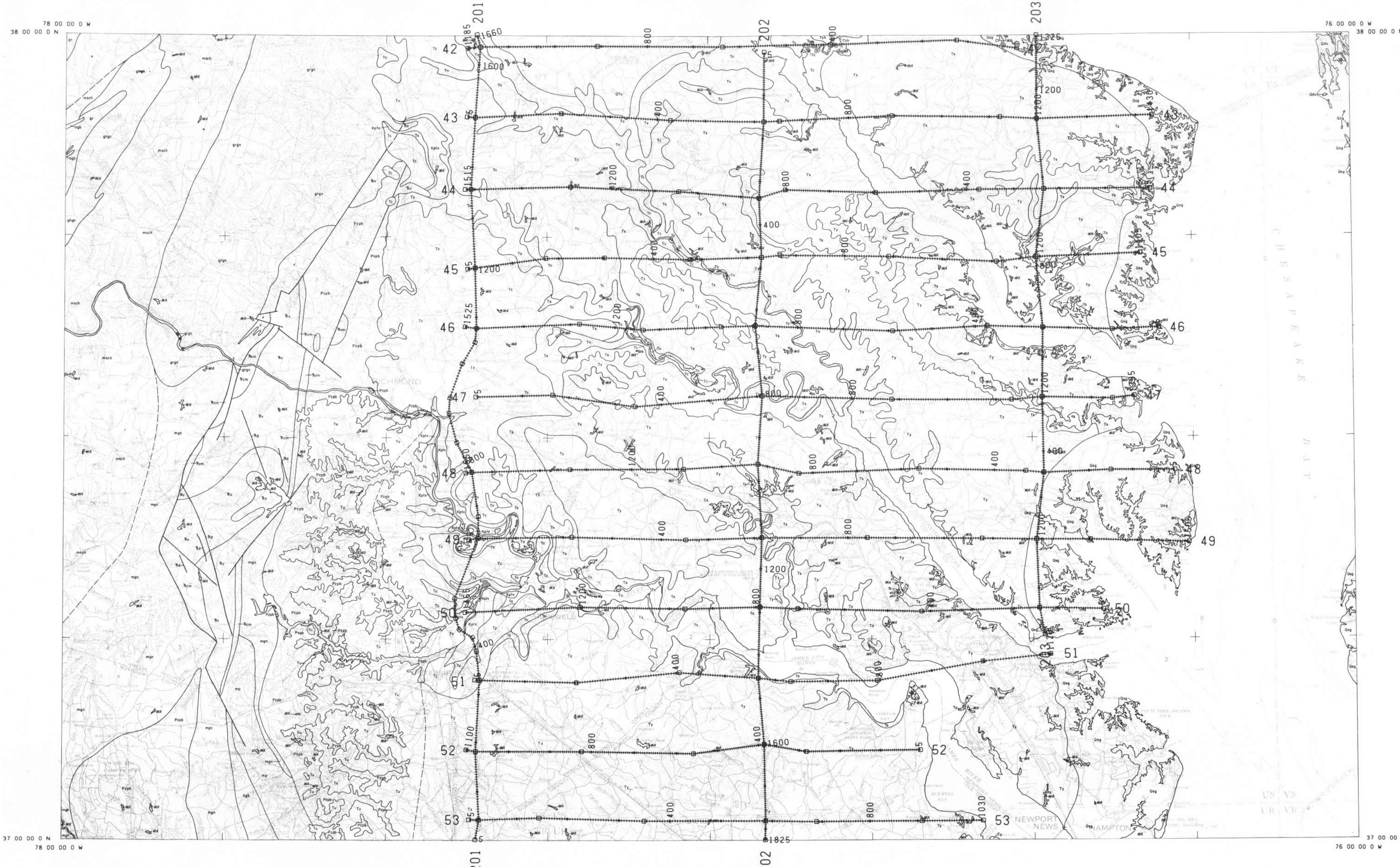
FLIGHT LINE 203

GEOLOGIC UNIT	TH AVG.	TH SAMPLES	U AVG.	U SAMPLES	K AVG.	K SAMPLES	U/K AVG.	U/K SAMPLES	U/TH AVG.	U/TH SAMPLES	TH/K AVG.	TH/K SAMPLES
QSG	31.1	355.	26.2	355.	45.5	355.	0.62	355.	0.86	355.	0.71	355.
TY	30.6	430.	22.7	430.	42.6	430.	0.66	430.	0.76	430.	0.82	430.
TS	23.9	295.	16.4	295.	40.5	295.	0.43	295.	0.92	295.	0.61	295.

MAPS

MAPS

RICHMOND NJ18-7 RICH/BALT SURVEY 1977



RECORD LOCATION MAP

5 0 5 10 15 MILES

10 0 10 20 30 KILOMETERS

LEGEND: □ = PHOTO-RECOVERED POINT

AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY

PREPARED BY

TEXAS INSTRUMENTS INCORPORATED

DALLAS, TEXAS

1977

WORK PERFORMED UNDER

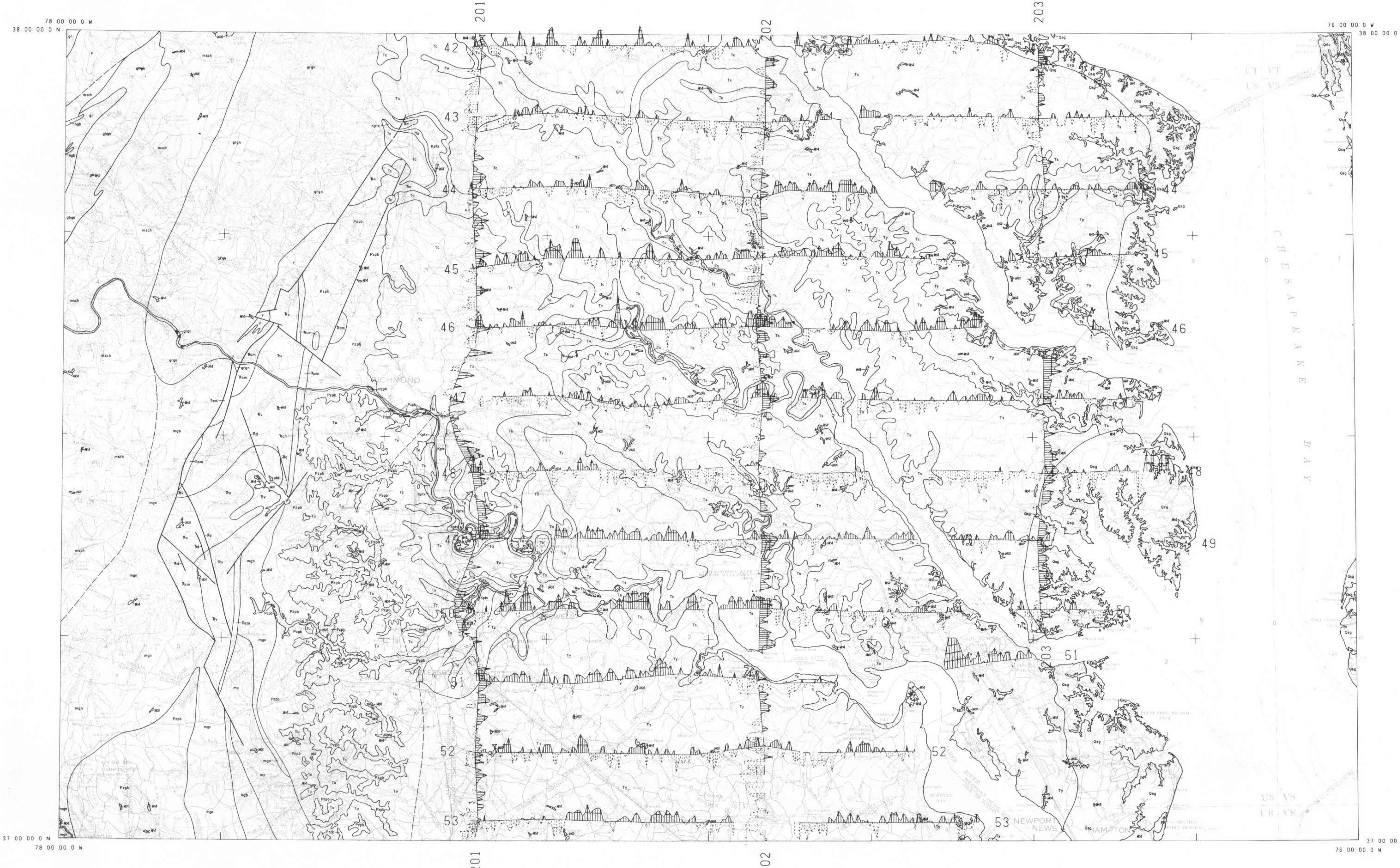
BENDIX FIELD ENGINEERING CORPORATION

SUBCONTRACT NO. 78-092-L

PREPARED FOR

U.S. DEPARTMENT OF ENERGY

RICHMOND NJ18-7 RICH/BALT SURVEY 1977



PROFILE MAP URANIUM 6.0 S.D./IN. TEXAS INSTRUMENTS

5 0 5 10 15 MILES

10 0 10 20 30 KILOMETERS

LEGEND: POSITIVE SIGNIFICANCE FACTORS—SOLID LINES
NEGATIVE SIGNIFICANCE FACTORS—DOTTED LINES

AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY
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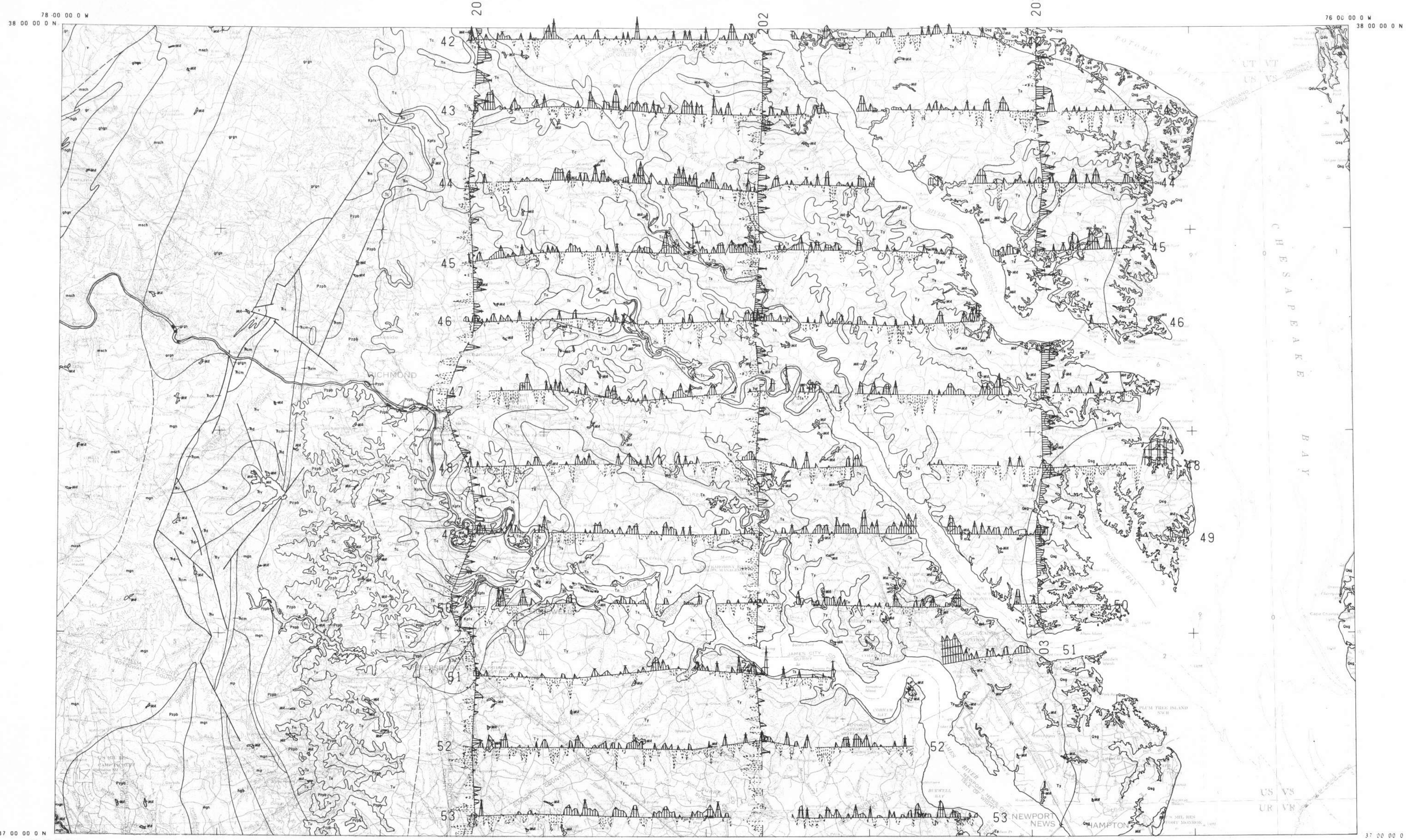
RICHMOND NJ18-7 RICH/BALT SURVEY 1977



PROFILE MAP U/TH 6.0 S.D./IN TEXAS INSTRUMENTS

5 0 5 10 15 MILES

10 0 10 20 30 KILOMETERS

LEGEND: POSITIVE SIGNIFICANCE FACTORS—SOLID LINES
NEGATIVE SIGNIFICANCE FACTORS—DOTTED LINES

AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY
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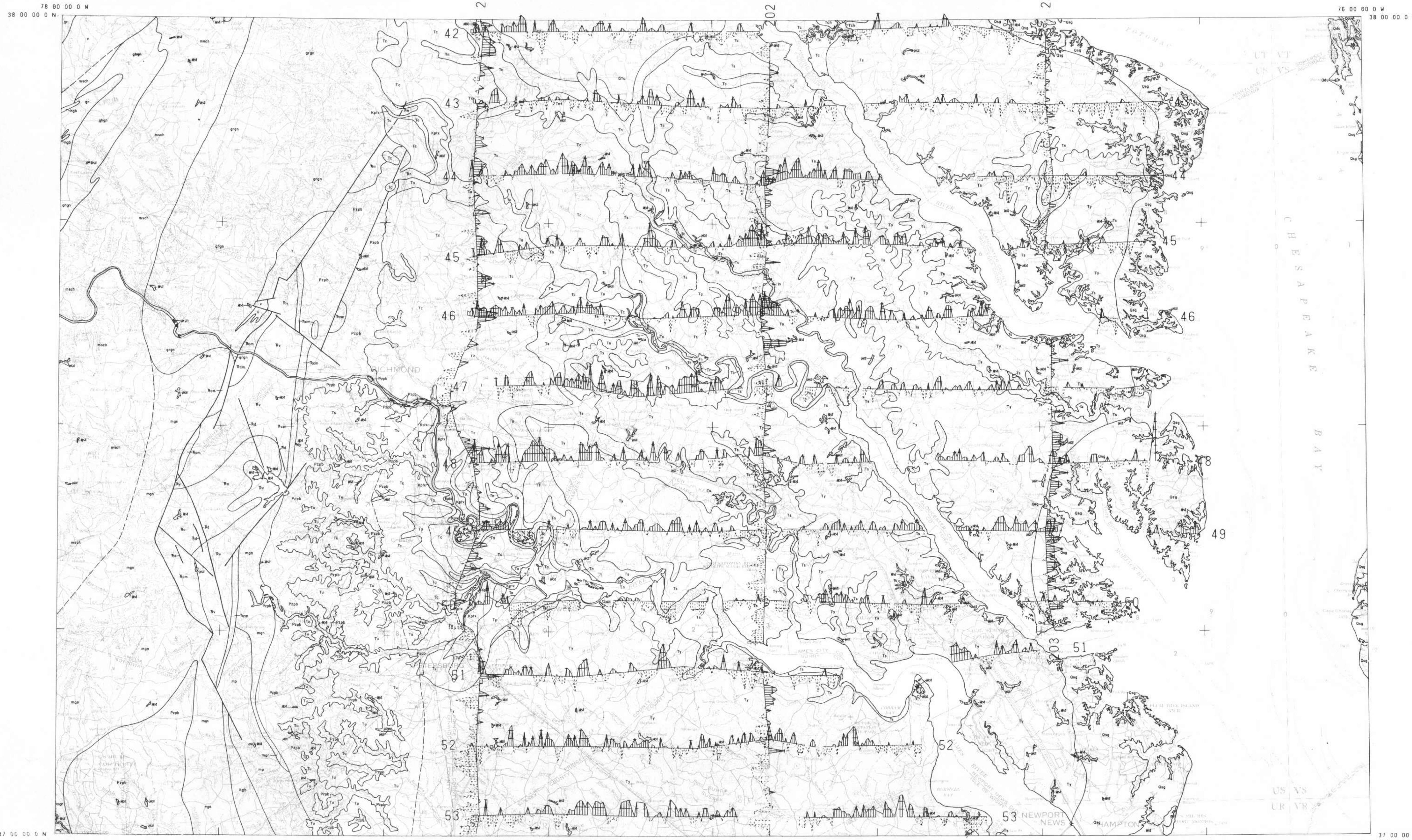
M-3

RICHMOND NJ18-7 RICH/BALT SURVEY 1977



PROFILE MAP U/K 6.0 S.D./IN TEXAS INSTRUMENTS

5 0 5 10 15 MILES

10 0 10 20 30 KILOMETERS

LEGEND: POSITIVE SIGNIFICANCE FACTORS—SOLID LINES
NEGATIVE SIGNIFICANCE FACTORS—DOTTED LINES

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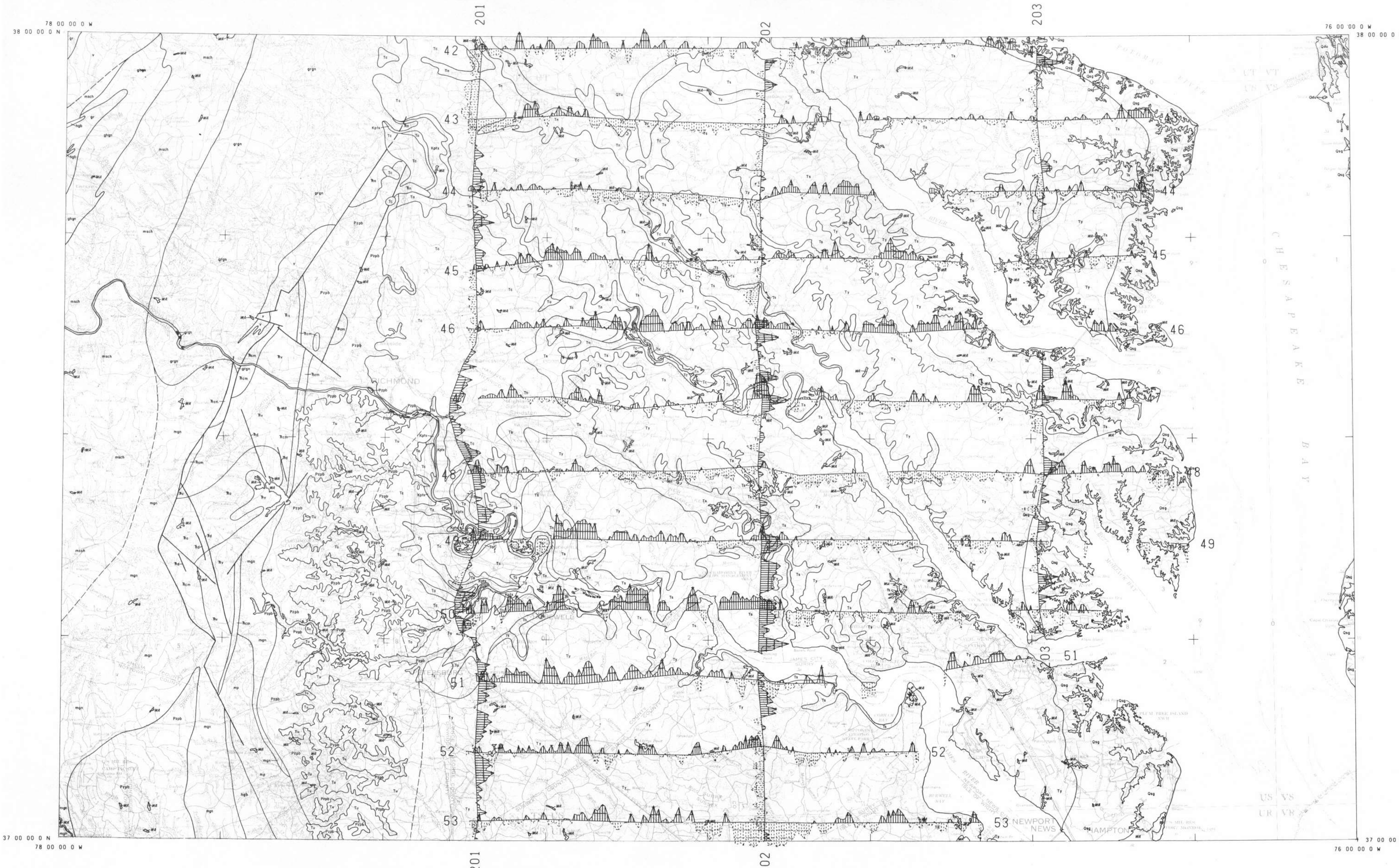
M-4



PROFILE MAP THORIUM 6.0 S.D./IN. TEXAS INSTRUMENTS

5 0 5 10 15 MILES

10 0 10 20 30 KILOMETERS

LEGEND: POSITIVE SIGNIFICANCE FACTORS—SOLID LINES
NEGATIVE SIGNIFICANCE FACTORS—DOTTED LINES

AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY

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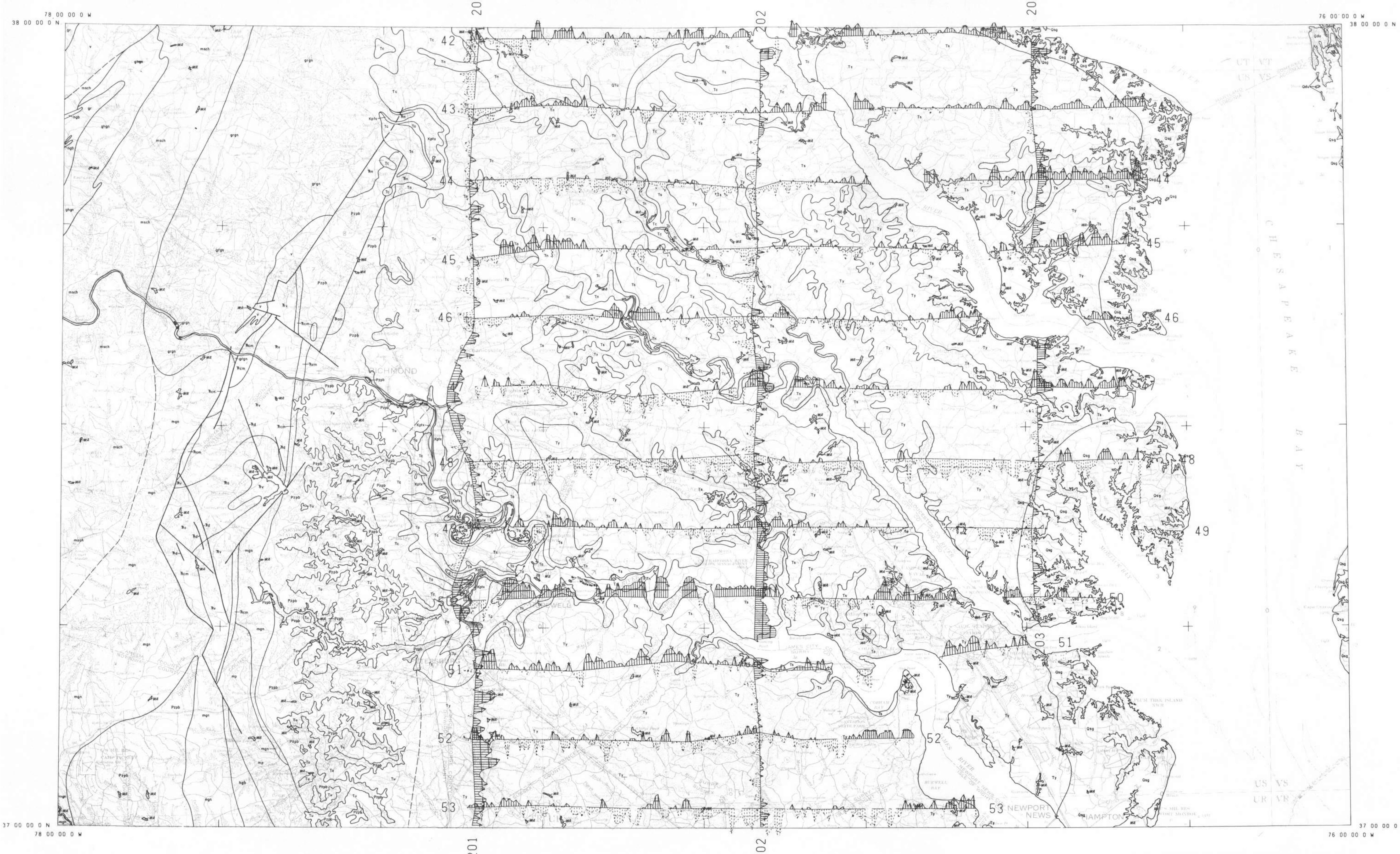
RICHMOND NJ18-7 RICH/BALT SURVEY 1977



PROFILE MAP POTASSIUM 6.0 S.D./IN. TEXAS INSTRUMENTS

5 0 5 10 15 MILES

10 0 10 20 30 KILOMETERS

LEGEND: POSITIVE SIGNIFICANCE FACTORS—SOLID LINES
NEGATIVE SIGNIFICANCE FACTORS—DOTTED LINES

AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY
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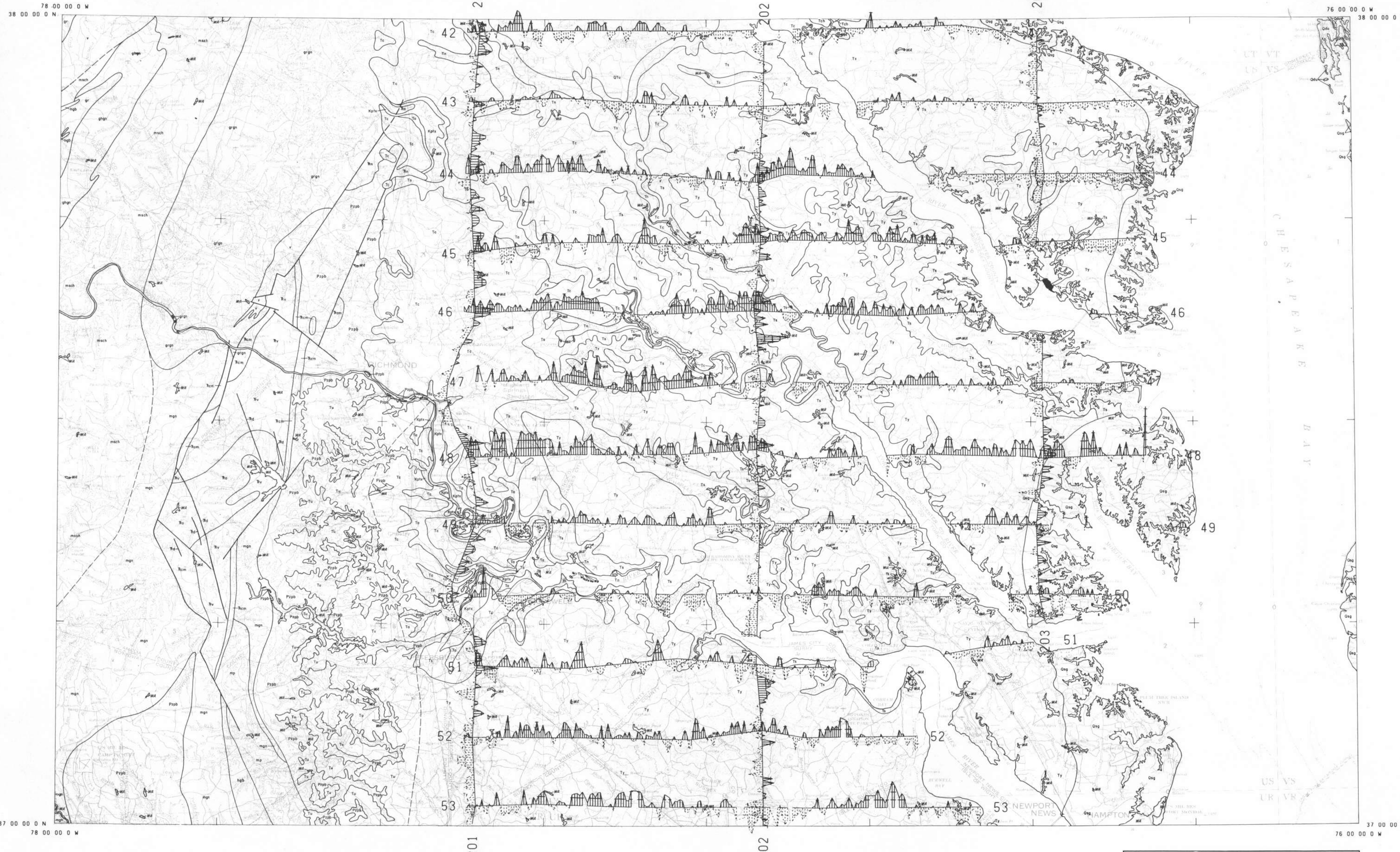
RICHMOND NJ18-7   RICH/BALT SURVEY 1977



PROFILE MAP   TH/K   6.0 S.D./IN.   TEXAS INSTRUMENTS

5 0 5 10 15 MILES

10 0 10 20 30 KILOMETERS

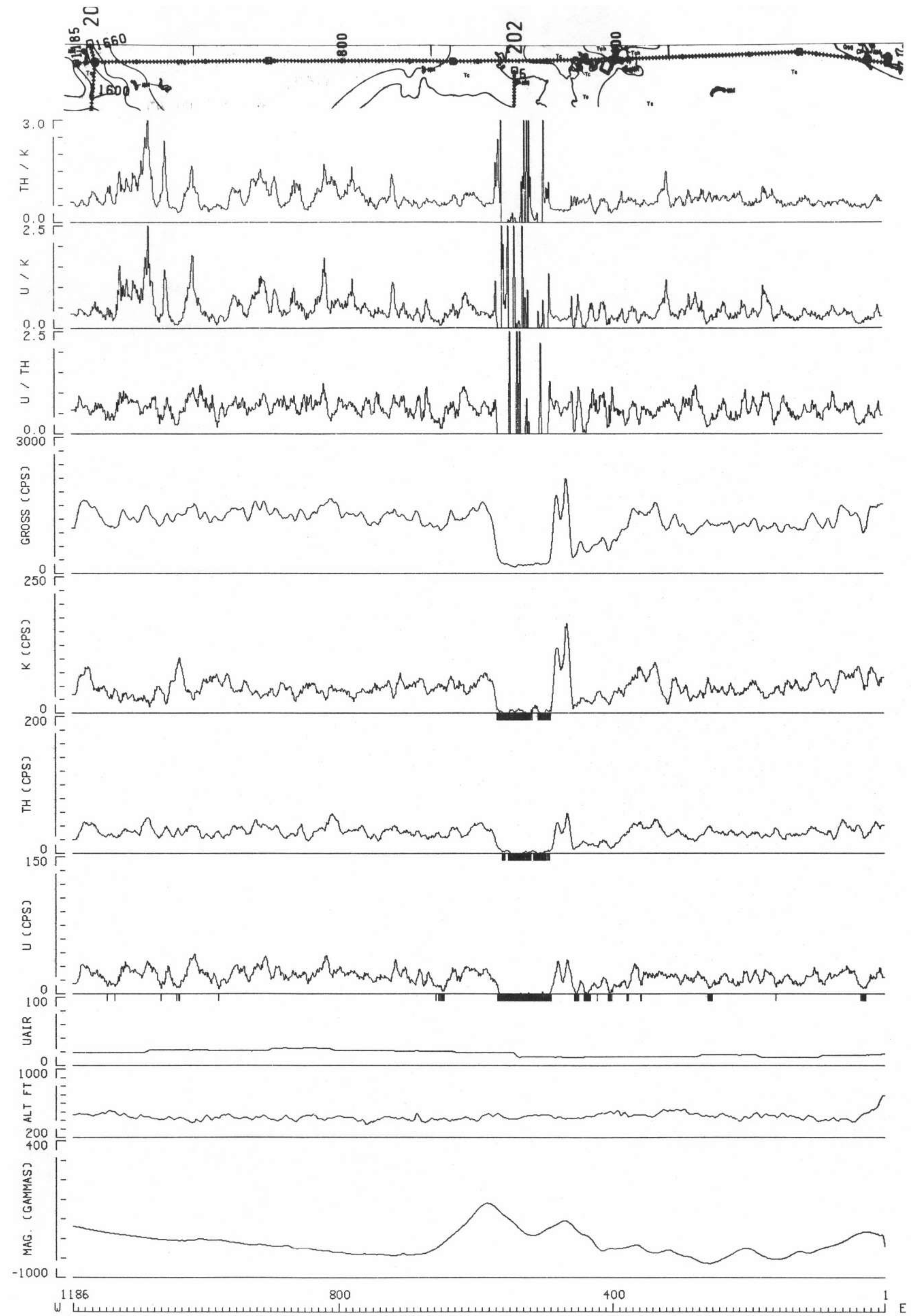
LEGEND: POSITIVE SIGNIFICANCE FACTORS—SOLID LINES
NEGATIVE SIGNIFICANCE FACTORS—DOTTED LINES

AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY
PREPARED BY
TEXAS INSTRUMENTS INCORPORATED
DALLAS, TEXAS
1977
WORK PERFORMED UNDER
BENDIX FIELD ENGINEERING CORPORATION
SUBCONTRACT NO. 78-092-L
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

M-7

PROFILES

PROFILES



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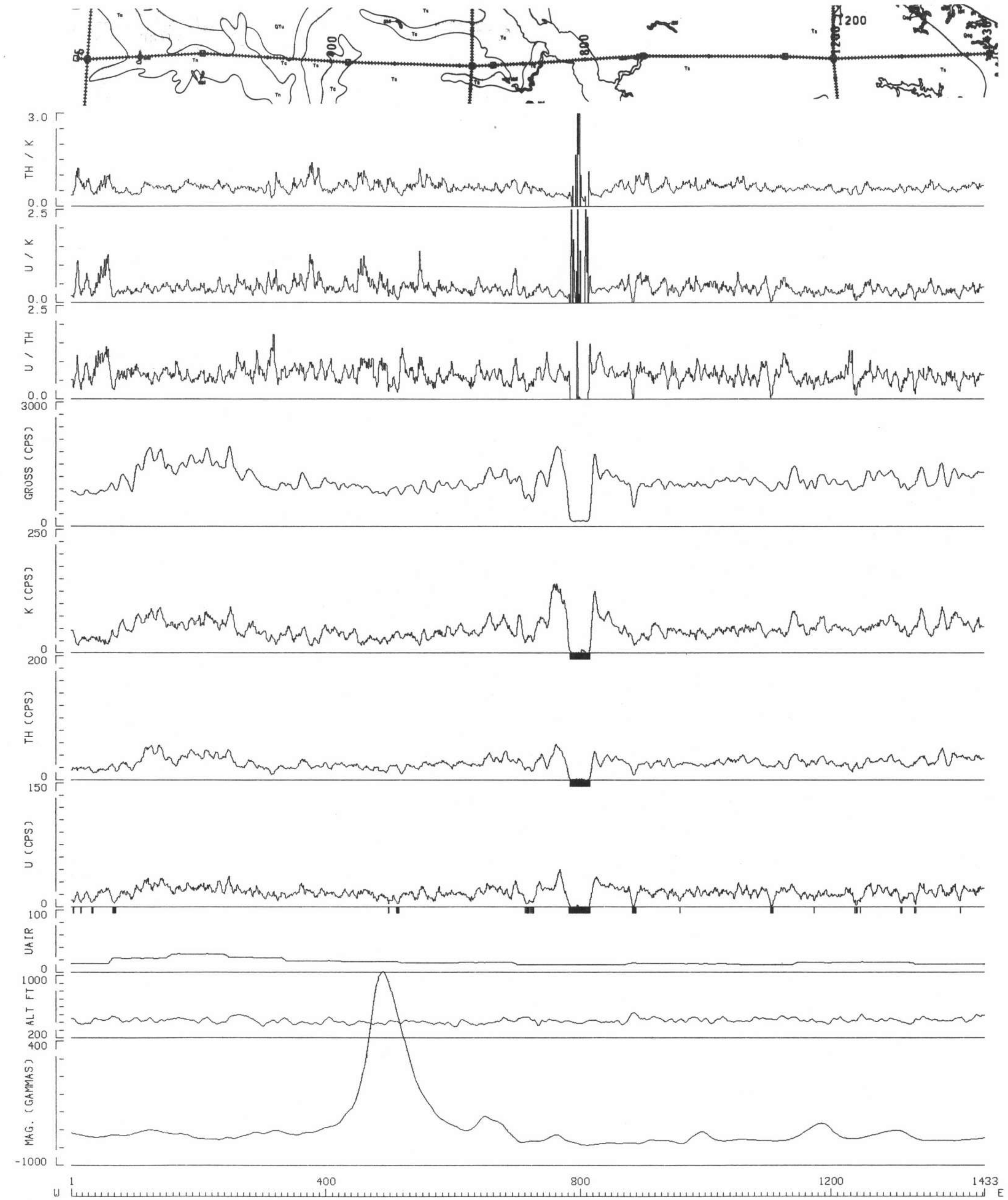
FL-042   RICHMOND   NJ 18-7



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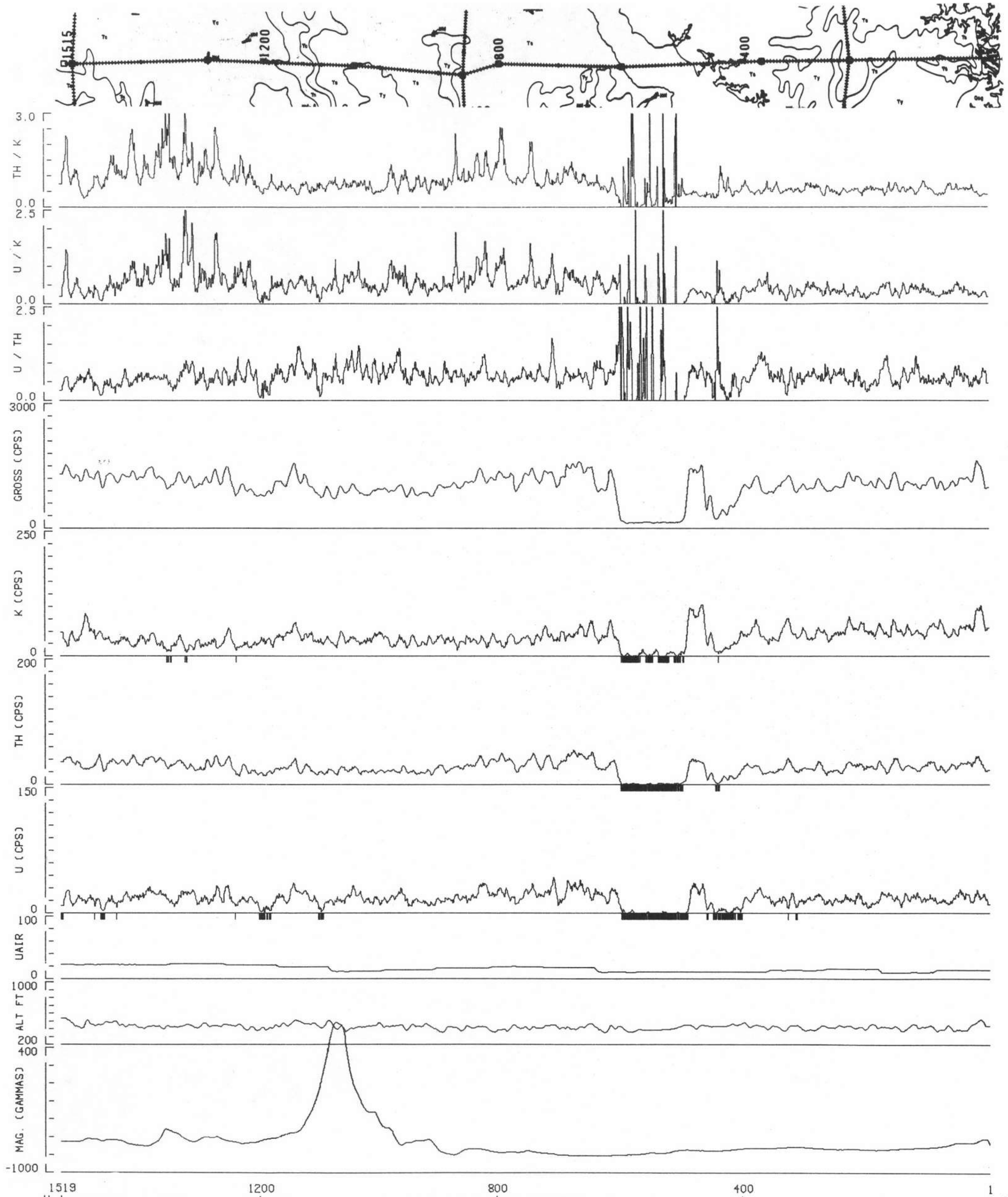

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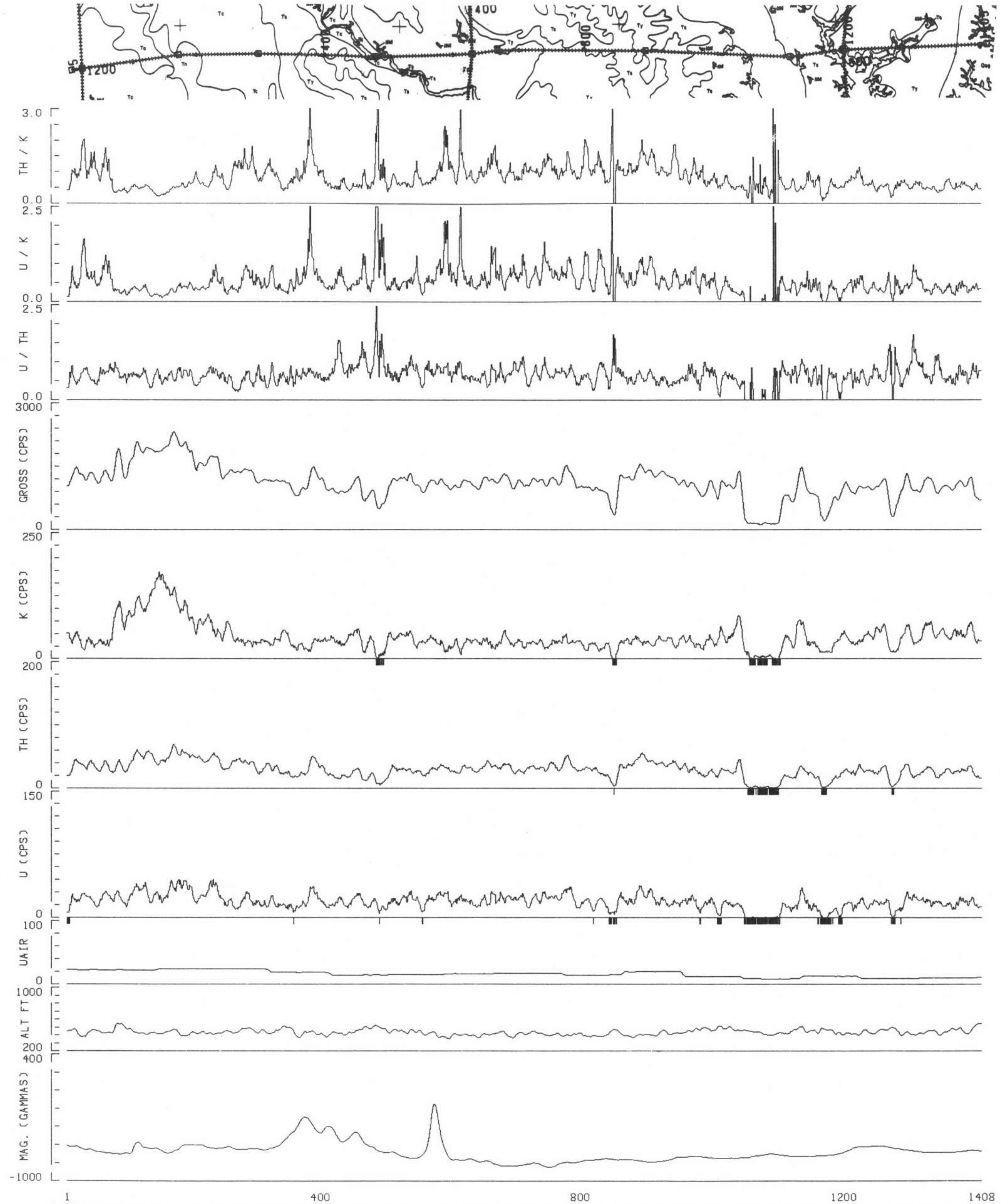

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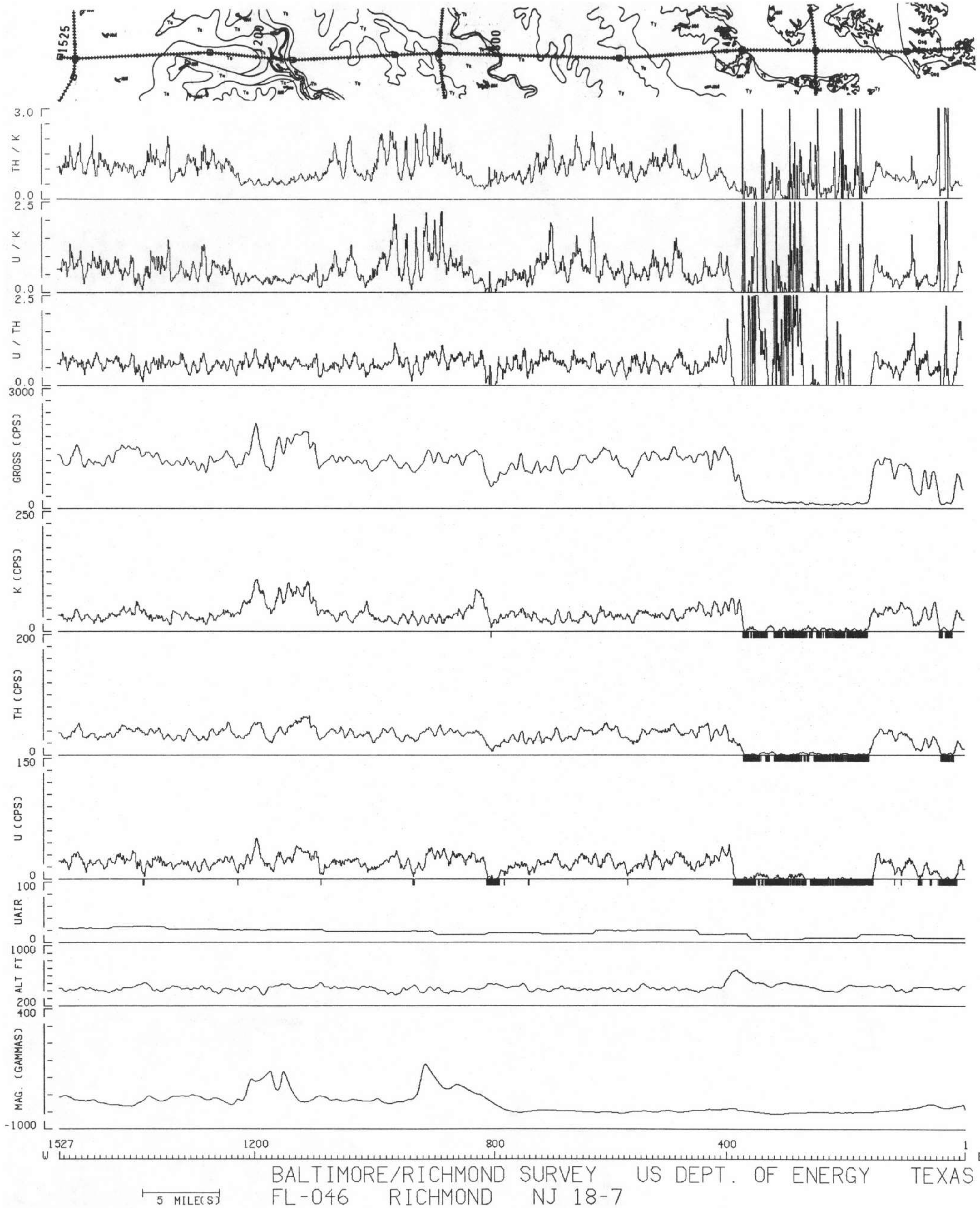
FL-045   RICHMOND   NJ 18-7



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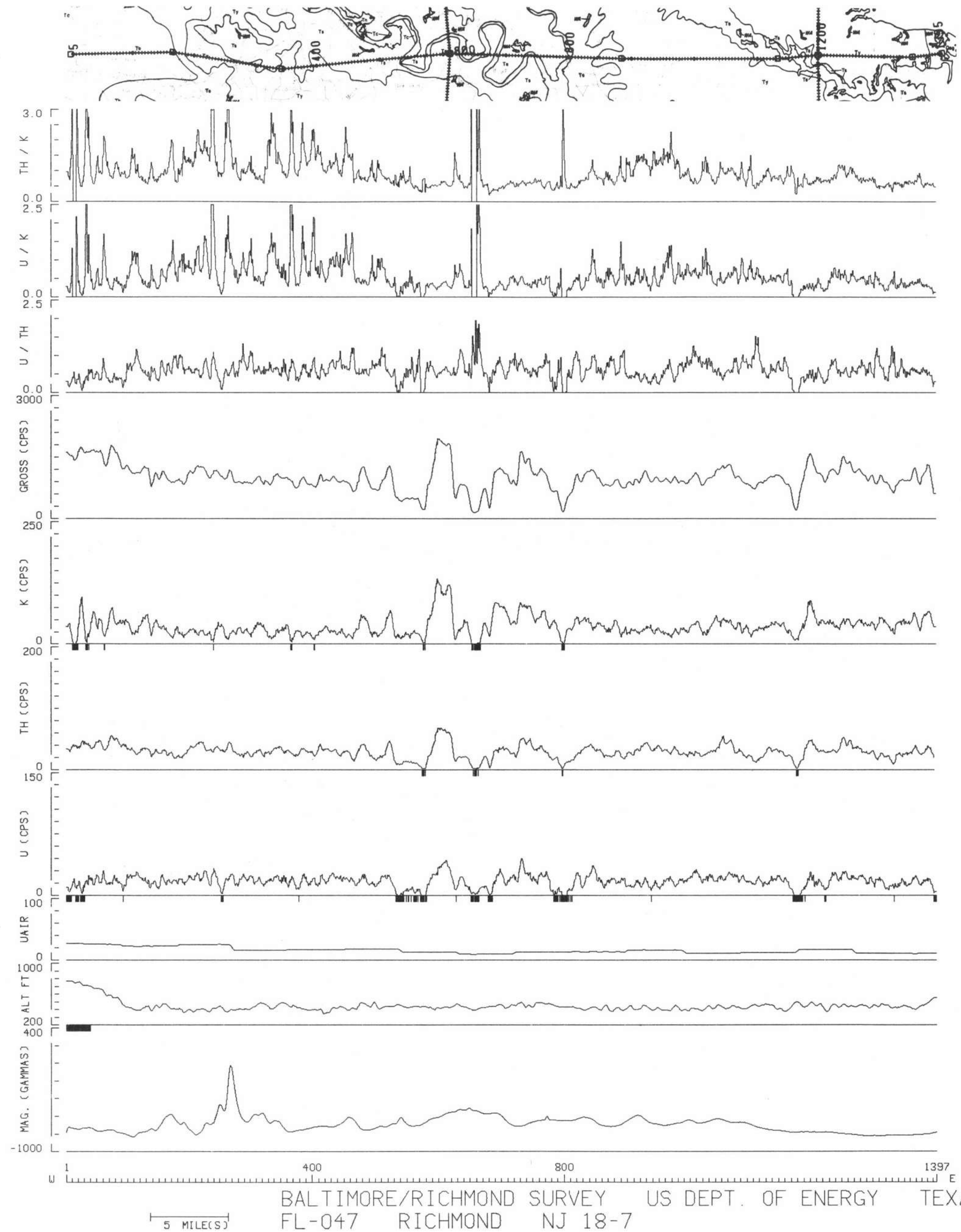

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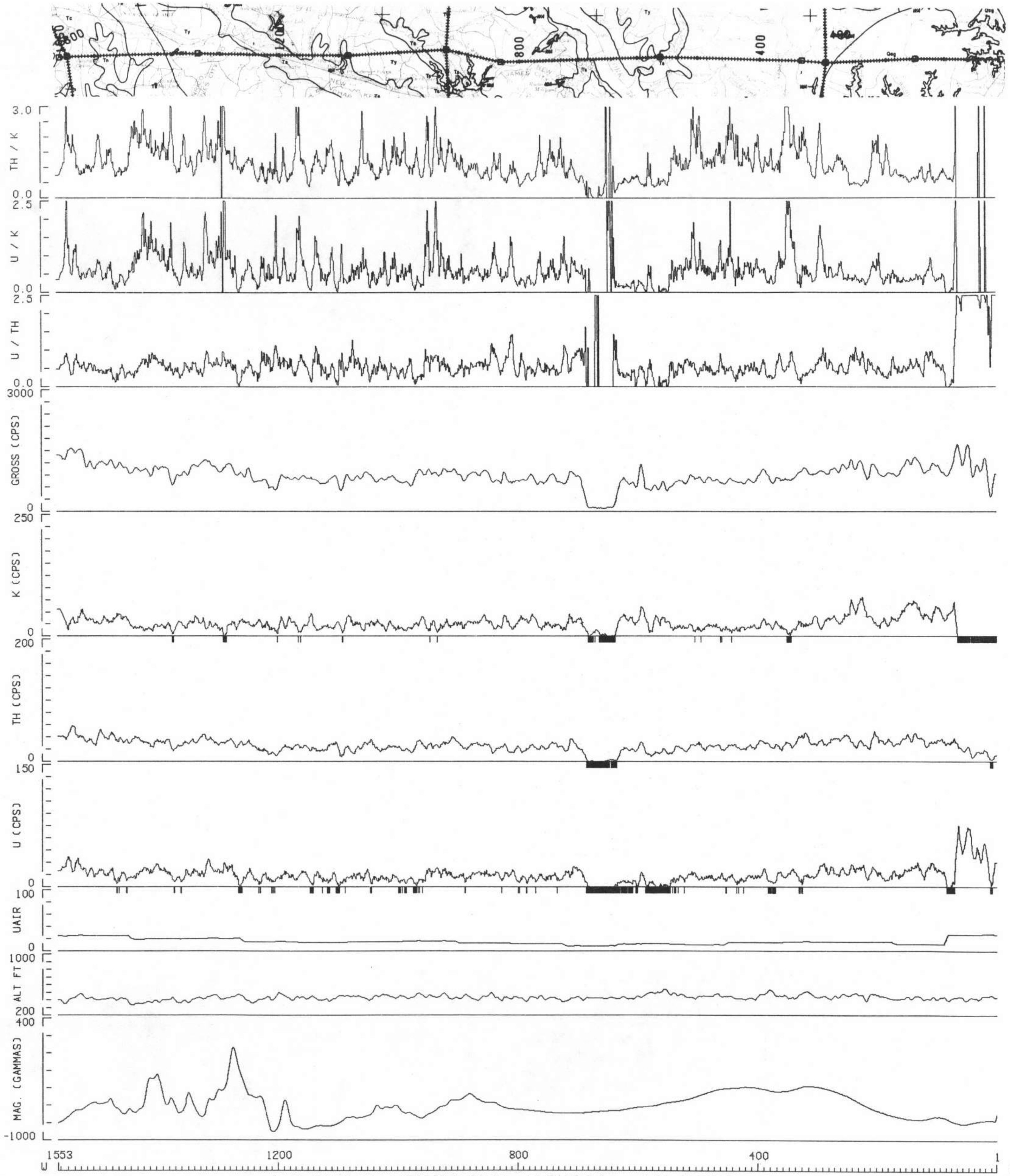
FL-047   RICHMOND   NJ 18-7



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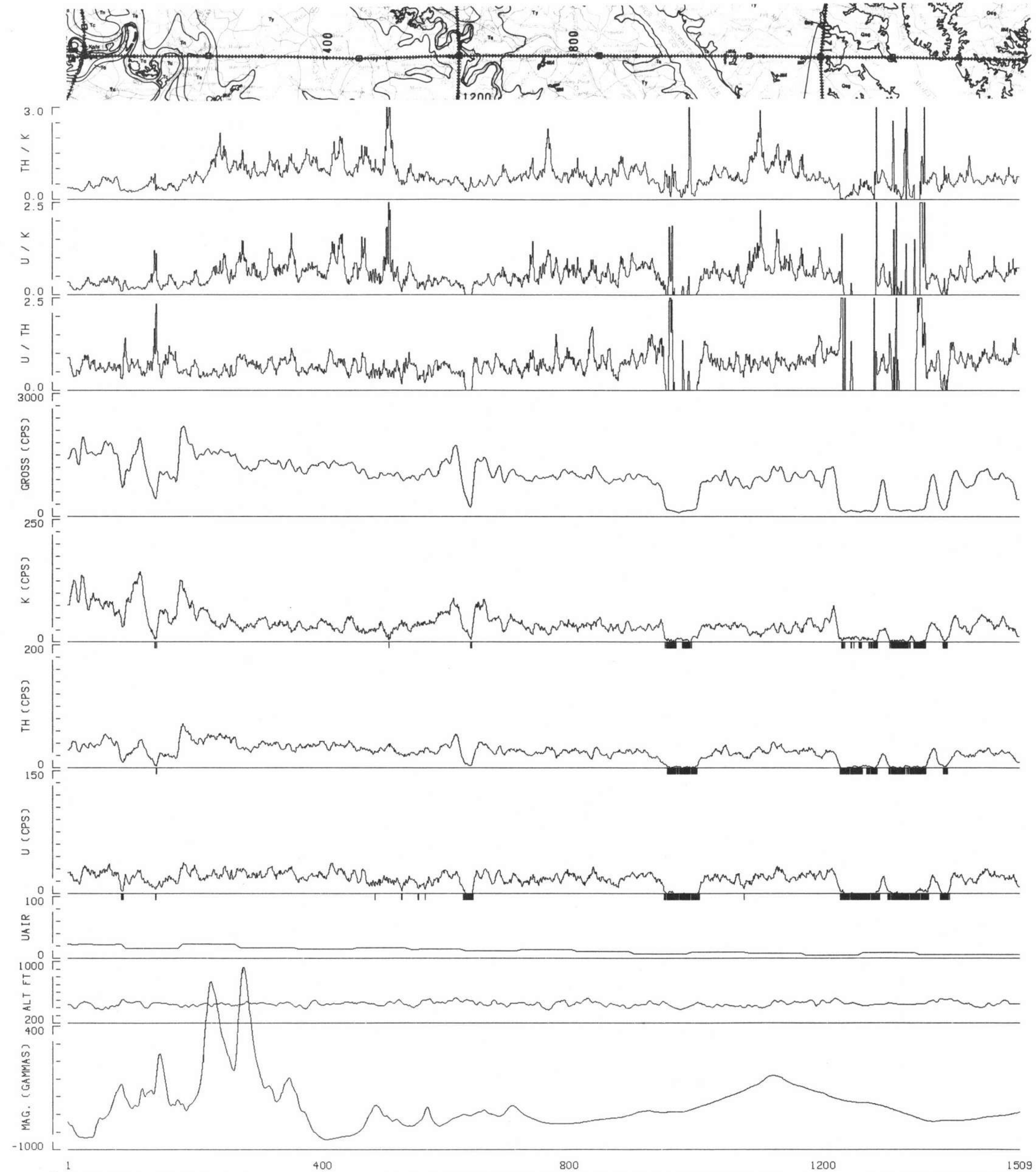

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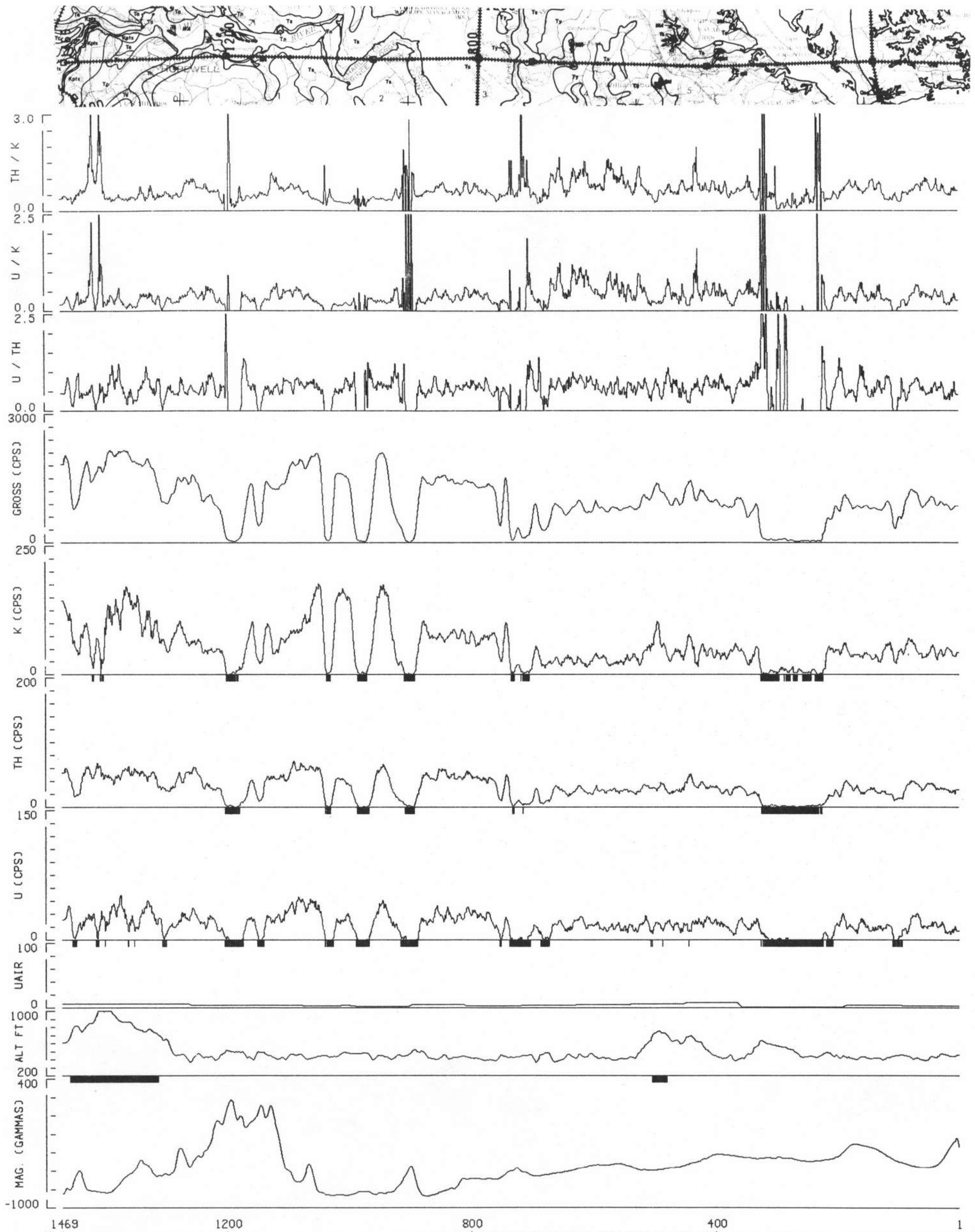

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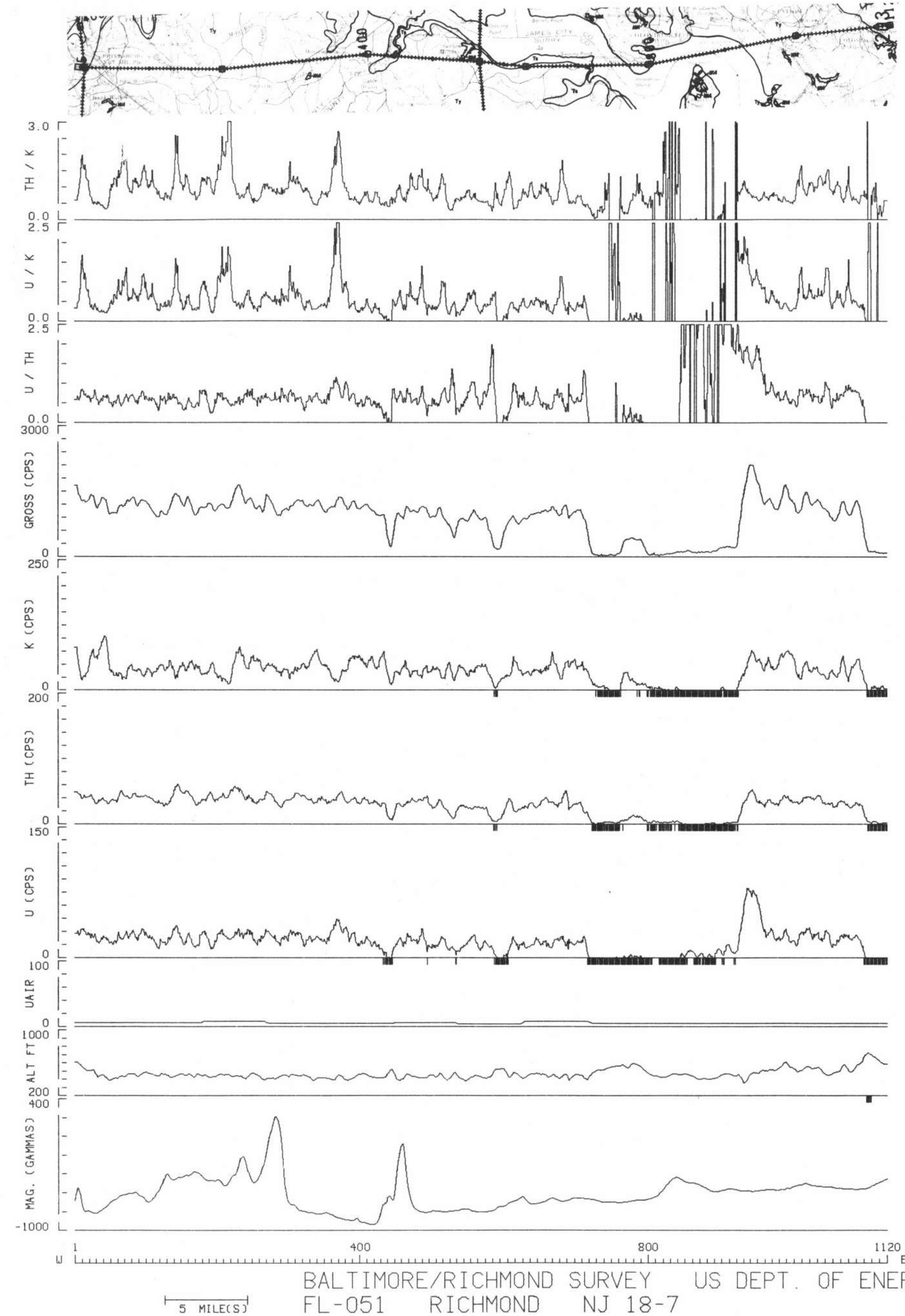

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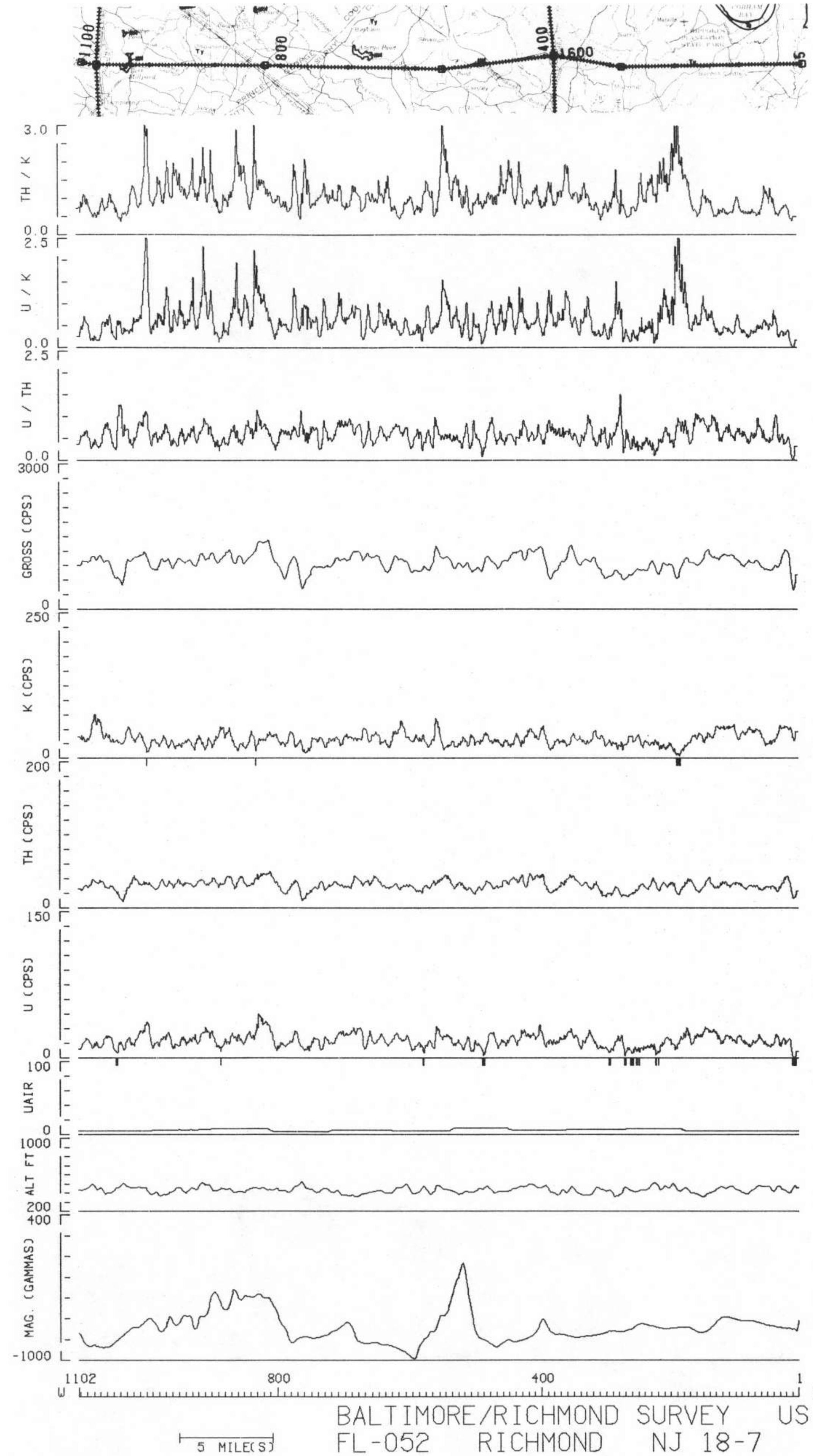

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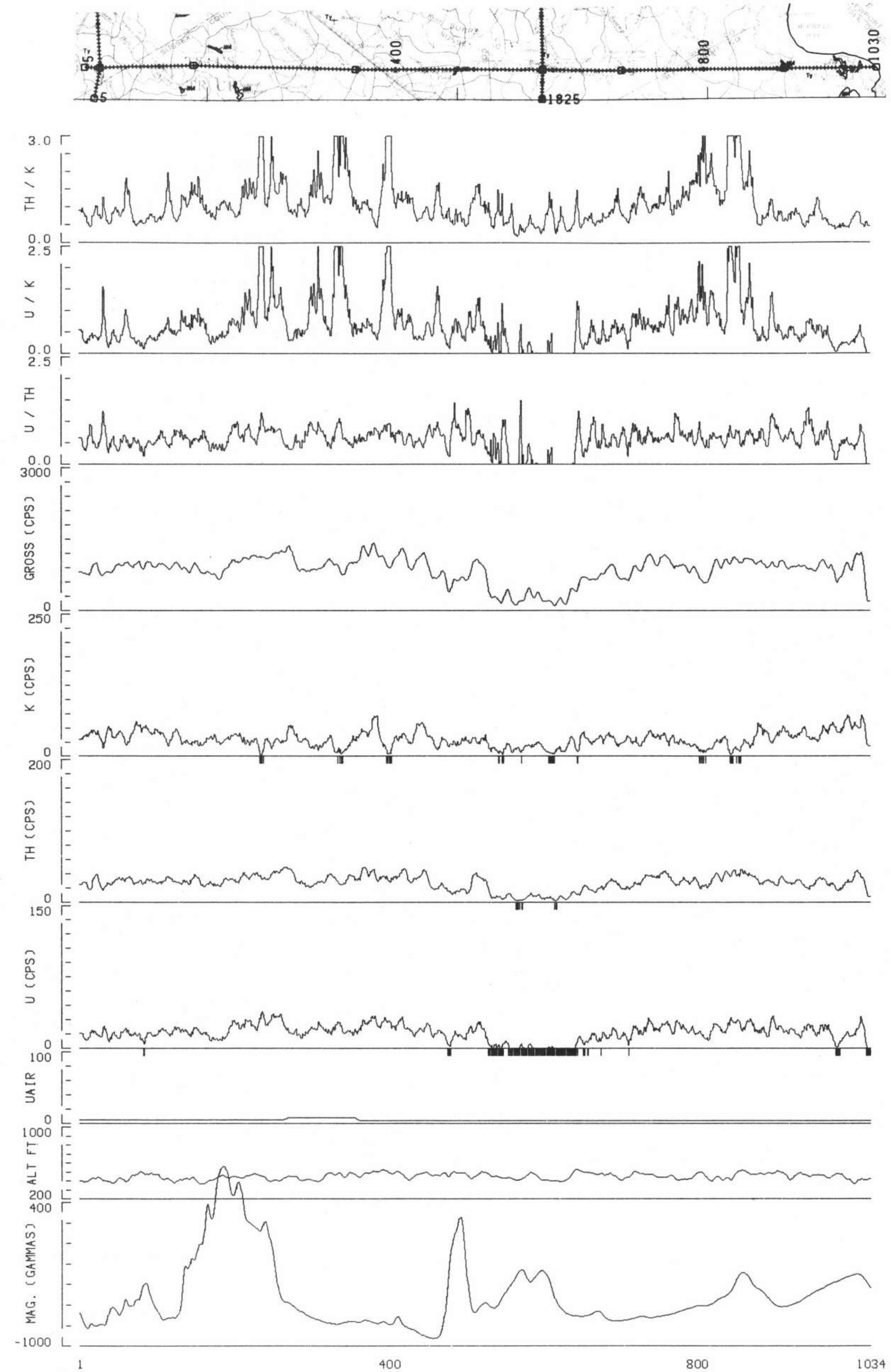

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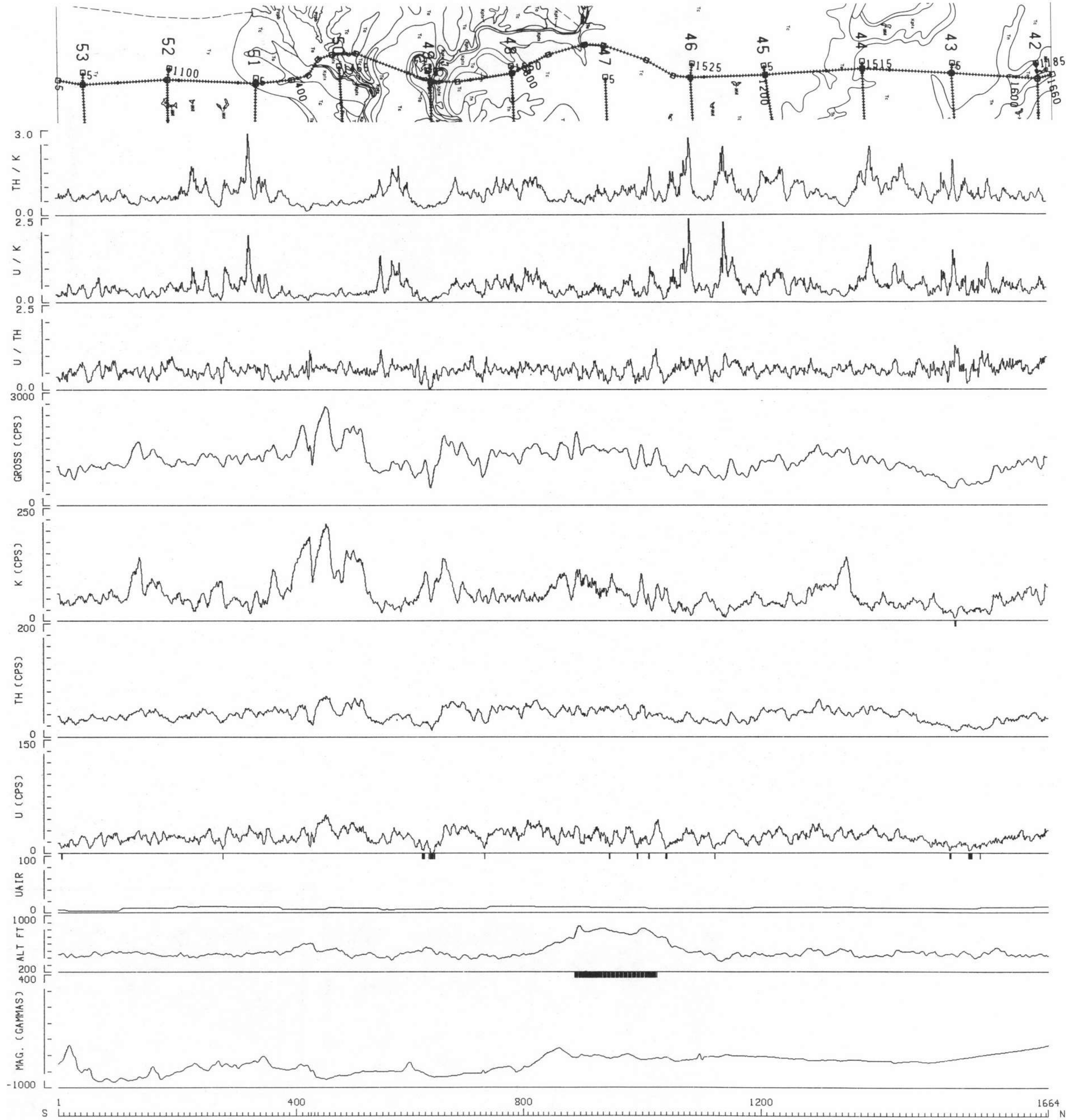

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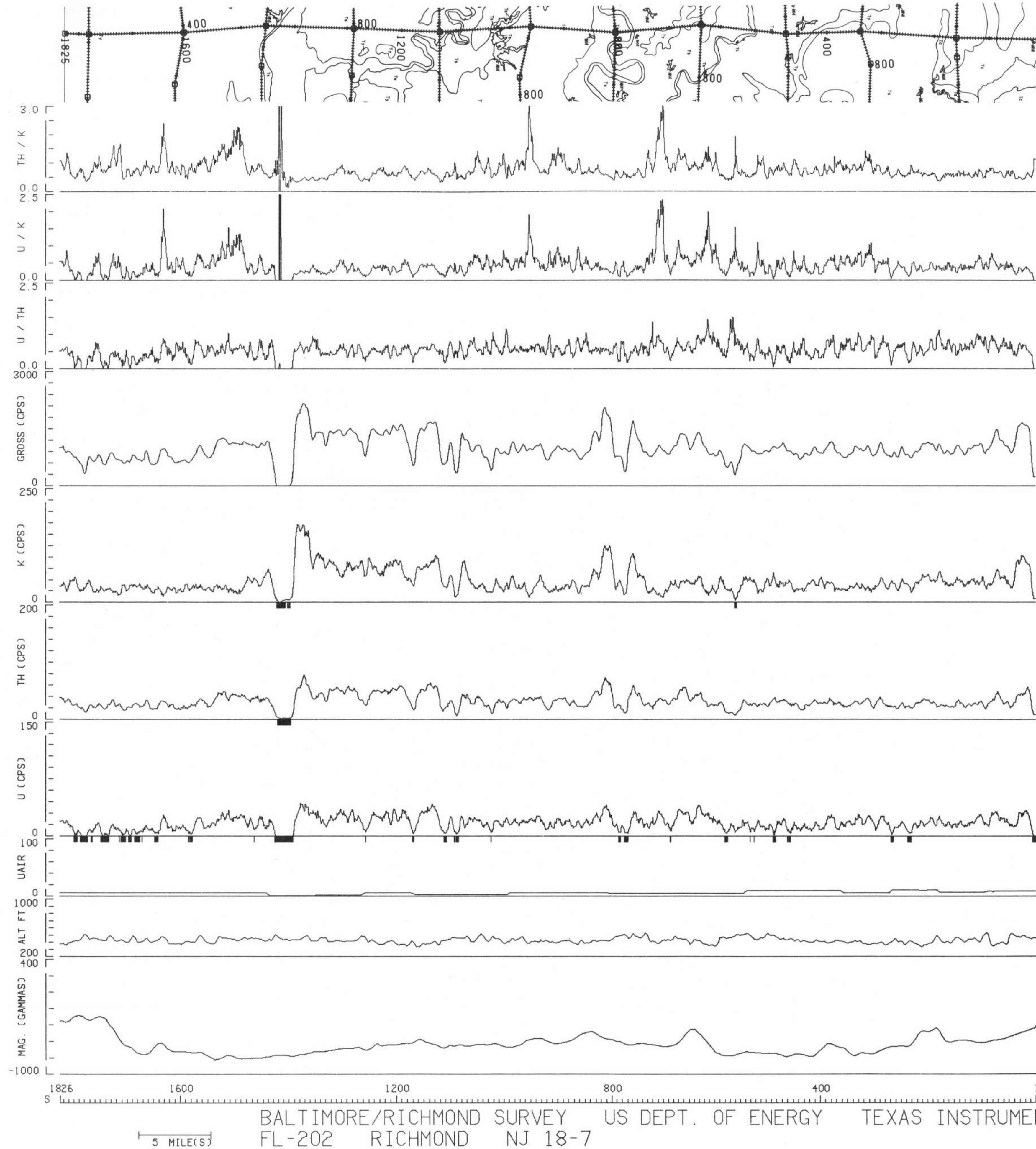
BALTIMORE/RICHMOND SURVEY   US DEPT. OF ENERGY   TEXAS INSTRUMENTS

FL-201   RICHMOND   NJ 18-7



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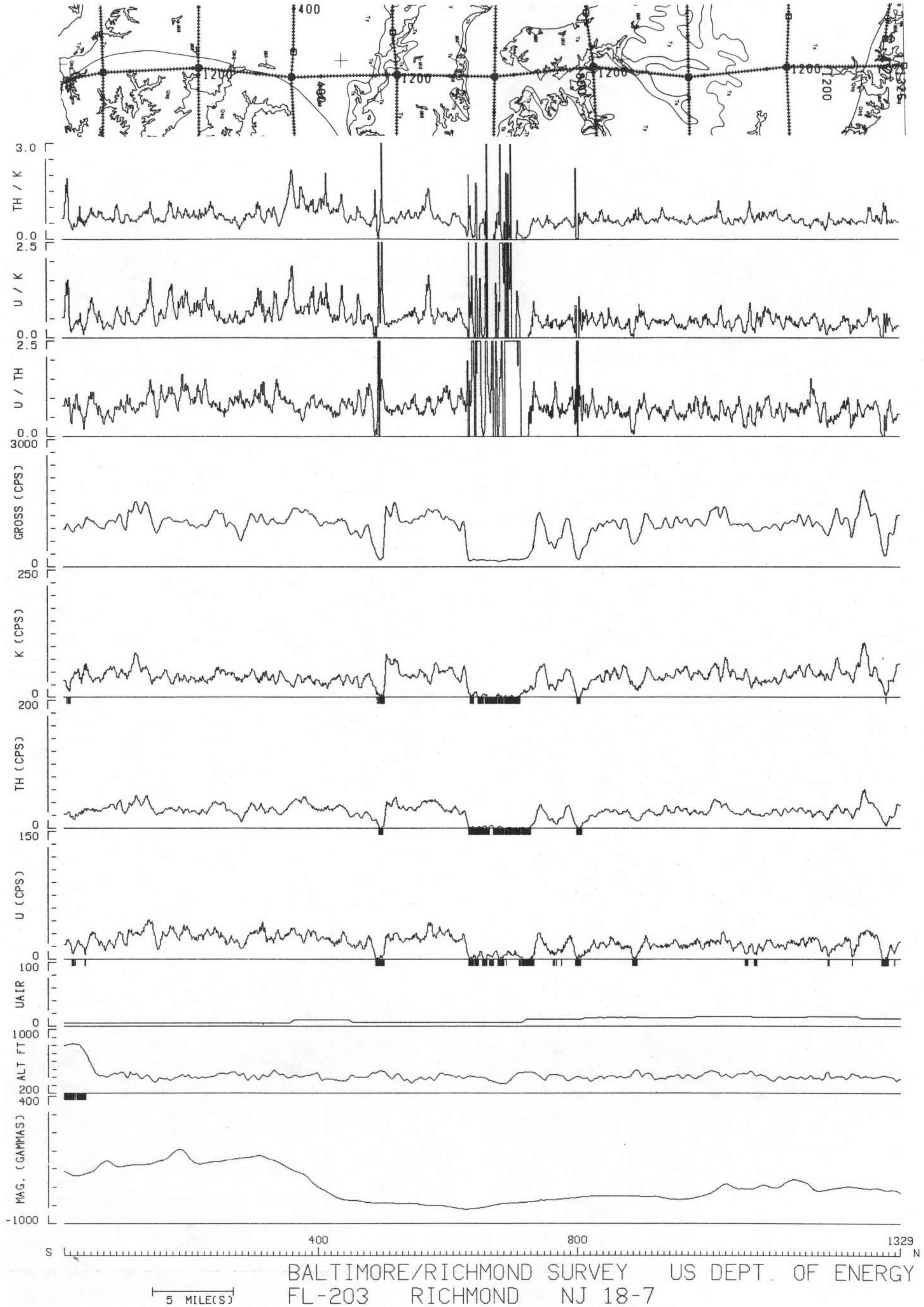
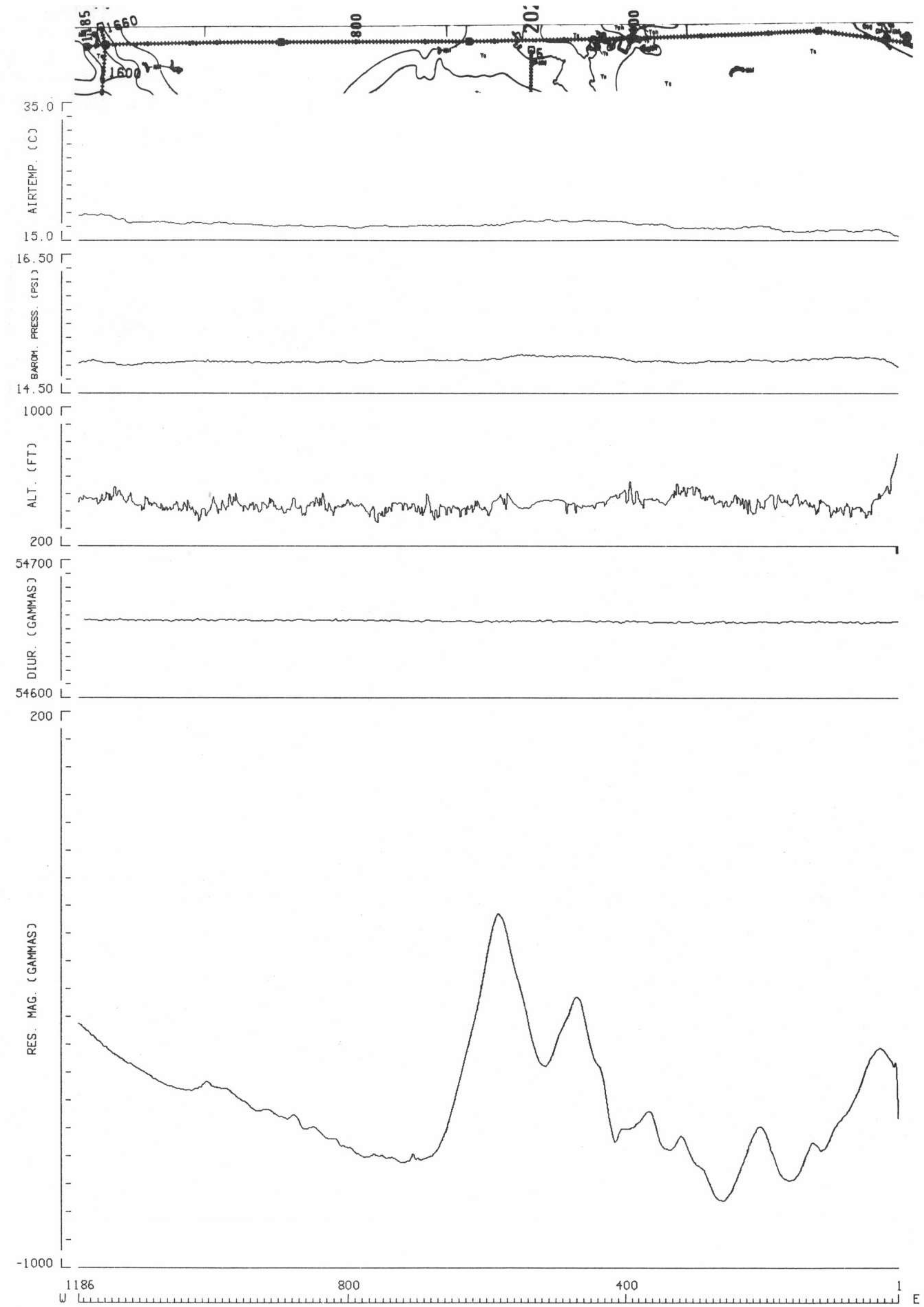


BALTIMORE/RICHMOND SURVEY US DEPT. OF ENERGY TEXAS INSTRUMENTS

FL-203 RICHMOND NJ 18-7



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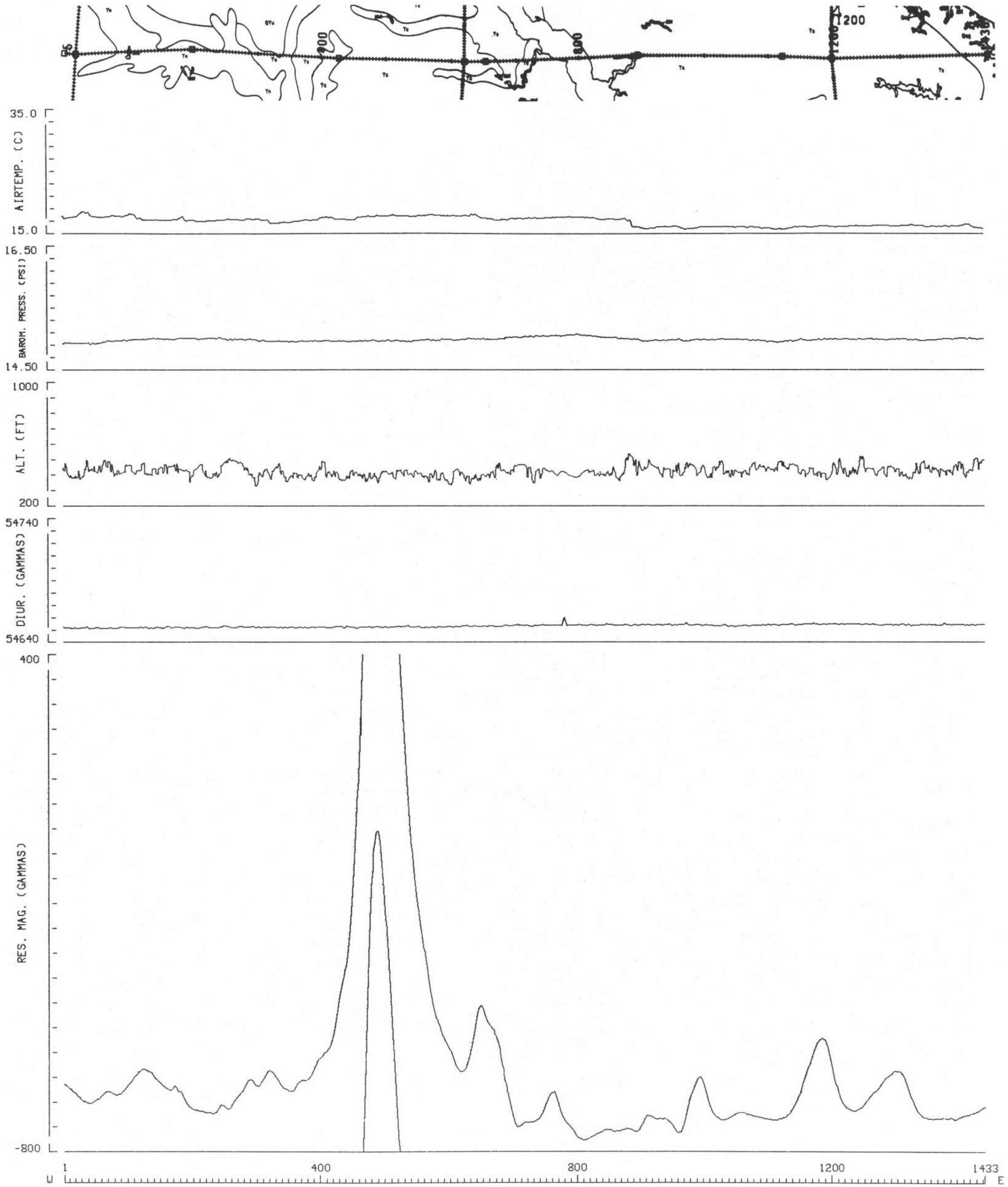
FL-042 RICHMOND NJ 18-7



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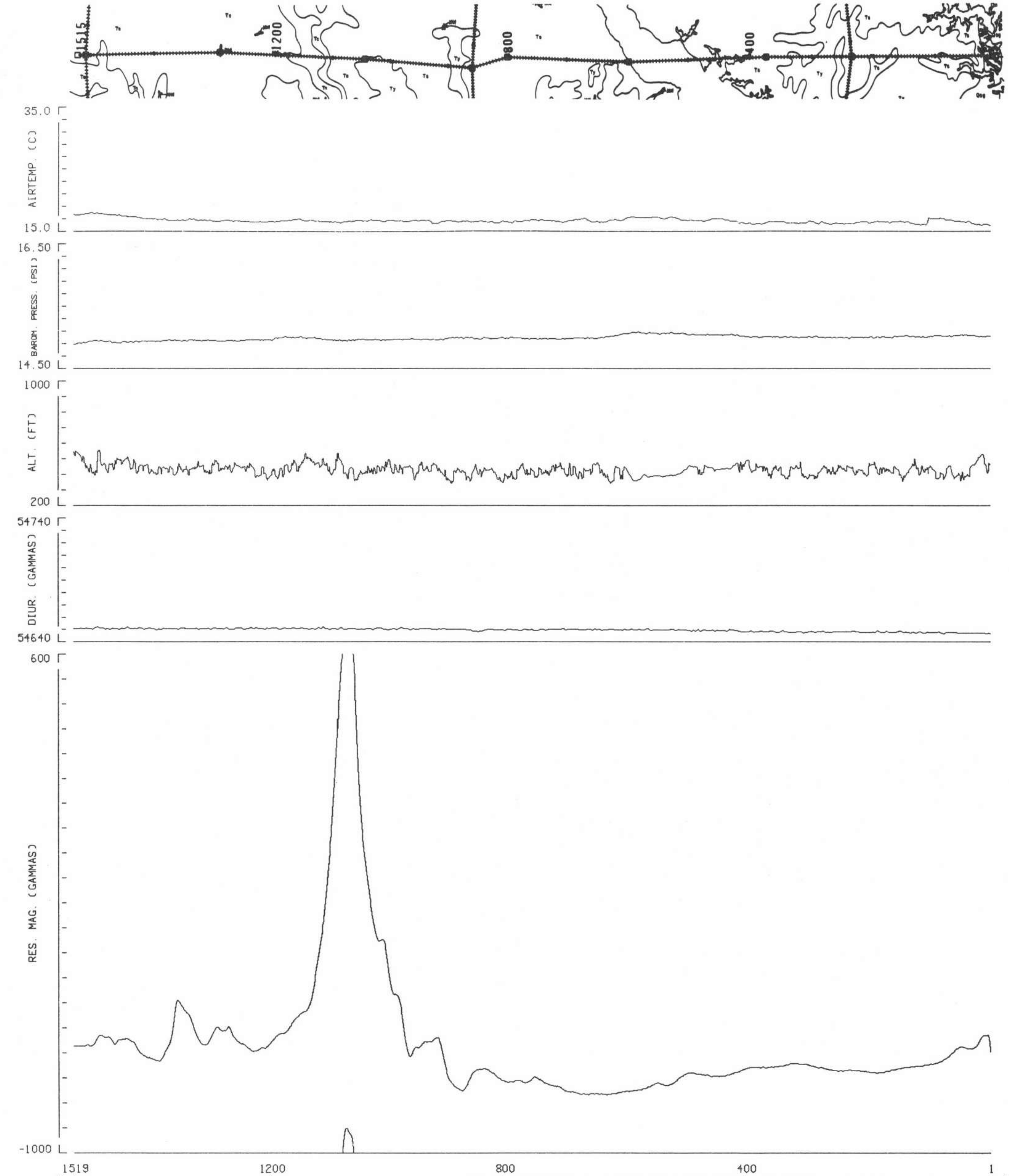

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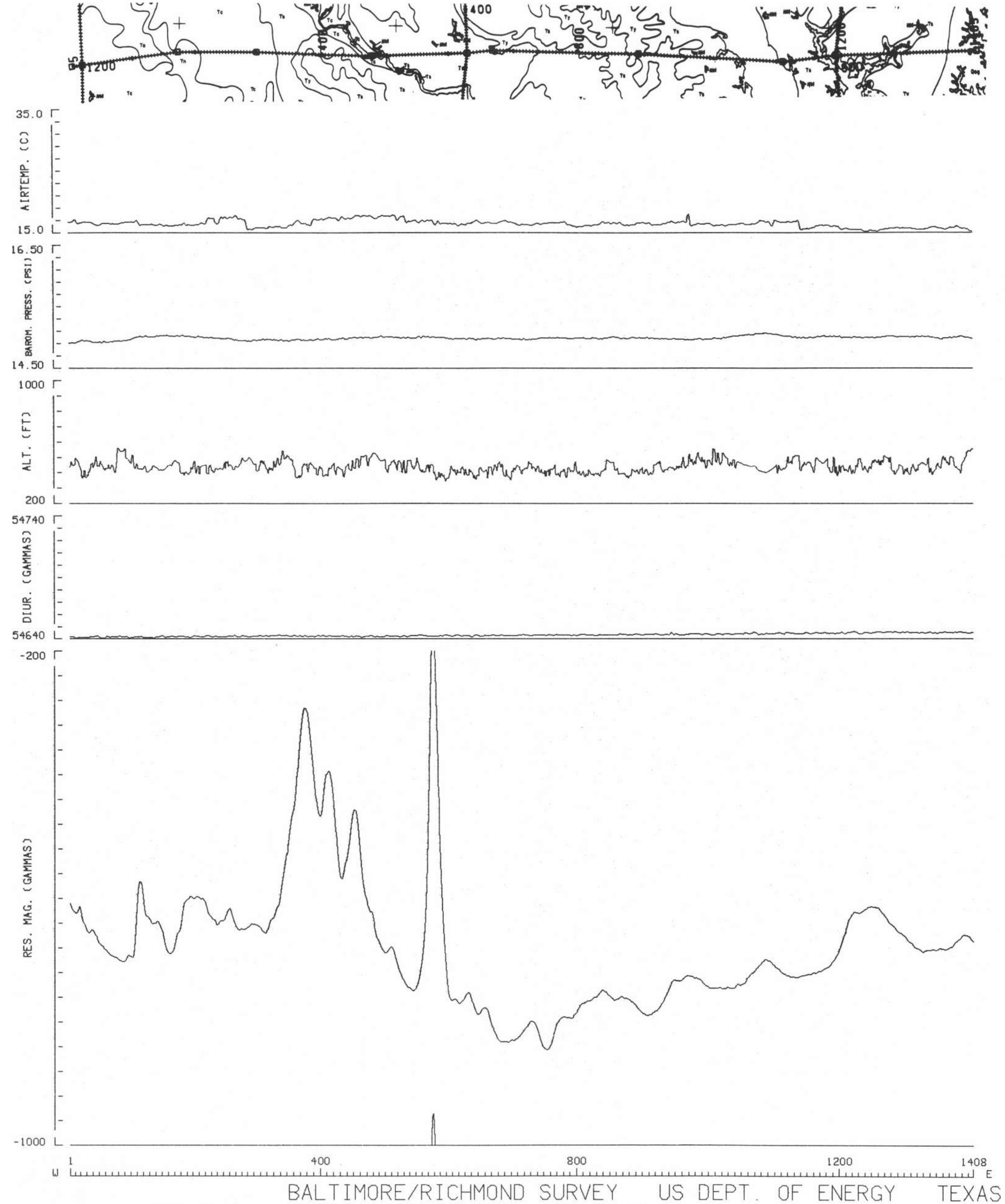
FL-044 RICHMOND NJ 18-7



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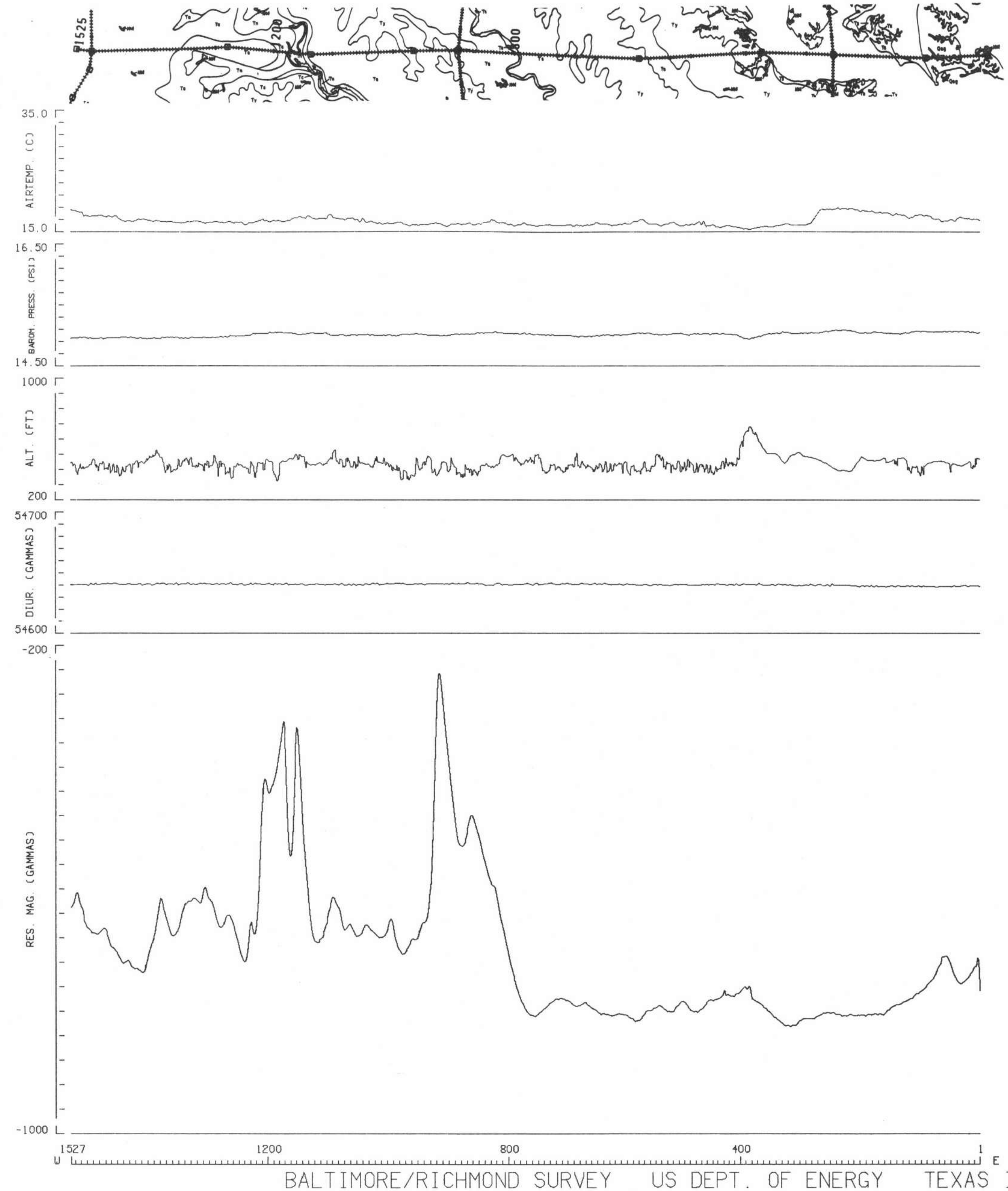

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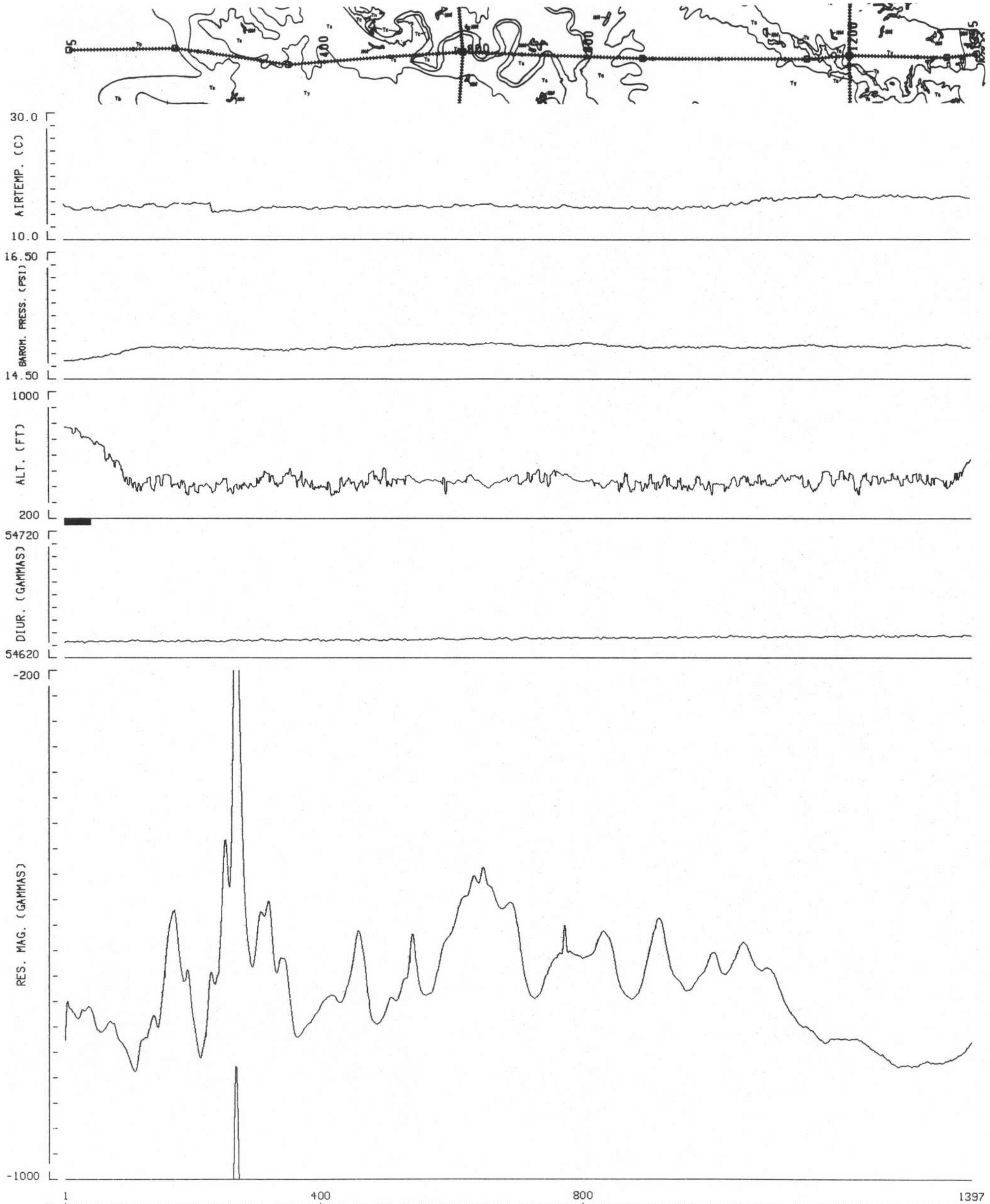

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BALTIMORE/RICHMOND SURVEY US DEPT. OF ENERGY TEXAS INSTRUMENTS

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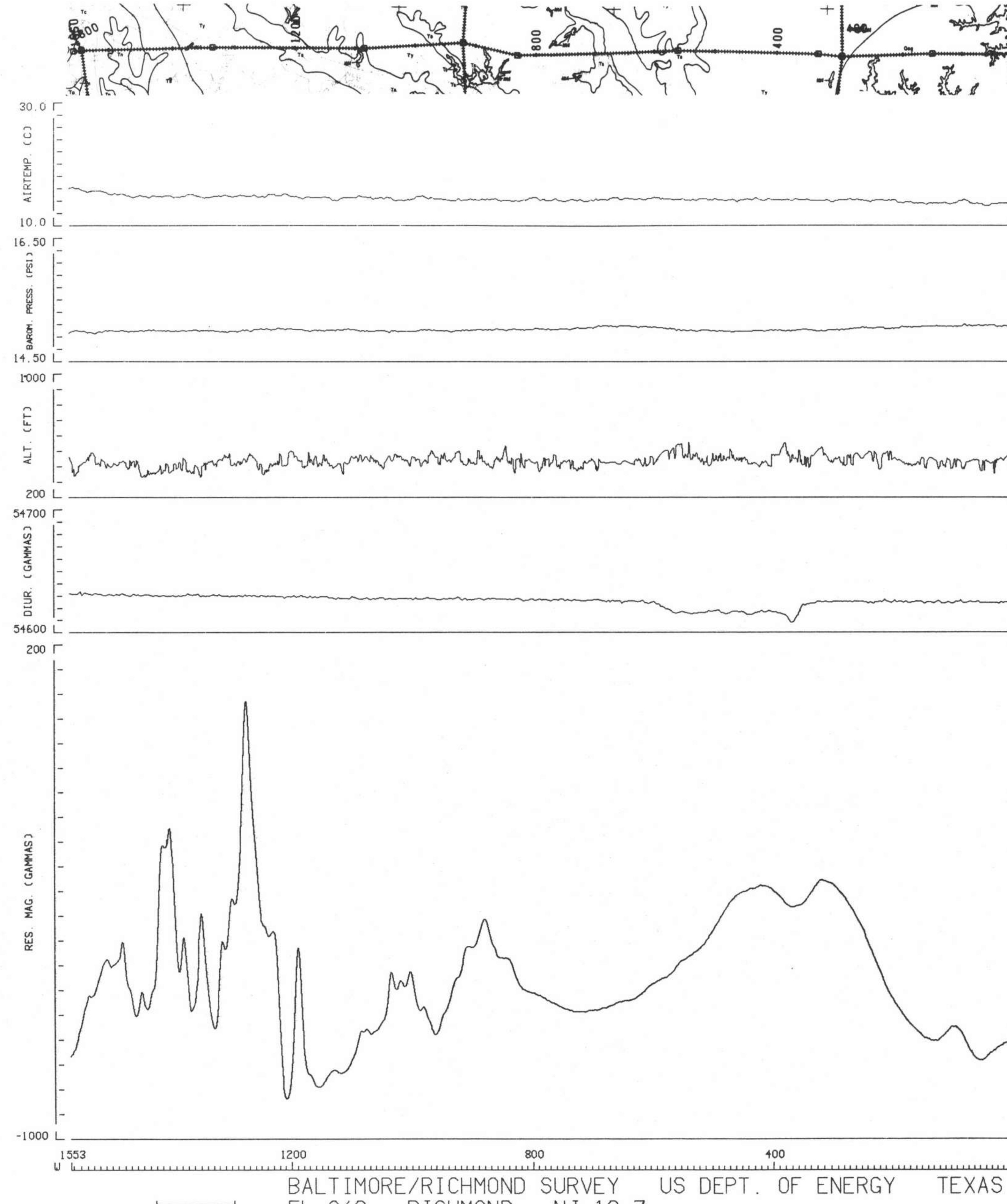

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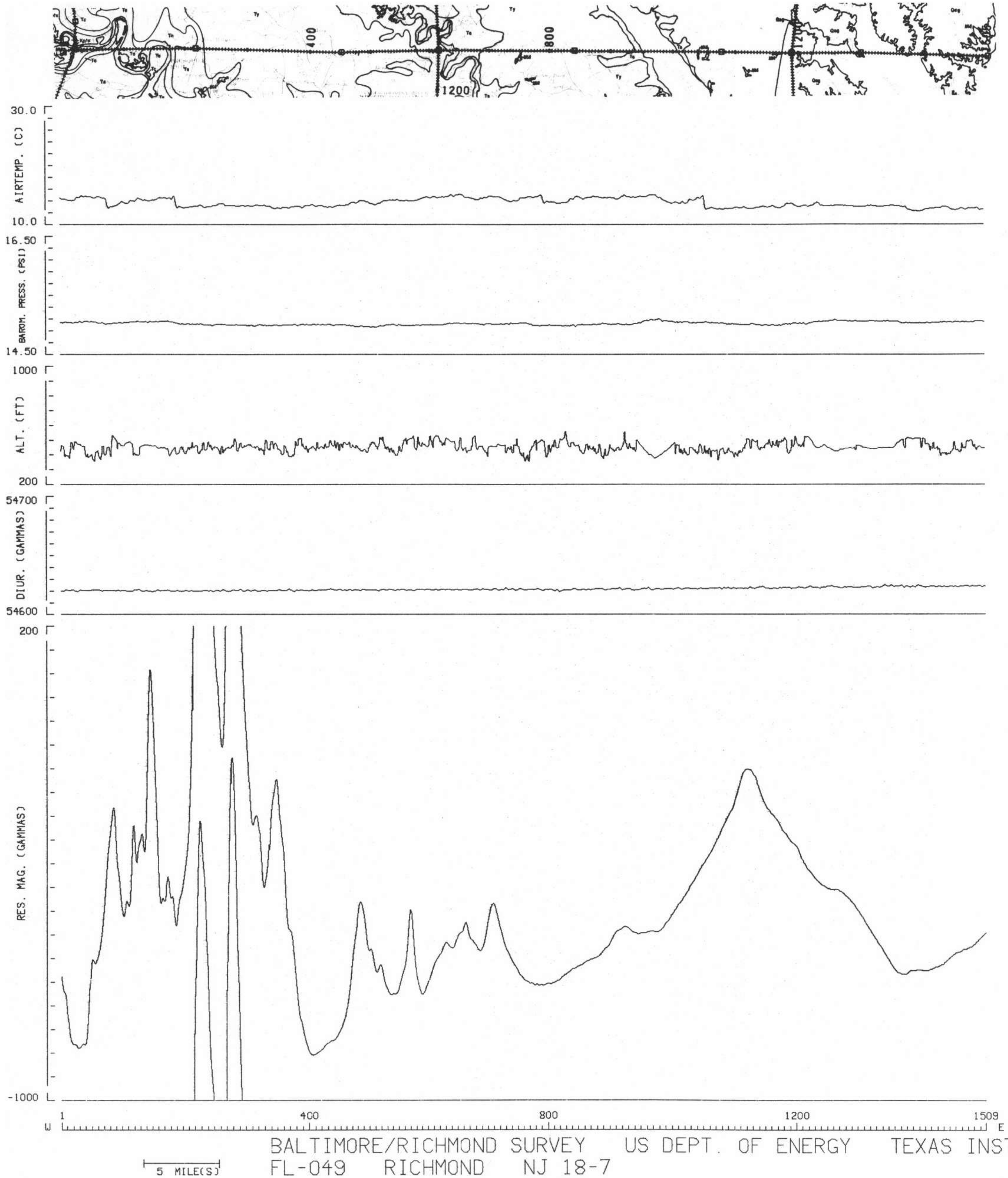
FL-048   RICHMOND   NJ 18-7



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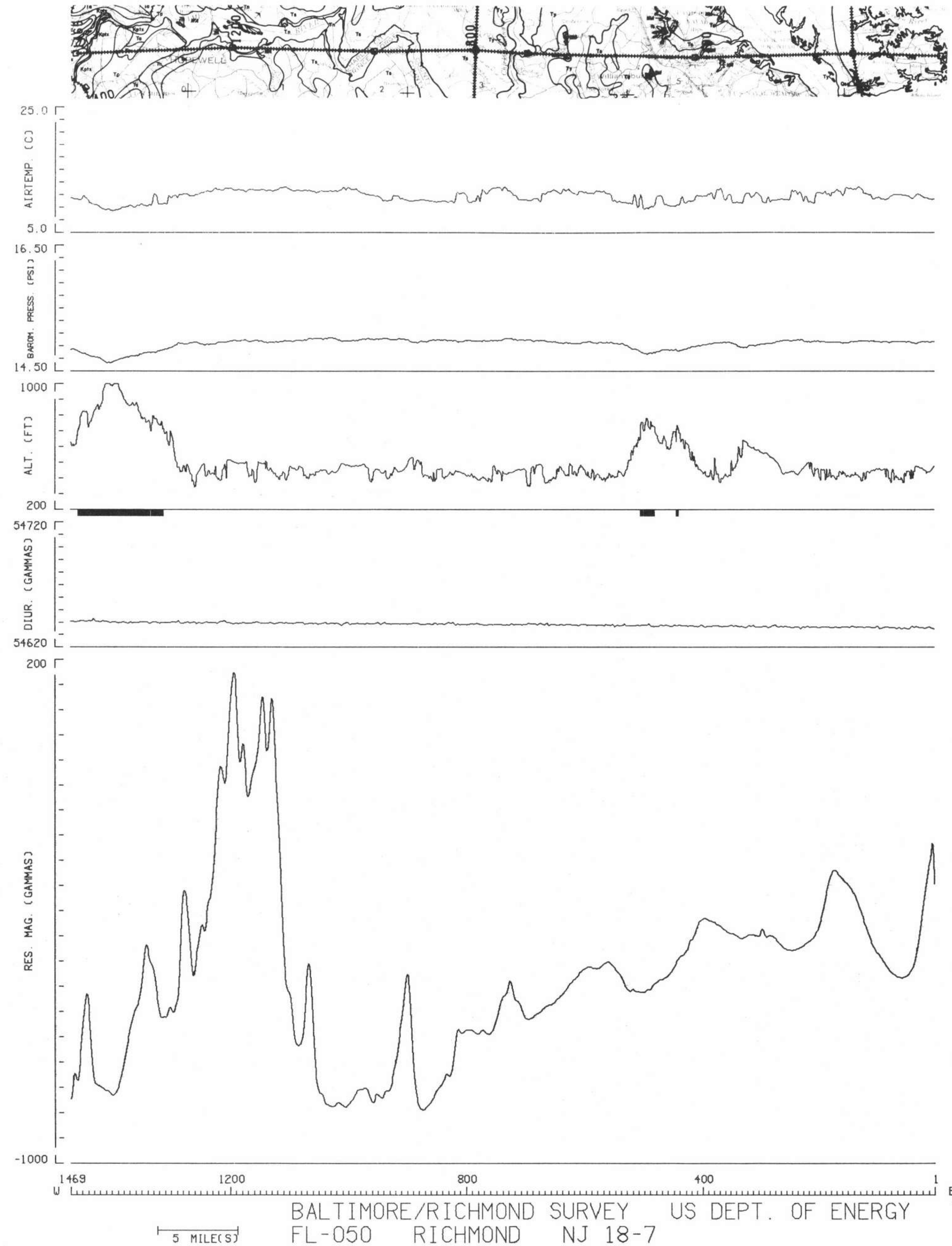
FL-049 RICHMOND NJ 18-7



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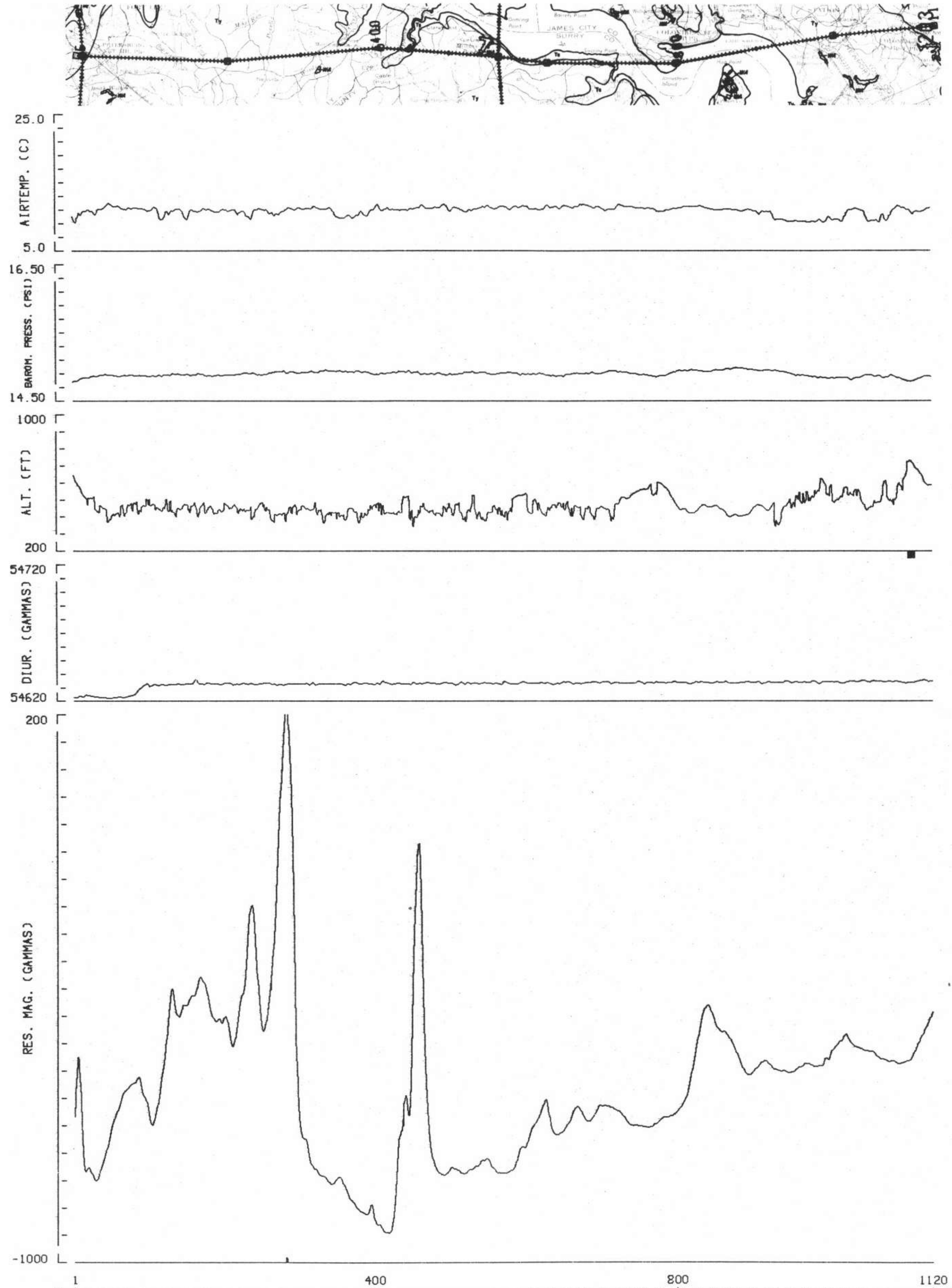

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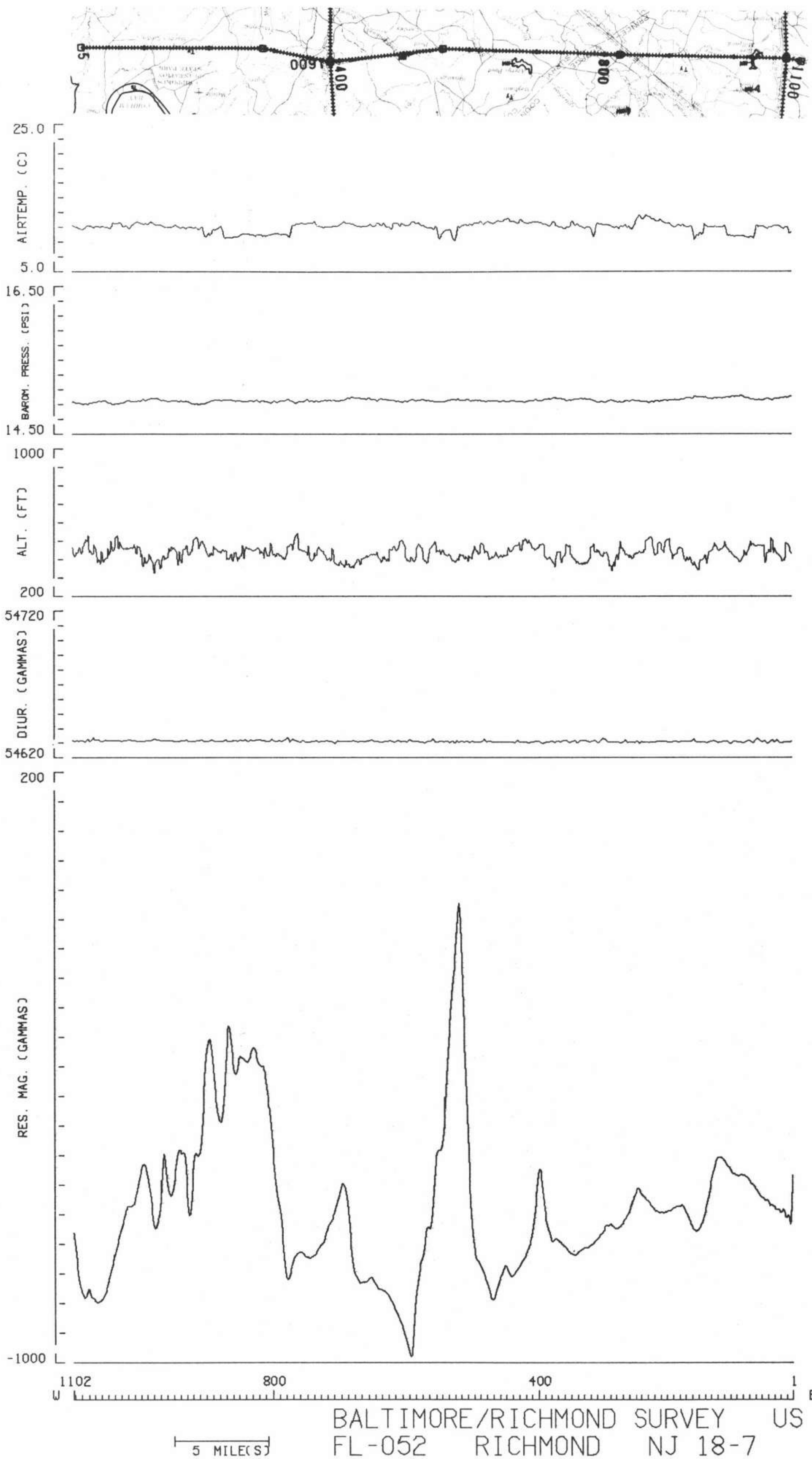

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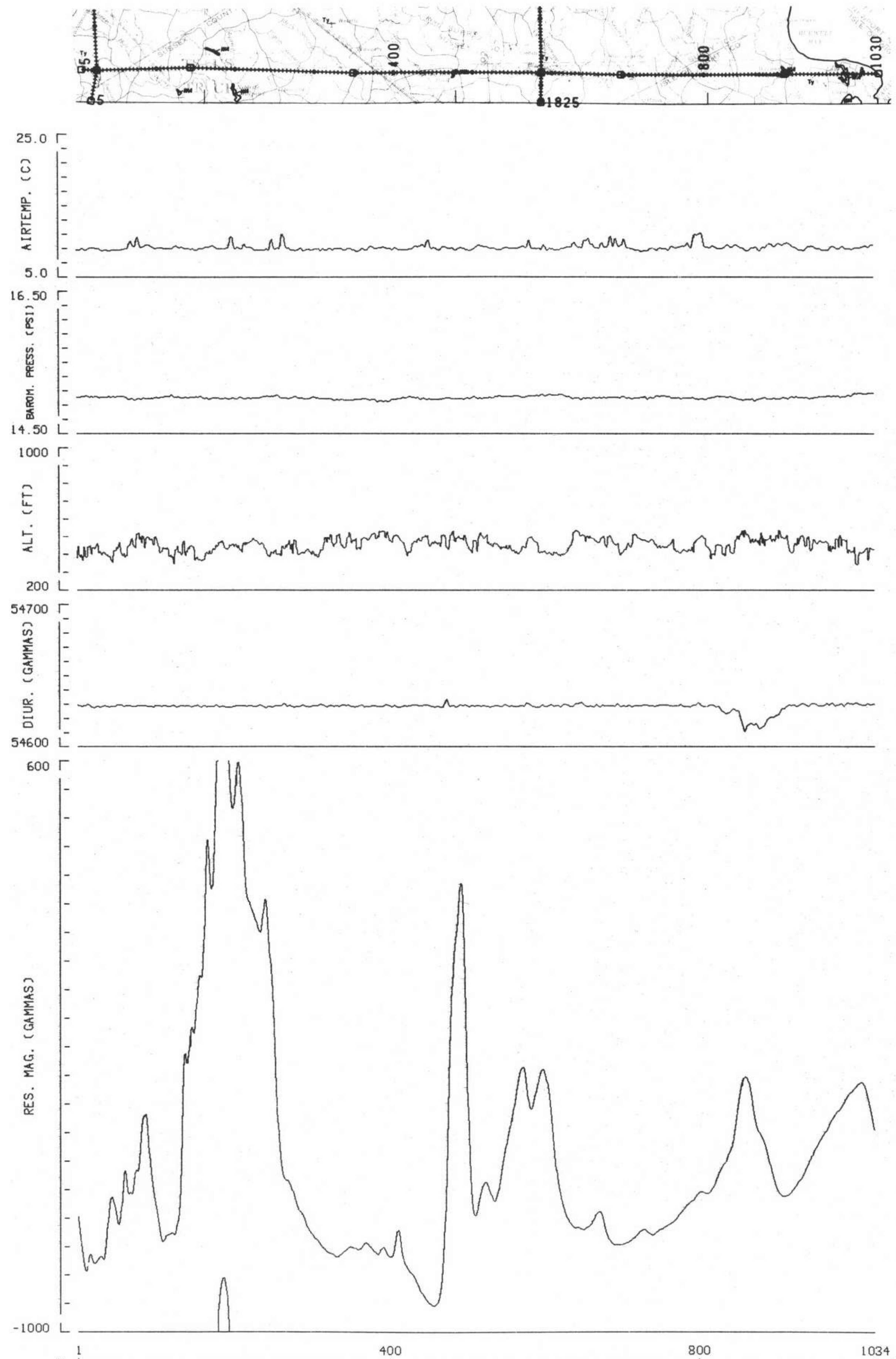
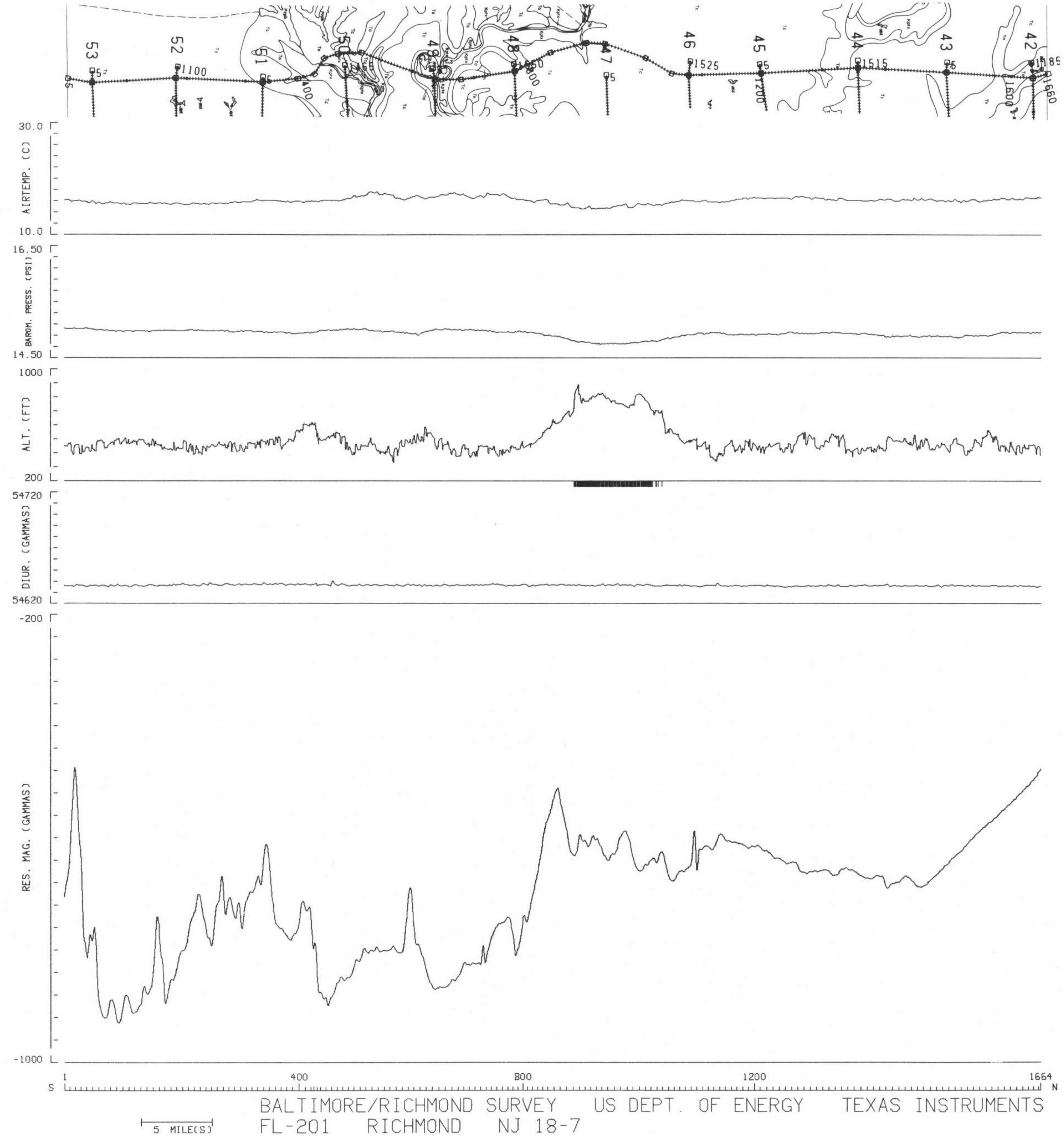
FL-052 RICHMOND NJ 18-7



BALTIMORE/RICHMOND SURVEY US DEPT. OF ENERGY TEXAS INSTRUMENTS

5 MILE(S)

FL-053 RICHMOND NJ 18-7



AIRTEMP. (C)
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10.0
BAROM. PRESS. (PSI)
16.50
14.50
ALT. (FT)
1000
200
DIUR. (GAMMAS)
54720
54620
RES. MAG. (GAMMAS)
-200
-1000
S
1
400
800
1200
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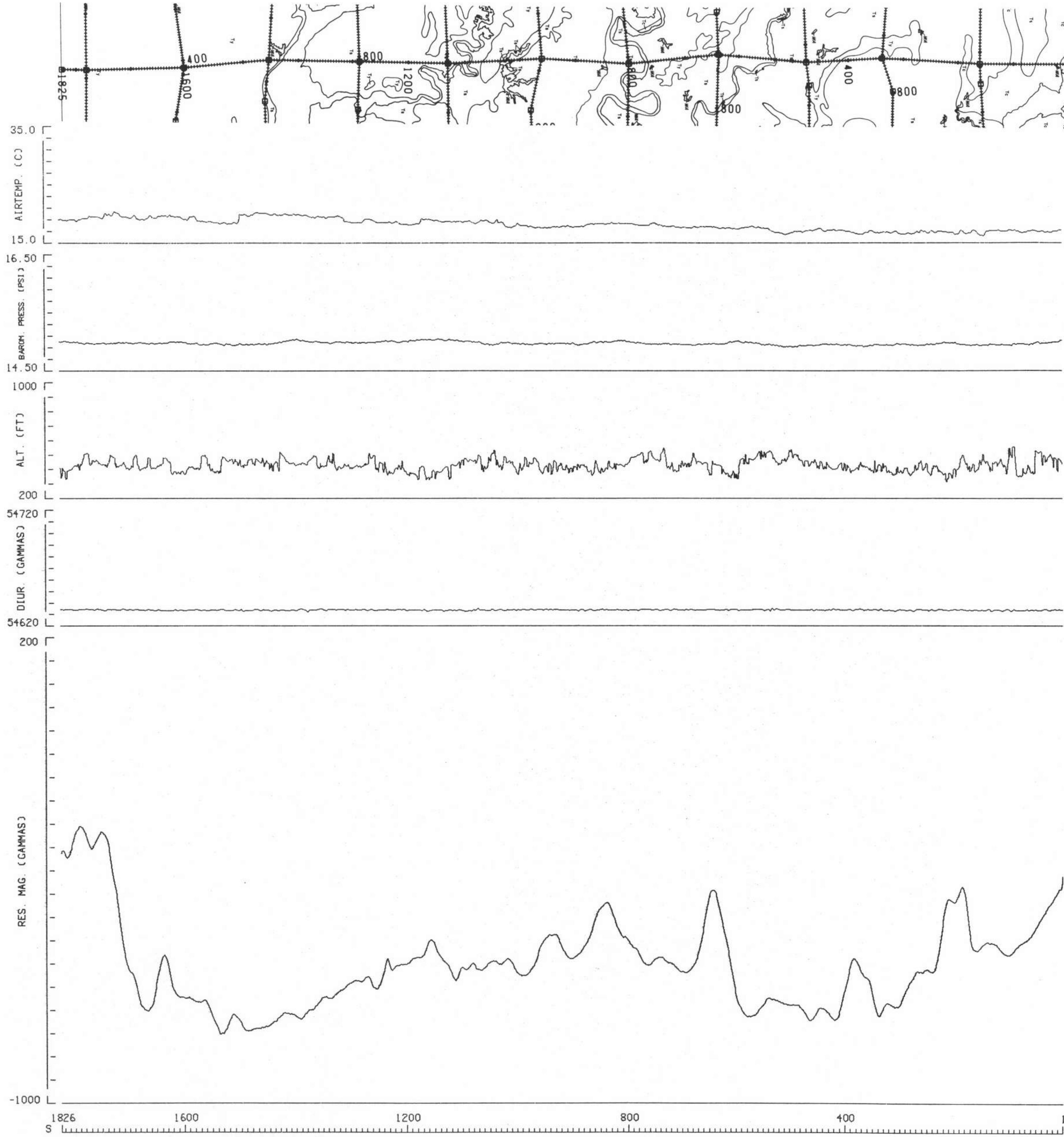
N
BALTIMORE/RICHMOND SURVEY US DEPT. OF ENERGY TEXAS INSTRUMENTS
FL-201 RICHMOND NJ 18-7
5 MILE(S)



BALTIMORE/RICHMOND SURVEY US DEPT. OF ENERGY TEXAS INSTRUMENTS

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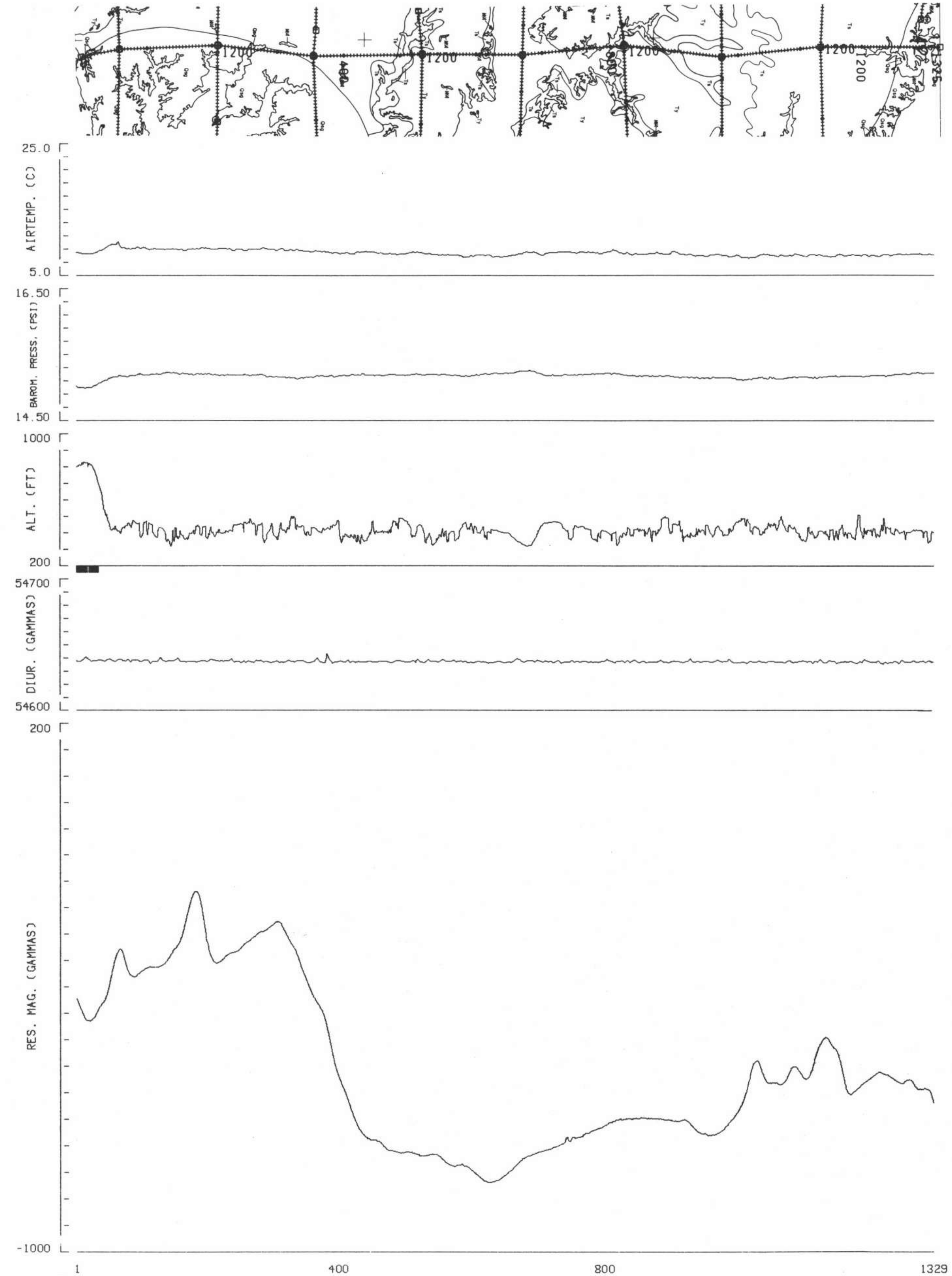


BALTIMORE/RICHMOND SURVEY   US DEPT. OF ENERGY   TEXAS INSTRUMENTS

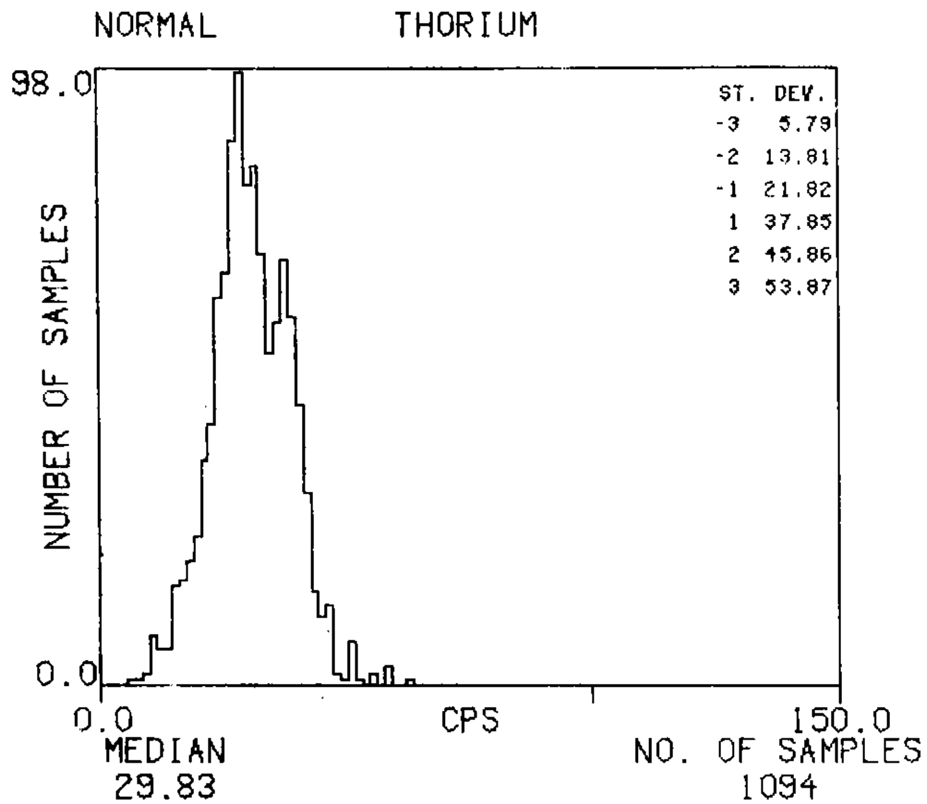
5 MILE(S)   FL-203   RICHMOND   NJ 18-7

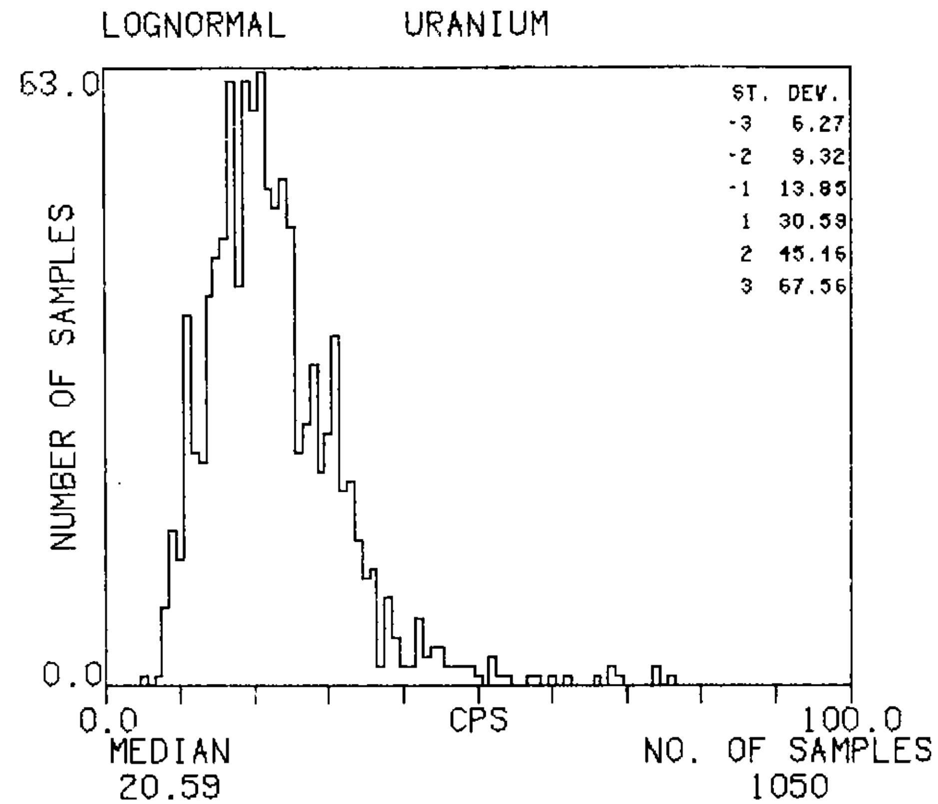
HISTOGRAMS

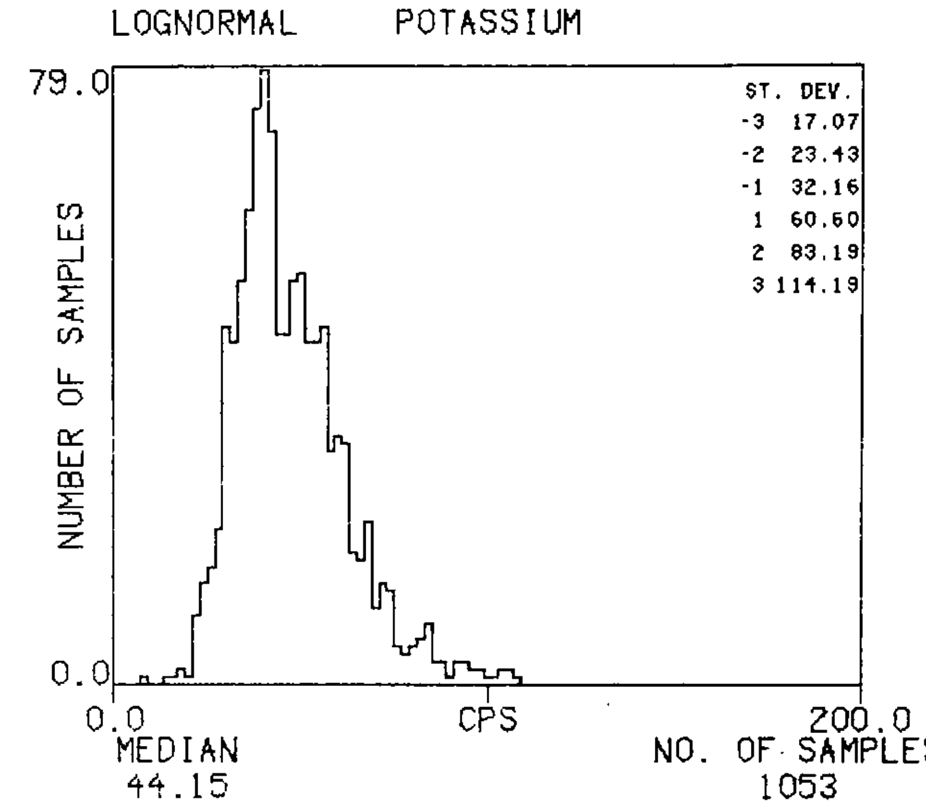
HISTOGRAMS

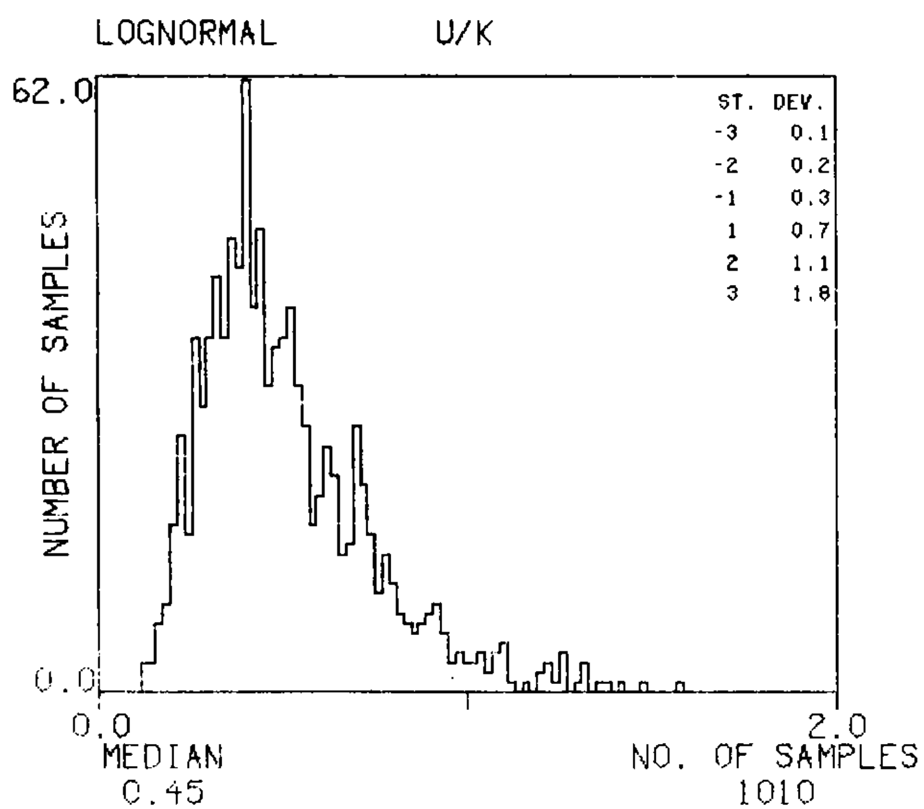
HISTOGRAMS : QSG

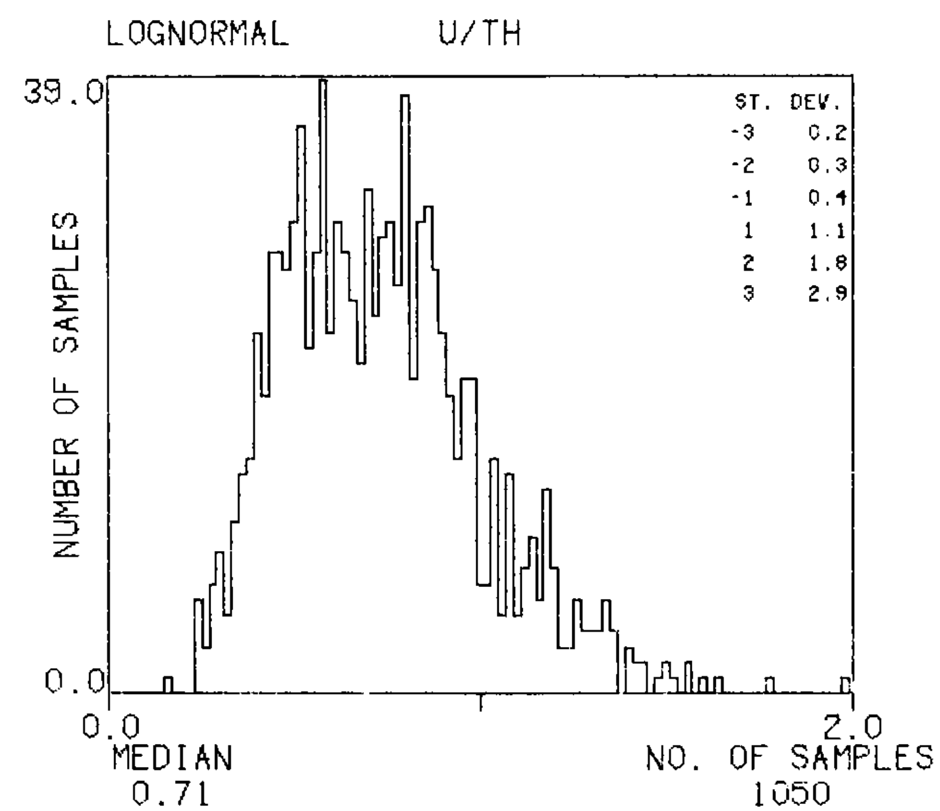
TEXAS INSTRUMENTS INC. RICHMOND NJ18-7 RICH/BALT SURVEY 1977

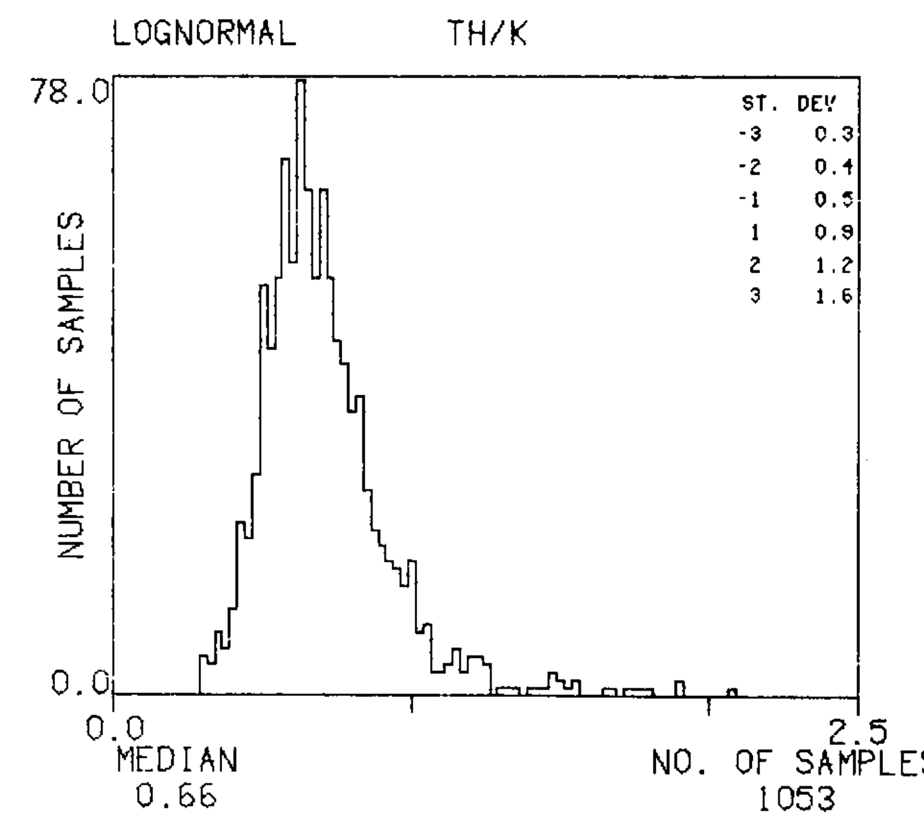












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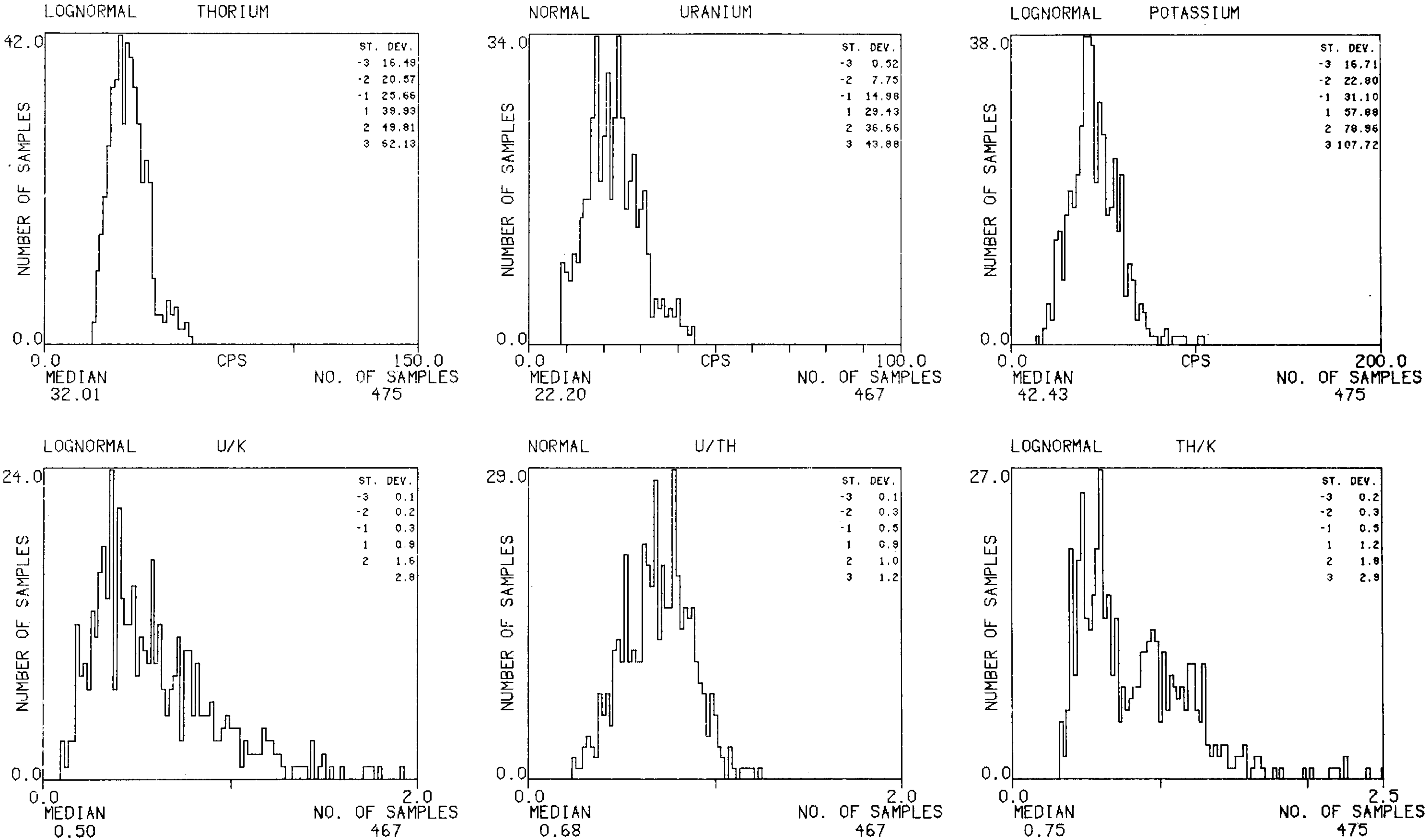

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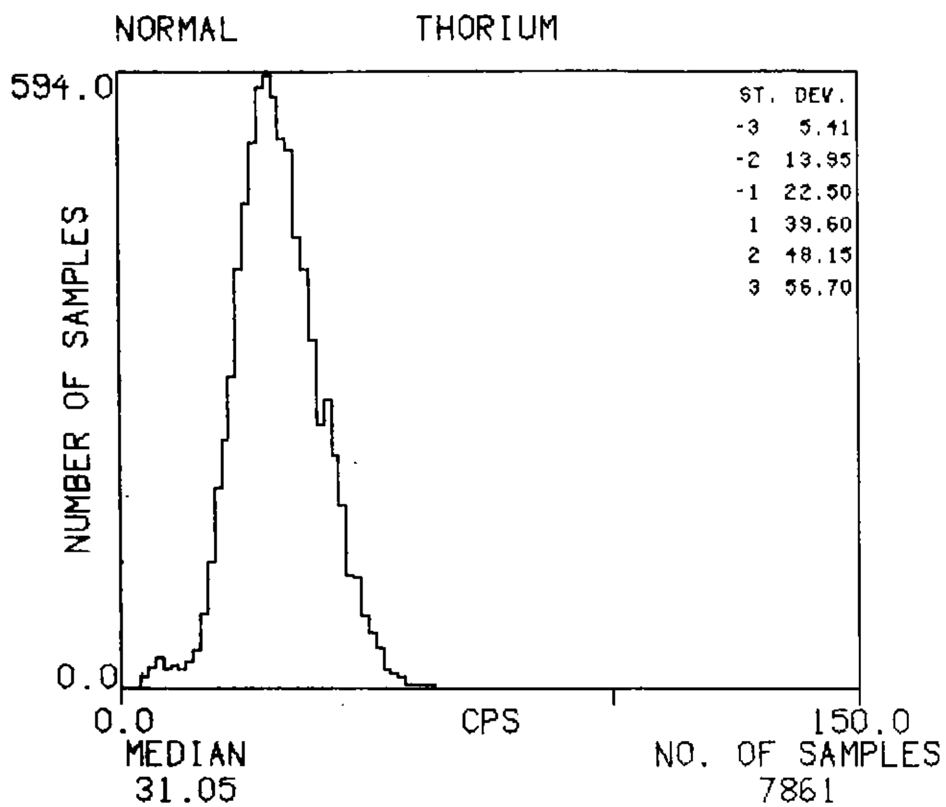

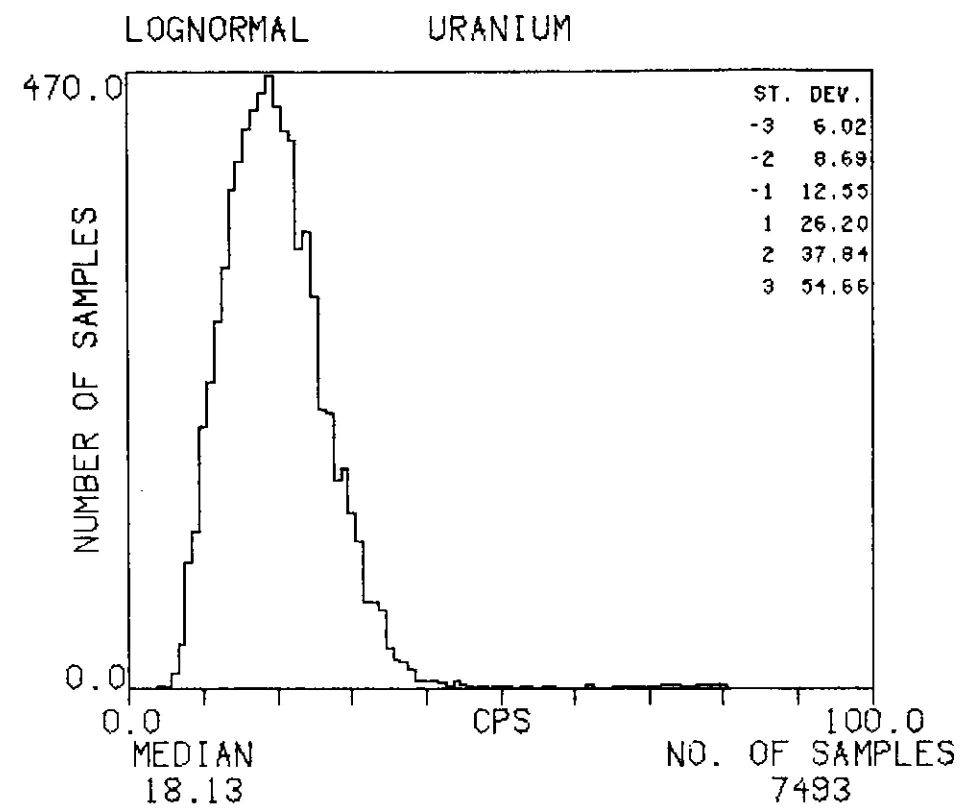

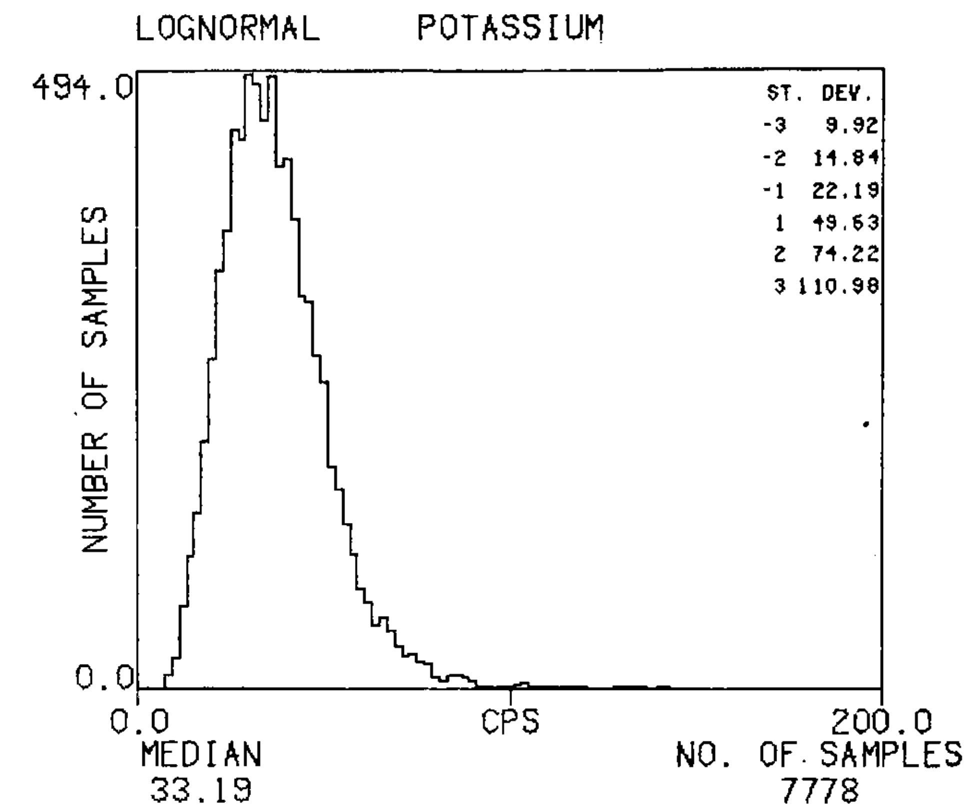

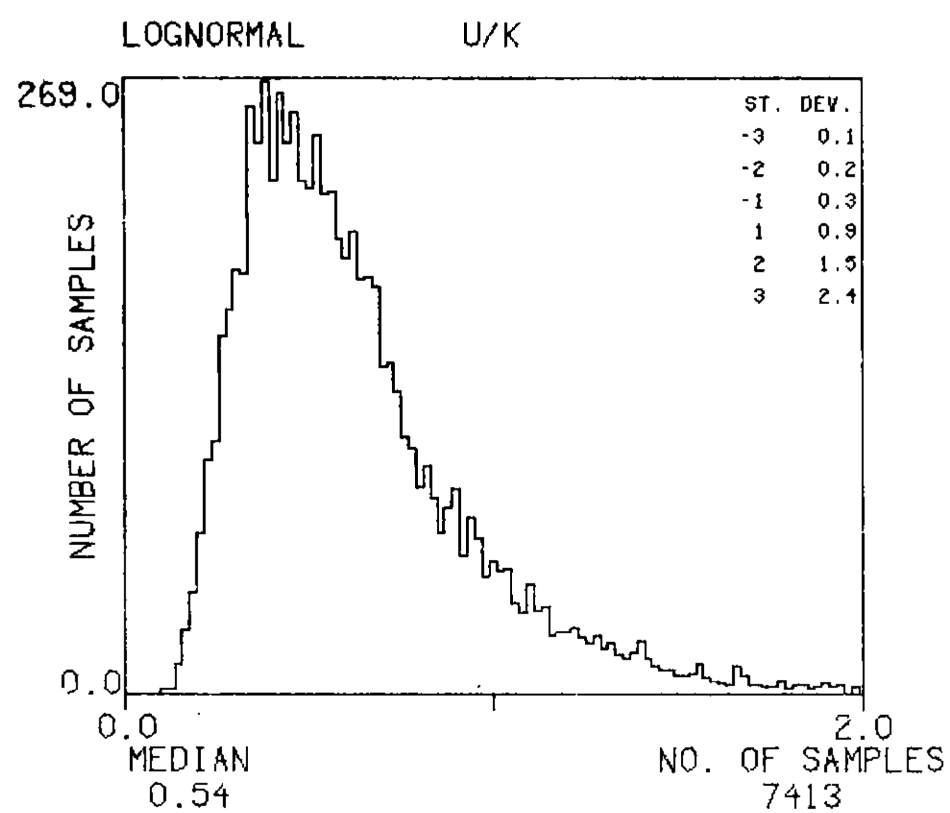

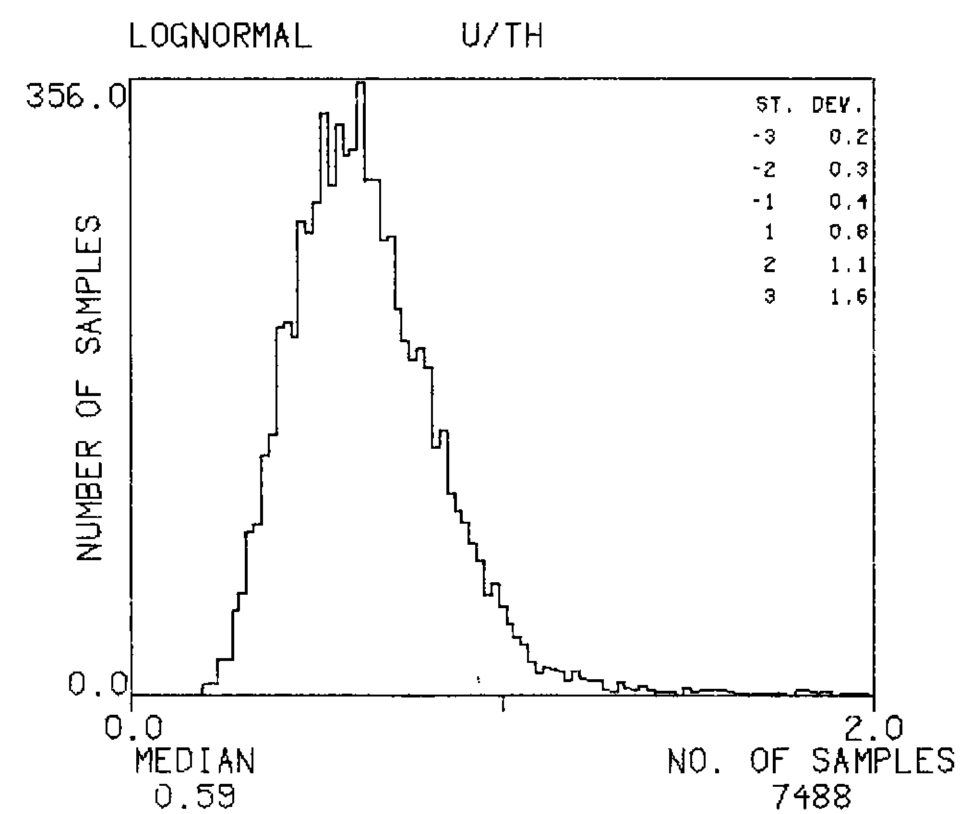

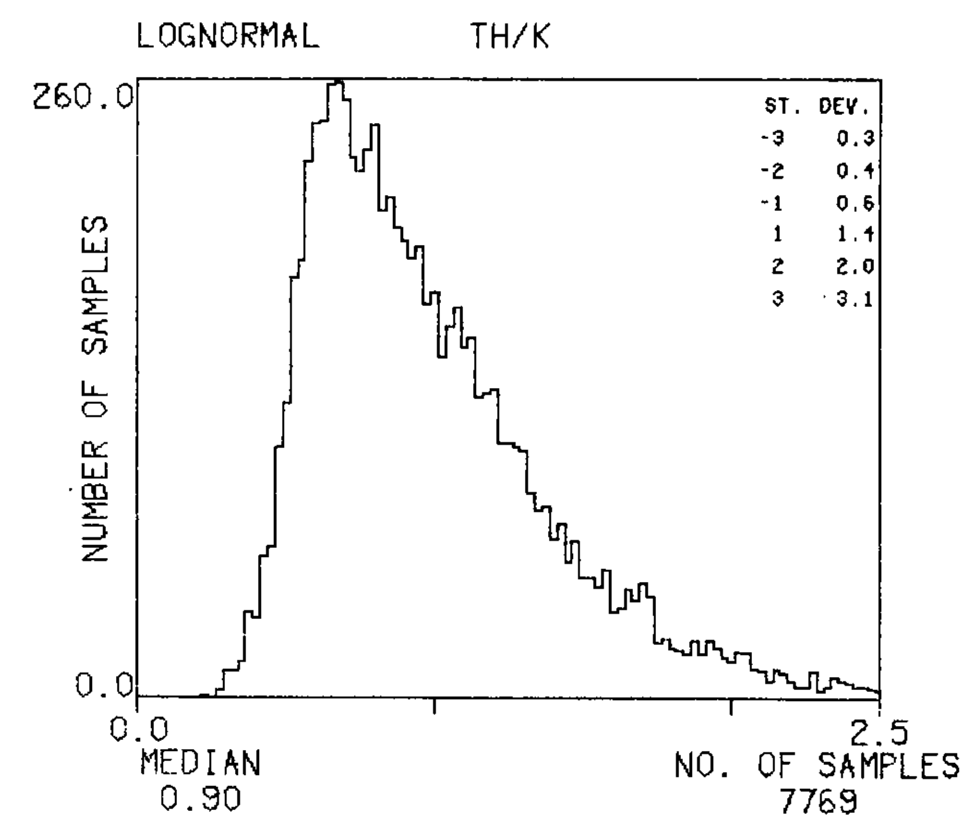

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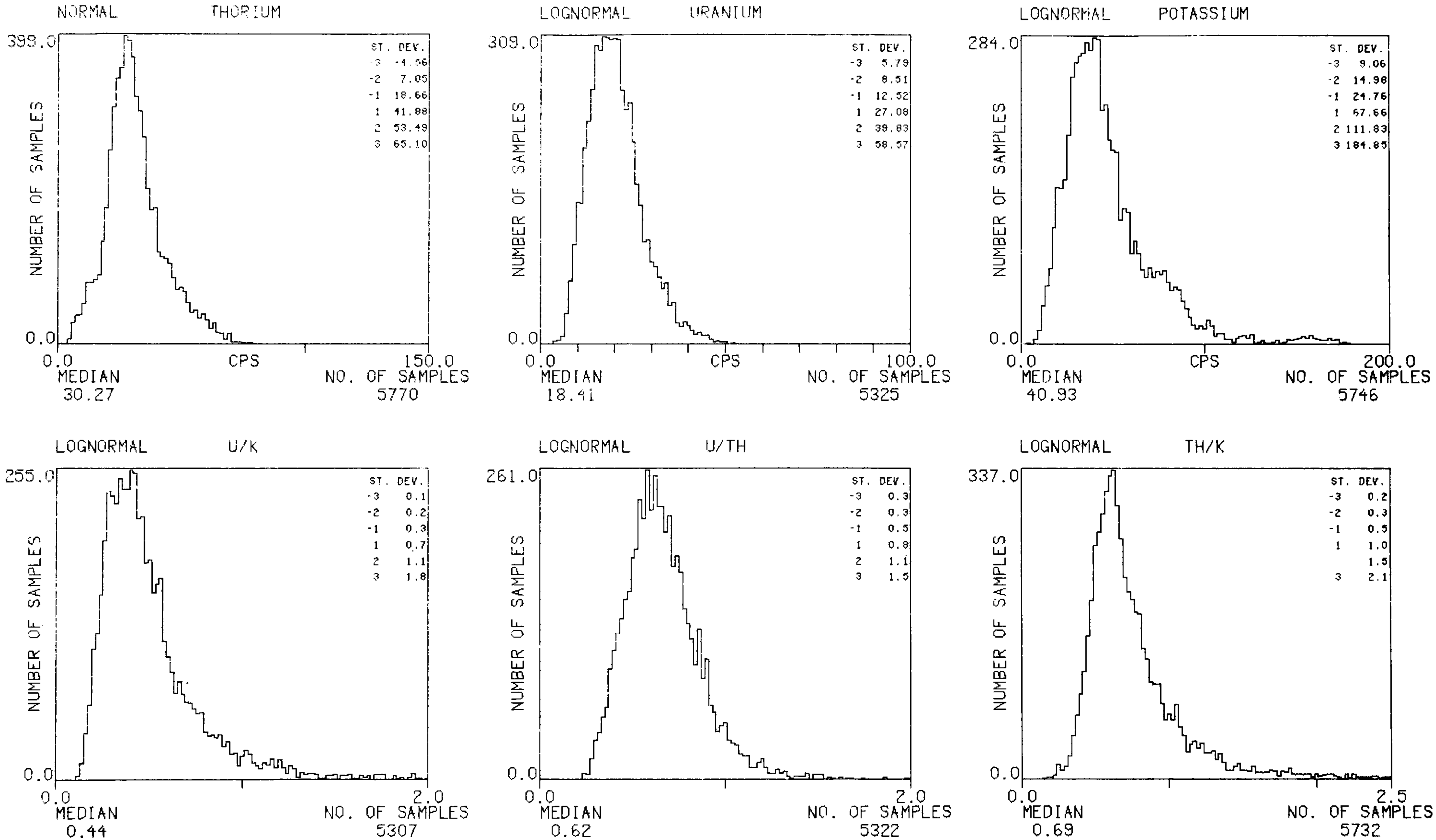

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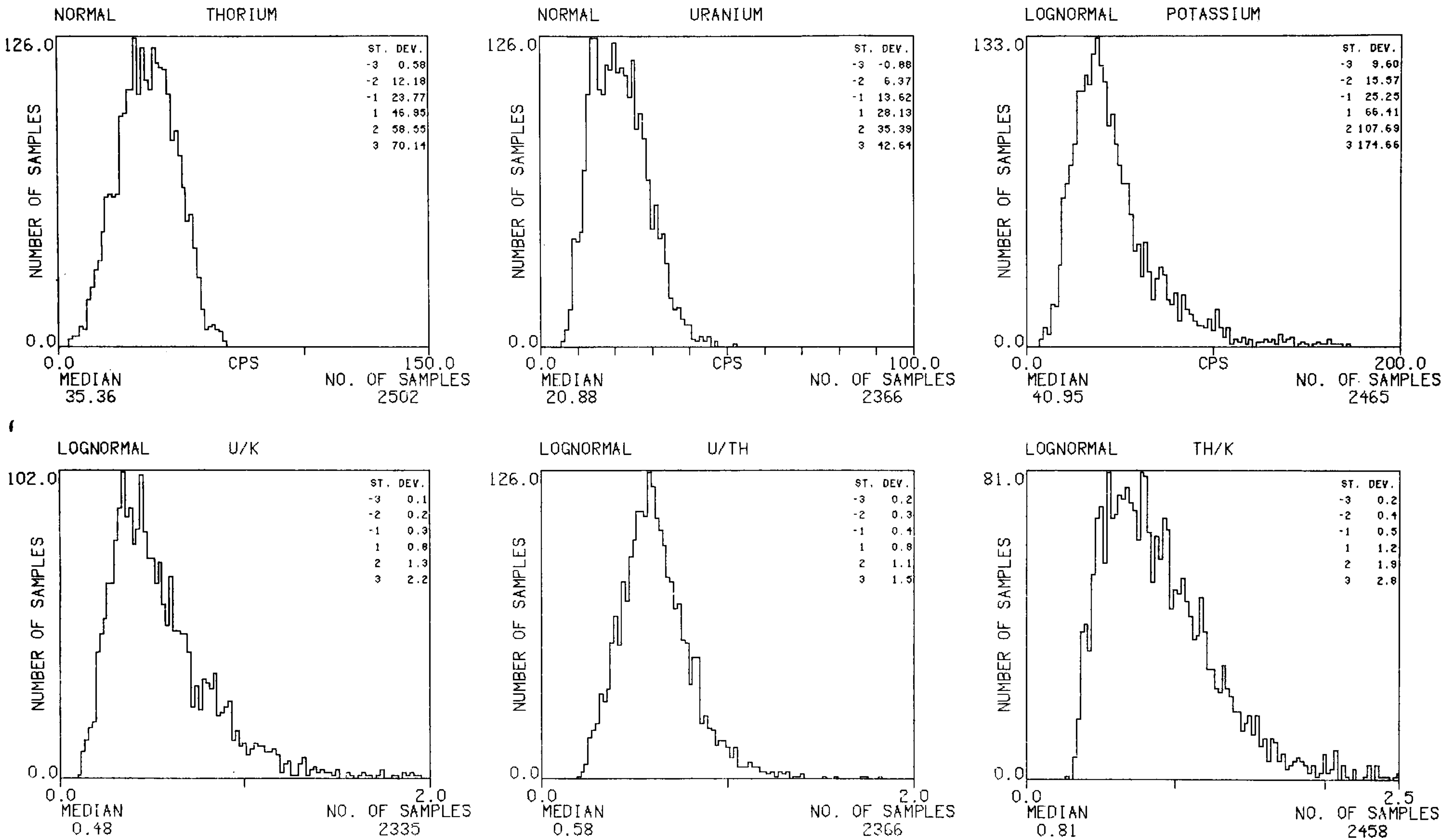

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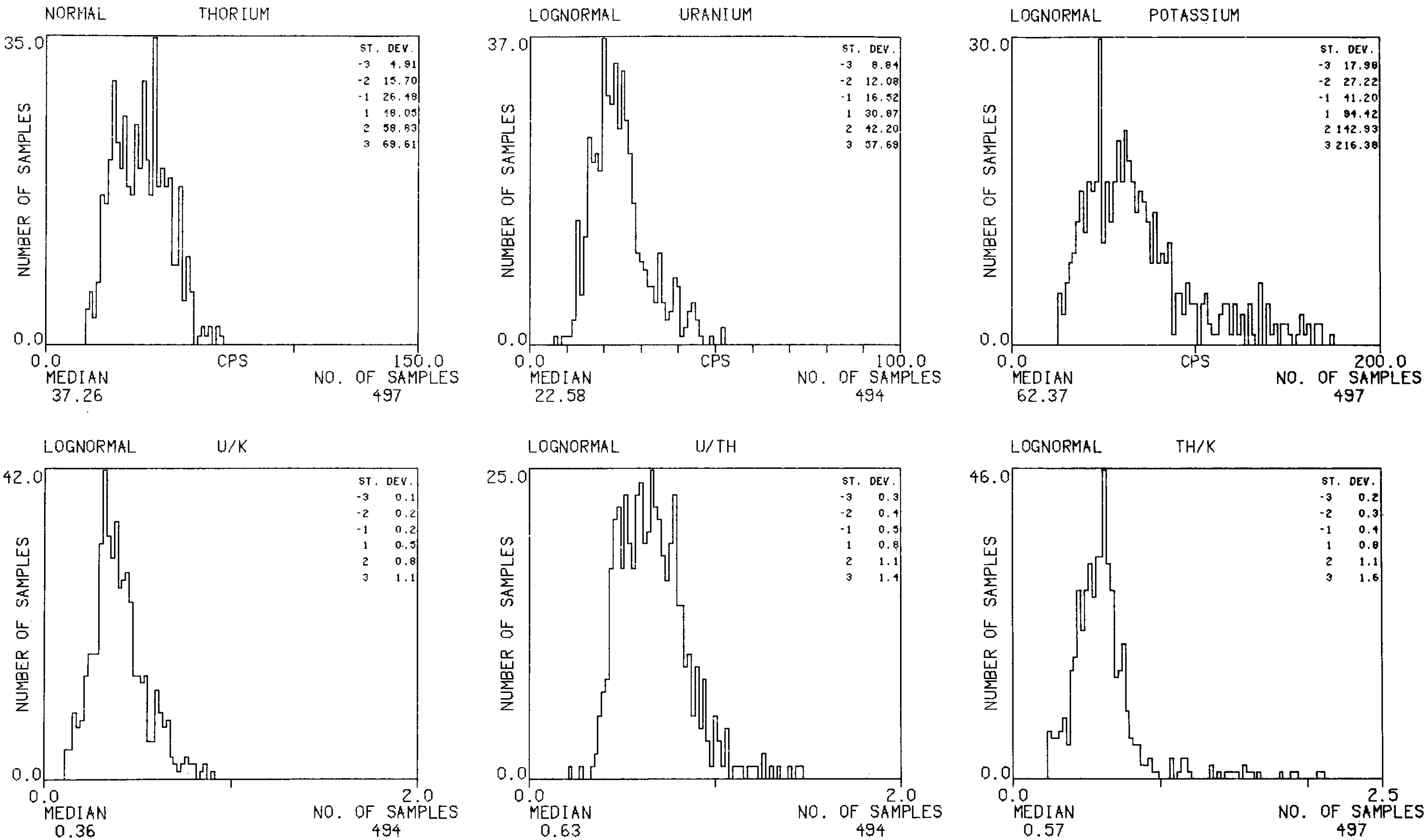

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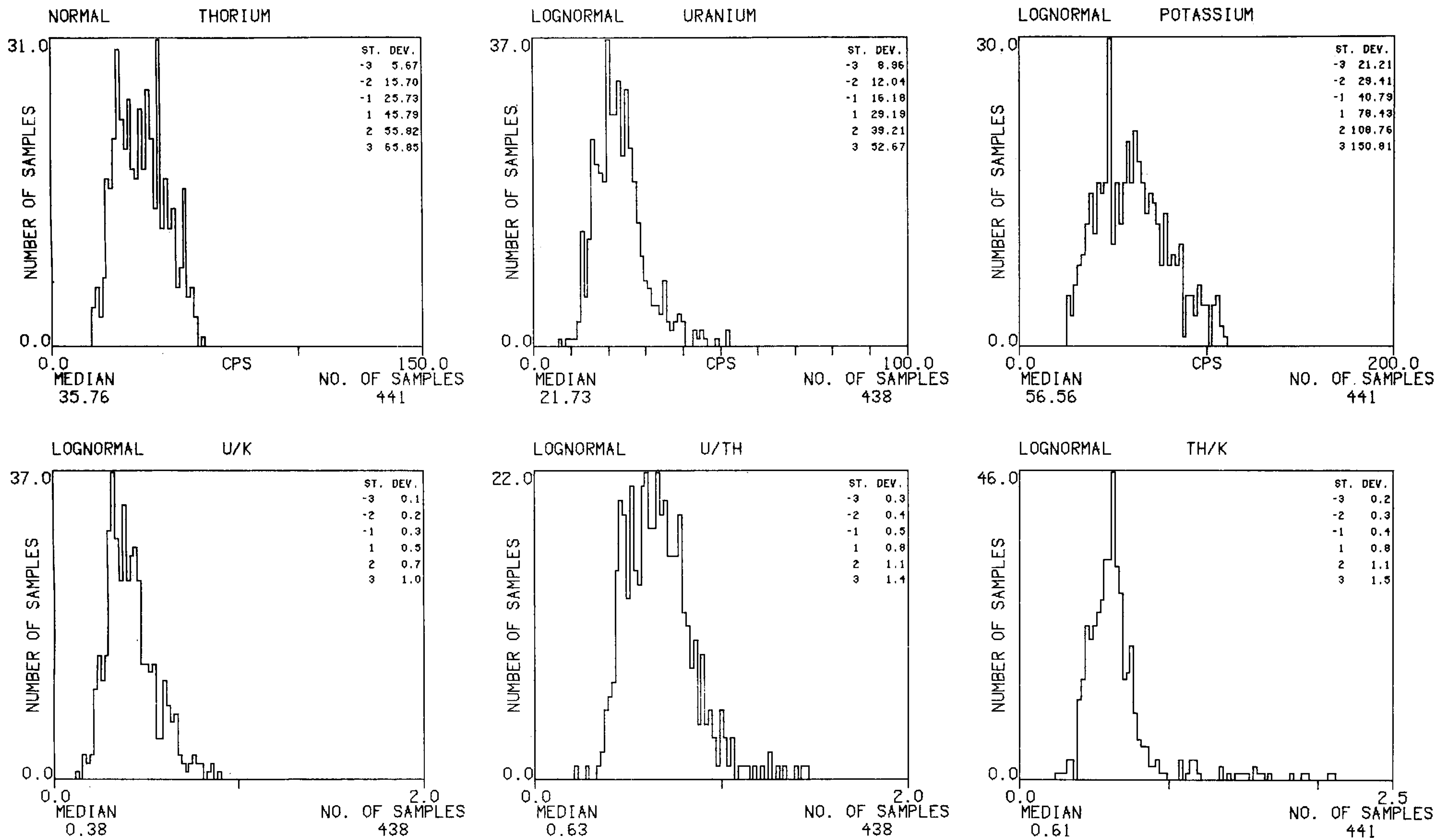

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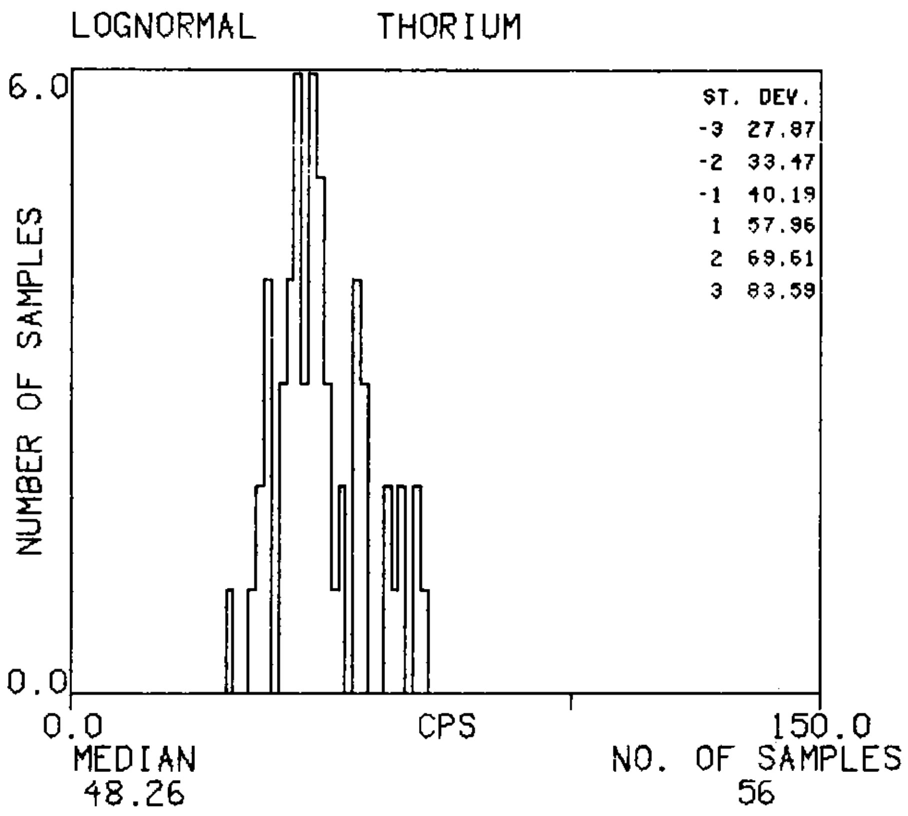

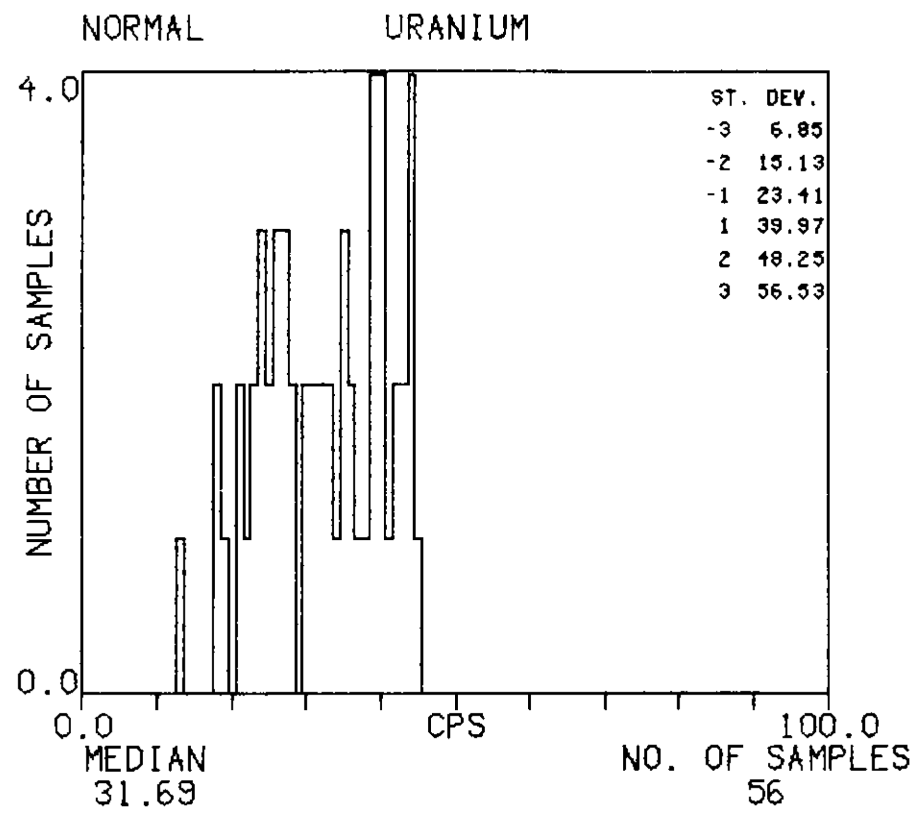

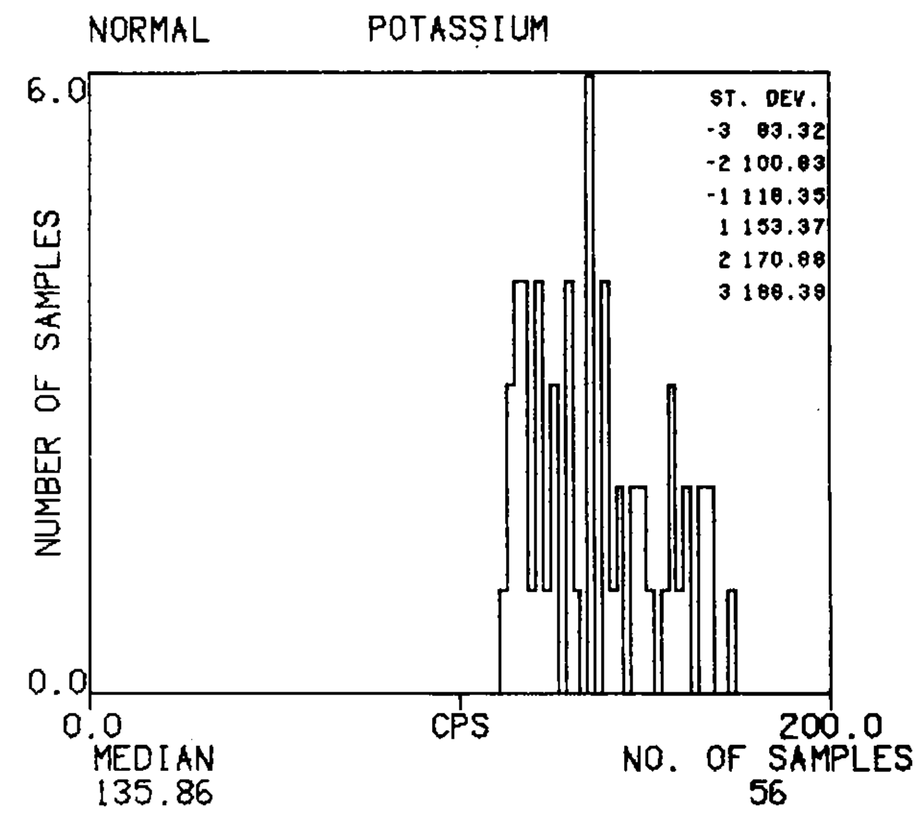

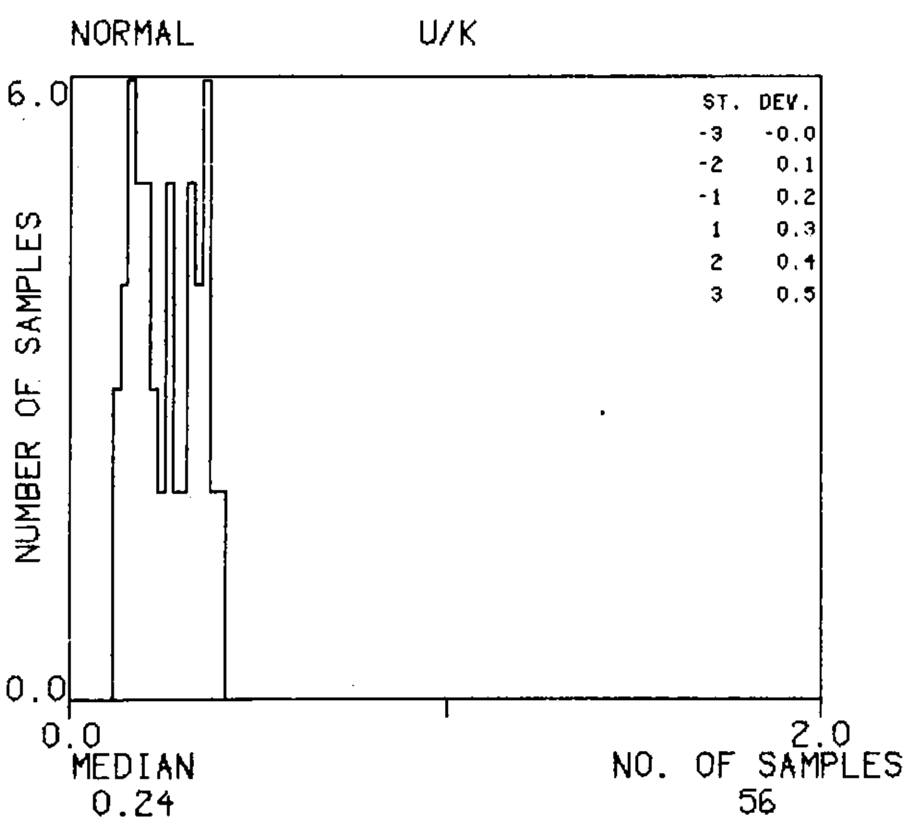

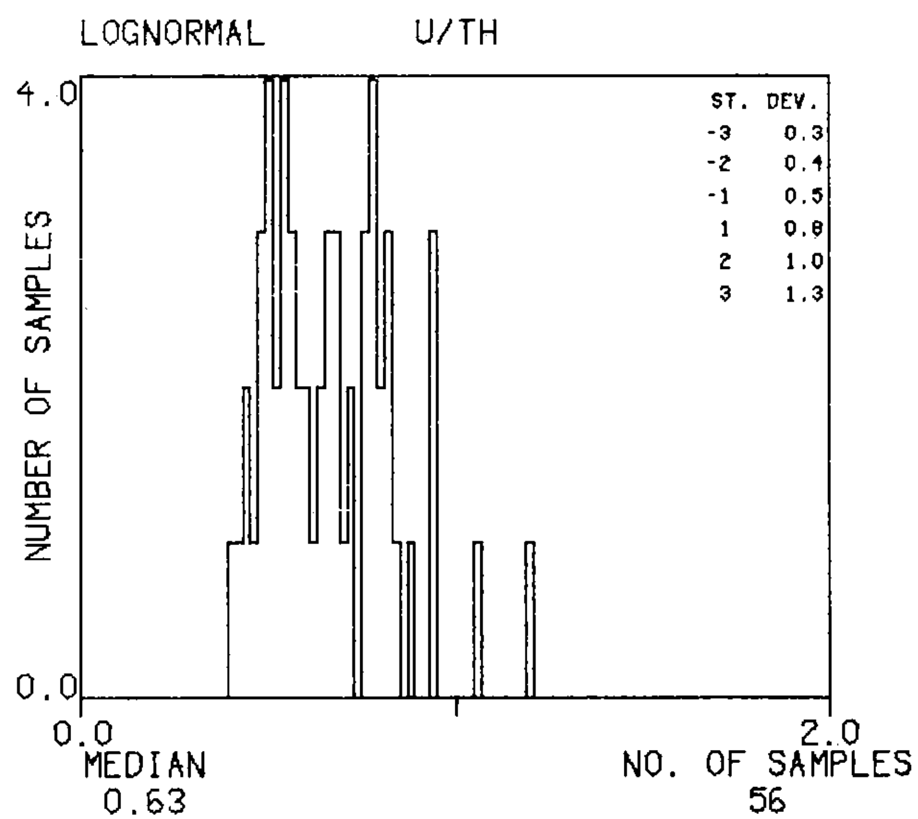

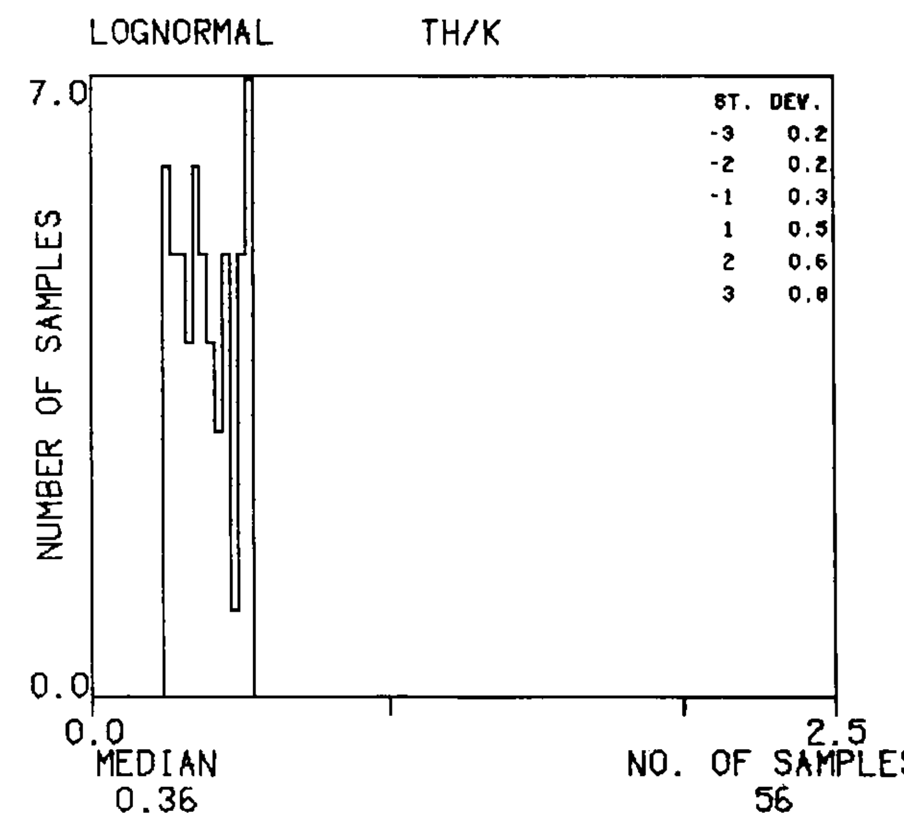

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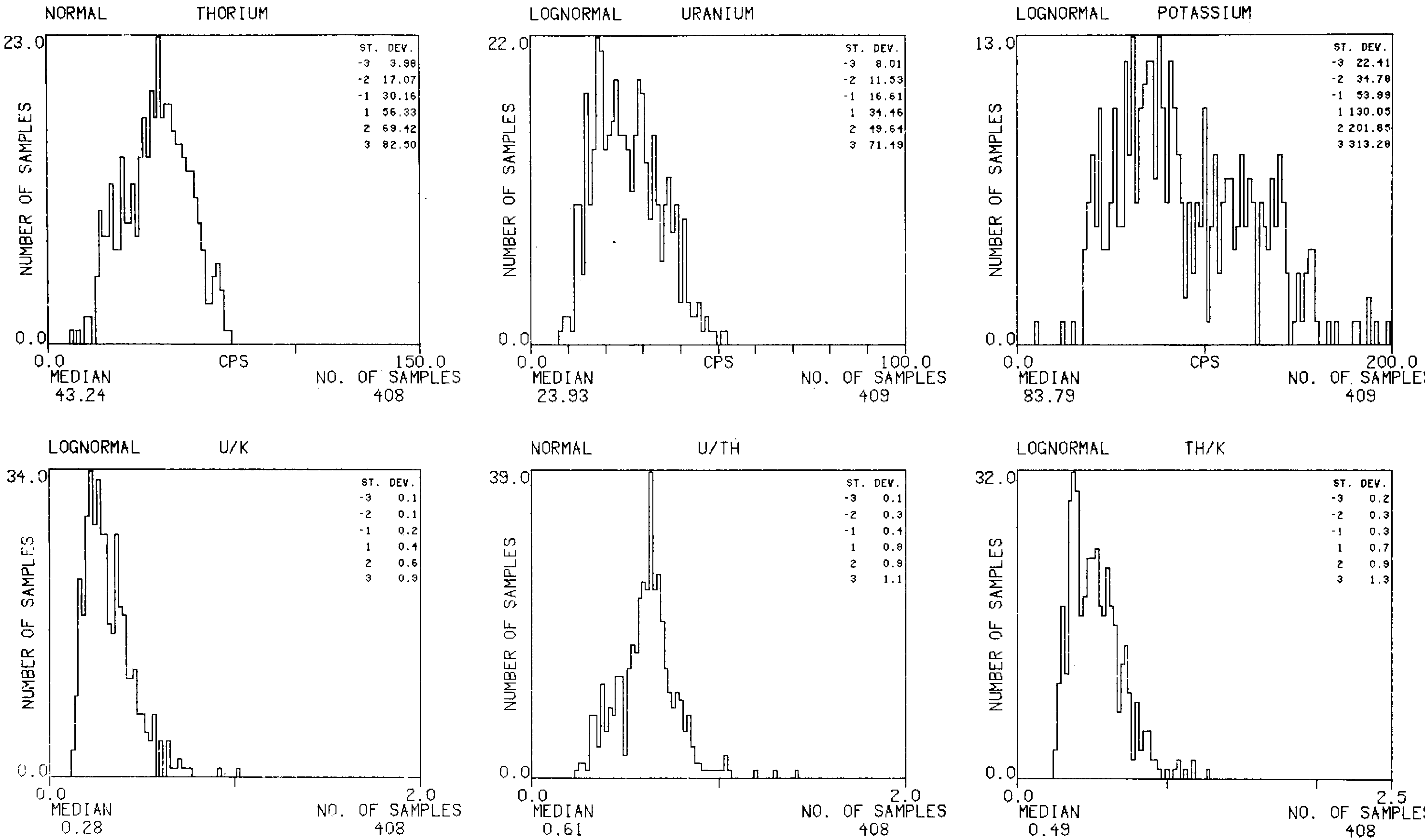

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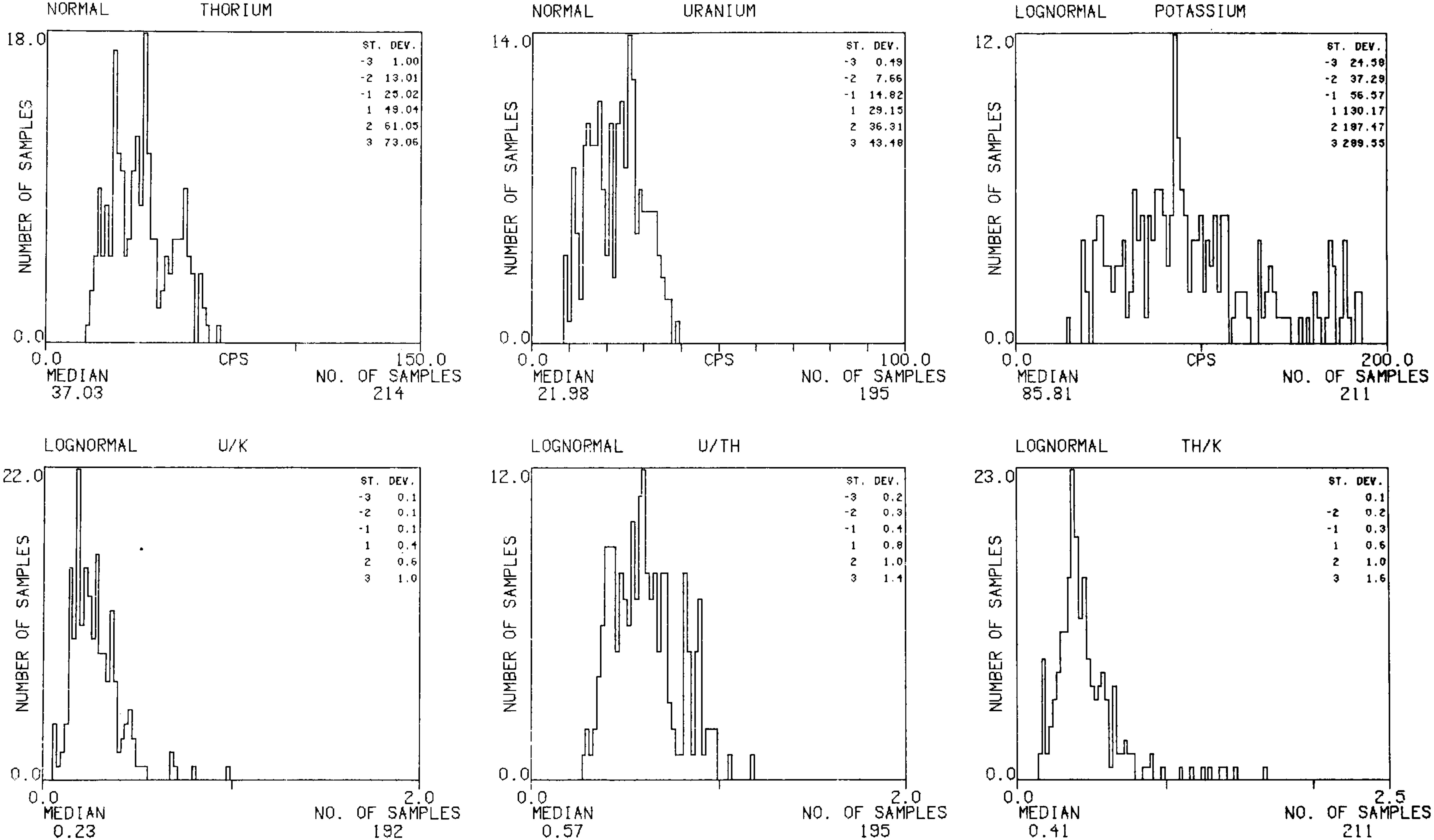

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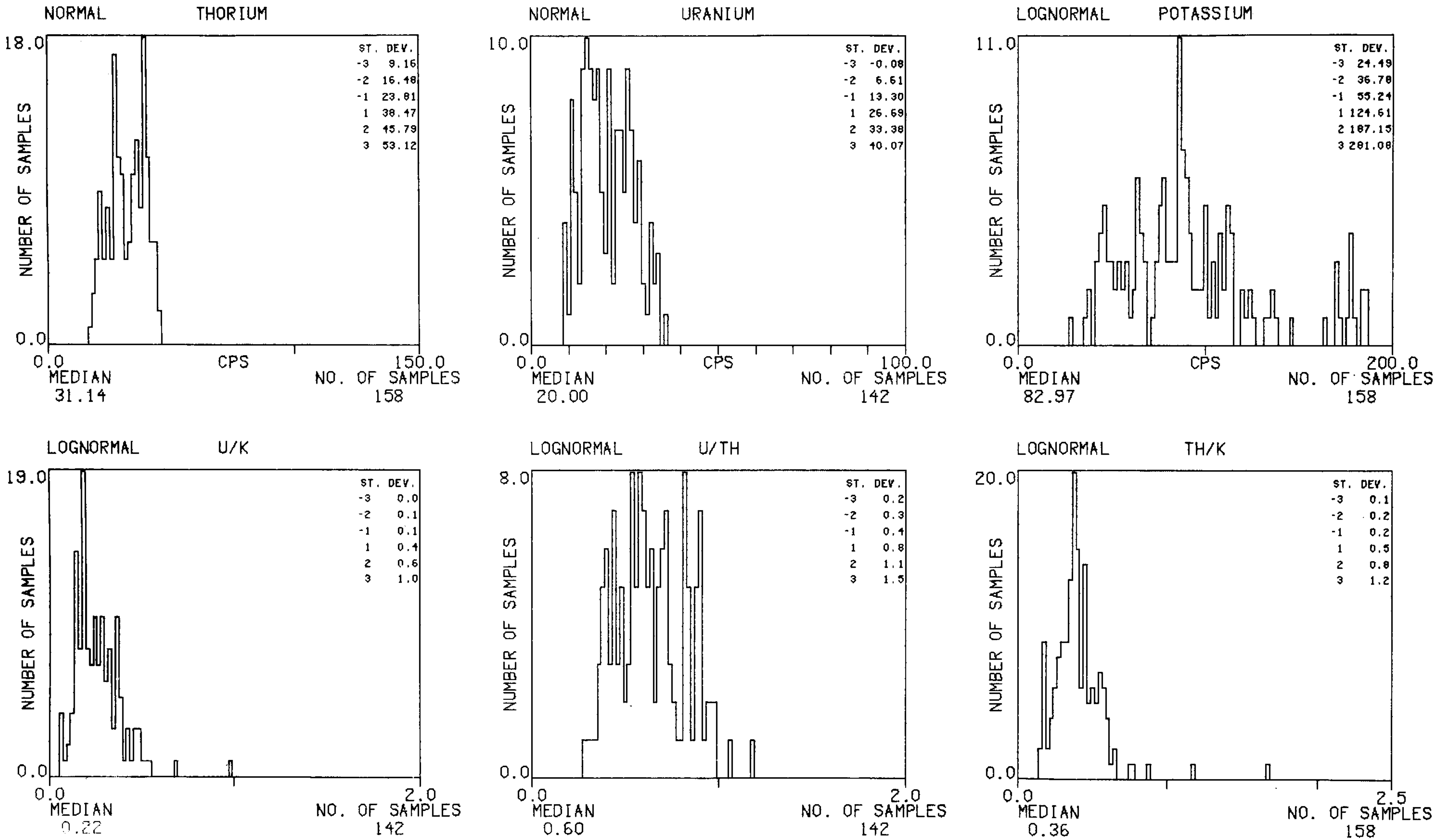

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