AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY OF PORTIONS OF ARKANSAS, ILLINOIS, INDIANA, KENTUCKY, MISSOURI, AND TENNESSEE
DYERSBURG, PADUCAH, POPLAR BLUFF, AND ROLLA QUADRANGLES

FINAL REPORT
Volume 1
and
Volume 2C

POPLAR BLUFF QUADRANGLE

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TABLE OF CONTENTS

Section	Title	Page
	ABSTRACT	i
I	INTRODUCTION	N-1
	A. GENERAL	N-1
	B. URANIUM GEOLOGY AND OCCURRENCES	N-1
	1. Uranium Occurrences	N-1
	2. Geologic Mapping	N-1
	3. Potential Uranium-Bearing Units	N-1
II	RADIOMETRIC DATA INTERPRETATION	N-3
	A. SELECTION OF URANIUM ANOMALIES	N-3
	1. Statistical Considerations	N-3
	2. Uranium Anomalies	N-3
	B. DATA TABLES AND HISTOGRAMS	N-6
	1. General	N-6
	2. Statistical Summary Tables	N-6
	3. Flight-Line Averages	N-6
	4. Histograms	N-6
	C. MAPS AND PROFILES	N-7
	1. General	N-7
	2. Profile Maps	N-7
	3. Printer Plot Contour Maps	N-7
	4. Radiometric Stacked Profiles	N-8
	5. Magnetic Stacked Profiles	N-8
	D. CONCLUSIONS	N-8
	1. General	N-8
	2. Suggestions for Further Work	N-9

TABLE OF CONTENTS (CONTD)

Section	Title	Page
III	REFERENCES	N-10
Appendix A	PRODUCTION SUMMARY	N-10
Appendix B	MICROFICHE	
	STATISTICAL SUMMARIES	
	FLIGHT-LINE AVERAGES	
	STATISTICAL ANALYSIS	
	TABLE OF GEOLOGIC UNITS	T-1
	STATISTICAL SUMMARIES	T-2
	FLIGHT-LINE AVERAGES	T-6
	RECORD LOCATIONS AND GEOLOGY	M-1
	eU PROFILE MAP	M-2
	eU/eTh PROFILE MAP	M-3
	eU/K PROFILE MAP	M-4
	eTh PROFILE MAP	M-5
	K PROFILE MAP	M-6
	eTh/K PROFILE MAP	M-7
	PRINTER PLOT CONTOUR MAPS	M-8 through M-14
	RADIOMETRIC PROFILES	P-1 through P-30
	MAGNETIC PROFILES	P-31 through P-60
	SIX-PARAMETER HISTOGRAMS BY GEOLOGIC UNIT	H-1 through H-22

Table 2-3. Preferred eU Anomalies

Anomaly No.	Line No.	Geologic Unit(s)	Highest eU S.F.*	No. of Anomalous Records	Remarks
1	1	Ojc	2.0	4	Possible railroad fill
2	1	Ku	1.5	8	Possible uranium prospect
3	1	Ku	1.5	6	
4	101	Ojc	3.4	4	
5	2	Ojc	1.5	5	
6	2	Ojc	1.5	4	
7	2	Ojc	2.3	5	
8	2	Ojc	2.3	5	
9	2	Or	2.2	4	
10	2	Or/Ojc	3.3	3	
11	2	Or	2.2	11	
12	2	Og	1.8	6	
13	2	Og	1.5	6	
14	101	Ojc	1.6	5	
15	3	Or	2.3	12	
16	4	Or	1.5	6	
17	4	Or	1.5	3	
18	4	Or	2.0	4	
19	4	Or	3.5	7	
20	4	Or	3.6	3	
21	5	Or	2.0	6	
22	6	Or/Og	2.5	4	Possible uranium prospect
23	106	Q	1.5	11	Possible railroad fill
24	7	Ojc/Or	1.5	5	Possible uranium prospect
25	7	Ojc	1.6	4	Possible highway fill
26	7	Ojc	1.8	6	Possible highway fill
27	8	Ojc/Or	1.7	5	Possible uranium prospect
28	8	Or	1.7	5	Possible uranium prospect
29	101	Ojc	2.0	5	Possible highway fill
30	9	Ojc	2.0	3	Possible uranium prospect
31	9	Ojc	2.4	7	Possible uranium prospect
32	9	Ojc/Or	1.5	2	Possible highway fill
33	9	Q	1.7	12	Possible railroad fill
34	10	Ojc	1.7	6	Possible uranium prospect
35	10	Ojc	1.5	3	Possible uranium prospect
36	10	Ojc/Or	2.0	5	Possible uranium prospect
37	10	Ojc	2.6	6	Possible uranium prospect
38	10	Q	2.2	5	Possible uranium rich quaternary deposits
39	10	Q	3.4	13	Possible highway fill
40	10	Q	2.5	3	Possible highway fill
41	10	Qtc	1.5	3	Possible uranium rich continental deposits
42	11	Ojc	2.2	6	Possible uranium prospect
43	11	Ojc	2.0	4	Possible railroad fill
44	11	Ojc	1.5	8	Possible uranium prospect
45	11	Q	1.5	4	Possible highway fill
46	102	Ojc	2.1	8	Possible uranium prospect
47	13	Ojc	1.5	3	Possible uranium prospect
48	13	Qal/Qt	1.8	9	Possible uranium rich alluvial/terrace deposits
49	15	Qal	2.0	5	Possible uranium rich alluvial deposits
50	15	Qal	1.5	3	Possible uranium rich alluvial deposits
51	15	Qt/Qso	1.5	3	Possible uranium rich terrace/sand dune deposits
52	16	Opw/Ojc	2.6	11	Possible uranium prospect
53	16	Opw/Ojc	1.5	7	Possible uranium prospect
54	16	Qt	2.0	7	Possible uranium rich terrace deposits
55	16	Qt	2.1	5	Possible uranium rich terrace deposits
56	16	Qal/Qt	2.0	4	Possible uranium rich alluvial/terrace deposits
57	16	Qt/Qtc	1.9	13	Possible uranium rich terrace/continental deposits
58	16	Qt/Qtc	3.8	34	Possible uranium rich terrace/continental deposits
59	16	Qt	3.9	36	Possible highway or railroad fill (overflight village)
60	17	Ose/Opw	1.5	7	Possible uranium prospect
61	17	Ose/Opw/Ojc	1.6	8	Possible uranium prospect
62	17	Ojc	2.8	9	Possible uranium prospect
63	17	Ose/Opw/Ojc	1.7	3	Possible uranium prospect
64	17	Ojc	1.5	3	Possible uranium prospect
65	17	Ojc	2.5	3	Possible uranium prospect
66	17	Qt	1.7	3	Possible uranium rich terrace deposits
67	18	Qso	2.2	4	Possible uranium rich sand dune deposits
68	18	Qt	1.5	8	Possible uranium rich terrace deposits
69	18	Qt	2.7	5	Possible uranium rich terrace deposits
70	19	Qal	2.8	10	Possible uranium rich alluvial deposits
71	19	Qt	1.8	8	Possible uranium rich terrace deposits
72	19	Qt	1.6	4	Possible uranium rich terrace deposits
73	20	Ose/Opw	2.0	5	Possible highway fill
74	20	Ose	1.5	3	Possible highway fill
75	23	Ose	1.5	7	Possible uranium prospect
76	23	Qt	1.8	6	Possible railroad fill
77	23	Qt/Qtc	1.5	4	Possible uranium rich terrace/continental deposits

*Significance Factor

○ = First Priority Anomaly

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 are also useful in delineating areas relatively depleted of uranium that was removed by geochemical activity and concentrated in nearby deposits. 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.

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.

B. DATA TABLES AND HISTOGRAMS

1. General

The flight-line numbers in the order they appear on each of the four types of data tapes (see Volume 1 for a description of these tapes) are east-west flights 1 through 23 followed by north-south flights 101 through 107.

Microfiche copies of the single-record and averaged-record data listings are included as an appendix to this volume. 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.

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/K, eU/eTh, and eTh/K as tables and microfiche copies. 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.

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 Poplar Bluff Quadrangle are given as tables and microfiche copies. These may be used to study the variation in gamma-ray parameters within a formation as one crosses the quadrangle from N to S or from E to W.

4. Histograms

Histograms for each radiometric parameter are presented for each geologic unit in the Histograms section. Several histograms showed multimodal distributions that indicated the presence of more than one distinct lithology in that geologic unit. In situations where the multimodal characteristic of a histogram was obvious, the unit was divided into two or more populations by splitting the histogram based on eTh or K but not eU. For example, in the case of Qt (Quaternary terrace Deposits), the eTh histogram could be reasonably split at 5.0 ppm. The distribution of the unsplit unit is shown in H-2, and the distributions after splitting are shown in H-3 and H-5. New means and standard deviations were calculated before computerized geologic analysis of the data. Table 2-5 summarizes all the histograms for the quadrangle. The eU, eTh, and K medians for the resulting subunits are

Table T-1. Geologic Map Units — Poplar Bluff Quadrangle

Computer Symbol	Map Symbol	Description
QUATERNARY		
QAL	Qal	Alluvium: Unconsolidated silt, sand, and gravel limited areally to stream beds and low flood plains.
QT	Qt	Fluviatile Terrace Deposits: Unconsolidated to partially consolidated clay, silt, sand, and gravel forming terraces along streams.
QSO	Qso	Sand Dunes: Sand, fine-to coarse-grained, recognizable dune forms, vegetated as well as mobile.
Q	Q	Quaternary Deposits: Undivided
QUATERNARY — TERTIARY		
QTC	QTc	Continental Deposits: Gravel, sand, silt and clay: gravel, red and brown to yellowish orange and light brownish gray; matrix of fine to coarse quartz sand.
TW	Tw	Wilcox Formation: Sand and clay: sand, yellow to reddish brown, very fine- to coarse-grained, argillaceous; clay, white to yellowish brown to pink, scattered lenses with variable amounts of lignitized plant fragments.
CRETACEOUS		
KU	Ku	Sedimentary Rocks: Undivided
MISSISSIPPIAN		
MBN	Mbn	Boone Formation: Limestone and chert, varying in relative proportions both horizontally and vertically.
ORDOVICIAN		
OPJ	Opj	Plattin Limestone: Limestone, grayish brown to dark brown, dolomitic, cherty in part, argillaceous in part, fine-grained, dense.
		Joachim Dolomite: Limestone and dolomite: limestone, brown to yellow-brown, argillaceous, fine, dense; dolomite, dark brown to grayish brown, argillaceous, fine, crystalline.
OSE	Ose	St. Peters Sandstone: Sandstone, yellow-gray to reddish orange, fine- to coarse-grained, bedding poor.
		Everton Dolomite: Dolomite, yellowish gray to dark brown, sandy, argillaceous, fine- to coarse-grained, massive in part.
OPW	Opw	Powell Dolomite: Dolomite, fine-grained, gray argillaceous, thin beds of shale, sandstone, and sandy dolomite in places.
OJC	Ojc	Cotter Dolomite: Dolomite, gray to buff, fine- to coarse-grained, predominantly cherty, thin- to massive-bedded.
		Jefferson City Dolomite: Dolomite, grayish brown to dark brown, sandy, argillaceous at base, cherty, fine- to sugary-grained.
OR	Or	Roubidoux Formation: Sandstone, yellowish gray, fine- to coarse-grained, massively bedded.
OG	Og	Gasconade Formation: Dolomite, cherty, coarsely crystalline, with a basal sandstone.
CAMBRIAN		
CEP	Ꞓep	Eminence Formation: Dolomite with chert.
		Potosi Formation: Dolomite with chert and druse.

Table T-2. Statistical Summaries

DISTRIBUTION TYPES OF GAMMA-RAY PARAMETERS

GEOL UNIT	TH	U	K	U/K	U/TH	TH/K
QAL	N	N	N	LN	LN	N
QT-1	N	LN	N	LN	LN	LN
QT-2	N	N	N	LN	N	LN
QSO	LN	N	N	LN	LN	LN
Q	N	N	N	N	N	N
QTC	N	N	N	LN	LN	LN
TW	N	N	N	LN	LN	N
KU-1	N	N	N	LN	LN	N
KU-2	N	LN	N	LN	LN	N
MBN	LN	LN	N	N	N	N
OPJ	N	N	LN	LN	LN	LN
OSE-1	N	N	LN	LN	LN	N
OSE-2	N	N	LN	N	N	N
OPW	N	N	LN	LN	LN	N
OJC	LN	N	LN	N	LN	N
OR	LN	N	LN	LN	LN	LN
OG	LN	N	LN	LN	LN	LN
CEP	LN	LN	LN	LN	LN	LN
TG	(LN)	(LN)	(LN)	(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.
QAL	3121.	1.738	3.107	4.475	5.844	7.212	8.581	9.950
QT-1	3024.	2.667	3.183	3.700	4.217	4.733	5.250	5.766
QT-2	8095.	3.694	4.718	5.741	6.765	7.789	8.813	9.837
QSO	1925.	2.987	3.593	4.322	5.199	6.254	7.523	9.049
Q	7460.	2.381	3.797	5.213	6.628	8.044	9.460	10.875
QTC	3137.	2.923	4.297	5.672	7.046	8.421	9.796	11.170
TW	98.	1.540	2.731	3.922	5.114	6.305	7.496	8.687
KU-1	318.	1.801	3.117	4.434	5.751	7.067	8.384	9.701
KU-2	453.	5.295	6.059	6.823	7.587	8.351	9.115	9.879
MBN	38.	1.226	1.735	2.453	3.470	4.907	6.940	9.815
OPJ	94.	1.399	2.460	3.520	4.581	5.641	6.702	7.762
OSE-1	3096.	1.025	1.651	2.277	2.902	3.528	4.153	4.779
OSE-2	2465.	2.656	3.508	4.361	5.213	6.066	6.918	7.771
OPW	3325.	1.511	2.569	3.627	4.685	5.744	6.802	7.860
OJC	23426.	2.480	3.122	3.930	4.947	6.228	7.840	9.869
OR	13602.	1.749	2.393	3.273	4.476	6.123	8.375	11.455
OG	2707.	1.429	1.915	2.566	3.439	4.610	6.178	8.280
CEP	207.	1.507	1.917	2.440	3.106	3.953	5.030	6.402
TG	3.	2.308	2.479	2.663	2.861	3.073	3.302	3.547

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 VALUESARE INDICATORS OF RELATIVE CONCENTRATIONS OF THE ELEMENTS IN THE VARIOUS GEOLOGIC RECK UNITS.

Table T-2. Statistical Summaries (Continued)

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.
QAL	3099.	0.097	0.771	1.444	2.118	2.792	3.466	4.140
QT-1	2932.	0.527	0.759	1.094	1.576	2.270	3.270	4.711
QT-2	8050.	0.292	0.965	1.638	2.311	2.984	3.657	4.329
QSO	1908.	0.285	0.847	1.409	1.971	2.532	3.094	3.656
Q	7424.	0.355	1.029	1.703	2.377	3.051	3.725	4.399
QTC	3134.	0.406	1.076	1.746	2.417	3.087	3.758	4.428
TW	98.	0.210	0.740	1.271	1.801	2.331	2.862	3.392
KU-1	317.	0.501	1.060	1.620	2.179	2.739	3.298	3.858
KU-2	453.	1.447	1.747	2.110	2.549	3.079	3.719	4.491
MBN	36.	0.452	0.642	0.912	1.294	1.837	2.607	3.701
OPJ	90.	-0.086	0.511	1.108	1.706	2.303	2.901	3.498
OSE-1	2891.	0.033	0.488	0.943	1.398	1.852	2.307	2.762
OSE-2	2447.	0.407	0.967	1.526	2.086	2.646	3.205	3.765
OPW	3295.	0.198	0.758	1.319	1.879	2.439	2.999	3.559
OJC	23313.	0.423	1.002	1.581	2.160	2.739	3.317	3.896
OR	13502.	0.312	0.898	1.483	2.069	2.655	3.240	3.826
OG	2613.	0.148	0.708	1.269	1.829	2.390	2.950	3.511
CEP	183.	0.466	0.693	1.029	1.528	2.270	3.372	5.008
TG	3.	0.516	0.594	0.684	0.788	0.907	1.045	1.204

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 VALUESARE INDICATORS OF RELATIVE CONCENTRATIONS OF THE ELEMENTS IN THE VARIOUS GEOLOGIC RECK 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.
QAL	3122.	0.191	0.422	0.653	0.884	1.115	1.346	1.577
QT-1	3024.	0.453	0.690	0.927	1.164	1.402	1.639	1.876
QT-2	8095.	0.474	0.688	0.903	1.118	1.333	1.547	1.762
QSO	1925.	0.664	0.850	1.035	1.221	1.407	1.592	1.778
Q	7455.	0.476	0.673	0.869	1.066	1.263	1.460	1.657
QTC	3137.	0.417	0.632	0.847	1.062	1.278	1.493	1.708
TW	98.	0.102	0.322	0.541	0.760	0.979	1.199	1.418
KU-1	318.	0.192	0.343	0.494	0.646	0.797	0.949	1.100
KU-2	453.	0.836	0.934	1.033	1.132	1.231	1.330	1.429
MBN	38.	0.153	0.223	0.293	0.363	0.433	0.504	0.574
OPJ	94.	0.180	0.232	0.301	0.389	0.504	0.652	0.844
OSE-1	3096.	0.126	0.172	0.235	0.322	0.441	0.604	0.827
OSE-2	2465.	0.200	0.274	0.375	0.513	0.703	0.963	1.319
OPW	3325.	0.183	0.273	0.407	0.607	0.905	1.350	2.014
OJC	23426.	0.210	0.289	0.399	0.551	0.761	1.050	1.449
OR	13602.	0.137	0.203	0.299	0.441	0.652	0.962	1.420
OG	2702.	0.111	0.162	0.235	0.342	0.497	0.722	1.050
CEP	207.	0.122	0.167	0.230	0.315	0.432	0.592	0.812
TG	3.	0.250	0.280	0.314	0.351	0.393	0.440	0.493

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 VALUESARE INDICATORS OF RELATIVE CONCENTRATIONS OF THE ELEMENTS IN THE VARIOUS GEOLOGIC RECK UNITS.

Table T-2. Statistical Summaries (Continued)

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.
QAL	3099.	0.787	1.132	1.628	2.341	3.367	4.843	6.966
QT-1	2932.	0.351	0.556	0.880	1.392	2.202	3.485	5.513
QT-2	8050.	0.630	0.928	1.366	2.012	2.962	4.362	6.423
QSO	1908.	0.538	0.767	1.094	1.561	2.227	3.177	4.532
Q	7418.	-0.295	0.580	1.455	2.331	3.206	4.082	4.957
QTC	3134.	0.964	1.276	1.689	2.236	2.959	3.917	5.186
TW	98.	1.042	1.364	1.785	2.336	3.056	3.999	5.233
KU-1	317.	1.411	1.881	2.509	3.345	4.460	5.946	7.928
KU-2	453.	1.227	1.504	1.844	2.260	2.770	3.395	4.161
MBN	36.	1.131	1.981	2.831	3.681	4.531	5.381	6.231
OPJ	90.	1.097	1.706	2.651	4.121	6.406	9.958	15.478
OSE-1	2891.	1.087	1.690	2.628	4.087	6.357	9.886	15.374
OSE-2	2447.	-0.793	0.888	2.570	4.252	5.934	7.615	9.297
OPW	3295.	0.650	1.078	1.787	2.962	4.910	8.139	13.491
OJC	23313.	-0.892	0.771	2.433	4.096	5.759	7.421	9.084
OR	13502.	1.357	2.021	3.012	4.487	6.686	9.962	14.844
OG	2610.	1.339	2.086	3.251	5.067	7.897	12.308	19.182
CEP	183.	1.154	1.881	3.066	4.997	8.145	13.275	21.638
TG	3.	2.015	2.088	2.165	2.244	2.325	2.410	2.498

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 VALUESARE INDICATORS OF RELATIVE CONCENTRATIONS OF THE ELEMENTS IN THE VARIOUS GEOLOGIC RECK UNITS.

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.
QAL	3099.	0.146	0.195	0.262	0.352	0.472	0.633	0.849
QT-1	2932.	0.121	0.176	0.257	0.376	0.549	0.801	1.170
QT-2	8050.	0.057	0.153	0.248	0.343	0.439	0.534	0.630
QSO	1908.	0.145	0.197	0.267	0.362	0.490	0.664	0.901
Q	7423.	0.081	0.175	0.269	0.364	0.458	0.552	0.646
QTC	3134.	0.149	0.196	0.256	0.336	0.440	0.577	0.756
TW	98.	0.143	0.191	0.256	0.342	0.458	0.612	0.819
KU-1	317.	0.178	0.229	0.293	0.375	0.481	0.616	0.789
KU-2	453.	0.182	0.224	0.275	0.338	0.415	0.510	0.627
MBN	36.	0.119	0.204	0.288	0.373	0.457	0.541	0.626
OPJ	90.	0.111	0.164	0.242	0.359	0.531	0.785	1.162
OSE-1	2890.	0.151	0.220	0.318	0.462	0.670	0.972	1.410
OSE-2	2447.	0.092	0.196	0.300	0.403	0.507	0.611	0.714
OPW	3295.	0.149	0.206	0.284	0.392	0.542	0.748	1.033
OJC	23313.	0.174	0.233	0.313	0.419	0.562	0.752	1.008
OR	13502.	0.174	0.237	0.324	0.442	0.604	0.824	1.125
OG	2612.	0.163	0.237	0.346	0.504	0.735	1.071	1.561
CEP	183.	0.117	0.189	0.306	0.496	0.804	1.302	2.108
TG	3.	0.203	0.225	0.249	0.275	0.305	0.338	0.374

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 VALUESARE INDICATORS OF RELATIVE CONCENTRATIONS OF THE ELEMENTS IN THE VARIOUS GEOLOGIC RECK UNITS.

Table T-2. Statistical Summaries (Continued)

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.
QAL	3121.	2.744	4.093	5.441	6.789	8.137	9.486	10.834
QT-1	3024.	1.576	2.094	2.781	3.695	4.909	6.521	8.663
QT-2	8095.	2.758	3.592	4.678	6.093	7.935	10.334	13.458
QSO	1925.	2.130	2.694	3.409	4.313	5.457	6.903	8.734
Q	7455.	1.650	3.231	4.813	6.394	7.976	9.557	11.139
QTC	3137.	4.704	5.279	5.924	6.648	7.460	8.371	9.394
TW	98.	3.785	4.825	5.865	6.905	7.944	8.984	10.024
KU-1	318.	4.434	5.974	7.514	9.055	10.595	12.135	13.675
KU-2	453.	4.334	5.135	5.937	6.738	7.540	8.342	9.143
MBN	38.	4.258	6.142	8.026	9.910	11.794	13.678	15.561
OPJ	94.	6.983	8.232	9.704	11.439	13.485	15.896	18.739
OSE-1	3095.	1.514	4.053	6.591	9.130	11.669	14.207	16.746
OSE-2	2465.	1.884	4.732	7.580	10.429	13.277	16.125	18.973
OPW	3325.	-0.018	2.651	5.320	7.989	10.659	13.328	15.997
OJC	23426.	0.797	3.673	6.549	9.425	12.301	15.177	18.053
OR	13602.	5.018	6.346	8.027	10.152	12.840	16.240	20.541
OG	2701.	4.647	6.014	7.782	10.071	13.034	16.867	21.828
CEP	207.	4.314	5.683	7.485	9.860	12.989	17.110	22.538
TG	3.	6.677	7.135	7.625	8.148	8.707	9.304	9.942

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 VALUESARE INDICATORS OF RELATIVE CONCENTRATIONS OF THE ELEMENTS IN THE VARIOUS GEOLOGIC RECK UNITS.

Table T-3. Flight-Line Averages

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 1

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
Q	4.7	150.	1.8	150.	0.6	150.	4.45	150.	0.43	150.	9.53	150.
QTC	6.8	6.	2.7	6.	1.0	6.	2.68	6.	0.40	6.	6.78	6.
KU-1	4.2	32.	2.2	32.	0.5	32.	4.73	32.	0.52	32.	9.04	32.
KU-2	7.7	39.	2.9	39.	1.1	39.	2.54	39.	0.38	39.	6.72	39.
OJC	6.2	597.	2.4	597.	0.6	597.	4.47	597.	0.39	597.	11.32	597.
OR	4.5	1145.	1.9	1145.	0.4	1145.	4.52	1145.	0.44	1145.	10.44	1145.
OG	3.7	585.	1.8	585.	0.4	585.	5.51	585.	0.51	585.	10.90	585.
CEP	3.4	90.	1.3	90.	0.3	90.	4.44	90.	0.38	90.	11.12	90.
TG	2.9	3.	0.8	3.	0.4	3.	2.24	3.	0.28	3.	8.16	3.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 2

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
Q	7.0	141.	2.6	141.	1.1	141.	16.09	141.	0.38	141.	20.86	141.
QTC	6.8	61.	2.2	61.	1.0	61.	2.22	61.	0.32	61.	6.86	61.
KU-1	5.5	6.	1.6	6.	0.8	6.	2.12	6.	0.29	6.	7.32	6.
KU-2	7.8	147.	2.6	147.	1.1	147.	2.28	147.	0.33	147.	6.94	147.
OJC	5.3	422.	2.5	422.	0.5	422.	5.60	422.	0.48	422.	11.59	422.
OR	4.3	1502.	2.1	1502.	0.4	1502.	5.67	1502.	0.50	1502.	11.20	1502.
OG	3.2	491.	1.7	491.	0.3	491.	6.47	491.	0.56	491.	11.36	491.
CEP	4.8	10.	1.8	10.	0.5	10.	3.52	10.	0.37	10.	9.25	10.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 3

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
Q	7.3	191.	2.6	191.	1.1	191.	2.29	191.	0.36	191.	6.39	191.
QTC	7.6	12.	2.8	12.	1.1	12.	2.65	12.	0.37	12.	7.11	12.
KU-1	5.2	2.	2.2	2.	0.9	2.	2.51	2.	0.43	2.	5.86	2.
KU-2	7.3	115.	2.6	115.	1.2	115.	2.23	115.	0.37	115.	6.21	115.
OJC	5.7	288.	2.6	288.	0.5	288.	5.58	288.	0.46	288.	12.09	288.
OR	4.6	1760.	2.1	1760.	0.4	1760.	5.30	1760.	0.47	1760.	11.15	1760.
OG	4.0	288.	1.9	288.	0.4	288.	5.29	288.	0.50	288.	10.58	288.
CEP	2.8	20.	1.6	20.	0.4	20.	4.90	20.	0.65	20.	7.40	20.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 4

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
Q	7.2	308.	2.8	308.	1.1	308.	2.57	308.	0.39	308.	6.71	308.
QTC	7.8	84.	2.9	84.	1.1	84.	2.60	84.	0.37	84.	6.98	84.
OJC	5.8	230.	2.5	230.	0.5	230.	5.80	230.	0.45	230.	13.12	230.
OR	4.4	1913.	2.1	1913.	0.4	1913.	5.39	1913.	0.49	1913.	10.96	1913.
OG	3.7	209.	1.8	209.	0.4	209.	5.50	209.	0.53	209.	10.28	209.
CEP	2.8	19.	1.3	19.	0.3	19.	5.28	19.	0.46	19.	11.26	19.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 5

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
Q	7.3	453.	2.4	453.	1.0	453.	2.34	453.	0.33	453.	7.15	453.
OJC	5.5	379.	2.4	379.	0.5	379.	5.46	379.	0.45	379.	12.22	379.
OR	4.7	1651.	2.0	1651.	0.5	1651.	4.85	1651.	0.45	1651.	10.60	1651.
OG	3.5	246.	1.9	246.	0.4	246.	5.83	246.	0.59	246.	10.35	246.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 6

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
Q	7.2	520.	2.5	520.	1.0	520.	2.47	520.	0.36	520.	7.02	520.
QTC	7.6	67.	2.2	67.	1.2	67.	1.88	67.	0.30	67.	6.36	67.
OJC	5.4	739.	2.2	739.	0.5	739.	5.03	739.	0.42	739.	12.07	739.
OR	4.8	1319.	2.1	1319.	0.5	1319.	4.59	1319.	0.45	1319.	10.24	1319.
OG	3.4	304.	1.7	304.	0.4	304.	5.18	304.	0.54	304.	9.77	304.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 7

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
Q	6.7	484.	2.2	484.	1.0	484.	2.29	484.	0.34	484.	6.68	484.
QTC	8.4	71.	2.7	71.	1.2	71.	2.14	71.	0.32	71.	6.76	71.
OJC	5.8	1096.	2.4	1096.	0.5	1096.	4.96	1096.	0.43	1096.	11.66	1096.
OR	4.7	802.	1.9	802.	0.5	802.	4.07	802.	0.42	802.	9.62	802.
OG	3.6	199.	1.6	199.	0.4	199.	4.36	199.	0.48	199.	9.18	199.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 8

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
Q	6.6	702.	2.2	702.	1.1	702.	2.14	702.	0.34	702.	6.33	702.
QTC	6.7	36.	2.5	36.	1.0	36.	2.42	36.	0.37	36.	6.59	36.
OJC	5.7	1533.	2.3	1533.	0.5	1533.	4.75	1533.	0.42	1533.	11.30	1533.
OR	5.2	761.	2.2	761.	0.6	761.	4.22	761.	0.44	761.	9.57	761.
OG	4.0	9.	0.1	9.	0.4	9.	0.29	9.	0.03	9.	9.22	9.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 9

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
Q	6.7	820.	2.5	820.	1.1	820.	2.36	820.	0.38	820.	6.25	820.
QTC	8.8	17.	3.4	17.	1.3	17.	2.53	17.	0.39	17.	6.50	17.
OJC	5.1	1649.	2.3	1649.	0.5	1649.	4.77	1649.	0.46	1649.	10.49	1649.
OR	5.7	381.	2.4	381.	0.7	381.	3.70	381.	0.42	381.	8.79	381.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 10

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
Q	6.5	821.	2.5	821.	1.1	821.	2.38	821.	0.39	821.	6.12	821.
QTC	5.4	45.	2.0	45.	0.8	45.	2.66	45.	0.37	45.	7.34	45.
OJC	4.9	1575.	2.2	1575.	0.5	1575.	4.34	1575.	0.47	1575.	9.28	1575.
OR	5.9	316.	2.4	316.	0.7	316.	3.38	316.	0.41	316.	8.16	316.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 11

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
Q	6.6	875.	2.4	875.	1.1	875.	2.30	875.	0.37	875.	6.22	875.
QTC	7.8	83.	2.7	83.	1.2	83.	2.22	83.	0.35	83.	6.34	83.
OJC	4.9	1685.	2.3	1685.	0.6	1685.	4.34	1685.	0.49	1685.	9.06	1685.
OR	6.3	76.	2.3	76.	0.8	76.	3.19	76.	0.40	76.	8.14	76.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 12

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
Q	6.4	921.	2.2	921.	1.1	921.	2.12	921.	0.35	921.	6.03	921.
QTC	7.8	156.	2.7	156.	1.3	156.	2.19	156.	0.35	156.	6.17	156.
OJC	5.1	1801.	2.2	1801.	0.6	1801.	3.78	1801.	0.43	1801.	8.83	1801.
OR	5.5	4.	2.9	4.	0.6	4.	4.87	4.	0.53	4.	9.16	4.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 13

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
QAL	6.6	196.	2.4	196.	0.8	196.	2.95	196.	0.37	196.	7.94	196.
QT-1	4.1	94.	1.4	94.	1.2	94.	1.17	94.	0.34	94.	3.41	94.
QT-2	6.9	546.	2.4	546.	1.1	546.	2.25	546.	0.35	546.	6.43	546.
QSO	5.5	204.	2.0	204.	1.2	204.	1.61	204.	0.36	204.	4.61	204.
QTC	8.2	98.	2.6	98.	1.2	98.	2.13	98.	0.33	98.	6.59	98.
KU-1	6.6	102.	2.3	102.	0.7	102.	3.26	102.	0.35	102.	9.39	102.
KU-2	6.8	1.	2.1	1.	0.9	1.	2.26	1.	0.30	1.	7.49	1.
OSE-1	3.5	3.	2.5	3.	0.3	3.	8.38	3.	0.74	3.	11.23	3.
OJC	4.7	1576.	2.0	1576.	0.6	1576.	3.84	1576.	0.44	1576.	8.80	1576.

Table T-3. Flight-Line Averages (Continued)

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 14

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
QAL	6.3	256.	2.3	256.	0.9	256.	2.59	256.	0.36	256.	7.18	256.
QT-1	4.5	72.	1.8	72.	1.1	72.	1.83	72.	0.40	72.	4.70	72.
QT-2	6.8	332.	2.4	332.	1.1	332.	2.21	332.	0.35	332.	6.17	332.
QSO	5.5	263.	1.9	263.	1.1	263.	1.72	263.	0.35	263.	4.97	263.
QTC	6.4	211.	2.0	211.	1.0	211.	2.12	211.	0.32	211.	6.74	211.
TW	3.6	8.	0.7	8.	0.5	8.	1.49	8.	0.20	8.	7.54	8.
KU-1	7.4	27.	2.8	27.	0.8	27.	3.36	27.	0.38	27.	9.05	27.
KU-2	7.9	32.	2.9	32.	1.0	32.	2.87	32.	0.36	32.	7.93	32.
OSE-1	2.7	14.	1.2	14.	0.3	14.	4.21	14.	0.44	14.	9.80	14.
OSE-2	5.0	44.	2.2	44.	0.4	44.	6.21	44.	0.46	44.	13.40	44.
OJC	4.8	1513.	1.9	1513.	0.6	1513.	3.43	1513.	0.41	1513.	8.37	1513.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 15

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
QAL	5.9	428.	2.2	428.	0.9	428.	2.61	428.	0.37	428.	6.93	428.
QT-1	4.2	95.	1.8	95.	1.2	95.	1.57	95.	0.42	95.	3.62	95.
QT-2	6.9	452.	2.5	452.	1.1	452.	2.33	452.	0.37	452.	6.33	452.
QSO	5.7	82.	2.0	82.	1.2	82.	1.76	82.	0.36	82.	4.83	82.
QTC	7.0	149.	2.4	149.	1.1	149.	2.26	149.	0.34	149.	6.63	149.
TW	5.9	10.	2.1	10.	1.1	10.	1.83	10.	0.36	10.	5.24	10.
KU-1	5.5	29.	1.9	29.	0.6	29.	3.09	29.	0.36	29.	8.73	29.
KU-2	7.2	5.	2.5	5.	0.9	5.	2.68	5.	0.35	5.	7.56	5.
OSE-1	3.7	25.	1.8	25.	0.4	25.	4.66	25.	0.49	25.	9.49	25.
OSE-2	4.7	53.	2.0	53.	0.4	53.	5.32	53.	0.44	53.	12.21	53.
OPW	4.3	64.	1.9	64.	0.4	64.	5.11	64.	0.45	64.	11.36	64.
OJC	4.6	1344.	1.9	1344.	0.7	1344.	3.30	1344.	0.43	1344.	7.67	1344.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 16

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
QAL	5.5	406.	2.2	406.	0.8	406.	2.73	406.	0.40	406.	6.80	406.
QT-1	3.8	118.	3.3	118.	1.1	118.	2.93	118.	0.85	118.	3.52	118.
QT-2	6.9	490.	2.8	490.	1.1	490.	2.55	490.	0.42	490.	6.23	490.
QSO	5.2	103.	2.1	103.	1.4	103.	1.52	103.	0.40	103.	3.84	103.
QTC	6.6	172.	3.0	172.	1.0	172.	3.18	172.	0.46	172.	6.86	172.
KU-1	4.3	14.	1.8	14.	0.5	14.	4.06	14.	0.44	14.	8.96	14.
KU-2	6.6	1.	2.2	1.	1.0	1.	2.35	1.	0.34	1.	6.97	1.
OSE-1	3.8	4.	1.7	4.	0.4	4.	4.53	4.	0.45	4.	10.11	4.
OSE-2	4.6	48.	2.1	48.	0.4	48.	5.37	48.	0.46	48.	11.61	48.
OPW	4.3	83.	2.3	83.	0.4	83.	5.68	83.	0.53	83.	10.66	83.
OJC	4.5	1418.	1.8	1418.	0.6	1418.	3.38	1418.	0.42	1418.	7.99	1418.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 17

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
QAL	5.8	399.	2.1	399.	0.8	399.	2.77	399.	0.38	399.	7.35	399.
QT-1	4.3	190.	1.5	190.	1.1	190.	1.62	190.	0.36	190.	4.45	190.
QT-2	6.5	576.	2.2	576.	1.1	576.	2.02	576.	0.33	576.	6.16	576.
QTC	6.4	178.	2.3	178.	1.0	178.	2.37	178.	0.36	178.	6.62	178.
TW	5.6	24.	2.1	24.	0.8	24.	2.53	24.	0.38	24.	6.75	24.
KU-1	5.7	43.	2.2	43.	0.6	43.	3.79	43.	0.38	43.	9.95	43.
KU-2	7.0	11.	2.4	11.	1.0	11.	2.49	11.	0.34	11.	7.31	11.
OSE-1	3.3	54.	1.9	54.	0.4	54.	5.00	54.	0.57	54.	9.03	54.
OSE-2	4.7	30.	2.1	30.	0.5	30.	4.64	30.	0.46	30.	10.18	30.
OPW	4.1	159.	2.0	159.	0.4	159.	4.98	159.	0.51	159.	9.86	159.
OJC	4.7	1190.	2.1	1190.	0.6	1190.	3.89	1190.	0.45	1190.	8.61	1190.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 18

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
QAL	5.4	214.	1.8	214.	0.9	214.	2.13	214.	0.34	214.	6.42	214.
QT-1	4.0	241.	1.6	241.	1.1	241.	1.46	241.	0.40	241.	3.71	241.
QT-2	7.2	608.	2.5	608.	1.1	608.	2.33	608.	0.35	608.	6.77	608.
QSO	4.7	122.	1.9	122.	1.2	122.	1.66	122.	0.42	122.	4.05	122.
QTC	6.3	168.	2.1	168.	1.0	168.	2.21	168.	0.35	168.	6.43	168.
KU-1	3.9	25.	1.7	25.	0.6	25.	2.91	25.	0.42	25.	6.91	25.
KU-2	5.4	3.	2.4	3.	1.0	3.	2.44	3.	0.44	3.	5.53	3.
OSE-1	2.9	53.	1.6	53.	0.4	53.	4.29	53.	0.60	53.	7.85	53.
OSE-2	5.2	5.	1.8	5.	1.5	5.	1.18	5.	0.35	5.	3.40	5.
OPW	4.6	288.	1.9	288.	0.7	288.	3.45	288.	0.44	288.	7.94	288.
OJC	5.2	1018.	2.1	1018.	0.6	1018.	3.49	1018.	0.40	1018.	8.63	1018.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 19

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
QAL	6.1	138.	2.4	138.	0.9	138.	2.74	138.	0.40	138.	6.87	138.
QT-1	4.2	234.	1.6	234.	1.2	234.	1.32	234.	0.39	234.	3.45	234.
QT-2	6.8	743.	2.4	743.	1.1	743.	2.27	743.	0.35	743.	6.53	743.
QSO	5.4	122.	2.1	122.	1.2	122.	1.77	122.	0.39	122.	4.59	122.
QTC	6.6	242.	2.4	242.	1.0	242.	2.45	242.	0.37	242.	6.69	242.
TW	4.0	10.	1.6	10.	0.7	10.	2.40	10.	0.41	10.	6.19	10.
OSE-1	3.0	167.	1.4	167.	0.3	167.	4.76	167.	0.49	167.	9.73	167.
OSE-2	4.6	16.	1.8	16.	0.7	16.	2.64	16.	0.39	16.	6.86	16.
OPW	4.9	636.	2.0	636.	0.7	636.	3.23	636.	0.41	636.	7.90	636.
OJC	5.5	547.	2.1	547.	0.8	547.	2.84	547.	0.39	547.	7.32	547.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 20

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
QAL	5.9	212.	2.0	212.	1.0	212.	2.18	212.	0.35	212.	6.23	212.
QT-1	4.4	248.	1.6	248.	1.2	248.	1.50	248.	0.37	248.	4.04	248.
QT-2	6.7	620.	2.3	620.	1.1	620.	2.11	620.	0.34	620.	6.19	620.
QSO	5.5	185.	2.1	185.	1.3	185.	1.66	185.	0.38	185.	4.41	185.
QTC	7.4	210.	2.4	210.	1.1	210.	2.19	210.	0.33	210.	6.62	210.
TW	3.3	9.	1.6	9.	0.5	9.	3.56	9.	0.51	9.	7.22	9.
KU-1	6.2	7.	2.3	7.	0.5	7.	4.90	7.	0.37	7.	13.36	7.
OSE-1	3.0	204.	1.4	204.	0.3	204.	4.61	204.	0.49	204.	9.40	204.
OSE-2	5.8	173.	2.3	173.	0.6	173.	4.44	173.	0.40	173.	11.04	173.
OPW	5.1	769.	1.9	769.	0.7	769.	3.23	769.	0.38	769.	8.27	769.
OJC	5.6	86.	2.3	86.	0.9	86.	2.56	86.	0.43	86.	6.10	86.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 21

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
QAL	6.0	152.	2.1	152.	1.0	152.	2.06	152.	0.35	152.	5.92	152.
QT-1	4.4	355.	1.6	355.	1.2	355.	1.41	355.	0.37	355.	3.88	355.
QT-2	6.7	771.	2.3	771.	1.1	771.	2.10	771.	0.34	771.	6.07	771.
QSO	5.1	153.	2.1	153.	1.2	153.	1.73	153.	0.41	153.	4.28	153.
QTC	7.2	141.	2.3	141.	1.1	141.	2.21	141.	0.33	141.	6.73	141.
OSE-1	3.0	364.	1.3	364.	0.3	364.	4.07	364.	0.42	364.	9.59	364.
OSE-2	4.9	185.	1.8	185.	0.6	185.	2.99	185.	0.36	185.	8.26	185.
OPW	4.4	762.	1.7	762.	0.6	762.	3.06	762.	0.40	762.	7.54	762.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 22

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
QAL	5.5	136.	2.0	136.	1.0	136.	2.03	136.	0.36	136.	5.67	136.
QT-1	4.4	385.	1.6	385.	1.2	385.	1.40	385.	0.37	385.	3.88	385.
QT-2	6.6	708.	2.1	708.	1.1	708.	2.03	708.	0.33	708.	6.26	708.
QSO	4.8	186.	1.7	186.	1.2	186.	1.52	186.	0.36	186.	4.29	186.
QTC	6.0	159.	2.0	159.	0.9	159.	2.26	159.	0.34	159.	6.71	159.
OSE-1	3.0	647.	1.3	647.	0.4	647.	3.90	647.	0.45	647.	8.66	647.
OSE-2	5.1	417.	2.0	417.	0.6	417.	3.62	417.	0.38	417.	9.38	417.
OPW	4.6	169.	1.9	169.	0.7	169.	2.79	169.	0.44	169.	6.53	169.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 23

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
QAL	6.0	221.	2.2	221.	0.9	221.	2.27	221.	0.36	221.	6.36	221.
QT-1	4.1	399.	1.7	399.	1.2	399.	1.55	399.	0.42	399.	3.66	399.
QT-2	6.6	804.	2.2	804.	1.0	804.	2.18	804.	0.33	804.	6.67	804.
QSO	5.5	161.	2.1	161.	1.2	161.	1.77	161.	0.40	161.	4.49	161.
QTC	6.9	204.	2.4	204.	0.9	204.	2.65	204.	0.35	204.	7.48	204.
TW	6.2	19.	2.1	19.	0.9	19.	2.46	19.	0.34	19.	7.19	19.
KU-1	4.9	16.	1.9	16.	0.6	16.	3.01	16.	0.39	16.	7.67	16.
MBN	3.7	38.	1.3	38.	0.4	38.	3.57	38.	0.36	38.	9.91	38.
OPJ	4.6	94.	1.7	94.	0.4	94.	4.38	94.	0.37	94.	11.59	94.
OSE-1	2.7	768.	1.3	768.	0.3	768.	4.77	768.	0.50	768.	9.54	768.
OSE-2	5.4	303.	2.0	303.	0.7	303.	3.24	303.	0.38	303.	8.50	303.

Table T-3. Flight-Line Averages (Continued)

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 101

GEOLOGIC	TH		U		K		U/K		U/TH		TH/K	
UNIT	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES
OSE-1	2.9	605.	1.3	605.	0.4	605.	3.78	605.	0.45	605.	8.46	605.
OSE-2	5.3	1107.	2.2	1107.	0.5	1107.	4.82	1107.	0.42	1107.	11.56	1107.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 102

GEOLOGIC	TH		U		K		U/K		U/TH		TH/K	
UNIT	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES
OSE-1	3.1	151.	1.2	151.	0.3	151.	4.18	151.	0.39	151.	10.44	151.
OSE-2	4.2	18.	1.3	18.	0.5	18.	2.94	18.	0.30	18.	9.46	18.
OPW	4.4	195.	1.5	195.	0.7	195.	2.48	195.	0.35	195.	7.11	195.
OJC	5.0	1121.	2.0	1121.	0.5	1121.	4.23	1121.	0.41	1121.	10.26	1121.
OR	4.6	268.	1.9	268.	0.4	268.	4.73	268.	0.43	268.	11.11	268.
OG	3.5	15.	2.1	15.	0.4	15.	6.05	15.	0.60	15.	10.07	15.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 103

GEOLOGIC	TH		U		K		U/K		U/TH		TH/K	
UNIT	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES
OSE-1	3.0	41.	1.6	41.	0.5	41.	4.19	41.	0.56	41.	7.20	41.
OSE-2	5.4	66.	1.9	66.	0.7	66.	3.36	66.	0.37	66.	8.92	66.
OPW	4.6	200.	1.8	200.	0.7	200.	2.94	200.	0.39	200.	7.43	200.
OJC	4.5	813.	1.8	813.	0.6	813.	3.50	813.	0.40	813.	8.64	813.
OR	4.4	473.	1.9	473.	0.4	473.	5.51	473.	0.47	473.	11.84	473.
OG	3.5	59.	1.8	59.	0.3	59.	5.49	59.	0.56	59.	10.00	59.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 104

GEOLOGIC	TH		U		K		U/K		U/TH		TH/K	
UNIT	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES
QAL	6.4	100.	2.1	100.	0.9	100.	2.46	100.	0.34	100.	7.33	100.
QT-1	4.8	5.	2.0	5.	0.8	5.	2.74	5.	0.43	5.	6.37	5.
QT-2	7.0	91.	2.2	91.	0.9	91.	2.72	91.	0.32	91.	8.36	91.
QSO	5.3	224.	1.9	224.	1.2	224.	1.63	224.	0.37	224.	4.47	224.
KU-1	6.1	15.	2.2	15.	0.7	15.	3.33	15.	0.36	15.	9.16	15.
OJC	5.4	737.	2.2	737.	0.8	737.	3.10	737.	0.42	737.	7.49	737.
OR	3.3	329.	1.8	329.	0.3	329.	5.78	329.	0.56	329.	10.23	329.
OG	3.3	195.	1.6	195.	0.3	195.	5.16	195.	0.50	195.	10.40	195.
CEP	2.9	68.	1.8	68.	0.3	68.	6.11	68.	0.66	68.	9.76	68.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 105

GEOLOGIC	TH		U		K		U/K		U/TH		TH/K	
UNIT	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES
QAL	5.2	167.	1.6	167.	0.8	167.	2.11	167.	0.32	167.	6.66	167.
QT-1	4.5	68.	1.8	68.	0.7	68.	2.88	68.	0.41	68.	6.94	68.
QT-2	6.8	444.	2.3	444.	1.0	444.	2.36	444.	0.34	444.	6.99	444.
QSO	5.0	120.	1.8	120.	1.3	120.	1.37	120.	0.36	120.	3.83	120.
Q	7.0	98.	2.4	98.	1.1	98.	2.21	98.	0.34	98.	6.77	98.
QTC	6.0	26.	1.8	26.	0.9	26.	2.05	26.	0.30	26.	6.75	26.
TW	5.5	14.	1.8	14.	0.7	14.	2.56	14.	0.33	14.	7.67	14.
OJC	7.0	69.	2.5	69.	0.7	69.	3.66	69.	0.36	69.	10.10	69.
OR	5.7	647.	2.2	647.	0.6	647.	3.79	647.	0.41	647.	9.31	647.
OG	5.3	33.	2.1	33.	0.6	33.	3.95	33.	0.41	33.	9.68	33.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 106

GEOLOGIC	TH		U		K		U/K		U/TH		TH/K	
UNIT	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES
QAL	5.2	97.	1.7	97.	0.9	97.	2.01	97.	0.34	97.	6.00	97.
QT-1	4.3	93.	1.4	93.	1.0	93.	1.58	93.	0.33	93.	4.67	93.
QT-2	7.1	488.	2.2	488.	1.2	488.	1.91	488.	0.32	488.	6.00	488.
Q	6.7	537.	2.5	537.	1.0	537.	2.66	537.	0.38	537.	6.92	537.
QTC	7.0	236.	2.2	236.	1.1	236.	2.15	236.	0.32	236.	6.63	236.
TW	3.5	4.	0.8	4.	0.5	4.	1.72	4.	0.22	4.	7.73	4.
OR	5.2	255.	2.1	255.	0.6	255.	3.36	255.	0.41	255.	8.28	255.
OG	3.7	76.	1.5	76.	0.4	76.	3.74	76.	0.46	76.	8.48	76.

AVERAGE COUNTING RATES PER GEOLOGIC UNIT

FLIGHT LINE 107

GEOLOGIC	TH		U		K		U/K		U/TH		TH/K	
UNIT	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES	AVG.	SAMPLES
QT-1	4.1	427.	1.4	427.	1.2	427.	1.21	427.	0.35	427.	3.45	427.
QT-2	6.3	422.	1.7	422.	1.3	422.	1.30	422.	0.28	422.	4.72	422.
Q	5.5	440.	1.8	440.	1.2	440.	1.59	440.	0.34	440.	4.72	440.
QTC	8.0	305.	2.7	305.	1.2	305.	2.21	305.	0.34	305.	6.58	305.
KU-2	7.7	99.	2.5	99.	1.2	99.	2.12	99.	0.32	99.	6.60	99.

AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY OF PORTIONS OF ARKANSAS, ILLINOIS, INDIANA, KENTUCKY, MISSOURI, AND TENNESSEE DYERSBURG, PADUCAH, POPLAR BLUFF, AND ROLLA QUADRANGLES

FINAL REPORT
Volume 1
and
Volume 2C

POPLAR BLUFF QUADRANGLE

TEXAS INSTRUMENTS INCORPORATED
Dallas, Texas

December 1979

WORK PERFORMED UNDER
BENDIX FIELD ENGINEERING CORPORATION
GRAND JUNCTION OPERATIONS, GRAND JUNCTION, COLORADO
Subcontract 79-285-L and Bendix Contract EY-76-C-13-1664

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Grand Junction Office
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ABSTRACT

Instrumentation and methods described were used for a Department of Energy (DOE) sponsored, high-sensitivity, aerial gamma-ray spectrometer and magnetometer survey of Dyersburg (Kentucky, Missouri, Tennessee); Paducah (Indiana, Illinois, Kentucky, Missouri); Poplar Bluff (Arkansas, Missouri); and Rolla (Missouri) NTMS, 1:250,000-scale Quadrangle. The survey was carried out by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-285-L. The objective of the work was to define areas showing surface indications of a generally higher uranium content where detailed exploration for uranium would most likely be successful.

A DC-3 aircraft equipped with a high-sensitivity gamma-ray spectrometer and ancillary geophysical and electronic equipment was employed for each quadrangle. The system was calibrated using the DOE calibration facilities at Grand Junction, Colorado, and Lake Mead, Arizona.

Gamma-ray spectrometric data were processed to correct for variations in atmospheric, flight, and instrument conditions and were statistically evaluated to remove the effects of surface geologic variations. The resulting first-priority uranium anomalies (showing simultaneously valid eU*, eU/eTh*, and eU/K* anomalies) were interpreted to evaluate their origin and significance. Results of the interpretation in the form of a preferred-anomaly map, along with significance-factor profile maps, stacked profiles, histograms, and descriptions of the geology and known uranium occurrences are presented in Volume 2 of this final report.

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

TABLE OF CONTENTS

Section	Title	Page
	Abstract	i
I	INTRODUCTION	N-1
	A. GENERAL	N-1
	1. Objectives	N-1
	2. Approach	N-2
II	DATA ACQUISITION	N-3
	A. EQUIPMENT	N-3
	1. Aircraft	N-3
	2. Airborne Geophysical System 3	N-3
	3. Base-Station Magnetometer	N-6
	B. PROCEDURES	N-6
	1. Airborne	N-6
	2. Ground Procedures	N-6
III	DATA REDUCTION AND ANALYSIS	N-7
	A. GAMMA-RAY DATA REDUCTION PROCEDURES	N-7
	1. General	N-7
	2. Channel-Energy Calibration	N-7
	3. Matrix-Reduction Correction	N-8
	4. Live-Time Normalization	N-8
	5. Cosmic-Radiation Correction	N-9
	6. Onboard Background-Radiation Corrections	N-9
	7. Terrain-Clearance Correction	N-9
	8. Atmospheric-Radiation Correction	N-9
	9. Correction Factors	N-9
	10. Statistical Significance Test	N-10
	11. Averaging	N-10
	B. NAVIGATION DATA PROCESSING	N-11
	C. DATA ANALYSIS PROCEDURES	N-11
	D. MAGNETOMETER DATA PROCESSING	N-12
IV	DATA PRESENTATION	N-13
	A. STACKED PROFILES	N-13
	B. RECORD-LOCATION MAPS	N-13
	C. GAMMA-RAY SIGNIFICANCE-FACTOR PROFILE MAPS	N-13
	D. HISTOGRAMS	N-14
	E. PRINTER PLOT CONTOUR MAPS	N-14
	F. COMPUTER DATA LISTINGS	N-14
	1. Single-Record Reduced Data Listings	N-14
	2. Averaged-Record (Statistical Analysis) Listings	N-15

TABLE OF CONTENTS (CONTD)

Section	Title	Page
	G. DATA TAPES	N-15
	1. General	N-15
	2. Tape Block Contents and Blocking Structures	N-16
	3. Raw Spectral-Data Tapes	N-16
	4. Single-Record Reduced Data Tapes	N-17
	5. Statistical Analysis Data Tapes	N-19
	6. Magnetic Data Tapes	N-19
	7. Statistical Analysis Summary Tape	N-21
V	DATA INTERPRETATION	N-22
	A. GAMMA-RAY DATA INTERPRETATION	N-22
	1. General	N-22
	2. Geologic Mapping	N-23
	3. Selection of Uranium Anomalies	N-24
	4. Evaluation of Anomalies	N-25
	B. MAGNETOMETER DATA INTERPRETATION	N-25
	1. Applications of Magnetic Data	N-25
	2. Interpretation of the Survey Data	N-26
	C. CONCLUSIONS	N-26
VI	REFERENCES	N-27

LIST OF ILLUSTRATIONS

Figure	Description	
1-1	Quadrangle Location Map	N-3
2-1	Texas Instruments Gamma-Ray System 3	N-4
3-1	Steps in Processing Fixed-Wing Survey Data	N-8

LIST OF TABLES

Table	Title	
4-1	Format Description Block Contents	N-17
4-2	Single Record Reduced Data Format Description Block Contents	N-18
4-3	Statistical Analysis Format Description Block Contents	N-19

TABLE OF CONTENTS (CONTD)

Table	Title	Page
4-4	Magnetic Tape Format Description Block Contents	N-20
4-5	Statistical Analysis Summary Tape Format Description Block Contents	N-21
5-1	Probability that a Single Statistically High Point is Caused by Random Deviations	N-24
5-2	Minimum Deviation from the Mean for all Points for Limiting Probability of 1:33,300	N-25
5-3	Examples of Potentially Important Second-Priority Anomalies	N-25

APPENDIX A

PRODUCTION SUMMARY AND REDUCED TEST-LINE DATA

SECTION I

INTRODUCTION

A. GENERAL

1. Objectives

a. Aerial Radiometric Reconnaissance Survey

The major goal of the National Uranium Resource Evaluation (NURE) program, sponsored by the Department of Energy (DOE), is to establish reliable and timely comprehensive estimates of the uranium resources of the nation (DOE, 1978). The Aerial Radiometric Reconnaissance Survey is one element of the NURE program.

The major short-term objectives of the aerial survey portion of the NURE program are (Dodd, 1976):

- Rapidly map and evaluate, on a national and regional scale, the distributions of the natural radioelements U, Th, and K and their ratios in the surface geologic units and materials by means of high-sensitivity aerial gamma-ray spectrometers.
- Provide a significant part of the fundamental geochemical-geological sample information needed for preliminary rating of the relative favorability of areas, and, in conjunction with other survey data and geologic modeling criteria, identify areas warranting follow-up investigations and possible exploration by industry.
- Encourage early exploration of new or under-explored geologic environments and minimize redundant reconnaissance surveys by industry.

Longer-term goals include: (1) Synthesize the aerial and other survey data to develop improved concepts of ore genesis to establish refined criteria for favorability and the recognition of subtle clues to possible concealed deposits, and (2) provide timely guides to future sophisticated exploration and thereby minimize exploration expenditures needed to discover an adequate reserve or probable resource base.

b. Delineation of Uraniferous Provinces

Saunders and Potts (1978) have summarized concepts of uraniferous metallogenic and geochemical provinces and methods for detecting and mapping them using reconnaissance aerial gamma-ray spectrometer data.

Turneaure (1955) pointed out that geologists have long recognized that specific parts of the world are characterized by groups of deposits of certain metals or of geochemically related metals. Such regions are of mining district size and have been termed as metallogenic, metallogenetic, or metallographic provinces. In addition, certain of these provinces or districts show clear evidence of more than one metallogenic epoch; i.e., similar deposits of different ages are grouped together spatially.

Some groups of related mining districts lie within broader geochemical provinces characterized by general enrichment of the host rocks in those elements making up the groups of ore deposits. Levinson (1974) describes them as relatively large (tens to hundreds of miles), well-defined areas of the earth's crust that have a distinct chemical composition. Geochemical provinces may be considered the largest example of primary geochemical "haloes."

Klepper and Wyant (1957) pointed out that most of the world's important uranium deposits are clustered in a few areas or provinces, and further speculated that perhaps these represent uranium-rich portions of an originally inhomogeneous crust. This is in general accord with the concept of broad geochemical provinces, which is further supported by the additional observation by Klepper and Wyant that uranium-enriched regions appear to persist through long periods of geologic time, with the uranium being moved from one type of deposit to another within each province by normal erosional, sedimentary, and igneous processes. They also observed that such provinces are characterized by uranium-rich rocks and waters and the presence of several types of uranium deposits (see also Darnley, 1973).

Darnley (1972) observed that districts containing uranium deposits in Canada are generally characterized, over tens or hundreds of square miles, by above-average radioactivity relative to their surroundings based on aerial radiometric survey results. Also, uranium is concentrated preferentially over the other naturally occurring radioelements, thorium and potassium, in anomalously radioactive areas considered more favorable for potentially economic uranium deposits. This is supported by other investigators who have pointed out that known uranium deposits tend to be concentrated in areas characterized by generally higher uranium contents in ground waters (Scott and Barker, 1958), igneous rocks (Everhart, 1958), and possible Precambrian source areas for stratiform deposits (Malan, 1972). This, in turn, leads to the concept that new uranium deposits will be found more frequently in such areas than in regions where the uranium content in associated soils, rocks, and ground waters is comparatively low (Brinck, 1974).

Recent studies on aerial gamma-ray spectral data (Texas Instruments, 1977; Saunders and Potts, 1978; Saunders, 1978) lead to the conclusion that known uraniferous provinces are characterized by:

(1) Higher eU, eTh, and K mean values on a regional basis (due to generally higher radioelement concentrations).

(2) Higher relative standard deviations for eU, eU/eTh, and eU/K (reflecting the presence of local uranium enrichments).

(3) Lower regional mean values for eU/eTh and eU/K (showing uranium loss from "average" rocks to form local enrichments).

(4) Relatively large numbers of local anomalies with statistically high eU, eU/eTh, and eU/K (indications of local uranium enrichments).

Statistical treatment of the aerial radiometric data allows regions with these characteristics to be defined. These uraniferous provinces constitute the preferred territory for followup exploration methods such as detailed aerial or surface radiometric prospecting, geological studies, etc., to define potential prospects for eventual testing by exploration drilling and logging (see Saunders and Potts, 1978).

2. Approach

Aerial gamma-ray spectrometer and magnetometer data were collected over Dyersburg (Kentucky, Missouri, Tennessee); Paducah (Illinois, Kentucky, Missouri); Poplar Bluff (Arkansas, Missouri); and Rolla (Missouri) NTMS, 1:250,000-scale quadrangle (Figure 1-1). The program also included processing and interpreting the gamma-ray spectrometer data to indicate potential new uranium prospecting areas.

This constitutes Volume 1 of the final report and includes information on methods and instrumentation common to all the quadrangles. Data and results for each quadrangle are included in Volume 2 of this report.

Flight-line patterns for this survey are shown on the record location maps of the individual quadrangle volumes. This survey was conducted for the Grand Junction Office of the United States Department of Energy (DOE) under Bendix Field Engineering Corporation (BFEC) Subcontract No. 79-285-L.

All maps and profiles prepared from this survey are presented at 1:500,000 scale, along with histograms of the radiometric data in the individual quadrangle volumes of this final report.

All data were digitally collected and processed and are presented in the form of computer listings and stacked profiles. Geologic maps at 1:250,000 scale were used as geologic source data in a statistical analysis of the gamma-ray data, which provided a quantitative measure of the anomalousness of each record value. Results of this analysis are presented as statistical tables, a preferred-anomaly map, a record-location map, and profile maps in the individual quadrangle volumes. The record-location and profile maps are printed in composite form with the geologic map. All map sheets conform to the name, scale, and sheet layout of the NTMS 1:250,000-scale topographic maps.

The work was done in accordance with Bendix Field Engineering corporation (BFEC) Specification No. PMD-1200-C and the subcontract work statement. The aerial radiometric system was calibrated in accordance with BFEC Specification No. PMD-1250-A.

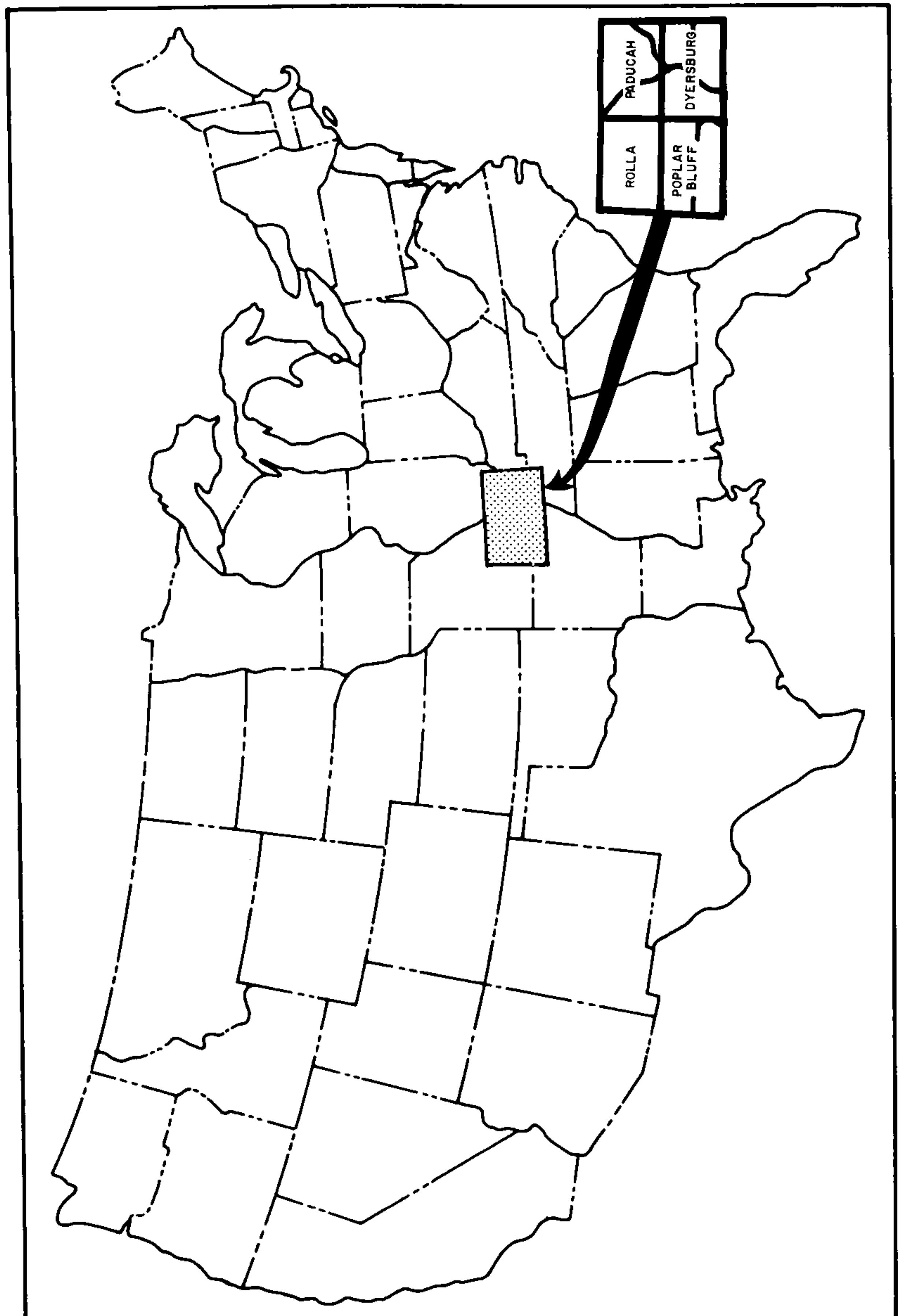

Figure 1-1. Quadrangle Location Map

SECTION II
DATA ACQUISITION

A. EQUIPMENT

1. Aircraft

A standard DC-3 aircraft equipped with Texas Instruments gamma-ray spectrometer system 3 was used for all quadrangles. The DC-3 provided sufficient size, range, carrying capacity, and safety margin for this project. Besides standard equipment, the aircraft was fitted with a Bendix automatic pilot and an inertial navigation system to assist in maintaining straight flight paths.

2. Airborne Geophysical System 3

The gamma-ray spectrometry system measures the amplitude spectrum of light created on the capture of incident gamma rays by thallium-activated sodium iodide (NaI [Tl]) crystal. The NaI crystal detectors must be large enough to absorb these incident gamma-ray photons. Several of the crystal detectors are connected in parallel to provide a spectral counting rate that allows adequate statistical measurements within the short measurement periods dictated by an airborne detection system.

Gamma-ray spectrometer surveying involves quantitative measurement of natural gamma radiation of thorium, uranium, and potassium occurring at or near the earth's surface. Thorium and uranium are assumed to be in equilibrium with their respective radiation decay products, thallium-208 and bismuth-214. These two decay products and potassium-40 give pronounced peaks at 2.615, 1.76, and 1.46 MeV respectively in the gamma-ray spectra of naturally occurring radiation and afford the means of measuring the distribution of their source elements (thorium, uranium, and potassium).

A typical gamma-ray spectrum measured in the field consists of discrete photoelectron peaks modified by Compton scattering and other effects caused by naturally occurring radioactive elements and by cosmic radiation and radiation emanating from radionuclides in the atmosphere. All these masking effects can be identified and removed by routine field measurements and data-reduction methods.

Figure 2-1 is a block diagram of Texas Instruments Gamma-Ray System 3 (TIGRS-3). Fourteen rectangular NaI crystal detectors, each 16 inches long and 4 inches by 4 inches in cross section, emit light pulses upon capture of gamma-ray photons, with light amplitude being proportional to photon energy. The light pulse (scintillation) created by the capture of each gamma-ray is amplified by a photomultiplier tube coupled to each crystal and converted to an electrical pulse proportional to the amplitude of the light pulse. Each electrical pulse is further amplified and routed by the detector interface unit to the gamma-ray spectrometer, which converts the amplitude of the pulse to one of 512 digital energy values. By this sequence, the variable energies of the gamma-ray photons are linearly assigned to one of the 512 calibrated energy bands (each approximately 12.05 KeV wide). During each counting period (1.0 second) the sums of the pulses falling in each of the first 255 energy bands, covering the energy range from 0.0 to 3.0720 MeV are accumulated as the first 255 channel sums of the spectrum. Pulses falling in energy bands 256 to 512 (3.070 to 6.0000 MeV) are accumulated as the 256th channel sum.

Two of the 14 detectors are shielded from gamma-rays originating below the aircraft by their position over a combination of four NaI crystals, each 4 inches thick, and 0.75 inch of lead. Analog signals from these two detectors are mixed, and the composite spectrum is used to measure the radioactivity of Bi-214 in the atmosphere. The other 12 detectors are essentially unshielded from ground radiation. Analog signals from these detectors are similarly mixed, and their composite spectrum represents the gamma-ray flux captured by these detectors from sources on the ground and in the atmosphere. The spectral information from the shielded detectors when corrected for relative sensitivity and geometry can be used to remove the atmospheric component from the unshielded detectors' spectra.

Each crystal is protected from thermal and mechanical shock and from thermally induced gain shifts in the spectra by the combination of thick polymeric insulation and automatically controlled internal heaters.

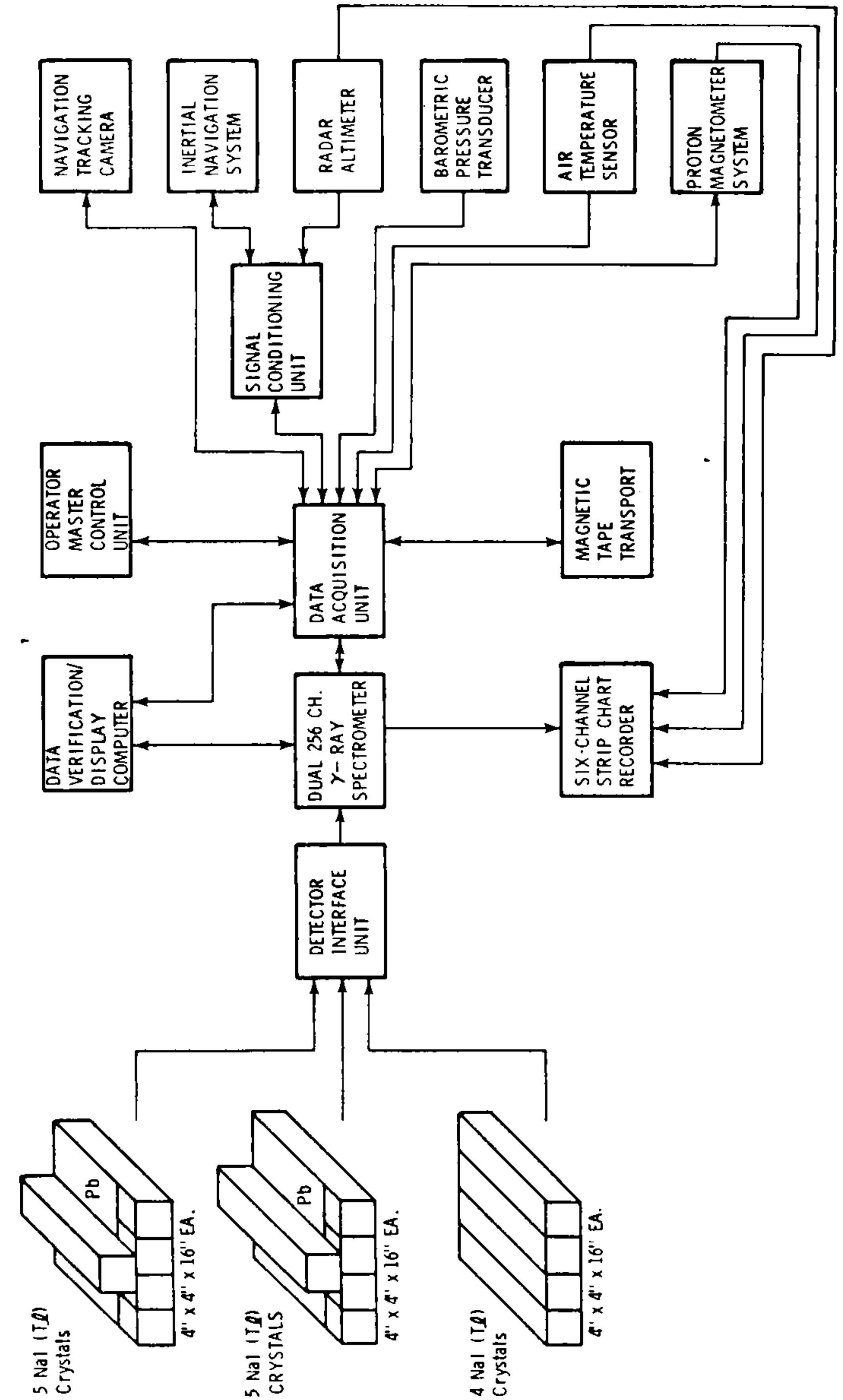

Figure 2-1. Texas Instruments Gamma-Ray System 3 (TIGRS-3)

At the end of each counting period the location for storing spectral information is switched to the other half of the spectrometer, and the accumulated spectra, together with other data (average radar-altimeter reading, air pressure, air temperature, magnetometer reading, record number, line number, day of year, time of day, etc.), are transferred to magnetic tape. This procedure prevents loss of spectral information between counting periods.

System control is maintained by the data acquisition control unit. This unit sequences all operations during each counting period and acquires data from the gamma-ray spectrometer, the peripheral sensors, and the navigation system computer for inclusion on magnetic tape. Its crystal-controlled clock provides timing information for the operator-selected counting period and for triggering the magnetometer reading and the 35-mm tracking camera. It measures average terrain clearance by digitally sampling the output of the radar altimeter continuously during the counting period.

The following describes the several units making up the Texas Instruments Gamma-Ray System 3:

Unit	Function
NaI crystals	Gamma-ray scintillation detectors each 16 inches long and 4 inches by 4 inches in cross section coupled to a photomultiplier tube. Two detectors are shielded from the ground by the combination of other crystals and 0.75 inch of lead
Detector interface unit	Provides high-voltage and temperature control for detectors, spectral gain calibration controls, and separate mixing of signals from the shielded and unshielded detectors
Gamma-ray spectrometer	Digitizes and stores spectral sums of pulses from the shielded and unshielded detectors and provides raw spectral sums for analog or digital display
Data acquisition unit	Controls the sequence of operations during a sample period and acquires all spectral and ancillary data for inclusion on magnetic tape; formats and performs quality checks on data as written magnetic tape
Magnetic-tape transport	Records all data in nine-track, mixed binary and BCD form with unformatted NRZI encoding at 800 bpi. The tapes are compatible with transports on large computers used for data processing
Data verification/ display computer	Displays all collected data in several analog or character formats; permits real-time visual verification and numerical analysis of spectral data from spectrometer or data acquisition unit and of all ancillary data
Operator master control unit	Provides operator control of system and remote displays of fiducial and navigation information
Signal conditioning unit	Interfaces inertial navigation system and radar altimeter with data acquisition unit
Proton-magnetometer system	Measures total magnetic field to nearest 0.25 gamma. Uses proton precession sensor towed at the end of a 100-foot cable. Digital output from the console is recorded with the other collected data, and an analog output is recorded at two scales on the strip-chart recorder
Pressure transducer	Measures ambient barometric pressure during each gamma-ray measurement interval using an absolute magnetic reluctance sensor
Air-temperature sensor	Measures flight-line air temperature during each gamma-ray interval using a conductivity-measuring thermometer
Radar altimeter	Measures aircraft terrain clearance. The output from the altimeter is continuously averaged during each gamma-ray measurement interval
Tracking camera	35-mm framing camera with wide-angle lens for recording the flight-path image. The camera is triggered at the midpoint of each gamma-ray measurement interval. Seven-segment LEDs in an attached data box expose the current record number and flight-line number on each film frame

Inertial navigation system	Delco Carousel IV-A system measures aircraft position relative to waypoints and geodetic grid
Strip-chart recorder	Six-channel analog recorder for real-time display of raw uranium counts (shielded detectors and unshielded detectors), ratio of raw uranium counts, average terrain clearance, magnetic field reading, and air temperature. Fiducial marks indicate completion of each sampling period

3. Base-Station Magnetometer

A base-station, proton precession magnetometer and digital recording system are used to monitor diurnal variations in the earth's total magnetic field. The system measures and records total intensity magnetic field data of 0.25-gamma resolution every 4 seconds. The system displays data with a six-digit illuminated display and analog strip-chart recorder with time fiducial markers. Data are recorded with the Julian date and time of day on a digital magnetic-tape transport.

B. PROCEDURES

1. Airborne

Flight operations were conducted from 17 June through 19 July 1979. Appendix A in Volume 2 contains a production summary for the quadrangle. The air port at Springfield, Missouri, was the base of operation for the quadrangle.

Traverse lines for the Dyersburg and Poplar Bluff quadrangles were flown in an east-west direction at intervals of 3 miles. Tie lines were flown north-south at intervals of 18 miles. Traverse lines for the Paducah and Rolla quadrangles were flown east-west at intervals of 6 miles. Tie lines were flown north-south at intervals of 36 miles.

The system was calibrated on the following dates according to BFEC Specifications 1250-A, and the results were reported separately:

High-altitude flights:	18 April 1979
Lake Mead test strip:	11 April 1979
Walker Field pads:	18 May 1979

The aircraft navigation system and a prepared set of topographic maps were used to maintain correct aircraft heading. The tracking camera provided a photographic record of the aircraft's location at the center of each recording interval.

Required terrain clearance was maintained by the pilot through monitoring the radar altimeter. Flight path and terrain clearance were maintained within contract specifications, except where local flight regulations or considerations of flight safety dictated otherwise.

Nominal terrain clearance, aircraft speed, and sampling time were 400 feet, 140 mph, and 1 second respectively. These survey configurations meant that an approximate 220-foot strip of terrain along the flight path was sampled with each record during the survey.

During flight, the equipment operator monitored system performance with the analog recorder displays incorporated into the collection system. When any actual or potential malfunction in any component's operation was detected, the flight line was immediately broken off until the problem was eliminated or its impact was determined to be negligible.

To minimize variations caused by variable ground moisture and equipment drift, a ground test line was established near the base of operation. Whenever possible, this line was flown under survey flight configuration at the beginning and end of each flight. The primary requirement was that the raw data be reproducible to within 20 percent from flight to flight. An additional test line was flown over a large body of water. The significance of this is discussed in subsection III.A.6. A summary of the data is presented in Appendix A.

2. Ground Procedures

Before each flight, each detector was calibrated and an appropriate gain was set by using standard radioactive sources. Reproducibility was checked prior to each takeoff with the aircraft positioned over a marked spot on the apron at each base of operation. At the conclusion of each data-collection flight, a data quality check was made by inspecting the airborne analog records. Flight lines or portions of flight lines that contained data failing to meet contract specifications were scheduled for reflights.

Detailed daily records of survey progress were kept, and at convenient intervals flight magnetic tapes and films were dispatched to the data processing center at Dallas, Texas, for quality checks as additional methods to ensure consistent data quality.

SECTION III
DATA REDUCTION AND ANALYSIS

A. GAMMA-RAY DATA REDUCTION PROCEDURES

1. General

Figure 3-1 shows the major steps of the data processing sequence used in fixed-wing surveys. Gamma-ray data reduction consisted of two main stages:

Stage I — Program TIGRRED. Raw data on the field tapes were edited and transferred to direct-access-disk intermediate storage. Two passes were made at the data stored on the disk. The first pass made an energy-to-channel calibration for the pulse-height analyzer outputs for the shielded and unshielded recording systems. The second pass reduced the data by carrying out various corrections for spectral unfolding, live-time normalization, terrain clearance, and atmospheric radiation. The output was in the form of intermediate magnetic tape with on-line printer listings for monitoring purposes.

Stage II — Programs GAMMIT and SORTLL. Flight-line navigation data were merged with the digital records; any required additional data corrections were made; and all data were sorted into individual NTMS quadrangles, averaged, and transferred to final data tapes.

2. Channel-Energy Calibration

Despite calibration at the beginning of each flight, the correspondence of channel number to energy level must be checked throughout the recording process. Slight variations in high-voltage supply, photomultiplier response, or amplifier gain can be corrected in this way, thereby increasing the system's overall resolution. In addition, because this process depends on the shape of the recorded spectra, any major changes in spectral shape because of instrument failures or other cause can be quickly and automatically detected. Channel calibration for both shielded and unshielded detector systems consists of the following steps:

- Sum sufficient individual spectra to obtain well-defined photoenergy peaks.
- Determine the exact channel location of the 2.615-MeV and 1.460-MeV photoenergy peaks.

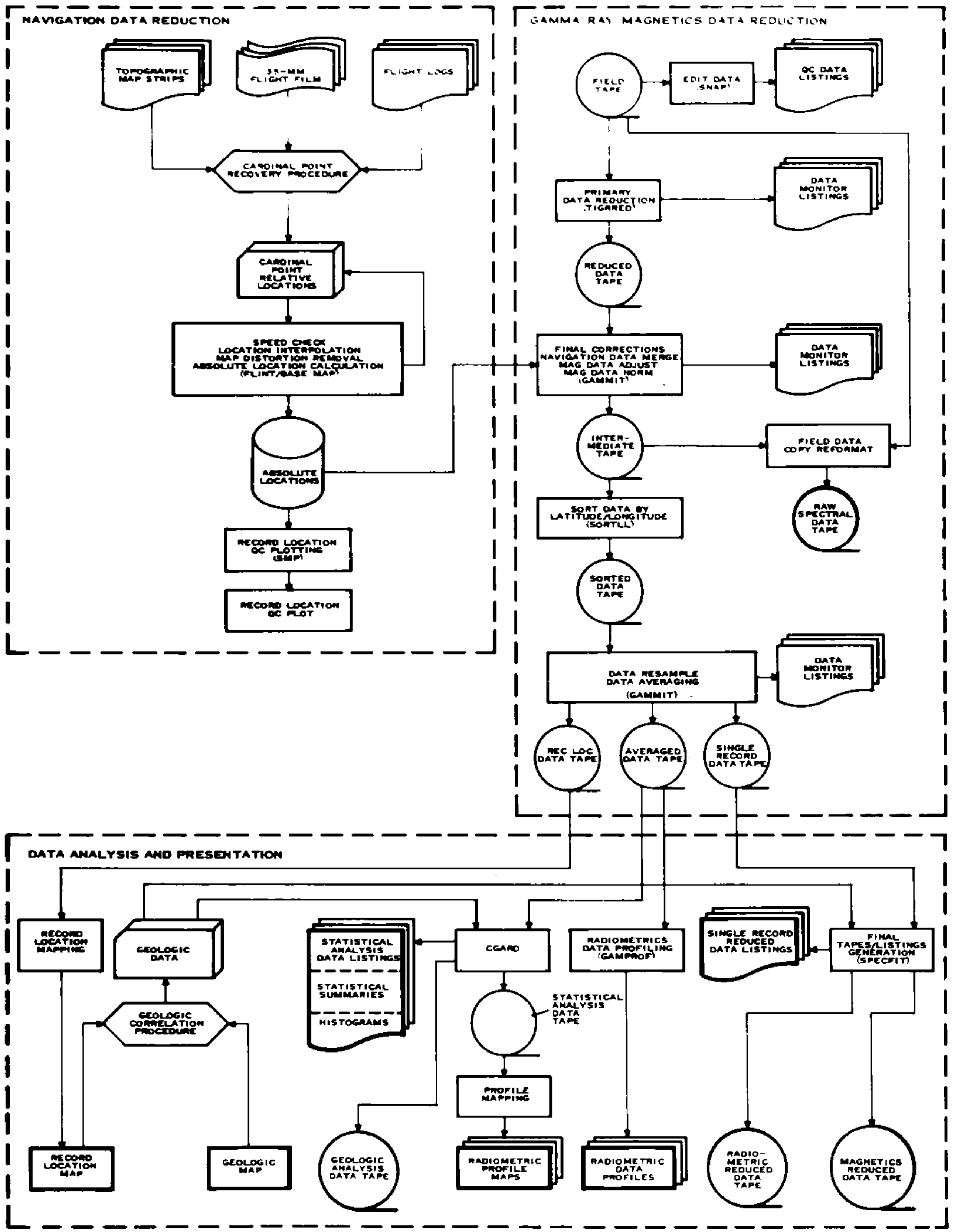

Figure 3-1. Steps in Processing Fixed-Wing Survey Data

- Calculate the zero-energy channel position and the energy per channel to obtain the required precise channel-to-energy calibration.

3. Matrix-Reduction Correction

Each field spectrum is assumed to be a composite formed by summing the spectra of decay products of naturally occurring potassium, uranium, and thorium, together with cosmic radiation. The quantitative separation (or unfolding) of the sum of the different gamma-radiation sources is performed using matrix reduction methods. The matrix, which is used to multiply the vector formed by the field-recorded spectra, was obtained by inverting the normalized matrix of standard calibration spectra for each of the major contributing sources. Because the standard calibration spectra were obtained using airborne measurements with the current operations system and crystals, and because the technique is normalized to 400 feet above the terrain, there is no need to identify separately and to correct for effects such as Compton scattering, backscattering in the crystals, crystal geometries, and spectral deformation caused by differential attenuation in the atmosphere between the ground and recording system. The basic assumptions, therefore, are:

- Field and standard spectra must be taken in the same experimental geometry.
- Field and standard spectra must be identically energy-calibrated.
- Any gamma-emitting nuclide in the field spectrum that is not represented by a standard must be present in relatively small quantities.

4. Live-Time Normalization

"Live time" is the actual time in which the gamma-ray detection system is not processing a gamma-ray pulse (and therefore can accept a gamma-ray pulse from any detector). This variable is strongly dependent on the counting rate, implying that the spectra recorded (and parts thereof) are reduced in proportion to the ratio of live time to total record time.

The total dead time incurred during the acquisition of one recorded spectrum is calculated from the total number of gamma-ray pulses in the spectrum times the fixed time per pulse necessary for conversion and storage.

5. Cosmic-Radiation Correction

The volume of the crystal detectors employed in the Texas Instruments gamma-ray spectrometer system is such that cosmic radiation has a measurable effect on the observed radiation; therefore, a correction for this is made.

Pulses in the energy range 3.0-6.0 MeV are automatically summed in the data acquisition computer and recorded as a tag word during each record. These values give a direct measure of incident cosmic radiation, since no naturally occurring terrestrial sources emit significant gamma radiation in this energy range. Inasmuch as the standard shape of the cosmic radiation spectrum is included in the reduction matrix, the effects of this radiation on the lower-energy photopeaks are removed.

6. Onboard Background-Radiation Corrections

Despite measures to eliminate all radioactive sources in the aircraft, there is always residual or background radiation. It is measured by recording spectra from the individual detectors while the aircraft is at altitudes greater than 6000 feet over the ocean with wind blowing toward land. The high altitude and wind direction make airborne radiation sources negligible. After correction for cosmic radiation and live-time normalization, the residual spectra thus measured in the survey area were subtracted from all subsequent spectral counts.

7. Terrain-Clearance Correction

To eliminate observed variations in counting rate as the distance between the aircraft and ground changes, all radiometric counts are normalized to a constant 400-foot vertical terrain clearance at standard temperature and pressure ($0^{\circ}C$ and 1 atmosphere). This normalization is achieved using a function of average terrain clearance, air temperature, air pressure, and empirically determined total attentuation coefficients for the respective energy windows.

8. Atmospheric-Radiation Correction

Radon-222 gas, with a half-life of 3.8 days, escapes from the ground into the atmosphere in significant amounts and decays to gamma-emitting bismuth-214. The bismuth-214 radionuclides in the atmosphere contribute a significant and variable portion of the bismuth-214 counts measured by the airborne system. Atmospheric conditions, air turbulence, and air-temperature inversion layers affect the distribution of radon, and consequently of bismuth-214, in the atmosphere. Failure to account for bismuth-214 radiation coming from airborne radionuclides could result in almost meaningless uranium estimations.

A similar gaseous decay product, radon-220 in the thorium radioactive decay series, has a half-life of only 54.5 seconds and therefore is not considered significant in the measurement of thorium distribution by detection of thallium-208.

Radiation due to atmospheric bismuth-14 is measured during the survey by shielded-detector spectra. These "upward-looking" spectra are calibrated and reduced in the same manner as the normal spectra, except that attenuation due to ground clearance is omitted. Under the assumption that atmospheric bismuth-214 is homogeneously distributed in the atmosphere surrounding the aircraft, the normalized bismuth-214 counts obtained from the shielded detector afford a correction factor, which is subtracted from the final bismuth-214 count obtained from the unshielded detectors.

9. Correction Factors

Below is a list of the correction factors used to correct the data. These factors were determined from the Walker Field pads and the Lake Mead Test Range sites.

- Detector energy bandwidths

  uranium (4-pi and 2-pi) = 1.6504 - 1.8673 MeV
  thorium (4-pi and 2-pi) = 2.4094 - 2.8311 MeV
  potassium (4-pi and 2-pi) = 1.3493 - 1.5661 MeV

- Stripping ratios:

  α (Th in U) = 0.301403
  β (U in K) = 0.422381
  γ (Th in K) = 0.907837
  δ (U in Th) = 0.05755

- Cosmic correction factors:

	4 pi	2 pi
Thorium window	0.151	0.158
Uranium window	0.120	0.127
Potassium window	0.154	0.160
Gross window	2.419	2.706

- Background correction factors (cps):

	4 pi	2 pi
Thorium window	4.376	0.515
Uranium window	7.581	1.319
Potassium window	23.268	4.870
Gross window	184.970	36.619

10. Statistical Significance Test

As a result of the above corrections and normalizations, the reduced counting-rate values for uranium (eU), thorium (eTh), potassium (K), and gross (0.4 to 3.0 MeV) and the ratios eU/eTh, eU/K, and eTh/K are obtained. However, since some samples are collected over water-saturated ground, some over areas with low radioelement content, and some at high terrain clearance, the measured counting rates may be so low that the reduced data are statistically meaningless. To eliminate such data, the statistical adequacy of each eU, eTh, and K value is analyzed using the ideas presented by Currie (1968). As applied here, a statistic is calculated for each eU, eTh, and K value that defines whether the value equals or exceeds a particular probability threshold (cutoff level). This statistic consists of the ratio of the cutoff level in counts per second (cps) to the observed net counting rate in cps. As taken from Currie (1968), the cutoff levels are defined on the basis of the observed background. Since the observed background in each energy window (onboard radioactivity, airborne radioactivity, and scattering from other sources) varies from record to record, the cutoff level for this statistic must be calculated on a record-by-record basis. Calculating the statistic in this manner (as a ratio analogous to a noise-to-signal ratio) allows the statistic to be recalculated for the averaged records to take into account the improved noise-to-signal ratio obtained by averaging (paragraph 3.A.11). Taking the detection-level cutoff as the limit, any values falling below this limit are excluded from the subsequent anomaly analysis procedure (subsection 3.C).

11. Averaging

For subsequent anomaly analysis and radiometric stacked-profile presentations, the following averages are calculated for successive groups of samples: eTh, eU, K, eU/K, eU/eTh, eTh/K, gross counting rates, and average terrain clearance. Each record is an average of a group of seven successive records, with the averaged record being the centroid of each group. A residual total magnetic-field value is also included in each averaged record but is not averaged.

To provide additional noise suppression for data of marginal quality, the following procedures were followed in the averaging:

- Include the data collected at altitudes in excess of the 1,000-foot terrain-clearance limit and retest for excessive average terrain clearance.
- Include observed values of negative counting rates in the averaging.
- Include record values regardless of whether they pass the statistical adequacy test and recalculate the Currie statistic after the averaging.

- Reject any records of poor quality not included in the above. Calculate the average eU/eTh, eU/K, and eTh/K values from the average eU, eTh, and K values and not from the average of the single-record ratios.

Each of these procedures can be shown to enhance the data and to allow more records with marginal signal-to-noise ratios to pass the statistical adequacy test.

B. NAVIGATION DATA PROCESSING

The procedure for navigation data processing is shown in the block diagram of the data-processing sequence (Figure 3-1). The flight path of the aircraft was recovered from the combined information available from the navigator's topographic map strips, the flight logs, and the 35-mm tracking film. The image on the film is compared with the corresponding image on the maps to locate the position of the aircraft precisely at intervals of 10 miles, except when terrain characteristics warranted picking points at closer intervals. The intermediate locations are determined by automatic interpolation. Whenever possible, every line-intersection position is recovered by this same method. The recovered points (designated as cardinal points) are posted to the 1:250,000-scale maps and digitized by means of an X-Y coordinate digitizer. The digitized cardinal-point locations are then edited for proper position and identification. A proprietary computer program, BASEMAP, is used to correct for map sheet distortion and to convert the X-Y cardinal locations to latitude and longitude. The output of this procedure is used both for mapping purposes and for merging with the gamma-ray data.

C. DATA ANALYSIS PROCEDURES

The averaged data is analyzed statistically by means of a software package, Computerized Geological Analysis of Radioactivity Data (CGARD), developed by Texas Instruments. This software package relates gamma-ray data to surface geologic map units, calculates estimates of the statistical parameters for the distribution of each element and ratio in each map unit sampled, and determines the statistical significance of each value relative to all other samples of that particular map unit.

The objective of this data analysis is to evaluate gamma-ray data by identifying variations in record values caused by geochemical differences between map units, identifying record values that are statistically significant relative to other samples of the map unit in which they occur, and calculating the magnitude (significance) of the deviation of such records from the mean.

Analyzing data within each geologic cell consists of the following steps:

(1) Record-location maps are superimposed on the geologic map for each NTMS quadrangle. Tabulations are prepared relating every individual averaged record to geologic map units.

(2) These tabulations, in thoroughly edited card form, are used as the input to the search/sort function of CGARD to separate the data according to geologic map unit and to provide the necessary preliminary calculations. Only error-free data passing the statistical adequacy test (paragraph III.A.10) are used in this analysis, which accounts for differing numbers of samples of eU, eTh, and K and their ratios for the same map unit. Data collected over land and open water are analyzed separately.

(3) Based on these calculations, the distributions of data in each geologic map unit are tested for normality/log-normality using a modified chi-squared statistical test.

(4) Means and variances (normal or log-normal as determined above) of each of the six gamma-ray parameters (eU, eTh, K, eU/eTh, eU/K, eTh/K) are calculated for each geologic map unit.

(5) Histograms of the data distribution for each parameter in each geologic map unit are generated (subsection IV.D) and provided in paper print form. Statistical summaries of the results of the chi-squared test, the distribution medians, and the limits of standard deviations (1, 2, 3, and 4 standard deviations above and below the mean) are compiled and provided in the individual quadrangle reports. For parameters with normally distributed data, the median is approximately equal to the mean. For log-normally distributed data, the linear median may be quite different from the linear mean. Although the mean (in the logarithmic domain) was used in calculating statistical significance of log-normally distributed data, medians of the data are included in the statistical summary tables as a measure of the central tendency. The median is considered a more efficient estimator than the mean for the purpose of gross lithologic/geochemical comparisons.

(6) In accordance with the project work statement, the preliminary histograms were examined for significant radiometric inhomogeneities, i.e., more than one mode indicating two or more radiometrically different formations mapped together. These were separated on the basis of potassium or thorium values, whichever showed the most significant modal separation. The minimum point(s) on the histogram between the modes was (were) chosen as the separation value(s). The records were reprocessed according to this partitioning, and new histograms were plotted with the separated units identified by dash numbers (e.g., QAL-1, QAL-2, etc.). The new sample designations are recorded in the computer data listings, and the subsequent analysis was based on these.

(7) Examination of the new histograms reveals that the parameter used as a basis for the partitioning exhibits truncated distributions at the split point(s). The variation among individual samples is sufficient to generate usable histograms for the other parameters, and since the primary purpose of this survey is uranium exploration, it is concluded that the statistical evaluation of the most significant parameters (eU, eU/eTh, and eU/K) is satisfactory. If one were searching for anomalies in the parameter used for separation (K or eTh), the separation should be repeated using one of the other parameters.

(8) Each of the six gamma-ray parameters for each averaged record is analyzed with respect to the statistics for that parameter and map unit. This analysis consists of calculating the significance factor (number of standard deviations above or below the mean) and preparing significance-factor profile maps with the results (subsection IV.C).

(9) All data are then stored on magnetic tape. These data consist of a summary of the means, standard deviations, number of samples, and distribution type for each geologic map unit sampled together with a record-by-record compilation of averaged-record counting rates and statistical significances (paragraph IV.F.5).

The geologic map unit symbols are not exactly reproducible in the computer printout because the printer is generally limited to block capital letters. Mapped unit symbols are related to those used to designate the map units on the data tapes, data listings, histograms, and statistical summary tables in the listings of geologic map units in each individual quadrangle volume.

D. MAGNETOMETER DATA PROCESSING

In the data collection process, one magnetometer record is obtained coincident with each gamma-ray sample. The reduction of the magnetometer data proceeds through three sequential stages: editing and correction, line-tying, and normal International Geomagnetic Reference Field (IGRF) magnetic-field removal. The base-station magnetometer data, collected simultaneously with the airborne data and displayed on the accompanying magnetometer data profiles, are not used in this data reduction.

Following reduction of the data on the field tapes, the magnetometer data are edited and corrected for spikes, recording errors, etc., as necessary.

The data are edited at flight-line intersections, and mismatches are determined using a proprietary computer program, BISTATS, for the statistical analysis of all data at line intersections. Because the actual locations at flight-line intersections are determined directly from the flight-tracking film wherever possible, mismatches caused by improper positioning of data locations are minimized. The mismatches in total-field and residual-field values are corrected by line biasing with linear adjustments. This procedure reduces the data to a common datum and removes most of the effects caused by uncompensated diurnal changes, position uncertainties at the intersections, and small changes in magnetic-field intensity caused by differences in altitude at intersections.

The corrected and adjusted data are then normalized by removal of the nearest-month IGRF calculated on a multiple-degree grid and interpolated to individual airborne magnetic record locations.

The residual magnetic field, after all corrections, adjustments, and normalization, is then used for all stacked profiles, data listings, and data tapes, except the raw spectral-data tapes.

SECTION IV
DATA PRESENTATION

A. STACKED PROFILES

Stacked profiles of two types were prepared at a horizontal scale of 1:250,000 for each NTMS quadrangle. The radiometric stacked profiles were generated from the averaged data and consist of the following parameters (from top to bottom): eTh/K, eU/K, eU/eTh, Gross, K, eTh, eU, atmospheric U daughter contribution (UAIR), average terrain clearance, and residual total magnetic field. The magnetic-field data stacked profiles were generated from the single-record (unaveraged) data and consist of the following parameters (from top to bottom): flight-level air temperature, flight-level barometric pressure, average terrain clearance, diurnal magnetics, and residual total magnetic field. Record positions with identification numbers at regular intervals are posted along the base of the profiles. A geologic strip map, with posted record locations marked at regular intervals, appears at the top of both types of stacked profiles. These strip maps have minimum planimetry, and when they are used it is suggested that they be supplemented by copies of the published geologic and topographic maps.

Each stacked profile contains all data collected on one flight line within a specific NTMS quadrangle. The name of the quadrangle and flight-line number, together with other information, are shown in the legend for each stacked profile. The altitude trace is flagged with a small vertical tick at the location of any records collected at an average terrain clearance of 700 feet or more. Breaks in data collection because of aircraft turnarounds are indicated as such at the base. The vertical scaling of each trace is based on an examination of flight-line histograms of the data generated before plotting profiles. Wild statistical fluctuations of the data are not accommodated by the vertical scaling, but to prevent vertical compression of the scale, certain large positive anomalies are allowed to plot above the maxima.

The stacked profiles at a reduced scale of 1:500,000 are included in Volume 2 of this report.

B. RECORD-LOCATION MAPS

Positional maps of each NTMS quadrangle were prepared on which the location of every tenth averaged record is posted and marked at regular intervals. In addition, the location of every record recovered from the flight-tracking film is indicated with a square symbol. The scale of these maps, generated on a UTM projection, is 1:250,000. These maps are composited with the geological base maps (see subsection V.A.2) for final presentation. Flight-line numbers are indicated at regular intervals. The record-location maps at a reduced scale of 1:500,000 are included in Volume 2 of this report.

C. GAMMA-RAY SIGNIFICANCE-FACTOR PROFILE MAPS

For each NTMS quadrangle in the survey area, a set of six gamma-ray significance-factor profile maps was prepared. Profiles of the statistical significance factors for eU, eTh, K, eU/eTh, eU/K, and eTh/K are presented in map form, with mean values represented by the record locations on the flight lines and lines drawn north or east proportional in length to the number of standard deviations above (solid lines) or below (dashed lines) the mean for every tenth averaged value.

The scale of these maps generated on a UTM projection is 1:250,000. These maps are composited with the geological base maps for final presentation. The geologic maps have minimum planimetry, and when they are used it is suggested that they be supplemented by copies of the published geologic and topographic maps. Flight-line numbers are indicated at regular intervals.

The gamma-ray significance-factor profile maps at a reduced scale of 1:500,000 are included in Volume 2 of this report.

D. HISTOGRAMS

Bar-graph displays are plotted for the counting rate distribution of data for each of the six gamma-ray parameters (averaged values for eU, eTh, K, eU/eTh, eU/K, and eTh/K) in each geological map unit. Histograms for all six gamma-ray parameters in a geological map unit are on a single page. Information is included on the distribution type, the median value, the absolute values at 1, 2, and 3 standard deviations above and below the mean, and the number of samples included in the data for each parameter. The histograms are included in Volume 2 of this report.

E. PRINTER PLOT CONTOUR MAPS

Printer plot contour maps of eTh, eU, K, eU/K, eU/eTh, eTh/K, and magnetic data at a scale of 1:500,000 are presented in Volume 2 of this report.

F. COMPUTER DATA LISTINGS

Single-record and averaged-record data listings are prepared in microfiche form for each NTMS quadrangle surveyed and are contained in Appendix B of Volume 2. Within each quadrangle, the data are arranged by flight line and contain as heading information on each page the subcontractor's name (Texas Instruments), the name of the survey, the name and number of the NTMS quadrangle, the flight-line number, and the day of year on which the data were collected. Microfiche internal indexing is by day of year and flight-line number.

1. Single-Record Reduced Data Listings

The following is an explanation of the column headings for the single-record data listings:

Heading	Description
SEQ	Sequence number of the record in the survey
ID	Record identification number
QUAL	Quality control identification: lists in order (left to right) whether the average terrain clearance, thorium, uranium, and potassium are acceptable. Data collected at greater than 700 feet average terrain clearance are indicated as nonacceptable by an F. Counting-rate data for thorium, uranium, or potassium which are found to be statistically inadequate are indicated by F. All other data are indicated as acceptable by a T.
ALT	Average terrain clearance in feet
LAT	Latitude of the ground location in ten-thousandths of a degree
LONG	Longitude of the ground location in ten-thousandths of a degree
MAG	Residual total magnetic-field value in gammas
RK. UNIT	Surface geologic map unit under the aircraft
TH, U, K	*Reduced counting rates for the three elements, equivalent thorium, equivalent uranium, and potassium, in counts per second
U/TH, U/K, TH/K	*Unitless ratios of the three elemental counting rates
GROSS	Integral counting rate in the gamma-ray energy interval of 0.4 to 3.0 MeV in counts per second
COS	Cosmic counting rate in counts per second
UAIR	Airborne uranium daughter counting rate in counts per second
PRESS	Aircraft-level barometric pressure in pounds per square inch
TEMP	Aircraft-level air temperature in degrees Celsius
SYS	Spectrometer-system number for the type of aircraft used (1 for fixed wing, 3 for rotary wing)

*Data found to be statistically inadequate were assigned a value of 0.

2. Averaged-Record (Statistical Analysis) Listings

The following is an explanation of the column headings for the statistical analysis data listings:

Heading	Description
ID	Record identification number
QUAL	Quality control identification: lists in order (left to right) whether the average terrain clearance, thorium, uranium, and potassium are acceptable. Data collected at greater than 700 feet average terrain clearance are indicated as nonacceptable by an F. Counting rate data for thorium, uranium, or potassium which are found to be statistically inadequate are indicated by an F. All other data are indicated as acceptable by a T.
ALT	Average terrain clearance in feet over the interval of the multiple record average
MAG	Residual total magnetic-field value in gammas. Value is not obtained by averaging.
LAT	Latitude of the ground location of the center record in the multiple-record average in ten-thousandths of a degree.
LONG	Longitude of the ground location of the center record in the multiple-record average in ten-thousandths of a degree.
RK. UNIT	Surface geologic map unit under the aircraft for the majority of the interval covered by the multiple-record average. This is blank if terrain clearance (ALT) was greater than 1000 feet.
U, TH, K	Equivalent uranium, equivalent thorium, and potassium counting rates and statistical significances. Absolute corrected counting rates for the three elements averaged over the multiple record averaging interval. Counting units are in counts per second. The symbol following each counting rate (blank, one, two, or three plus or minus signs) indicates the statistical significance of the counting rate value as being within one standard deviation, one to two standard deviations, two to three standard deviations, or greater than three standard deviations above or below the mean for this geologic rock unit. The symbol N.A. indicates that the value was not acceptable (i.e., did not pass detection-limit test). The statistical significance of data collected over water is not determined.
U/K, U/TH, TH/K	Unitless ratios of the multiple record average values for the three elements. The symbol following each ratio value has the same meaning as that described for the three elements.
GROSS	Multiple record average of the integral counting rate in the gamma-ray energy interval of 0.4 and 3.0 MeV in counts per second.
COS	Cosmic counting rate in counts per second.
UAIR	Airborne uranium daughter counting rate in counts per second.
SYS	Spectrometer-system number for the type of aircraft used (1 for fixed wing, 3 for rotary wing).

G. DATA TAPES

1. General

Five types of data tapes are generated for each NTMS quadrangle surveyed:

1. Raw spectral
2. Single-record reduced
3. Statistical analysis
4. Magnetic
5. Statistical analysis summary

All data tapes are IBM-compatible, nine-track, 800-bpi (NRZI), odd parity, and EBCDIC coded.

A gummed label is attached to each tape reel containing the following information:

- Survey project name, month, and year of survey
- Data tape type
- Subcontractor name (Texas Instruments)
- Tape creation date
- Tape reel count
- Tape recording characteristics
- Block size in bytes
- Tape format information

Single-record reduced, statistical analysis and magnetic data are organized on the tape by flight line. Within a given flight line or tie line, data are organized sequentially by location (latitude and longitude). Within a given survey area, flight lines and tie lines are organized sequentially by location, and all flight-line data precede tie-line data. Processed data from any individual flight line or tie line are completely contained on one tape. The raw spectral data are organized on tape exactly as are processed data.

2. Tape Block Contents and Blocking Structures

The content of each physical block on tape for all five types of data tapes are:

Physical Block Number	Description
1	Format description block
2	Tape identification block
3	First data block
4	Second data block
5	Third data block
.	. . .
.	. . .
.	. . .
.	Last data block
EOF	

The format description block is a literal alphanumeric listing of the Fortran formats and data-item descriptions required to read and identify the contents of the tape. The tape identification block identifies the survey area, the subcontractor (Texas Instruments), the aerial system used, etc., and summarizes the flight-line data recorded on the tape.

Data blocks contain records of data. Formats for each type of data tape are specified below.

All data blocks are recorded in fixed physical block lengths with the following block sizes, record lengths, and blocking factors:

Tape Code	Tape Name	Block size (bytes)	Record Length (bytes)	Blocking Factor
01	Raw spectral	6600	1100	6
02	Single record reduced	6900	138	50
03	Statistical analysis	8000	160	50
04	Magnetic	8000	80	100
05	Statistical analysis summary	7000	140	50

3. Raw Spectral-Data Tapes

The raw spectral data tape provides properly formatted raw spectral data for data bank deposition without normalization, reduction, or corrections.

The first physical block on this tape is the format description block, providing information needed to read the tape. The first 4248 characters on this block are 59 consecutive 72-character lines, literally written as shown in Table 4-1. The remaining 2352 characters in the block are blank.

Table 4-1

Format Description Block Contents

```
 Line                         Character Number
Number  123456789012345678901234567890123456789012345678901234567890123456789012

  1     01 0978  (DATA TAPE TYPE AND FØRMAT SPECIFICATION DATE CØDES)
  2
  3     RAW SPECTRAL DATA TAPE
  4
  5     FØRMAT FØR TAPE IDENTIFICATIØN BLØCK (SECØND BLØCK ØN TAPE)
  6
  7     ITEM        FØRMAT     DESCRIPTIØN
  8     1           A40        QUADRANGLE NAME AS PRØJECT IDENTIFICATIØN
  9     2           A20        NAME ØF SUBCØNTRACTØR
 10     3           I4         APPRØXIMATE DATE ØF SURVEY (MØNTH,YEAR)
 11     4           I1         AERIAL SYSTEM IDENTIFICATIØN CØDE
 12     5           A20        AIRCRAFT IDENTIFICATIØN BY TYPE AND FAA NUMBER
 13     6           I3         BFEC CALIBRATIØN REPØRT NUMBER
 14     7           F6.3       4PI SYSTEM DATA CØLLECTIØN INTERVAL TØ THREE DECIMAL
 15                            PLACES IN SECØNDS
 16     8           F6.3       2PI SYSTEM DATA CØLLECTIØN INTERVAL TØ THREE DECIMAL
 17                            PLACES IN SECØNDS
 18     9           I3         NUMBER ØF CHANNELS (0-3 MEV) FØR 4PI SYSTEM
 19     10          I3         NUMBER ØF CHANNELS (0-3 MEV) FØR 2PI SYSTEM
 20     11          I3         NUMBER ØF FLIGHT LINES ØN THIS TAPE
 21     12          I4         FIRST FLIGHT LINE NUMBER ØN THIS TAPE
 22     13          I6         FIRST RECØRD NUMBER ØF FIRST FLIGHT LINE
 23     14          I3         JULIAN DATE (DAY ØF YEAR) FIRST FLIGHT LINE WAS
 24                            CØLLECTED
 25     15-17       I4,I6,I3   REPEAT ØF ITEMS 12-14 FØR SECØND FLIGHT LINE ØN THIS
 26                            TAPE
 27     *           *                         *
 28     *           *                         *
 29     *           *                         *
 30     306-308     I4,I6,I3   REPEAT ØF ITEMS 12-14 FØR 99TH FLIGHT LINE ØN THIS
 31                            TAPE
 32
 33     FØRMAT FØR RAW SPECTRAL DATA RECØRD (THIRD THRU LAST BLØCK ØN TAPE)
 34
 35     ITEM        FØRMAT     DESCRIPTIØN
 36     1           I1         AERIAL SYSTEM IDENTIFICATIØN CØDE
 37     2           I4         FLIGHT LINE NUMBER
 38     3           I6         RECØRD IDENTIFICATIØN NUMBER
 39     4           I6         GMT TIME ØF DAY (HHMMSS)
 40     5           F8.4       LATITUDE TØ FØUR DECIMAL PLACES IN DEGREES
 41     6           F8.4       LØNGITUDE TØ FØUR DECIMAL PLACES IN DEGREES
 42     7           F6.1       TERRAIN CLEARANCE TØ ØNE DECIMAL PLACE IN METERS
 43     8           F7.1       TØTAL MAGNETIC FIELD INTENSITY TØ ØNE DECIMAL PLACE
 44                            IN GAMMAS
 45     9           A8         SURFACE GEØLØGIC MAP UNIT CØDE
 46     10          I4         QUALITY FLAG CØDES
 47     11          F4.1       ØUTSIDE AIR TEMPERATURE TØ ØNE DECIMAL PLACE IN
 48                            DEGREES CELSIUS
 49     12          F5.1       ØUTSIDE AIR PRESSURE TØ ØNE DECIMAL PLACE IN MMHG
 50     13          F5.3       LIVE TIME CØUNTING PERIØD TØ THREE DECIMAL PLACES IN
 51                            SECØNDS
 52     14          I4         SUMMED RAW ØUTPUT FRØM CØSMIC CHANNELS (3-6 MEV) IN
 53                            CØUNTS
 54     15          I4         RAW ØUTPUT FRØM CHANNEL 1 IN CØUNTS
 55     16          I4         RAW ØUTPUT FRØM CHANNEL 2 IN CØUNTS
 56     *           *                         *
 57     *           *                         *
 58     *           *                         *
 59     270         I4         RAW ØUTPUT FRØM CHANNEL 256 IN CØUNTS
```

The second block on tape is the tape identification block. It provides information identifying the survey, the approximate date of the survey, the subcontractor (Texas Instruments), etc. The data written on this block are in the same format as the first block of this tape and as shown in Table 4-1. The remaining 5204 characters on this block remain blank.

The third and all subsequent blocks on the raw spectral data tape are raw spectral data records with six records per physical block. The data written in each record are in the same format as the first block of this tape as shown on Table 4-1.

4. Single Record Reduced Data Tapes

The single record reduced data tape provides 1-second, summed channel information that is corrected and normalized.

The first physical block on this tape is the format description block, providing information needed to read this tape. The first 6768 characters on this block consist of 94 consecutive 72-character lines, as shown in Table 4-2. The remaining 132 characters on this block remain blank.

The second block on tape is the tape identification block, providing information identifying the survey, the approximate date of the survey, the subcontractor (Texas Instruments), flight lines, etc. The data written on this block are in the same format as the first block of this tape and as shown in Table 4-2. The remaining 4978 characters on this block remain blank.

The third and all subsequent blocks on the single record reduced data tape are single record reduced data records with 50 records per physical block. The data written in each record are in the same format as the first block of this tape and as shown in Table 4-2.

Table 4-2

Single Record Reduced Data Format Description Block Contents

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
1	02 0978 (DATA TAPE TYPE AND FØRMAT SPECIFICATIØN DATE CØDES)		
2			
3	SINGLE RECØRD REDUCED DATA TAPE		
4			
5	FØRMAT FØR TAPE IDENTIFICATIØN BLØCK (SECØND BLØCK)		
6			
7	ITEM	FØRMAT	DESCRIPTIØN
8	1	A40	QUADRANGLE NAME AS PRØJECT IDENTIFICATIØN
9	2	A20	NAME ØF SUBCØNTRACTØR
10	3	I4	APPRØXIMATE DATE ØF SURVEY (MØNTH,YEAR)
11	4	I1	NUMBER ØF AERIAL SYSTEMS USED TØ CØLLECT DATA FØR
12			THIS QUADRANGLE
13	5	I1	AERIAL SYSTEM IDENTIFICATIØN CØDE FØR FIRST SYSTEM
14	6	A20	AIRCRAFT IDENTIFICATIØN BY TYPE AND FAA NUMBER FØR
15			FIRST SYSTEM
16	7	F6.1	NØMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TØ
17			TERRESTRIAL PØTASSIUM (K-40) TØ ØNE DECIMAL PLACE
18			IN CPS PER PERCENT K FOR FIRST SYSTEM
19	8	F6.1	NØMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TØ
20			TERRESTRIAL URANIUM (BI-214) TØ ØNE DECIMAL PLACE
21			IN CPS PER PPM EQUIVALENT U
22	9	F6.1	NØMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TØ
23			TERRESTRIAL THØRIUM (TL-208) TØ ØNE DECIMAL PLACE
24			IN CPS PER PPM EQUIVALENT TH
25	10	I6	BLANK FIELD (999999)
26	11	F6.3	4PI-SYSTEM DATA CØLLECTION INTERVAL TØ THREE DECIMAL
27			PLACES IN SECØNDS FØR FIRST SYSTEM
28	12	F6.3	2PI-SYSTEM DATA CØLLECTION INTERVAL TØ THREE DECIMAL
29			PLACES IN SECØNDS FØR FIRST SYSTEM
30	13	I3	NUMBER ØF CHANNELS (0-3 MEV) IN 4PI SYSTEM FØR FIRST
31			AERIAL SYSTEM
32	14	I3	NUMBER ØF CHANNELS (0-3 MEV) IN 2PI SYSTEM FØR FIRST
33			AERIAL SYSTEM
34	15-24	(SAME)	REPEAT ØF ITEMS 5-14 FØR SECØND AERIAL SYSTEM
35	*	*	*
36	*	*	*
37	*	*	*
38	85-94	(SAME)	REPEAT ØF ITEMS 5-14 FØR NINTH AERIAL SYSTEM
39	95	I3	NUMBER ØF FLIGHT LINES ØN THIS TAPE
40	96	I4	FIRST FLIGHT LINE NUMBER ØN THIS TAPE
41	97	I6	FIRST RECØRD NUMBER ØF FIRST FLIGHT LINE
42	98	I3	JULIAN DATE (DAY ØF YEAR) FIRST FLIGHT-LINE DATA WAS
43			CØLLECTED
44	99-101	I4,I6,I3	REPEAT ØF ITEMS 96-98 FØR SECØND FLIGHT LINE ØN THIS
45			TAPE
46	*	*	*
47	*	*	*
48	*	*	*
49	390-392	I4,I6,I3	REPEAT ØF ITEMS 96-98 FØR 99TH FLIGHT LINE ØN THIS
50			TAPE
51			

Table 4-2 (Contd)

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
52	FØRMAT FØR SINGLE RECØRD REDUCED DATA RECØRD (THIRD THRU LAST BLØCK)		
53			
54	ITEM	FØRMAT	DESCRIPTIØN
55	1	I1	AERIAL SYSTEM IDENTIFICATIØN CØDE
56	2	I4	FLIGHT LINE NUMBER
57	3	I6	RECØRD IDENTIFICATIØN NUMBER
58	4	I6	GMT TIME ØF DAY (HHMMSS)
59	5	F8.4	LATITUDE TØ FØUR DECIMAL PLACES IN DEGREES
60	6	F8.4	LØNGITUDE TØ FØUR DECIMAL PLACES IN DEGREES
61	7	F6.1	TERRAIN CLEARANCE TØ ØNE DECIMAL PLACE IN METERS
62	8	F7.1	RESIDUAL (IGRF REMØVED) MAGNETIC FIELD INTENSITY
63			TØ ØNE DECIMAL PLACE IN GAMMAS
64	9	A8	SURFACE GEØLØGIC MAP UNIT CØDE
65	10	I4	QUALITY FLAG CØDES
66	11	F6.1	APPARENT CØNCENTRATIØN ØF TERRESTRIAL PØTASSIUM
67			(K-40) TØ ØNE DECIMAL PLACE IN PERCENT K
68	12	F4.1	UNCERTAINTY IN TERRESTRIAL PØTASSIUM TØ ØNE DECIMAL
69			PLACE IN PERCENT K
70	13	F6.1	APPARENT CØNCENTRATIØN ØF TERRESTRIAL URANIUM
71			(BI-214) TØ ØNE DECIMAL PLACE IN PPM EQUIVALENT U
72	14	F4.1	UNCERTAINTY IN TERRESTRIAL URANIUM TØ ØNE DECIMAL
73			PLACE IN PPM EQUIVALENT U
74	15	F6.1	APPARENT CØNCENTRATIØN ØF TERRESTRIAL THØRIUM
75			(TL-208) TØ ØNE DECIMAL PLACE IN PPM EQUIVALENT TH
76	16	F4.1	UNCERTAINTY IN TERRESTRIAL THØRIUM TØ ØNE DECIMAL
77			PLACE IN PPM EQUIVALENT TH
78	17	F6.1	URANIUM-TØ-THØRIUM RATIØ TØ ØNE DECIMAL PLACE IN
79			PPM EQUIVALENT U PER PPM EQUIVALENT TH
80	18	F6.1	URANIUM-TØ-PØTASSIUM RATIØ TØ ØNE DECIMAL PLACE IN
81			PPM EQUIVALENT U PER PERCENT K
82	19	F6.1	THØRIUM-TØ-PØTASSIUM RATIØ TØ ØNE DECIMAL PLACE IN
83			PPM EQUIVALENT TH PER PERCENT K
84	20	F8.1	GRØSS GAMMA (0.4-3.0 MEV) CØUNT RATE TØ ØNE DECIMAL
85			PLACE IN CØUNTS PER SECØND
86	21	F6.1	UNCERTAINTY IN GRØSS GAMMA CØUNT RATE TØ ØNE DECIMAL
87			PLACE IN CØUNTS PER SECØND
88	22	F5.1	ATMØSPHERIC BI-214 4PI CØRRECTIØN TØ ØNE DECIMAL
89			PLACE IN PPM EQUIVALENT U
90	23	F4.1	UNCERTAINTY IN ATMØSPHERIC BI-214 4PI CØRRECTIØN
91			TØ ØNE DECIMAL PLACE IN PPM EQUIVALENT U
92	24	F4.1	ØUTSIDE AIR TEMPERTURE TØ ØNE DECIMAL PLACE IN
93			DEGREES CELSIUS
94	25	F5.1	ØUTSIDE AIR PRESSURE TØ ØNE DECIMAL PLACE IN MMHG

5. Statistical Analysis Data Tapes

The statistical analysis tape provides averaged-record parameters for each radioelement and radioelement ratios in relation to the appropriate geologic map unit.

The first physical block on this tape is the format description block, providing information needed to read this tape. The first 7560 characters on this block consist of 105 consecutive 72-character lines, literally written as shown in Table 4-3. The remaining 440 characters on this block remain blank.

The second block on tape is the tape identification block, providing information identifying the survey, the approximate date of the survey, the subcontractor (Texas Instruments), flight lines, etc. The data written on this block are in the same format as the first block of this tape and as shown in Table 4-3. The remaining 6078 characters on this block remain blank.

The third and all subsequent blocks on the statistical analysis data tape are statistical analysis data records with 50 records per physical block. The data written in each record are in the same format as the first block of this tape and as shown in Table 4-3.

6. Magnetic Data Tapes

The purpose of the magnetic data tape is to provide industry and other government agencies magnetic data separate from radiometric information.

The first physical block on each magnetic data tape is the format description block, providing information needed to read this tape. The first 3384 characters on this block consist of 47 consecutive 72-character lines, literally written as shown in Table 4-4. The remaining 4616 characters on this block remain blank.

Table 4-3

Statistical Analysis Format Description Block Contents

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
1	03 0978 (DATA TAPE TYPE AND FØRMAT SPECIFICATIØN DATE CØDES)		
2			
3	STATISTICAL ANALYSIS DATA TAPE		
4			
5	FØRMAT FØR TAPE IDENTIFICATIØN BLØCK (SECØND BLØCK)		
6			
7	ITEM	FØRMAT	DESCRIPTIØN
8	1	A40	QUADRANGLE NAME AS PRØJECT IDENTIFICATIØN
9	2	A20	NAME ØF SUBCØNTRACTØR
10	3	I4	APPRØXIMATE DATE ØF SURVEY (MØNTH,YEAR)
11	4	I1	NUMBER ØF AERIAL SYSTEMS USED TØ CØLLECT DATA FØR
12			THIS QUADRANGLE
13	5	I1	AERIAL SYSTEM IDENTIFICATIØN CØDE FØR FIRST SYSTEM
14	6	A20	AIRCRAFT IDENTIFICATIØN BY TYPE AND FAA NUMBER FØR
15			FIRST SYSTEM
16	7	F6.1	NØMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TØ
17			TERRESTRIAL PØTASSIUM (K-40) TØ ØNE DECIMAL PLACE
18			IN CPS PER PERCENT K
19	8	F6.1	NØMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TØ
20			TERRESTRIAL URANIUM (BI-214) TØ ØNE DECIMAL PLACE
21			IN CPS PER PPM EQUIVALENT U
22	9	F6.1	NØMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TØ
23			TERRESTRIAL THØRIUM (TL-208) TØ ØNE DECIMAL PLACE
24			IN CPS PER PPM EQUIVALENT TH
25	10	I6	BLANK FIELD (999999)
26	11	F6.3	4PI-SYSTEM DATA CØLLECTIØN INTERVAL TØ THREE DECIMAL
27			PLACES IN SECØNDS FØR FIRST SYSTEM
28	12	F6.3	2PI-SYSTEM DATA CØLLECTIØN INTERVAL TØ THREE DECIMAL
29			PLACES IN SECØNDS FØR FIRST SYSTEM
30	13	I3	NUMBER ØF CHANNELS (0-3 MEV) IN 4PI SYSTEM FØR FIRST
31			AERIAL SYSTEM
32	14	I3	NUMBER ØF CHANNELS (0-3 MEV) IN 2PI SYSTEM FØR FIRST
33			AERIAL SYSTEM
34	15-24	(SAME)	REPEAT ØF ITEMS 5-14 FØR SECØND AERIAL SYSTEM
35	*	*	*
36	*	*	*
37	*	*	*
38	85-94	(SAME)	REPEAT ØF ITEMS 5-14 FØR NINTH AERIAL SYSTEM
39	95	I3	NUMBER ØF FLIGHT LINES ØN THIS TAPE
40	96	I4	FIRST FLIGHT LINE NUMBER ØN THIS TAPE
41	97	I6	FIRST RECØRD NUMBER ØF FIRST FLIGHT LINE
42	98	I3	JULIAN DATE (DAY ØF YEAR) FIRST FLIGHT LINE DATA WAS
43			CØLLECTED
44	99-101	I4,I6,I3	REPEAT ØF ITEMS 96-98 FØR SECØND FLIGHT LINE ØN THIS
45			TAPE
46	*	*	*
47	*	*	*
48	*	*	*
49	390-392	I4,I6,I3	REPEAT ØF ITEMS 96-98 FØR 99TH FLIGHT LINE ØN THIS
50			TAPE
51			

Table 4-3 (Contd)

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
52	FØRMAT FØR STATISTICAL ANALYSIS DATA RECØRD (THIRD THRU LAST BLØCK)		
53			
54	ITEM	FØRMAT	DESCRIPTIØN
55	1	I1	AERIAL SYSTEM IDENTIFICATIØN CØDE
56	2	I4	FLIGHT LINE NUMBER
57	3	I6	RECØRD IDENTIFICATIØN NUMBER
58	4	I6	GMT TIME ØF DAY (HHMMSS)
59	5	F8.4	LATITUDE TØ FØUR DECIMAL PLACES IN DEGREES
60	6	F8.4	LØNGITUDE TØ FØUR DECIMAL PLACES IN DEGREES
61	7	F6.1	TERRAIN CLEARANCE TØ ØNE DECIMAL PLACE IN METERS
62	8	F7.1	RESIDUAL (IGRF REMØVED) MAGNETIC FIELD INTENSITY
63			TØ ØNE DECIMAL PLACE IN GAMMAS
64	9	A8	SURFACE GEØLØGIC MAP UNIT CØDE
65	10	I5	QUALITY FLAG CØDES
66	11	F6.1	AVERAGED CØNCENTRATIØN ØF TERRESTRIAL PØTASSIUM
67			(K-40) TØ ØNE DECIMAL PLACE IN PERCENT K
68	12	F4.1	UNCERTAINTY IN TERRESTRIAL PØTASSIUM TØ ØNE DECIMAL
69			PLACE IN PERCENT K
70	13	F5.1	PØTASSIUM STANDARD DEVIATION FRØM THE MEAN TØ ØNE
71			DECIMAL PLACE AND ALGEBRAICALLY SIGNED
72	14	F6.1	AVERAGED CØNCENTRATIØN ØF TERRESTRIAL URANIUM
73			(BI-214) TØ ØNE DECIMAL PLACE IN PPM EQUIVALENT U
74	15	F4.1	UNCERTAINTY IN TERRESTRIAL URANIUM TØ ØNE DECIMAL
75			PLACE IN PPM EQUIVALENT U
76	16	F5.1	URANIUM STANDARD DEVIATION FRØM THE MEAN TØ ØNE
77			DECIMAL PLACE AND ALGEBRAICALLY SIGNED
78	17	F6.1	AVERAGED CØNCENTRATIØN ØF TERRESTRIAL THØRIUM
79			(TL-208) TØ ØNE DECIMAL PLACE IN PPM EQUIVALENT TH
80	18	F4.1	UNCERTAINTY IN TERRESTRIAL THØRIUM TØ ØNE DECIMAL
81			PLACE IN PPM EQUIVALENT TH
82	19	F5.1	THØRIUM STANDARD DEVIATION FRØM THE MEAN TØ ØNE
83			DECIMAL PLACE AND ALGEBRAICALLY SIGNED
84	20	F8.1	GRØSS GAMMA (0.4-3.0 MEV) CØUNT RATE TØ ØNE DECIMAL
85			PLACE IN CØUNTS PER SECØND
86	21	F6.1	UNCERTAINTY IN GRØSS GAMMA CØUNT RATE TØ ØNE DECIMAL
87			PLACE IN CØUNTS PER SECØND
88	22	F5.1	ATMØSPHERIC BI-214 4PI CØRRECTIØN TØ ØNE DECIMAL
89			PLACE IN PPM EQUIVALENT U
90	23	F4.1	UNCERTAINTY IN ATMØSPHERIC BI-214 4PI CØRRECTIØN
91			TØ ØNE DECIMAL PLACE IN PPM EQUIVALENT U
92	24	F6.1	AVERAGED URANIUM-TØ-THØRIUM RATIØ TØ ØNE DECIMAL
93			PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
94	25	F5.1	URANIUM-TØ-THØRIUM RATIØ STANDARD DEVIATIØN FRØM THE
95			MEAN TØ ØNE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
96	26	F6.1	AVERAGED URANIUM-TØ-PØTASSIUM RATIØ TØ ØNE DECIMAL
97			PLACE IN PPM EQUIVALENT U PER PERCENT K
98	27	F5.1	URANIUM-TØ-PØTASSIUM RATIØ STANDARD DEVIATIØN FRØM
99			THE MEAN TØ ØNE DECIMAL PLACE AND ALGEBRAICALLY
100			SIGNED
101	28	F6.1	AVERAGED THØRIUM-TØ-PØTASSIUM RATIØ TØ ØNE DECIMAL
102			PLACE IN PPM EQUIVALENT TH PER PERCENT K
103	29	F5.1	THØRIUM-TØ-PØTASSIUM RATIØ STANDARD DEVIATIØN FRØM
104			THE MEAN TØ ØNE DECIMAL PLACE AND ALGEBRAICALLY
105			SIGNED

Table 4-4

Magnetic Tape Format Description Block Contents

line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
1	04 0978 (DATA TAPE TYPE AND FØRMAT SPECIFICATIØN DATE CØDES)		
2			
3	MAGNETIC DATA TAPE		
4			
5	FØRMAT FØR TAPE IDENTIFICATIØN BLØCK (SECØND BLØCK)		
6			
7	ITEM	FØRMAT	DESCRIPTIØN
8	1	A40	QUADRANGLE NAME AS PRØJECT IDENTIFICATIØN
9	2	A20	NAME ØF SUBCØNTRACTØR
10	3	I4	APPRØXIMATE DATA ØF SURVEY (MØNTH,YEAR)
11	4	I3	NUMBER ØF FLIGHT LINES ØN THIS TAPE
12	5	I4	FIRST FLIGHT LINE ØN THIS TAPE
13	6	I6	FIRST RECØRD NUMBER ØF FIRST FLIGHT LINE
14	7	I3	JULIAN DATA (DAY ØF YEAR) FIRST FLIGHT LINE DATA WAS
15			CØLLECTED
16	8	F8.4	LATITUDE ØF GRØUND BASE STATIØN TØ FØUR DECIMAL
17			PLACES IN DEGREES FØR FIRST FLIGHT LINE
18	9	F8.4	LØNGITUDE ØF GRØUND BASE STATIØN TØ FØUR DECIMAL
19			PLACES IN DEGREES FØR FIRST FLIGHT LINE
20	10-14	(SAME)	REPEAT ØF ITEMS 5-9 FØR SECØND FLIGHT LINE ØN THIS
21			TAPE
22	*	*	*
23	*	*	*
24	*	*	*
25	495-499	(SAME)	REPEAT ØF ITEMS 5-9 FØR 99TH FLIGHT LINE ØN THIS
26			TAPE
27			
28	FØRMAT FØR MAGNETIC DATA RECØRD (THIRD THRU LAST BLØCK)		
29			
30	ITEM	FØRMAT	DESCRIPTIØN
31	1	I1	AERIAL SYSTEM IDENTIFICATIØN CØDE
32	2	I4	FLIGHT LINE NUMBER
33	3	I6	RECØRD IDENTIFICATIØN NUMBER
34	4	I6	GMT TIME ØF DAY (HHMMSS)
35	5	F8.4	LATITUDE TØ FØUR DECIMAL PLACES IN DEGREES
36	6	F8.4	LØNGITUDE TØ FØUR DECIMAL PLACES IN DEGREES
37	7	F6.1	TERRAIN CLEARANCE TØ ØNE DECIMAL PLACE IN METERS
38	8	F5.1	ØUTSIDE AIR PRESSURE TØ ØNE DECIMAL PLACE IN MMHG
39	9	A8	SURFACE GEØLOGIC MAP UNIT CØDE
40	10	F7.1	TØTAL MAGNETIC FIELD INTENSITY TØ ØNE DECIMAL PLACE
41			IN GAMMAS
42	11	F7.1	RESIDUAL (IGRF REMØVED) MAGNETIC FIELD INTENSITY
43			TØ ØNE DECIMAL PLACE IN GAMMAS
44	12	F7.1	DIURNAL MAGNETIC INTENSITY VARIATIØN TØ ØNE DECIMAL
45			PLACE IN GAMMAS
46	13	F7.1	MAGNETIC DEPTH-TØ-BASEMENT TØ ØNE DECIMAL PLACE
47			IN METERS (IF REQUIRED)

The second block on tape is the tape identification block, providing information identifying the survey, the approximate date of the survey, the subcontractor (Texas Instruments), flight-lines, etc. The data written on this block are in the same format as the first block of this tape and as shown on Table 4-4. The remaining 5062 characters on this block remain blank.

The third and all subsequent block on the magnetic data tape are magnetic data records with 100 records per physical block. The data written in each record are in the same format as the first block of this tape and as shown in Table 4-4.

7. Statistical Analysis Summary Tape

The statistical analysis summary tape provides a condensation of the information contained in the statistical analysis data tape, divided according to the geologic map unit. The statistical analysis summary data tape is recorded and labeled as a second but separate file on the statistical analysis data tape.

The first physical block on the statistical analysis summary data file is the format description block, providing information needed to read this tape file. The first 4320 characters on this block are 60 consecutive 72-character lines, literally written as shown in Table 4-5. The remaining 2680 characters on this block remain blank.

The second block on tape is the tape identification block, providing information identifying the survey, the approximate date of the survey, the subcontractor (Texas Instruments), etc. The data written on this block are in the same format as in the first block of this file and as shown in Table 4-4. The remaining 6930 characters on this block remain blank.

The third and all subsequent blocks on the statistical analysis summary file are statistical analysis summary records with 50 records per physical block. The data written in each record are in the same format as the first block of this file and as shown in Table 4-4.

Table 4-5

Statistical Analysis Summary Tape Format Description Block Contents

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
1	05 0978 (DATA TAPE TYPE AND FØRMAT SPECIFICATIØN DATE CØDE)		
2			
3	STATISTICAL ANALYSIS SUMMARY TAPE (ØR FILE)		
4			
5	FØRMAT FØR TAPE IDENTIFICATIØN BLØCK (SECØND BLØCK)		
6			
7	ITEM	FØRMAT	DESCRIPTIØN
8	1	A40	QUADRANGLE NAME AS PRØJECT IDENTIFICATIØN
9	2	A20	NAME ØF SUBCØNTRACTØR
10	3	I4	APPRØXIMATE DATE ØF SURVEY (MØNTH,YEAR)
11	4	I6	NUMBER ØF GEØLØGIC MAP UNITS USED FØR THIS
12			QUADRANGLE
13			
14	FØRMAT FØR STATISTICAL ANALYSIS SUMMARY DATA RECØRD (THIRD THRU LAST		
15	BLØCK)		
16			
17	ITEM	FØRMAT	DESCRIPTIØN
18	1	A8	SURFACE GEØLØGIC MAP UNIT IDENTIFYING CØDE
19	2	I6	TØTAL RECØRDS FØR GEØLØGIC MAP UNIT
20	3	I6	NUMBER ØF PØTASSIUM RECØRDS CØMPUTED FØR GEØLØGIC
21			UNIT
22	4	F6.1	PØTASSIUM CØNCENTRATIØN MEAN TØ ØNE DECIMAL PLACE
23			IN PERCENT K
24	5	F6.1	PØTASSIUM CØNCENTRATIØN STANDARD DEVIATIØN TØ ØNE
25			DECIMAL PLACE IN PERCENT K
26	6	A3	PØTASSIUM CØNCENTRATIØN DISTRIBUTIØN CØDE
27	7	I6	NUMBER ØF URANIUM RECØRDS CØMPUTED FØR GEØLØGIC UNIT
28	8	F6.1	URANIUM CØNCENTRATIØN MEAN TØ ØNE DECIMAL PLACE
29			IN PPM EQUIVALENT U
30	9	F6.1	URANIUM CØNCENTRATIØN STANDARD DEVIATIØN TØ ØNE
31			DECIMAL PLACE IN PPM EQUIVALENT U
32	10	A3	URANIUM CØNCENTRATIØN DISTRIBUTIØN CØDE
33	11	I6	NUMBER ØF THØRIUM RECØRDS CØMPUTED FØR GEØLØGIC UNIT
34	12	F6.1	THØRIUM CØNCENTRATIØN MEAN TØ ØNE DECIMAL PLACE IN
35			PPM EQUIVALENT TH
36	13	F6.1	THRØIUM CØNCENTRATIØN STANDARD DEVIATIØN TØ ØNE
37			DECIMAL PLACE IN PPM EQUIVALENT TH
38	14	A3	THØRIUM CØNCENTRATIØN DISTRIBUTIØN CØDE
39	15	I6	NUMBER ØF URANIUM-TØ-THØRIUM RATIØ RECØRDS CØMPUTED
40			FØR GEØLØGIC UNIT
41	16	F6.1	URANIUM-TØ-THØRIUM RATIØ MEAN TØ ØNE DECIMAL PLACE
42			IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
43	17	F6.1	URANIUM-TØ-THØRIUM RATIØ STANDARD DEVIATIØN TØ ØNE
44			DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT
45			TH
46	18	A3	URANIUM-TØ-THØRIUM RATIØ DISTRIBUTIØN CØDE
47	19	I6	NUMBER ØF URANIUM-TØ-PØTASSIUM RATIØ RECØRDS
48			CØMPUTED FØR GEØLØGIC UNIT
49	20	F6.1	URANIUM-TØ-PØTASSIUM RATIØ MEAN TØ ØNE DECIMAL PLACE
50			IN PPM EQUIVALENT U PER PERCENT K
51	21	F6.1	URANIUM-TØ-PØTASSIUM RATIØ STANDARD DEVIATIØN TØ ØNE
52			DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
53	22	A3	URANIUM-TØ-PØTASSIUM RATIØ DISTRIBUTIØN CØDE
54	23	I6	NUMBER ØF THØRIUM-TØ-PØTASSIUM RATIØ RECØRDS
55			CØMPUTED FØR GEØLØGIC UNIT
56	24	F6.1	THØRIUM-TØ-PØTASSIUM RATIØ MEAN TØ ØNE DECIMAL PLACE
57			IN PPM EQUIVALENT TH PER PERCENT K
58	25	F6.1	THØRIUM-TØ-PØTASSIUM RATIØ STANDARD DEVIATIØN TØ ØNE
59			DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
60	26	A3	THØRIUM-TØ-PØTASSIUM RATIØ DISTRIBUTIØN CØDE

SECTION V
DATA INTERPRETATION

A. GAMMA-RAY DATA INTERPRETATION

1. General

Correct interpretation of an airborne gamma-ray spectrometer survey demands an understanding of principles and theory of the survey and data processing techniques. The preceding sections have provided much of this information. However, some additional explanations, especially pertaining to statistical analysis of the data, are presented to call attention to some of the obvious and not so obvious pitfalls.

The nature of the statistical analysis used in producing the accompanying significance-factor profile maps is such that extremely high and low values will be pinpointed in each geologic map unit. Because emission and detection of gamma rays are random processes, high and low extreme values may be obtained in situations with poor counting statistics. Such is the case in areas of great topographic relief, where the survey aircraft is forced to maintain high terrain clearance. Cursory examination of topographic maps will reveal most such problematic areas, but reference to the terrain-clearance data on the stacked profiles will be necessary for detailed analyses. As discussed in Section III, in some areas data collected at extreme terrain clearance (somewhat arbitrarily set at 1000 feet) were necessarily omitted from the statistical analysis and the profile maps. Including such data and their random, meaningless extreme high and low values would have severely biased the total analysis. Reference to the data listings or the stacked profiles (in Volume 2) is necessary to identify such data.

In general, the significance of extreme values in any geologic map unit also becomes more questionable as the average content of uranium, thorium, or potassium decreases (with corresponding decreases in the emission rates of their gamma rays) and as the number of individual samples of the map unit decreases. This latter situation, which can be determined by reference to the tabulation of the number of samples (in the microfiche Statistical Summary Tables), prevents adequate definition of the distribution of equivalent uranium (eU), equivalent thorium (eTh), and potassium values (K).

High equivalent uranium values in some cases will be caused by undetected temperature inversions that trap atmospheric radon decay products beneath the aircraft and falsely increase the reduced equivalent uranium values. In spite of preflight monitoring of atmospheric conditions and continuous measurements of airborne radioactivity, localized atmospheric conditions can prevent the mixing of radon necessary for proper correction. High measured eU values associated with topographic lows may be the result of such conditions.

The success of the CGARD statistical analysis at delineating anomalous values depends largely on the ability to define precisely the distributions of the data in statistical terms. Ideally, only data from one geochemical unit (as opposed to lithologic or mapping unit) should be grouped together for analysis, and the proper distribution type (normal, lognormal, etc.) should be selected. If more than one geochemical unit is present in a radiometric-parameter histogram, a bimodal or multimodal distribution may result, with consequent misleading statistical parameters. In this survey, all eU, eTh, and K histograms were examined, and any distinctly bimodal or multimodal distributions were split at the minima between the modes of the K or eTh histograms. New histograms and statistical parameters were computed before CGARD processing. Examination of the new histograms showed that this "geochemical analysis" procedure generally reduced the problem of misleading anomalies caused by more than one geochemical type being included in a single map unit.

A special problem is caused by snow, water cover, and water-saturated surface materials. Where a particular formation is partly water-saturated and partly well-drained, a bimodal histogram may result, with one mean value near zero and another near the normal mean value for the formation if analysis will result in a falsely low mean and falsely high standard deviation and may obscure possibly meaningful broad low anomalies. Only the "tips" of the highest anomalies may be defined on the significance-factor maps. Another effect may be the definition of any particularly dry portions of the formation as anomalous even though they may contain only normal amounts of uranium, thorium, and potassium. This problem was not important in this survey.

Quaternary deposits in general and stream and glacial deposits in particular present another situation requiring special attention. Because the geochemistry of these deposits is controlled in large part by provenance, uranium, thorium, and potassium concentrations in these deposits may reflect the higher or lower content of these elements in distant source materials. On the other hand, concentrations in Quaternary deposits which are accompanied by concentrations in adjoining rocks may be considered as meaningful as any enriched zones that traverse rock-type boundaries.

Since the terms "anomaly" and "anomalous values" have no universally accepted meanings, their present usage warrants explanation. Data on the accompanying profile maps are simply indications of the statistical significance of the data at each point relative to all other sample values in the same geologic map unit. In turn, the statistical significance (or significance factor) is a measure of the degree of certainty that particular values fall above or below the mean value for that particular geologic map unit. As the significance factor increases in a positive or negative sense, the certainty that the value is different from the mean increases. In practical terms, this implies that the computed value is relatively unusual. At some level of significance, this unusualness of the value may be arbitrarily declared anomalous. The approach of Hawkes and Webb (1962), perhaps the one in widest use, is to declare values deviating at least two standard deviations from the mean (i.e., absolute values of significance factors greater than or equal to two) as anomalous. Another approach, and the one used here, is that an anomaly consists of a spatial association of statistically high or statistically low values. In addition to avoiding a conflict with the dictionary meaning of the term anomaly (i.e., deviation in excess of normal variation), the use of a spatial association is more in keeping with the regional exploration concept adopted for this survey. The terms "statistically high" and "statistically low" will be applied to individual values deviating significantly from the mean.

Some individual values may be occasionally geologically misclassified, resulting in the assignment of an incorrect statistical significance. In rare instances, this could result in a grouping of points that might be falsely interpreted as an anomaly. The relative importance of this problem is inversely dependent on the accuracy and completeness of the geologic mapping.

False equivalent uranium anomalies caused by extreme terrain clearances, geologic misclassification, or a mixture of water-saturated and well-drained surface materials all have a general common characteristic that may be used to identify them; i.e., their potassium and equivalent thorium values will probably be falsely anomalous also. Therefore, anomalies where there are similar positive or negative significance factors for all three elements should be viewed with suspicion. A legitimate mapped positive equivalent uranium anomaly in most instances should be associated with an area enriched in uranium relative to thorium and potassium.

The following analysis attempts to relate the major features of the equivalent uranium data and the eU/eTh and eU/K ratios to the geology and known uranium occurrences in the survey area. Follow-up studies could apply similar approaches to the equivalent thorium and potassium data as well as to their ratio to yield a broader understanding of their regional distribution and relationships to the mapped equivalent uranium anomalies.

2. Geologic Mapping

A special geologic map at 1:250,000 scale of this quadrangle is described in Volume 2.

3. Selection of Uranium Anomalies

The eU, eU/eTh, and eU/K data sets were each 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 5-1.

Table 5-1

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
Mean + 4 standard deviations	0.00003 or 1:33,300

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

The maximum probability of 1:33,300 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 1:33,300, Table 5-2 gives the minimum requirements for all adjacent points in a reliable anomaly. This allows groupings of statistically high (or low) points more than 1.45 standard deviations from the mean to be evaluated. Data including eU, eU/eTh, and eU/K are searched by the computer, and all acceptable significant anomalies are identified. These are printed out on a "preferred-anomaly" map 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.

Table 5-2

Minimum Deviation from the Mean for all Points for Limiting Probability of 1:33,300 (Elkins, 1940)

Number of Points Supporting Anomaly	Minimum Deviation
1	4.00 standard deviations
2	2.54 standard deviations
3	1.87 standard deviations
4	1.45 standard deviations

The next step is to identify eU anomalies that show a geochemical enrichment of eU over the eTh and/or K present. First-priority anomalies are those that show simultaneous valid eU, eU/eTh, and eU/K anomalies. The preferred-anomaly maps are marked to show all such first-priority anomalies, and they are presented with accompanying anomaly evaluation tables in Table 2-3 of Volume 2.

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 relatively depleted of uranium. These may have been sources from which the uranium was removed by geochemical activity and concentrated in nearby deposits. 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, 1977b).

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 maps in the individual quadrangle volumes (Figure 2-1). Examples of special situations where second-priority anomalies can be important indicators of uranium prospects are presented in Table 5-3.

Table 5-3

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.

4. Evaluation of Anomalies

The translucent preferred-anomaly maps were examined, along with the supporting data tables, published topographic maps, and the geologic maps, to evaluate each first-priority anomaly by judging its validity as a potential indication of actual uranium enrichment that deserves further investigation. Each valid or preferred first-priority anomaly should fulfill the following requirements:

- It should not be suspect of being caused by an atmospheric inversion or other uncompensated atmospheric Bi-214; i.e., it should not be confined to a topographic low and be accompanied by other anomalies also in topographic lows on the same flight line. (Another criterion of suspect inversion effects is the presence of early morning calm-wind conditions as indicated on the flight log.) Under normal conditions, this buildup has dissipated before 10:00 a.m., when flying normally began during this survey.

- It should be associated with geologic formations that would be reasonable hosts for vein or stratiform uranium deposits that might be worked economically. This would include most sedimentary, metamorphic, or igneous map units. The presence of black shales and other lithologies in a given map unit would suggest that the shales caused the anomaly and that under present economic conditions the deposit would not be workable. The presence of alluvium and high eU, normal eU/eTh, (high eTh), and high eU/K could indicate a placer deposit of monazite and/or radioactive "blacks" that also probably would not be economic at present. The presence of continental sandstones or alkaline intrusives, however, would indicate favorable prospects for possible economic uranium recovery.

- It should not be suspect of resulting from any cultural cause unrelated to natural radioactivity such as nuclear testing, reactor operations, structures such as highways, railroads, dams, levees, or buildings.

The final anomaly evaluations are presented in the individual quadrangle volumes of this report.

B. MAGNETOMETER DATA INTERPRETATION

1. Applications of Magnetic Data

The utility of aeromagnetic data in enhancing results of reconnaissance gamma-ray surveys lies not in any direct relationship but rather in providing a better understanding of the geology of the region. The magnetic data may be interpreted to map:

- Regional tectonic patterns

- Lithologic variations in the crystalline basement

- Depth to and structural configurations of the crystalline basement surface

- Location, depth, and areal extent of plutons, dikes, sills, and volcanic horizons

- Major faults in the crystalline basement and fracture zones.

These geologic features are identified by the qualitative recognition of characteristic variations in magnetic patterns supplemented by the quantitative analysis of individual magnetic anomalies (Domalshi, 1966; Paterson, 1962; Reford and Sumner, 1964).

The study of magnetic anomalies and the rocks that cause them shows that the anomalies are chiefly caused by the presence of the mineral magnetite, which occurs as an accessory mineral in igneous and metamorphic rocks. In general, the greater the amplitude of a magnetic anomaly, the higher the magnetite content of the rock causing the anomaly. It is also likely to have a relatively basic composition. Sedimentary rocks are essentially nonmagnetic, except for iron formations. Major rock units can be differentiated on the basis of variations in the frequency, areal extent, shape, orientation, local amplitude, and general intensity level of their corresponding magnetic anomalies. Faults are displayed magnetically by disruptions in magnetic pattern or by persistent gradients or pattern changes over long distances; plugs, dikes, and related igneous intrusions can be detected by the shape and intensity of their magnetic expression. Techniques have been developed for the quantitative analysis of magnetic anomalies with regard to the depth, dimension, shape, and susceptibility contrast of their sources; but these techniques are far more complex than the qualitative assessment of variations in the magnetic pattern. The quantitative analysis of even relatively simple geometric forms representing geologic bodies such as dikes involves complex computations.

Especially pertinent to NURE surveys are the experiences of Zietz, et al. (1966, 1969, 1971) in reconnaissance aeromagnetic surveys using flight-line spacings of approximately 5 miles. They were highly successful in delineating differences in the crustal fabric associated with each tectonic unit and in mapping gross basement lithologic units and structural trends. Providing this sort of information is compatible with the concept of regional uranium exploration by airborne gamma-ray spectrometric techniques. Individual profiles flown at relatively constant barometric altitude during portions of the survey can be interpreted in detail to provide:

- Depth-to-basement computations
- Qualitative basement lithology
- Location of major faults, dikes, etc.

2. Interpretation of the Survey Data

Because the main purpose of the contracted survey was to collect and analyze airborne gamma-ray spectral data, the interpretation of the magnetic data was excluded and reserved for future efforts.

C. CONCLUSIONS

Conclusions and suggestions for further work are included in Volume 2.

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APPENDIX A

PRODUCTION SUMMARY AND REDUCED TEST-LINE DATA

1. Production Summary - 4 Quadrangles

Flight-Line Miles by Quadrangle	
Rolla	1,595
Paducah	1,595
Poplar Bluff	3,037
Dyersburg	3,037
Total Flight-Line Miles	9,264

	Total
Total Field Days	34
Production Time	50%
Down Time	44%
Mobilization and Demobilization Time	6%
Total	100%

Flight-Line Miles Per Production Day

Average Production Rate = 545

Note: Ground-speed and altitude summaries are on microfiche in Appendix B, and additional production summary data are in Appendix A of the individual quadrangle volumes.

2. Reduced Test-Line Data

Month	Day	Preproduction Test (Counts per Test Line)	Postproduction Test (Counts per Test Line)	Average of Previous Tests (Counts per Test Line)	Last Test Minus Previous Average	Percent Difference
6	17	16890		new line		
			13807	15349	-3083	-22.3
6	18	15476		15391	+127	+0.8
			15529	15426	+138	+0.8
6	19	16007		15542	+581	+3.6
			16411	15687	+869	+5.3
6	20	16151		15753	+464	+2.9
			15956	15778	+203	+1.3
6	21	18485		16079	+2707	+14.6
			17447	16216	+1368	+7.8
6	25	16776		16267	+560	+3.3
			17233	16347	+966	+5.6
6	26	15771		16303	-576	-3.7
			16624	16326	+321	+1.9
6	27	17154		16381	+828	+4.8
			16286	16375	-95	-0.6
6	29	17025		16413	+650	+3.8
			17597	16479	+1184	+6.7
6	30	17787		16549	+1308	+7.4
			17324	16587	+775	+4.5
7	11	18532		16679	+1945	+10.5
			18864	16779	+2185	+11.6
7	13	18337		16847	+1558	+8.5
			18506	16916	+1659	+9.0
7	14	18005		16959	+1089	+6.0
			17764	16990	+805	+4.5
7	15	17215		16999	+225	+1.3
			17814	17028	+815	+4.6
7	17	19303		17106	+1489	+7.7
			19237	17177	+2131	+11.1
7	18	18155		17209	+978	+5.4
			18372	17245	+1163	+6.3
7	19	17700		17259	+455	+2.6
			17074	17254	-185	-1.1

ABSTRACT

The results of a high-sensitivity, aerial, gamma-ray spectrometer and magnetometer survey of the Poplar Bluff Quadrangle, in Arkansas and Missouri, 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. 79-285-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 43 uranium anomalies worthy of field-checking as possible uranium prospects. They do not appear to be associated with any particular area or geologic unit.

TABLE OF CONTENTS

Section	Title	Page
	ABSTRACT	i
I	INTRODUCTION	N-1
	A. GENERAL	N-1
	B. URANIUM GEOLOGY AND OCCURRENCES	N-1
	1. Uranium Occurrences	N-1
	2. Geologic Mapping	N-1
	3. Potential Uranium-Bearing Units	N-1
II	RADIOMETRIC DATA INTERPRETATION	N-3
	A. SELECTION OF URANIUM ANOMALIES	N-3
	1. Statistical Considerations	N-3
	2. Uranium Anomalies	N-3
	B. DATA TABLES AND HISTOGRAMS	N-6
	1. General	N-6
	2. Statistical Summary Tables	N-6
	3. Flight-Line Averages	N-6
	4. Histograms	N-6
	C. MAPS AND PROFILES	N-7
	1. General	N-7
	2. Profile Maps	N-7
	3. Printer Plot Contour Maps	N-7
	4. Radiometric Stacked Profiles	N-8
	5. Magnetic Stacked Profiles	N-8
	D. CONCLUSIONS	N-8
	1. General	N-8
	2. Suggestions for Further Work	N-9

TABLE OF CONTENTS (CONTD)

Section	Title	Page
III	REFERENCES	N-10
Appendix A	PRODUCTION SUMMARY	N-10
Appendix B	MICROFICHE	
	STATISTICAL SUMMARIES	
	FLIGHT-LINE AVERAGES	
	STATISTICAL ANALYSIS	
	TABLE OF GEOLOGIC UNITS	T-1
	RECORD LOCATIONS AND GEOLOGY	M-1
	eU PROFILE MAP	M-2
	eU/eTh PROFILE MAP	M-3
	eU/K PROFILE MAP	M-4
	eTh PROFILE MAP	M-5
	K PROFILE MAP	M-6
	eTh/K PROFILE MAP	M-7
	PRINTER PLOT CONTOUR MAPS	M-8 through M-14
	RADIOMETRIC PROFILES	P-1 through P-30
	MAGNETIC PROFILES	P-31 through P-60
	SIX-PARAMETER HISTOGRAMS BY GEOLOGIC UNIT	H-1 through H-22

SECTION I

INTRODUCTION

A. GENERAL

This volume contains information and survey results pertaining specifically to the Poplar Bluff NTMS 1:250,000 scale Quadrangle, in Arkansas and Missouri, one of a group of eight such quadrangles included in an aerial radiometric and magnetic reconnaissance survey. Information of a general nature concerning the instrumentation and methods used in data acquisition, processing, and interpretation of this and the adjacent Dyersburg, Paducah, and Rolla quadrangles is presented in Volume 1 of this final report.

The survey was conducted by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 79-285-L as part of the U.S. Department of Energy National Uranium Resource Evaluation (NURE) Program.

B. URANIUM GEOLOGY AND OCCURRENCES

1. Uranium Occurrences

Carbonaceous nodules and streaks in a quartzose sandstone are reported to contain slightly less than 0.005 percent eU near Bardley, Missouri. The quantity of material is not reported (Southern Interstate Nuclear Board, 1969). The location is shown in Figure 2-1.

There is no reported mineable uranium deposit or past production in the Poplar Bluff Quadrangle (DOE, 1979; Southern Interstate Nuclear Board, 1969; Finch, 1967; and Butler et al., 1962).

2. Geologic Mapping

The geologic map used for the survey of the Poplar Bluff Quadrangle was the 1:250,000-scale map produced by Trollinger Geological Associates Inc. Table T-1 lists the mapped geologic units.

3. Potential Uranium-Bearing Units

The southeast portion of the Poplar Bluff Quadrangle lies in the Coastal Plain physiographic province (Lobeck, 1932), where predominantly alluvium, fluviatile terrace, and continental deposits of Quaternary age are exposed. The remainder of the quadrangle lies in the Ozark Plateaus physiographic province (Lobeck, 1932), where relatively flat lying sandstones, limestones, and dolomites of Ordovician age are exposed.

DOE (1979) identifies the Wilcox Formation with only very limited exposures in the southeast portion of the quadrangle as favorable but with insufficient basis for estimation of potential uranium resources.

Swanson (1962) reports selected samples having very high uranium content collected from a small lens of marine black shale in the basal sandstone of the Boone Formation. Marion County, Arkansas, where these samples were collected, is less than 1 degree west of the Poplar Bluff Quadrangle.

SECTION II

RADIOMETRIC DATA INTERPRETATION

A. SELECTION OF URANIUM ANOMALIES

1. Statistical Considerations

Each of the equivalent uranium, equivalent uranium/equivalent thorium, and equivalent uranium/potassium 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
Mean + 4 standard deviations	0.00003 or 1:33,300

*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:

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

where

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

Assuming the same certainty criterion of 1:33,300, 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 1.45 standard deviations from the mean to be evaluated.

Table 2-2

Minimum Deviation from the Mean for All Points for Limiting Probability of 1:33,300 (Elkins, 1940)

Number of Points Supporting Anomaly	Minimum Deviation
1	4.00 standard deviations
2	2.54 standard deviations
3	1.87 standard deviations
4	1.45 standard deviations

2. Uranium Anomalies

Data for the Poplar Bluff Quadrangle, including eU,* eU/eTh,* and eU/K,* were searched by the computer, and all acceptable significant anomalies were identified. These were printed out on the "preferred-anomaly" map (Figure 2-1) as asterisk symbols for each tenth 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 that showed a geochemical enrichment of eU over the eTh and/or K present were identified. First-priority anomalies are those showing simultaneous statistically valid eU, eU/eTh, and eU/K anomalies. The preferred-anomaly map (Figure 2-1) is marked to indicate the locations of all preferred 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.

POPLAR BLUFF NJ15-12 TEXAS-KENTUCKY SURVEY 1979

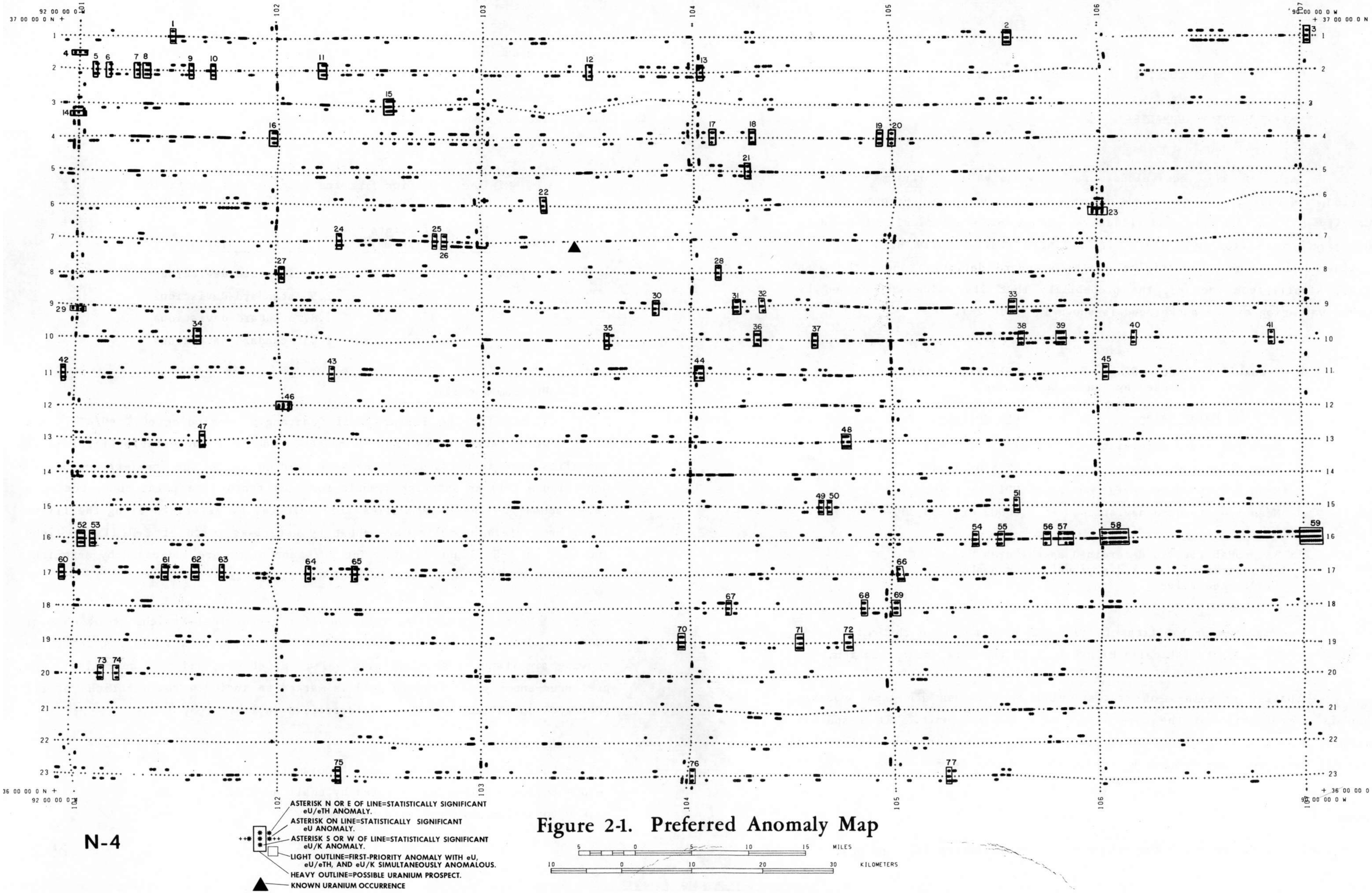

Figure 2-1. Preferred Anomaly Map

Table 2-3. Preferred eU Anomalies

Anomaly No.	Line No.	Geologic Unit(s)	Highest eU S.F.*	No. of Anomalous Records	Remarks
1	1	Ojc	2.0	4	Possible railroad fill
2	1	Ku	1.5	8	Possible uranium prospect
3	1	Ku	1.5	6	
4	101	Ojc	3.4	4	
5	2	Ojc	1.5	5	
6	2	Ojc	1.5	4	
7	2	Ojc	2.3	5	
8	2	Ojc	2.3	5	
9	2	Or	2.2	4	
10	2	Or/Ojc	3.3	3	
11	2	Or	2.2	11	
12	2	Og	1.8	6	
13	2	Og	1.5	6	
14	101	Ojc	1.6	5	
15	3	Or	2.3	12	
16	4	Or	1.5	6	
17	4	Or	1.5	3	
18	4	Or	2.0	4	
19	4	Or	3.5	7	
20	4	Or	3.6	3	
21	5	Or	2.0	6	
22	6	Or/Og	2.5	4	Possible uranium prospect
23	106	Q	1.5	11	Possible railroad fill
24	7	Ojc/Or	1.5	5	Possible uranium prospect
25	7	Ojc	1.6	4	Possible highway fill
26	7	Ojc	1.8	6	Possible highway fill
27	8	Ojc/Or	1.7	5	Possible uranium prospect
28	8	Or	1.7	5	Possible uranium prospect
29	101	Ojc	2.0	5	Possible highway fill
30	9	Ojc	2.0	3	Possible uranium prospect
31	9	Ojc	2.4	7	Possible uranium prospect
32	9	Ojc/Or	1.5	2	Possible highway fill
33	9	Q	1.7	12	Possible railroad fill
34	10	Ojc	1.7	6	Possible uranium prospect
35	10	Ojc	1.5	3	Possible uranium prospect
36	10	Ojc/Or	2.0	5	Possible uranium prospect
37	10	Ojc	2.6	6	Possible uranium prospect
38	10	Q	2.2	5	Possible uranium rich quaternary deposits
39	10	Q	3.4	13	Possible highway fill
40	10	Q	2.5	3	Possible highway fill
41	10	Qtc	1.5	3	Possible uranium rich continental deposits
42	11	Ojc	2.2	6	Possible uranium prospect
43	11	Ojc	2.0	4	Possible railroad fill
44	11	Ojc	1.5	8	Possible uranium prospect
45	11	Q	1.5	4	Possible highway fill
46	102	Ojc	2.1	8	Possible uranium prospect
47	13	Ojc	1.5	3	Possible uranium prospect
48	13	Qal/Qt	1.8	9	Possible uranium rich alluvial/terrace deposits
49	15	Qal	2.0	5	Possible uranium rich alluvial deposits
50	15	Qal	1.5	3	Possible uranium rich alluvial deposits
51	15	Qt/Qso	1.5	3	Possible uranium rich terrace/sand dune deposits
52	16	Opw/Ojc	2.6	11	Possible uranium prospect
53	16	Opw/Ojc	1.5	7	Possible uranium prospect
54	16	Qt	2.0	7	Possible uranium rich terrace deposits
55	16	Qt	2.1	5	Possible uranium rich terrace deposits
56	16	Qal/Qt	2.0	4	Possible uranium rich alluvial/terrace deposits
57	16	Qt/Qtc	1.9	13	Possible uranium rich terrace/continental deposits
58	16	Qt/Qtc	3.8	34	Possible uranium rich terrace/continental deposits
59	16	Qt	3.9	36	Possible highway or railroad fill (overflight village)
60	17	Ose/Opw	1.5	7	Possible uranium prospect
61	17	Ose/Opw/Ojc	1.6	8	Possible uranium prospect
62	17	Ojc	2.8	9	Possible uranium prospect
63	17	Ose/Opw/Ojc	1.7	3	Possible uranium prospect
64	17	Ojc	1.5	3	Possible uranium prospect
65	17	Ojc	2.5	3	Possible uranium prospect
66	17	Qt	1.7	3	Possible uranium rich terrace deposits
67	18	Qso	2.2	4	Possible uranium rich sand dune deposits
68	18	Qt	1.5	8	Possible uranium rich terrace deposits
69	18	Qt	2.7	5	Possible uranium rich terrace deposits
70	19	Qal	2.8	10	Possible uranium rich alluvial deposits
71	19	Qt	1.8	8	Possible uranium rich terrace deposits
72	19	Qt	1.6	4	Possible uranium rich terrace deposits
73	20	Ose/Opw	2.0	5	Possible highway fill
74	20	Ose	1.5	3	Possible highway fill
75	23	Ose	1.5	7	Possible uranium prospect
76	23	Qt	1.8	6	Possible railroad fill
77	23	Qt/Qtc	1.5	4	Possible uranium rich terrace/continental deposits

*Significance Factor

○ = First Priority Anomaly

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 are also useful in delineating areas relatively depleted of uranium that was removed by geochemical activity and concentrated in nearby deposits. 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.

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.

B. DATA TABLES AND HISTOGRAMS

1. General

The flight-line numbers in the order they appear on each of the four types of data tapes (see Volume 1 for a description of these tapes) are east-west flights 1 through 23 followed by north-south flights 101 through 107.

Microfiche copies of the single-record and averaged-record data listings are included as an appendix to this volume. 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.

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/K, eU/eTh, and eTh/K as microfiche copies. 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.

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 Poplar Bluff Quadrangle are given as microfiche copies. These may be used to study the variation in gamma-ray parameters within a formation as one crosses the quadrangle from N to S or from E to W.

4. Histograms

Histograms for each radiometric parameter are presented for each geologic unit in the Histograms section. Several histograms showed multimodal distributions that indicated the presence of more than one distinct lithology in that geologic unit. In situations where the multimodal characteristic of a histogram was obvious, the unit was divided into two or more populations by splitting the histogram based on eTh or K but not eU. For example, in the case of Qt (Quaternary terrace Deposits), the eTh histogram could be reasonably split at 5.0 ppm. The distribution of the unsplit unit is shown in H-2, and the distributions after splitting are shown in H-3 and H-5. New means and standard deviations were calculated before computerized geologic analysis of the data. Table 2-5 summarizes all the histograms for the quadrangle. The eU, eTh, and K medians for the resulting subunits are given in concentration units computed from the Statistical Summary Tables. Comparing the values in Table 2-5 with the estimated crustal averages for various rock types (Table 2-6) compiled by Kogan, et al. (1971; see also Saunders and Potts, 1978) allows at least a reasonable estimate of the probable average lithology of the units. In Table 2-5, eTh/eU can be used for comparison with Table 2-6.

Table 2-5

Radiometric Analysis of Geologic Units

Geologic Unit	Split On (ppm/%)	eTh (ppm)	eU (ppm)	K (%)	eTh/eU	Probable Lithology
Qal		5.84	2.12	0.88	2.77	Silt, sand, gravel
Qt-1	Th=5.0	4.22	1.58	1.16	2.70	Clay, silt, sand, gravel
Qt-2		6.77	2.31	1.12	2.94	Clay, silt, sand, gravel
Qso		5.20	1.97	1.22	2.63	Sand
Q		6.63	2.38	1.07	2.77	Silt, sand, gravel, clay
Qtc		7.05	2.42	1.06	2.94	Gravel, sand, silt, clay
Tw		5.11	1.80	0.76	2.86	Sand, clay
Ku-1	K=9.0	5.75	2.18	0.65	2.63	Sandstone, limestone, shale
Ku-2		7.59	2.55	1.13	2.94	Sandstone, limestone, shale
Mbn		3.47	1.29	0.36	2.70	Limestone, chert
Opj		4.58	1.71	0.39	2.70	Limestone
Ose-1	Th=4.0	2.90	1.40	0.32	2.08	Dolomite
Ose-2		5.21	2.09	0.51	2.50	Sandstone
Opw		4.69	1.88	0.61	2.50	Dolomite
Ojc		4.95	2.16	0.55	2.27	Dolomite
Or		4.48	2.07	0.44	2.17	Sandstone
Og		3.44	1.83	0.34	1.89	Dolomite
Cep		3.11	1.53	0.31	2.04	Dolomite, chert
Tg		2.86	0.79	0.35	3.57	Unidentified on map legend

Table 2-6

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

Rock Type	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. 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 the geographic variations in the other radiometric parameters.

3. Printer Plot Contour Maps

Printer plot contour maps showing smoothed absolute magnitudes of eU, eTh, K, eU/eTh, eU/K, and eTh/K and residual magnetics are presented in the Map section (M-8 through M-14). This presentation provides a convenient way of examining each quadrangle for broad regional changes in magnitude that may be associated with geology or may indicate uraniferous geochemical province.

The contour interval and minimum contour value for the residual magnetic printer plot contour maps are indicated on each individual sheet, as well as the map scale and quadrangle identification. For the six radiometric printer plot contour maps, the levels of response for each band are shown in Table 2-7.

Table 2-7

Response Levels for Bands Shown on Printer-Plot Contour Maps

Symbol	ppm eTh (Tl-208)	ppm eU (Bi-214)	% K (K-40)	eU/K, eU/eTh, and eTh/K
Blank	2.8	1.4	0.05	0.1
A	2.8-4.0	1.4-2.0	0.05-0.1	0.1-0.2
Blank	4.0-5.6	2.0-2.8	0.1-0.2	0.2-0.3
B	5.6-8.0	2.8-4.0	0.2-0.3	0.3-0.4
Blank	8.0-11.0	4.0-5.6	0.3-0.4	0.4-0.6
C	11-16	5.6-8.0	0.4-0.6	0.6-0.8
Blank	16-22	8.0-11.0	0.6-0.8	0.8-1.1
D	22-31	11-16	0.8-1.1	1.1-1.6
Blank	31-44	16-22	1.1-1.6	1.6-2.2
E	44-64	22-31	1.6-2.2	2.2-3.1
Blank	64-90	31-44	2.2-3.1	3.1-4.4
F	90-125	44-64	3.1-4.4	4.4-6.4
Blank	125-180	64-90	4.4-6.4	6.4-9.0
G	180-250	90-125	6.4-9.0	9.0-13
Blank	250-350	125-180	9.0-12.5	13-18
H	350-500	180-250	12.5-18	18-25
Blank	500-700	250-350	18-25	25-35
I	700-1000	350-500	25-35	35-50
Blank	1000-1400	500-700	35-50	50-70
J	1400-2000	700-1000	50-70	70-100
Blank	2000	1000	70	100

4. 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-30). 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 are the profile maps) and provide an opportunity to study the relative differences in counting rates among the geologic units.

The altitude (terrain-clearance) trace allows identification of 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 because of Currie significance test failure. The discarded data points are included in the stacked profiles and may be examined, keeping in mind that they are generally statistically unreliable. If the rock types are sufficiently radioactive, normal terrain clearance may be exceeded somewhat with reasonably reliable statistics, and the added information may be useful.

5. 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 (P-17 through P-60).

D. CONCLUSIONS

1. General

Table 2-8 lists the number of preferred anomalies and the total number of eU records in each formation.

Forty-three of the 77 anomalies in Table 2-3 have been classified as first priority with possible uranium prospects based on their geological location and eU anomaly characteristics. The remaining 37 anomalies in Table 2-3 are classified as follows:

12 Possible uranium rich terrace deposits
5 Possible uranium rich alluvial deposits

Table 2-8

Geologic Units with eU Anomalies

Geologic Units	Total No. of eU Records	No. of First-Priority Anomalies
Qal	3,099	-
Qt	10,982	-
Qso	1,908	-
Q	7,424	-
Qtc	3,134	-
Tw	98	-
Ku	770	2
Mbn	36	-
Opj	90	-
Ose	5,338	4
Opw	3,295	5
Ojc	23,313	26
Or	13,502	15
Og	2,613	3
Cep	183	-
Tg	3	-

4 Possible uranium rich continental deposits
2 Possible uranium rich sand dune deposits
1 Possible uranium rich quaternary deposits
9 Possible highway fill
5 Possible railraod fill
1 Possible highway or railroad fill (overflight village)

Some of the first-order anomalies on the west end of flight line 2 and 17 may be due to radon gas trapped by a cooler layer of air in topographically low areas. Data collection for August 11, 1978, was initiated at 10:50 a.m. at the west end of flight line 2, and data collection for August 17, 1978, was initiated at 9:55 a.m. at the west end of flight line 17. This condition, if present, cannot be described as a typical inversion but rather the stagnation of cooler air in topographically low areas causing a local buildup of radon gas.

The anomaly on the extreme east end of flight line 16 is at least partly due to the fact that it crosses two highways, a railroad, and the village of White Oak. The primary cause for this anomaly and the five anomalies immediately to the west on the same flight line was the several local rain showers encountered during data collection. The airborne radon daughters were washed from the atmosphere to the ground, causing higher than normal eU values. The added moisture on the gound depresses the eTh and K values. The magnetic data also became erratic during the same period, but all readings returned to normal as soon as the aircraft cleared the rain showers.

No first-priority anomalies appear to be associated with the reported uranium occurrence near Bardley.

2. Suggestions for Further Work

The primary objective of this survey is to locate areas favorable for the occurrence of uranium. The relatively low-density coverage during this reconnaissance survey precludes inferences as to the presence or absence of deposits over much of the area. The probabilities for encountering individual deposits in this type of survey are relatively low, and consequently it will be necessary to conduct more detailed surveys (airborne or ground) in the most promising areas. In the Poplar Bluff Quadrangle, further work should be conducted in areas highlighted by first-priority anomalies. The anomalies do not appear to be concentrated in any particular area or geologic unit.

SECTION III
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APPENDIX A

PRODUCTION SUMMARY — POPLAR BLUFF

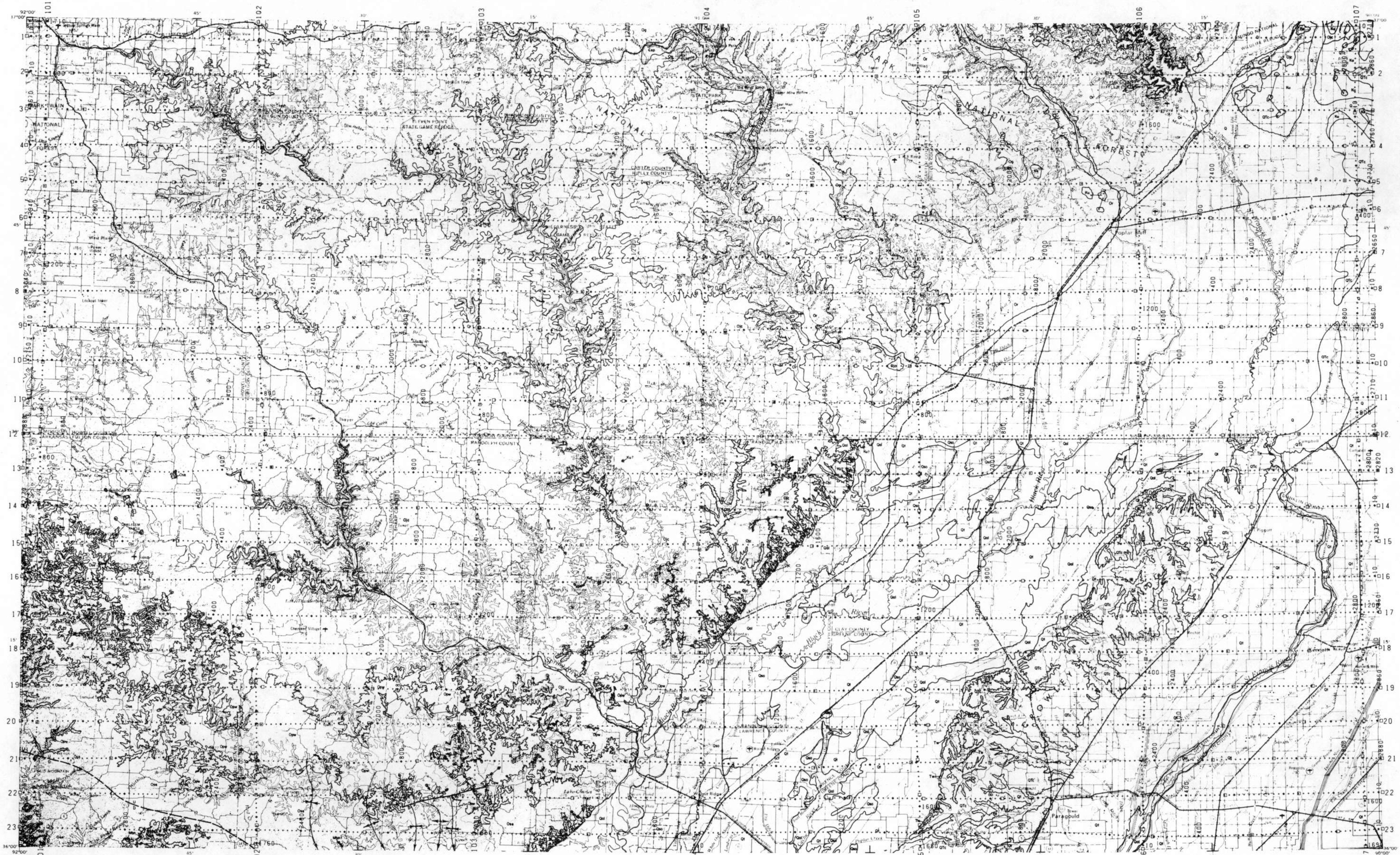
Operation	Start	Completion
Data Collection	29 June 1979	19 June 1979
Data Processing	24 July 1979	29 October 1979
Data Interpretation	31 October 1979	8 November 1979
Flight-Line Miles	3038	

Note: Additional production summary data are in Appendix A Volume 1.

Table T-1. Geologic Map Units — Poplar Bluff Quadrangle

Computer Symbol	Map Symbol	Description
QUATERNARY		
QAL	Qal	Alluvium: Unconsolidated silt, sand, and gravel limited areally to stream beds and low flood plains.
QT	Qt	Fluviatile Terrace Deposits: Unconsolidated to partially consolidated clay, silt, sand, and gravel forming terraces along streams.
QSO	Qso	Sand Dunes: Sand, fine-to coarse-grained, recognizable dune forms, vegetated as well as mobile.
Q	Q	Quaternary Deposits: Undivided
QUATERNARY — TERTIARY		
QTC	QTc	Continental Deposits: Gravel, sand, silt and clay: gravel, red and brown to yellowish orange and light brownish gray; matrix of fine to coarse quartz sand.
TW	Tw	Wilcox Formation: Sand and clay: sand, yellow to reddish brown, very fine- to coarse-grained, argillaceous; clay, white to yellowish brown to pink, scattered lenses with variable amounts of lignitized plant fragments.
CRETACEOUS		
KU	Ku	Sedimentary Rocks: Undivided
MISSISSIPPIAN		
MBN	Mbn	Boone Formation: Limestone and chert, varying in relative proportions both horizontally and vertically.
ORDOVICIAN		
OPJ	Opj	Plattin Limestone: Limestone, grayish brown to dark brown, dolomitic, cherty in part, argillaceous in part, fine-grained, dense.
		Joachim Dolomite: Limestone and dolomite: limestone, brown to yellow-brown, argillaceous, fine, dense; dolomite, dark brown to grayish brown, argillaceous, fine, crystalline.
OSE	Ose	St. Peters Sandstone: Sandstone, yellow-gray to reddish orange, fine- to coarse-grained, bedding poor.
		Everton Dolomite: Dolomite, yellowish gray to dark brown, sandy, argillaceous, fine- to coarse-grained, massive in part.
OPW	Opw	Powell Dolomite: Dolomite, fine-grained, gray argillaceous, thin beds of shale, sandstone, and sandy dolomite in places.
OJC	Ojc	Cotter Dolomite: Dolomite, gray to buff, fine- to coarse-grained, predominantly cherty, thin- to massive-bedded.
		Jefferson City Dolomite: Dolomite, grayish brown to dark brown, sandy, argillaceous at base, cherty, fine- to sugary-grained.
OR	Or	Roubidoux Formation: Sandstone, yellowish gray, fine- to coarse-grained, massively bedded.
OG	Og	Gasconade Formation: Dolomite, cherty, coarsely crystalline, with a basal sandstone.
CAMBRIAN		
CEP	€ep	Eminence Formation: Dolomite with chert.
		Potosi Formation: Dolomite with chert and druse.

POPLAR BLUFF NJ15-12 TEXAS-KENTUCKY SURVEY 1979



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

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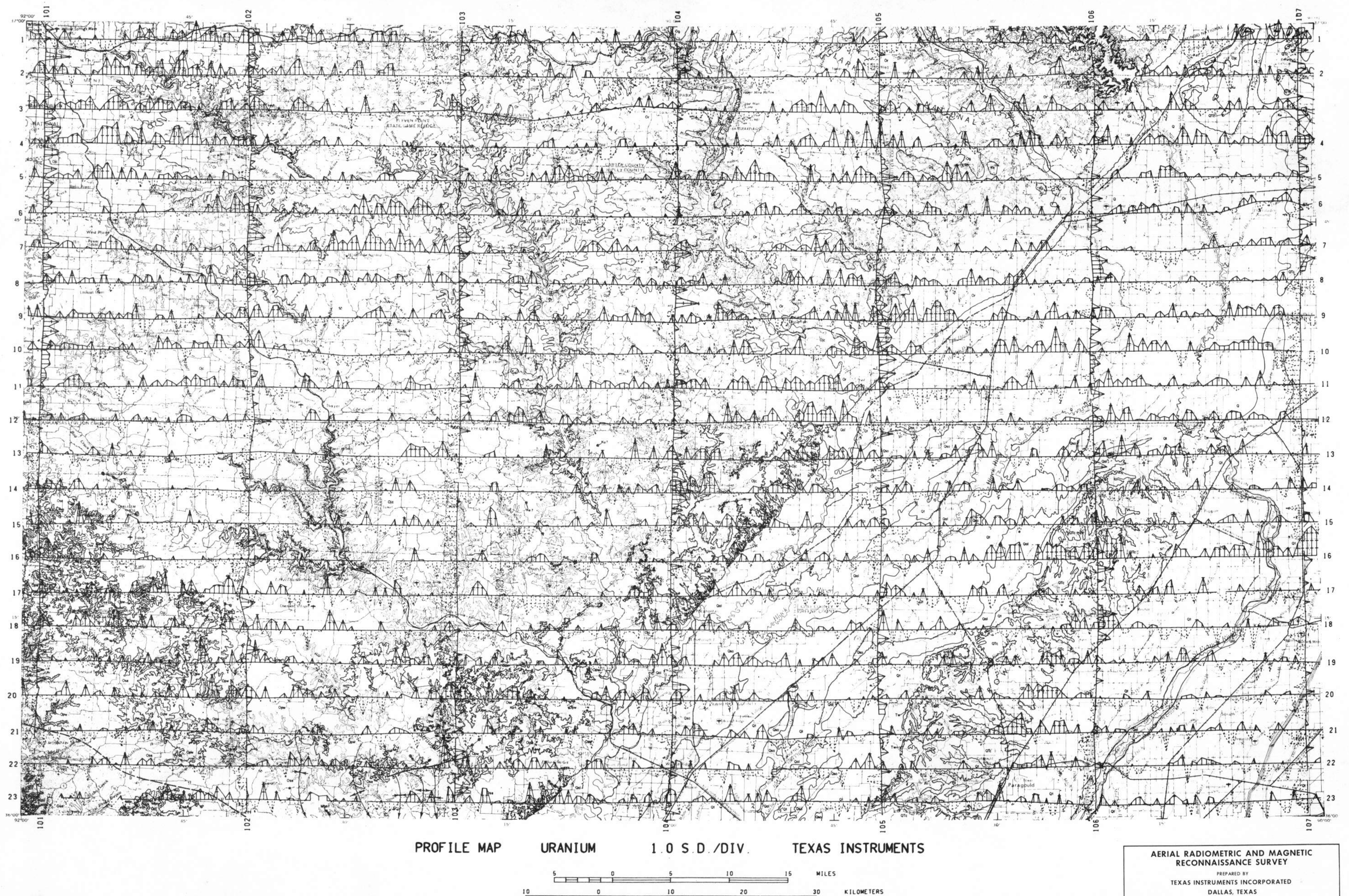
DALLAS, TEXAS
1979

WORK PERFORMED UNDER
BENDIX FIELD ENGINEERING CORPORATION
SUBCONTRACT NO. 79-285-L
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

M-1

POPLAR BLUFF NJ15-12 TEXAS-KENTUCKY SURVEY 1979



PROFILE MAP URANIUM 1.0 S.D./DIV. TEXAS INSTRUMENTS

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

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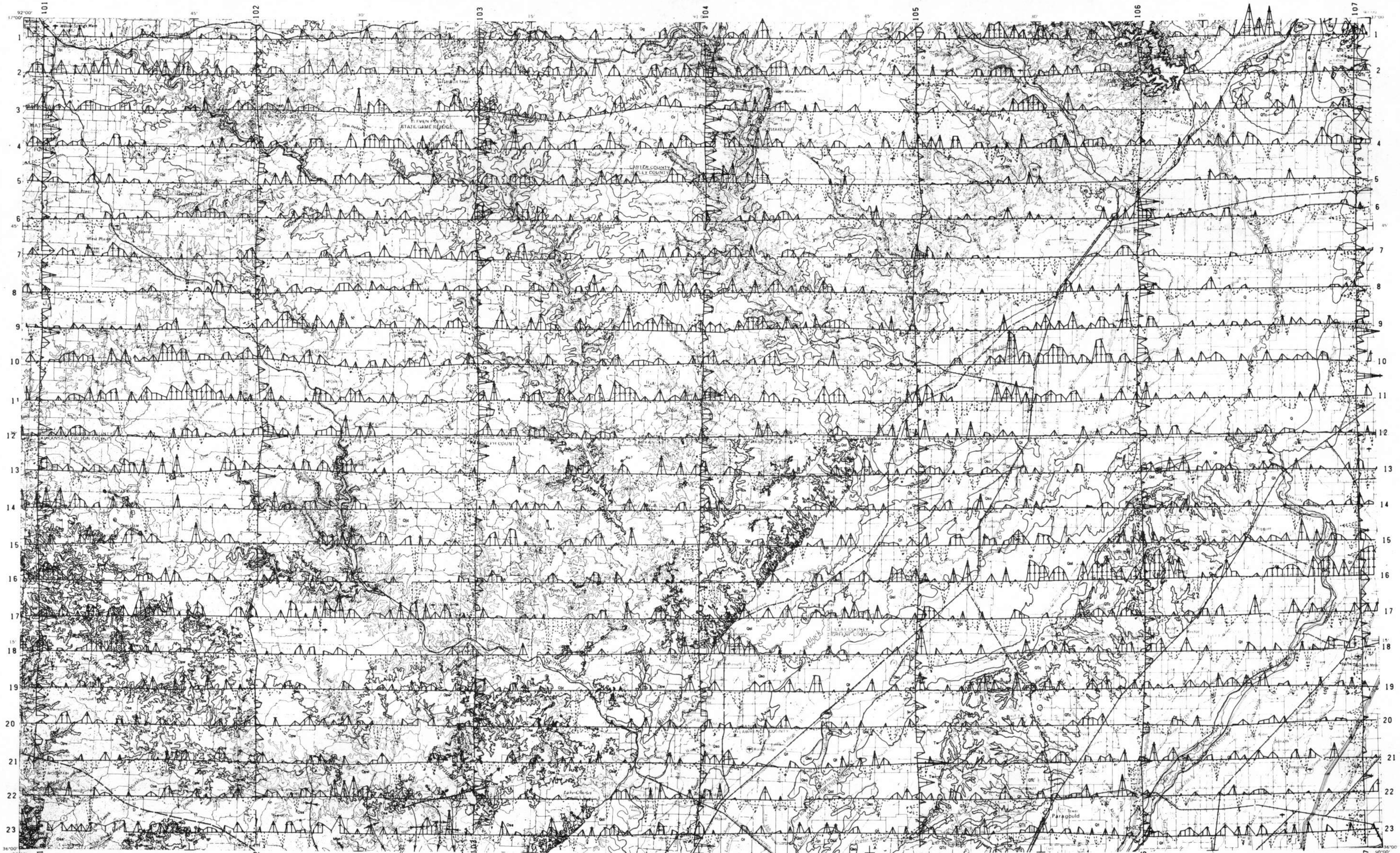
M-2

POPLAR BLUFF NJ15-12 TEXAS-KENTUCKY SURVEY 1979



PROFILE MAP U/TH 1.0 S.D./DIV. 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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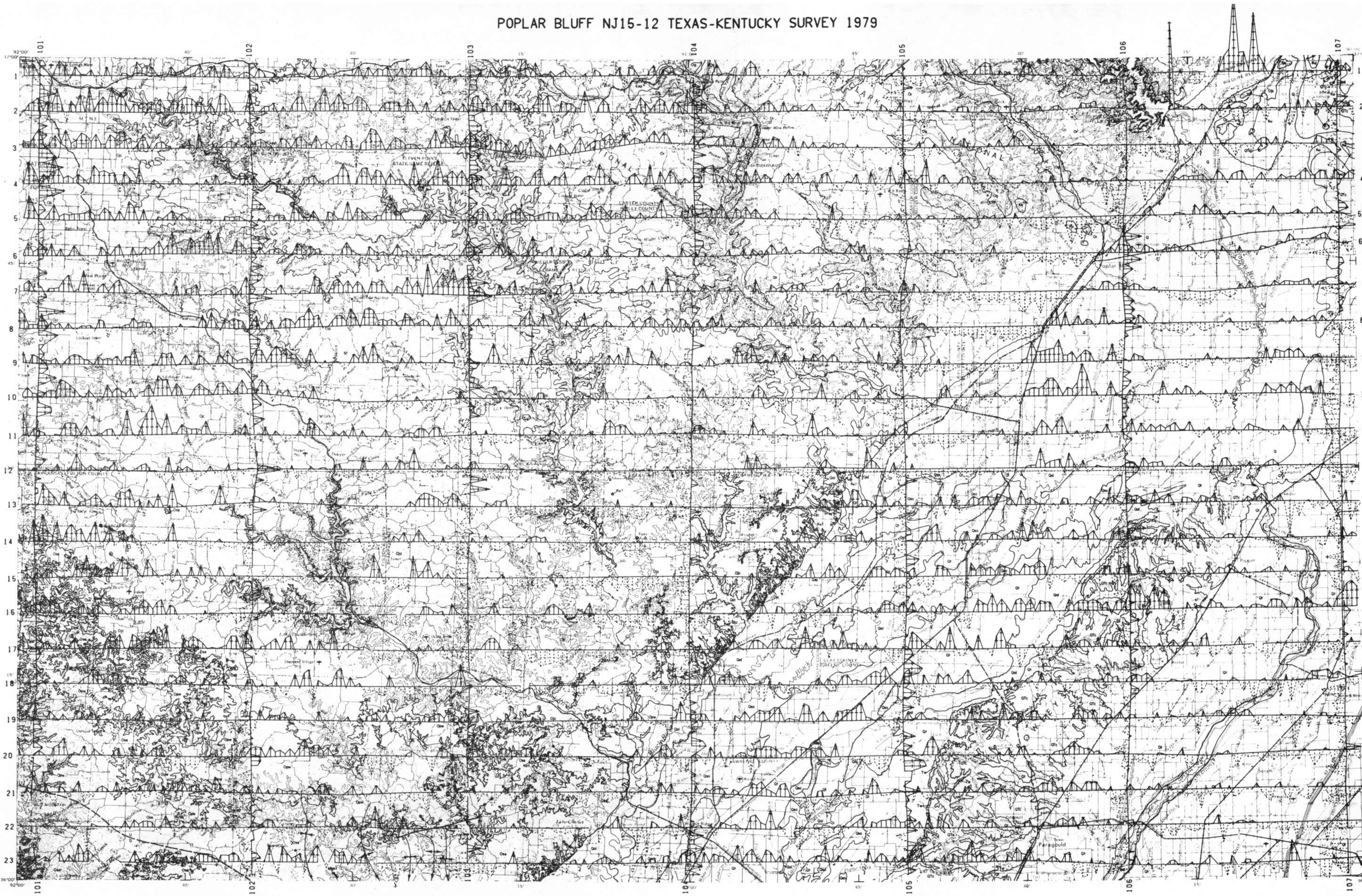
M-3

POPLAR BLUFF NJ15-12 TEXAS-KENTUCKY SURVEY 1979



PROFILE MAP U/K 1.0 S.D./DIV. TEXAS INSTRUMENTS

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10 0 10 20 30 KILOMETERS

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

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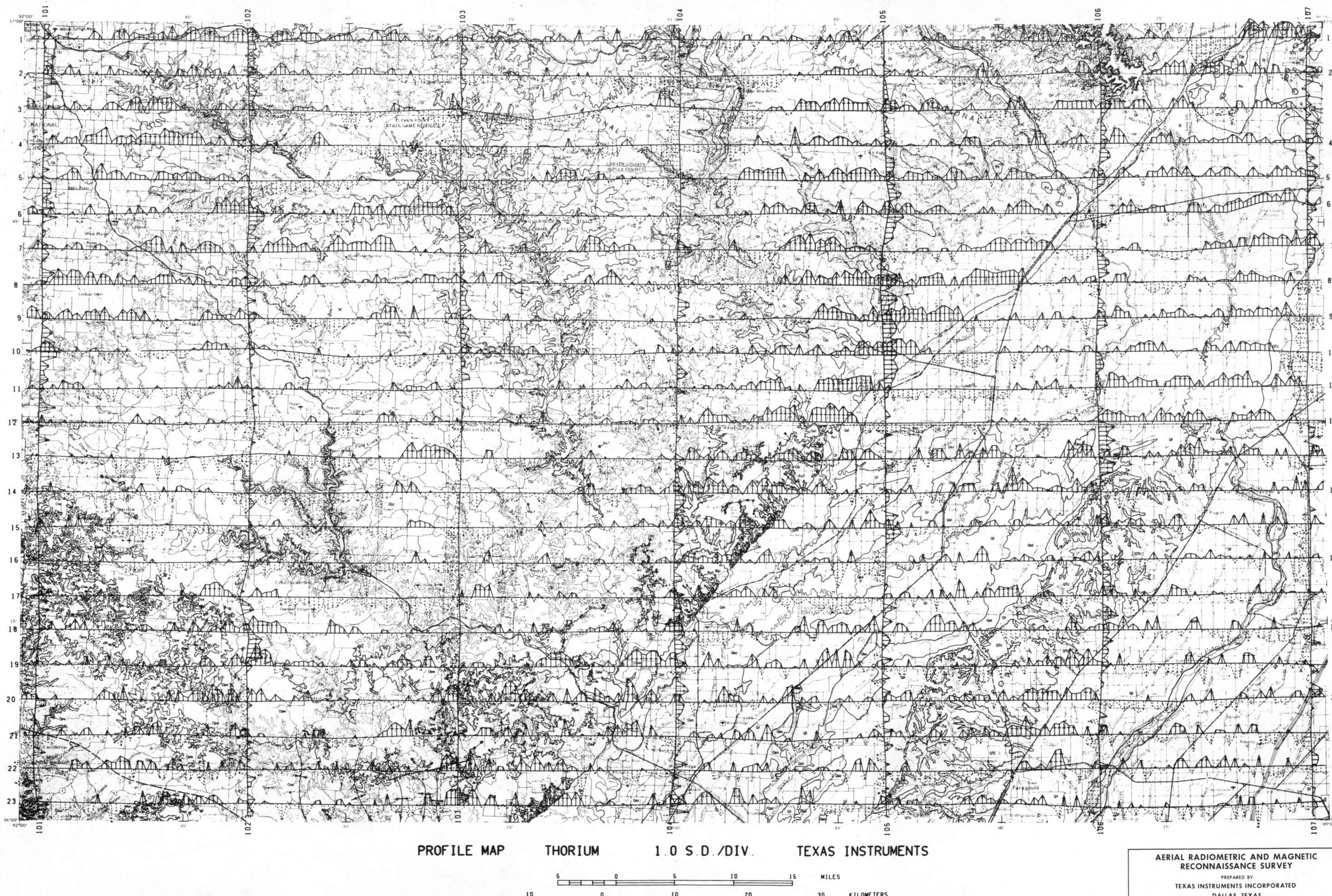
M-4

POPLAR BLUFF NJ15-12 TEXAS-KENTUCKY SURVEY 1979



PROFILE MAP THORIUM 1.0 S.D./DIV. TEXAS INSTRUMENTS

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

AERIAL RADIOMETRIC AND MAGNETIC RECONNAISSANCE SURVEY
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M-5

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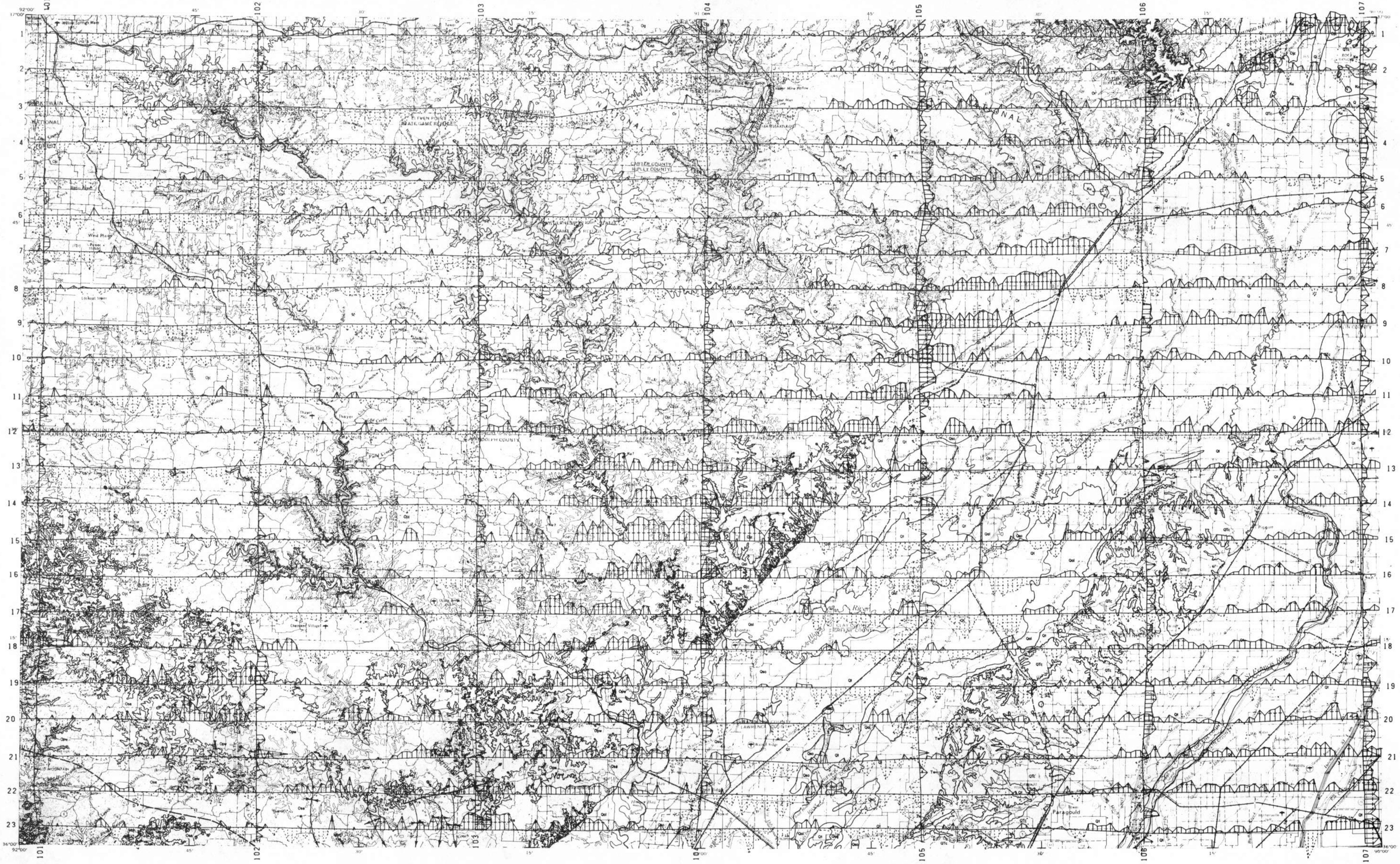

PROFILE MAP   POTASSIUM   1.0 S.D./DIV.   TEXAS INSTRUMENTS

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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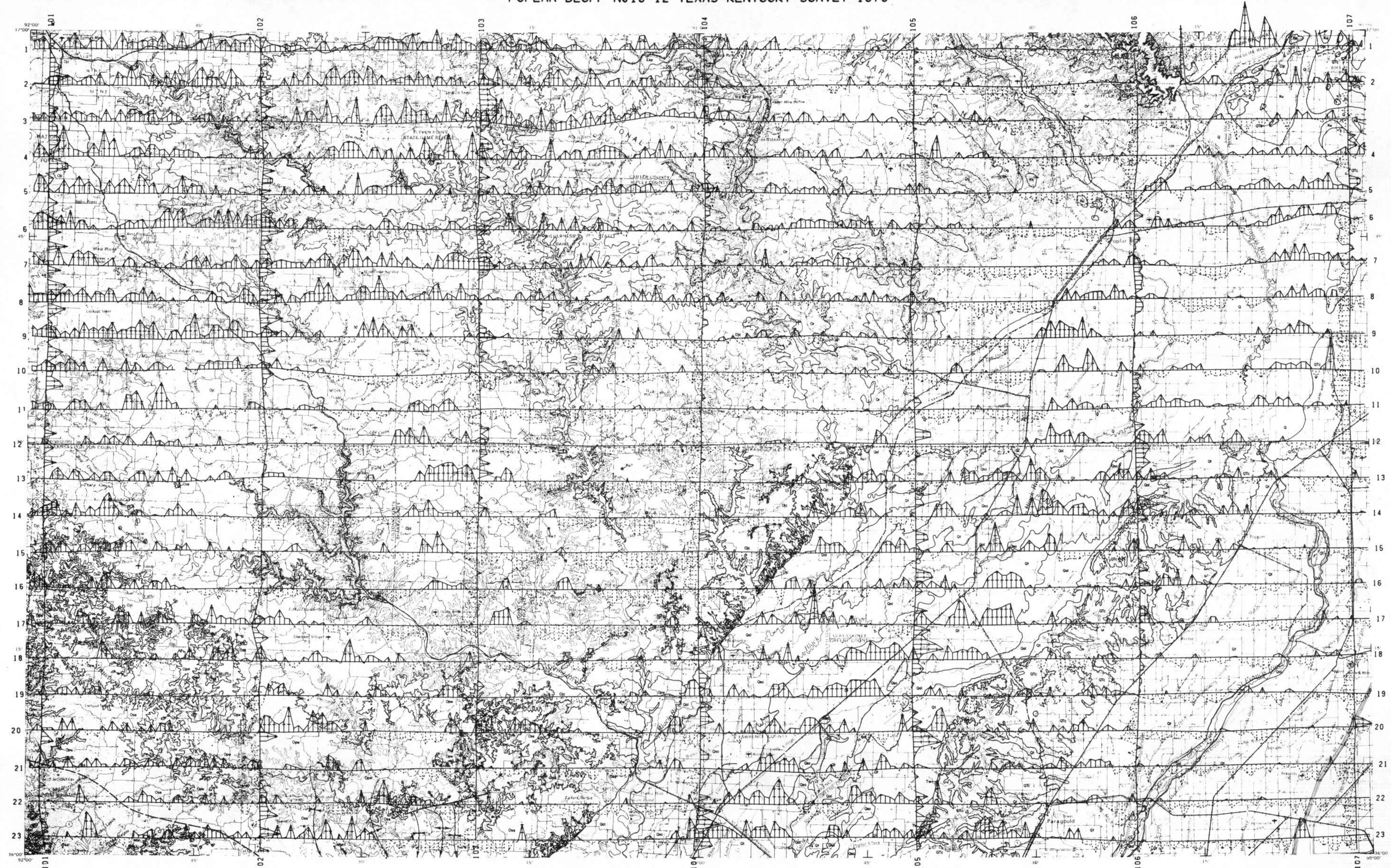

PROFILE MAP TH/K 1.0 S.D./DIV TEXAS INSTRUMENTS

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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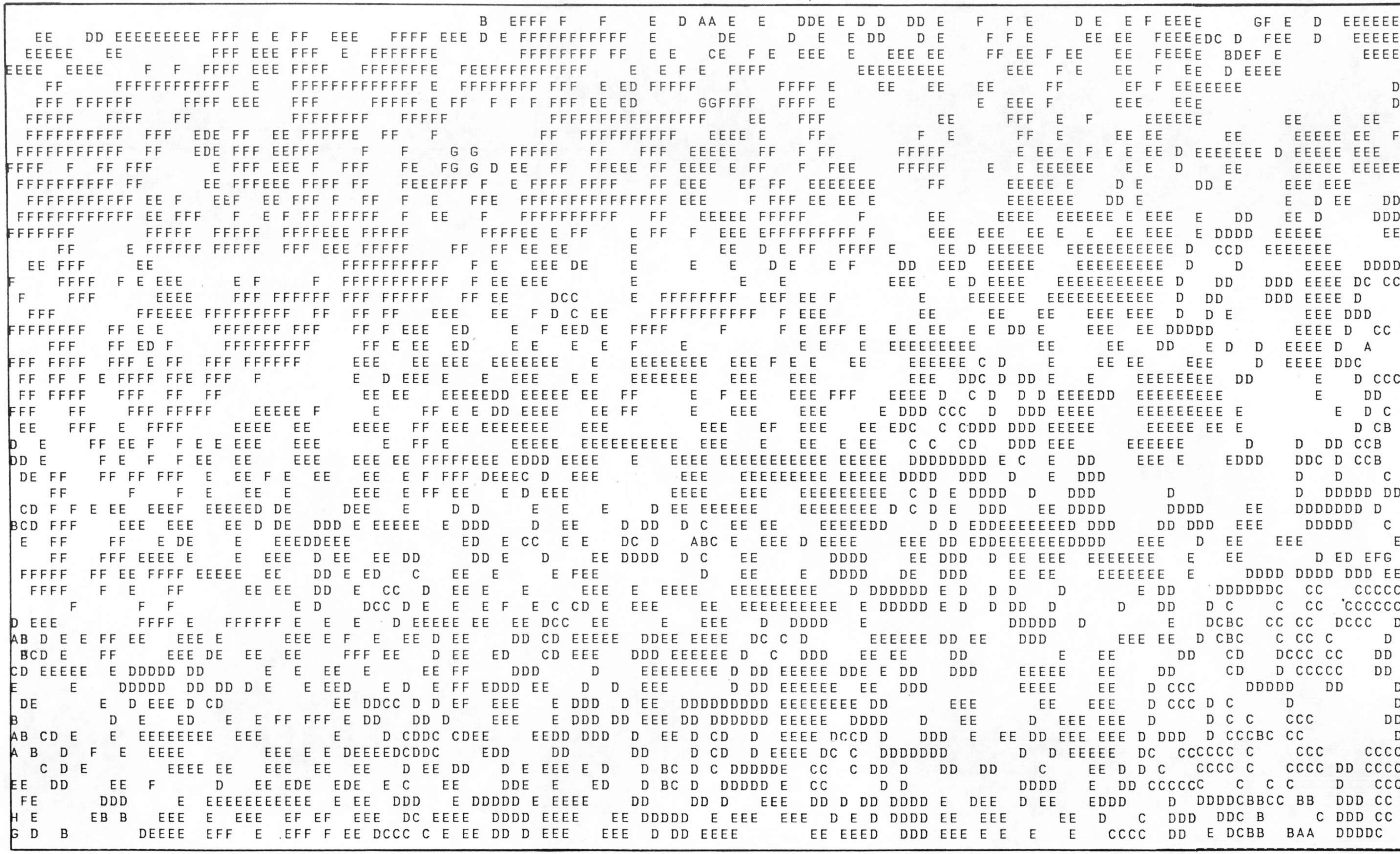
URANIUM PRINTER PLOT CONTOUR MAP 1:500,000 SCALE TEXAS INSTRUMENTS

U/Th PRINTER PLOT CONTOUR MAP 1:500,000 SCALE TEXAS INSTRUMENTS

POPLAR BLUFF NJ 15-12 TEXAS-KENTUCKY SURVEY 1979



U/K PRINTER PLOT CONTOUR MAP 1:500,000 SCALE TEXAS INSTRUMENTS

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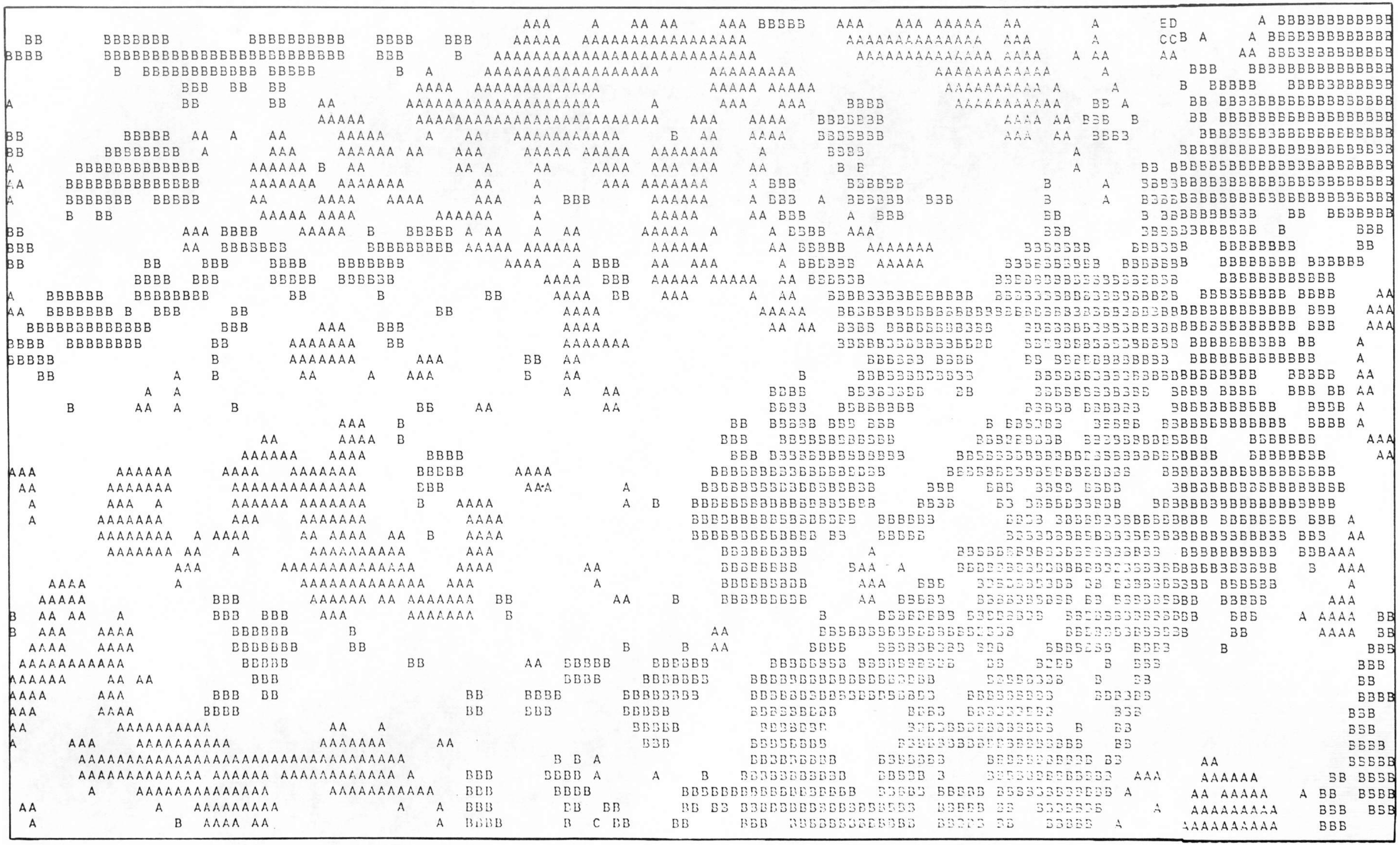
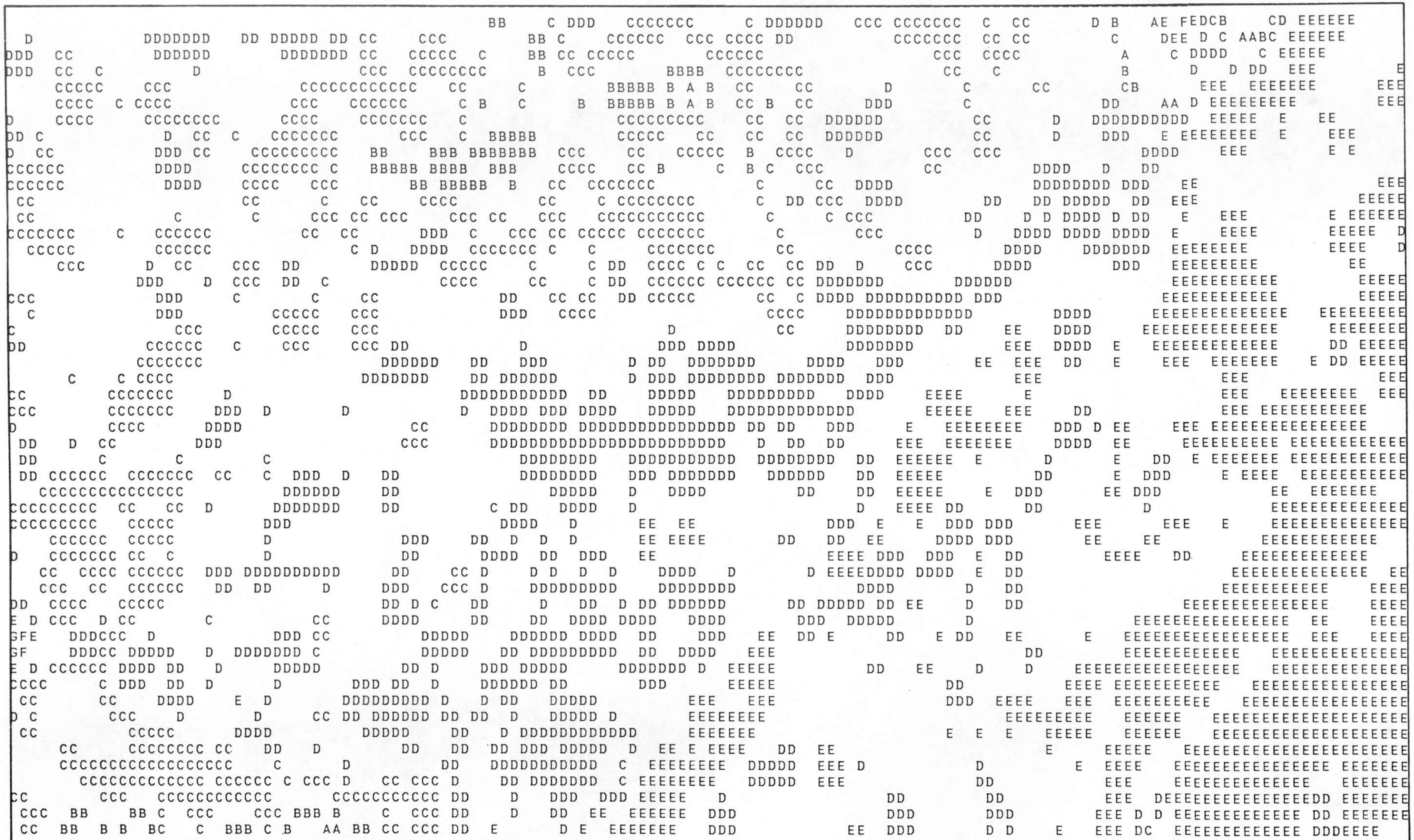


THORIUM PRINTER PLOT CONTOUR MAP 1:500,000 SCALE TEXAS INSTRUMENTS

POPLAR BLUFF NJ 15-12 TEXAS-KENTUCKY SURVEY 1979



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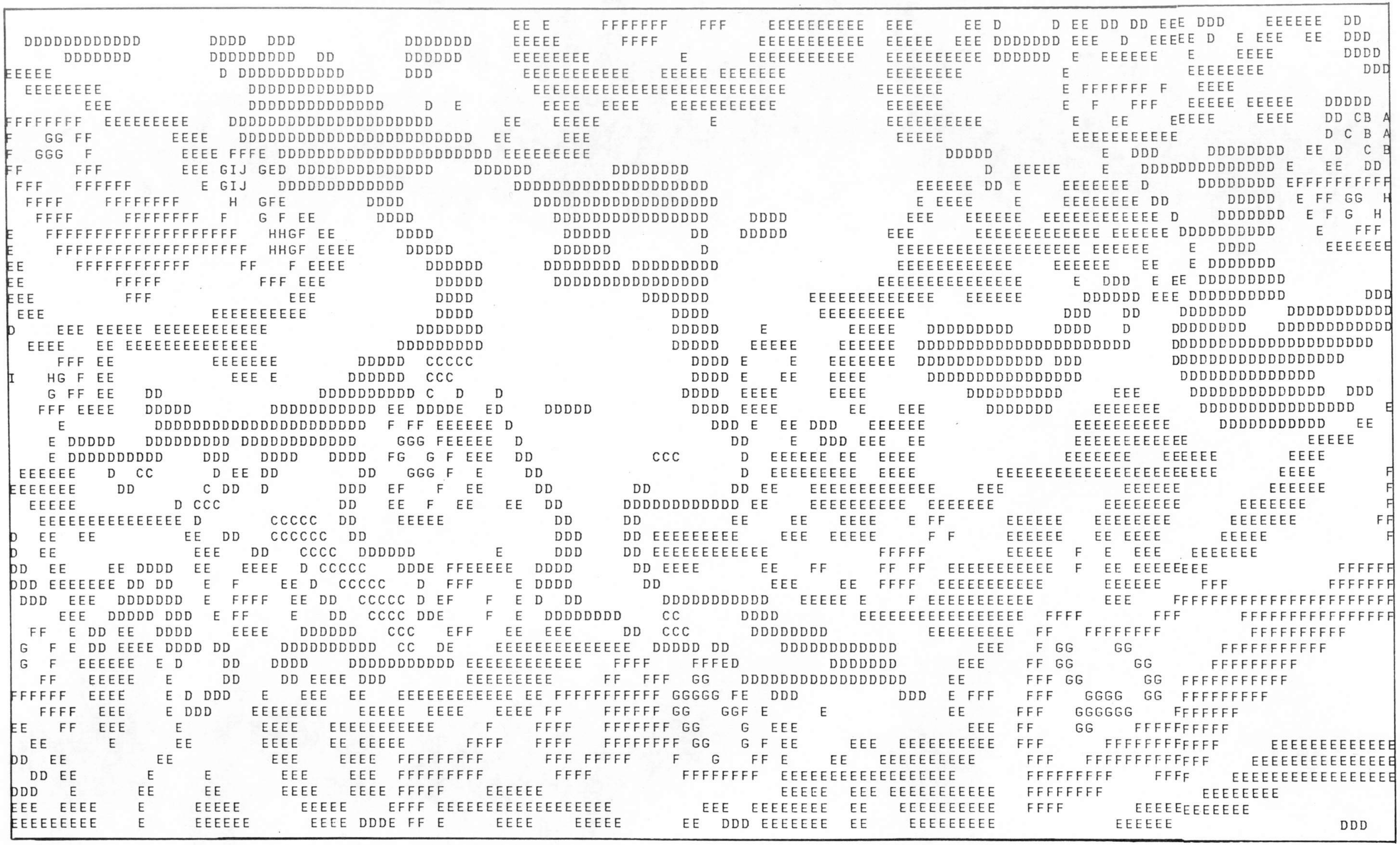
POPLAR BLUFF NJ 15-12 TEXAS-KENTUCKY SURVEY 1979

Th/K PRINTER PLOT CONTOUR MAP 1:500,000 SCALE TEXAS INSTRUMENTS

POPLAR BLUFF NJ 15-12 TEXAS-KENTUCKY SURVEY 1979



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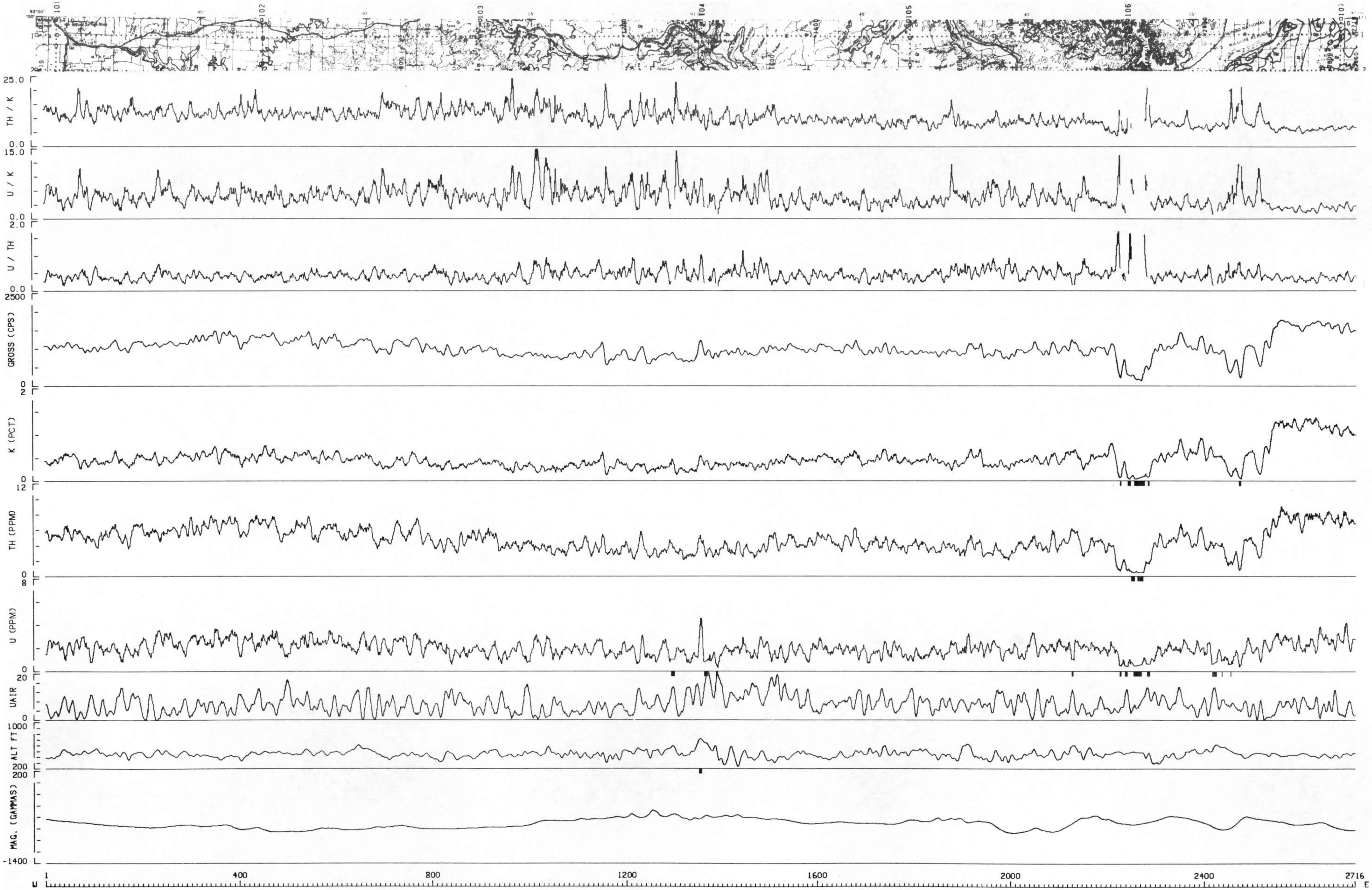
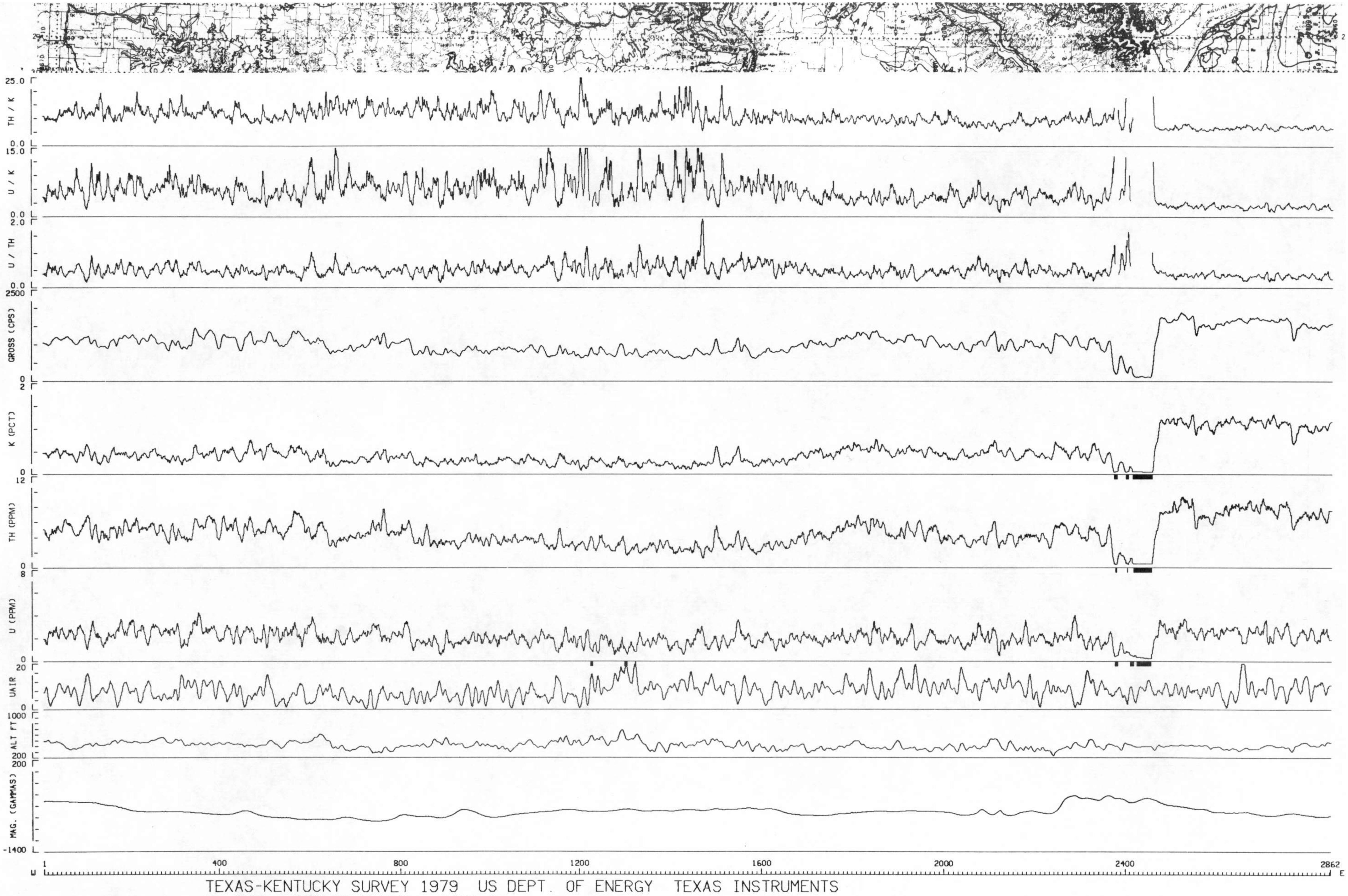


TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS
FL-001 POPLAR BLUFF NJ15-12



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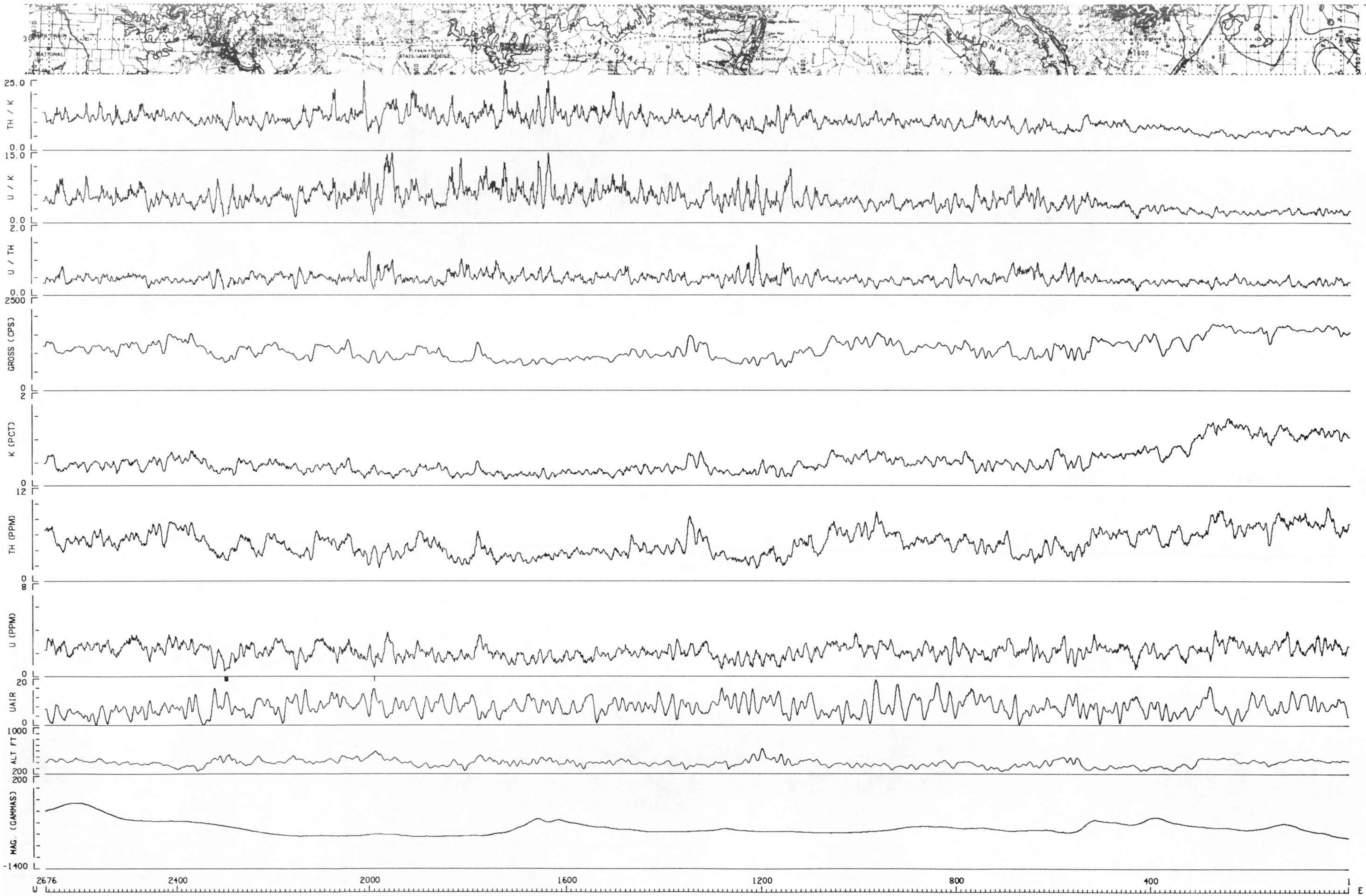
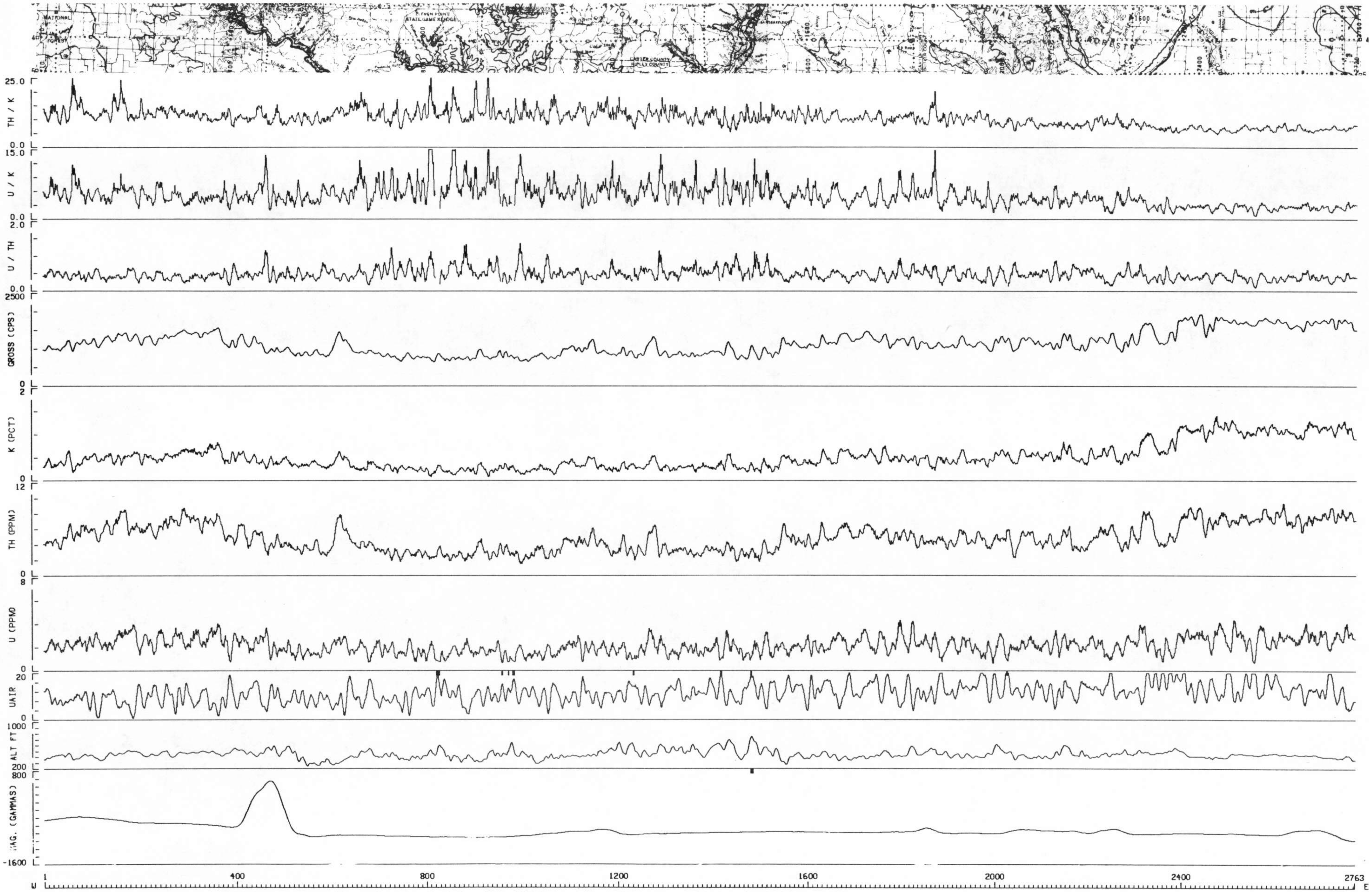


TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

FL-003 POPLAR BLUFF NJ15-12



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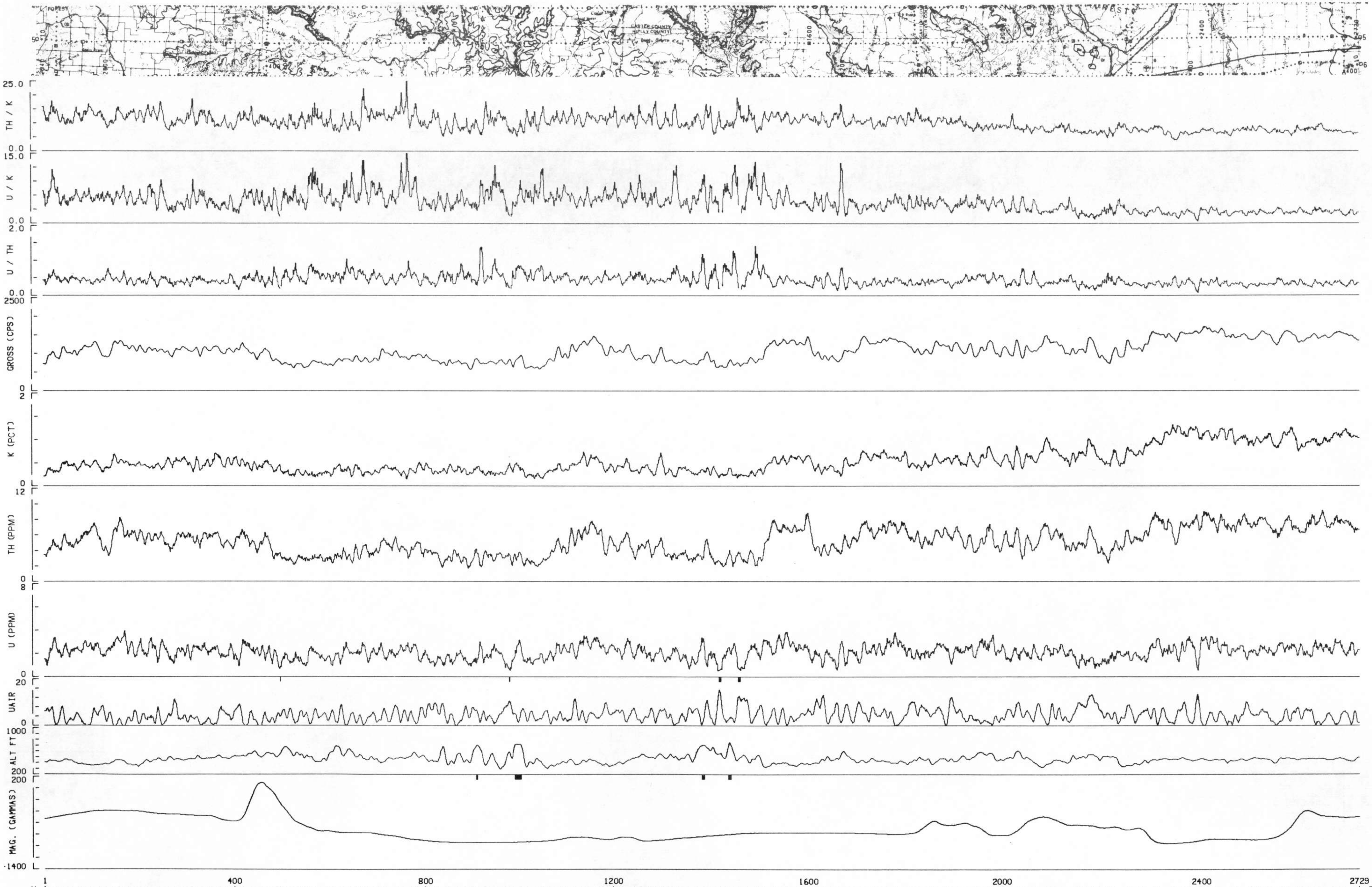
TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

FL-004 POPLAR BLUFF NJ15-12



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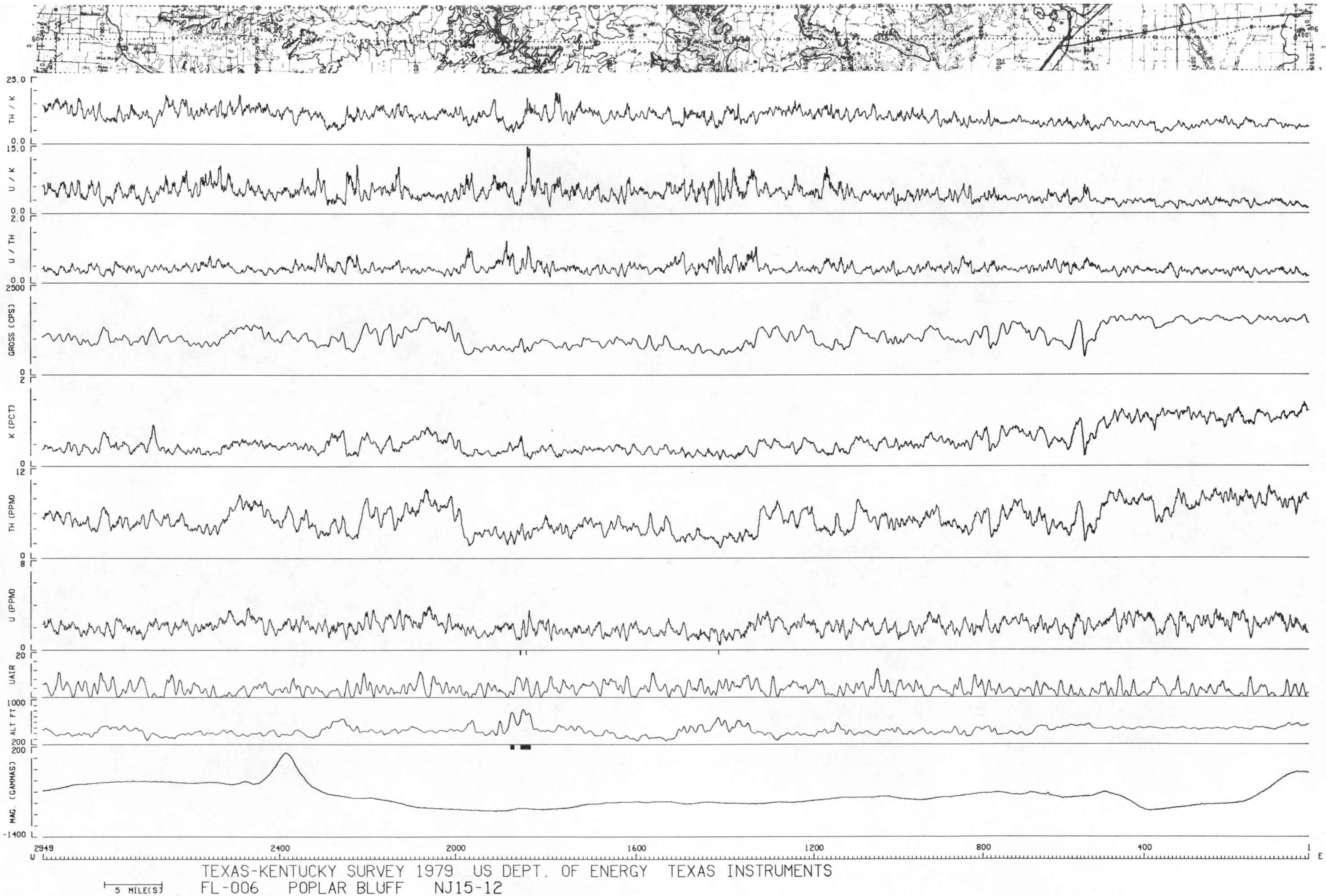
FL-005 POPLAR BLUFF NJ15-12



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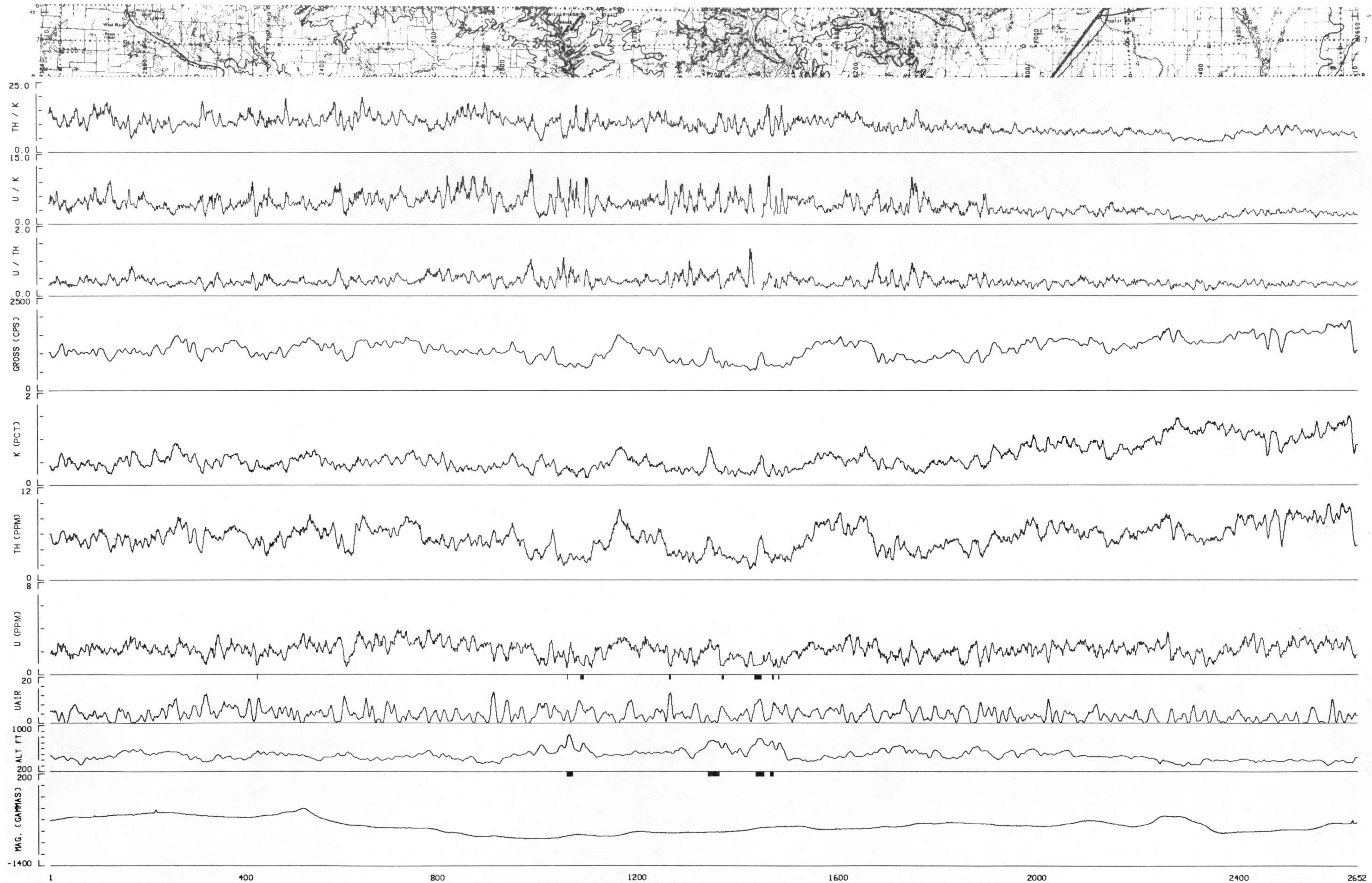
FL-006 POPLAR BLUFF NJ15-12



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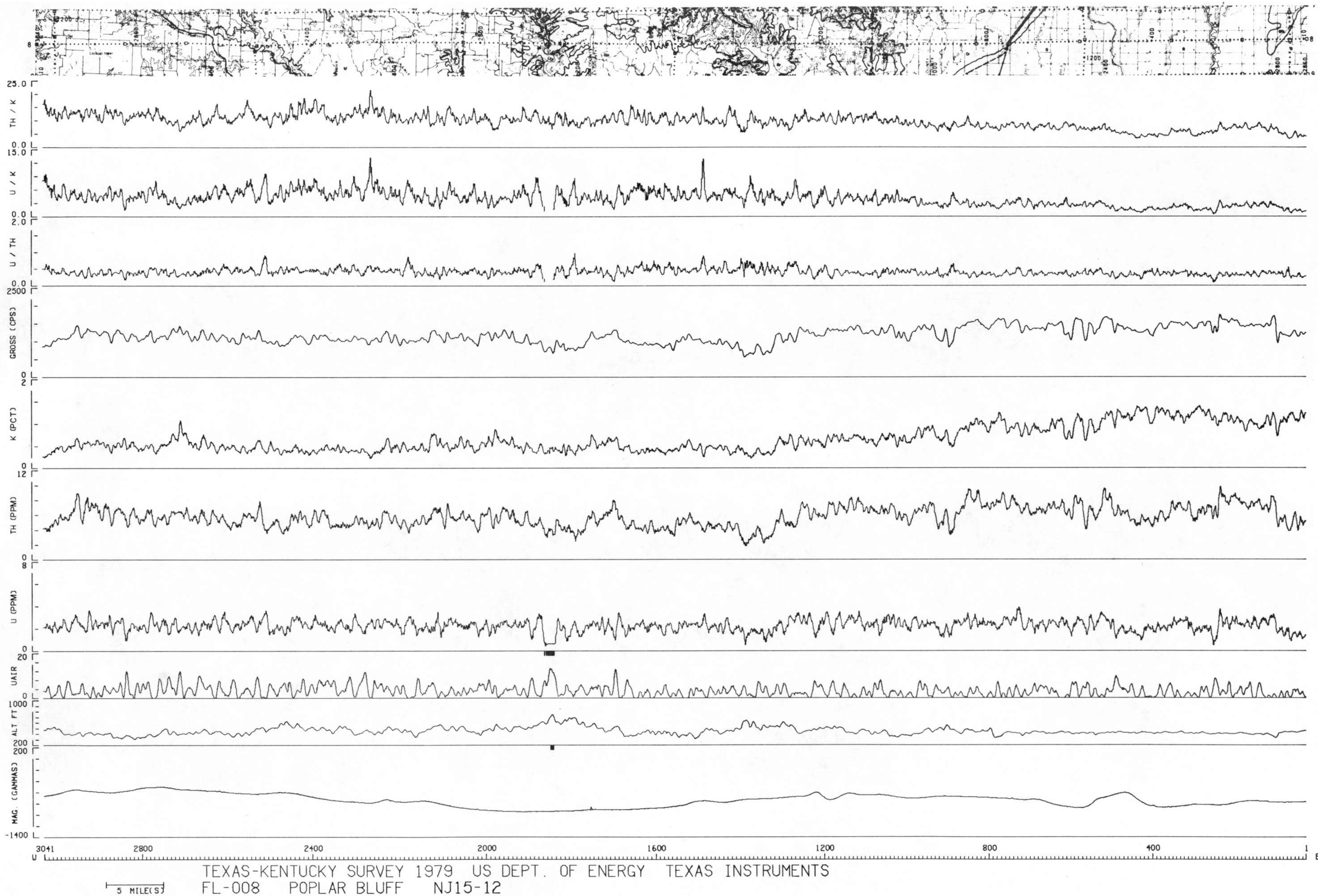
FL-007 POPLAR BLUFF NJ15-12



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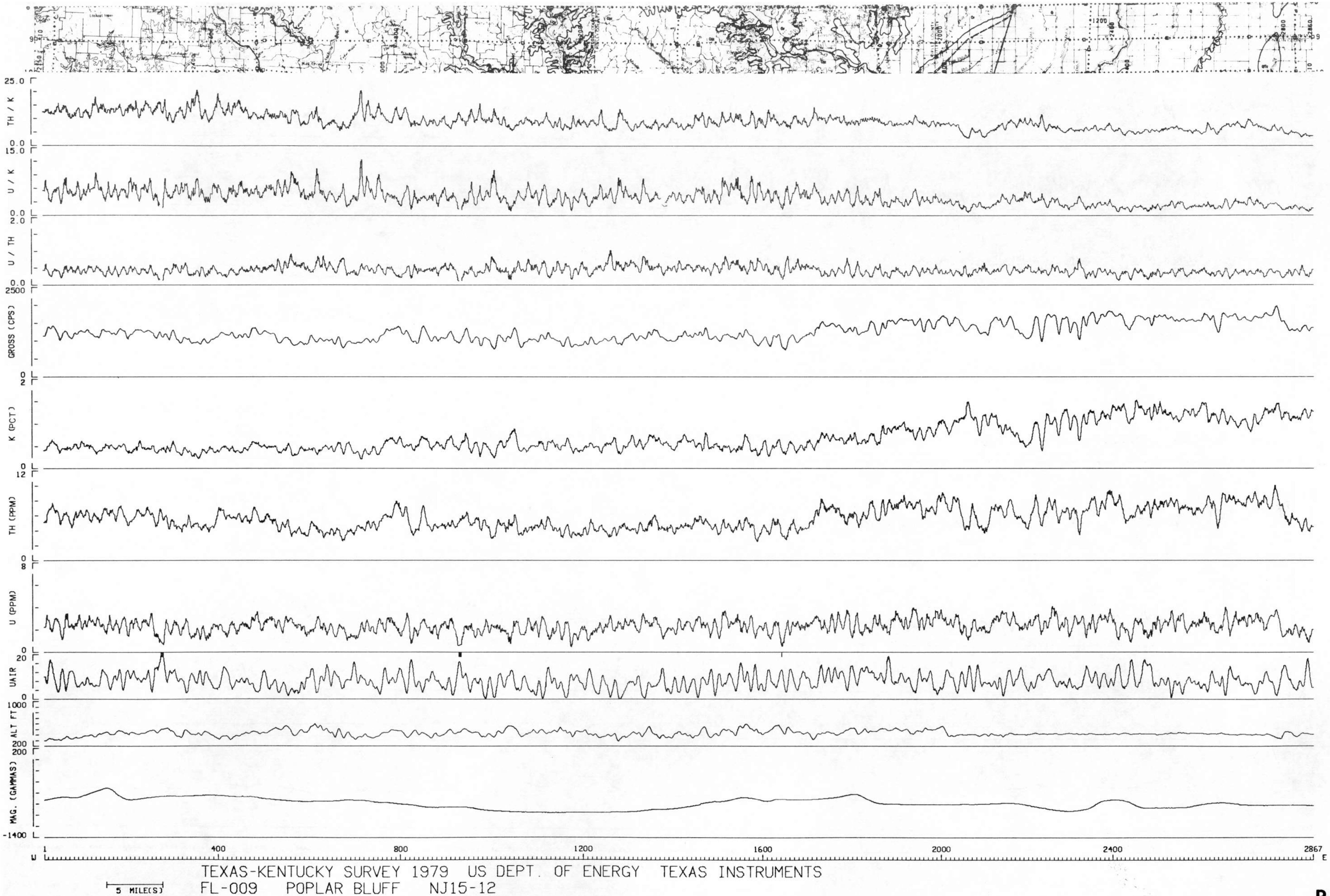

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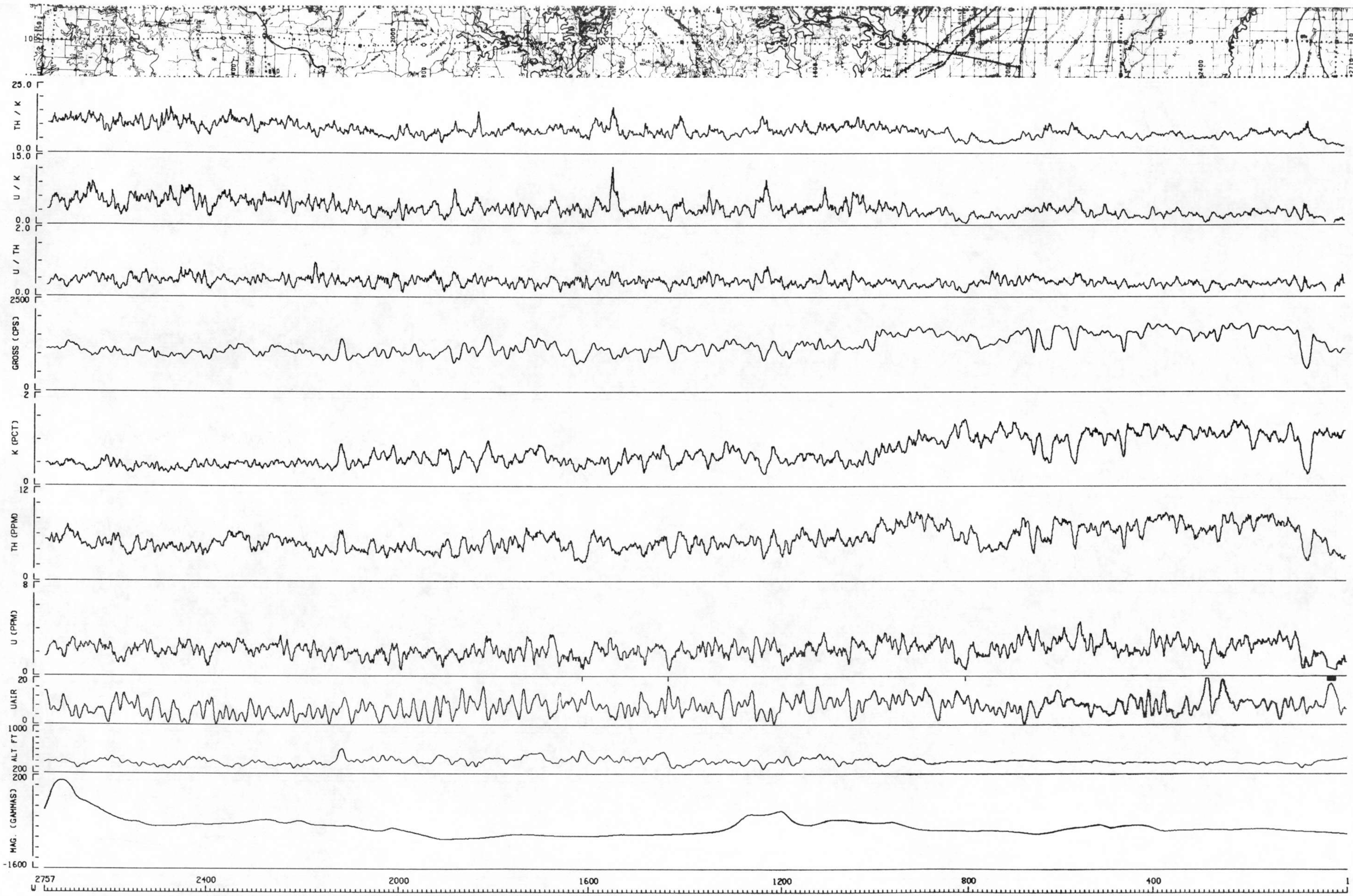
FL-009 POPLAR BLUFF NJ15-12



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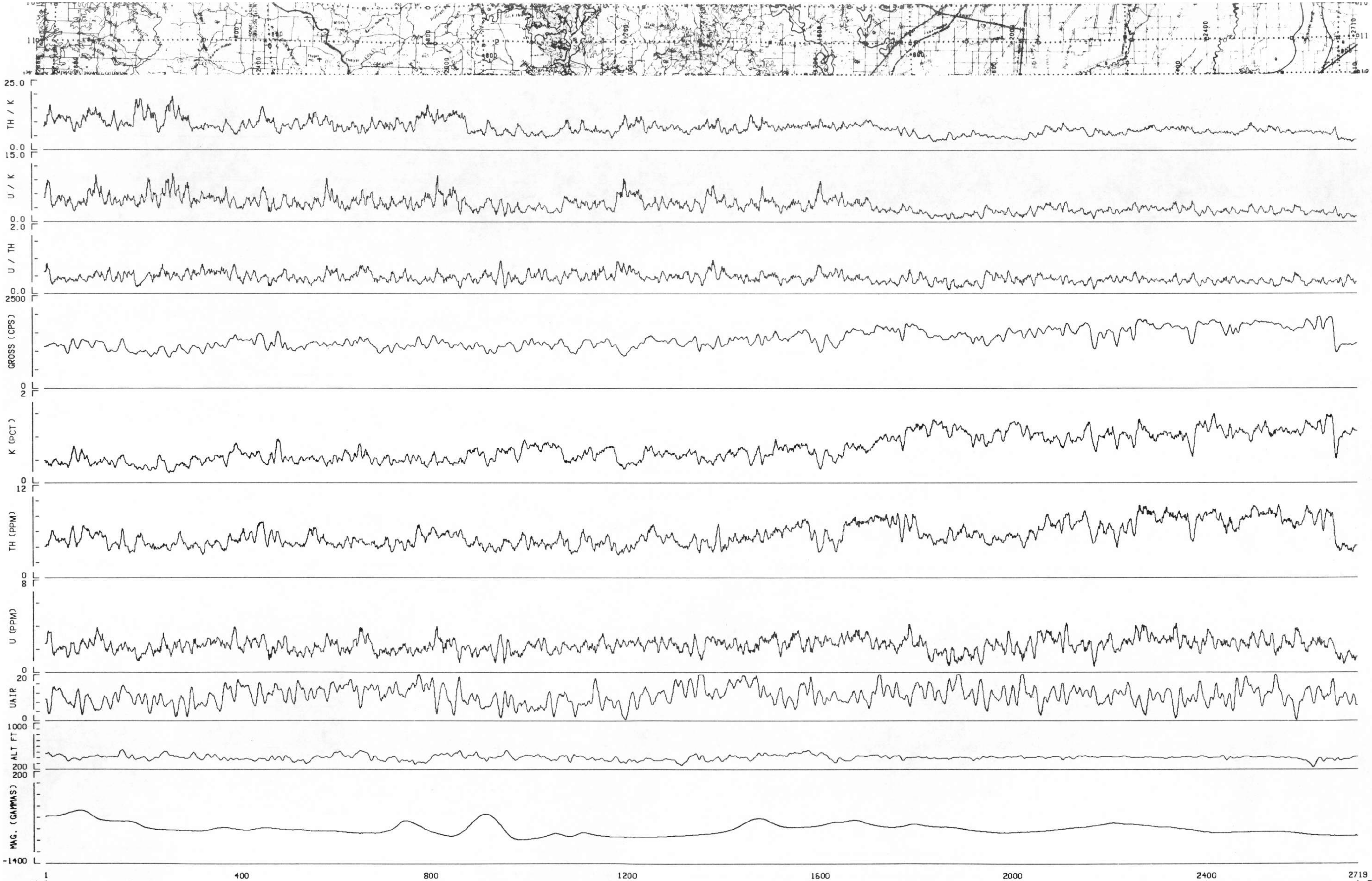

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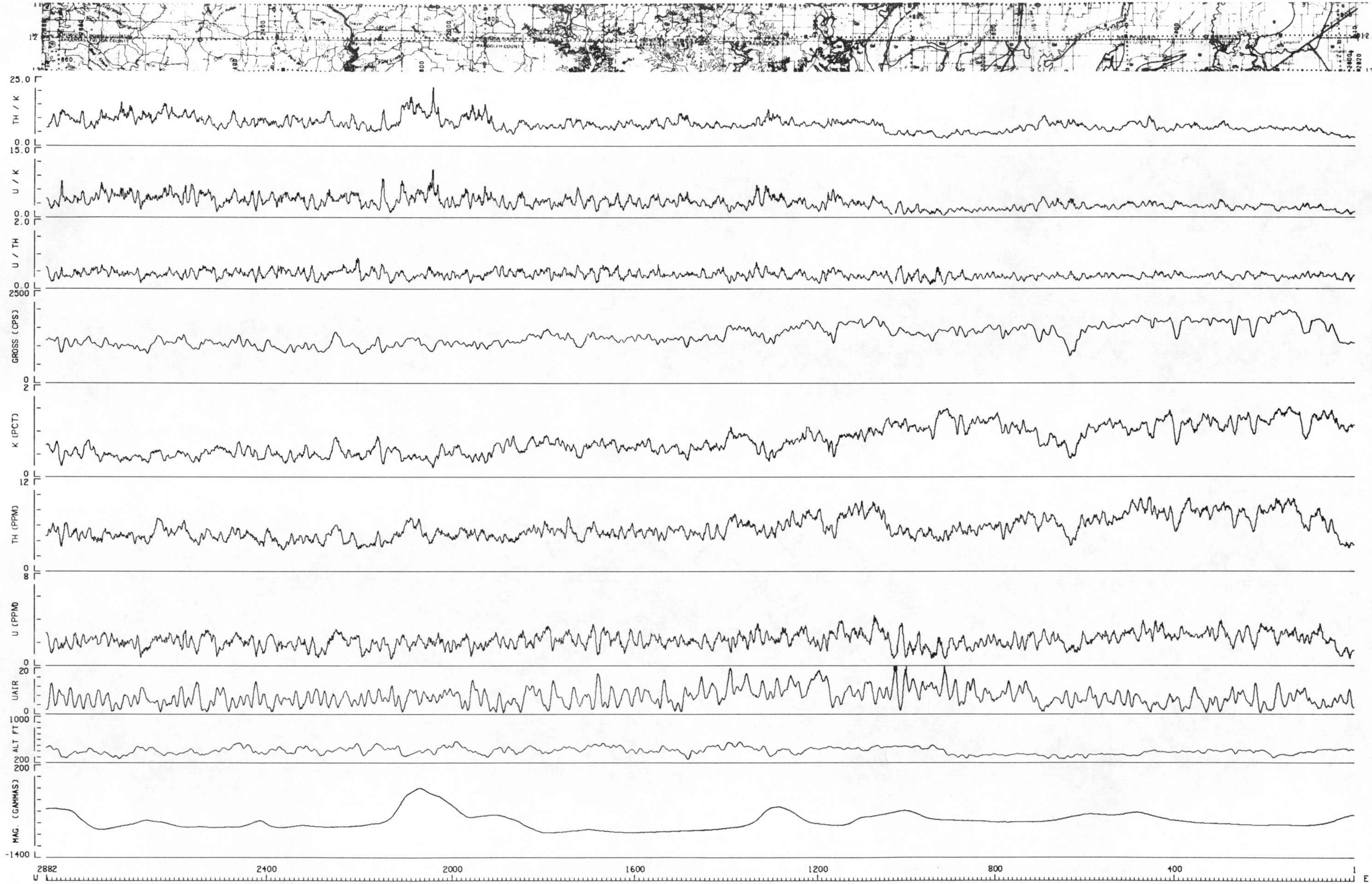

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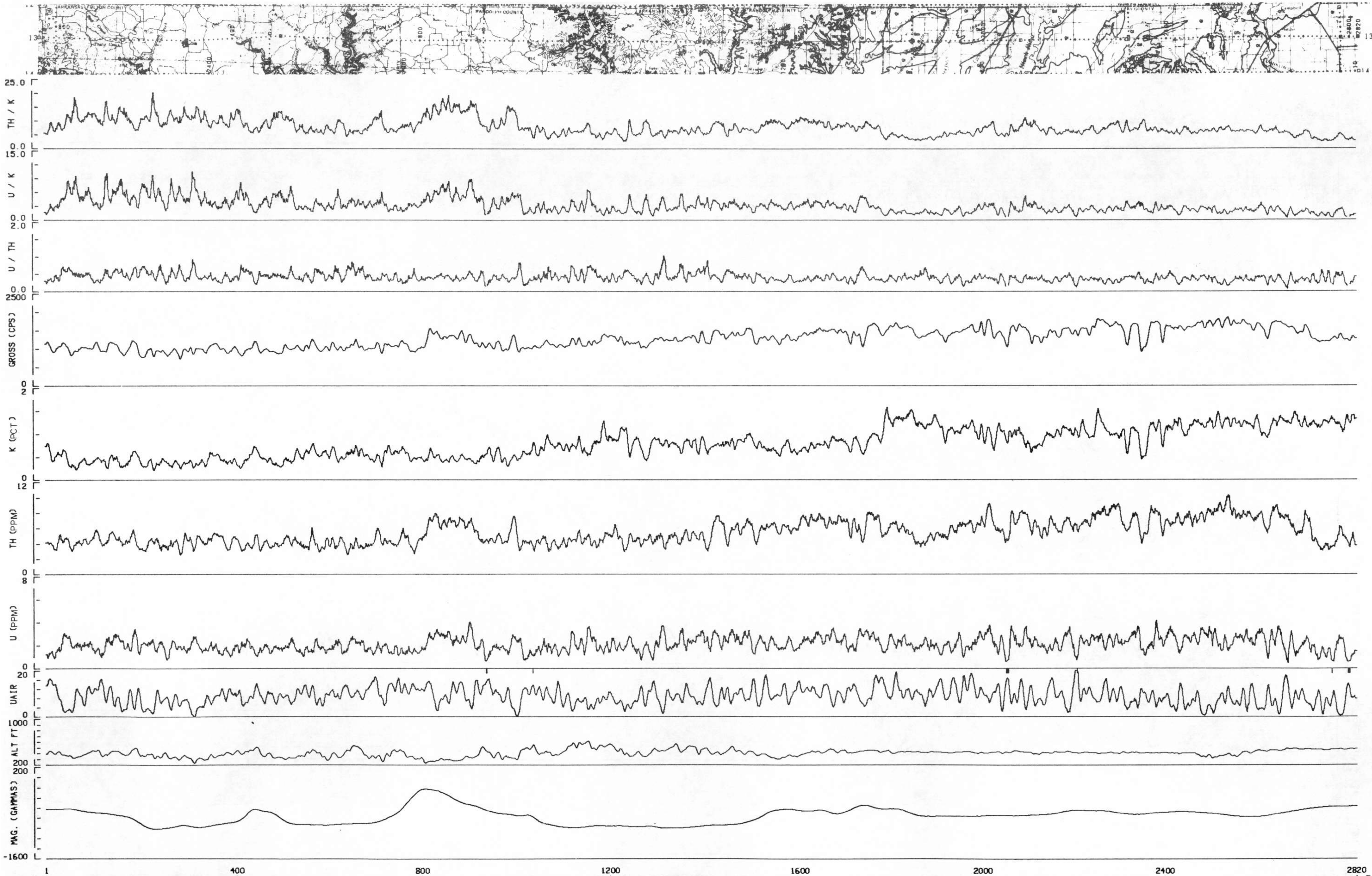

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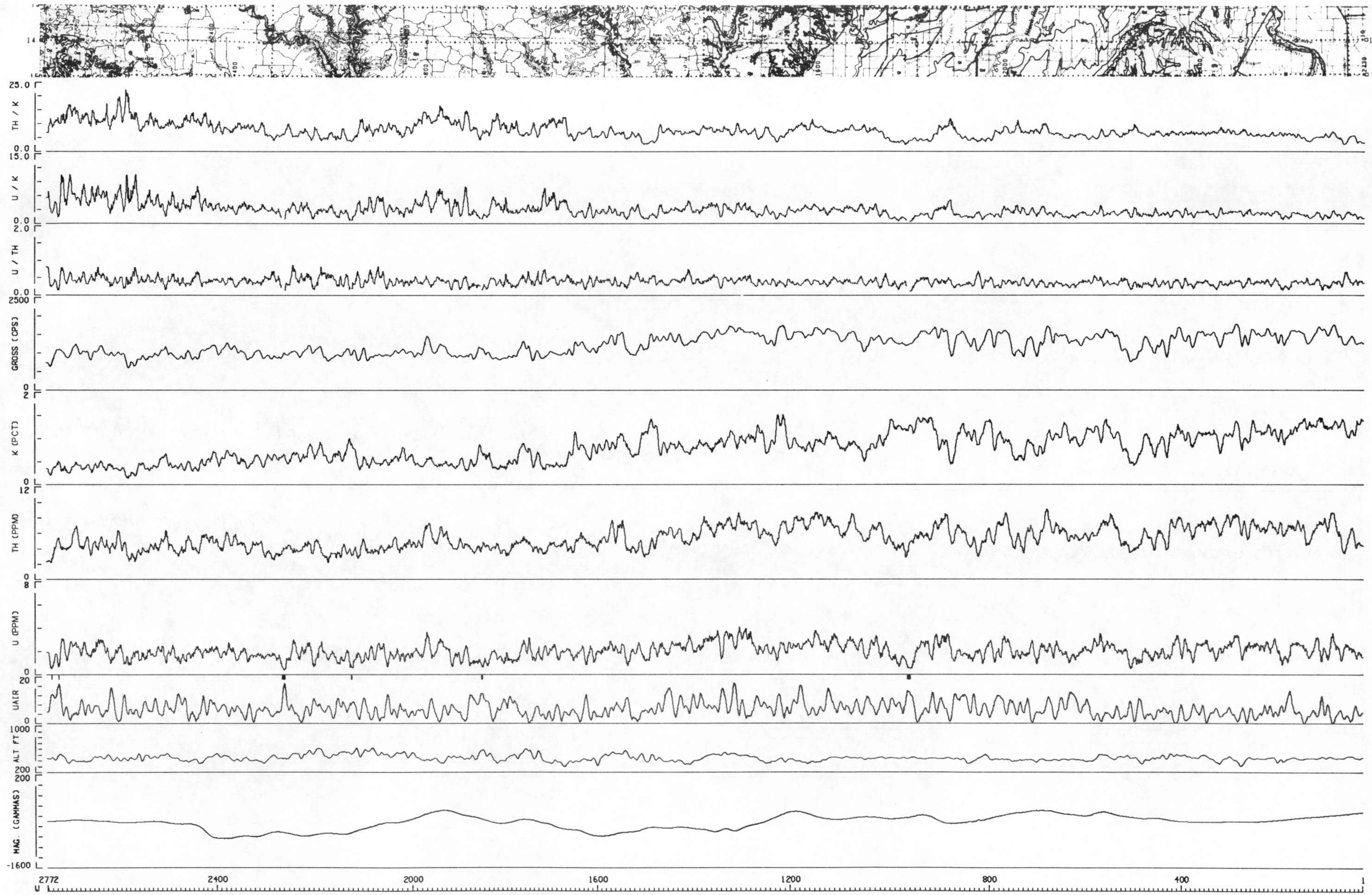

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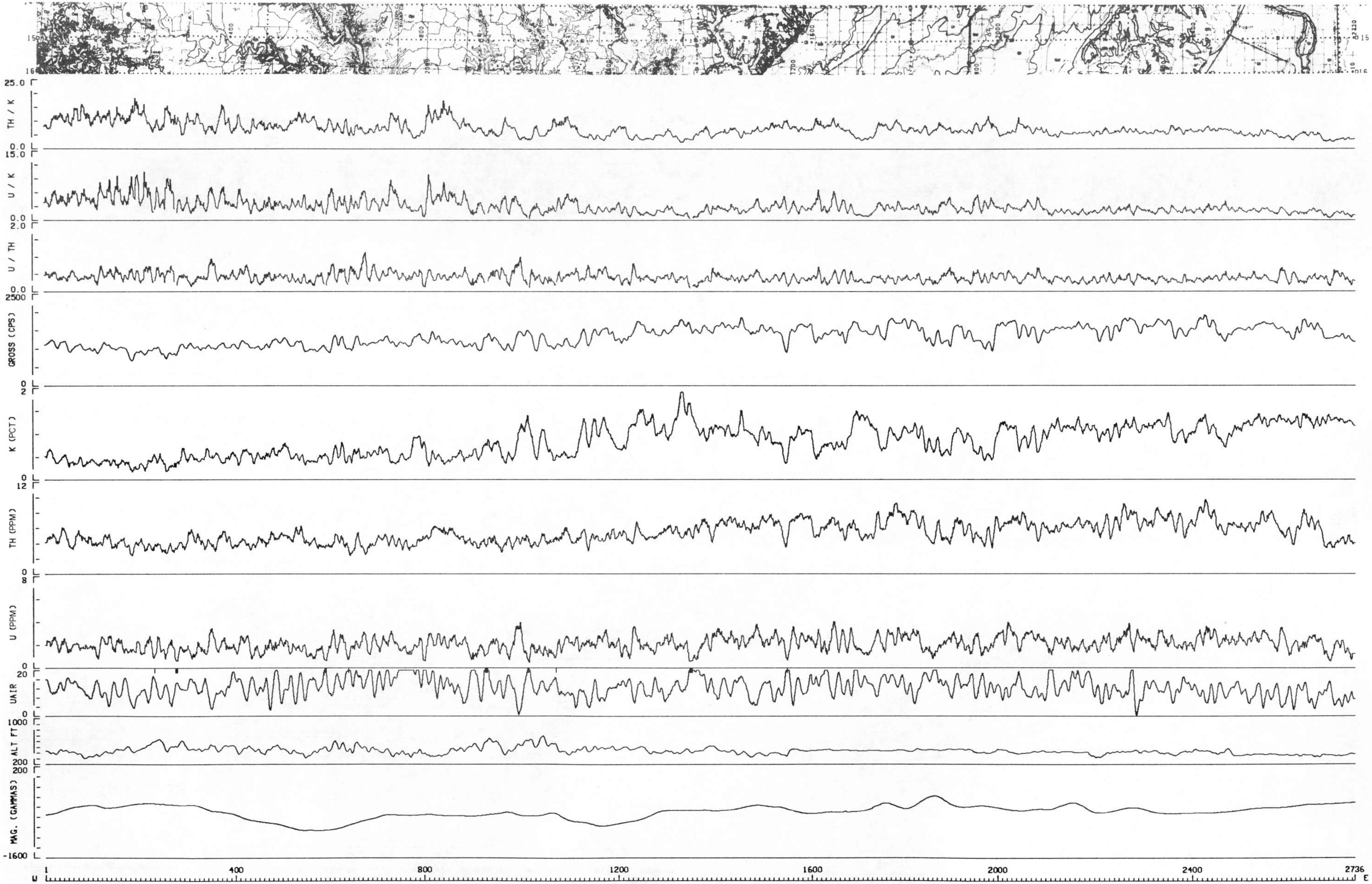

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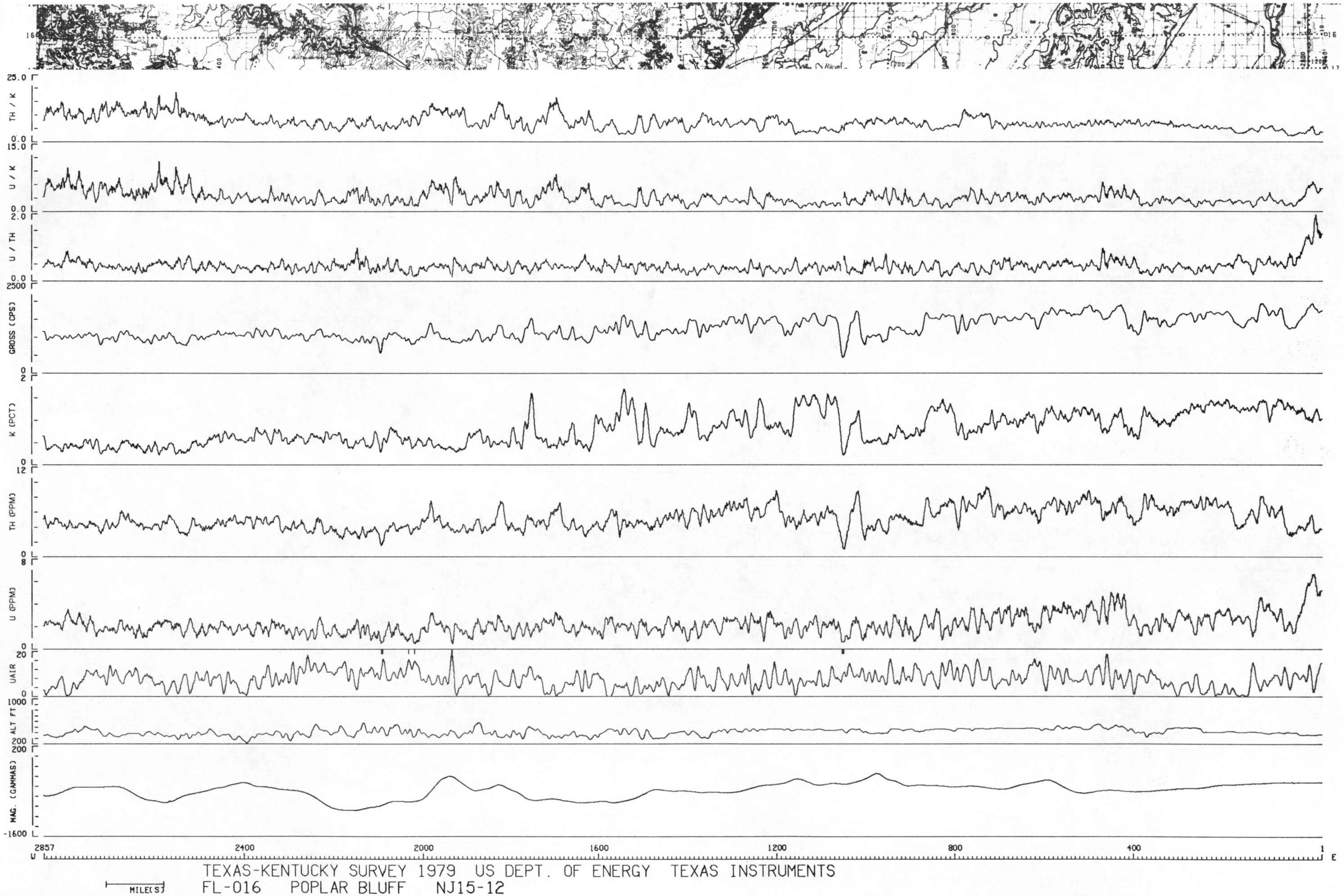
FL-015 POPLAR BLUFF NJ15-12



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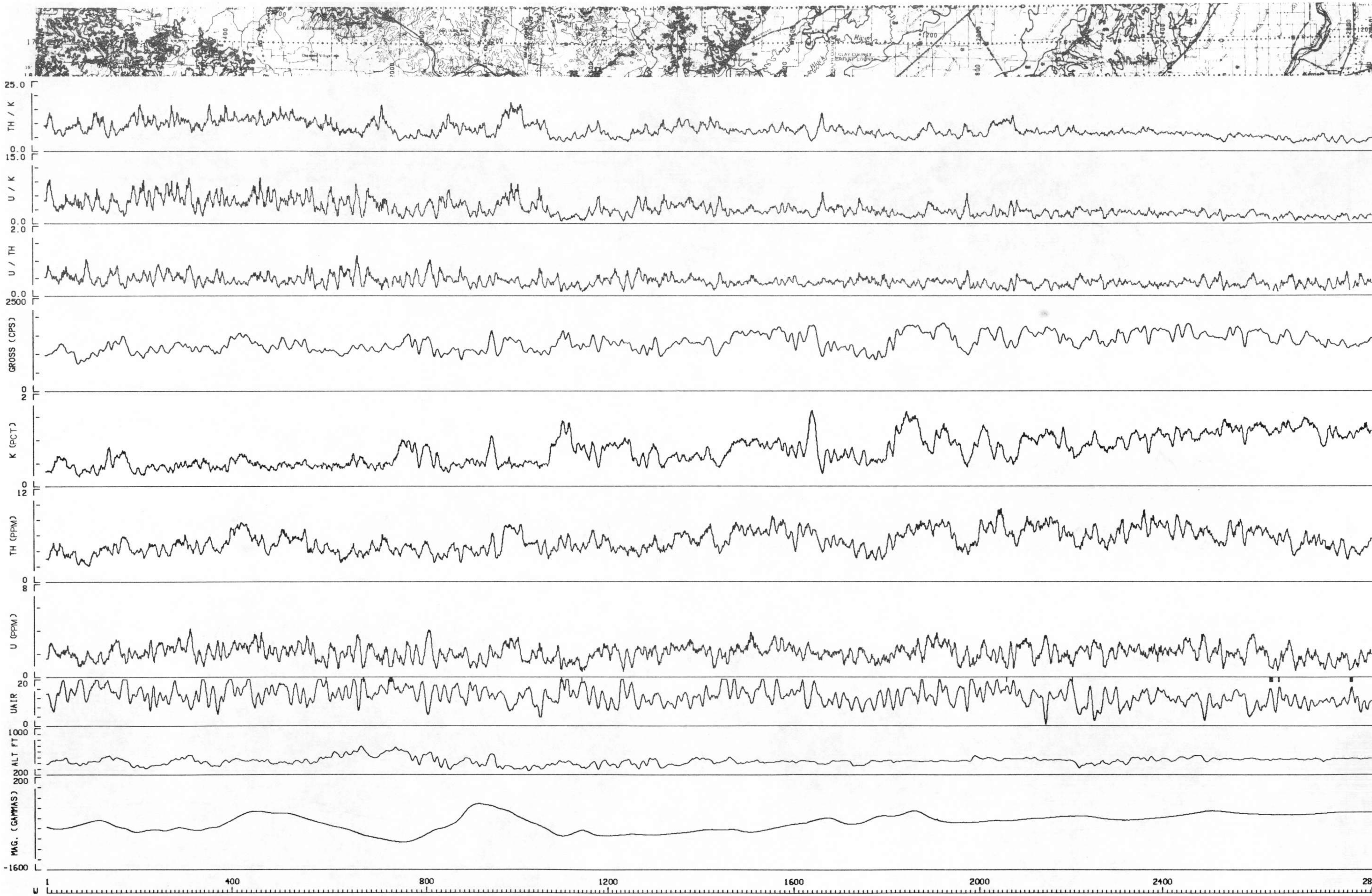

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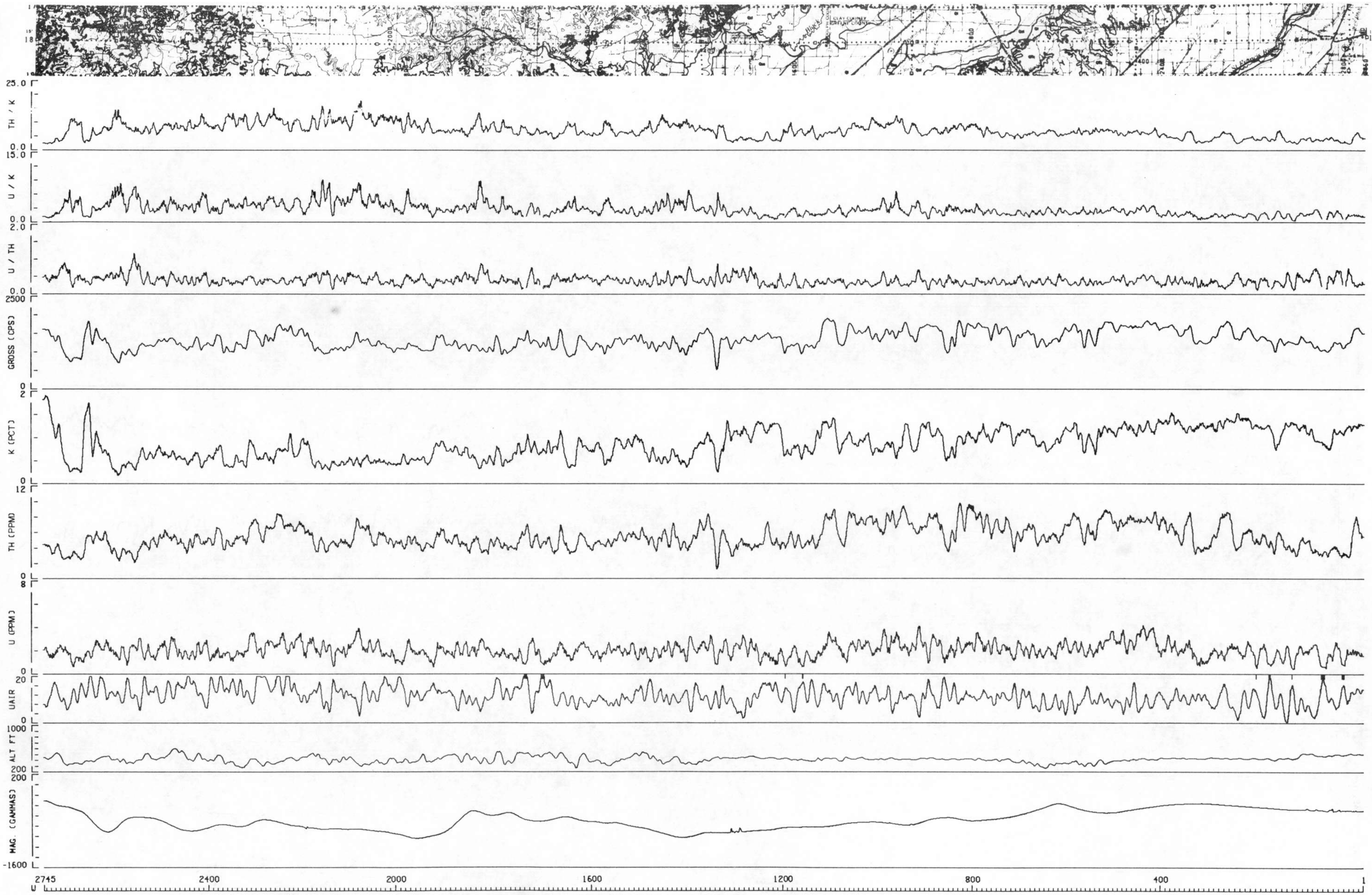

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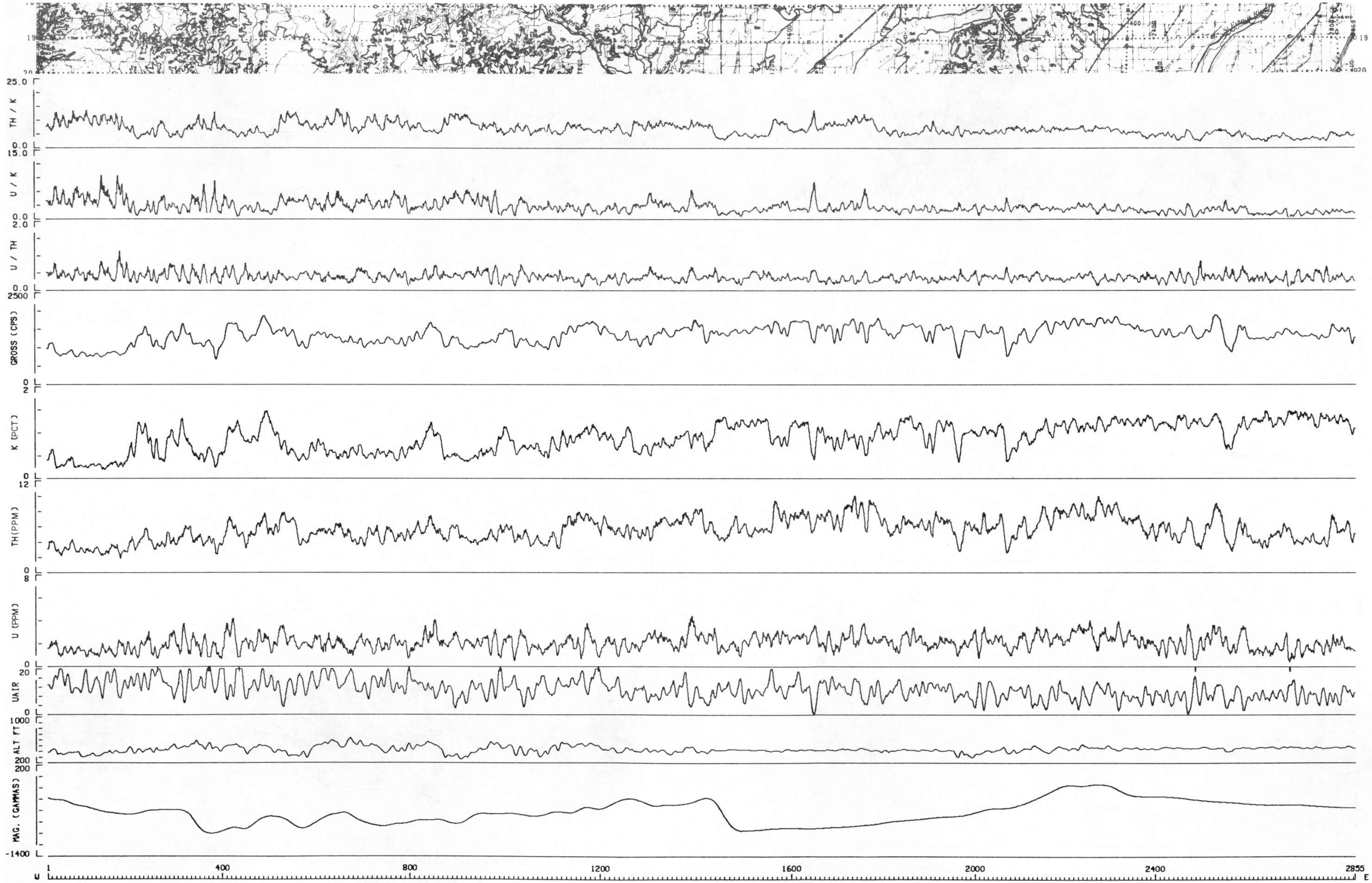
FL-018 POPLAR BLUFF NJ15-12



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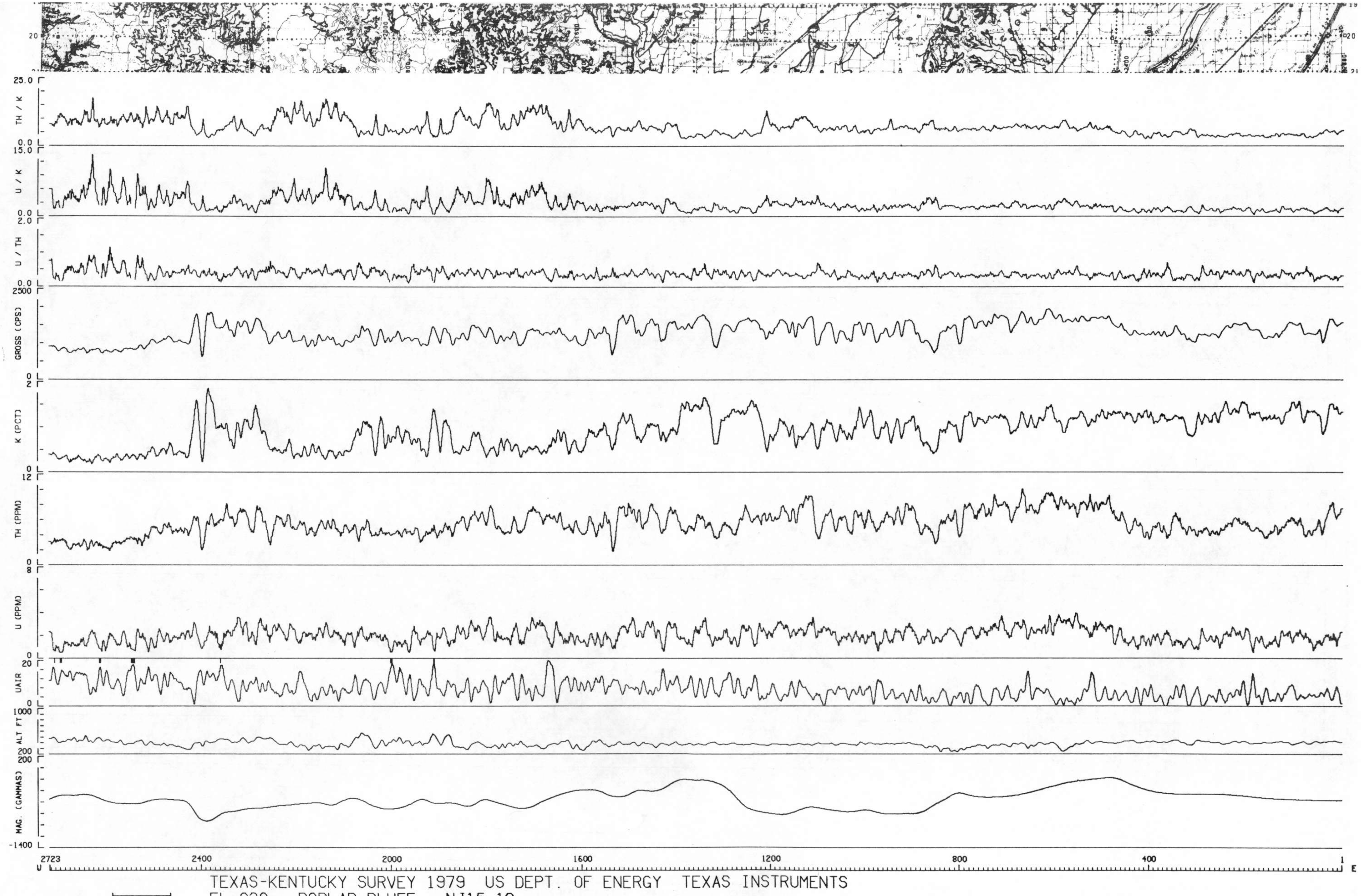
TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

FL-019 POPLAR BLUFF NJ15-12



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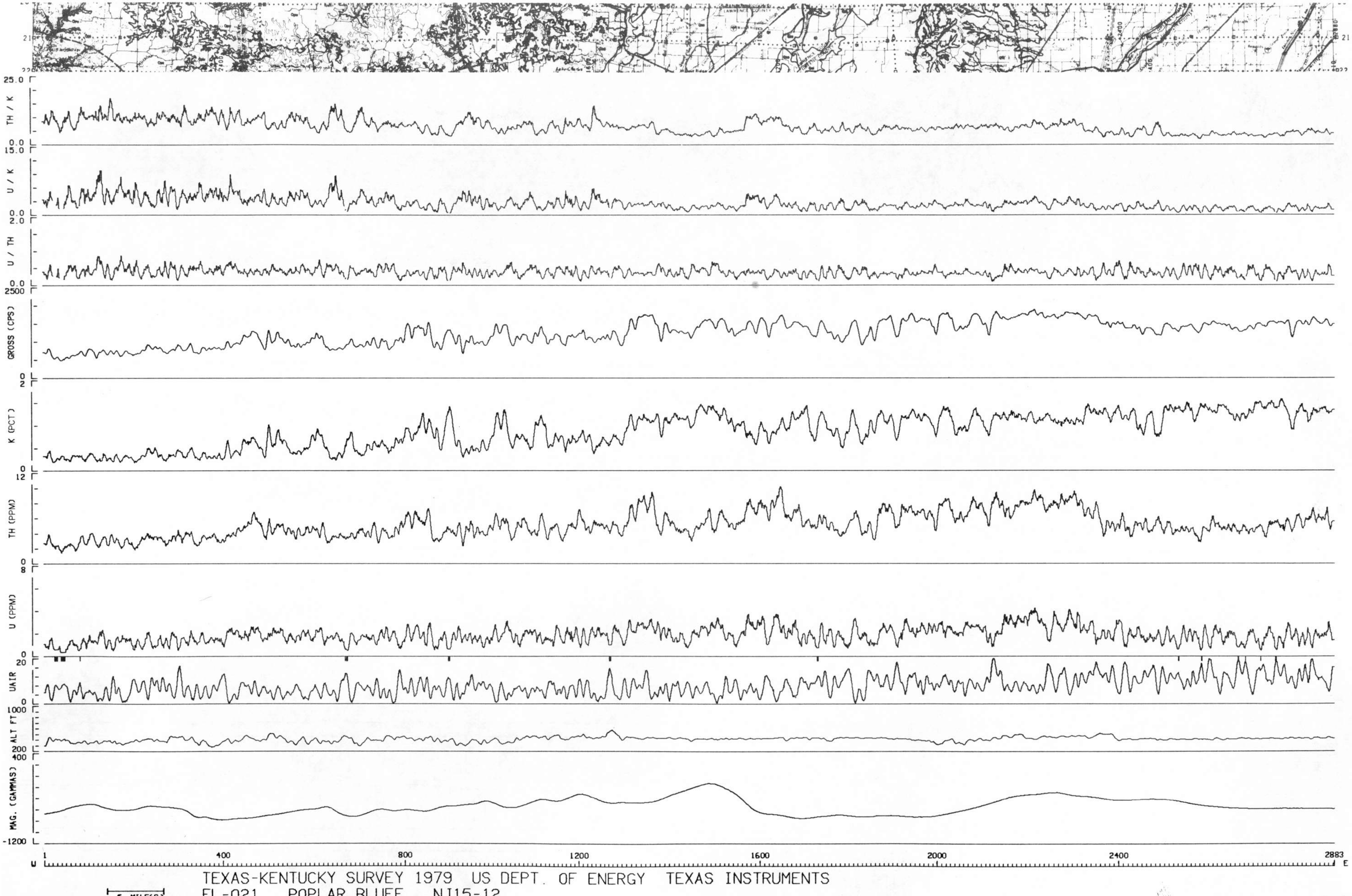
FL-020 POPLAR BLUFF NJ15-12



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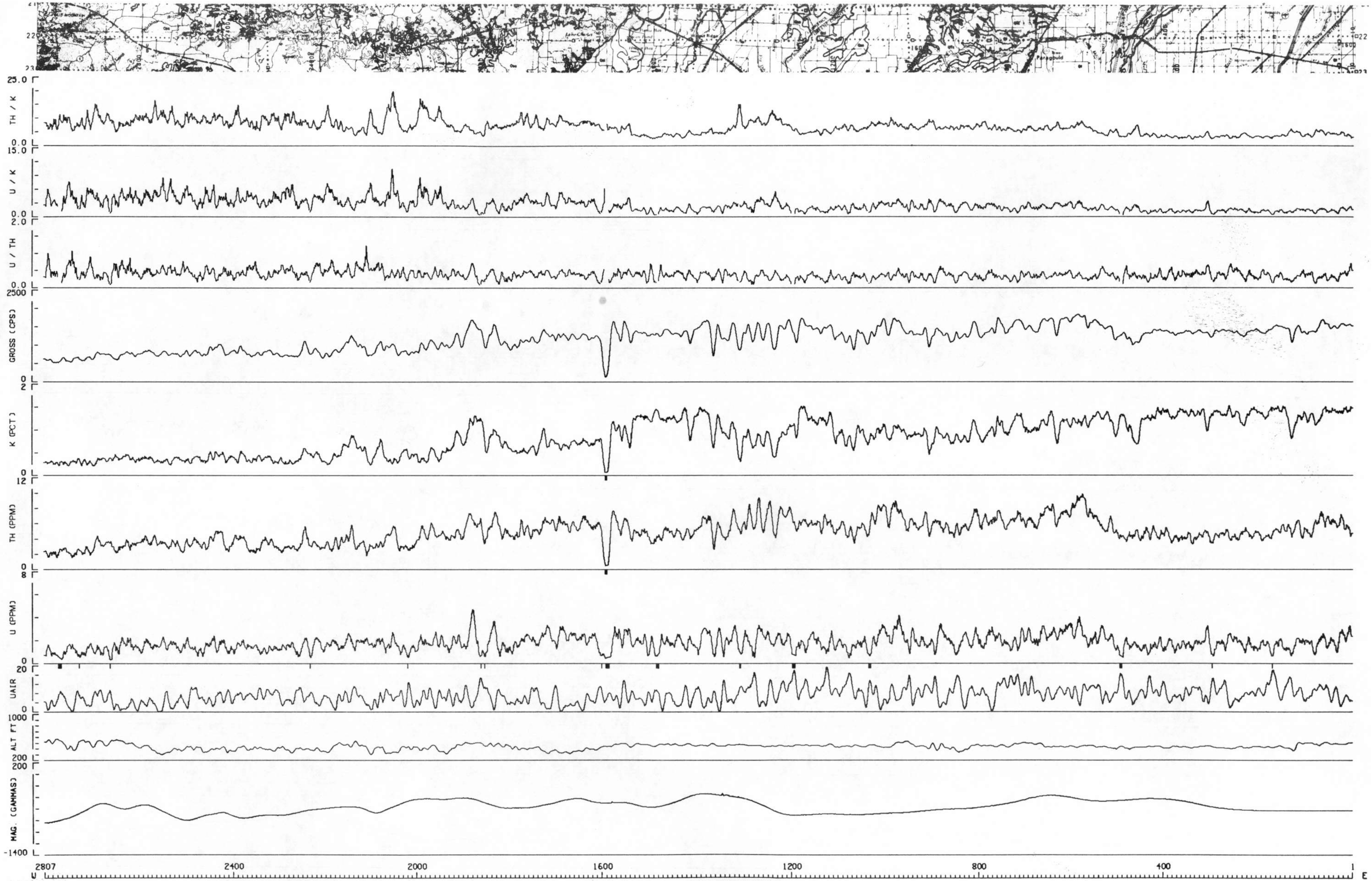
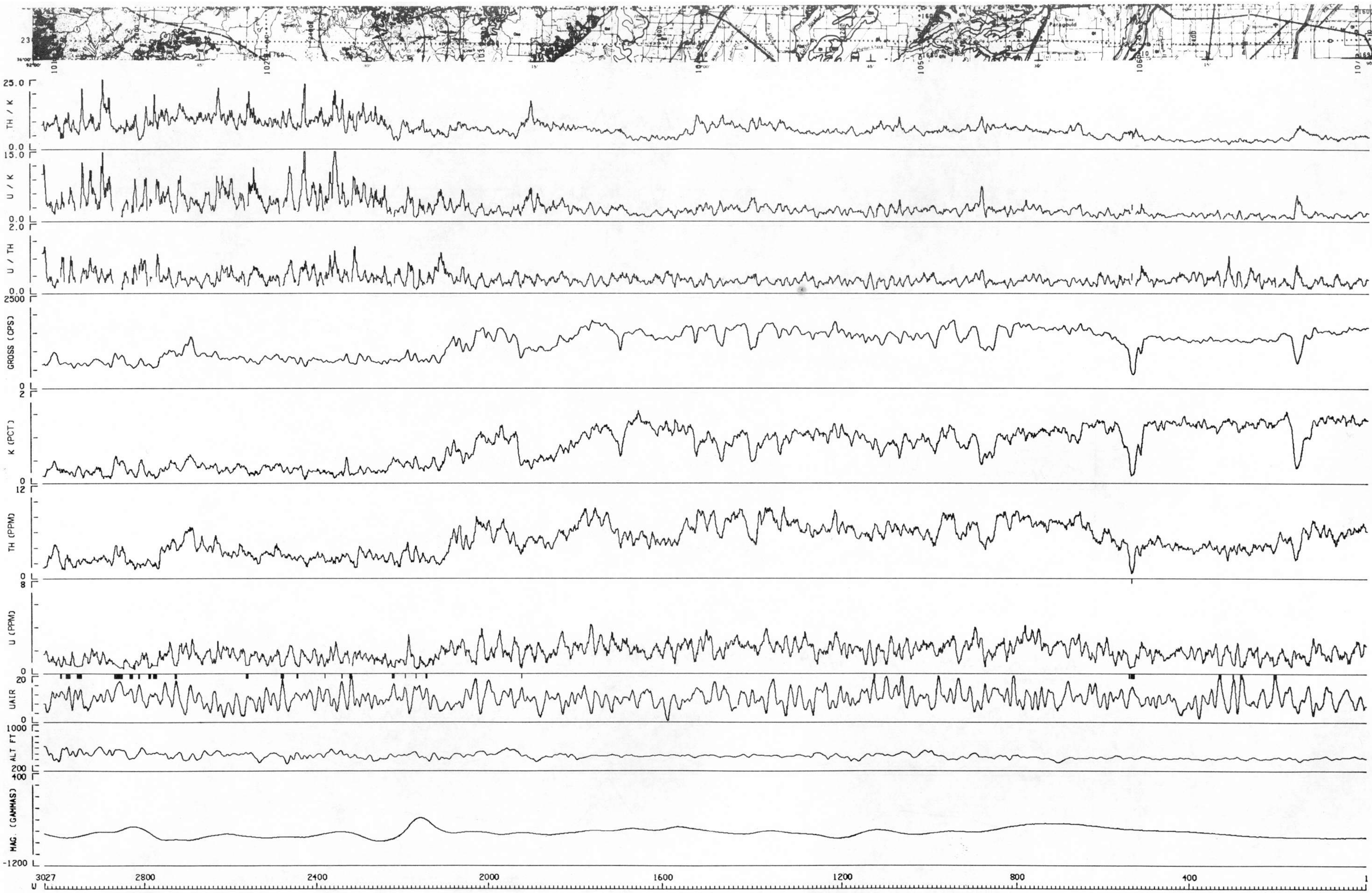


TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

5 MILE(S) FL-022 POPLAR BLUFF NJ15-12



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TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

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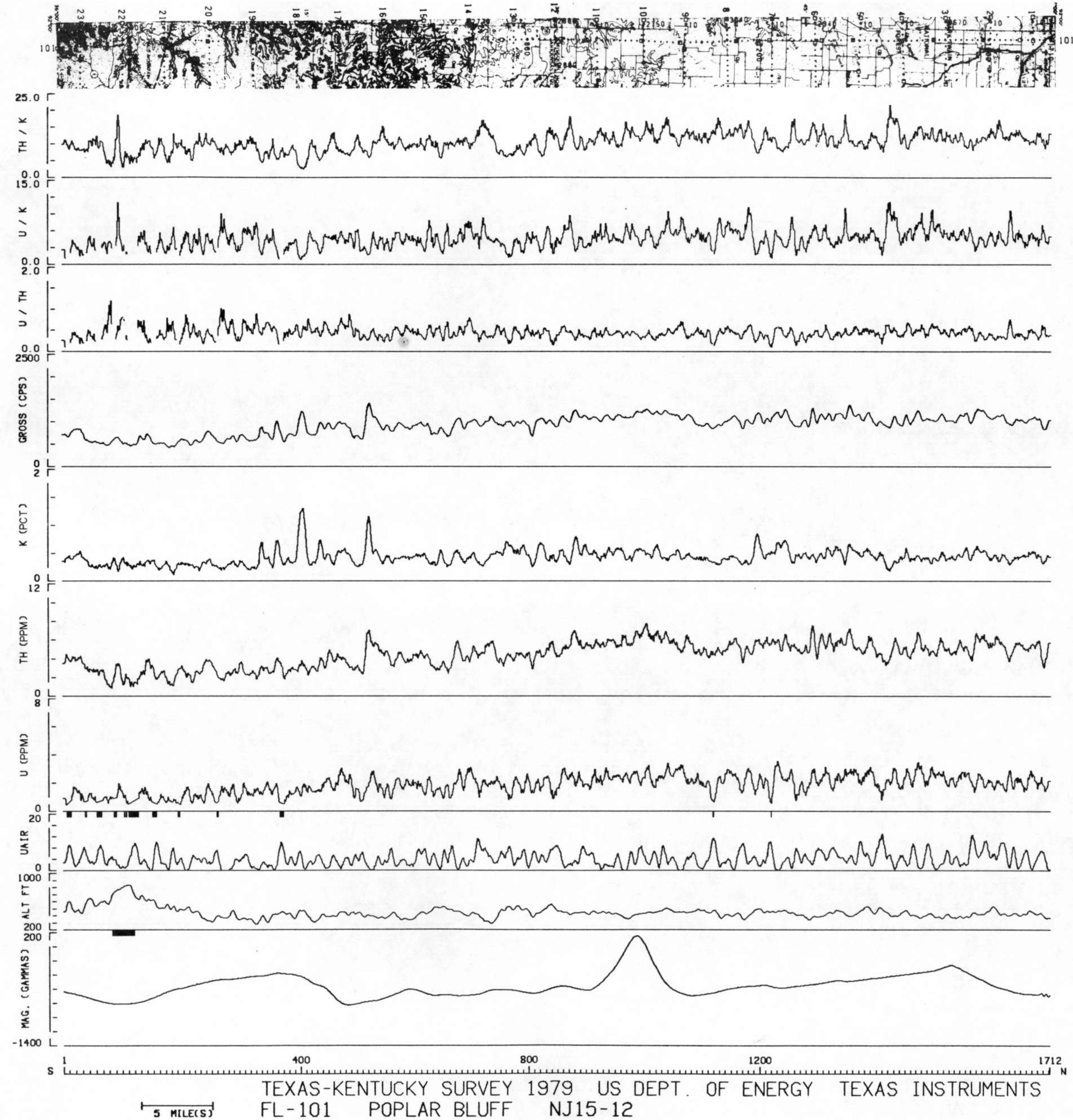

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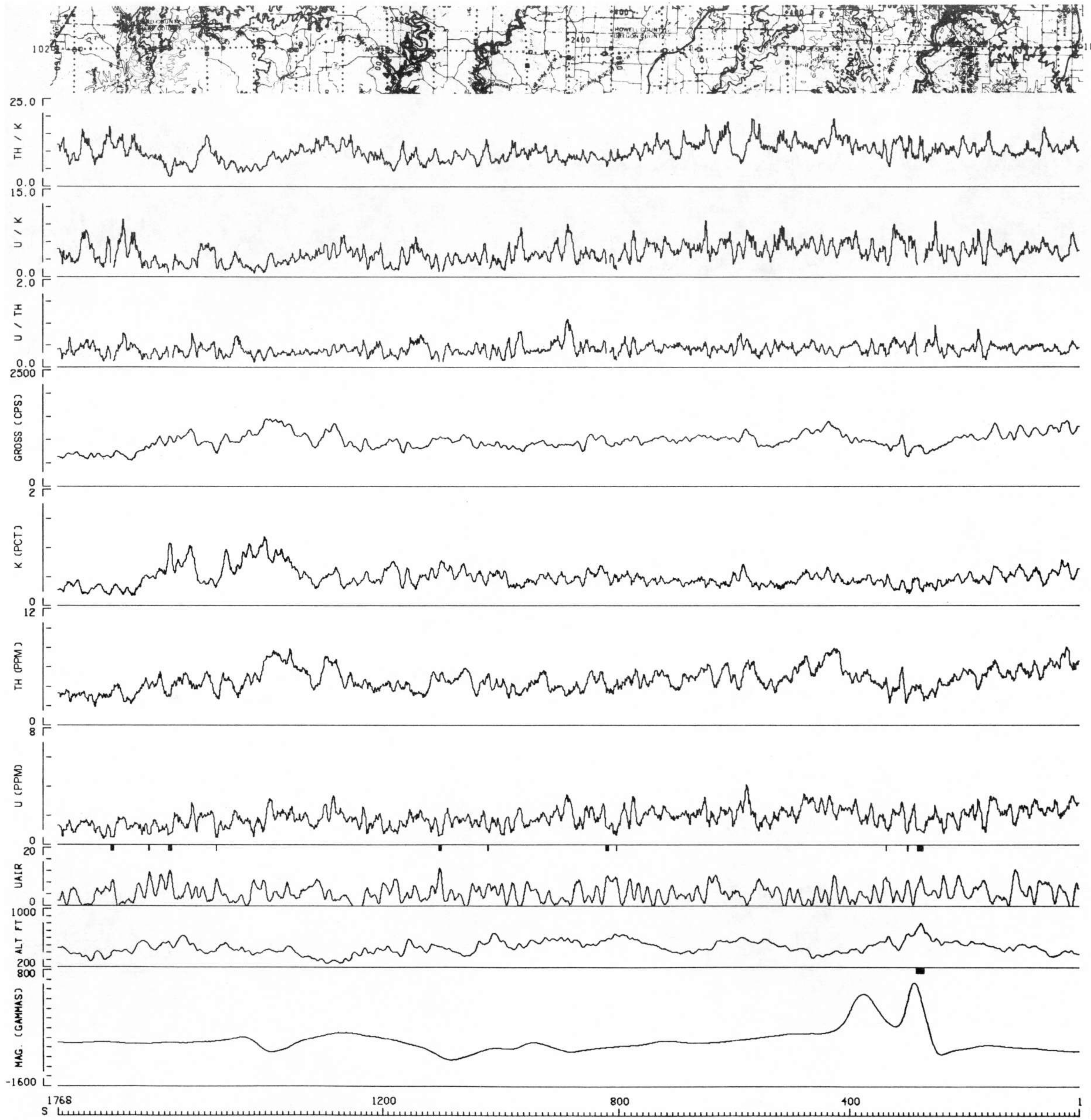

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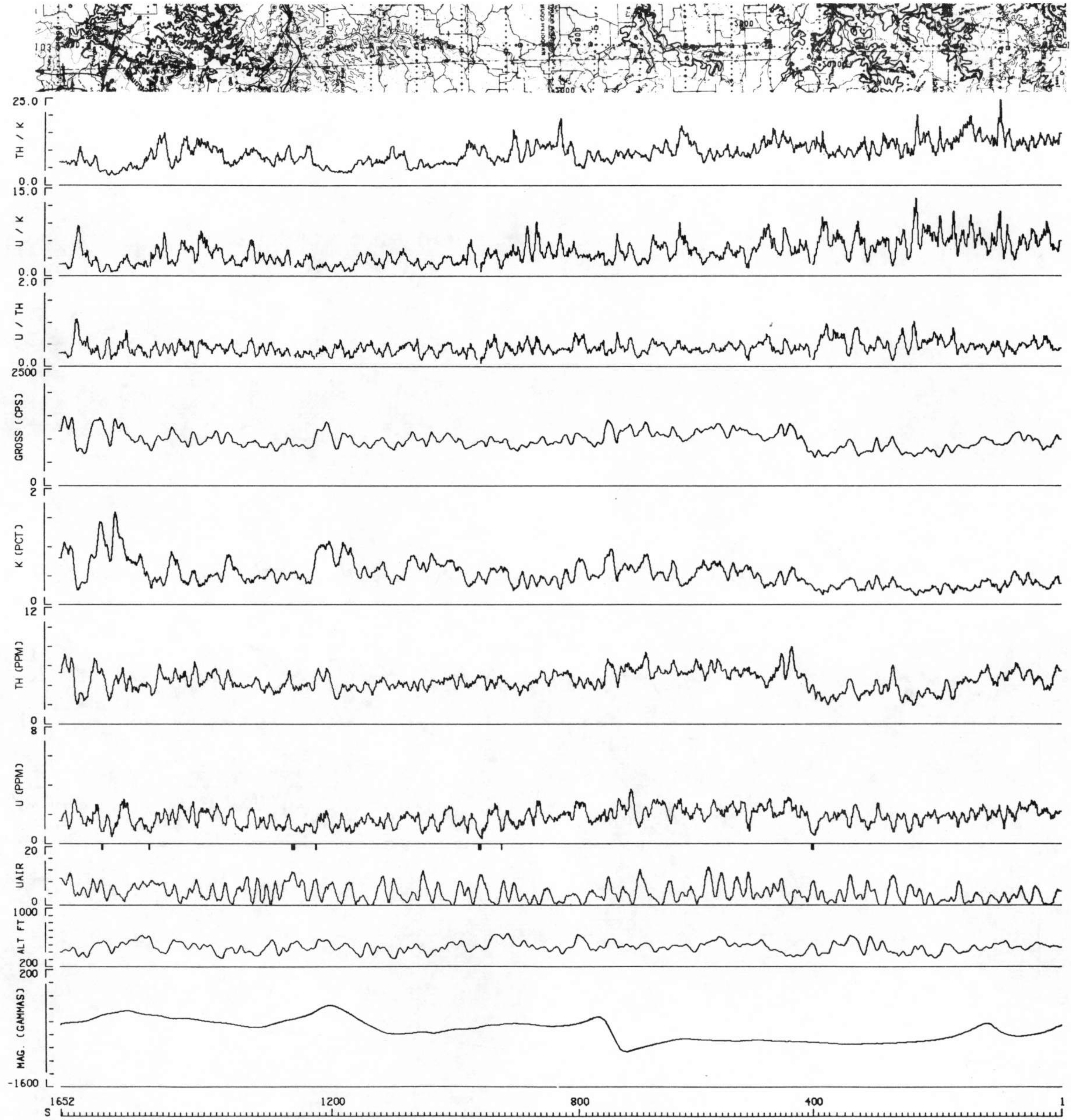

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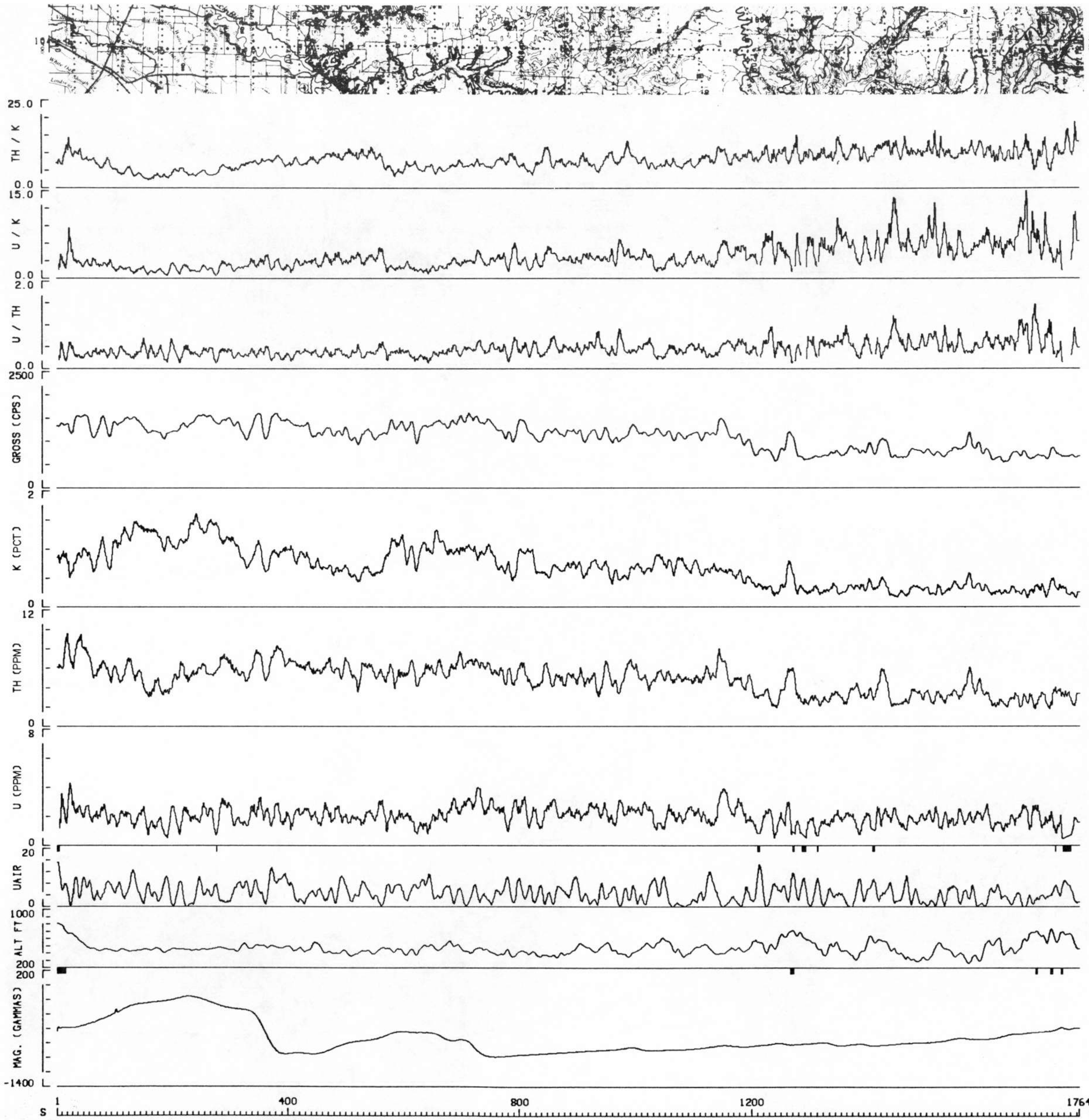

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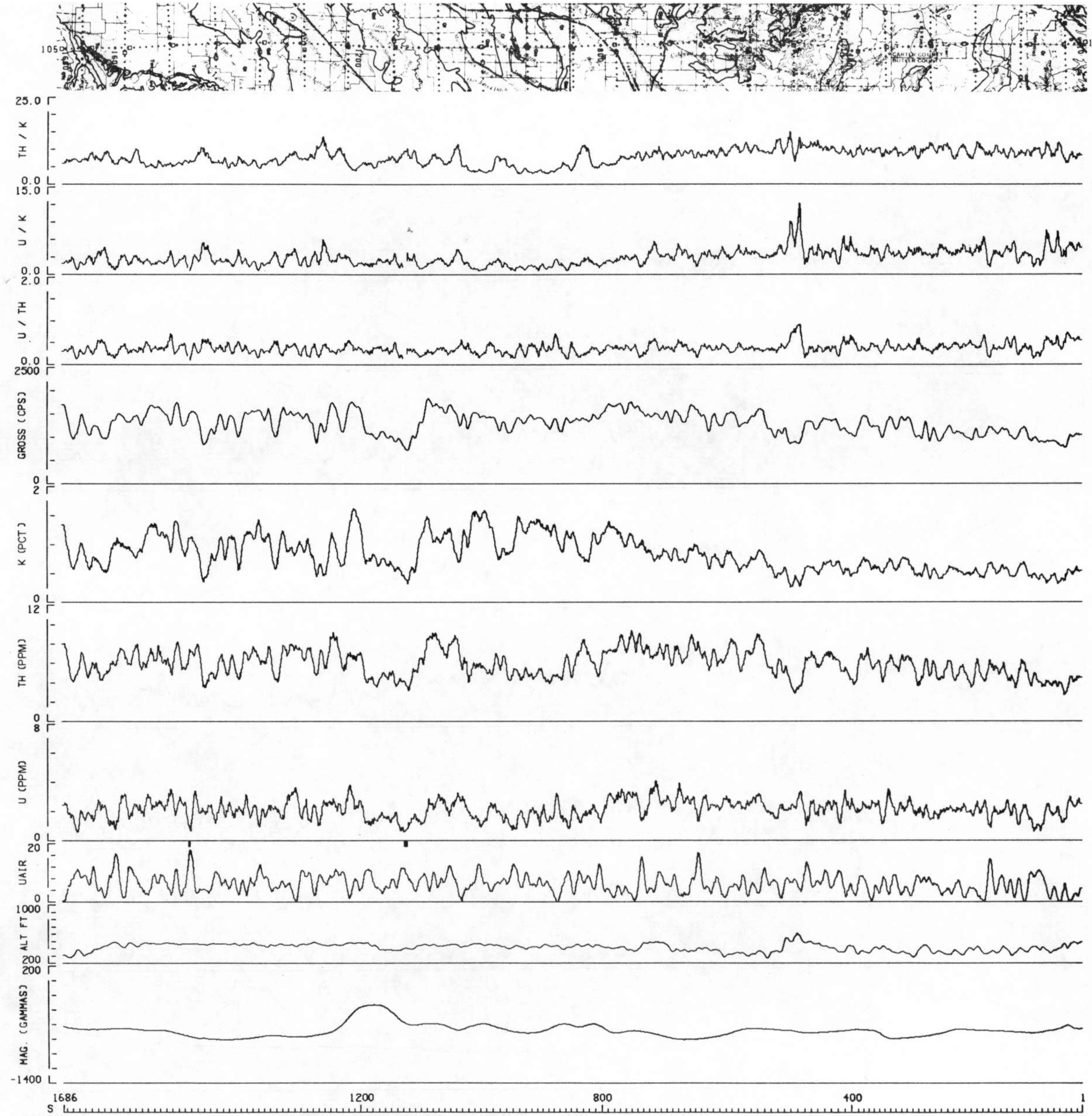

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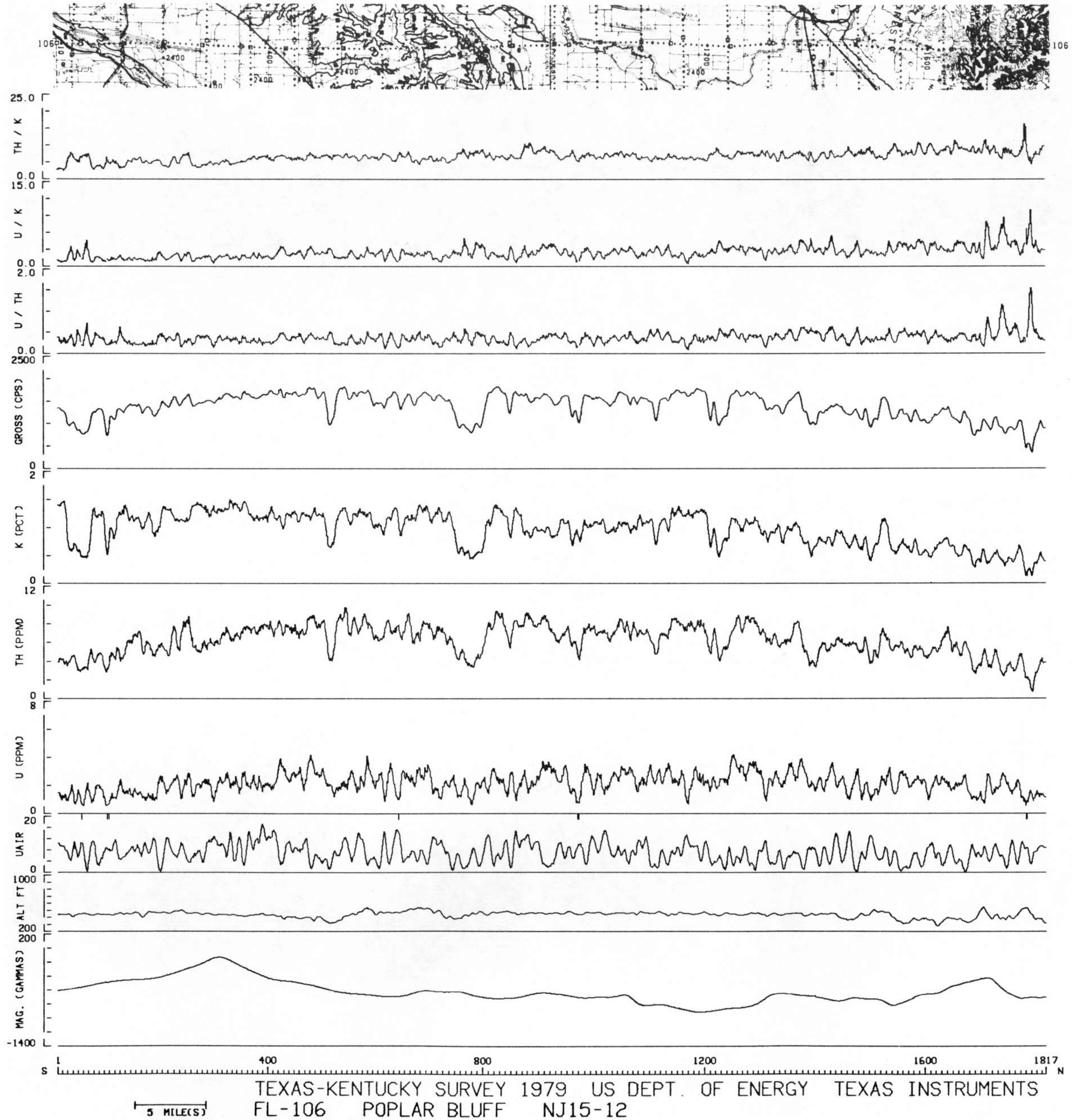

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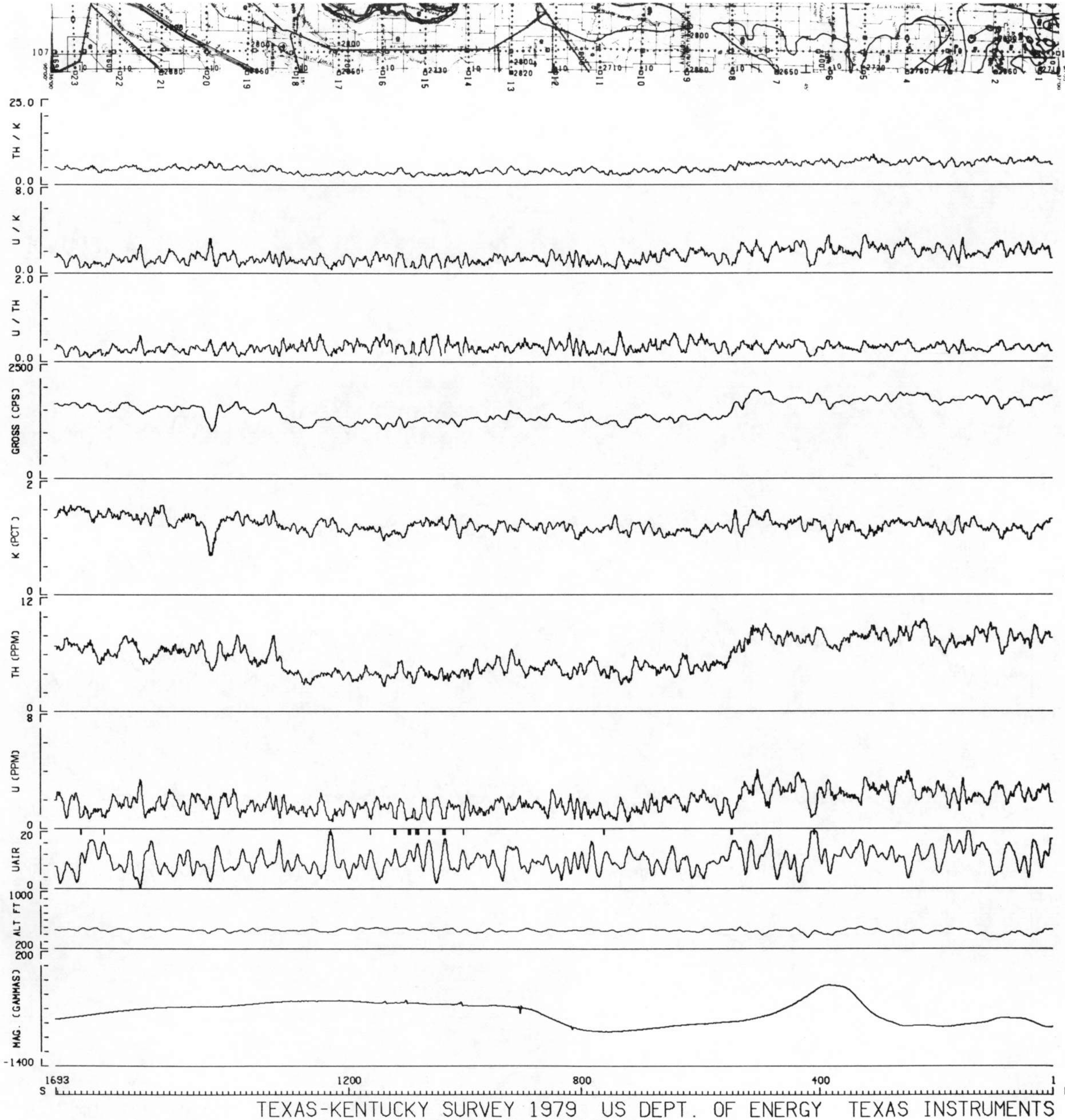

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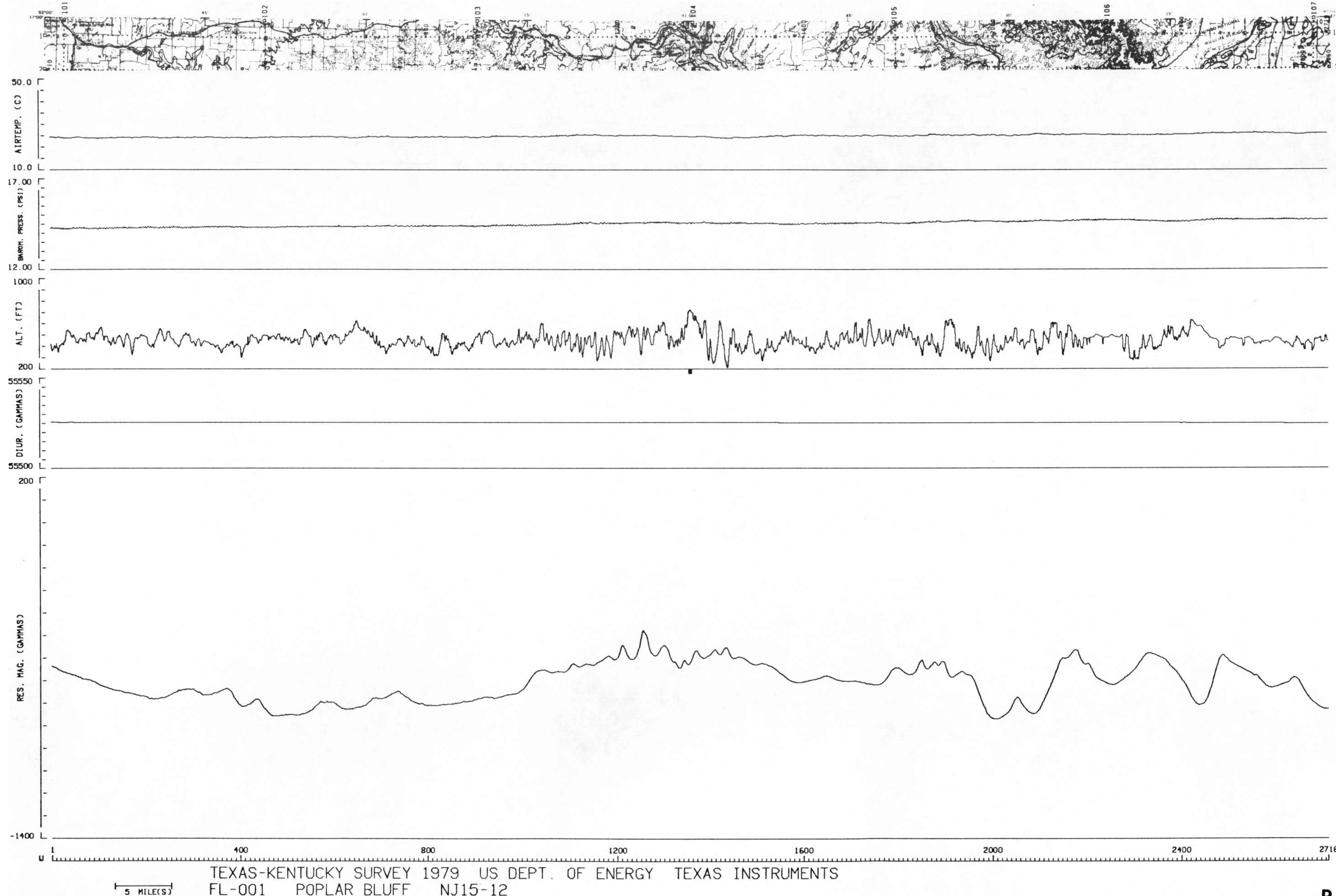
FL-107 POPLAR BLUFF NJ15-12



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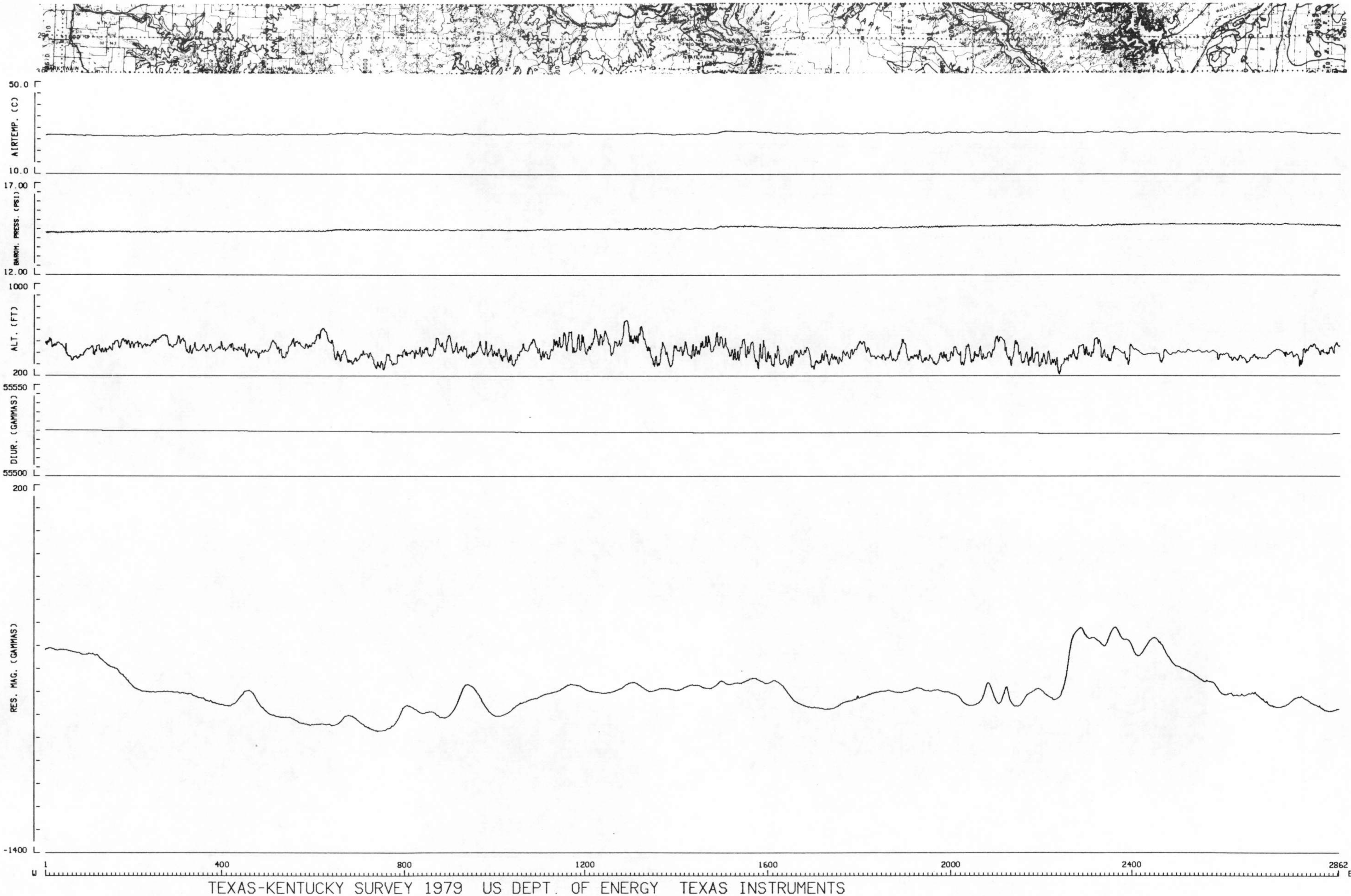
FL-001 POPLAR BLUFF NJ15-12



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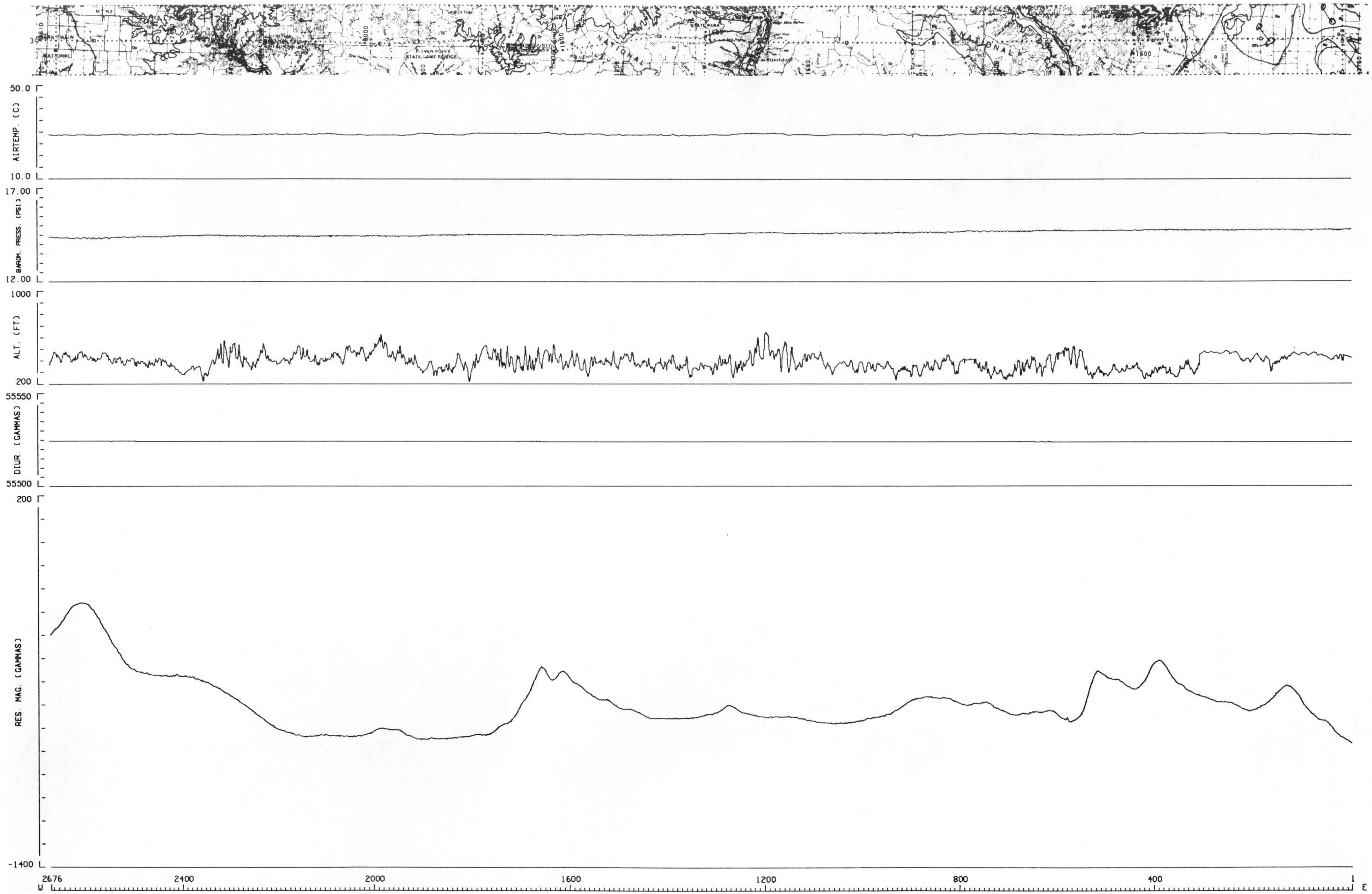
FL-002 POPLAR BLUFF NJ15-12



5 MILE(S)

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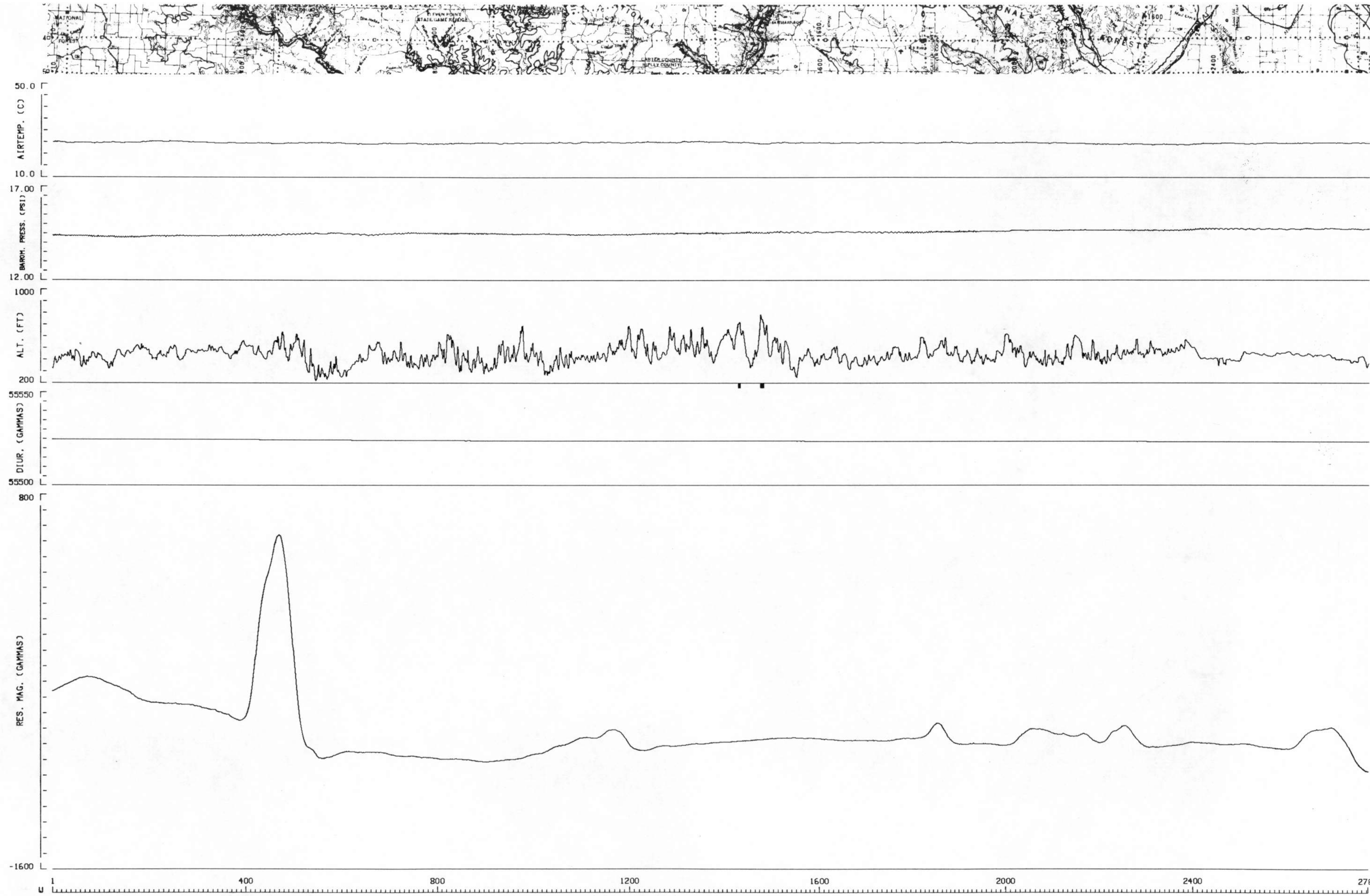
FL-003 POPLAR BLUFF NJ15-12



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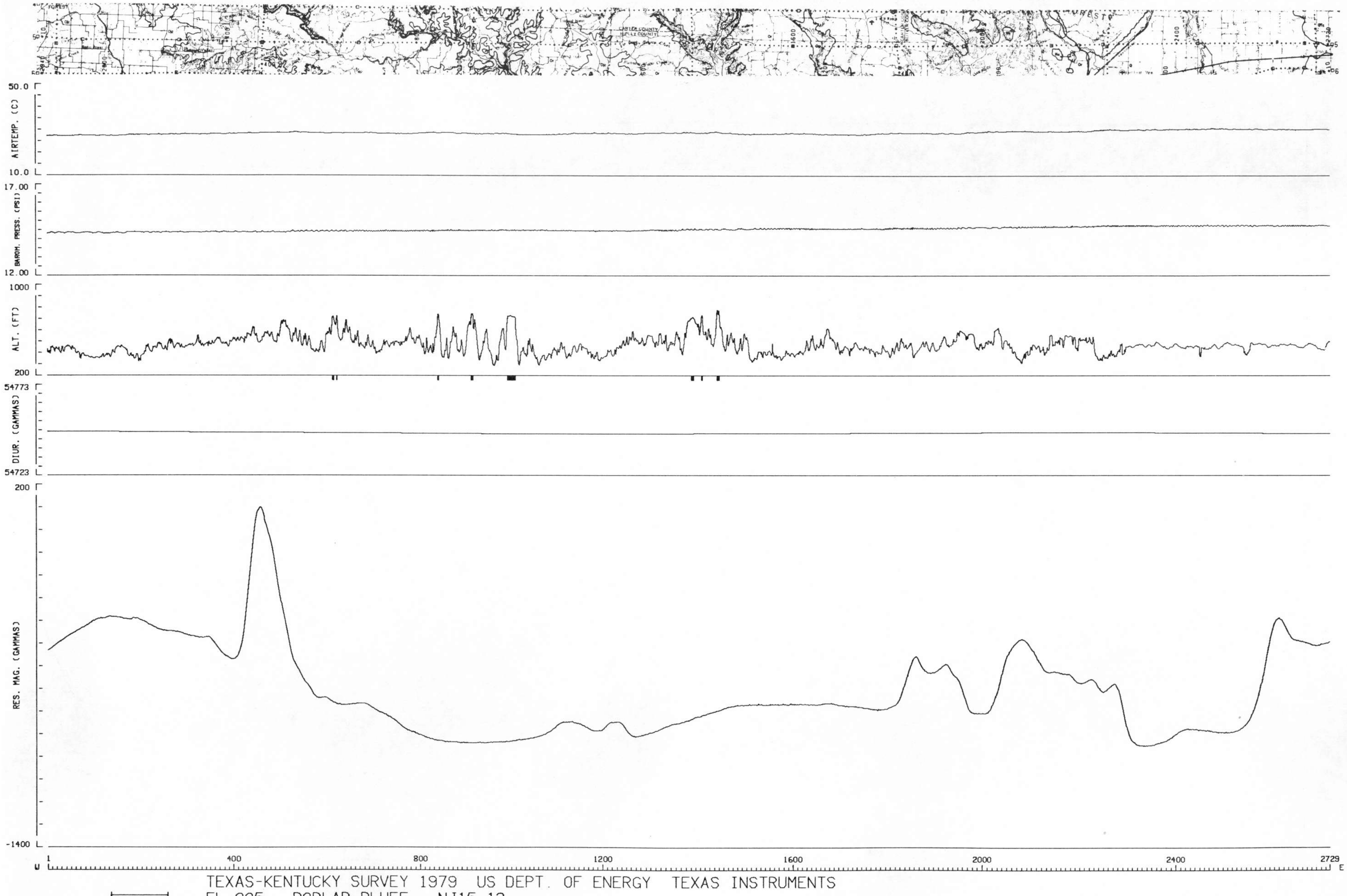

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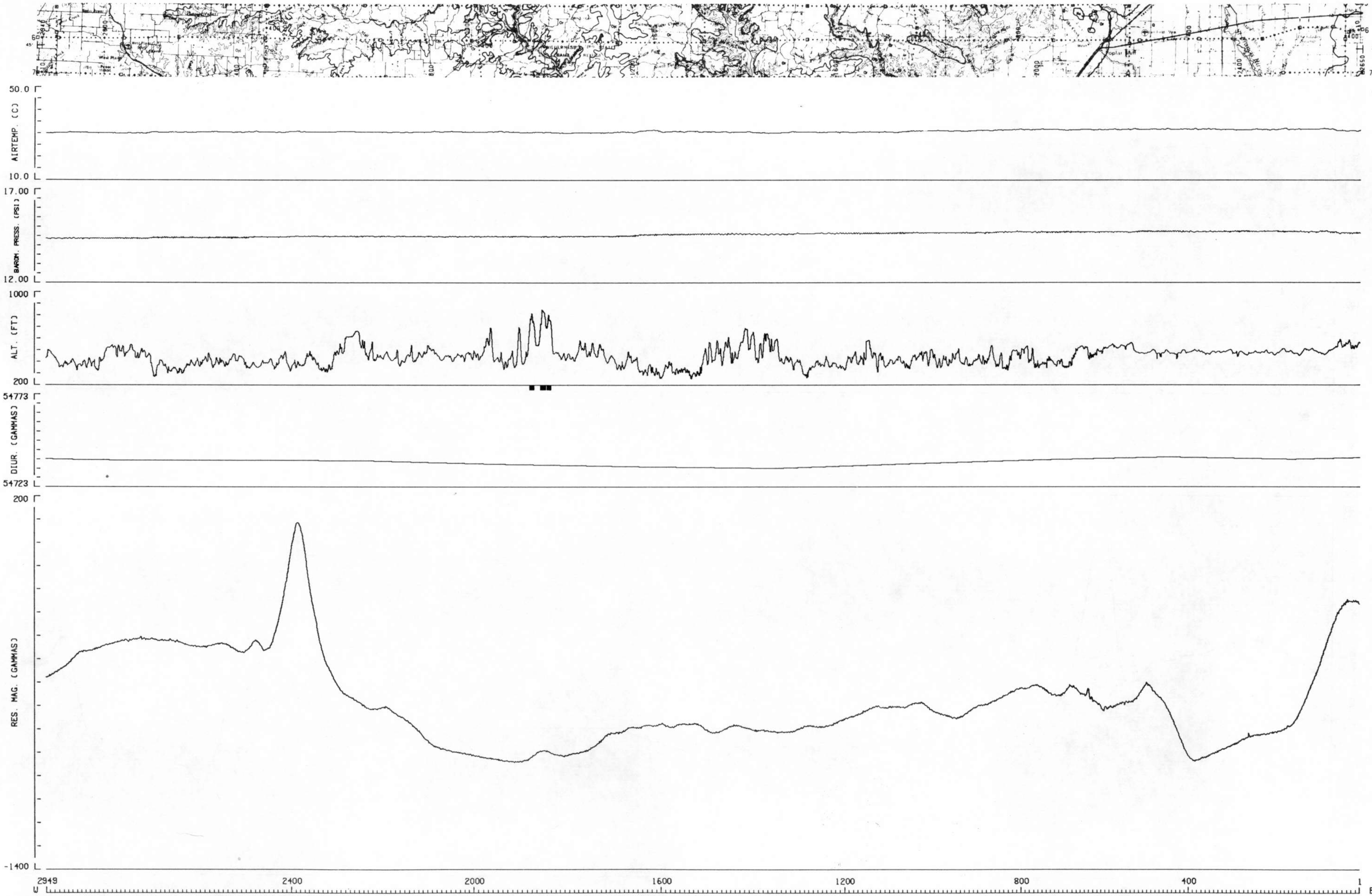

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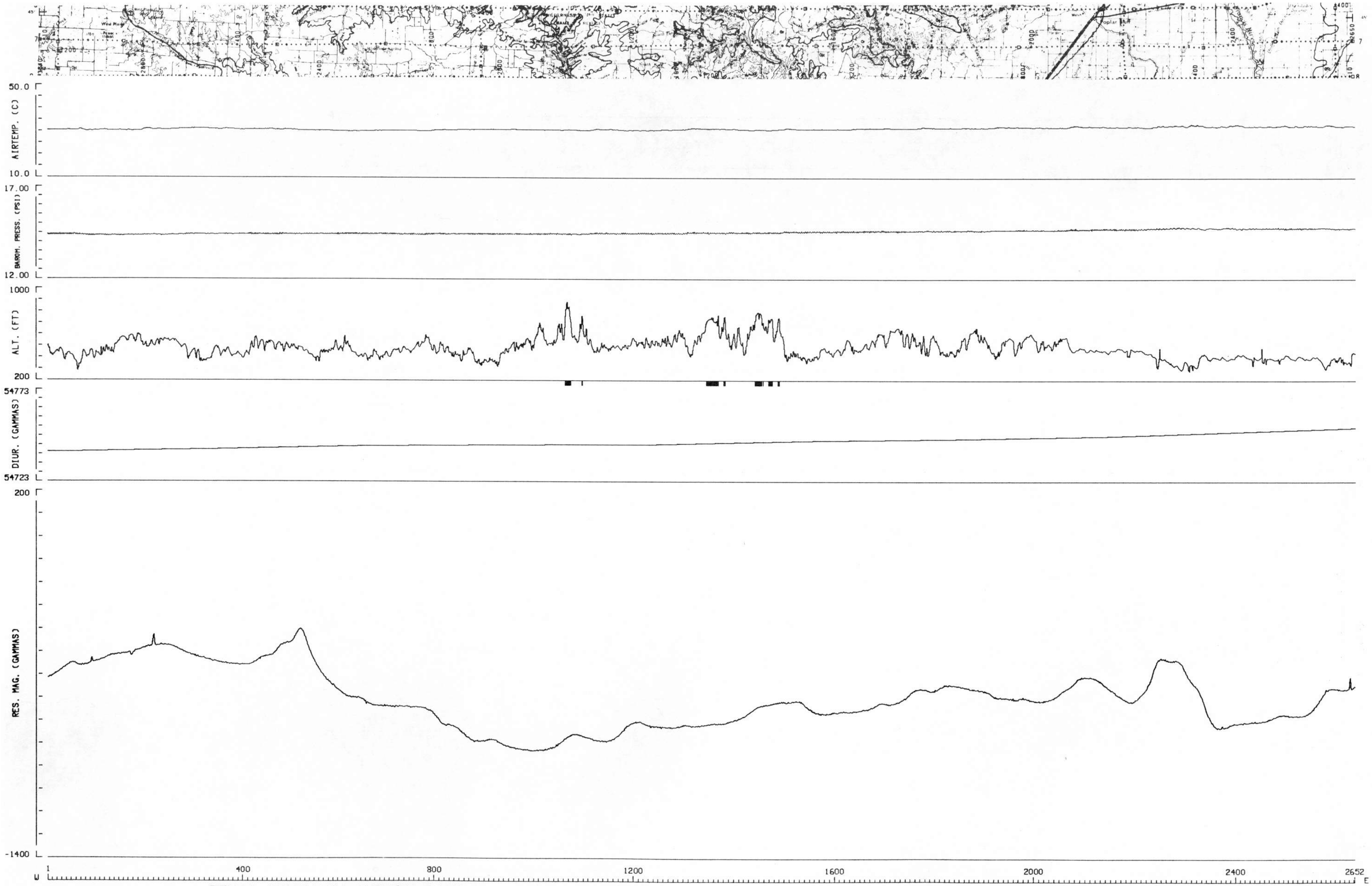

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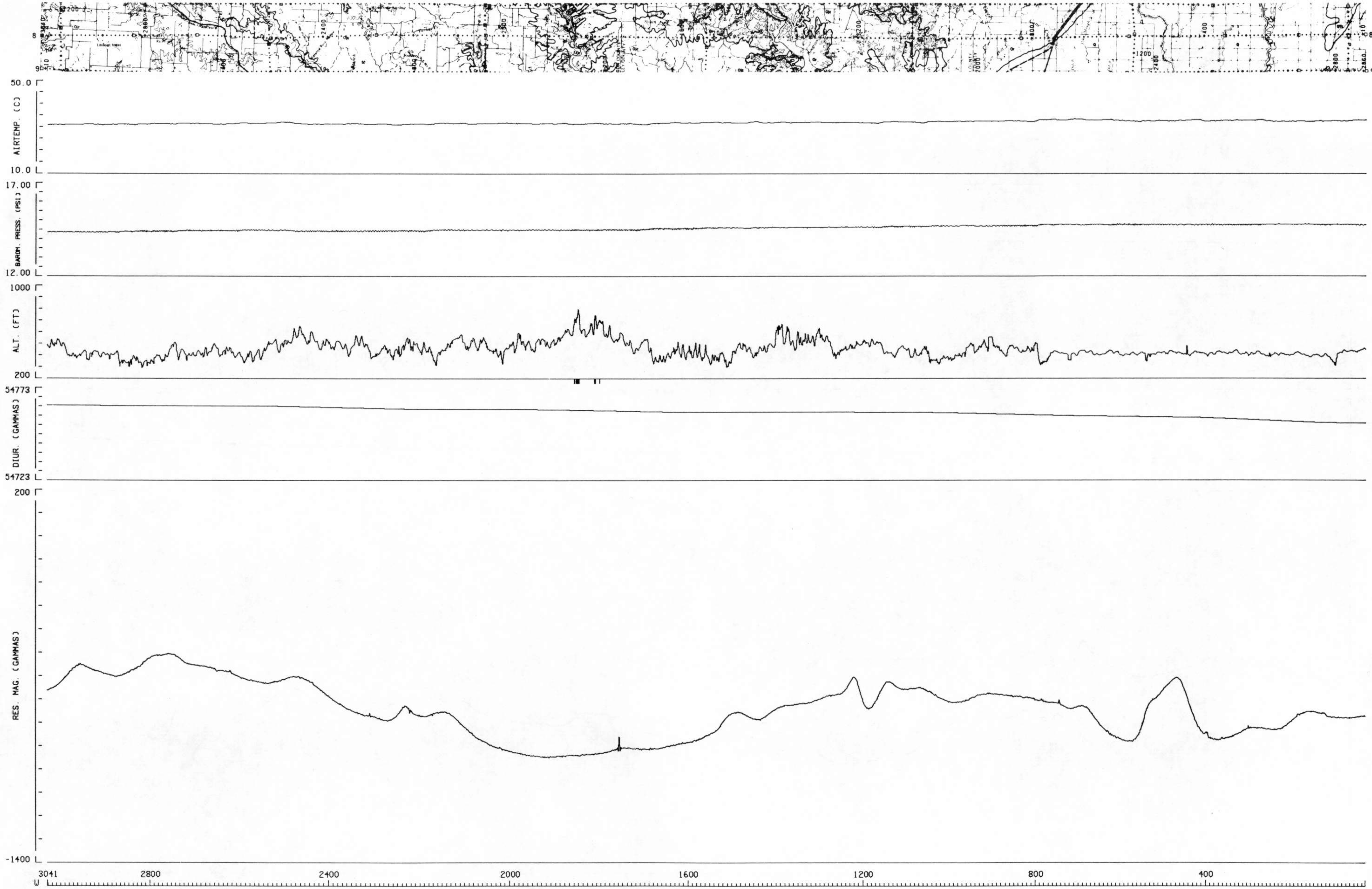

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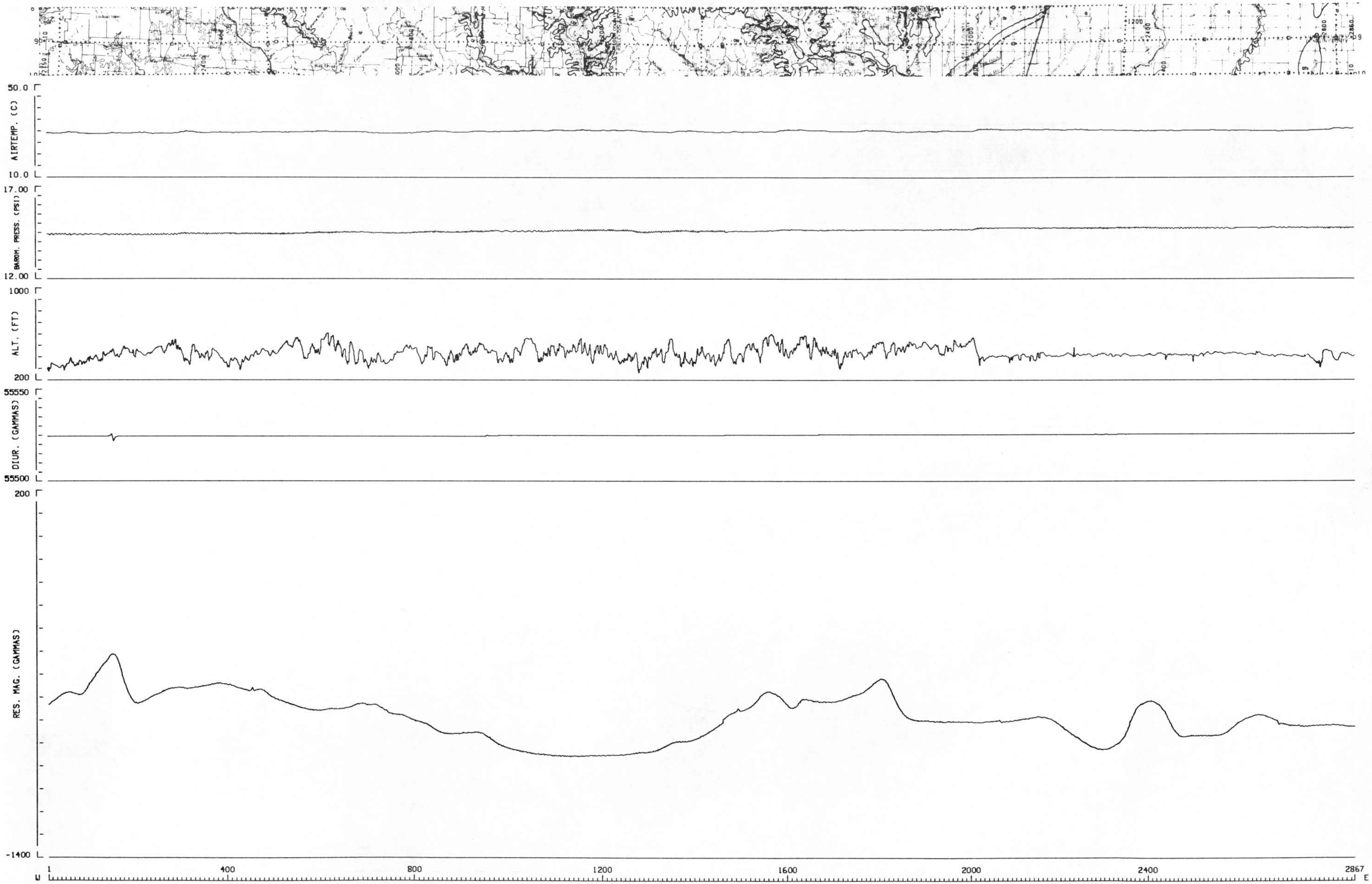

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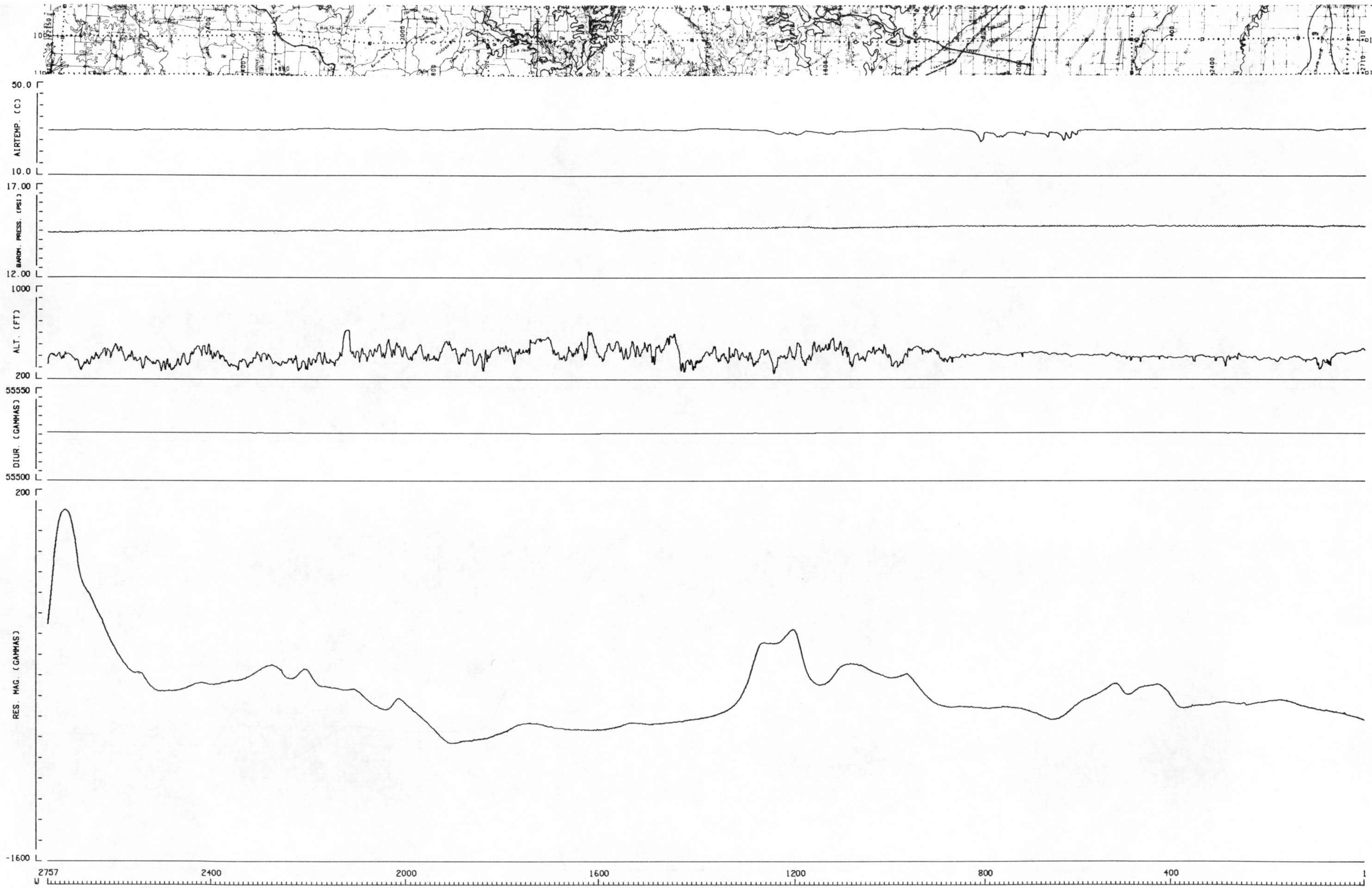

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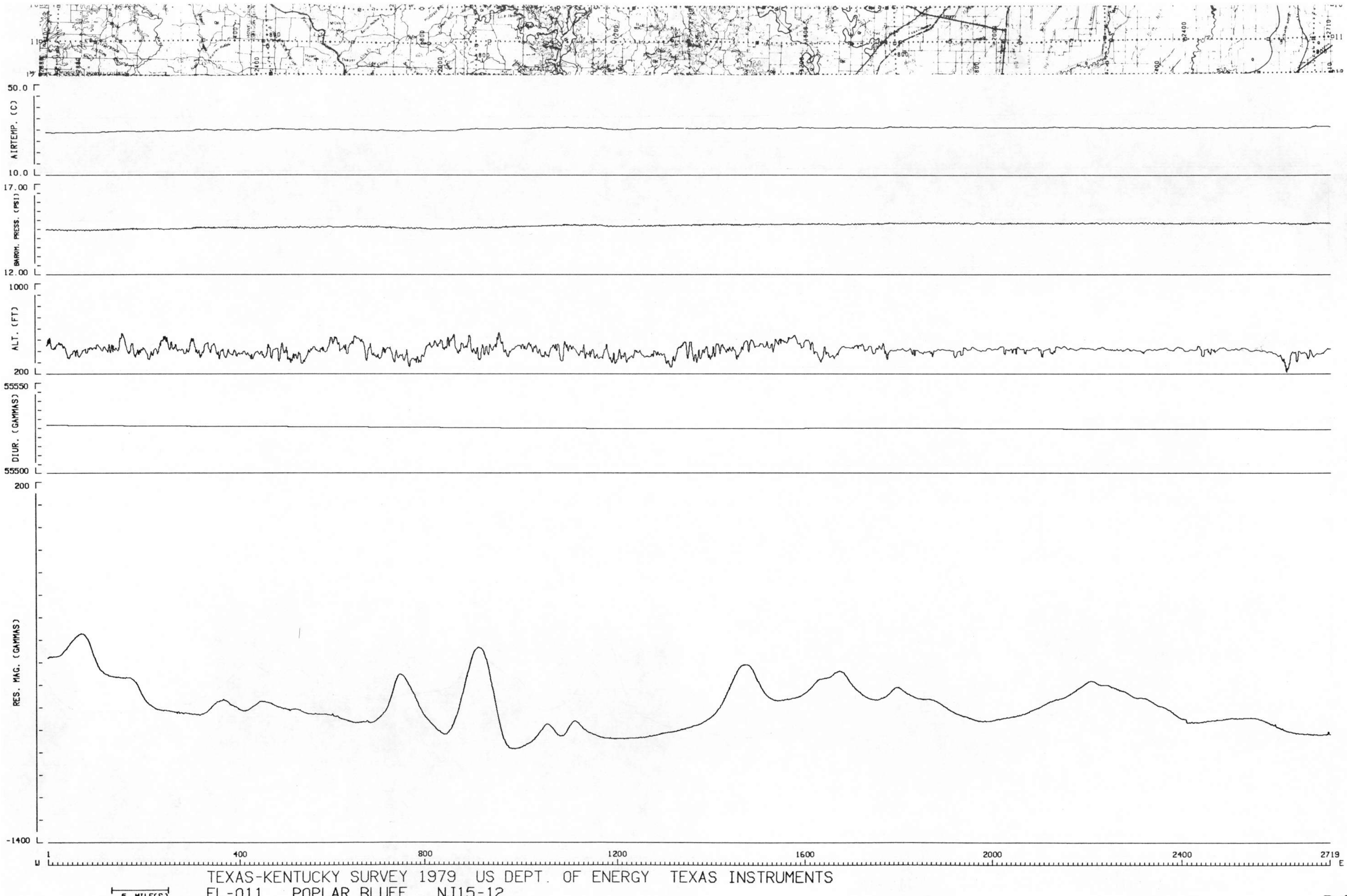

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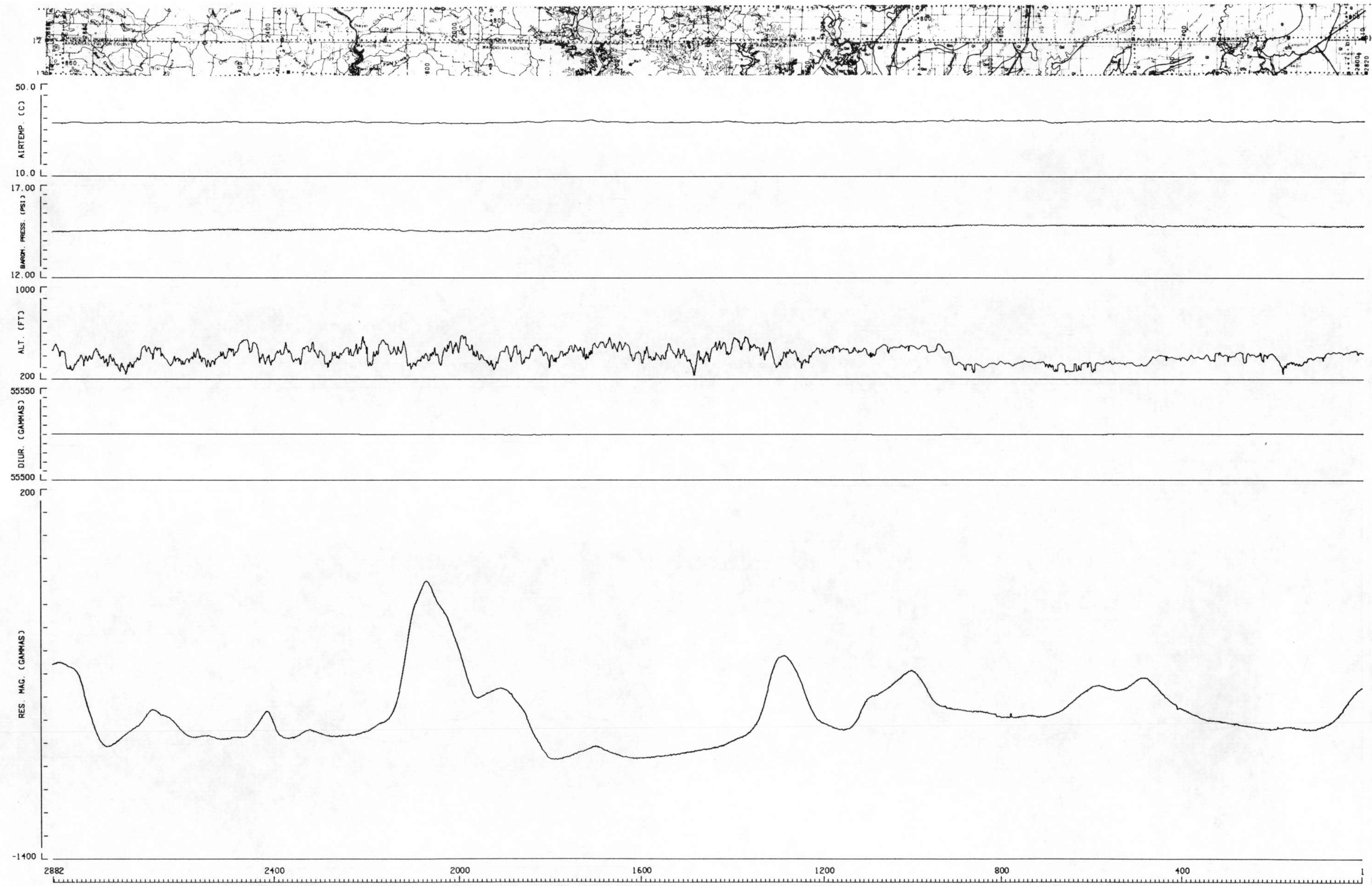

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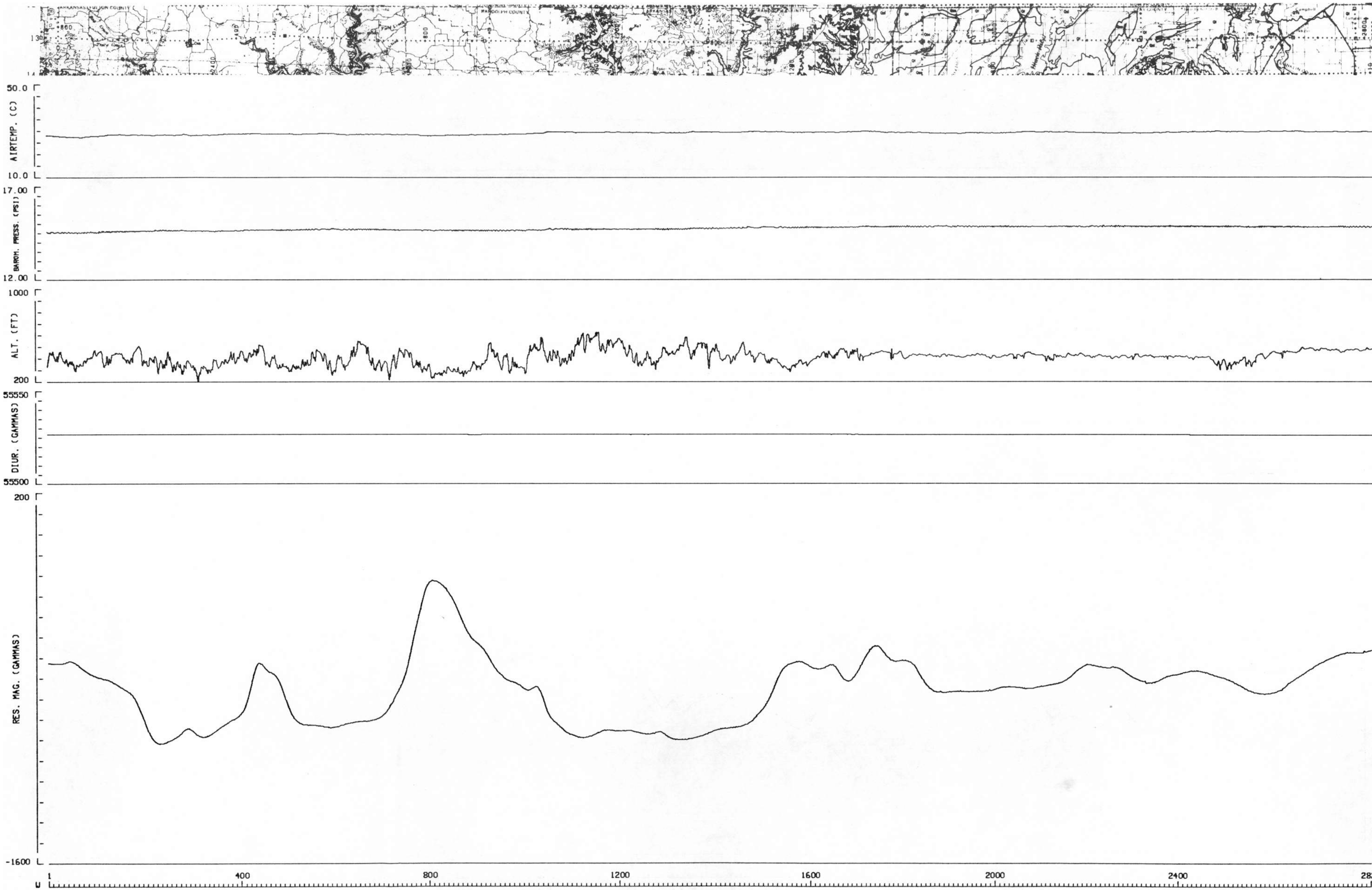

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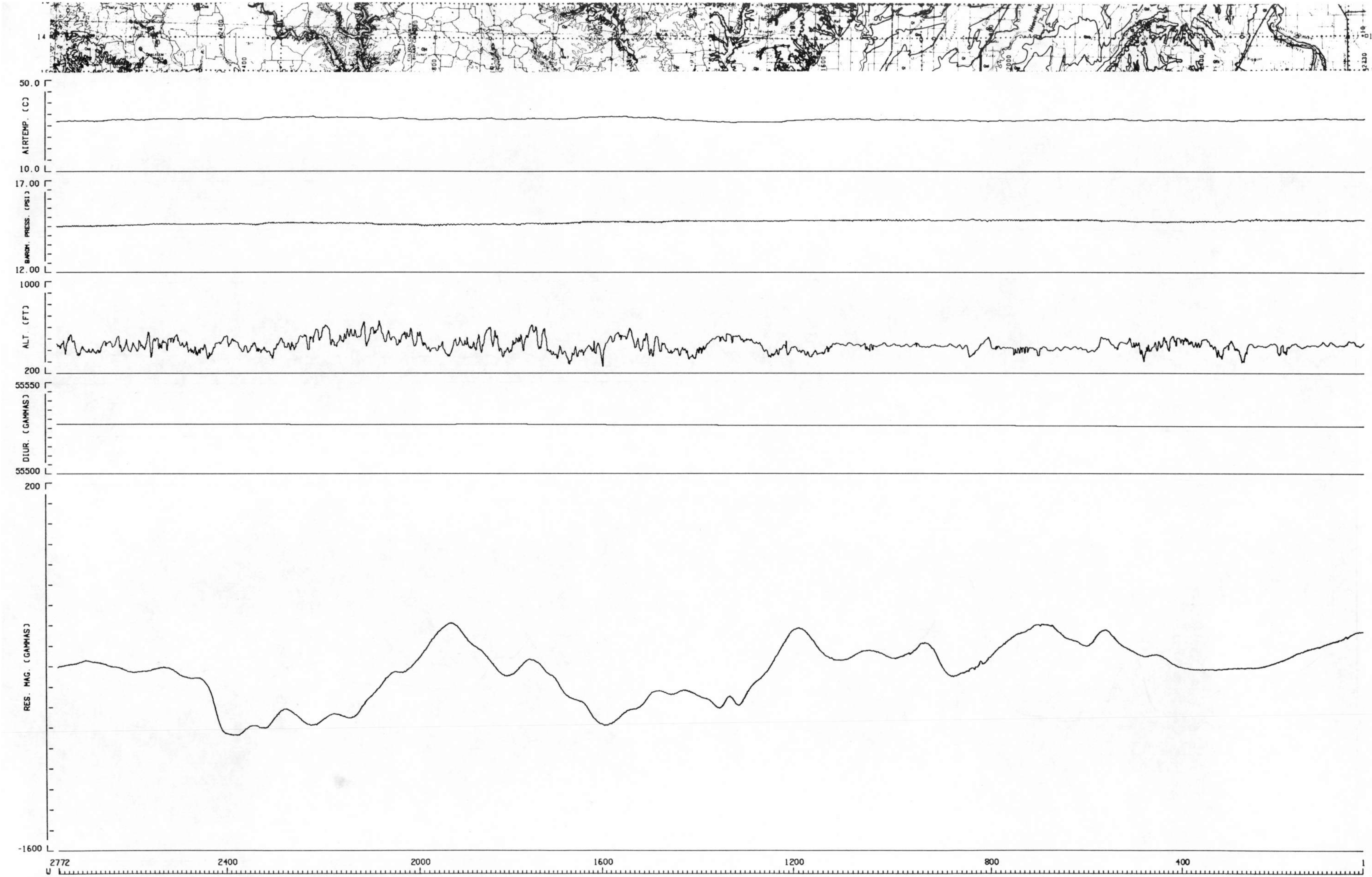

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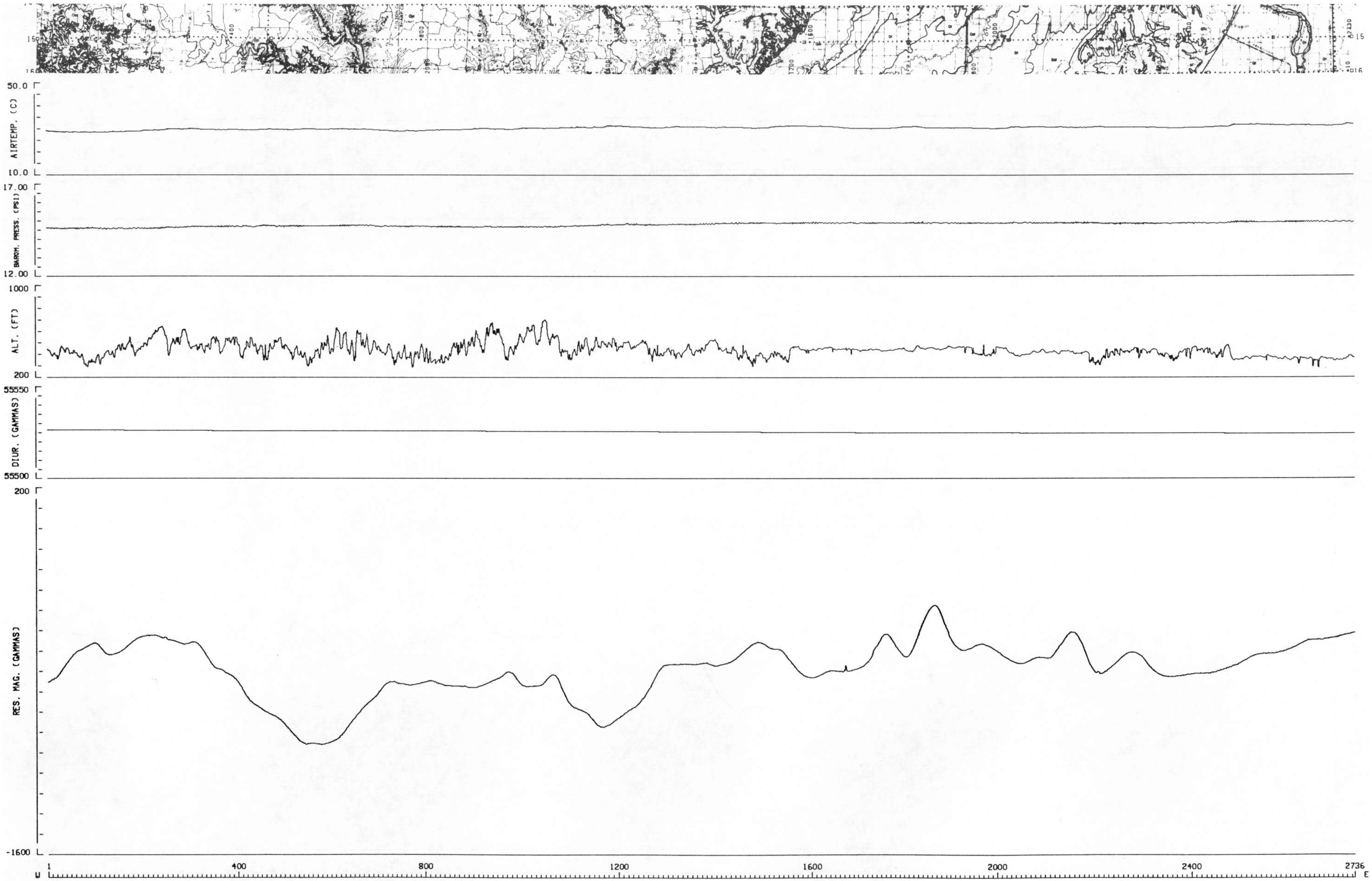

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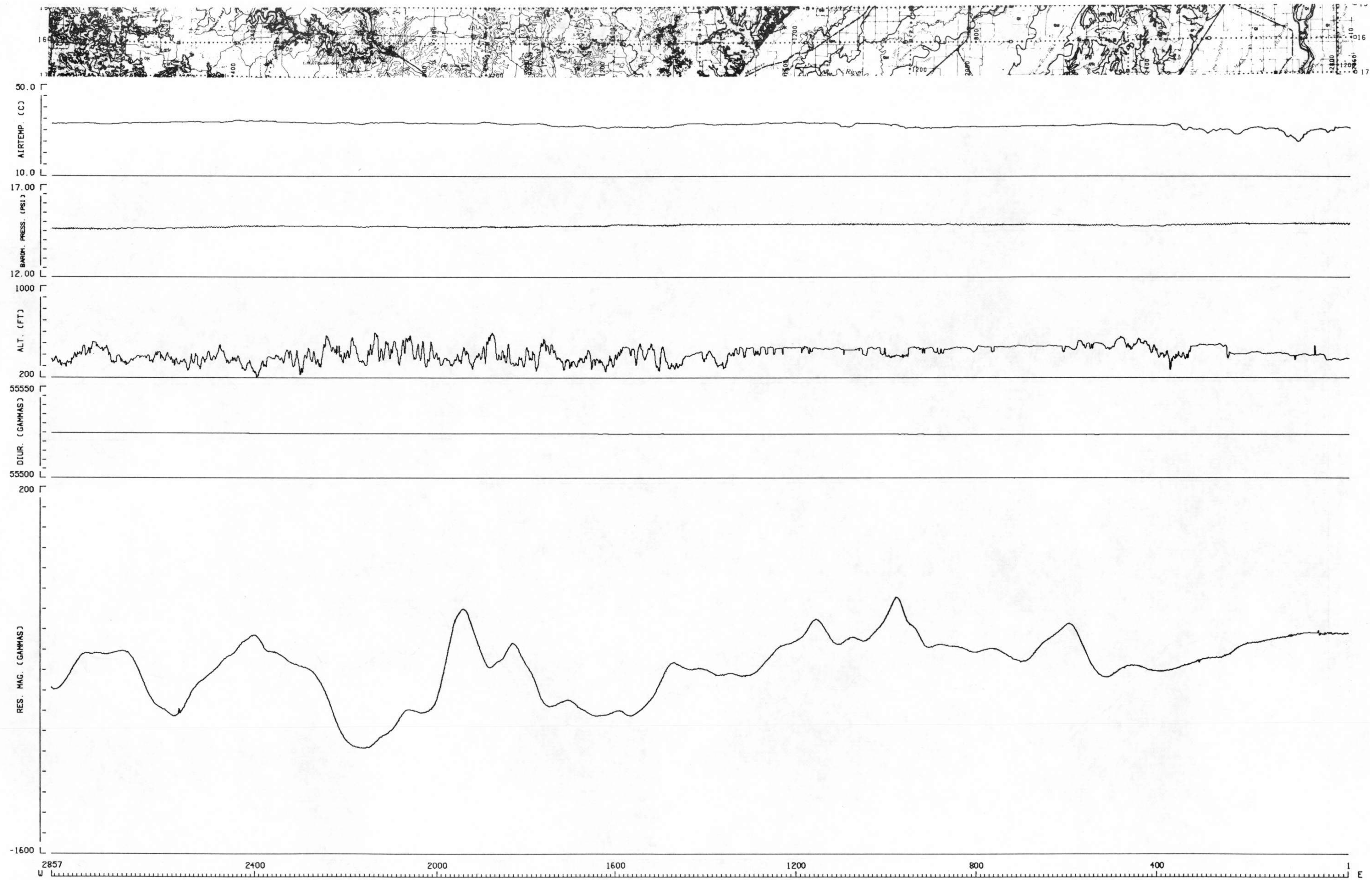

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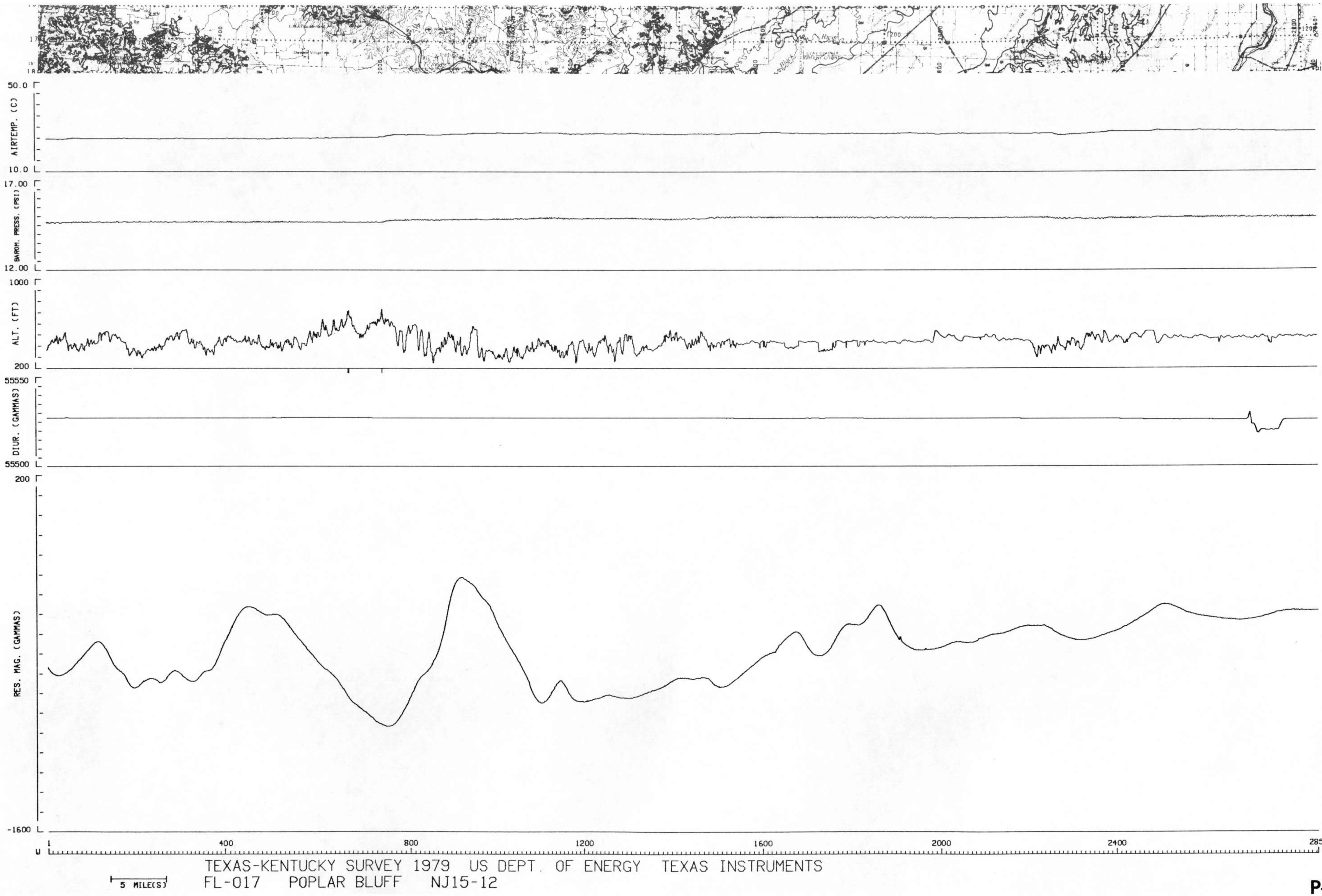
FL-016 POPLAR BLUFF NJ15-12



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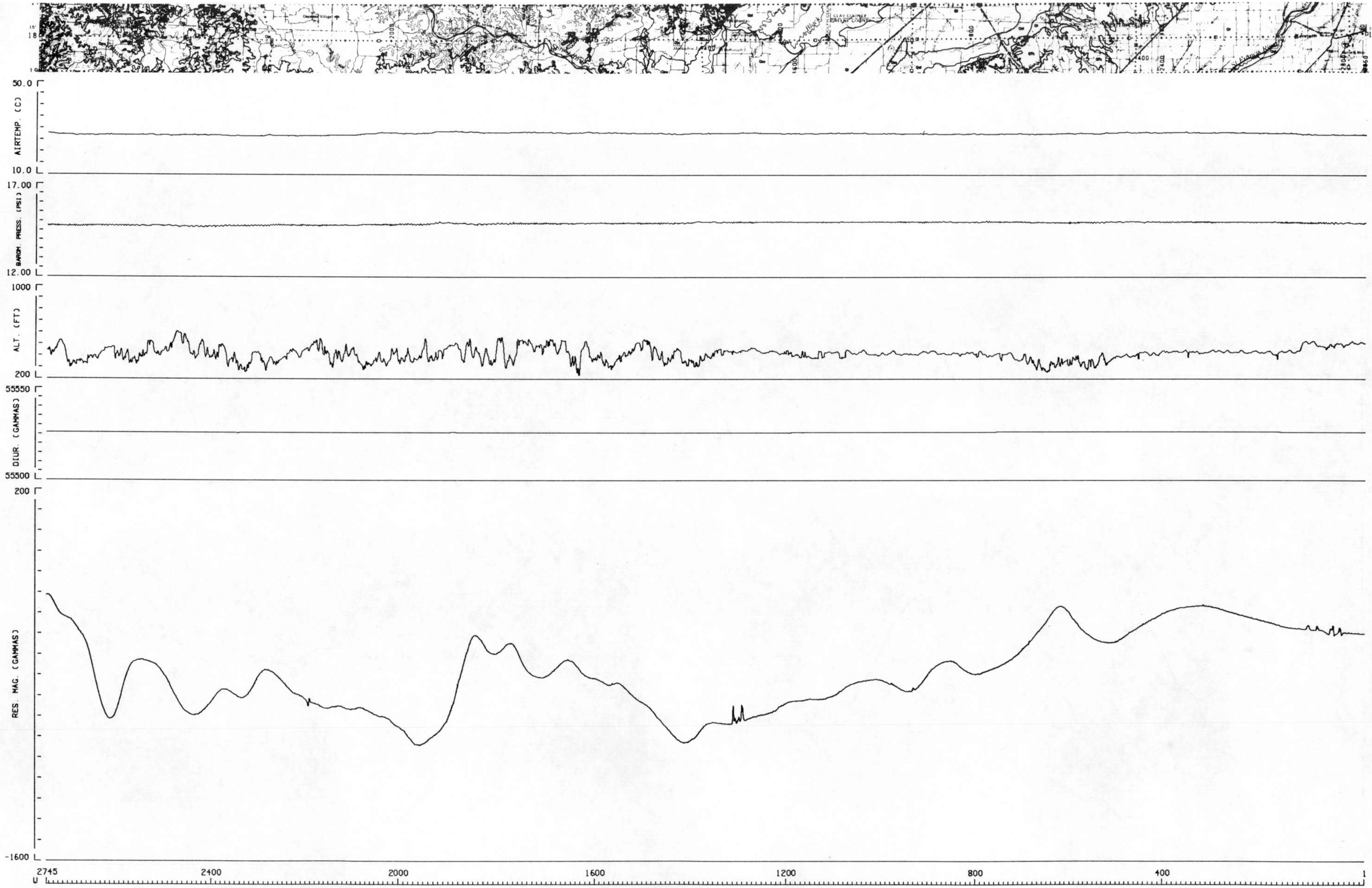
FL-017 POPLAR BLUFF NJ15-12



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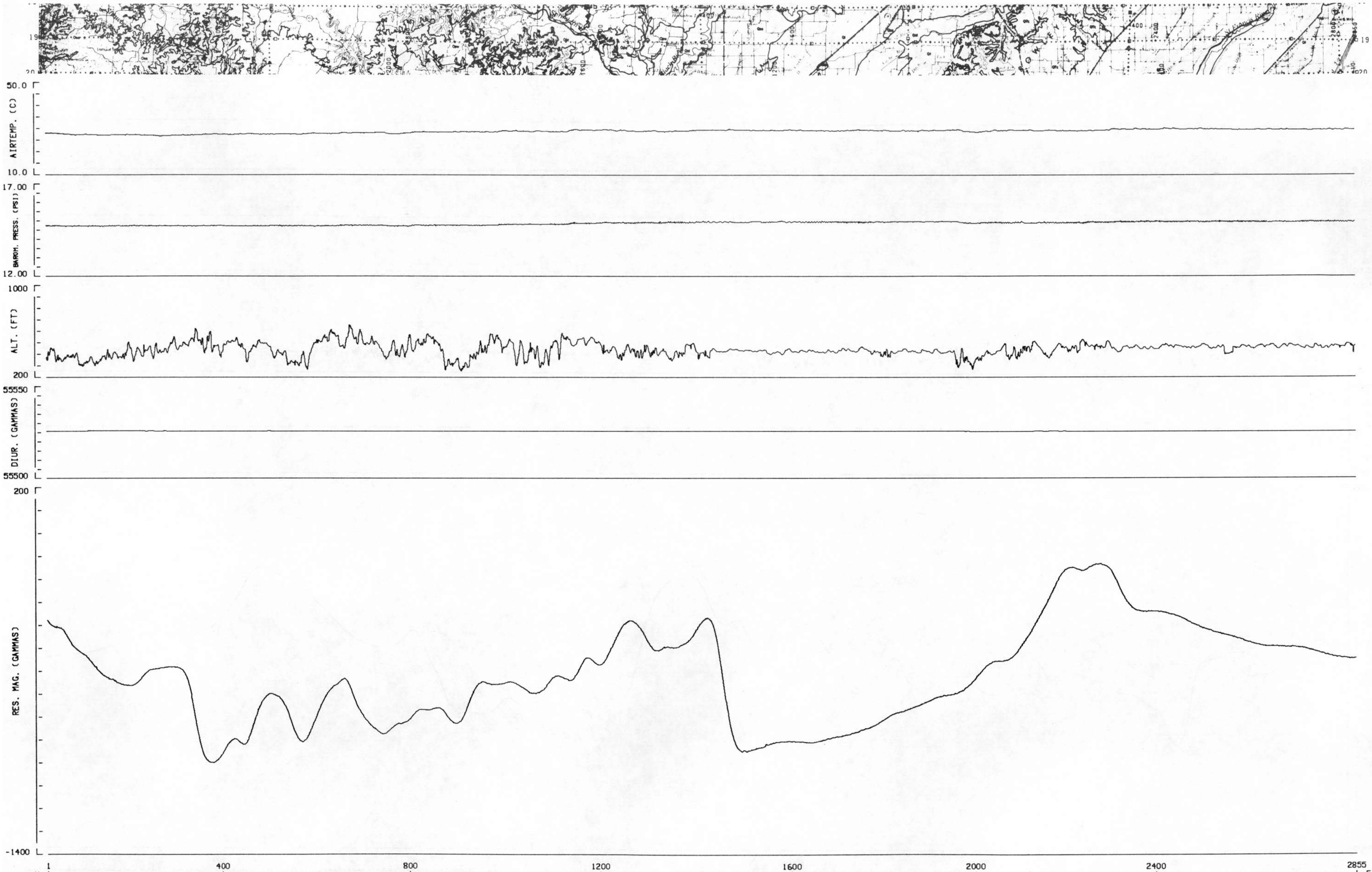
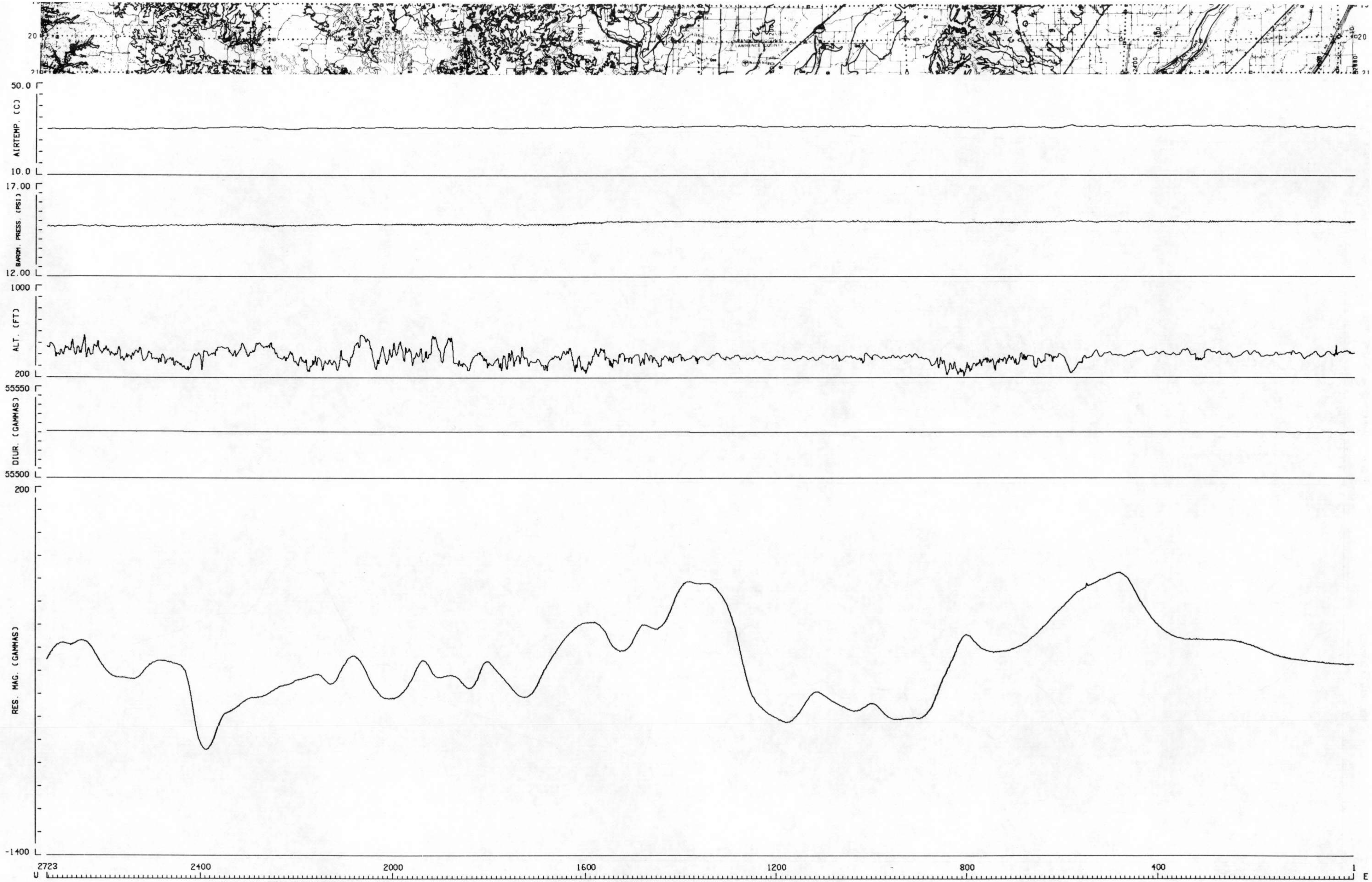


TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

5 MILE(S) FL-019 POPLAR BLUFF NJ15-12



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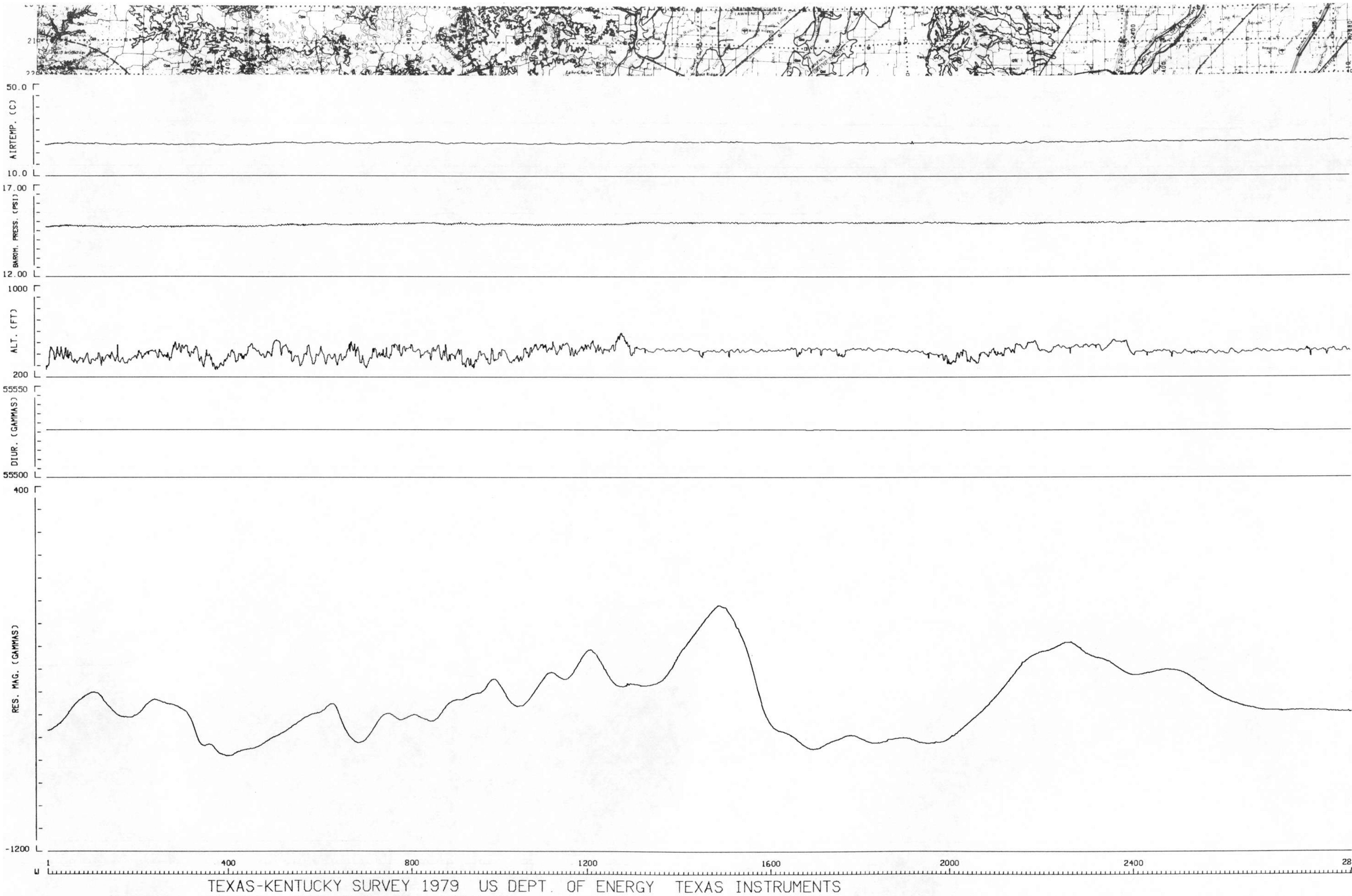
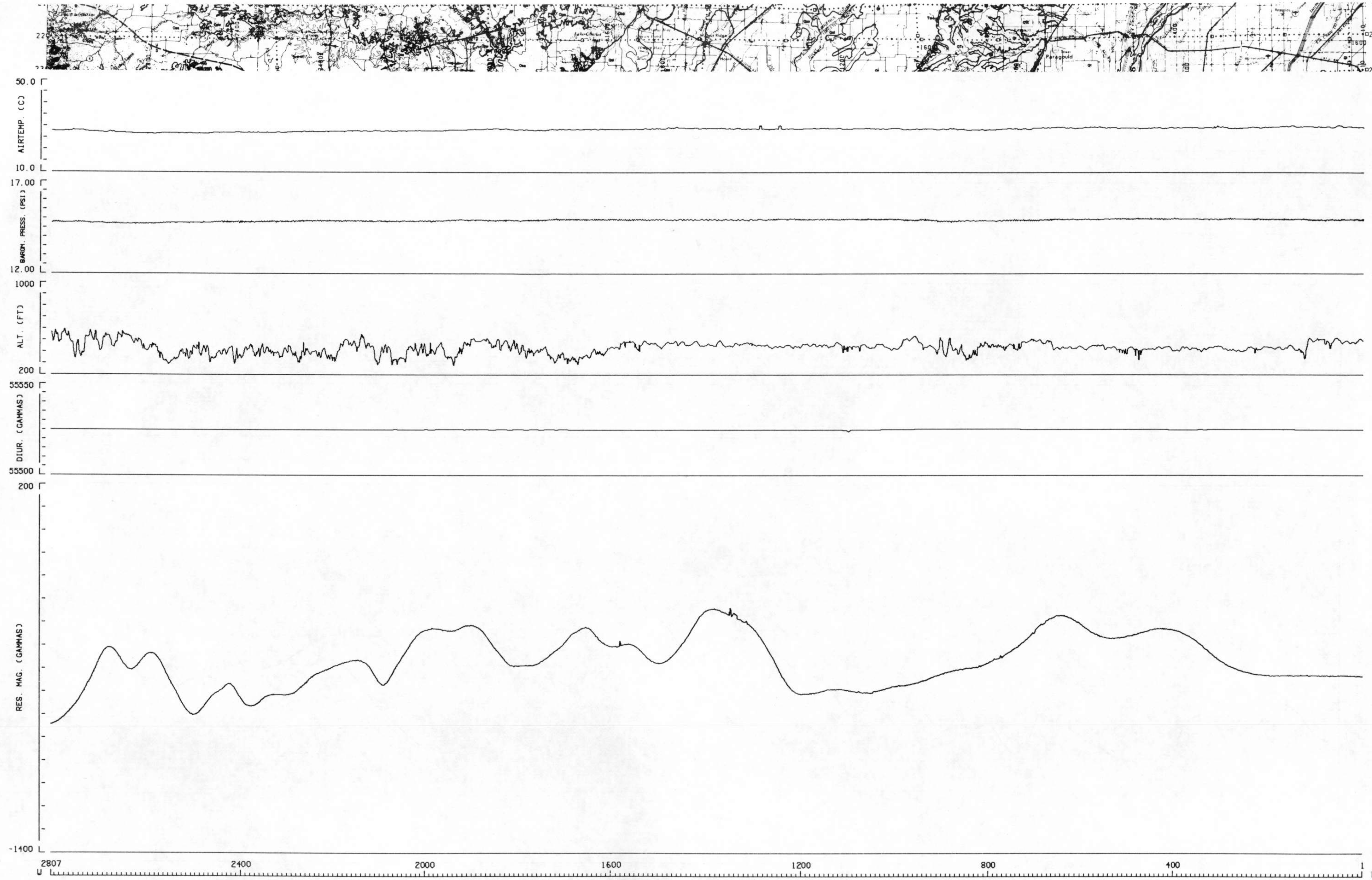
FL-020 POPLAR BLUFF NJ15-12



TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

FL-021 POPLAR BLUFF NJ15-12



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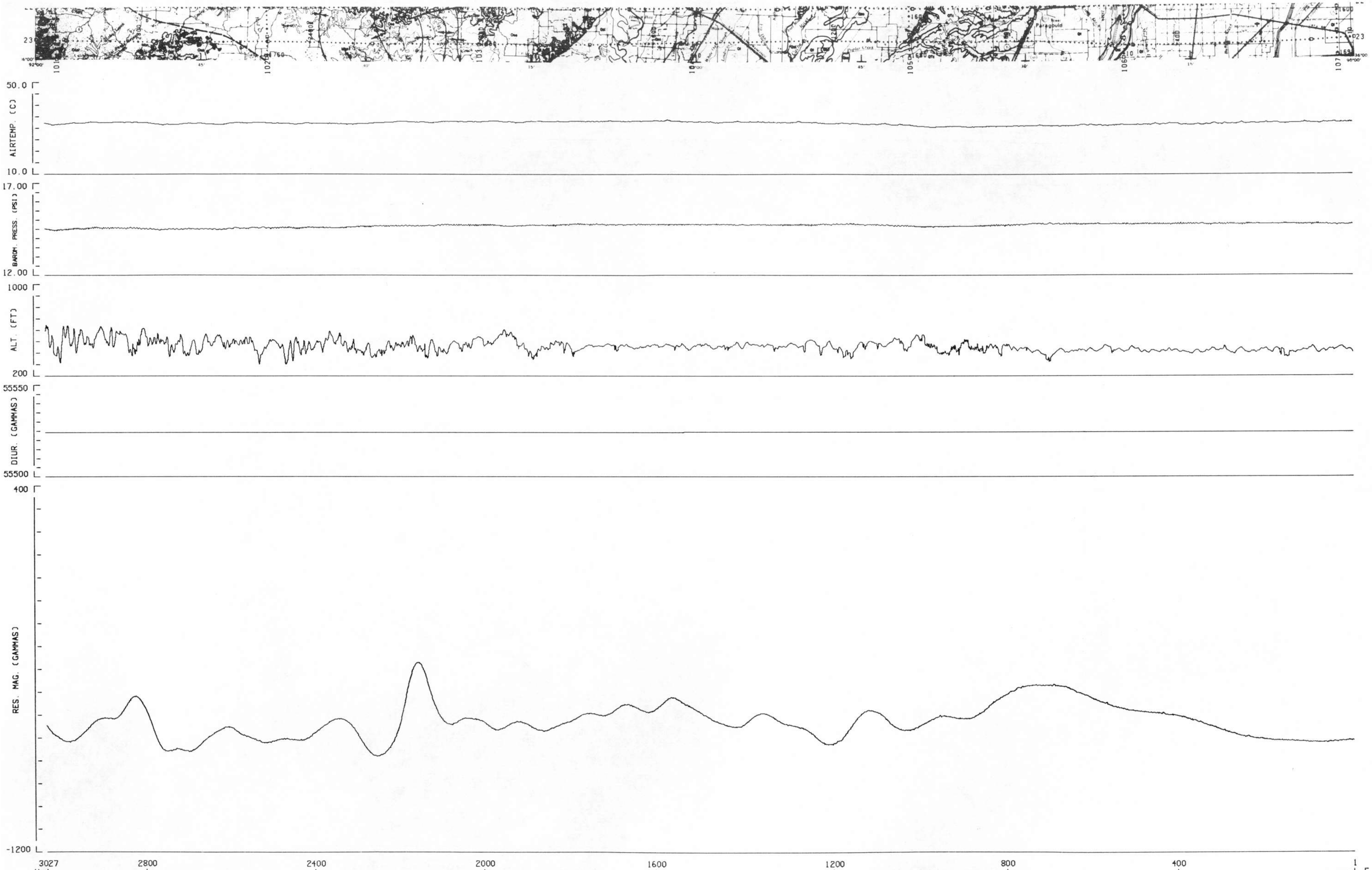
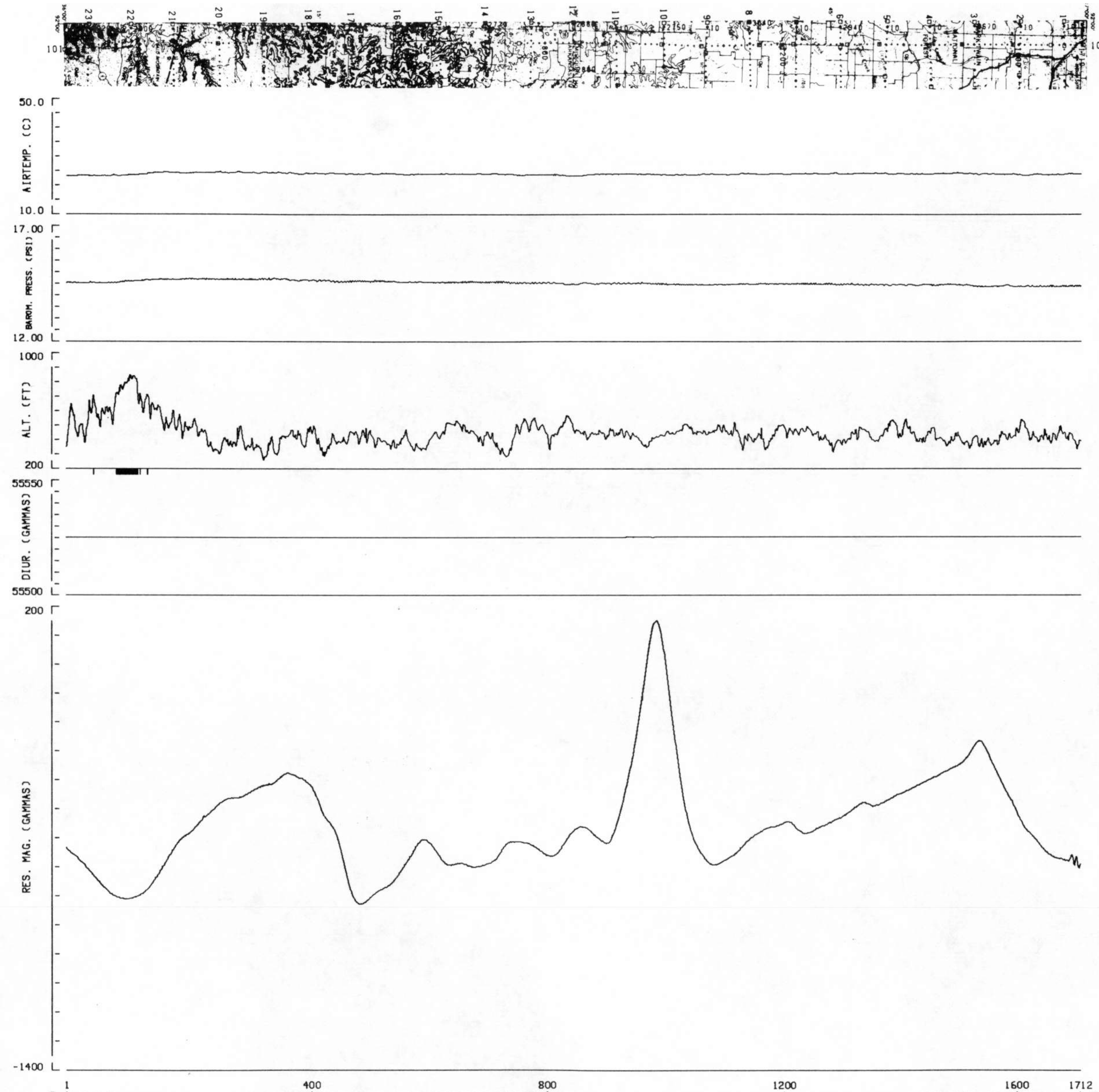
FL-022 POPLAR BLUFF NJ15-12



5 MILE(S)

TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS
FL-023 POPLAR BLUFF NJ15-12



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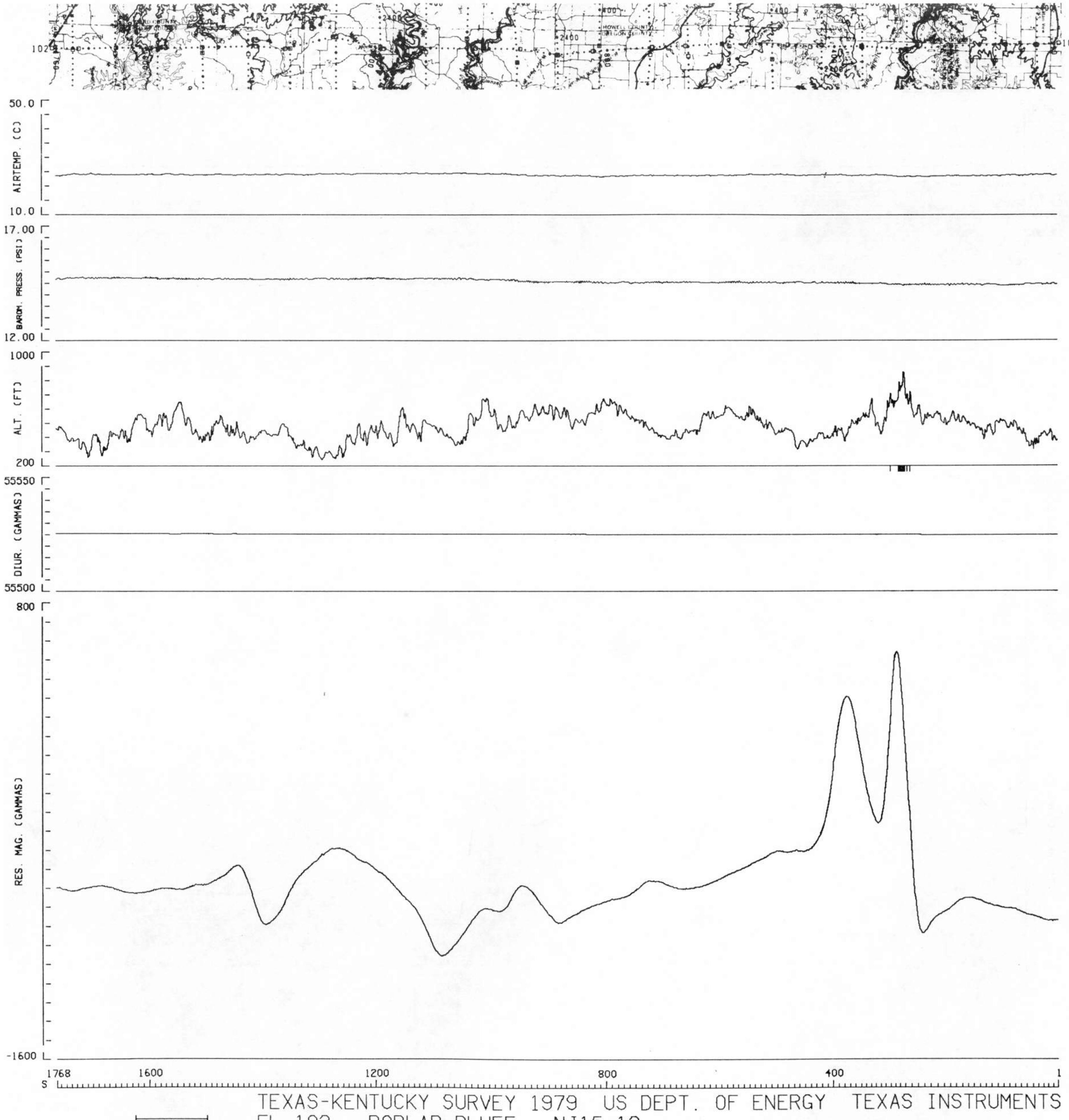
FL-101 POPLAR BLUFF NJ15-12



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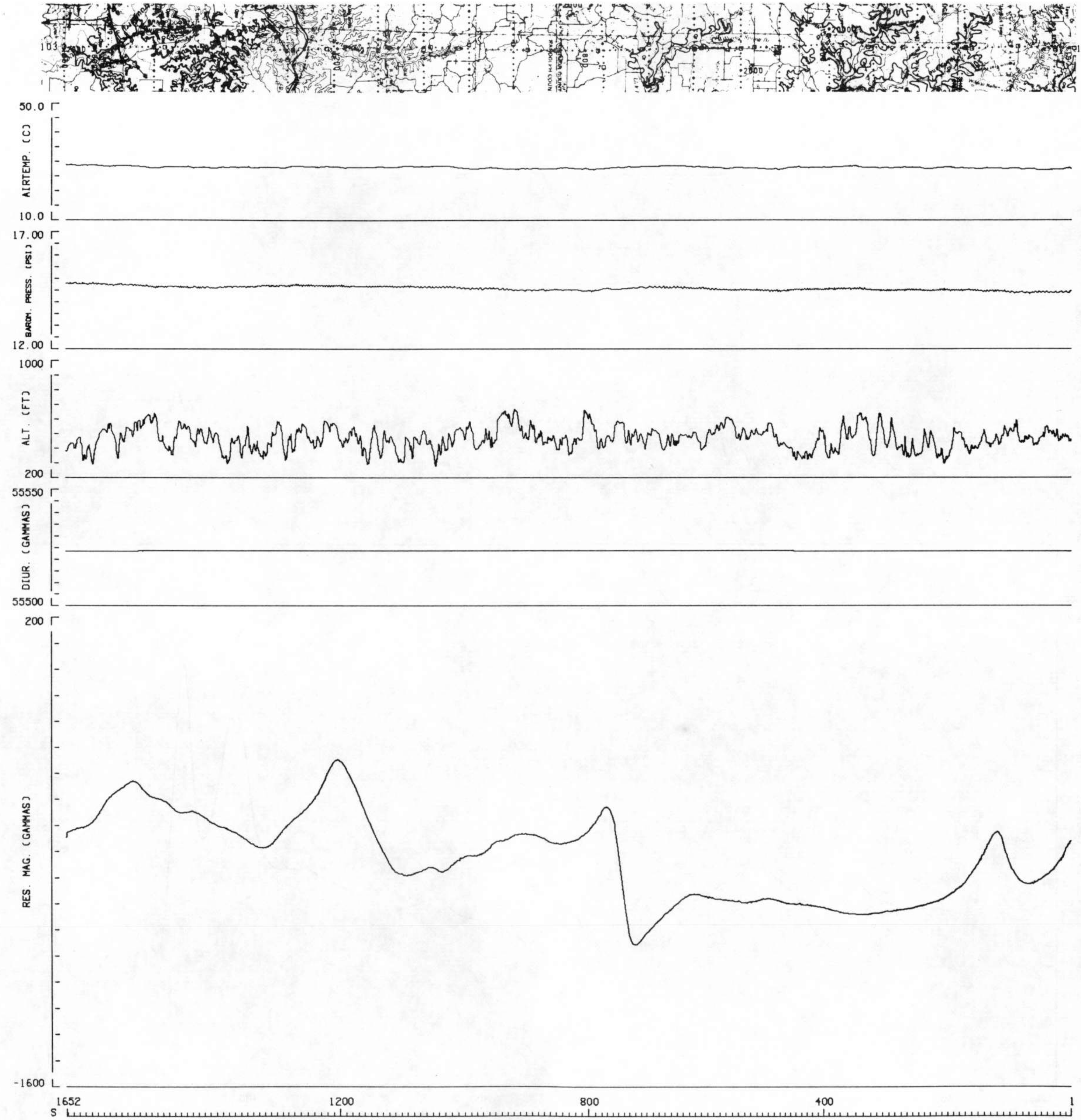
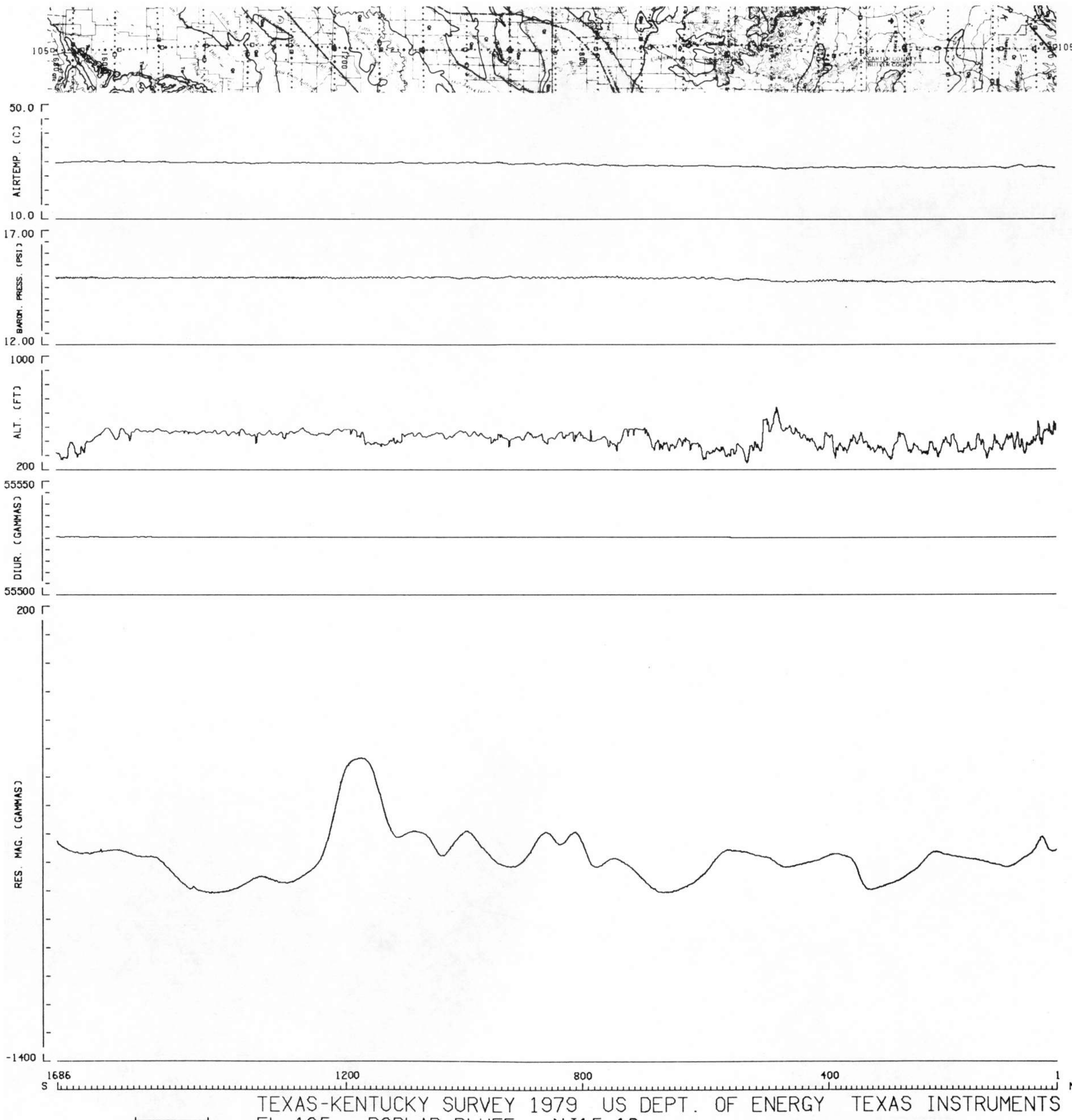
FL-102 POPLAR BLUFF . NJ15-12



TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

5 MILE(S) FL-103 POPLAR BLUFF NJ15-12



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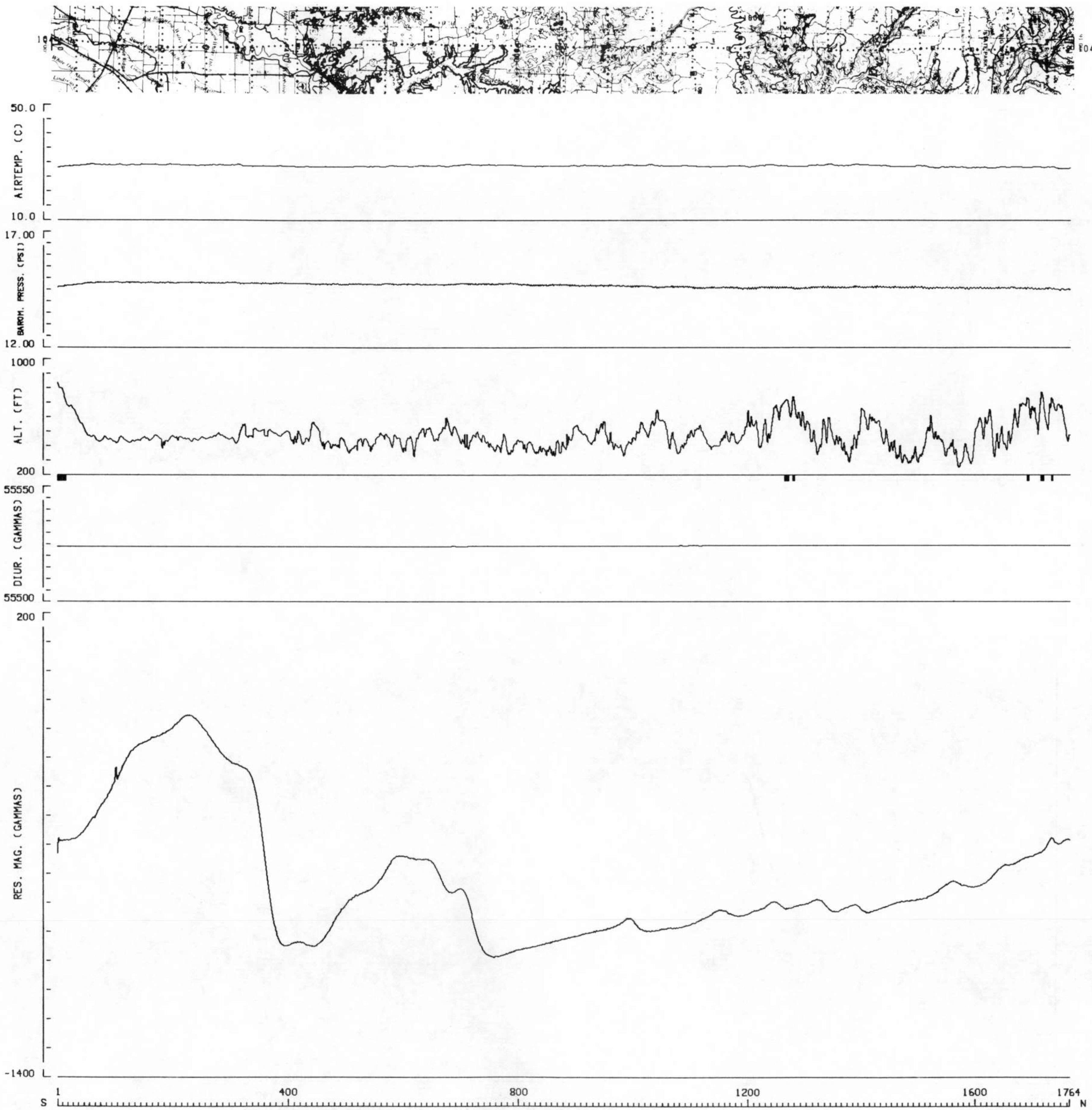
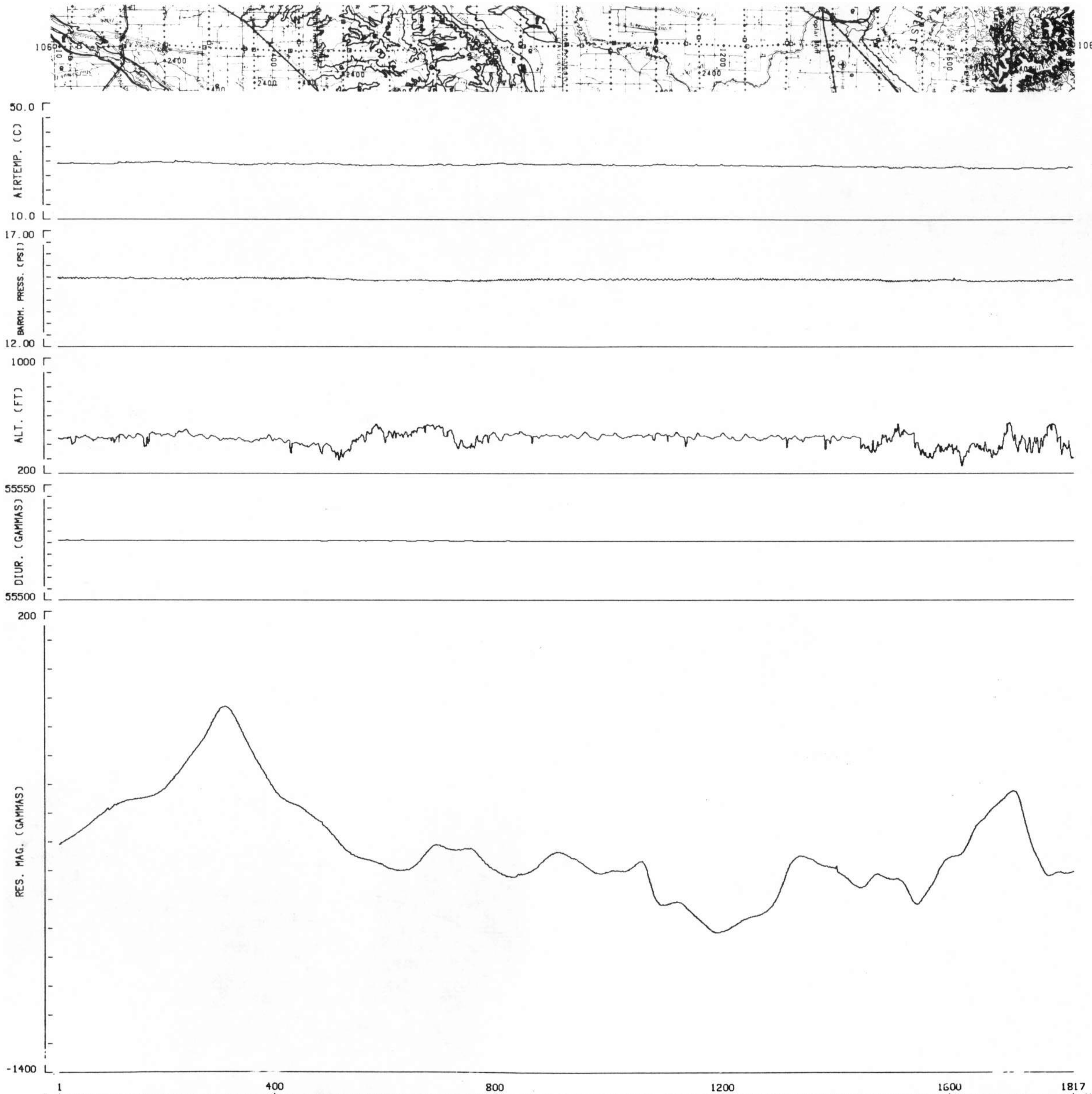
FL-105 POPLAR BLUFF NJ15-12



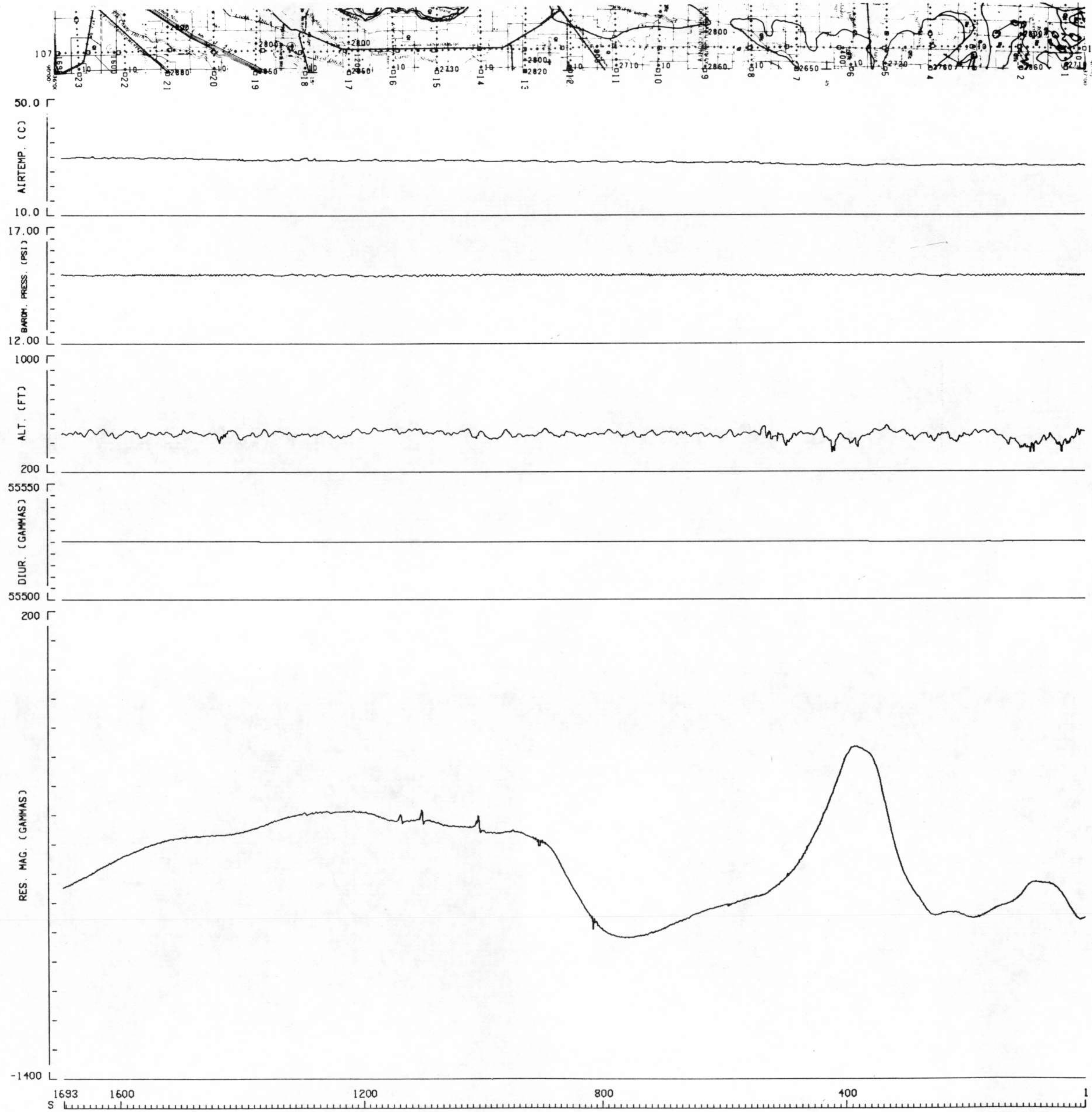
TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS
FL-104 POPLAR BLUFF NJ15-12



5 MILE(S)

TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

FL-106 POPLAR BLUFF NJ15-12



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TEXAS-KENTUCKY SURVEY 1979 US DEPT. OF ENERGY TEXAS INSTRUMENTS

FL-107 POPLAR BLUFF NJ15-12

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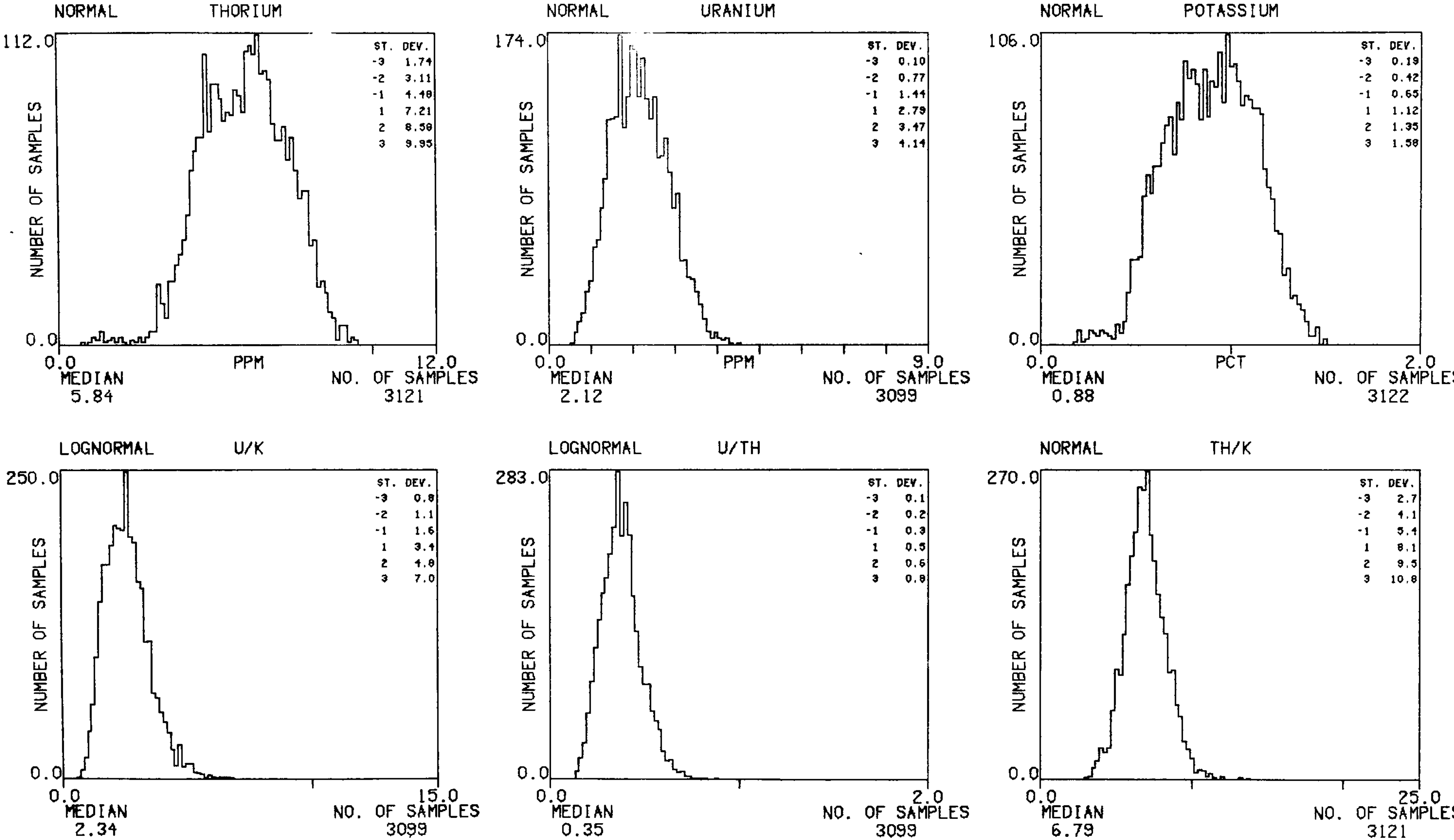

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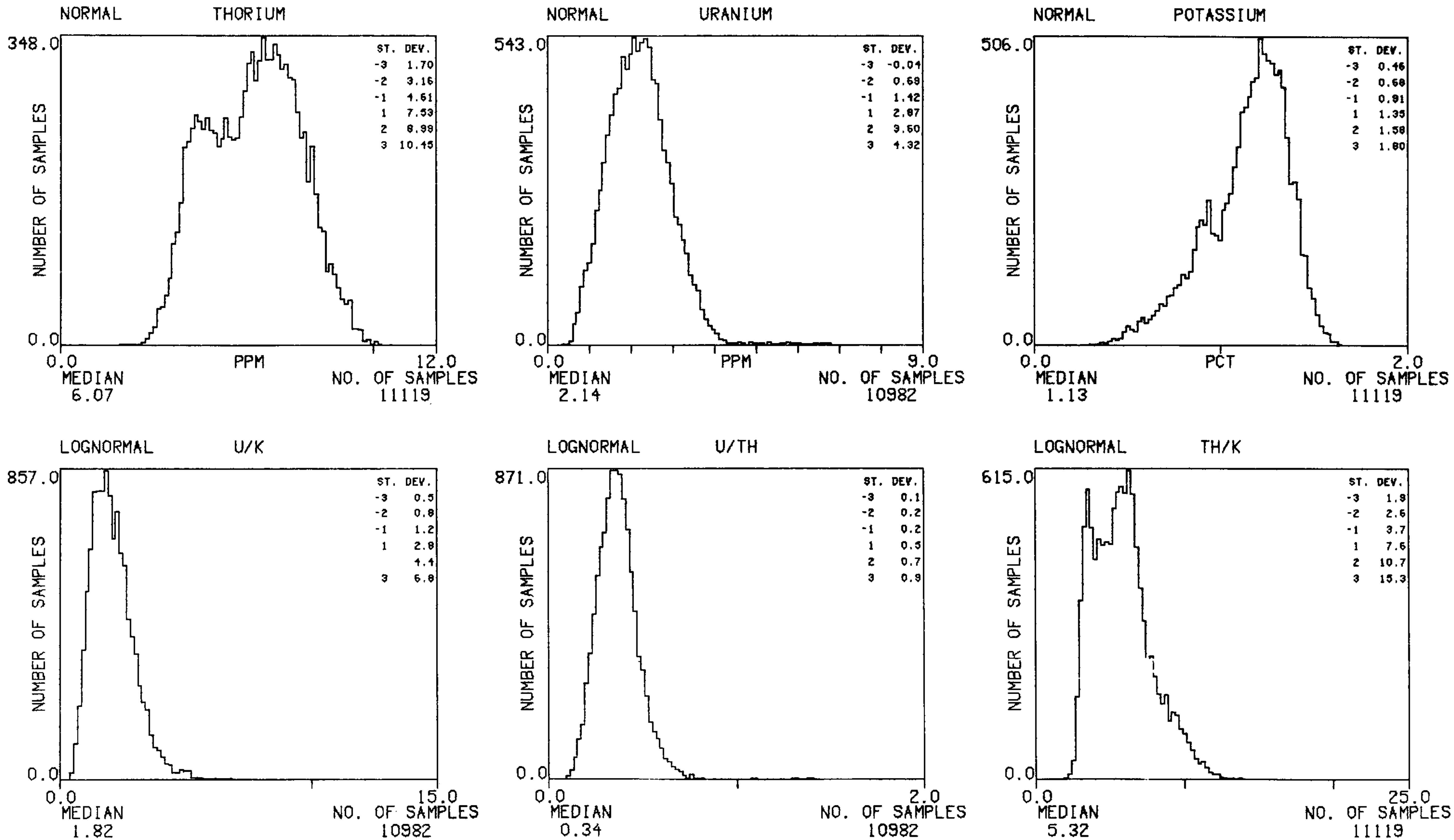

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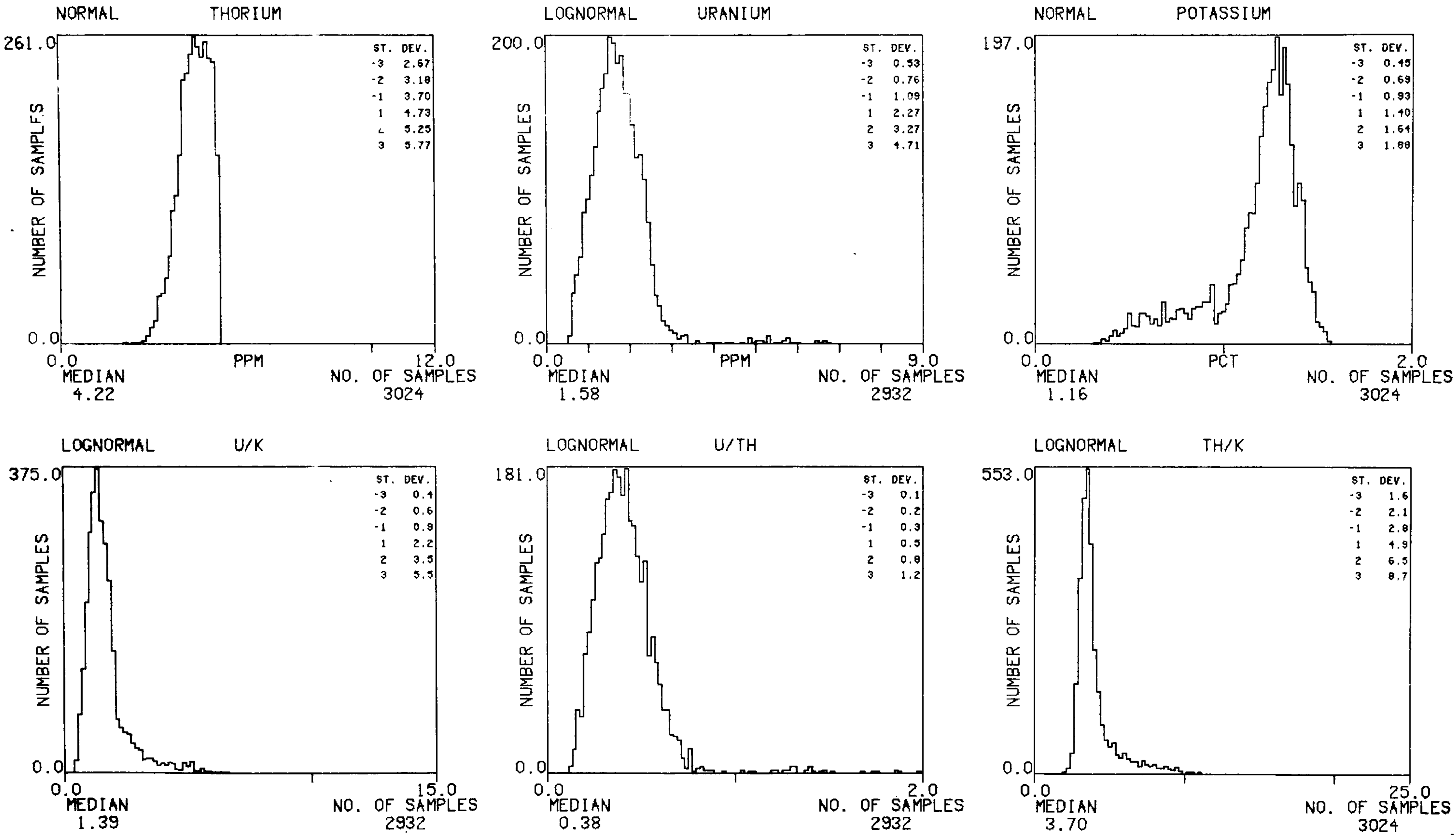

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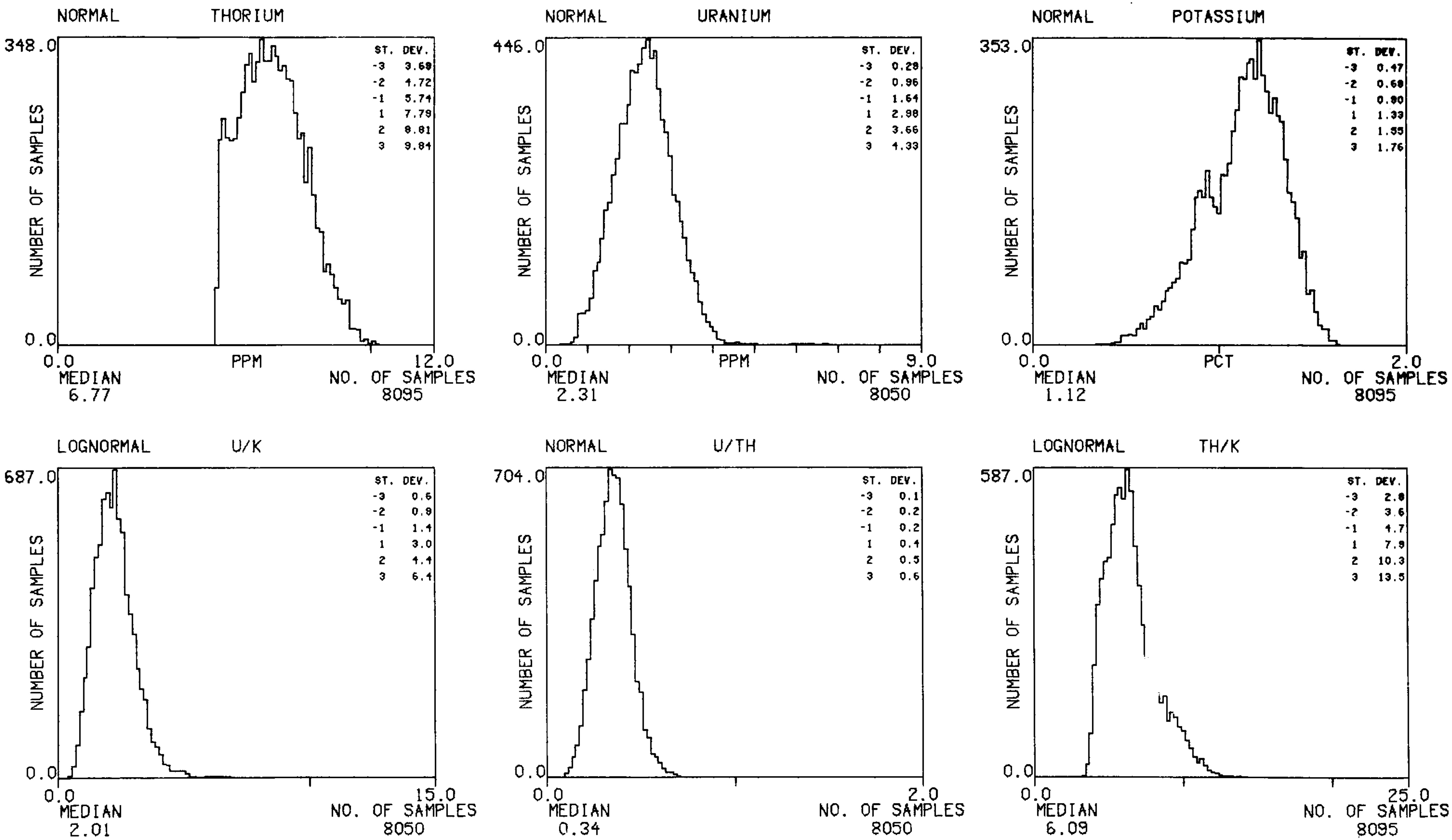

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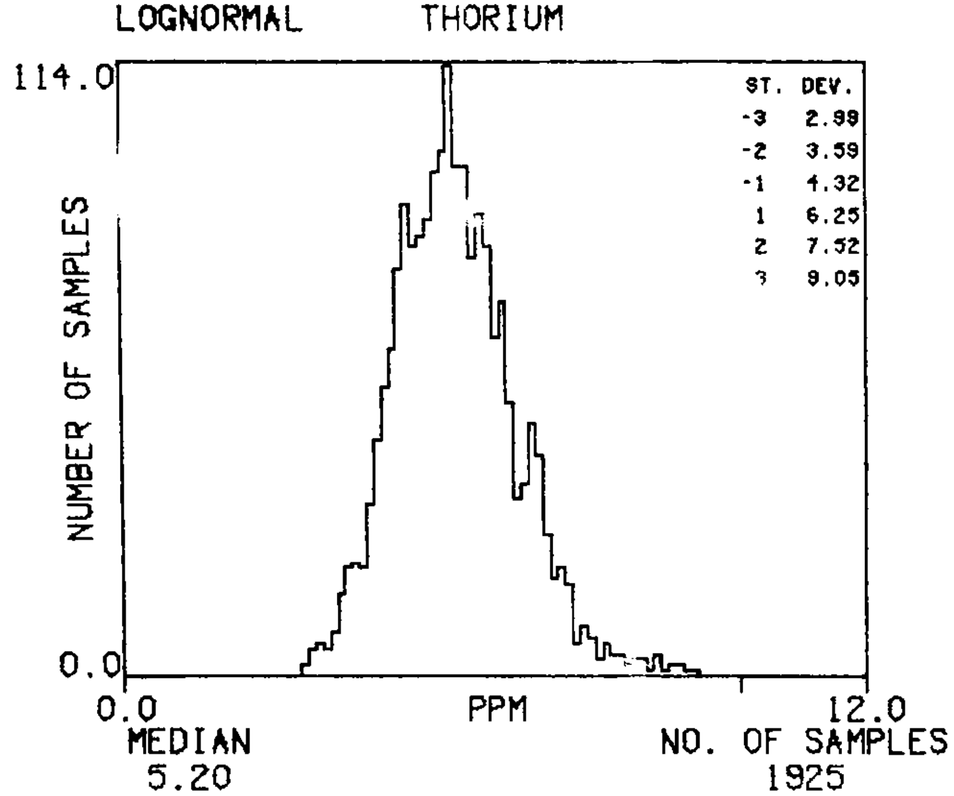

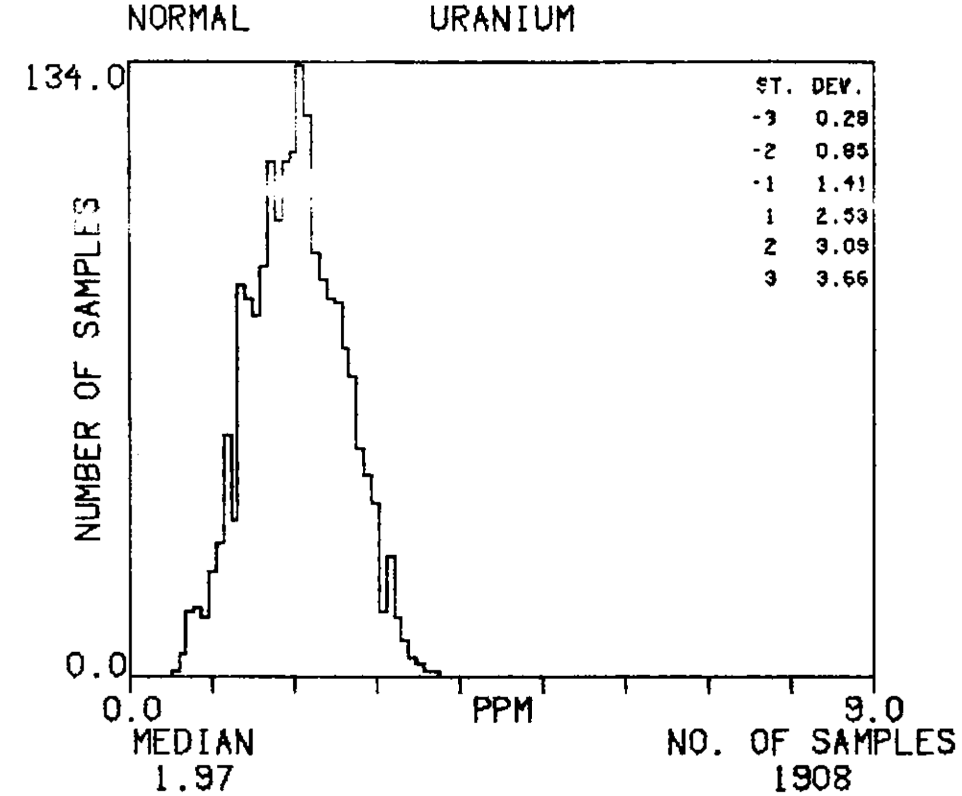

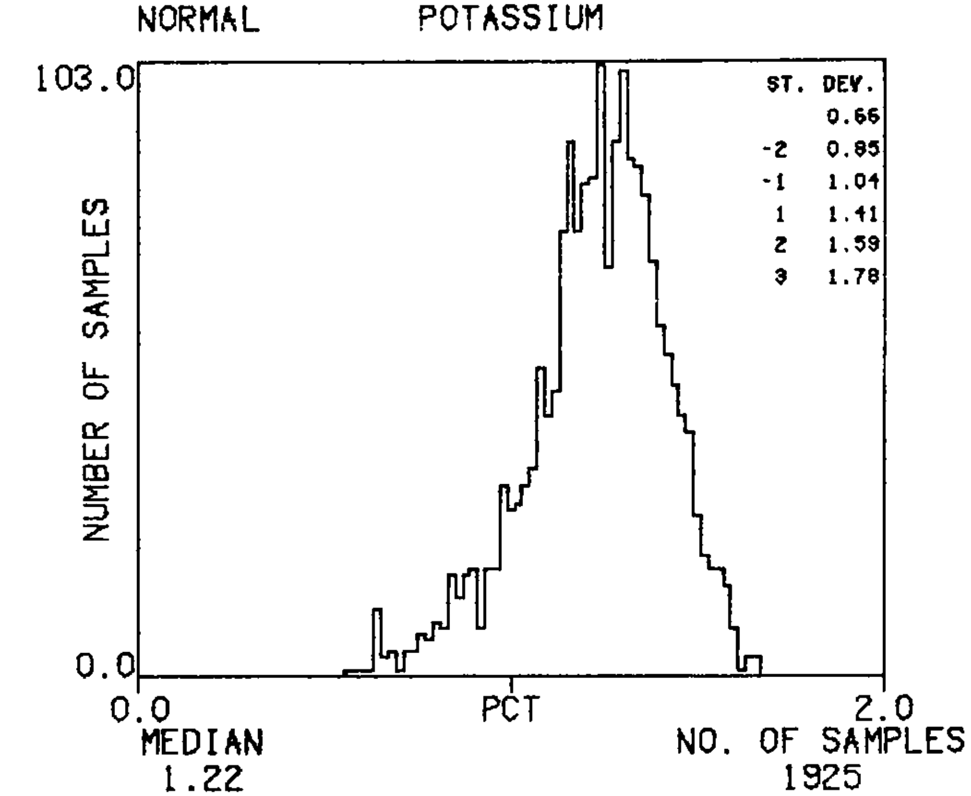

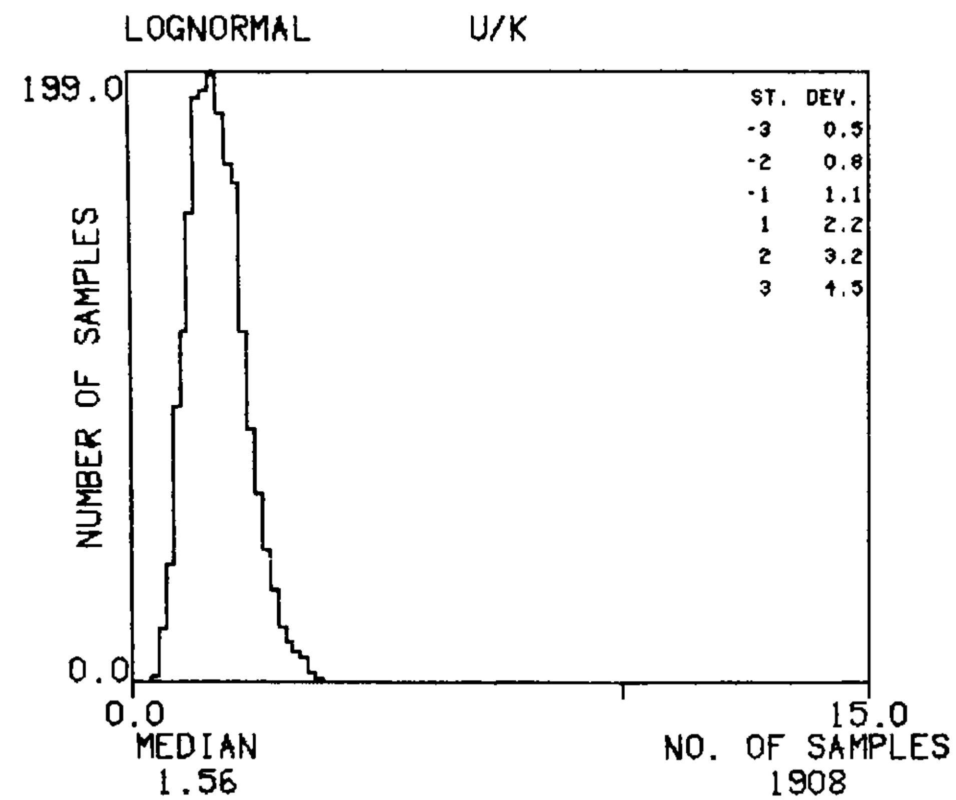

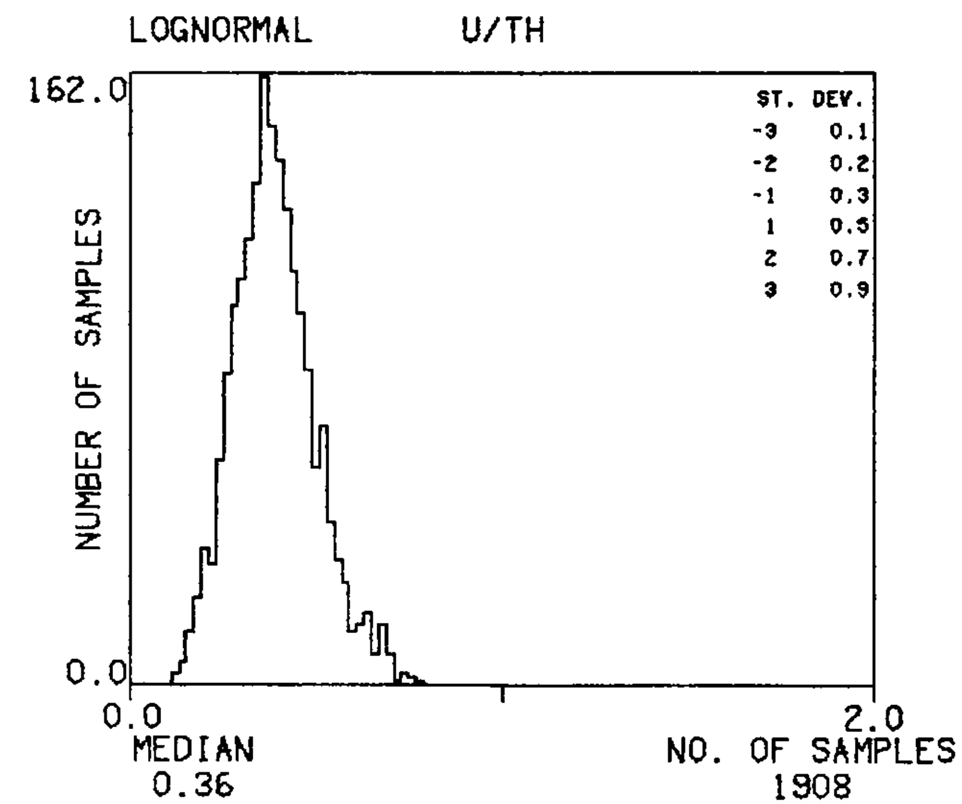

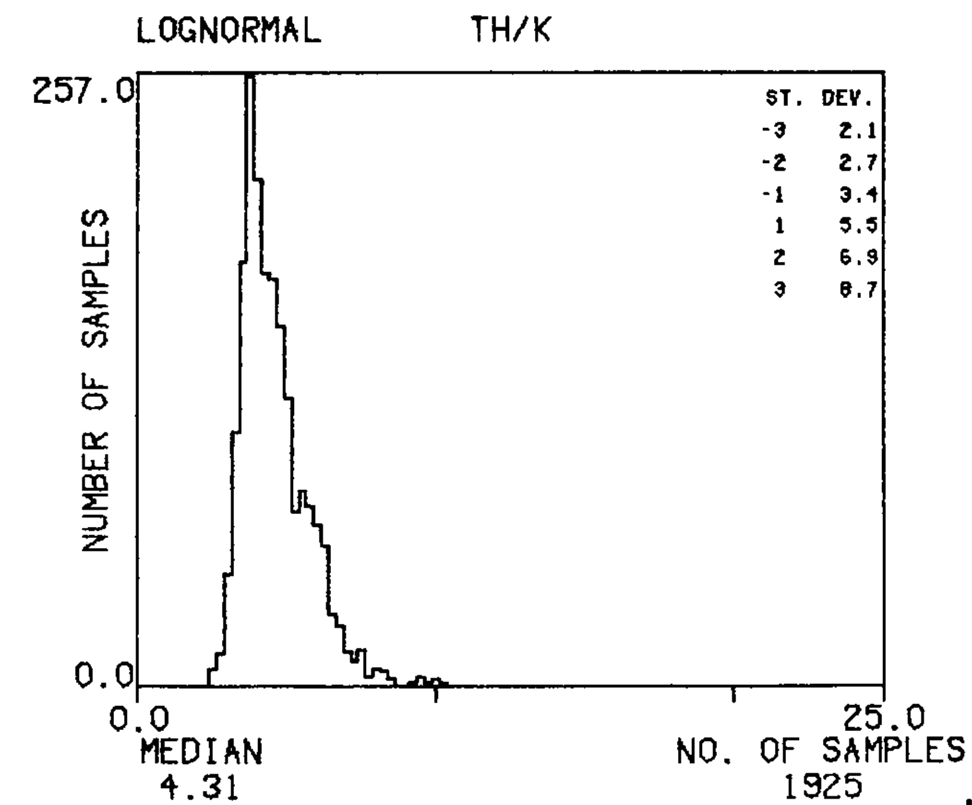

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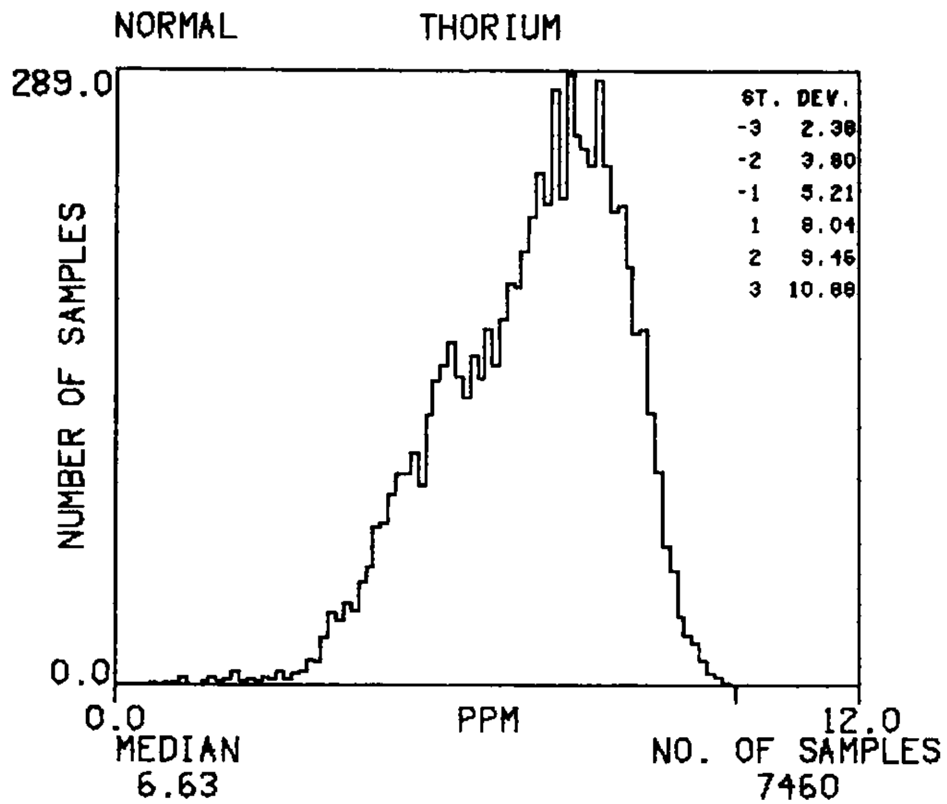

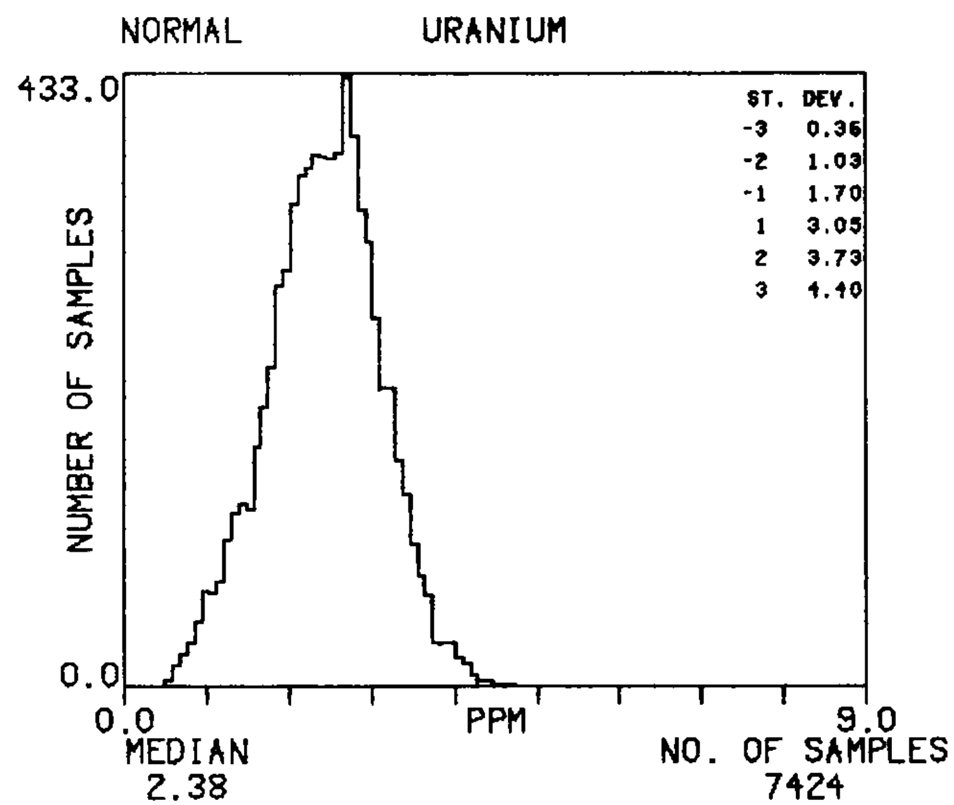

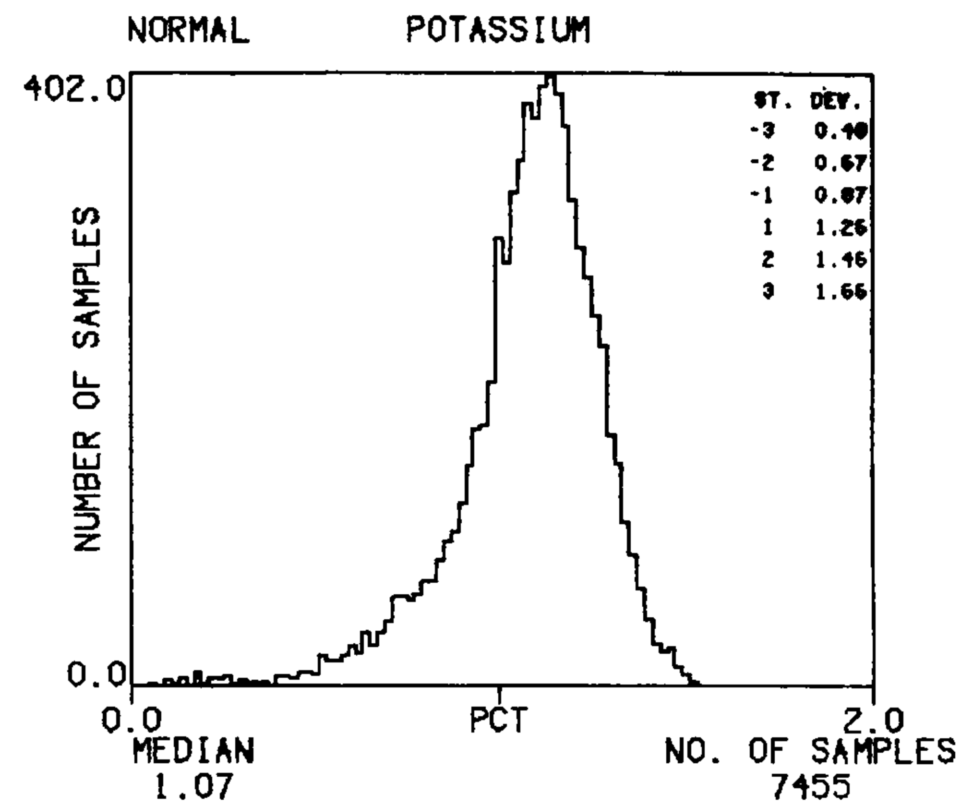

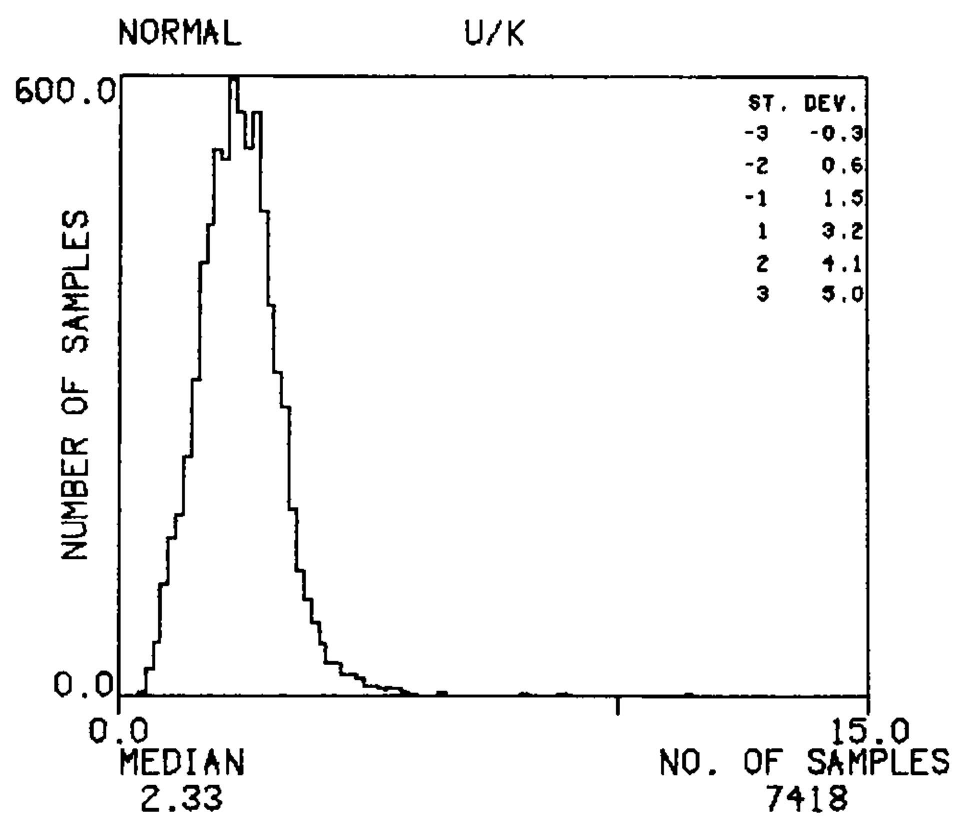

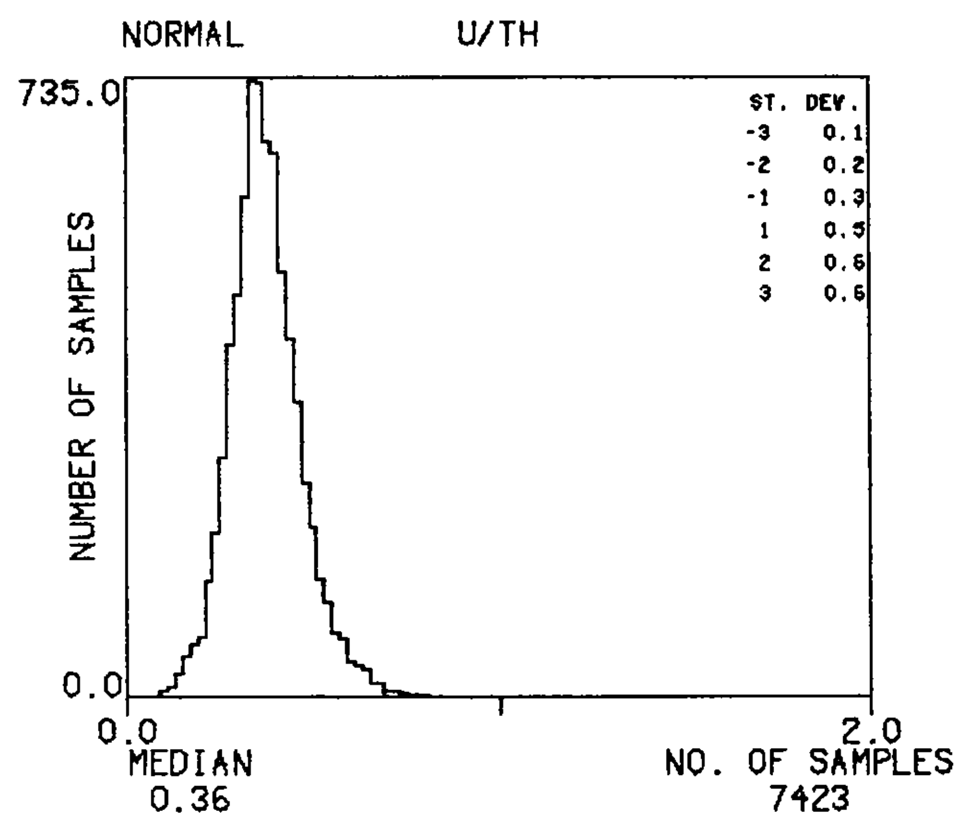

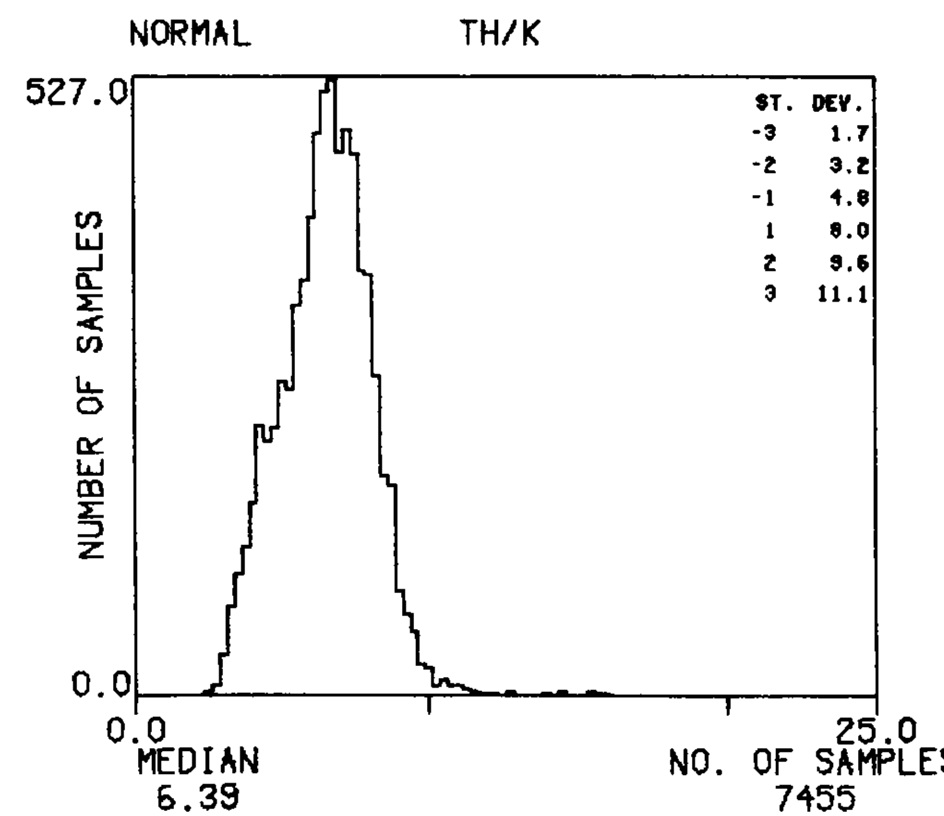

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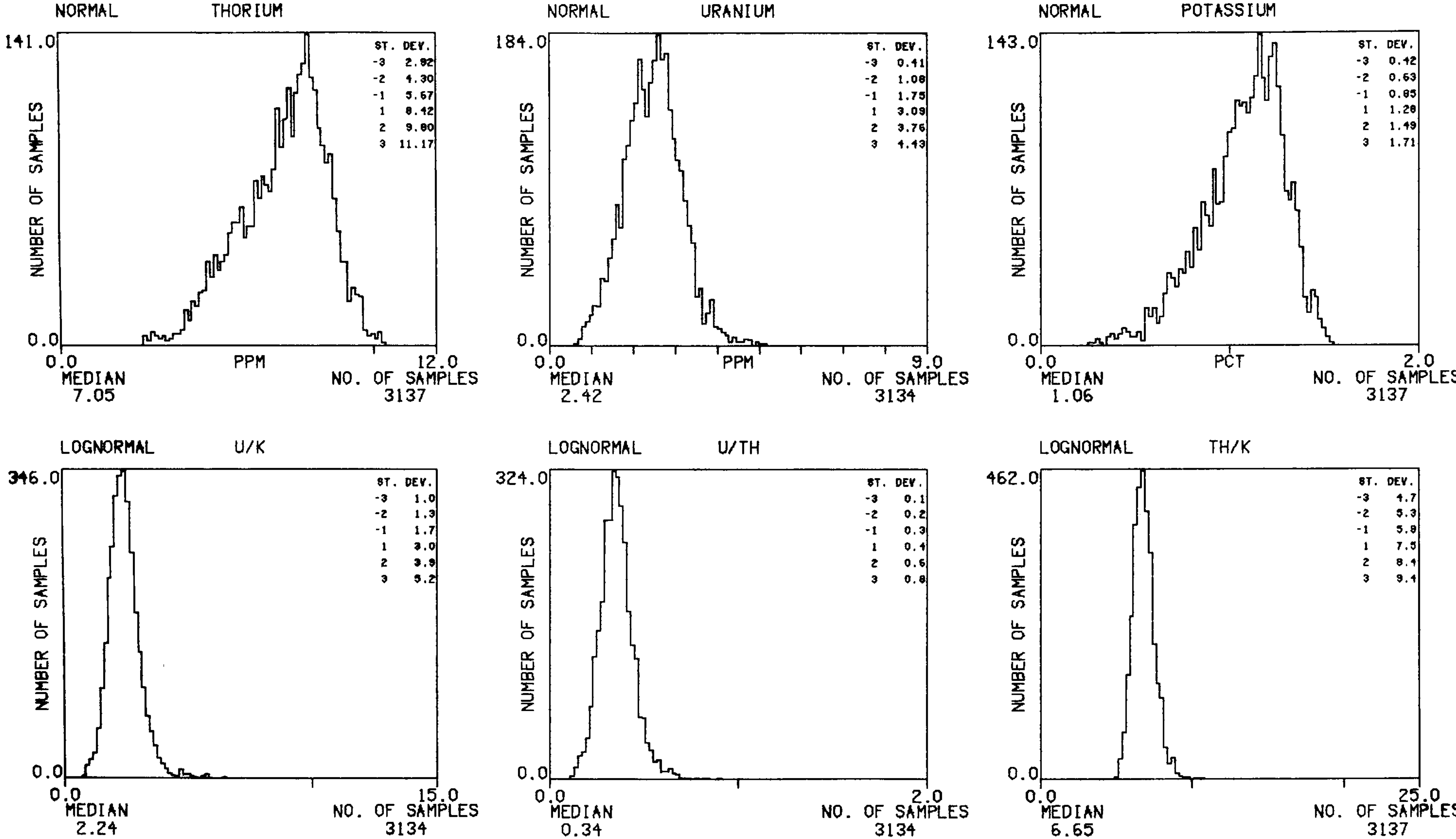

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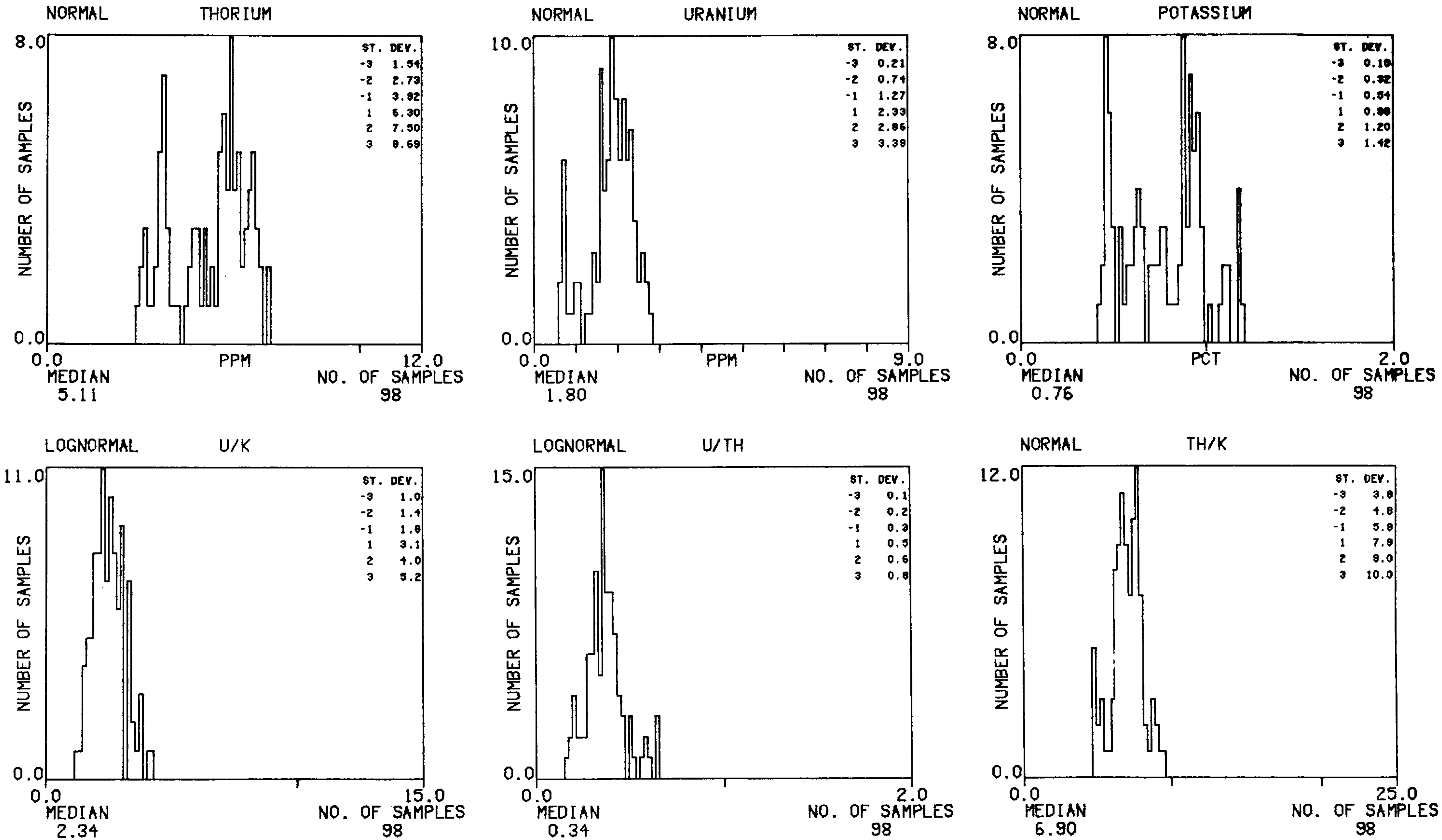

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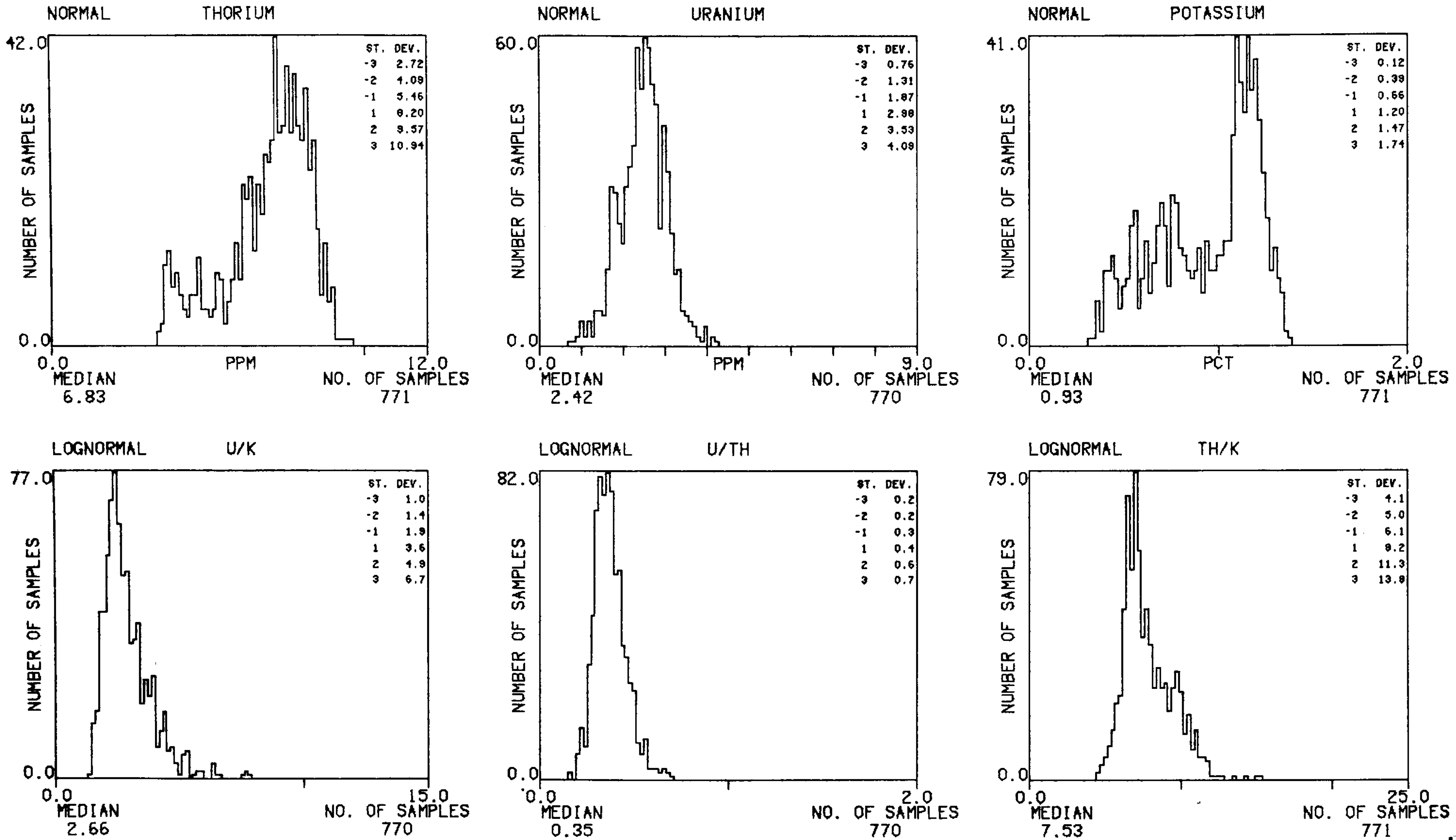

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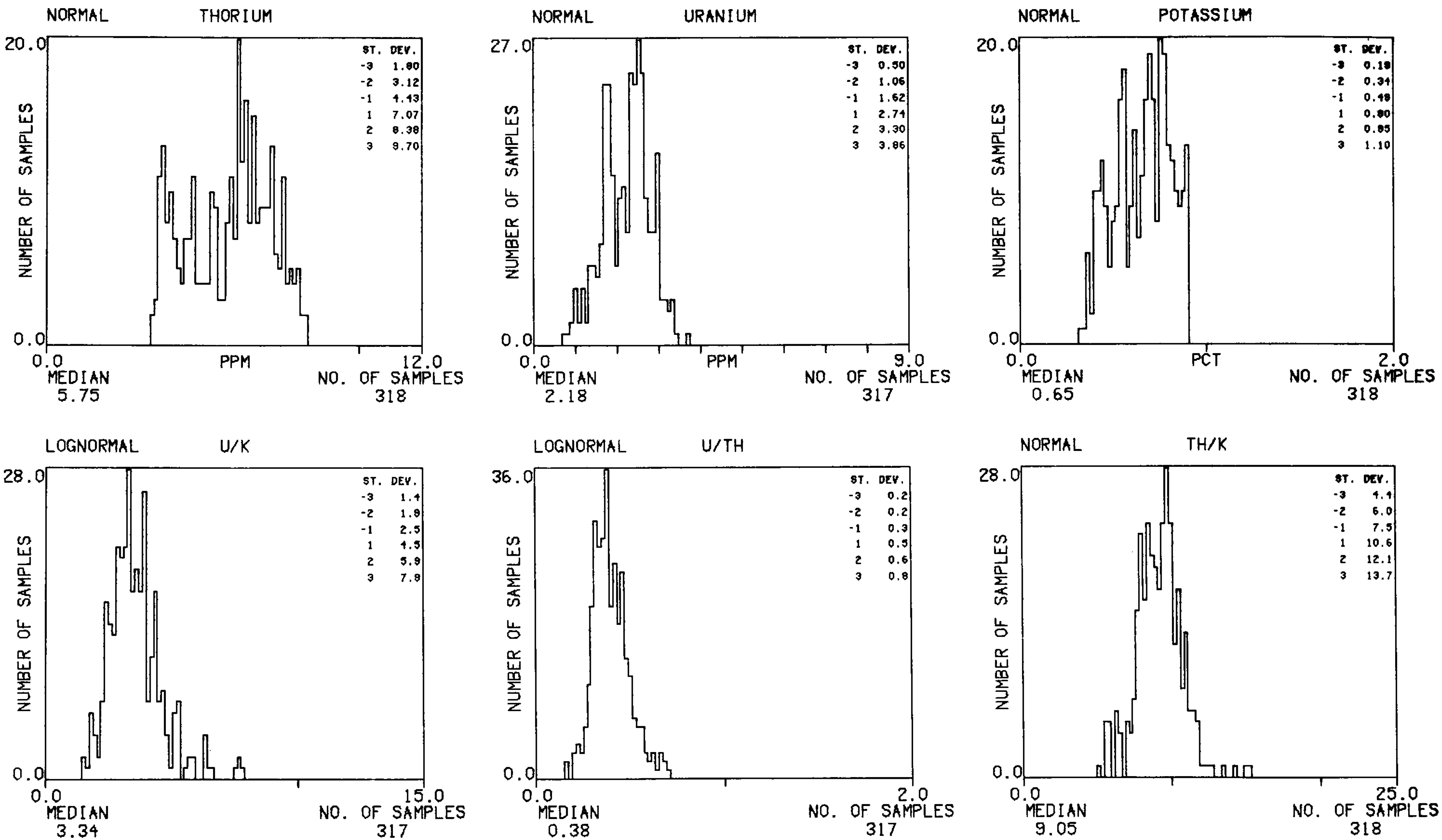

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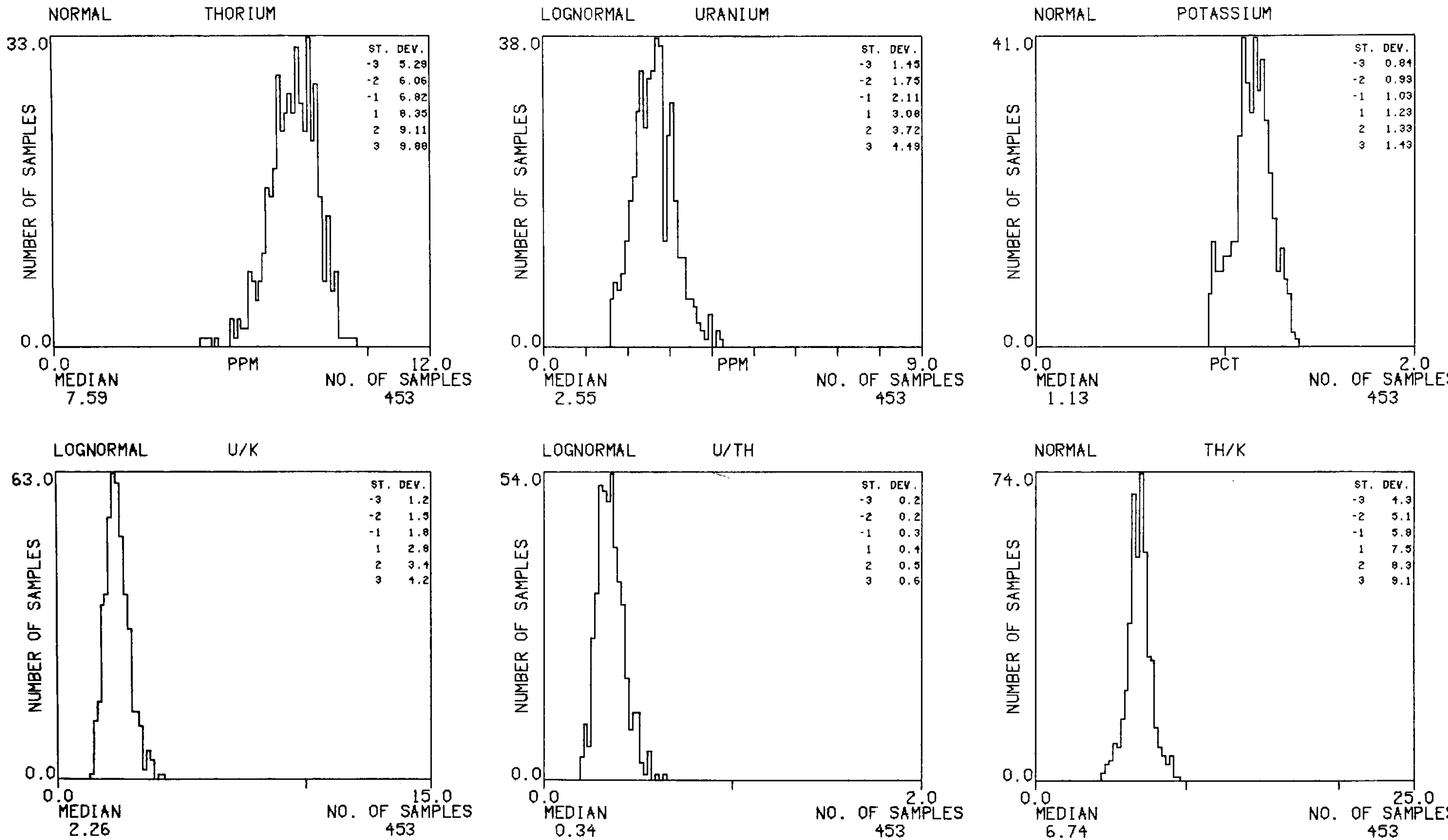

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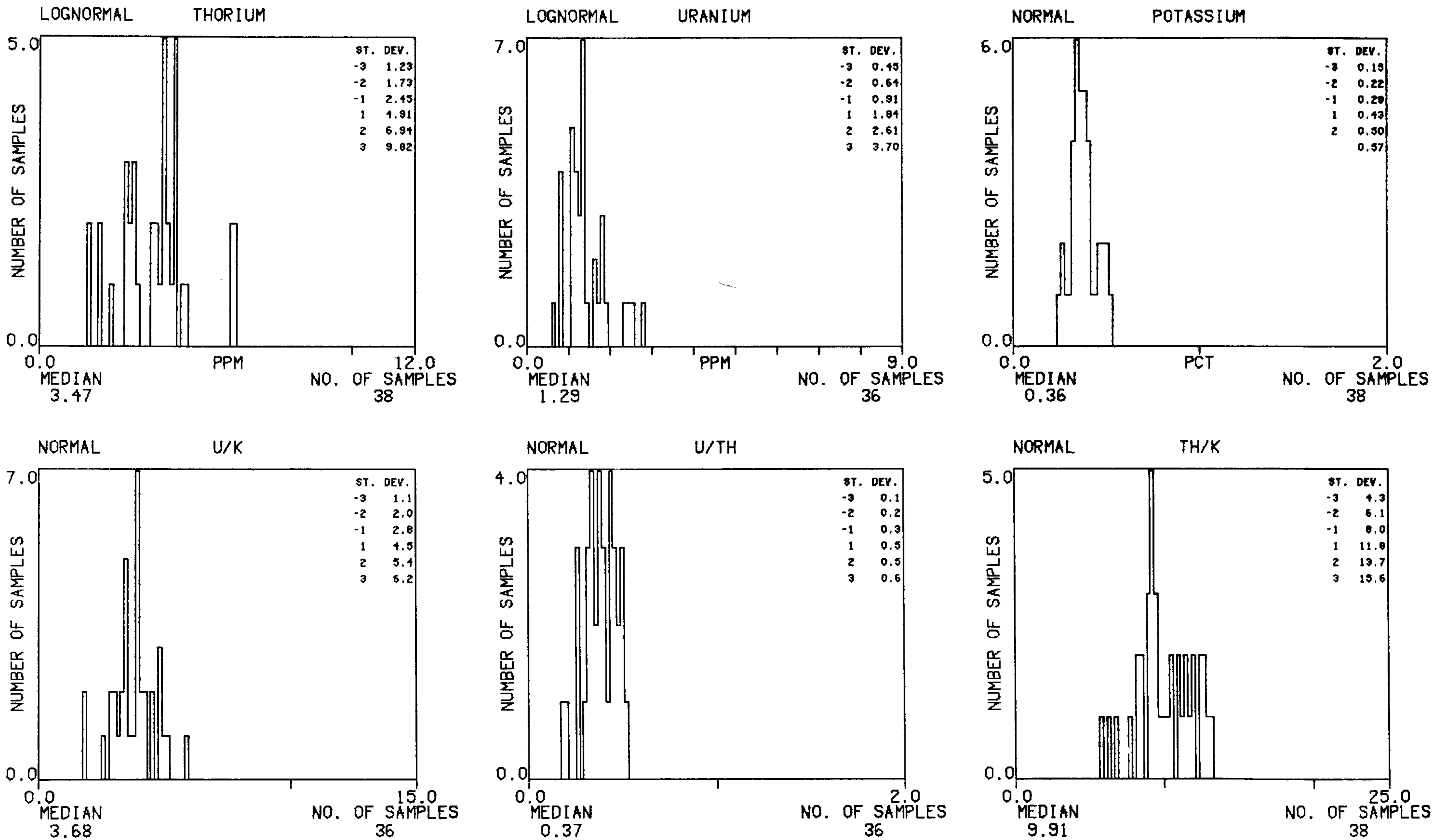

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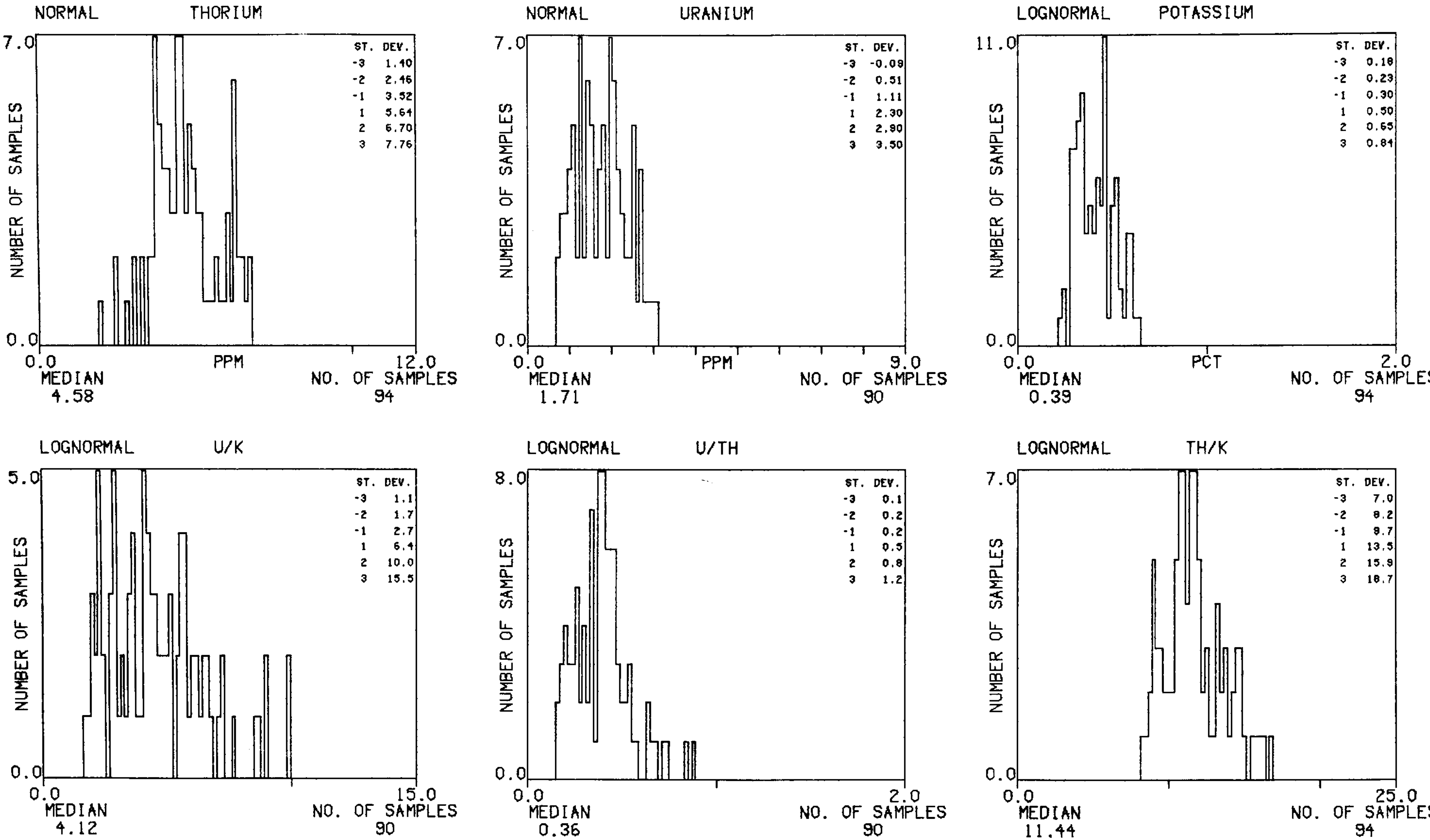

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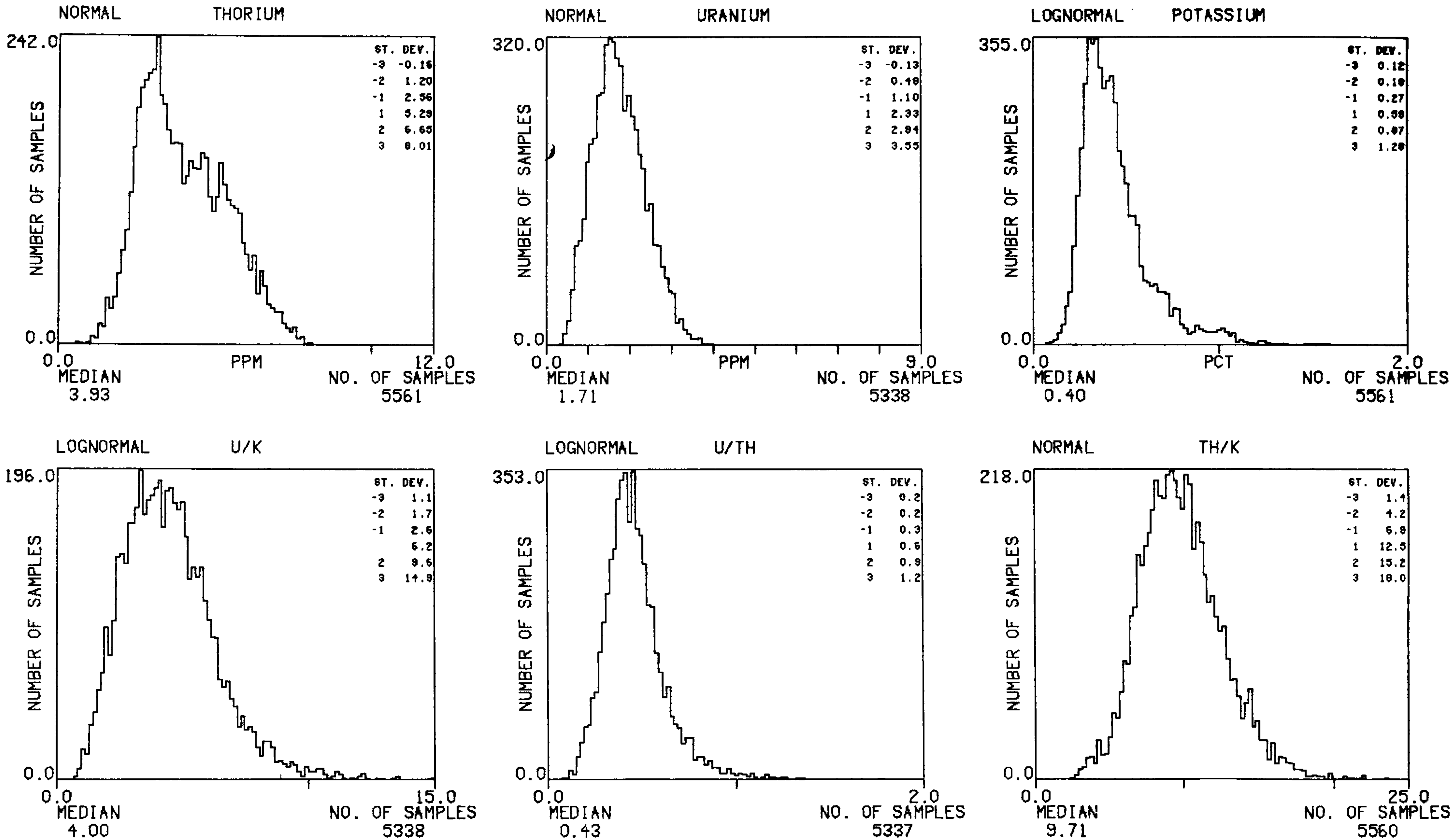

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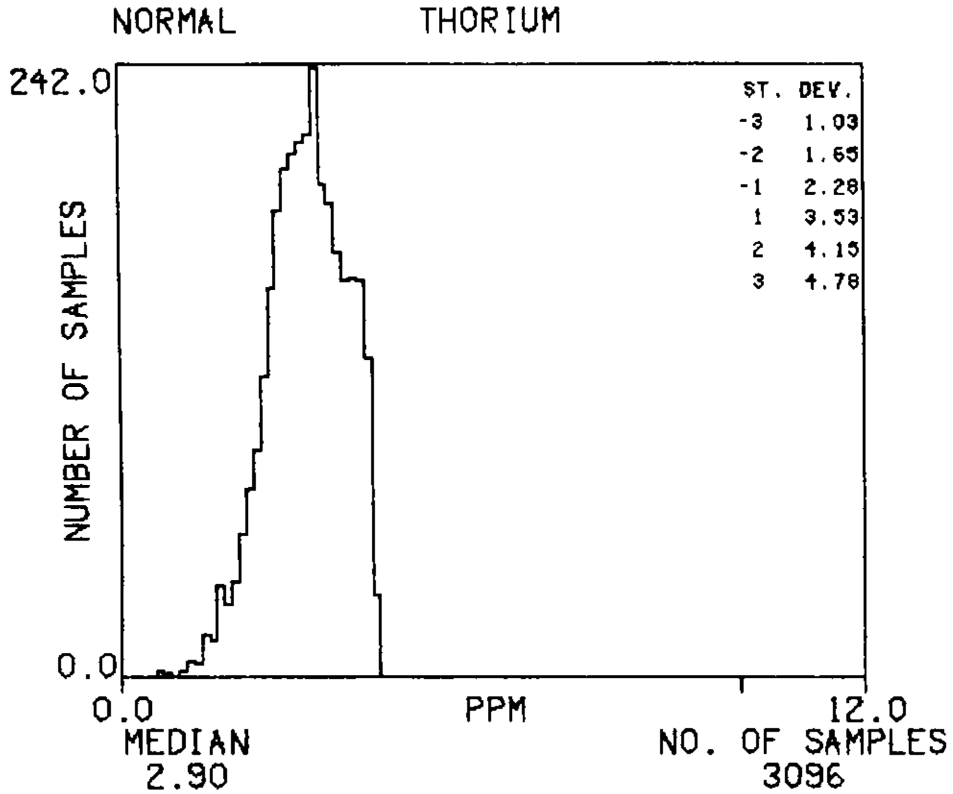

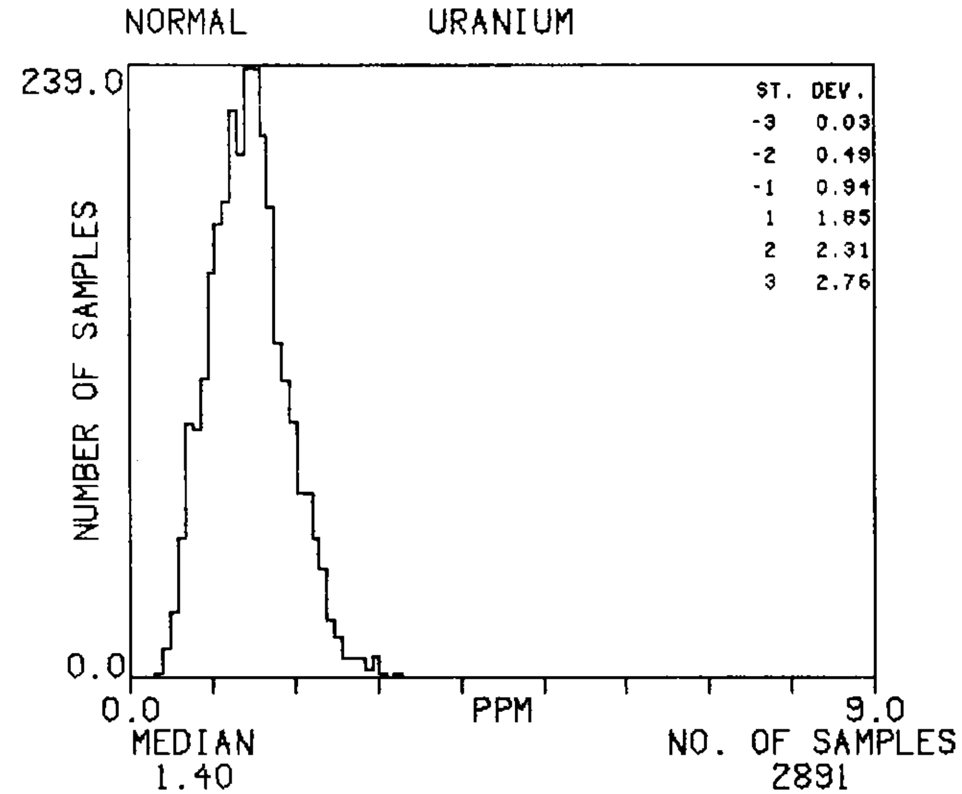

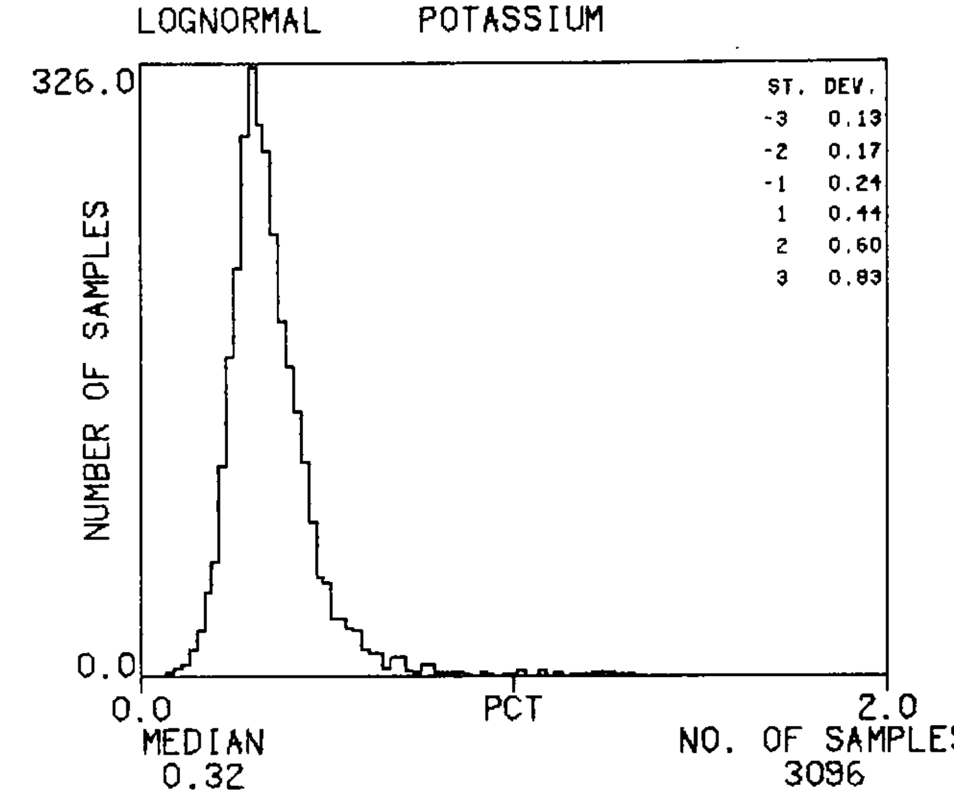

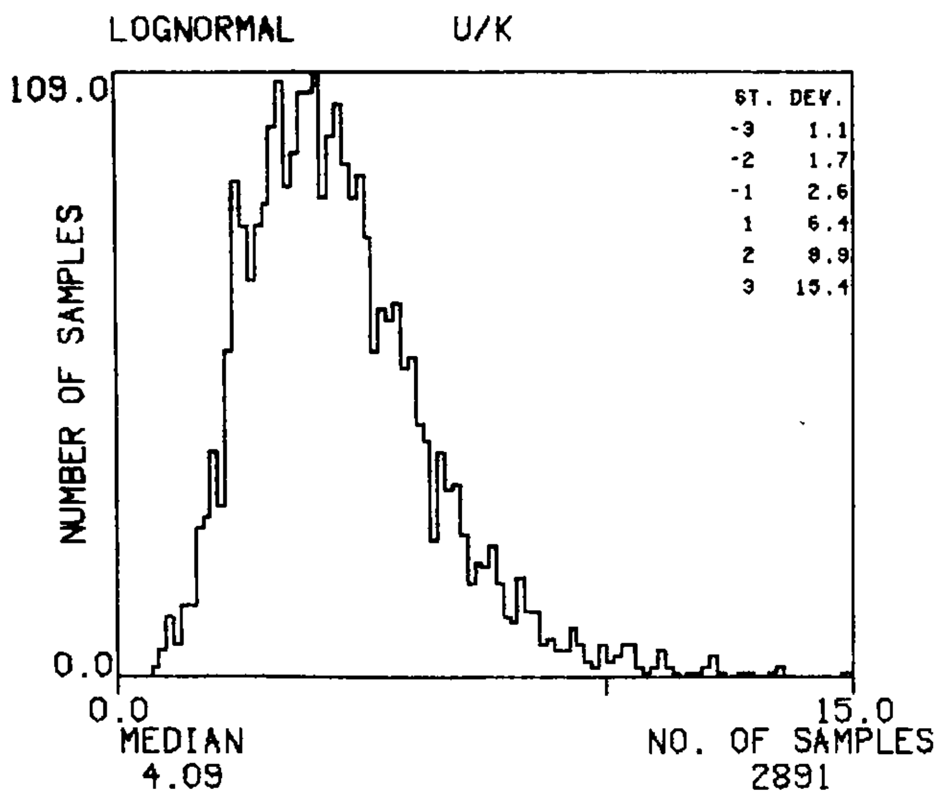

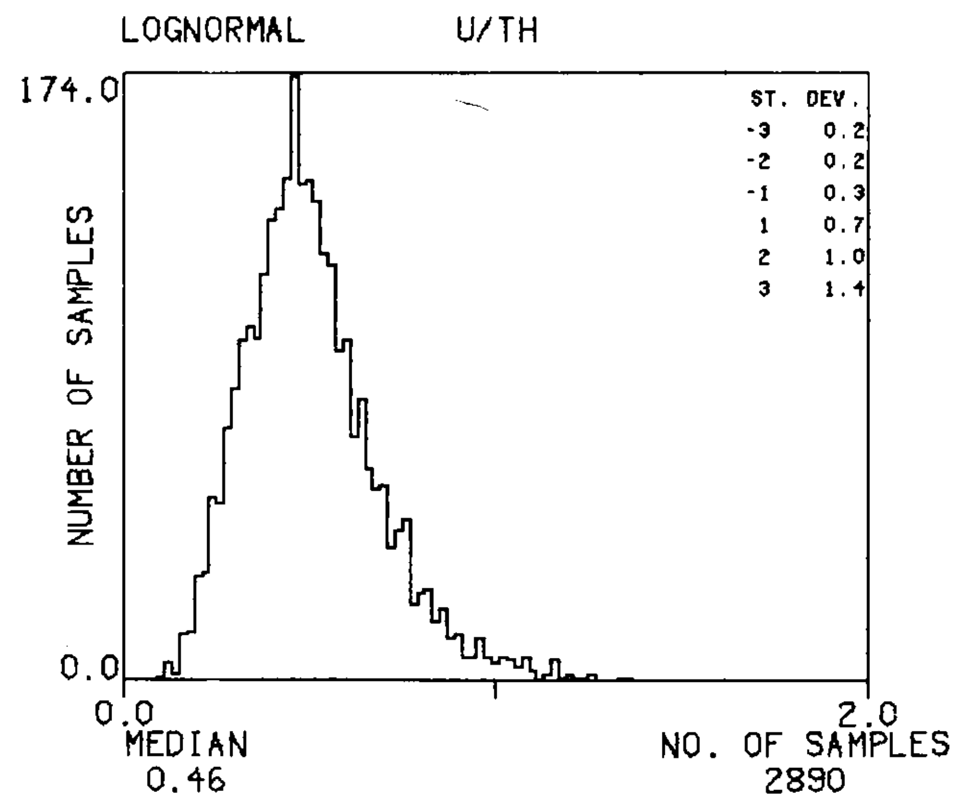

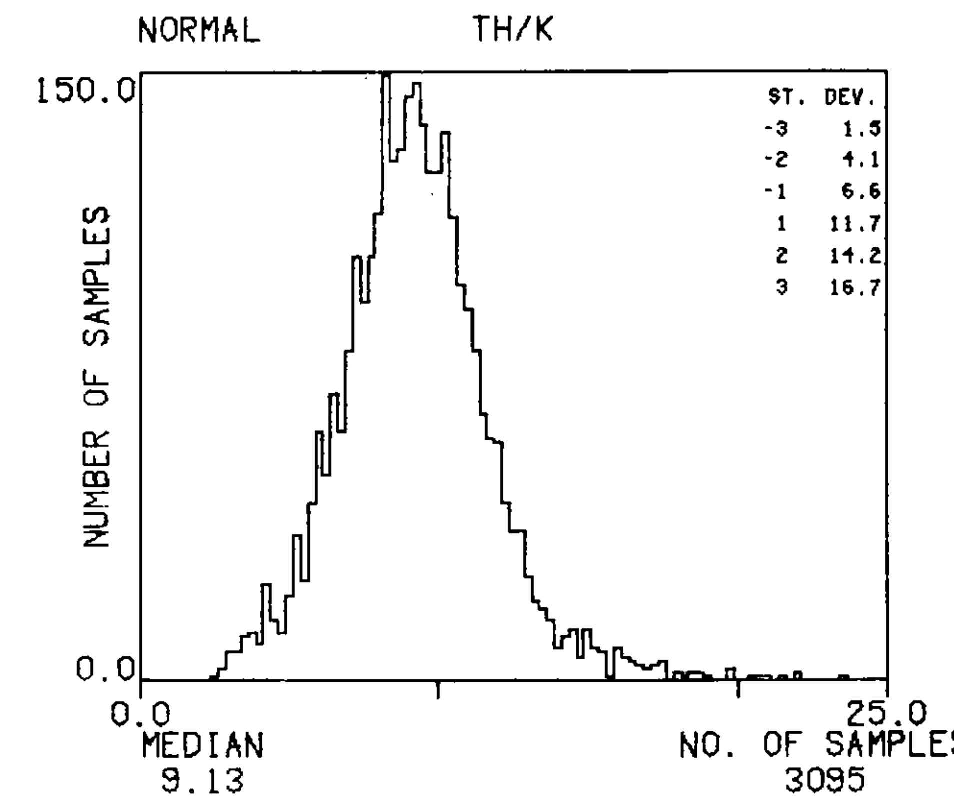

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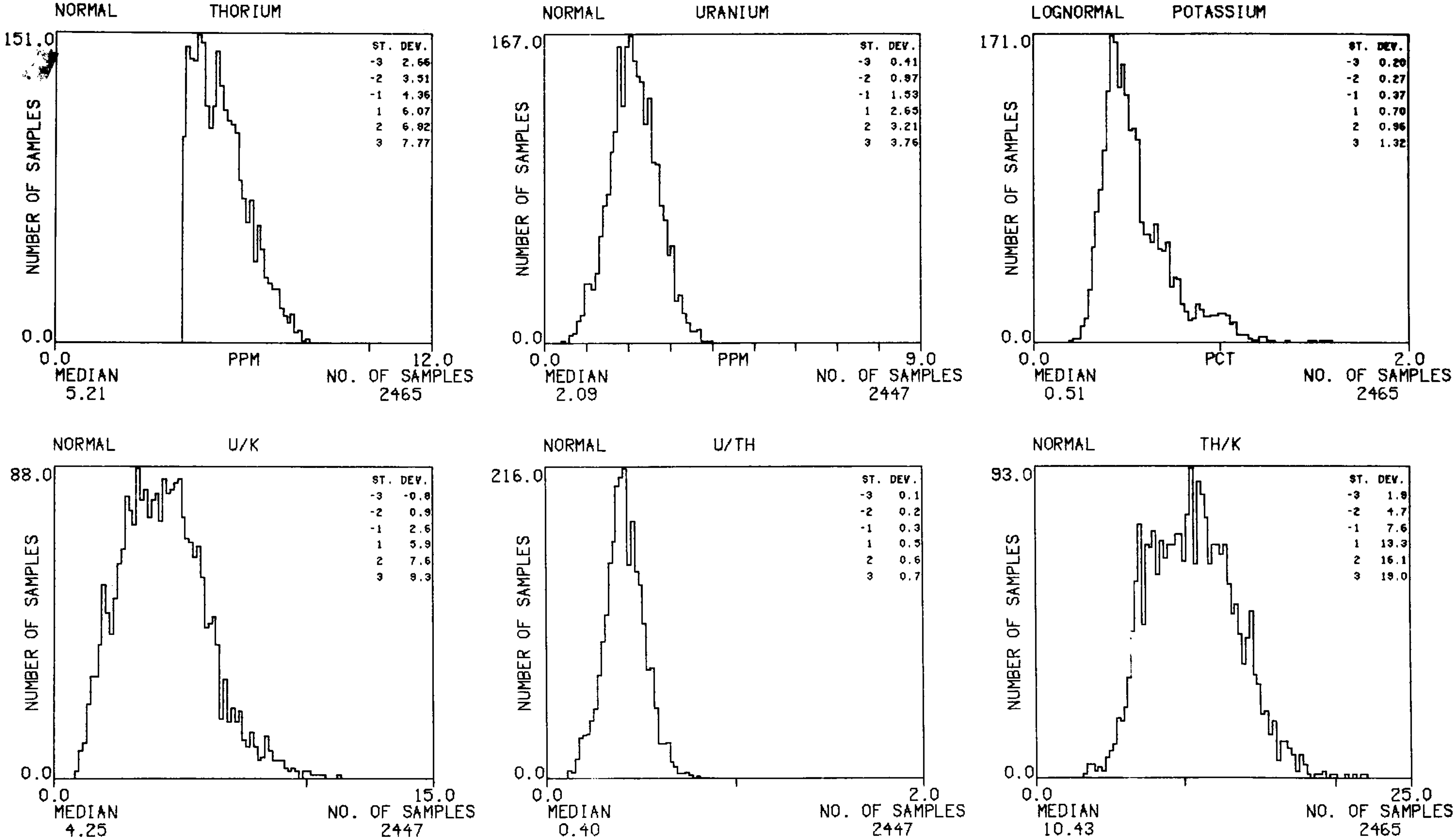

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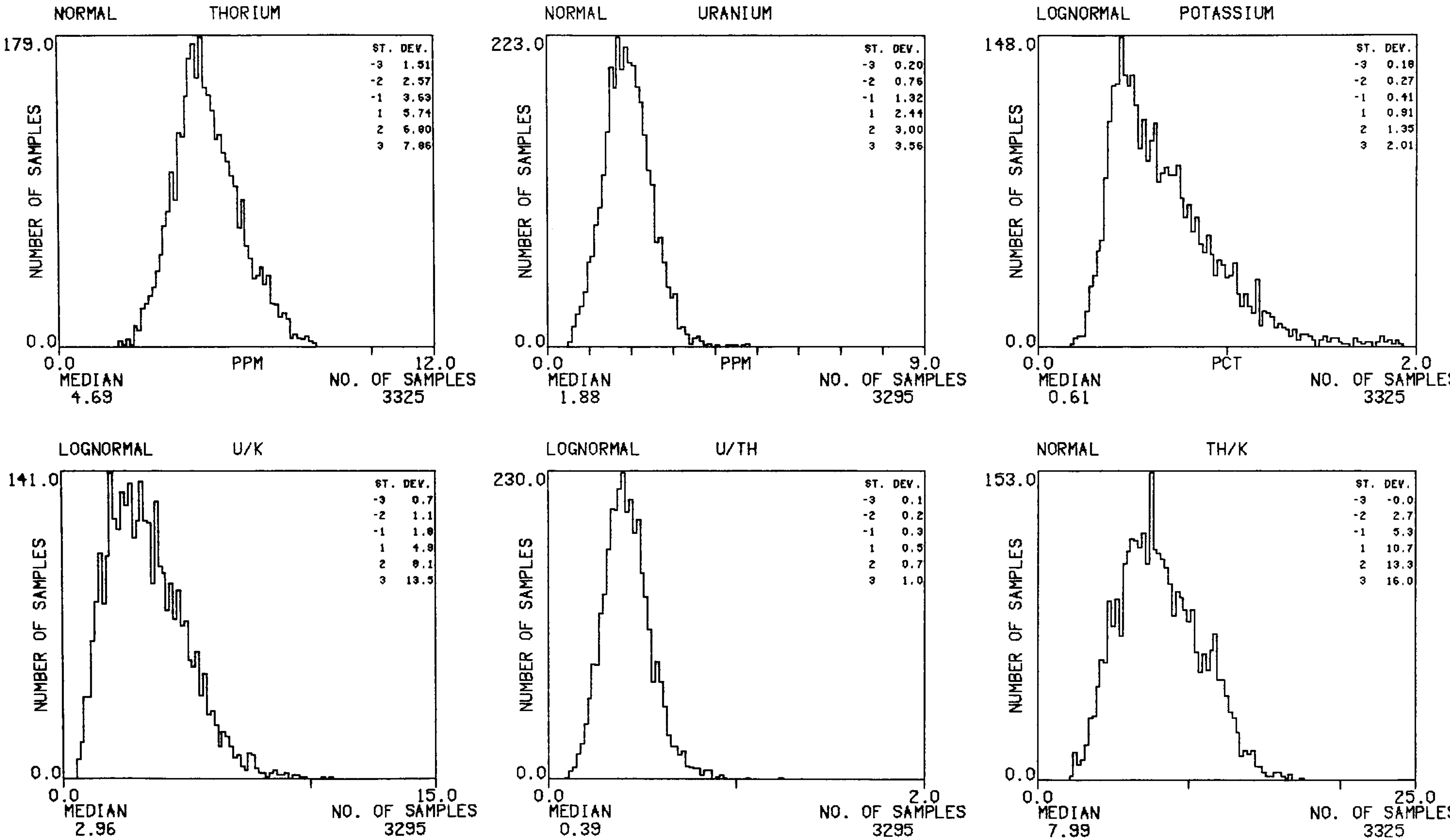

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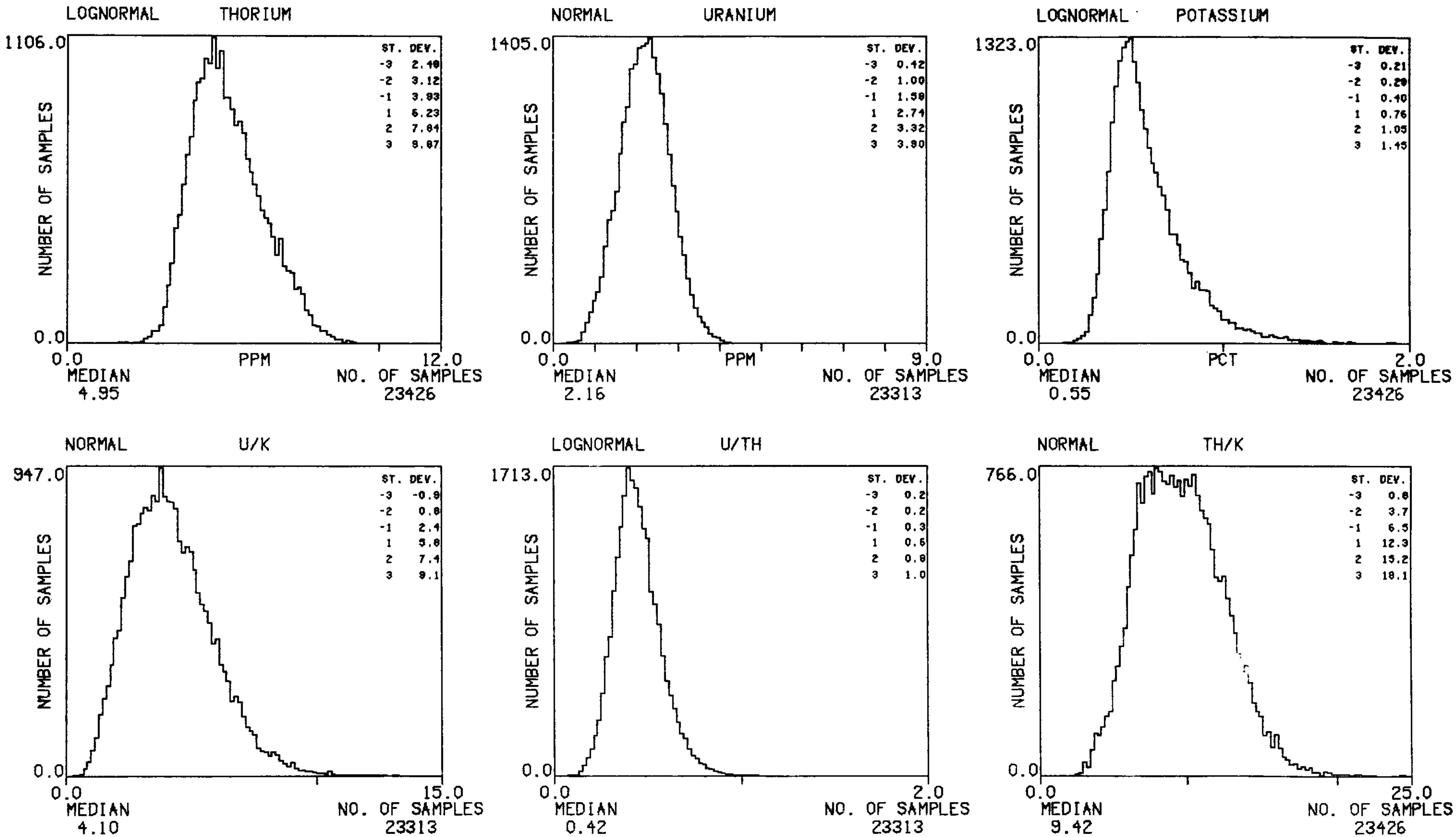

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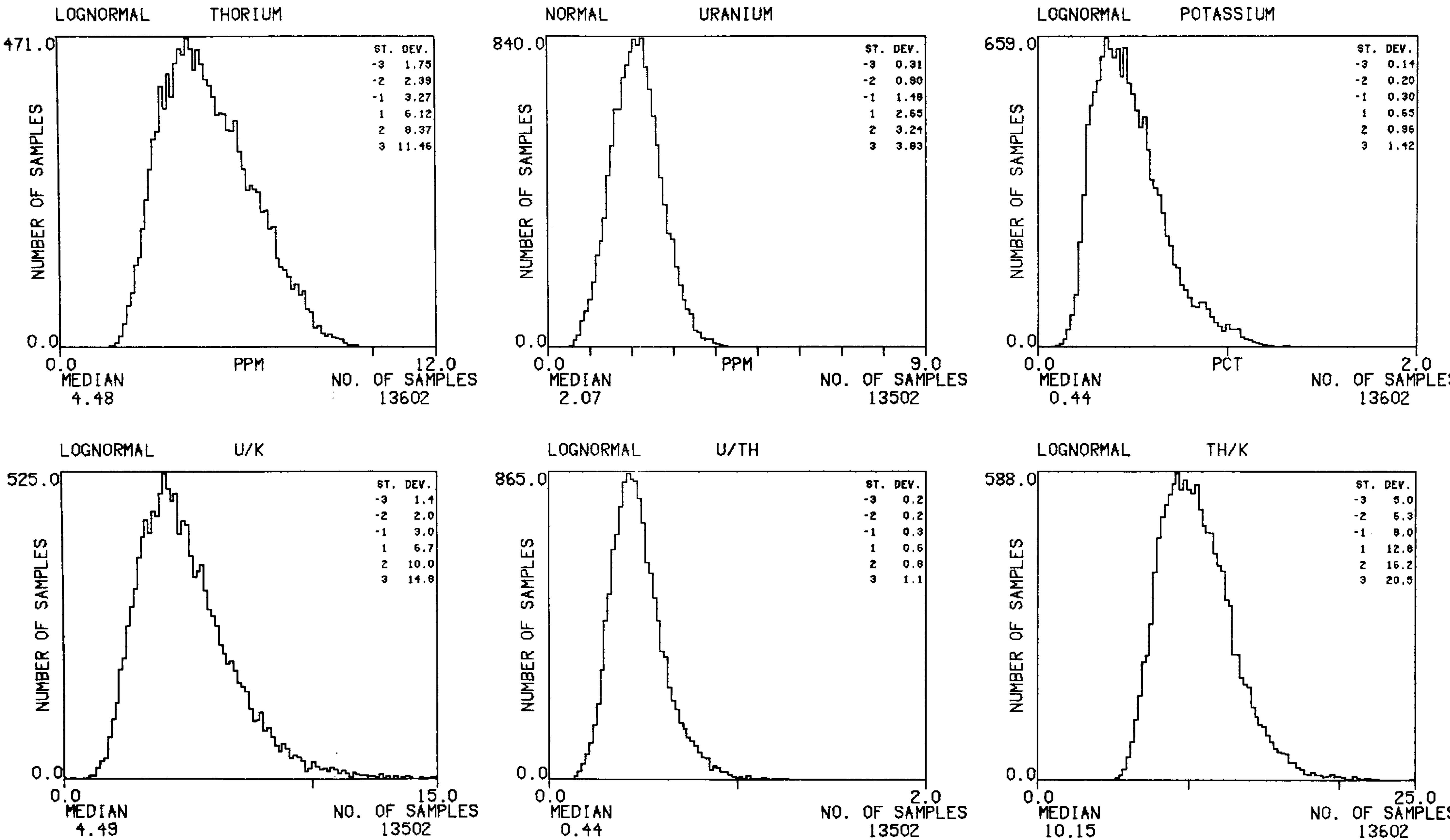

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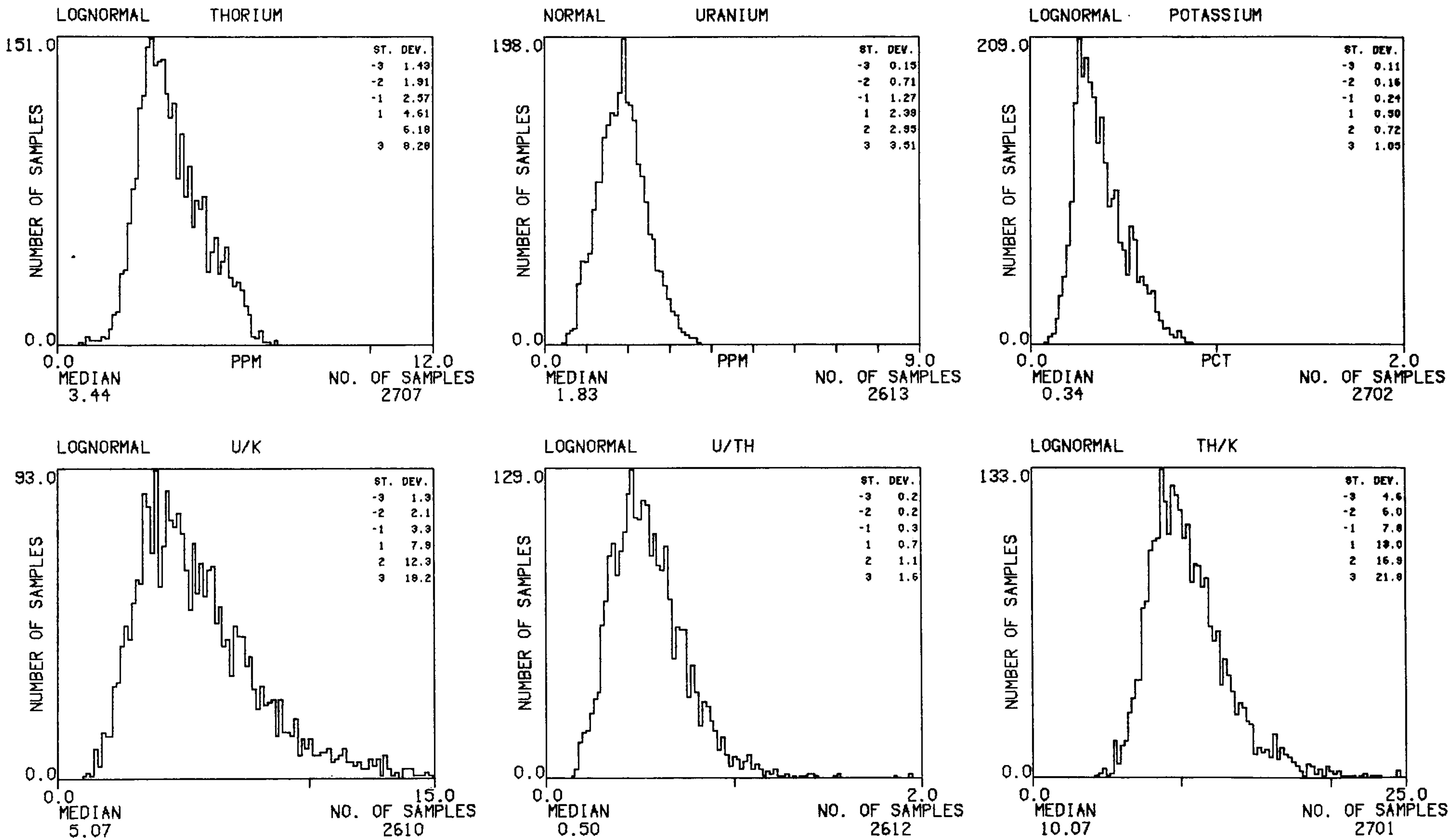

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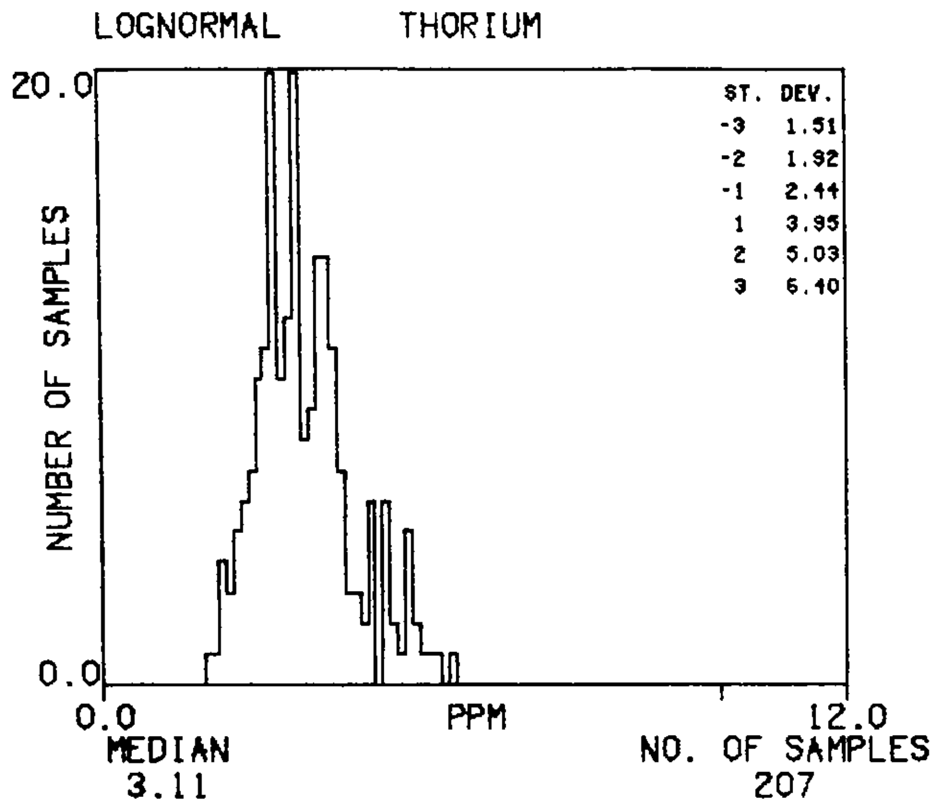

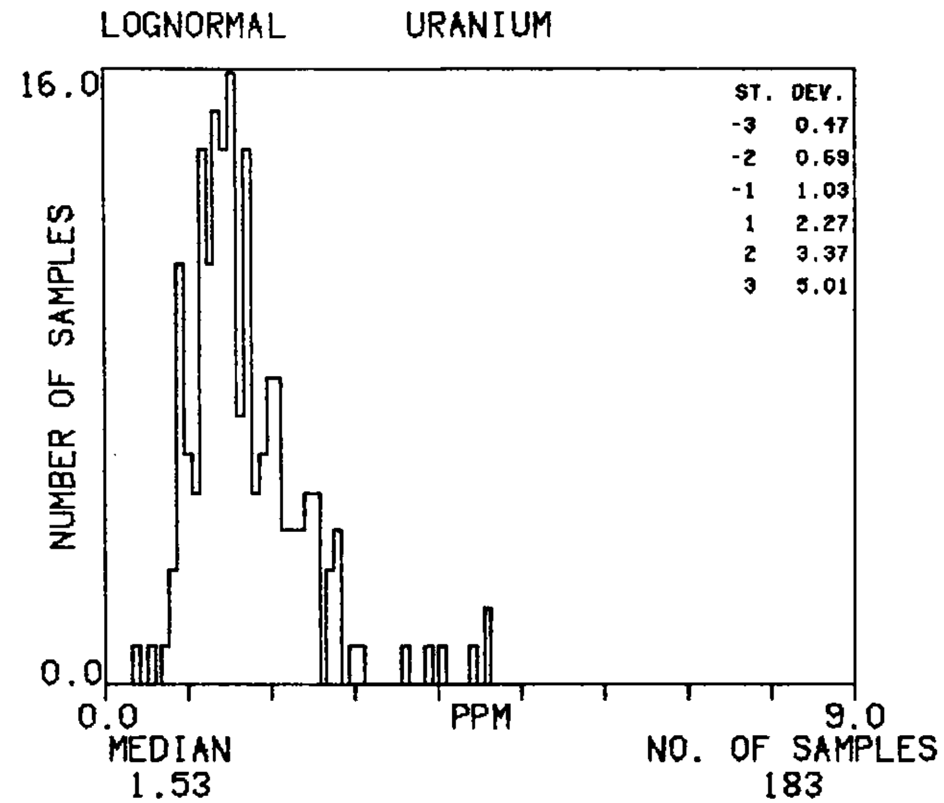

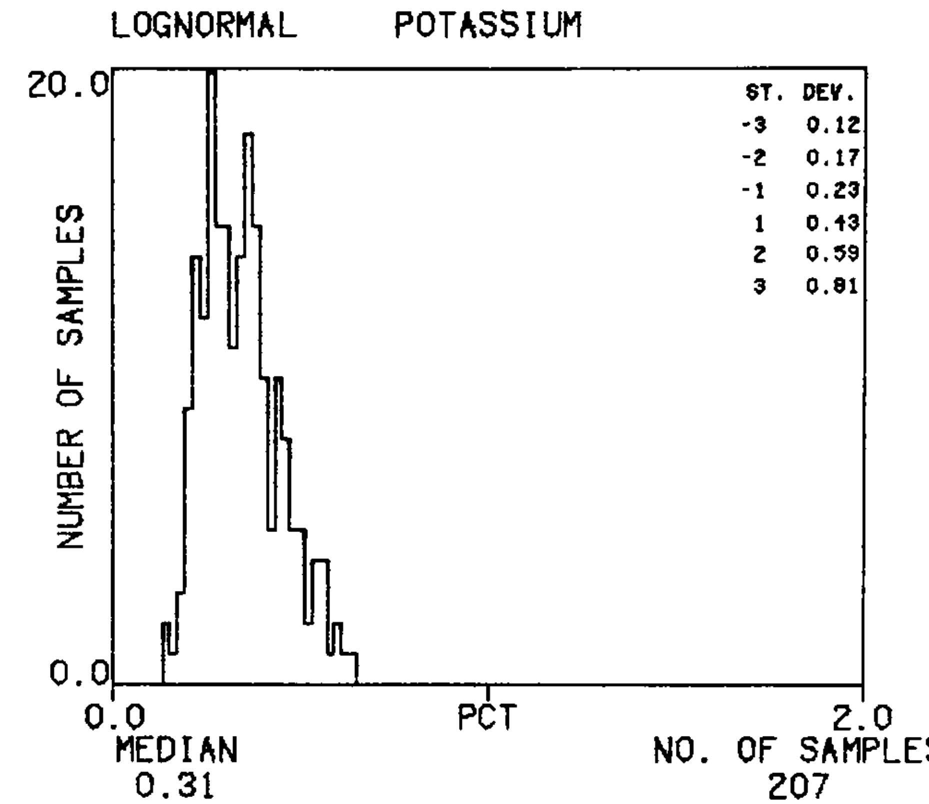

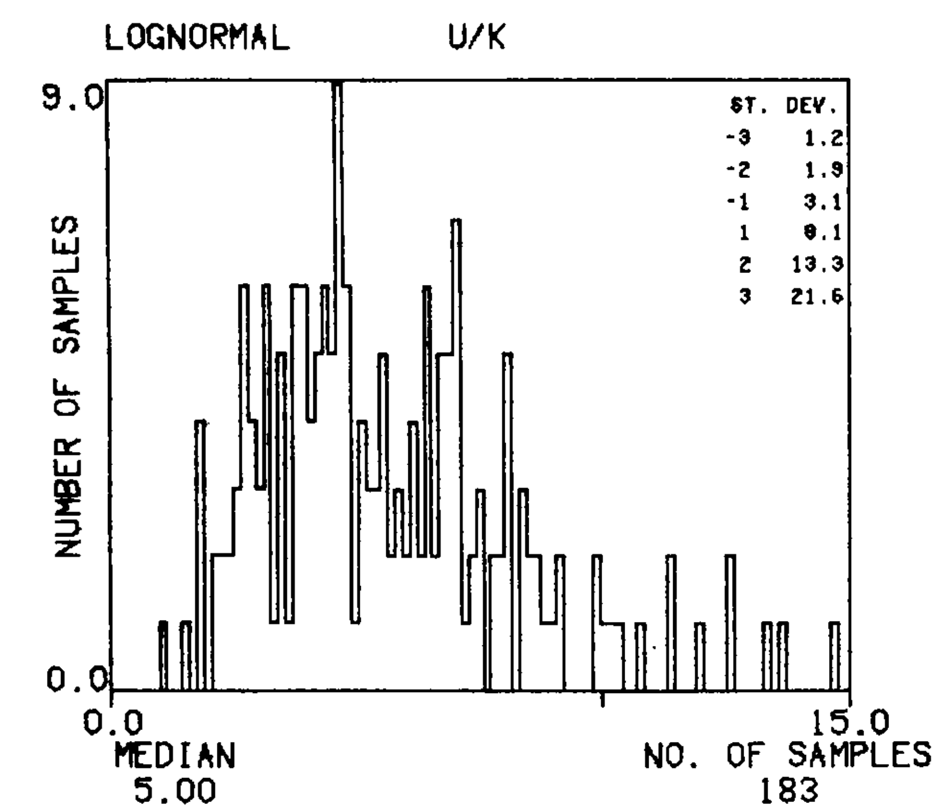

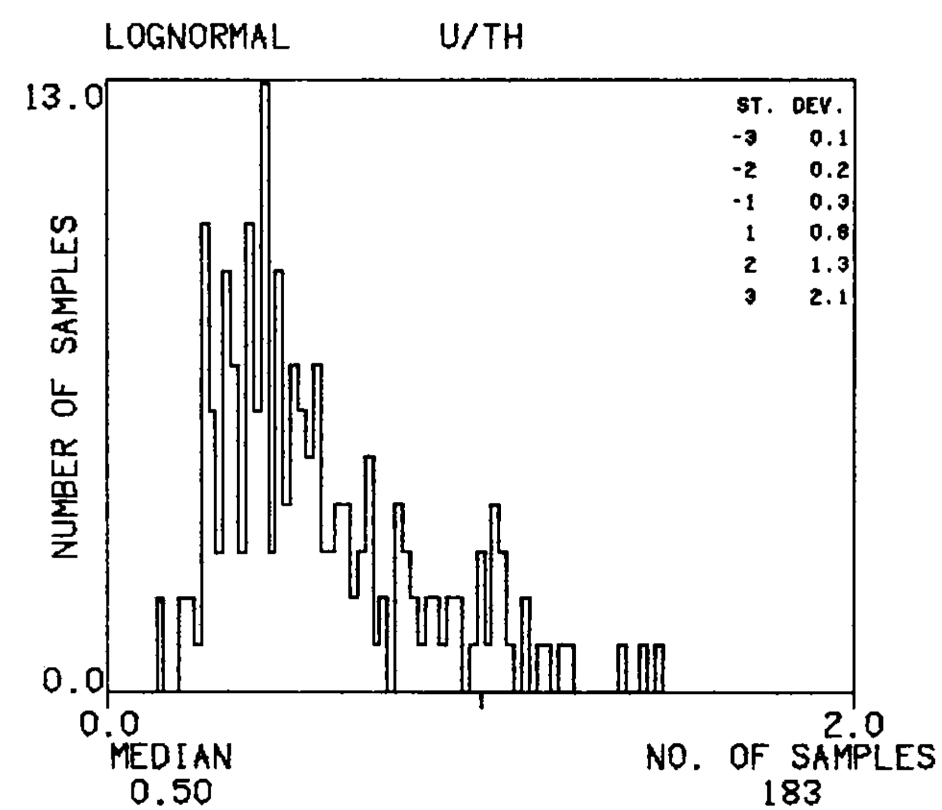

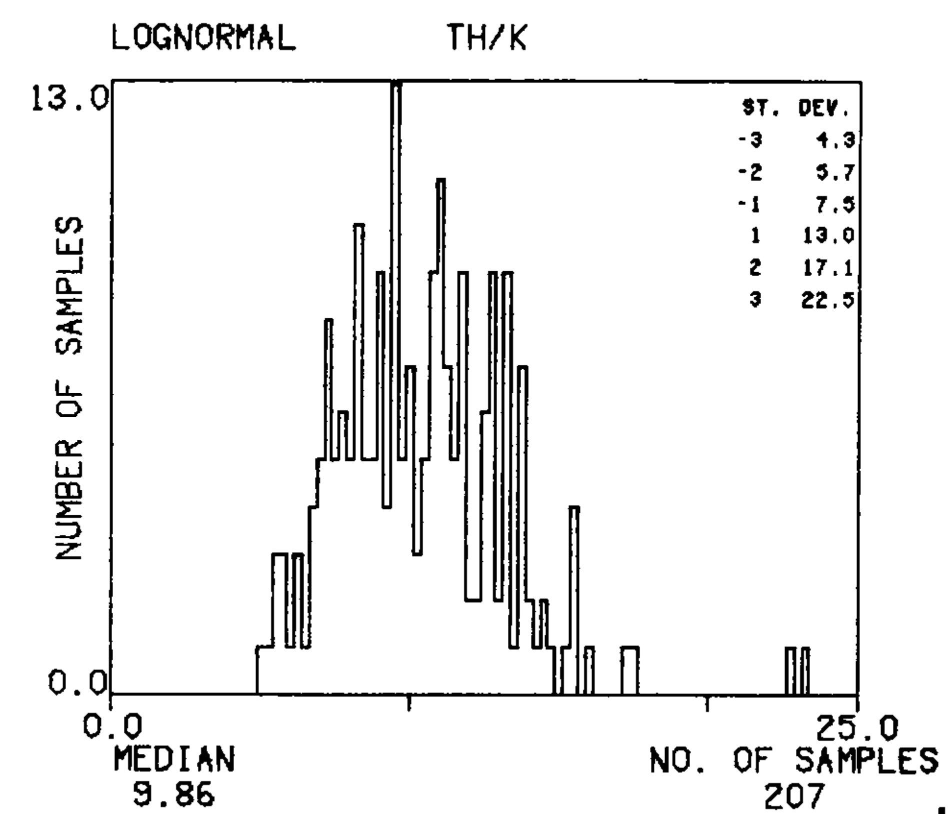

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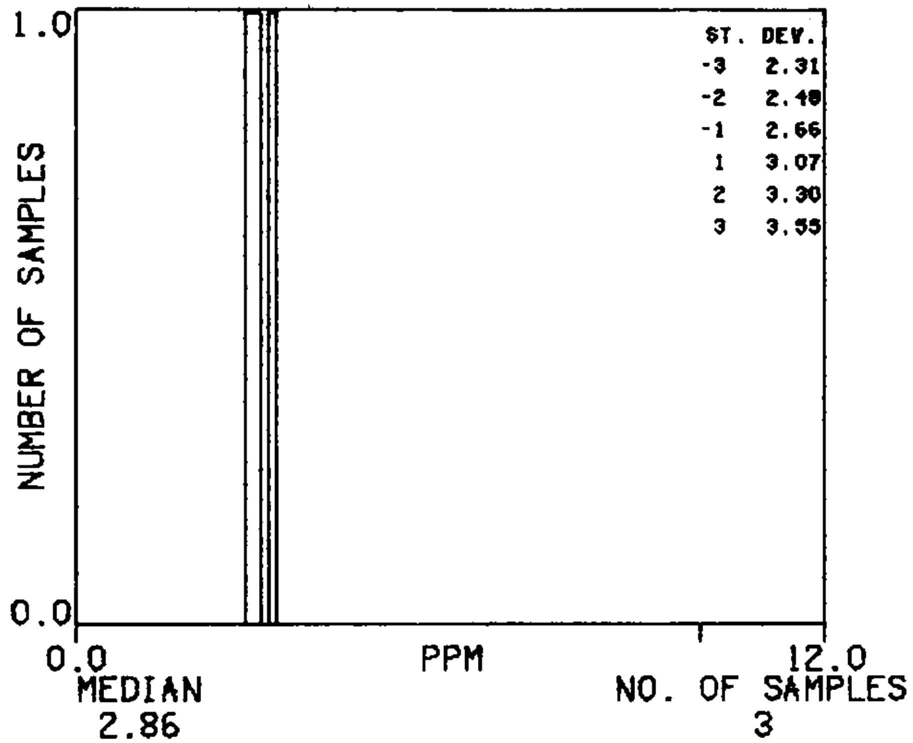
TEXAS INSTRUMENTS INC POPLAR BLUFF NJ15-12 TEXAS-KENTUCKY SURVEY 1979

LOGNORMAL THORIUM



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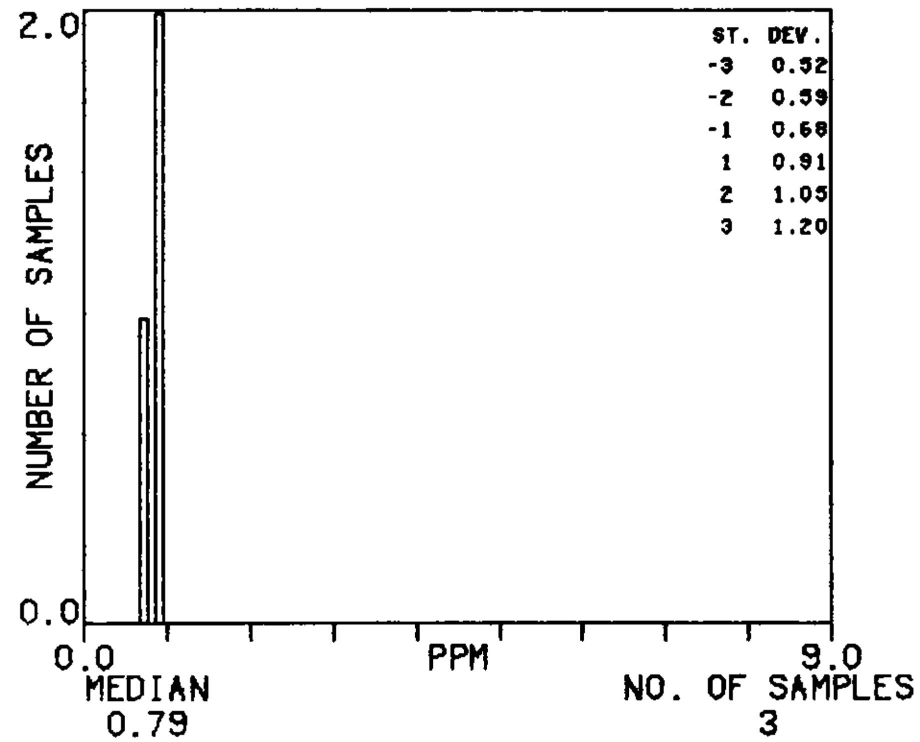

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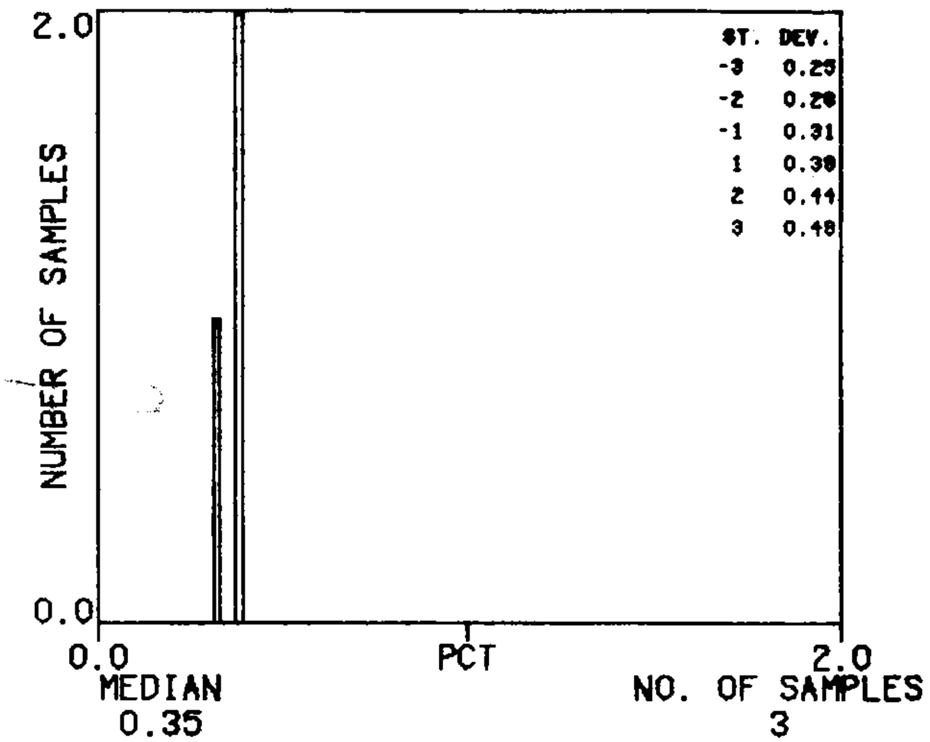

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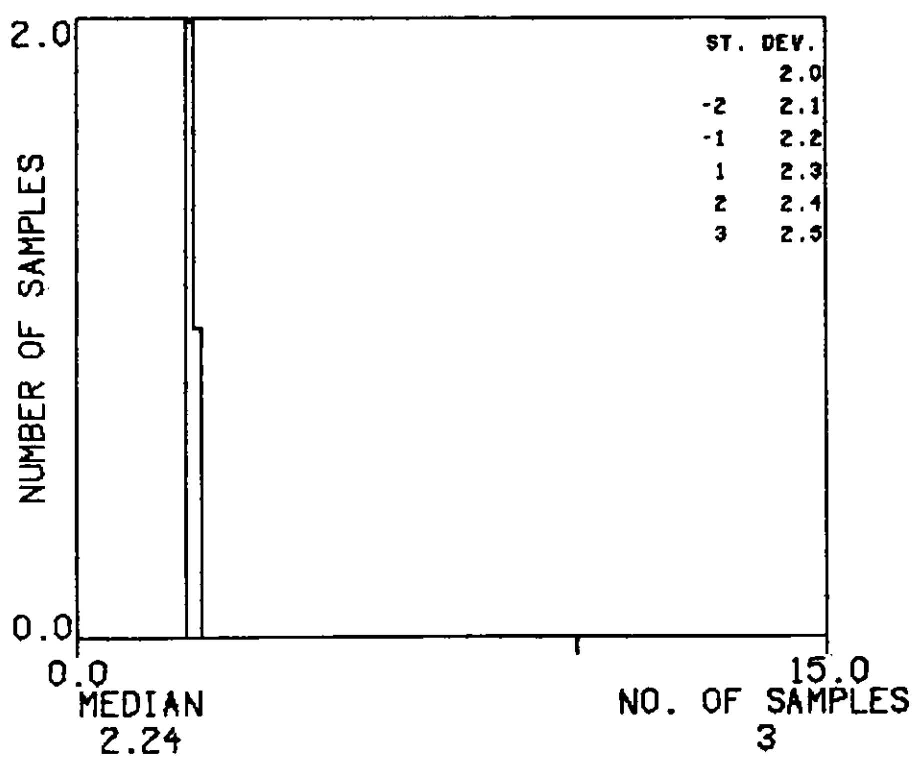

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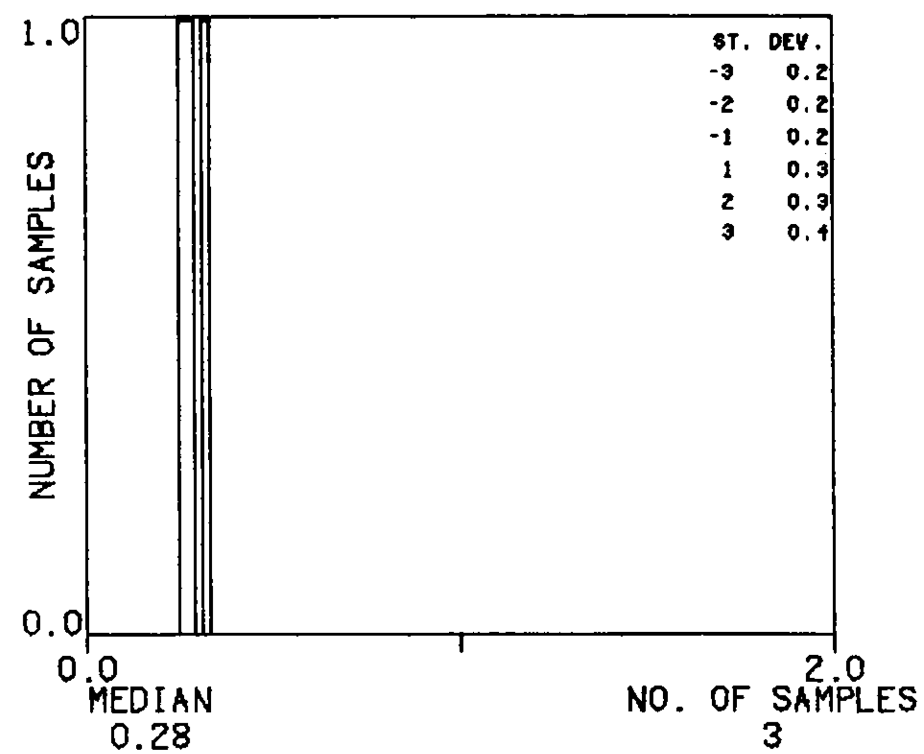

LOGNORMAL TH/K