GJBX-168 '80

NATIONAL URANIUM RESOURCE EVALUATION

AERIAL RADIOMETRIC AND MAGNETIC SURVEY

NATIONAL TOPOGRAPHIC MAP

SAN ANGELO

TEXAS

MASTER

FINAL REPORT

MAY 1980

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

UNDER CONTRACT NO. DE-AC13-76 GJO 1664

AND BENDIX FIELD ENGINEERING CORPORATION SUBCONTRACT NO. 80-418-S

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AERIAL RADIOMETRIC AND MAGNETIC SURVEY

SAN ANGELO NATIONAL TOPOGRAPHIC MAP

TEXAS

WEST TEXAS PROJECT

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE
GRAND JUNCTION, COLORADO

UNDER BENDIX FIELD ENGINEERING SUBCONTRACT NO. 80-418-S
BY
GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

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ABSTRACT

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the San Angelo National Topographic Map NH14-1 is presented in this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

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SECTION I

INTRODUCTION

SECTION I.

INTRODUCTION

A. SURVEY AREA

Geodata International, Inc., Dallas, Texas, conducted an airborne gamma ray and total magnetic field survey for the San Angelo National Topographic Map Sheet as outlined in Figure I.1. This survey was performed from a fixed-wing aircraft, using a computer-controlled, large-volume radiation detector system to detect the gamma radiation flux emanating from the surface materials. Each map line was flown in an east-west direction with line lengths of 118.0 miles; each tie line was flown in a north-south direction with line lengths of 69.0 miles. Map lines and tie lines are located as shown in Figure II.1.

Sections I through IV of this report present information and results associated with this specific survey. Section V gives the data acquisition and the processing procedures which are generally applicable to any survey flown with the equipment described.

B. SUMMARY OF MAP LOCATION, GEOLOGY AND PHYSIOGRAPHY

The San Angelo National Topographic Map Sheet (N.T.M.S., 1954) represents a portion of westcentral Texas. The area is bounded by latitudes 31°00' to 32°00' north, longitudes 100°00' to 102°00' west. The map area includes all, or part of, the following counties: Coke, Concho, Crockett, Glasscock, Irion, Menard, Midland, Reagan, Runnels, Schleicher, Sterling, Tom Green and Upton. (Figure I.2)

The map sheet area is located within the Central Texas, Edwards Plateau and High Plains sections of the Great Plains topographic province. Each section appears to have a discrete age and type of exposed rock associated with it.

The San Angelo map area is included within the Midland Basin portion of the Permian Salt Basin. The former structural element began control of sedimentation for the region during the Pennsylvanian period, and was subsequently buried by Cretaceous and Cenozoic deposition.

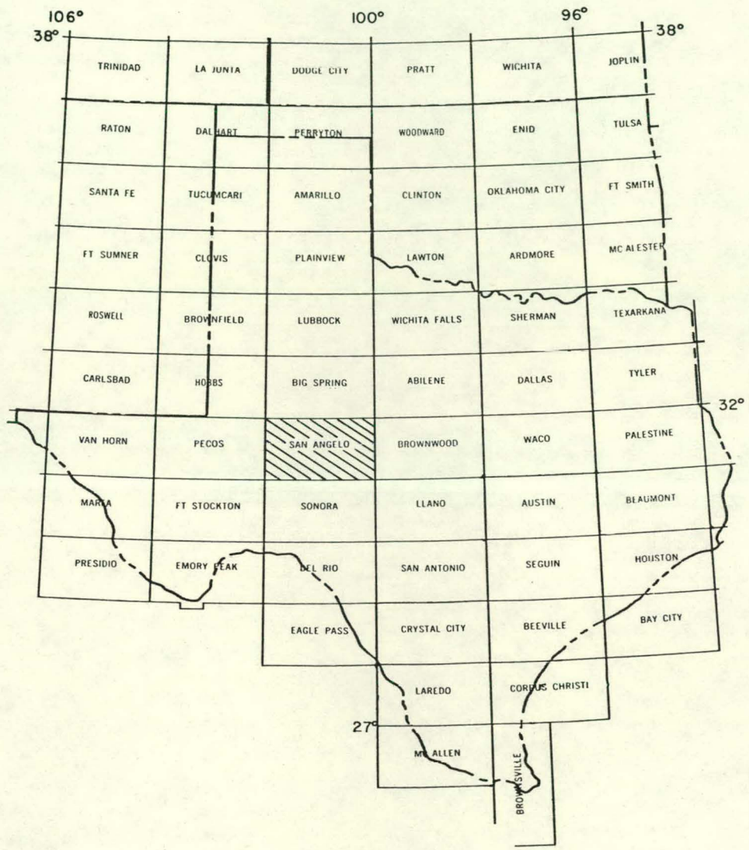
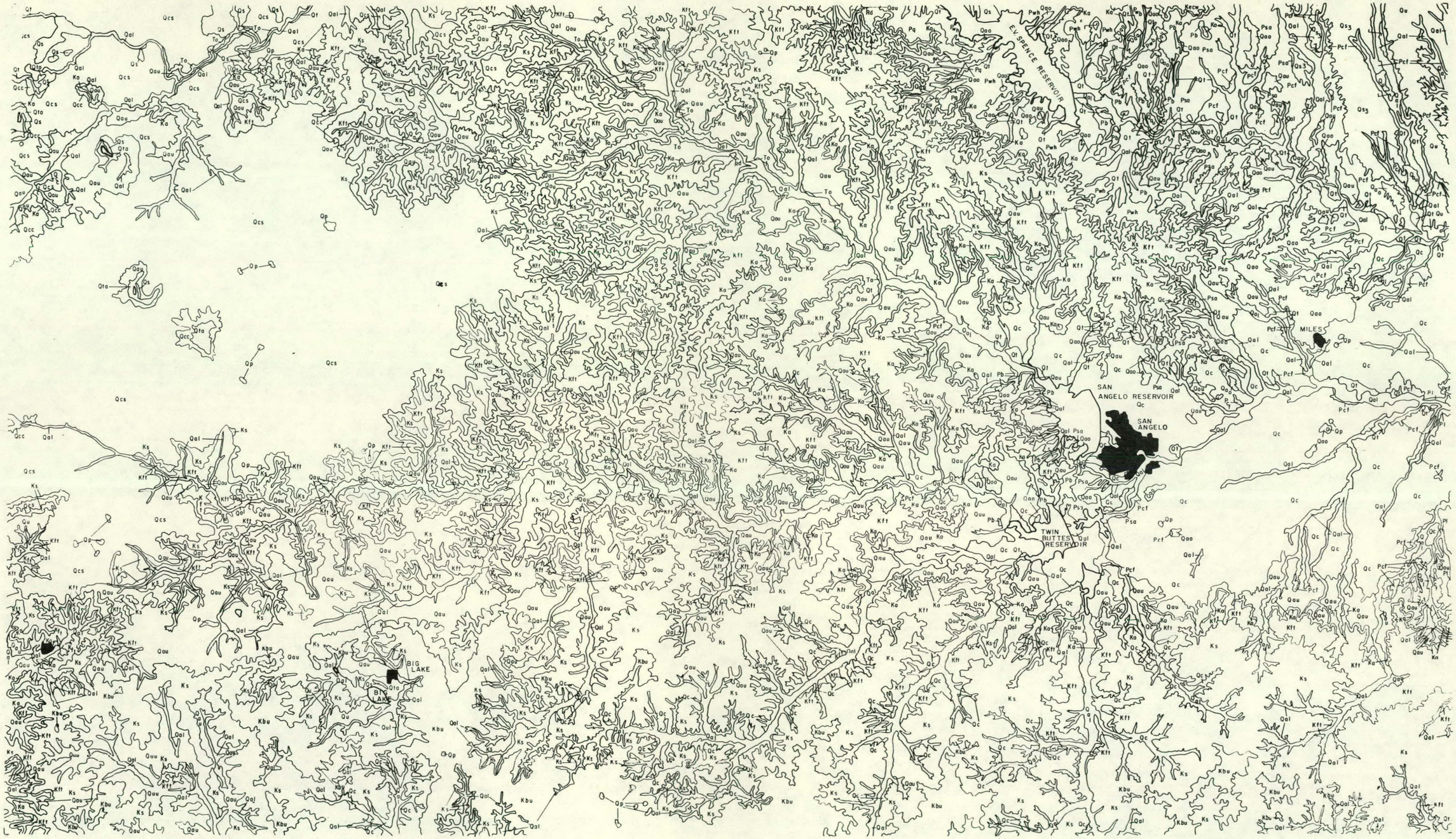


Figure I.1 Survey Index Map



GEODATA INTERNATIONAL, INC.
7033 JOHN ★ CARPENTER FRWY DALLAS, TEXAS 75247

NATIONAL GAMMA RAY MAP SERIES

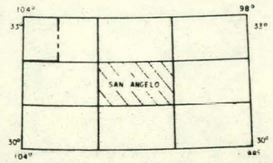
San Angelo, Texas

GEOLOGY BASE

REF. NTMS, NH 14-1

PREPARED FOR
U.S. DEPARTMENT OF ENERGY

I-3



N

Figure I.2 Geologic Base Map

5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETERS

SECTION II

FLIGHT OPERATIONS

SECTION II.

FLIGHT OPERATIONS

A. SURVEY TIME SUMMARY

The San Angelo map sheet was flown between March 30 and April 4, 1980. A detailed list of dates flown and lines flown on those dates, as well as average altitude and speed for those dates, appears in Appendix I.A.

B. LINE COORDINATE LOCATION

Doppler navigation system data have been used to locate the positions of the flight lines. These lines are positioned and verified by point locations, determined by visual sighting by the navigator or photographic recovery, and corresponding record numbers displayed by the on-board computer. The data are then plotted as solid lines with ticks every ten records, circles every fifty records, and record numbers every one hundred records. Record numbers and circles also appear at the end of each line. The points used for location reference (at least every 10 miles) are marked with an "X". The flight base is then photographed with the geologic base map to produce the composite map in Figure II.1.

C. TEST LINES

When conditions allow, two five-mile test lines are flown, one at the beginning of the day and one at the end of the day, over the same base. The data are used to check the repeatability of the system's measurements, and are presented in Appendix I.B.

D. MAGNETIC DIURNAL CORRECTION - BASE STATION

A base station magnetometer is set up in the area to acquire data pertaining to the diurnal changes in the magnetic field. These data are analyzed to evaluate a diurnal correction to the magnetic data obtained by the aircraft. A list of these corrections appears in Appendix I.C.

E. ALTITUDE AND GROUND SPEED SUMMARY

The average altitude and ground speed for each line is determined. A list by date appears in Appendix I.A, and is discussed in Section II.A. A list by flight line is given in Appendix I.E.

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NATIONAL GAMMA RAY MAP SERIES

San Angelo, Texas

FLIGHT BASE

REF. NTMS, NH 14-1
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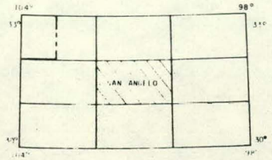


Figure II.1 NTMS Showing Flight Line Location

5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETERS

SECTION III

GEOLOGY OF THE SURVEYED AREA

SECTION III.

GEOLOGY OF THE SURVEYED AREA

A. LOCATION and GENERAL PHYSIOGRAPHY

The aerial radiometric and magnetic survey was conducted over a portion of westcentral Texas. The San Angelo National Topographic Map sheet area (N.T.M.S., 1954) is delimited by latitudes 31°00' to 32°00' north, longitudes 100°00' to 102°00' west. The survey area includes all or part of the counties of Coke, Concho, Crockett, Glasscock, Irion, Menard, Midland, Reagan, Runnels, Schleicher, Sterling, Tom Green, and Upton.

According to Fennman (1931), the San Angelo map sheet area is located within the Central Texas, Edwards Plateau and High Plains sections of the Great Plains topographic province. The Central Texas section is characterized as a plateau in maturity and later stages of erosion. The rocks associated with the region are typically Permian in age, and have a Quaternary rock cover. The Edwards Plateau region is described as a young plateau with a mature margin of moderate to strong relief, and it exposes Cretaceous-aged limestones and dolomite. The High Plains section is marked by broad, intervalley remnants of smooth, fluviatile plains, and Pleistocene-aged rocks predominate. The Colorado and Concho rivers flow through the map sheet area.

B. GEOLOGY

The structural and depositional history of the San Angelo map sheet area (Figure I.2) has been reported by Sellards et.al. (1932), Sellards and Baker (1934), Conselman (1960) and McGowen et.al. (1979), and these data are summarized in the following.

Paleozoic Era

The oldest exposed rock in the San Angelo region in westcentral Texas is the Leuders Formation (unit P1) of Permian age. This predominantly shaley unit was provided clastics from a land mass to the east-southeast. The Llanoria land mass is presumed to have uplifted several times during the Paleozoic.

The region in which the San Angelo map area is included was subjected to relatively mild downwarping during the Middle Pennsylvanian. A basin was formed as an antecedent to the Permian Salt Basin, and continued to subside throughout the Permian period.

Within the basin and presumably synchronous with basin formation, the relatively localized Pecos and Reagan uplifts were formed. The

former uplift or platform divides the southern Permian Basin into two subbasins. The eastern subbasin, termed the Midland Basin, includes the map sheet area.

Along with Leuders Formation deposition, chemical sedimentation occurred in the partially restricted basin throughout the Permian. A localized halt in subsidence of the Midland Basin produced an unconformable surface in some areas at the close of the Permian.

Mesozoic Era

The Mesozoic Era initially saw little change of structural features in the survey area. The continent continued to emerge. There was, however, renewed subsidence over those uplifted portions of the basin during the Upper Triassic to produce the Dockum Group.

The Permian Basin was then peripherally filled, receiving sediment from the east, south, and west. Lowlands to the east and west were transversed chiefly by meandering streams. Higher gradient streams with flashy discharge existed over the southern part of the basin. Chief sediment sources were Paleozoic sedimentary rocks (McGowen et.al., 1979).

By Late Mesozoic, Paleozoic structural features were covered by Cretaceous sedimentation during encroachment of the Late Cretaceous sea. Subsequent regression meant the relative removal of these sediments over the High Plains region of Texas. The streams reversed their flow direction to flow gulfward. The approximate present-day order of land forms in the region become established.

Cenozoic Era

The history of the Cenozoic Era records a series of transgressions and regressions of the sea. Facies relationships are reportedly quite complicated due to relatively abrupt lateral as well as vertical change in sediment type. The predominant environment of deposition for Cenozoic-aged deposits was terrestrial, and included lacustrine, fluviatile, colluvial, and aeolian deposition. Structural elements in the Midland Basin region are partly obscured by evaporite solution resulting from Cenozoic surface drainage (McGowen et.al., 1979).

C. DESCRIPTION of GEOLOGIC MAP UNITS

The following brief descriptions of the outcropping units in the San Angelo map sheet area are given, based on descriptions from Henderson (1928), Page and Adams (1940) and the Army Map Service (1974). Thicknesses are reported where known.

Cenozoic Era

Quaternary

Qal: Alluvium

Floodplain deposits. The unit includes low terrace deposits near floodplain level, localized deposits of bedrock in the stream channels and localized deposits of well-cemented, limestone- and chert cobble-conglomerate.

Qs: Windblown Sand

Comprised of sand and silt which form sheets. It locally includes cover sand.

Qau: Quaternary Deposits, Undivided

Undistinguishable deposits of alluvium and unit Qao in dissected areas. Includes caliche locally covered by silt in gently sloping areas.

Qc,Qcc: Caliche and Gravel Deposits

In the eastern portion of the map, the unit Qc forms partly alluviated flats above the level of fluviatile terraces. The deposit is partly stream cut, mostly soil covered. In the western portion, the unit Qcc represents caliche devoid of covering materials. Total thickness of both units is no greater than 15 feet.

Qu: Pleistocene Surficial Deposits, Undivided

In the eastern portion of the map, the unit is comprised of sand, clay, caliche and gravel. It may include older terrace remnants, lag gravel, residual soil and colluvium commonly cemented by caliche. In the central and western portions of the map, the unit consists of brown and greyish-brown silty sand and sandy silt deposited as broad, gently sloping sheets produced mainly by sheetwash action.

Qt: Fluviatile Terrace Deposits

The unit contains gravel, sand and silt clastics. The gravel is comprised of pebbles and cobbles of chert, quartzite, igneous rock, metamorphic rock and caliche. Toward the upper limit of the unit, abraded *Gryphaea* fossils predominate. The sand constituent is characterized as a quartz sand with cross-bedded to massive, lenticular beds. The unit is reddish-brown, pink, grey to light-grey in color.

Qp: Playa Deposits

Comprised of light-grey clay and silt. In shallow depressions, the unit is typically covered by a thin deposit of Recent sediment of Wisconsonian age.

Qs3: Seymour Formation

The unit predominantly consists of limestone pebbles, reworked from Cretaceous outcrops, that are angular to moderately well-rounded. The deposits have a caliche cement and are elongate in the direction of slope and wedge-shaped in cross-section; deposited by high-gradient streams. The thickness ranges from 5 to 40 feet. Probably equivalent to the unit Qao.

Qao: Quaternary Deposits

This unit is predominantly comprised of boulders, cobbles, and pebbles of Cretaceous limestone and chert. Locally overlain by brown silt.

Qta: Tahoka Formation

Lacustrine clay, silt, sand, and gravel, locally calcareous and selenitic. The clay and silt subunits are sandy and indistinctly bedded to massive and weakly coherent. Various shades of light-grey and bluish-grey in color. The sand is characteristically a fine- to coarse-grained quartz sand, and it is indistinctly bedded to massive. It is friable, grey in color, and grades to a gravel at the margins of the deposits. Molluscan and vertebrate fossils are present in the unit. Up to 25 feet thick.

Qcs: Windblown Cover Sand

Contains fine- to medium-grained quartz. The unit is silty, calcareous, massive, contains caliche nodules, and is greyish-red in color. It has a distinct soil profile. Maximum thickness is approximately 15 feet; feathers out locally.

Tertiary

To: Ogallala Formation

Comprised of fluviatile sand, silt, clay, and gravel capped by caliche. The sand is a fine- to medium-grained, quartz sand which are moderately silty and calcareous. The upper portion of the sand unit is clayey with clay balls; it is indistinctly bedded to massive, cross-bedded, unconsolidated to weakly cohesive, with localized quartzite lenses. Various shades of grey and red. The silt and clay constituents are associated with caliche nodules;

the subunits are reddish-brown, dusky red, and pink in color. The gravel is not present throughout the formation. Where present, it is predominantly quartz with some quartzite, sandstone, limestone, chert, igneous rock, metamorphic rock, and weathered *Gryphaea* in intraformational channel deposits and in basal conglomerate. The caliche is sandy, hard, and pisolitic at the top of the sequence. Fossil plants and vertebrates are scarce. Maximum thickness is 50 feet.

Mesozoic Era

Cretaceous

Kbu: Buda Limestone

The limestone is aphanitic, compact, nodular, and bears many fragments of molluscs. Marly interbeds are present. Grey to yellowish-grey in color. The basal beds are typically a marly, nodular limestone and thin, yellow marl with scarce *Budaiceras* fossils. The remaining lower portion of the unit is 80 feet thick.

Ks: Segovia Formation

The unit is comprised of cherty limestone and dolomite. The limestone is miliolid, shell fragment and rudistid-bearing and light-grey in color. The dolomite is massive to thin-bedded, porous, and medium brownish-grey in color. The lower portion of the unit contains miliolid limestone and marl, and marly limestone; it is light yellowish-grey in color, and contains *Exogyra texana* and oxytropidocerid ammonite fossils. The uppermost beds include one or more thick limestone units, each forming a prominent ledge or "caprock". Maximum thickness of the unit is 300 feet. Along with the unit Kft, unit Ks is included in the Edwards Group.

Kft: Fort Terrett Formation

This unit contains cherty limestone and dolomite. In the upper portion, the limestone is in part porcellaneous, aphanitic, in part miliolid, shell fragment, rudistid-bearing, and light- to dark-grey in color. The dolomite is a medium brownish-grey. In the lower portion, the limestone is argillaceous with thin shale interbeds; it is nodular and irregularly bedded to thick-bedded. Light-grey, greyish-yellow, and yellowish-brown in color. Marine megafossils are present. Thickness of the unit ranges from 120 to 140 feet.

Ka: Antlers Sand

Consists of sand, sandstone, conglomerate, siltstone, and localized quartzite. The sand, sandstone, and quartzite are characterized as fine- to coarse-grained quartz, locally argillaceous, poorly

bedded, moderately indurated to friable, and white, brown, light-grey, greyish-yellow, and pale purple in color. The basal conglomerate is comprised of white and pink quartz, black chert, and clay pebbles, with interbeds of coarse sand, ferruginous to slightly calcareous. The siltstone is thin-bedded, and grey and pink in color. The thickness ranges from 90 to 100 feet.

Triassic

Trd: Dockum Group

The unit contains terrestrial deposits of sandstone, clay, shale and conglomerate. The sandstone is fine- to coarse-grained quartz, micaceous, silty, thin-bedded to massive, cross-bedded and well-indurated. Greenish-grey and brownish-red in color. The clay is sandy, silty, and reddish-brown in color. The shale is sandy, locally calcareous, indistinctly bedded, and various shades of red, green, grey and yellow. Conglomerate containing various colored chert pebbles is common in the lower part. The basal conglomerate also contains quartz, sandstone slabs and petrified wood. Maximum thickness is 150 to 200 feet.

Paleozoic Era

Permian

Pq: Quartermaster Formation

Interbedded shale, siltstone, sandstone, gypsum and dolomite; various shades of red. The shale is silty, evenly bedded, with beds 2 to 4 inches thick; locally massive. The siltstone is sandy, well-indurated and red to orangish-red in color. The sandstone is silty, fine-grained, with frosted grains. A few gypsum and dolomite beds, 1 to 4 feet thick, are present. Maximum thickness is 450 feet.

Pwh: Whitehorse Sandstone and Cloud Chief Gypsum, Undivided

This unit is composed of sandstone, sand, shale, local conglomerate, gypsum, selenite, and dolomite interbedded. The sand and sandstone are fine-grained quartz, silty, locally gypsiferous, thin-bedded to massive, friable; orange-brown to various shades of red, mottled greyish-green. The shale is sandy in part, indistinctly bedded to massive, and red in color. The gypsum and selenite are thin-bedded to massive, in part banded with beds up to 12 feet thick. White and pink in color. The dolomite occurs as thin, discontinuous beds associated with gypsum; grey in color. Marine megafossils are scarce. Maximum thickness for the unit is difficult to determine, due to the width of the outcrop, but it is presumably 850 to 900 feet in thickness.

Pb: Blaine Formation

Comprised of shale, sandstone, gypsum, selenite and dolomite interbedded. The shale is silty and in part calcareous, selenitic, in part very thin-bedded, predominantly indistinctly bedded to massive, and various shades of grey, green and red. The sandstone is fine-grained quartz, silty, locally cross-bedded, moderately indurated, and red, yellow, brown and orange in color. The gypsum and selenite are thin-bedded to massive, contorted, and white, bluish-grey and pink in color. The dolomite is locally calcitic and argillaceous, sand scarce, locally oolitic, and beds a few inches to 3 feet in units up to 10 feet thick; it is various shades of grey, streaked with purple, pink and white. Asphaltite is recorded within the unit. Marine megafossils are rare. Thickness ranges from 150-175 feet.

Psa: San Angelo Formation

Deltaic sandstone, shale and conglomerate. The sandstone is composed of fine-grained quartz particles, and is thin-bedded to massive, cross-bedded, friable, and red, grey, yellow, brown in color. The shale is sandy in part, indistinctly bedded, and red and bluish-green in color. The conglomerate consists of dolomite and siliceous pebbles associated with sandstone. The upper contact of the formation is locally indefinite. Thickness ranges from 125 to 200 feet.

Pcf: Clear Fork Group

Shale and dolomite. The shale is the predominant constituent; it is sandy in part, and alternating red and bluish-green in color. The dolomite is thin-bedded to massive. Thickness of the unit is approximately 750 feet. Includes the Arroyo, Vale, and Choza formations.

Pl: Leuders Formation

The unit is comprised of limestone and shale, which alternate in units of 1 to 5 feet in thickness. The shale is the predominant constituent; it is calcareous and grey in color. The limestone is argillaceous, moderately hard to soft, and weathers to a very light-grey to white color. The uppermost portion of the formation is exposed only in the easternmost portion of the Concho River basin.

D. RADIOACTIVE MINERAL PROSPECTS in the SURVEYED AREA

The Southern Interstate Nuclear Board (1969) reports epigenic uranium mineralization from the lower members of the Triassic-aged Dockum Group (unit Trd) in the Midland Basin area. The deposits occur in red-bed channel sandstone units of approximately fifty feet in thickness.

Finch (1967) records uranium deposits in the sandstone constituent of the Clear Fork Group (unit Pcf). The unit contains plant material which might have served as an intrinsic reductant for uranyl ion concentration.

The vanadium oxysalts carnotite, tyuyamunite and metatyuyamunite are recorded (Southern Interstate Nuclear Board, 1969) from Upton County. The minerals occur in limestone, shale and sand from a slush pit.

SECTION IV

RESULTS OF DATA ANALYSIS

SECTION IV.

RESULTS OF DATA ANALYSIS

A. DESCRIPTION OF STACKED DATA PROFILES

1. Multivariable Radiometric Stacked Data Profiles

These profiles are presented at a horizontal scale of 1:500,000. The vertical scales are:

Altitude: 100 feet/div.; aircraft altitude above the surface

TL(^{208}Tℓ)* 1.5 ppm/div; 7.15 c/s = 1 ppm/eTh

BI(^{214}Bi)* .5 ppm/div; 13.52 c/s = 1 ppm/eU

K (^{40}K)* .25 %/div; 98.06 c/s = 1%K

BiAir 5. c/s/div. .5 seconds averaged

Residual Magnetic Field 20 gammas/div. (See Sec.V.B.1)

GC (Count from 400 keV to 3.0 MeV) 400 c/s/div.

Bi/TL .05 /div.

Bi/K .4 /div.

TL/K .75 /div.

Geology Strip: An approximate six-mile width of the geology map, containing each line, is displayed above the profiles.

* 7-second average weighted 1:2:3:4:3:2:1 is used and plotted at center.

2. Residual Magnetic Field Profiles

Altitude: 100 feet/div.

Temperature: 1 ^{o}C/div.

Pressure: 3 mm of Hg/div.

Base Magnetic Field: 10 gammas/div.

Residual Magnetic Field: 10 gammas/div.

Geology Strip: An approximate six-mile width of the geology map, containing each line, is displayed above the profiles.

All profiles appear in Section IV.H.

B. SINGLE AND AVERAGE RECORD LISTINGS

Single and average record listings are provided on microfiche. Samples of each type are presented in Appendix III.

C. STATISTICAL PRESENTATION OF DATA BY GEOLOGIC TYPE

Tables IV.(1-6) contain the average value of each variable as a function of line number and geologic type. The tables are in order eTh, eU, K, eU/eTh, eU/K, eTh/K.

D. FREQUENCY DISTRIBUTON OF DATA FOR EACH GEOLOGIC TYPE

Table IV.7 contains the mean, standard deviation, and number of events for each geologic type encountered over the entire map sheet. Histograms for these data appear in Section IV.H.2.

E. DATA INTERPRETATION

1. Analysis of Geologic Histograms

The radioactivity data is shown in histogram form with parts per million or percent plotted against number of events (Appendix I). The histograms for ^{208}Tℓ and ^{40}K were examined for conformity to a Gaussian curve. It is generally assumed that a geologic map unit, which encompasses a fairly homogeneous lithology, would have a unimodal distribution. Where map units vary significantly from a unimodal distribution, a further subdivision into more homogeneous lithologic types may be recommended. Table IV.8 shows the map units, which vary from a unimodal model, and for which separation of two or more distributions is feasible. Only units with excess of 200 events are considered.

2. Discussion of Anomalies

Introduction

The ^{208}Tℓ, ^{214}Bi, and ^{214}Bi/^{208}Tℓ (ratio) data were examined for anomalous values. An anomaly is defined by a minimum of two adjacent, two-standard deviation values, or a single, three-standard deviation value. The anomalies were listed by flight line in Table IV.9; by geologic map unit in Table IV.10; Table IV.10 is statistically summarized in Table IV.11. Only positive anomalies were examined for ^{208}Tℓ and ^{214}Bi, but both positive and negative values were studied for the ratio anomaly.

SAN ANGELO
TABLE: TL PPP X 10

UNIT: LINE	QAL	QS	QAU	QC	QCC	QU	QT	QP	QS3	QAO	QTA	QCS	TO	KBU	KS	KFT	KA	TRD	PO
ML 20:	64		53	63										74	46	49	30		
ML 40:	64		67	62										66	50	54			
ML 60:	62		68	71										63	50	41			
ML 80:	67		70	64		52								66	49	50			
ML 100:	67		66	58										66	48	44	49		
ML 120:	64	70	68	57										76	47	46	48		
ML 140:	70		70	72								74			54	46	52		
ML 160:	65		69	74		65						70			65	53	42		
ML 180:	72		59	76		65						78			64	48	54		
ML 200:	65		63	76						50		77			66	47	47		
ML 220:	66		59	74				66	67	67		75			67	47	45		
ML 240:	64		61	71	64			66	61	57		75			64	46	47		
ML 260:	63		56	64				73		49		75			74	44	50		
ML 280:	68		58	74	64			68	85	59	59	77			56	46	46		
ML 300:	64		63	73	72			59		80		77			72	46	46		
ML 320:	76	75	68	77					75	69	67	77	68		70	46	46		
ML 340:	71		79		57			74		64		76	66		59	42	44		
ML 360:	67		62			68		71		54		76			66	45	42		
ML 380:	69		66			66		66		64	64	67	71		66	47	45	64	
ML 400:	67	44	71		47	57		60	67	56	44	59	67		66	52	48		55
ML 420:	65		66		40	59		52	76	49		69	70		68	52	37		55
ML 440:	68	23	63			65		54		68		43	60		68	53	52		49
ML 460:	62	26	80			63		56		62		42	68		66	51	35	56	54
ML 5020:	70		69	80		57		66		57		61			51	64	67		
TL 5040:	65		69	77				62				59		71	49	53	57		
TL 5060:	64		55	65				56				48			46	40	48		
TL 5080:	63		59	61								51			59	40	47		47
TL 5100:	71		67	73									52	70	73	56	40	48	
TL 5120:	70		70	65					86				75	81	49	46	54		
TL 5140:	70		65									84	71	74	65	53			
TL 5160:	69		69	61		59						78		57	59	65			
TL 5180:	73	22	69		69				78		52	69	43		57	72			
TL 5200:	54	29	55		59							65		52	49	48			

SAN ANGELO
TABLE: TL PPK X 10

UNIT: LINE	PWR	PWH	PB	PSA	PCF	PL	UNK
ML 20:							
ML 40:							
ML 60:							
ML 80:							
ML 100:							47
ML 120:					57	67	
ML 140:					59	61	
ML 160:					59		
ML 180:			53	48	46		
ML 200:			62		61		43
ML 220:					47	45	48
ML 240:			51		60		
ML 260:				55	65		64
ML 280:				50	65		
ML 300:				62	78		
ML 320:			56	59	67		
ML 340:		59	72	63	68		
ML 360:		52	54	67	67		
ML 380:		56	61	52	62		
ML 400:		54	47	52	62		
ML 420:	55	54	49	58	61		
ML 440:	55	50	57	57	60		
ML 460:					72		
ML 5020:				61	67		
TL 5040:		56	64	50			
TL 5060:		52					
TL 5080:							
TL 5100:							
TL 5120:							
TL 5140:							
TL 5160:							
TL 5180:							
TL 5200:							

Table IV.1 Geologic Unit Average Value as a Function of Map Line for eTh (PPM Times 10)

SAN ANGELO
TABLE: RI PPM X 10

UNIT: LINE	QAL	QS	QAU	QC	QCC	QU	QT	QP	QS3	QAO	QTA	QCS	TO	KBU	KS	KFT	KA	TRD	PO
ML 20:	14		18	14										15	13	13	15		
ML 40:	16		16	14										14	13	14			
ML 60:	15		18	16										15	13	12			
ML 80:	15		19	15		17								17	13	13			
ML 100:	15		16	13										15	13	12	18		
ML 120:	17	19	18	13										16	13	12			
ML 140:	16		16	15								17			16	13	11		
ML 160:	16		16	13		18						18			17	16	11		
ML 180:	16		15	14		20						18			16	13	13		
ML 200:	16		15	15						10		19			17	16	12		
ML 220:	17		16	16			15	18		11		19			18	16	13		
ML 240:	17		16	16	19		13	15		15		19	—		17	15	14		
ML 260:	16		15	14			14			14		20			17	14	15		
ML 280:	14		15	15	24		16	16		14	20	18			16	14	14		
ML 300:	14		15	16	21		11			17		19			17	14	14		
ML 320:	18	18	17	18				19		14	16	18	14		19	14	14		
ML 340:	16		17		19			19	23	14		16	15		16	14	14		
ML 360:	15		15			14	15			10		18			15	13	12		
ML 380:	16		15			11	12		11	13	12	16	17		12	12	14	14	
ML 400:	15	7	16		14	14	14		12	13	16		18		15	15			14
ML 420:	15		16		11	10	13	11	10	12		12	16		17	16	14		13
ML 440:	17	5	16			12	12		14	10		11	20		16	14	15		14
ML 460:	15	6	16			12	14		14	10		10	17		17	14	13	14	13
ML 5020:	15		12	14		9	16		12	14					10	13	13		
TL 5040:	15		14	16			14			14				14	10	12	13		
TL 5060:	16		12	15			14			11					14	12	14		
TL 5080:	16		13	16						14				13	13	13	14		14
TL 5100:	15		16	14								14		15	13	12	13		
TL 5120:	16		17	16				14				15		15	13	13	14		
TL 5140:	14		16									19		15	16	16	16		
TL 5160:	15		17	15		14						19		15	17	16			
TL 5180:	18	6	18		21			20			23	17	16		18	17			
TL 5200:	16	6	16		22							15		18	18	19			

SAN ANGELO
TABLE: RI PPM X 10

UNIT: LINE	PWR	PWH	PB	PSA	PCF	PL	UNK
ML 20:							
ML 40:							
ML 60:							
ML 80:							
ML 100:							13
ML 120:							
ML 140:					14	11	
ML 160:					11	14	
ML 180:					11		
ML 200:			15	11	7		
ML 220:			12		12		11
ML 240:					13	18	12
ML 260:			18		13		
ML 280:				15	10		13
ML 300:				18	12		
ML 320:				13	18		
ML 340:			16	10	16		
ML 360:		15	18	14	12		
ML 380:		13	12	15	12		
ML 400:		14	16	10	13		
ML 420:		13	14	11	12		
ML 440:	16	14	12	13	14		
ML 460:	14	13	14	13	12		
ML 5020:					15		
TL 5040:				13	15		
TL 5060:		12	14	12			
TL 5080:		15					
TL 5100:							
TL 5120:							
TL 5140:							
TL 5160:							
TL 5180:							
TL 5200:							

Table IV.2 Geologic Unit Average Value as a Function of Map Line for eU (PPM Times 10)

SAN ANGELO
TABLE: K PC X 100

UNIT: LINE	QAL	QS	QAU	QC	QCC	QG	QT	QP	QS3	QAO	QTA	QCS	TO	KBO	KS	KFT	KA	TRD	PQ
ML 20:	104		97	107										113	67	64	52		
ML 40:	111		130	94										101	72	92			
ML 60:	100		132	114										105	74	59			
ML 80:	106		137	102		96								121	74	76			
ML 100:	112		125	90										117	73	65	93		
ML 120:	113	119	124	92										134	74	67	66		
ML 140:	125		126	121								124			94	70	77		
ML 160:	115		124	127		128						145			116	91	76		
ML 180:	131		106	127		122						158			117	80	87		
ML 200:	125		120	127						86		158			126	82	80		
ML 220:	124		103	121			127	158		82		152			126	76	71		
ML 240:	110		102	118	123		99	128		107		153			103	67	73		
ML 260:	106		91	105			121			95		153			118	64	68		
ML 280:	109		90	120	135		125	136		100	128	151			86	64	71		
ML 300:	106		104	111	138		85			114		151			118	67	68		
ML 320:	130	117	116	123				154		98	146	147	118		119	66	68		
ML 340:	129		124		112		145		114	105		148	103		93	60	64		
ML 360:	128		111			109	108			85		147			111	69	71		
ML 380:	136		118			87	151		90	73	125	133	141		102	70	75	123	
ML 400:	141	98	131		92	74	109		103	133	96	120	138		106	89	85		92
ML 420:	126		123		83	94	114	172	104	84		100	140		115	89	67		101
ML 440:	144	45	117			91	112		114	83		88	129		116	88	83		73
ML 460:	125	45	143			92	119		100	79		83	140		116	85	69	85	128
ML 5020:	116		107	127		74	111		85	87					69	96	93		
TL 5040:	126		108	130			119			98				91	63	72	89		
TL 5060:	108		96	122			102			115					61	59	90		
TL 5080:	110		103	115						89				102	86	57	74		94
TL 5100:	128		115	119									87	100	82	57	76		
TL 5120:	125		124	117				138					143	133	76	71	84		
TL 5140:	123		120									147	154	127	113	87			
TL 5160:	111		132	101		108						148		106	107	125			
TL 5180:	152	41	137		149			153			129	141	102		99	142			
TL 5200:	112	54	101		120							130		86	83	86			

UNIT: LINE	PWB	PWH	PB	PSA	PCF	PL	UNK
ML 20:							
ML 40:							
ML 60:							
ML 80:							
ML 100:							86
ML 120:							
ML 140:					94	91	
ML 160:					86	94	
ML 180:					87		
ML 200:				122	99 71		
ML 220:				152	88		67
ML 240:					69	65	75
ML 260:				140	100		
ML 280:					75 120		88
ML 300:					90 107		
ML 320:					85 128		
ML 340:				89	84 117		
ML 360:			158	201	99 118		
ML 380:			126	99	102 115		
ML 400:			149	157	105 107		
ML 420:			142	86	83 119		
ML 440:	116	136	91	94	117		
ML 460:	140	131	153	102	109		
ML 5020:					112		
TL 5040:					84 126		
TL 5060:		140	164	95			
TL 5080:		127					
TL 5100:							
TL 5120:							
TL 5140:							
TL 5160:							
TL 5180:							
TL 5200:							

Table IV.3 Geologic Unit Average Value as a Function of Map Line for K (PC Times 100)

SAN ANGELO
TABLE: RI/TL X 100

UNIT: LINE	QAL	QS	QAU	QC	QCC	QG	QT	QP	QS3	QAO	QTA	QCS	TO	KBO	KS	KFT	KA	TRD	PQ
ML 20:	23		37	24										22	30	29	52		
ML 40:	27		25	24										22	27	28			
ML 60:	25		28	24										26	27	32			
ML 80:	22		27	23		32								26	27	28			
ML 100:	24		25	23										24	29	29	36		
ML 120:	27	27	27	23										22	28	29	26		
ML 140:	23		23	21								24			31	31	24		
ML 160:	25		23	19		28						26			27	33	27		
ML 180:	24		26	19		31						24			25	29	25		
ML 200:	27		26	21					24			24			28	37	27		
ML 220:	27		26	22			23	21	23			25			27	38	31		
ML 240:	27		27	22	31		20	18	27			26			27	34	32		
ML 260:	26		28	23			20		28			27			23	35	32		
ML 280:	22		28	20	38		24	19	24		35	24			30	32	32		
ML 300:	22		24	22	30		19		21			25			28	32	32		
ML 320:	24	24	25	23				25	22		24	24	22		28	32	32		
ML 340:	23		25		33		25	30	22			24	22		28	34	34		
ML 360:	23		25			21	22		20			25			25	32	32		
ML 380:	24		25			21	19	20	28	36		25	25		24	33	34	23	
ML 400:	24	16	25		32	23	24	20	21	36		24	27		26	31	34		29
ML 420:	24		25		29	16	25	15	25			24	24		24	32	40		35
ML 440:	25	24	26			19	23		21	21		26	35		25	27	30		30
ML 460:	25	27	20			20	25		23	26		24	27		26	29	38	27	25
ML 5020:	22		17	18		17	25		22	24					20	21	20		
TL 5040:	23		24	21			29			25				20	20	23	27		
TL 5060:	25		23	24			27			24					33	31	32		
TL 5080:	25		24	27						28				20	24	38	29		30
TL 5100:	22		24	21									26	23	26	32	28		
TL 5120:	23		24	25				17					20	19	28	33	32		
TL 5140:	26		27										21	21	26	32			
TL 5160:	27		25	24			23						27	27	29	25			
TL 5180:	25	29	28		31			26			45	25	37		35	24			
TL 5200:	31	23	29		38							24		35	39	43			

UNIT: LINE	PWB	PWH	PB	PSA	PCF	PL	UNK
ML 20:							
ML 40:							
ML 60:							
ML 80:							
ML 100:							28
ML 120:							
ML 140:					25	17	
ML 160:					19	23	
ML 180:					20		
ML 200:				30	23 19		
ML 220:				21	19		28
ML 240:					29	40	25
ML 260:				35	22		
ML 280:				27	16		21
ML 300:				22	18		
ML 320:				22	24		
ML 340:			25	18	24		
ML 360:		26	25	24	18		
ML 380:		28	24	23	19		
ML 400:		25	29	30	21		
ML 420:		24	31	23	22		
ML 440:	18	25	25	23	23		
ML 460:	26	26	26	23	21		
ML 5020:					21		
TL 5040:				22	22		
TL 5060:		23	23	24			
TL 5080:		30					
TL 5100:							
TL 5120:							
TL 5140:							
TL 5160:							
TL 5180:							
TL 5200:							

Table IV.4 Geologic Unit Average Value as a Function of Map Line for eU/eTh (Times 100)

SAN ANGELO
TABLE: BI/K x 1000

LINE	UNIT:	QAL	QS	QAU	QC	QCC	QU	QT	QP	QS3	QAO	QTA	QCS	TO	KBU	KS	KFT	KA	TRD	PQ
ML	20:	1496		2237	1520										1471	2092	2209	3054		
ML	40:	1635		1382	1668										1539	1948	1811			
ML	60:	1635		1523	1543										1645	1972	2319			
ML	80:	1485		1527	1522		1813								1475	1883	1918			
ML	100:	1434		1394	1623								1452		1349	2065	2076	1965		
ML	120:	1582	1626	1523	1466								1314		1243	1914	2077	1977		
ML	140:	1315		1344	1293								1190			1919	2126	1653		
ML	160:	1453		1333	1114		1439						1201			1640	2123	1559		
ML	180:	1329		1496	1177		1676						1283			1433	1852	1558		
ML	200:	1425		1432	1278						1437		1308			1565	2323	1682		
ML	220:	1520		1569	1394			1271	1163		1375		1308			1516	2506	2150		
ML	240:	1704		1685	1386	1613		1409	1196		1508		1326			1743	2463	2118		
ML	260:	1628		1834	1455			1230			1554		1235			1527	2583	2521		
ML	280:	1606		1848	1285	1841		1316	1203		1422	1656	1299			2018	2417	2353		
ML	300:	1362		1494	1499	1592		1390			1524		1261	1334		1542	2316	2311		
ML	320:	1450	1596	1531	1517				1270		1572	1128	1269	1539		1710	2336	2242		
ML	340:	1320		1497		1717		1347		2015	1421		1269			1847	2479	2491		
ML	360:	1279		1424			1373	927			1200		1209			1652	2150	2018		
ML	380:	1268		1398			1382	857		1358	1780	1558	1296	1351		1610	2104	2094	1206	
ML	400:	1196	748	1259		1582	1900	1358		1305	987	1672	1271	1359		1664	1947	2029		1785
ML	420:	1251		1436		1423	1071	1254	691	1068	1577		1208	1264		1593	1981	2343		1437
ML	440:	1208	1248	1482			1451	1184		1295	1319		1325	1607		1479	1725	2101		2084
ML	460:	1250	1632	1167			1371	1251		1501	1428		1258	1475		1547	1891	2239	1985	1251
ML	5020:	1353		1157	1184		1330	1479		1521	1749					1532	1412	1518		
TL	5040:	1246		1332	1256			1540			1707				1637	1652	1785	1582		
TL	5060:	1558		1427	1310			1480			1088					2497	2207	2013		
TL	5080:	1499		1400	1445						1677				1447	1726	2705	1920		1556
TL	5100:	1251		1415	1350									1605	1738	1856	2298	1867		
TL	5120:	1324		1447	1469				1068					1092	1179	1907	2207	2259		
TL	5140:	1550		1549									1251	1296	1227	1572	2015			
TL	5160:	1526		1371	1521		1311						1249		1499	1683	1360			
TL	5180:	1246	1760	1449		1451			1356			1841	1238	1593		2163	1231			
TL	5200:	1578	1292	1697		1926							1233		2264	2440	2541			

SAN ANGELO
TABLE: BI/K x 1000

LINE	UNIT:	PWB	PWH	PB	PSA	PCF	PL	UNK
ML	20:							
ML	40:							
ML	60:							
ML	80:							
ML	100:							1613
ML	120:							
ML	140:					1546	1236	
ML	160:					1337	1544	
ML	180:					1401		
ML	200:			1330	1240	1056		
ML	220:			873		1338		1844
ML	240:					2080	2816	1684
ML	260:			1345		1351		
ML	280:				2071	913		1550
ML	300:				1538	1170		
ML	320:				1697	1500		
ML	340:			1592	1268	1424		
ML	360:		983	943	1537	1122		
ML	380:		1217	1365	1577	1150		
ML	400:		980	1172	1546	1267		
ML	420:		976	1742	1490	1209		
ML	440:	937	1050	1394	1536	1342		
ML	460:	1040	1048	1001	1356	1217		
ML	5020:					1391		
TL	5040:				1704	1259		
TL	5060:		1043	907	1350			
TL	5080:		1270					
TL	5100:							
TL	5120:							
TL	5140:							
TL	5160:							
TL	5180:							
TL	5200:							

Table IV.5 Geologic Unit Average Value as a Function of Map Line for eU/K (Times 1000)

SAN ANGELO
TABLE: TL/K x 1000

LINE	UNIT:	QAL	QS	QAU	QC	QCC	QU	QT	QP	QS3	QAO	QTA	QCS	TO	KBU	KS	KFT	KA	TRD	PQ
ML	20:	6418		5844	6252										6624	7120	7550	5804		
ML	40:	5966		5341	6786										6728	7278	6138			
ML	60:	6507		5328	6336										6269	7123	7116			
ML	80:	6504		5373	6434		5497								5515	6931	6819			
ML	100:	5773		5411	6724										5715	6969	7142	5333		
ML	120:	5963	5910	5684	6408										5726	6639	7158	7509		
ML	140:	5736		5684	5976											6102	6843	6887		
ML	160:	5757		5695	5856		5151									5807	6243	5606		
ML	180:	5594		5695	6011		5299									5632	6221	6954		
ML	200:	5277		5429	6019						5867					5372	6054	6008		
ML	220:	5539		5870	6138			5288	5493		5808					5464	6538	6660		
ML	240:	6049		6089	6100	5195		6732	6342		5467					6299	7137	6556		
ML	260:	6074		6404	6209			6090			5644					6388	7252	7702		
ML	280:	6336		6462	6229	4827		5454	6254		5882	4646				6586	7381	6925		
ML	300:	6234		6172	6687	5259		7088			7051					6140	7041	7046		
ML	320:	5867	6603	5999	6465				4920		7086	4578				5997	7275	7033		
ML	340:	5609		5836		5187		5178		6581	6257					6511	7180	7164		
ML	360:	5357		5751				4186			6350					6070	6687	6243		
ML	380:	5231		5606			6275	6722	4467		6221	4350				6545	6278	6195	5180	
ML	400:	4869	4532	5557		5131	7408	5596		6494	4278	4641				4927	4933	5178		6091
ML	420:	5253		5513		4968	6350	4897	4461	6433	6054					5017	5108	5997		5558
ML	440:	4906	5412	5560			7239	5008		5997	6113					5013	4644	5953		6892
ML	460:	5139	5963	5623			6895	4784		6288	5369					5161	5218	5779		4629
ML	5020:	6162		6581	6358		7820	6160		6804	7155							7579	7060	
TL	5040:	5293		6487	5926			5285			6851				7879			8010	7419	6522
TL	5060:	6071		6033	5422			5576			4417							7567	6939	6197
TL	5080:	5832		5836	5354						5865				7035			7112	7153	6577		5186
TL	5100:	5601		5927	6353										7420			7067	7214	6456		
TL	5120:	5808		5825	5748				6236						6159			6849	6612	6896		
TL	5140:	5744		5610											5851			5888	6180			
TL	5160:	5502		5324	6135		5489								5470			5681	5319			
TL	5180:	4824	5811	5147		4696			5172			4083						5979	5138			
TL	5200:	5031	5501	5604		4984									6282			6108	5847			

SAN ANGELO
TABLE: TL/K x 1000

LINE	UNIT:	PWB	PWH	PB	PSA	PCF	PL	UNK
ML	20:							
ML	40:							
ML	60:							
ML	80:							
ML	100:							5551
ML	120:							
ML	140:					6140	6905	
ML	160:					6874	6582	
ML	180:					7050		
ML	200:			4532	5229	5696		
ML	220:			4159		6943		6671
ML	240:					7043	6968	6597
ML	260:			3784		6128		
ML	280:				7451	5501		7293
ML	300:				6754	6276		
ML	320:				7474	6164		
ML	340:			6358	7105	5893		
ML	360:		3910	3673	6385	5950		
ML	380:		4231	5943	6717	5955		
ML	400:		3851	3938	5094	5921		
ML	420:		3955	5624	6659	5475		
ML	440:	4856	4184	5563	6547	5743		
ML	460:	3931	3934	3805	6054	5661		
ML	5020:					6608		
TL	5040:				7621	5527		
TL	5060:			4260	3911	5447		
TL	5080:			4206				
TL	5100:							
TL	5120:							
TL	5140:							
TL	5160:							
TL	5180:							
TL	5200:							

Table IV.6 Geologic Unit Average Value as a Function of Map Line for eTh/K (Times 1000)

eTh		eU		K		eU/eTh		eU/K		eTh/K		MAX. NO. EVENTS	GEOL. UNIT
σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$		
1.3383	6.6	0.4265	1.6	0.3131	1.2	0.0739	0.2501	0.4672	1.4322	1.0183	5.7631	7888.0	QAL
1.3375	2.8	0.3784	0.7	0.2405	0.5	0.0975	0.2672	0.6961	1.5520	1.2209	5.8035	362.0	QS
1.4226	6.6	0.4906	1.6	0.3220	1.2	0.0811	0.2543	0.5144	1.4494	0.8742	5.7121	12310.0	QAU
1.2316	7.3	0.3474	1.5	0.2230	1.2	0.0586	0.2176	0.3860	1.3272	0.8109	6.1260	7003.0	QC
1.2485	6.1	0.4991	2.0	0.2733	1.2	0.0795	0.3241	0.3700	1.6069	0.6163	5.0075	327.0	QCC
0.9917	6.0	0.4513	1.4	0.2156	0.9	0.0817	0.2299	0.4377	1.4791	1.1567	6.6347	640.0	QU
1.1876	6.2	0.3806	1.5	0.3022	1.2	0.0620	0.2426	0.3853	1.2689	1.1135	5.7550	872.0	QT
0.7066	7.7	0.3232	1.9	0.1359	1.5	0.0500	0.2468	0.2222	1.2396	0.5982	5.0968	244.0	QP
1.2109	6.4	0.3474	1.3	0.2109	1.0	0.0684	0.2120	0.4505	1.3586	0.7774	6.4369	592.0	QOJ
1.5610	5.6	0.3693	1.3	0.2655	1.0	0.0751	0.2435	0.4724	1.4606	1.2111	6.0587	1332.0	QAO
0.9935	5.4	0.4909	1.9	0.2278	1.2	0.1175	0.3603	0.4894	1.6074	0.4484	4.5080	89.0	QTA
1.5434	7.1	0.4706	1.8	0.2964	1.4	0.0625	0.2518	0.2984	1.2693	0.5691	5.0863	12579.0	QCS
1.3827	6.6	0.4096	1.8	0.3134	1.3	0.0894	0.2791	0.4411	1.4138	0.8429	5.1236	409.0	TO
1.6191	7.9	0.3610	1.6	0.2854	1.1	0.0757	0.2329	0.5165	1.4842	1.0264	6.4165	3871.0	KBU
1.5814	5.5	0.4592	1.5	0.3300	0.9	0.0971	0.2796	0.7156	1.9588	1.2708	6.6860	15565.0	KS
1.3710	4.8	0.3975	1.5	0.2916	0.8	0.1117	0.3249	0.8592	2.1817	1.2348	6.7072	13178.0	KFT
1.2649	4.8	0.3806	1.4	0.2354	0.7	0.1151	0.3130	0.8471	2.0769	1.2283	6.6368	2696.0	KA
0.9975	5.9	0.2869	1.5	0.3019	1.0	0.0726	0.2583	0.8771	1.6816	1.7787	6.3267	82.0	TRD
1.0809	5.3	0.3330	1.4	0.3404	1.0	0.0864	0.2765	0.6213	1.5038	1.2950	5.3846	297.0	PQ
0.6880	5.5	0.3027	1.2	0.2683	1.3	0.0713	0.2221	0.3620	0.9853	0.7281	4.4263	43.0	PWH
1.0013	5.5	0.3370	1.4	0.3353	1.4	0.0827	0.2583	0.4292	1.0494	0.7919	4.0522	1139.0	PWH
1.1698	5.8	0.3804	1.5	0.4945	1.3	0.0718	0.2676	0.4495	1.2419	1.1576	4.6528	381.0	PB
0.9944	5.8	0.3567	1.3	0.2589	0.9	0.0682	0.2344	0.5161	1.5297	1.4460	6.5918	965.0	PSA
1.4055	6.7	0.4472	1.4	0.3154	1.2	0.0644	0.2193	0.4267	1.3092	1.0236	5.9939	1862.0	PCF
0.9481	6.0	0.4406	1.3	0.1734	0.9	0.0881	0.2293	0.5880	1.5486	0.6987	6.7732	44.0	PL
0.8737	4.7	0.2809	1.2	0.1558	0.7	0.0808	0.2719	0.5461	1.7558	1.3535	6.5556	180.0	UNK

Table IV.7 Mean ($\bar{X}$) and Standard Deviation (σ) for Each Geologic Type.

TABLE IV.8 Geologic Units with Apparent Significant Variations from Unimodal Distributions, Based on the Analysis of the eTh Histograms*

Geologic Unit	No. Events	^{208}Tℓ Recommended Split (equivalent ppm)
Qal	7888	none
Qs	362	none
Qau	12310	none
Qc	7003	none
Qcc	327	none
Qu	640	none
Qt	872	none
Qp	244	63,70,82,91
Qs3	592	none
Qao	1332	none
Qcs	12579	54
To	409	none
Kbu	3871	69
Ks	15565	none
Kft	13178	none
Ka	2696	none
Pq	297	none
Pwh	1139	none
Pb	381	none
Psa	965	none
Pcf	1862	none

*Recommended Splits on the Histograms are Given Only Where Such Splits Appear to be Obvious.

TABLE IV.9 SUMMARY OF ANOMALIES
SAN ANGELO

	208 TL	214 BI	214 208 BI/ TL
ML20			QAL 1093 QAU 1098- 1103 1113- 1118 KS 1136- 1163 KBU 1168 1178 KS 1253- 1258 1268 1328- 1438 1358 QAU 1388 1413 KS 1418- 1423 QAU 1428 KS 1433- 1438 KBU 1568- 1583 1623- 1628 KS 3193
ML40	KS 3675- 3685 3700- 3705 KFT 3850		KS 1810- 1815 QC 1845 2195 QAL 4160- 4165
ML60		QC 5820- 5825	KS 4320- 4330 4660- 4665 QAL 4720 KBU 5565 6280 QAL 6495 6520- 6525
ML80	KFT 1051- 1061	KBU 3466- 3471	QC 1711 KS 2101 QC 2411 QU 3316- 3321 KBU 3466- 3476 KS 3701 3761 QAU 3986 KFT 3996- 4001
ML100		QAL 4086 KFT 4196- 4206 4216- 4221 KS 4826- 4831	KFT 4191- 4206 KS 4826- 4831 5721 6151- 6156 6191- 6196

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

	208 TL	214 BI	214 208 BI/ TL
ML100			KS 6381- 6396 6561
ML120		KBU 3203- 3213 QAL 3538- 3543 3558- 3563 QAU 3568- 3573 QAL 3578- 3583 3593- 3598	QC 1713 KBU 3198 KS 3323- 3328 QAL 3538- 3543 3558- 3563 QAU 3568- 3573 QAL 3578- 3583 3593 KFT 3988- 3998 QAU 3983
ML140	KFT 4939- 4944	KFT 4134- 4144 KS 4274- 4279	KS 5739- 5744 KFT 6059
ML160	KFT 2866- 2871 3626- 3636	KFT 3156- 3161 4036- 4041	QC 2151 KS 2336- 2341 2391- 2401 KFT 2511 QAL 4001- 4006
ML180		QC 6905- 6910	QAU 5570
ML200	KFT 3820- 3830	KFT 3065 3355- 3365 QAU 3390- 3395	QC (1300- 1305) 1890 QAU 1935- 1945 PH 2020 KFT 2050 QAU 2080 QAU 2250 QC 2420 KFT 2875 3065 QAL 3185 3225 KS 3350 QAU 3475 3505
ML220	KFT 4639- 4659 4714- 4724	KFT 5179 KS 5299 KFT 5439- 5444 QC 6939- 6944	KFT 4984- 4989 5379 5434- 5439 5934- 5944 KA 6424 QC 6779

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

	208 TL	214 BI	214 208 BI/ TL
ML220			QC 7014
ML240		QC 1026 1231- 1241 KFT 2881- 2886	QAU 2306 KA 2331 QAL 2396 KFT 2416 2921
ML260	KS 4955- 4965 QAL 5090- 5095 KS 5200- 5235 5380- 5386	QCS 4510- 4520	QCS 4510- 4525 QC 5130 QAL 5400 6690 KFT 5595- 5606 QC 5645 KFT 5960- 5970 QC 6820- 6825
ML280	KFT 2828- 2833		QAU 1793 QAU 2083- 2088 2353
ML300	KS 5217- 5227 QAU 6757- 6767	KS 5242- 5247	QCS 4442- 4447
ML320	QAU 1421- 1426 QS 2411- 2421 KFT 2626- 2631 QAL 2746- 2751 KS 2896- 2916	PCF 1126- 1136 QS 2411- 2421 KS 2816 KFT 2821- 2826 2836- 2846	KS 2816
ML340	QAU 5381- 5391 KFT 5401- 5406	KFT 5211- 5221 PCF 6841- 6846	KFT 6431 PSA (6601- 6606) PCF 6841- 6846 6871
ML360	KS 2196- 2201	KS 3211	QAL 2096 KFT 2476 KA 2726 KS 3211 QCS 3986- 3991
ML380	KA 5667- 5672 KS 6162- 6172	KFT 5242- 5247	QCS 4477- 4482 4507- 4517 QAU 4522 KA 6332- 6337 6412 PWH 6417

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

	208 TL		214 BI		214 BI/ 208 TL	
BL380					PWH	6427
					QAU	6732
BL400	QAU	3061- 3066	KS	2201- 2206	PCF	1071
	KFT	3196- 3201			KFT	2376
					KA	2796
					KS	2871- 2876
					QCS	3686
BL420	KFT	4845- 4850			QCS	(4200- 4205)
	KS	5745- 5760				4270
						4410- 4415
					QAU	5605
					KFT	6010
					QT	6260- 6265
					PCF	6900- 6905
BL440	KS	2238- 2243	QAL	3568	QCS	3553- 3558
		2263- 2273			QAL	3568
	KFT	2298- 2303			TU	3573
	KS	2413- 2418			QCS	3648- 3653
		2433- 2438				4043- 4048
		2458- 2463				
	KFT	3283- 3293				
		3358- 3363				
BL460	KFT	4797			QCS	(4617- 4622)
	QAU	5052- 5057				4677- 4682
		5172- 5182				4787
					QS3	6707
TL5020	KFT	1611- 1626				
	PCF	2546				
TL5040					QAU	3492
					QC	3817- 3822
TL5060	PWH	6162			QAL	4747
					KFT	5017
					QC	5247
					PWH	6007- 6012
TL5080	KS	1336- 1351	PWH	1091- 1096	KFT	1571
						1806
					QAU	2166

(...) DENOTES NEGATIVE ANOMALY

(TABLE IV.9 CONT'D)

	208 TL		214 BI		214 BI/ 208 TL	
TL5100	KS	2618- 2623			KS	1588
		2643- 2653			KFT	1763
		2663- 2673				2328
TL5120	KA	3104- 3109	KFT	2869- 2874	KFT	3189
	KFT	3289				3819
						3849
TL5140			KFT	5462- 5467	KS	5437
					KFT	5462- 5467
					QAU	5507- 5512
TL5160	KFT	1351- 1356	KS	1121- 1131	QAU	2001
				2101	KS	2101
				2431- 2436		
TL5180	KFT	3355- 3365	KS	2925	QAU	2785- 2790
		3410- 3415	QCS	4030- 4035		2810- 2815
					KS	2885
						2925- 2930
					QS	4390
TL5200			KS	5650- 5655	QCS	4435- 4440
			KFT	5660		4500
				5700	QAL	4800- 4805
				5715- 5720	KS	5650- 5655
					KFT	5660
						5740
					KS	5915- 5920
					QAU	5950
					KS	6035- 6040
						6050- 6060
					KBU	6120- 6125
					KS	6135

(...) DENOTES NEGATIVE ANOMALY

TABLE IV.10 RADIOACTIVITY ANOMALIES PER GEO-MAP UNIT
SAN ANGELO

GEO-MAP UNIT	208 TL	214 BI	214 BI/ 208 TL	
KA	2	0	6	
KAU	0	2	9	
KFT	22	19	32	
KS	19	12	38	
PA	0	0	1	
PCF	1	2	4	
PSA	0	0	0	(1)
PWH	1	1	3	
QAL	2	6	19	
QAU	2	0	5	
QAU	4	2	23	
QC	0	5	15	(1)
QCS	0	2	15	(2)
QS	1	1	1	
QS3	0	0	1	
QT	0	0	1	
QU	0	0	1	
TU	0	0	1	

(...) DENOTES NEGATIVE ANOMALY

TABLE IV.11 Statistical Summary of Radioactivity Anomalies per Geologic Period(s)

Geologic Unit	^{208}Tl	^{214}Bi	$^{214}Bi/^{208}Tl$
Quaternary			
No. of units w/anomalies	4	5	9
No. of anomalies	9	16	81 (3)
Tertiary			
No. of units w/anomalies	0	0	1
No. of anomalies	0	0	1
Cretaceous			
No. of units w/anomalies	3	3	4
No. of anomalies	43	33	85
Permian			
No. of units w/anomalies	2	2	4
No. of anomalies	2	3	8 (1)
Total Sample			
No. of units w/anomalies	9	10	18
No. of Anomalies	54	52	175 (4)

(...) denotes negative anomaly

Quaternary Geologic Units: Qal,Qao,Qau,Qc,Qcs,Qs,Qs3,Qt,Qu

^{208}Tl Anomalies

Approximately seventeen percent of all the ^{208}Tl anomalies recorded in the San Angelo map sheet area are found in the Quaternary units Qs, Qau, Qao and Qal. The Quaternary units comprise roughly 30% of the map sheet area. Given that the thorium ion is relatively insoluble in most surface waters and is rarely concentrated through chemical precipitation, these anomalies are probably not economically significant.

^{214}Bi and $^{214}Bi/^{208}Tl$ Anomalies

Roughly thirty-one percent of the ^{214}Bi anomalies and forty-six percent of the positive ratio anomalies are reported from the Quaternary units. There are six loci of coincident ^{214}Bi and ratio anomalies within the units: ML120, stations 3558-3563 (Qal), 3568-3573 (Qau), 3578-3583 (Qal), 3593 (Qal); ML260, stations 4510-4520 (Qcs); ML440, station 3568 (Qal). Three negative ratio anomalies (75% of all the negative ratio anomalies recorded) occur in units Qcs and Qc. Both Quaternary-aged anomalous types may be a function of intraunit changes in lithology, especially since the units appear to diverge from a unimodal geochemical distribution (Table IV.8).

Tertiary Geologic Unit: To

$^{214}Bi/^{208}Tl$ Anomaly

There is one positive ratio anomaly in the unit To, comprising one-half of a percent of all recorded positive ratio anomalies in the map sheet area. It is not considered to be significant.

Cretaceous Geologic Units: Ka,Kbu,Kft,Ks

^{208}Tl Anomalies

Approximately eighty percent of the ^{208}Tl anomalies are reported from the Cretaceous units, with the exception of the unit Kbu. Outcropping Cretaceous units make up roughly 60% of the map sheet area.

^{214}Bi and ^{208}Tl Anomalies

Sixty-three percent of the ^{214}Bi anomalies and forty-eight percent of the positive ratio anomalies occur in the Cretaceous units. There are ten points of geographical coincidence between ^{214}Bi anomalies and ratio anomalies: ML80, stations

3466-3471 (Kbu); ML100, stations 4196-4206 (Kft), 4826-4831 (Ks); ML200, station 3065 (Kft); ML220, station 5439 (Kft); ML320, station 2816 (Ks); ML360, station 3211 (Ks); TL5140, stations 5462-5467 (Kft); TL5160, station 2101 (Ks); TL5180, station 2925 (Ks). The Cretaceous units are predominantly marine chemical deposits. Where units are homogenous in character, radioactive ions may have epigenetically accumulated.

Permian Geologic Units: Pb,Pcf,Psa,Pwh

^{208}Tl Anomaly

Approximately four percent of the ^{208}Tl anomalies are found in the units Pcf and Pwh. These anomalies are not considered to be economically significant.

^{214}Bi and $^{214}Bi/^{208}Tl$ Anomalies

Roughly six percent of the ^{214}Bi anomalies and four percent of the positive ratio anomalies are recorded over the Permian units. One negative ratio anomaly is found in the unit Psa. There is one point of coincident ^{214}Bi and ratio anomalies: ML340, stations 6841-6846 (Pcf). These anomalous values are presumably not economically significant.

Trends

^{208}Tl Anomalies

The ^{208}Tl anomalies in the San Angelo map sheet area do not appear to be delimited into discrete clusters or groups. They are, for the most part, absent from the eastern portion of the map. In the western and central regions, the anomalies trend in a northeasterly direction.

^{214}Bi Anomalies

The ^{214}Bi anomalies are absent from the central portion of the map area.

$^{214}Bi/^{208}Tl$ Anomalies

There appears to be no specific pattern to the distribution of the ratio anomalies in the map sheet area, with the exception of the increased concentration of anomalies in the southwestern corner of the map. All three anomalous types are scarce to absent in the unit Qcs around the location of many small, intermittent lakes.

Relationship between Radioactivity Anomalies and Cultural Features in the Surveyed Area

Cultural features which may affect the radioactivity data recorded in the San Angelo map sheet area include the city of San Angelo and the towns of Miles, Bronte, Robert Lee, Sterling City, Big Lake and Rankin. Major bodies of water include the Nasworth and Big lakes and the San Angelo and Twin Buttes reservoirs. The Colorado and Concho rivers drain the map area, as well as do many intermittent creeks.

There is one positive ratio "anomaly" reported over the E.V. Spence Reservoir at ML420, stations 6205-6210. This "anomaly" is presumed to be the product of fluctuating water level in the reservoir.

Relationship between Radioactivity Anomalies and Known Radioactive Mineral Deposits

The Triassic-aged Dockum Group (unit Trd) is known to contain uranium deposits. The limited exposure of the Dockum Group in the northernmost portion of the San Angelo map sheet area contains no anomalous occurrences, however. A review of the radiometric profiles illustrates no high values for ^{214}Bi in the unit Trd.

3. Summary and Recommendations

The majority of ^{208}Tℓ, ^{214}Bi, and ratio anomalies reported from the San Angelo map sheet area are recorded over the exposed Cretaceous units and, to a lesser extent, over the Quaternary units. Of the Cretaceous units, Ks and Kft have both the greatest number of anomalous values and the greatest number of coincident anomalies.

According to the Southern Interstate Nuclear Board (1969), control on uranium mineralization for the region is sedimentologic. It is suggested that the anomalous values for the Cretaceous units may be a function of facies changes within the units. Where the intraunit lithology is relatively uniform, epigenetic concentrations of uranyl ions may have occurred.

F. NATIONAL GAMMA RAY MAP SERIES (NGRMS)

The geologic base has been photographically screened to allow emphasis of the flight line locations and of the information regarding data analysis. These maps are used as the base for presenting statistical information on the six variables:

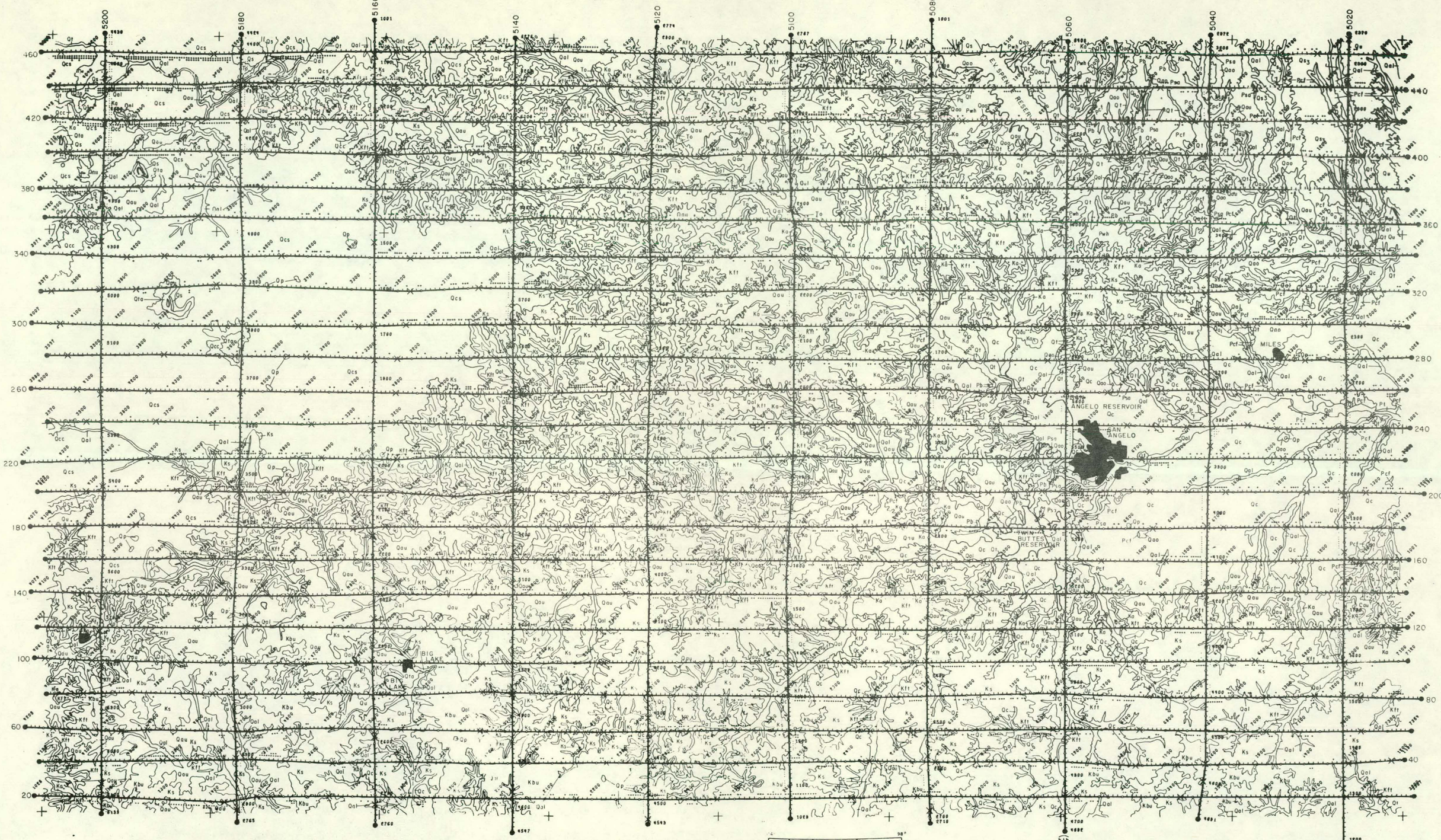
* ^{208}Tℓ
* ^{214}Bi
* ^{40}K
* ^{214}Bi/^{208}Tℓ Ratio
* ^{214}Bi/^{40}K Ratio
* ^{208}Tℓ/^{40}K Ratio

The six NGRMS sheets are presented in Figures IV. (1-6) of this report at a scale of 1:500,000 and as separate sheets at a scale of 1:250,000.

The statistical information is summarized on these maps through the utilization of one, two or three dots above or below the flight line at every fifth data point. One dot above the line indicates that the variable value at that point is between 1σ and 2σ greater than the mean value for that geologic type where σ values are determined for each geologic type based on all flight line data from the area, as is discussed further in Section V.B.4. Two dots indicate values between 2σ and 3σ, and three dots show values greater than 3σ. Dots below the line indicate the variable values which are less than the mean value by 1, 2 or 3σ in the same manner.

G. LINE PRINTER CONTOURS

Printer contours have been generated at a 1:500,000 scale for seven variables (eTh, eU, K, eU/eTh, eU/K, eTh/K, and RMag, respectively). They appear in Appendix IV. Note that every alternate contour interval is composed of blanks to help delineate contour boundaries. Dots are used where the denominator value for a ratio is approaching zero, and to denote non-data areas.



GEODATA INTERNATIONAL, INC.
7035 JOHN W. CARPENTER FRWY DALLAS, TEXAS 75247

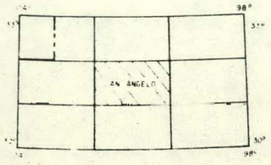
NATIONAL GAMMA RAY MAP SERIES

San Angelo, Texas

208T $\frac{A}{K}$ ± STANDARD DEVIATIONS

REF. NTMS, NH 14-1
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

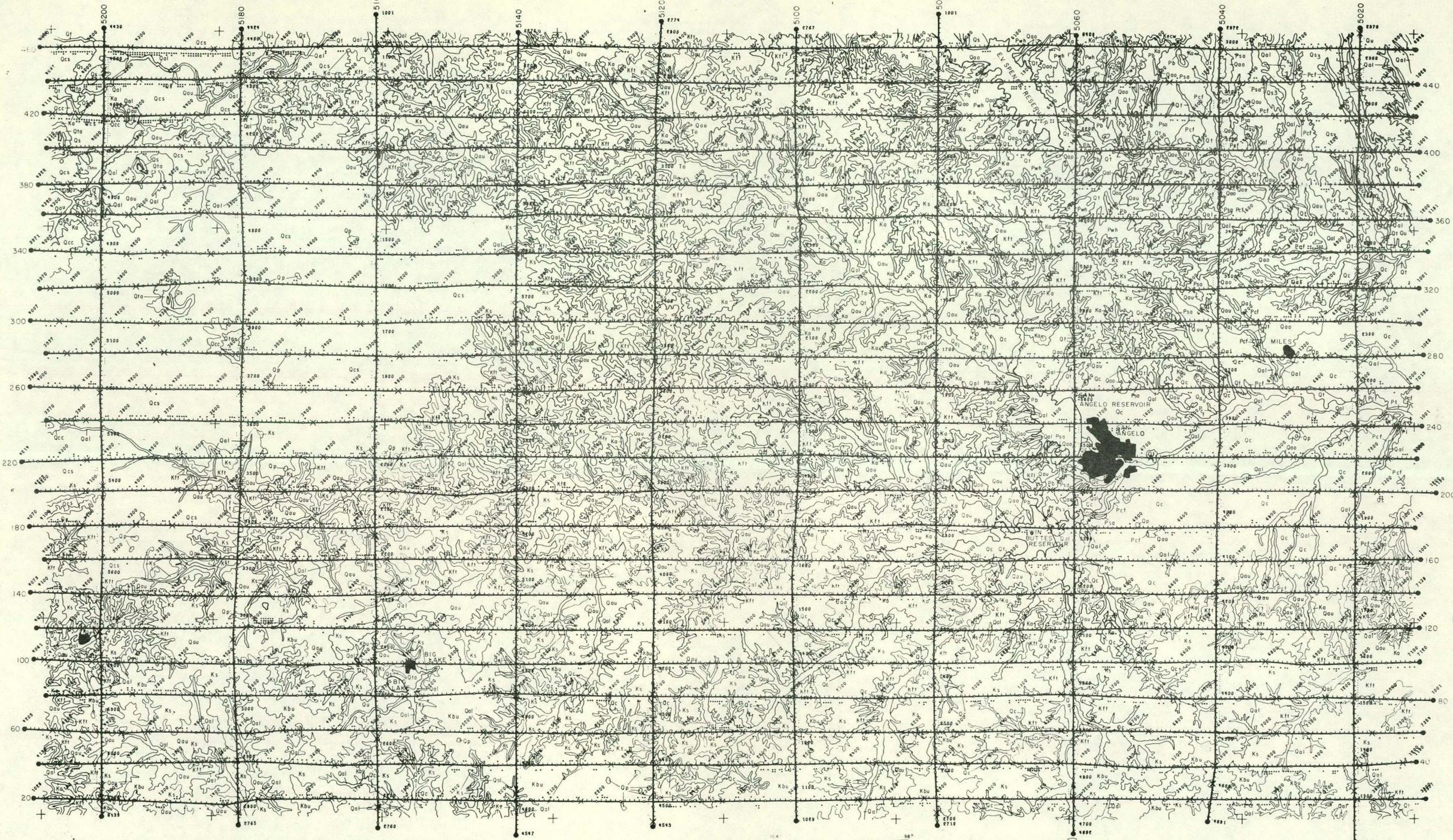
IV-18a



N

5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETERS

Figure IV.1 National Gamma Ray Map Series



GEODATA INTERNATIONAL, INC.
7015 JOHN W. CARPENTER FRWY DALLAS, TEXAS 75247

NATIONAL GAMMA RAY MAP SERIES

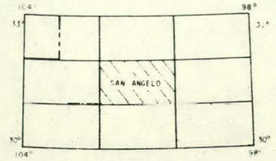
San Angelo, Texas

214 Di ± STANDARD DEVIATIONS

REF. NTMS, NH 14-1

PREPARED FOR
U.S. DEPARTMENT OF ENERGY

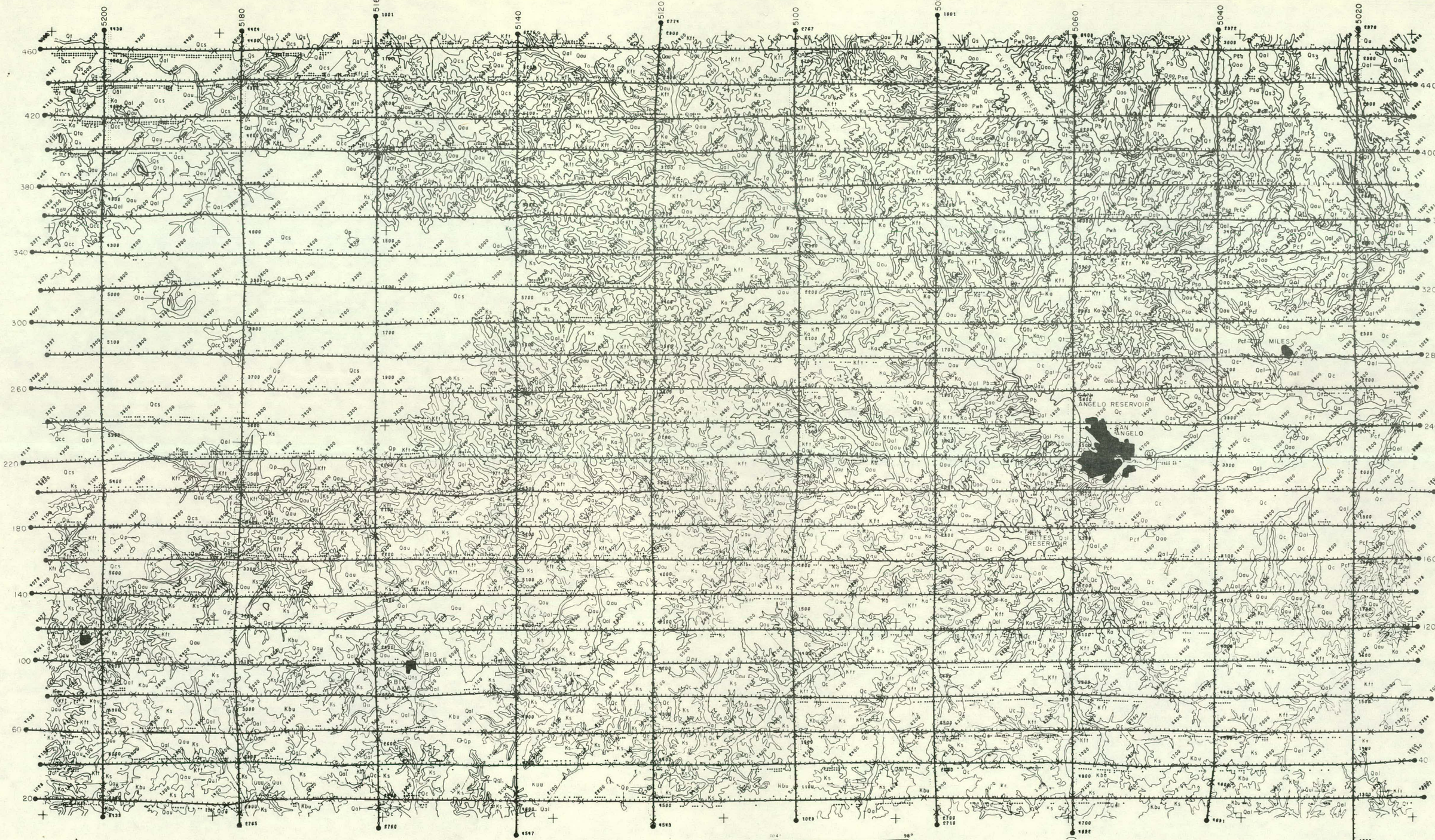
IV-18b



N

20 MILES
30 KILOMETERS

Figure IV.2 National Gamma Ray Map Series



GEODATA INTERNATIONAL, INC.
7035 JOHN W. CARPENTER FRWY DALLAS, TEXAS 75247

NATIONAL GAMMA RAY MAP SERIES

San Angelo, Texas

40K ± STANDARD DEVIATIONS

REF. NTMS, NH 14-1
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

IV-18c

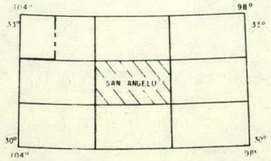


Figure IV.3 National Gamma Ray Map Series

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NATIONAL GAMMA RAY MAP SERIES

San Angelo, Texas

214Bi/208Tl STANDARD DEVIATIONS

REF NTMS, NH 14-1
PREPARED FOR
U S DEPARTMENT OF ENERGY

IV-18d

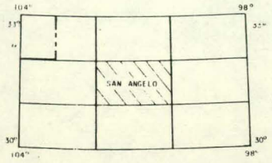
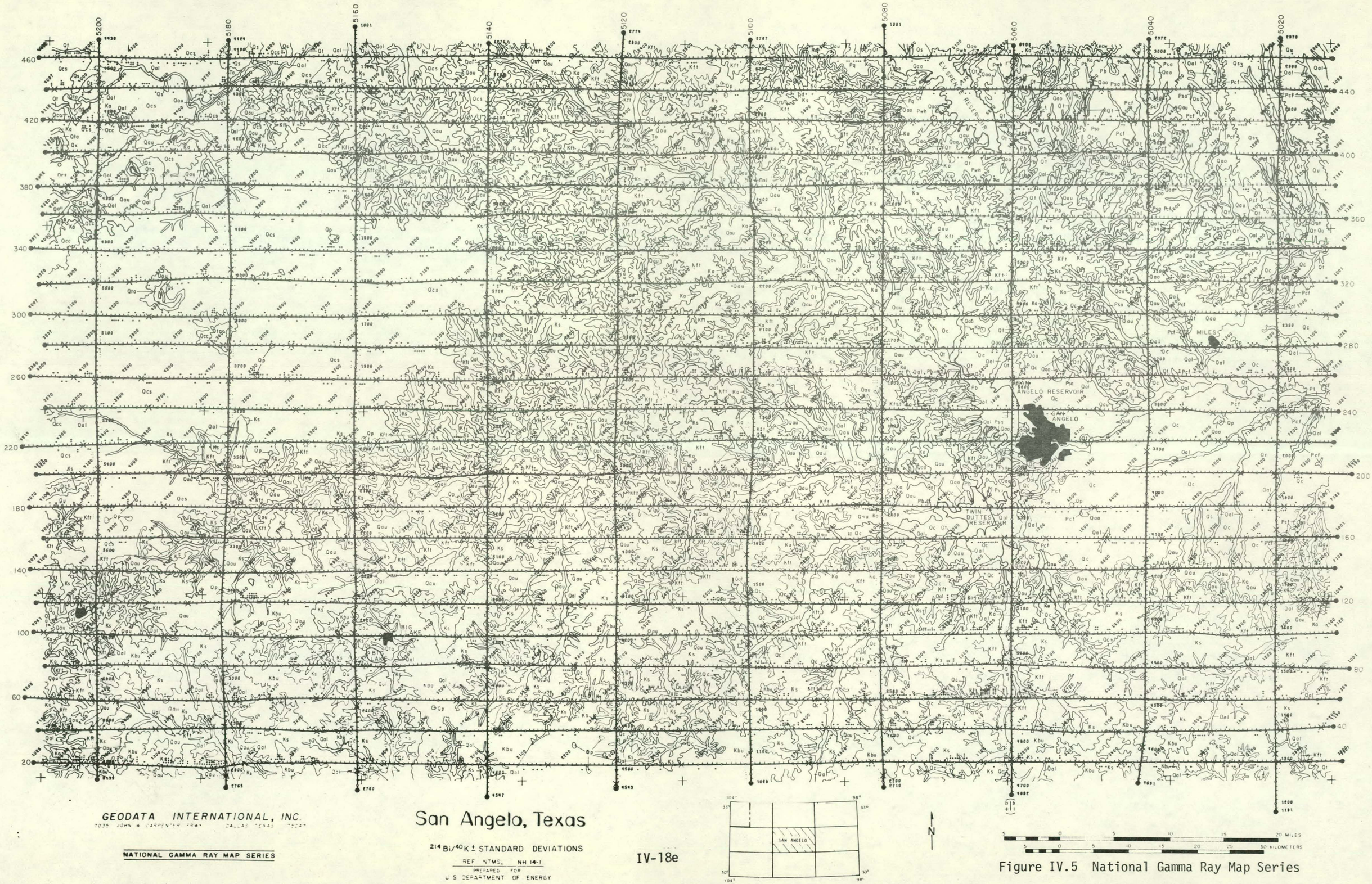


Figure IV.4 National Gamma Ray Map Series



GEODATA INTERNATIONAL, INC.

NATIONAL GAMMA RAY MAP SERIES

San Angelo, Texas

$^{214}Bi/^{40}K$ ± STANDARD DEVIATIONS

REFERENCE NTMS, NH 14-1

PREPARED FOR U.S. DEPARTMENT OF ENERGY

IV-18e

Figure IV.5 National Gamma Ray Map Series

GEODATA INTERNATIONAL, INC.
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NATIONAL GAMMA RAY MAP SERIES

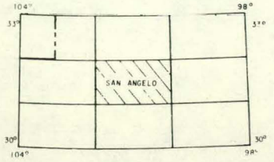
San Angelo, Texas

208Tl/40K ± STANDARD DEVIATIONS

REF. NTMS, NH 14-1

PREPARED FOR
U.S. DEPARTMENT OF ENERGY

IV-18f

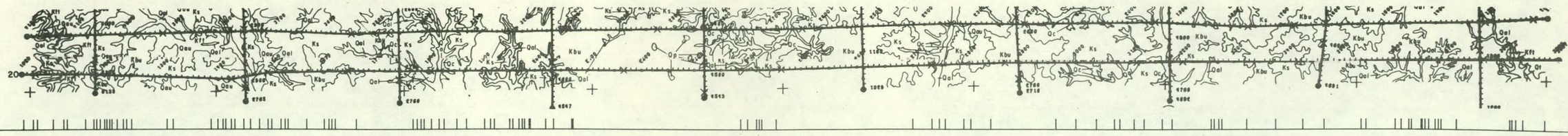


N

5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETERS

Figure IV.6 National Gamma Ray Map Series

H. STACKED DATA PROFILES AND GEOLOGIC HISTOGRAMS



TL/K
.75 /DIV

BI/K
.90 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

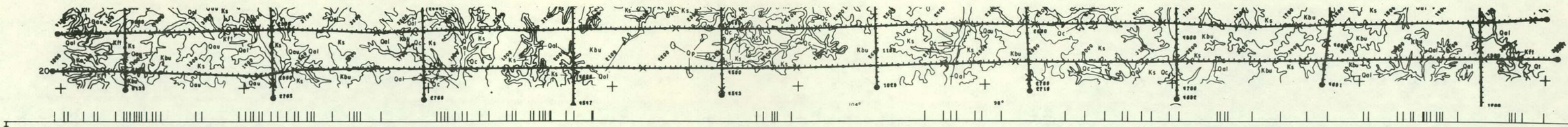
BI
.50 PPM/DIV

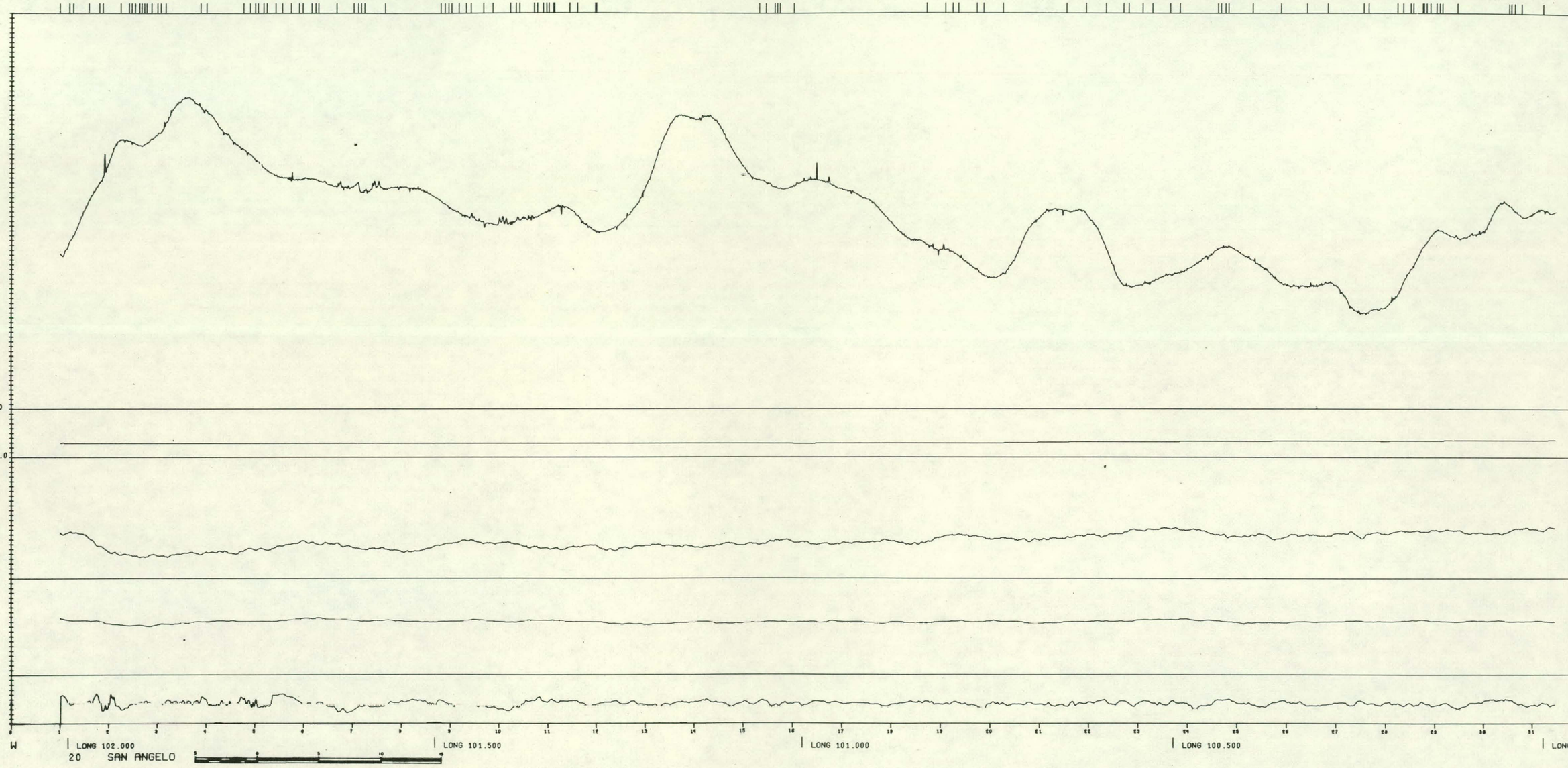
TL
1.5 PPM/DIV

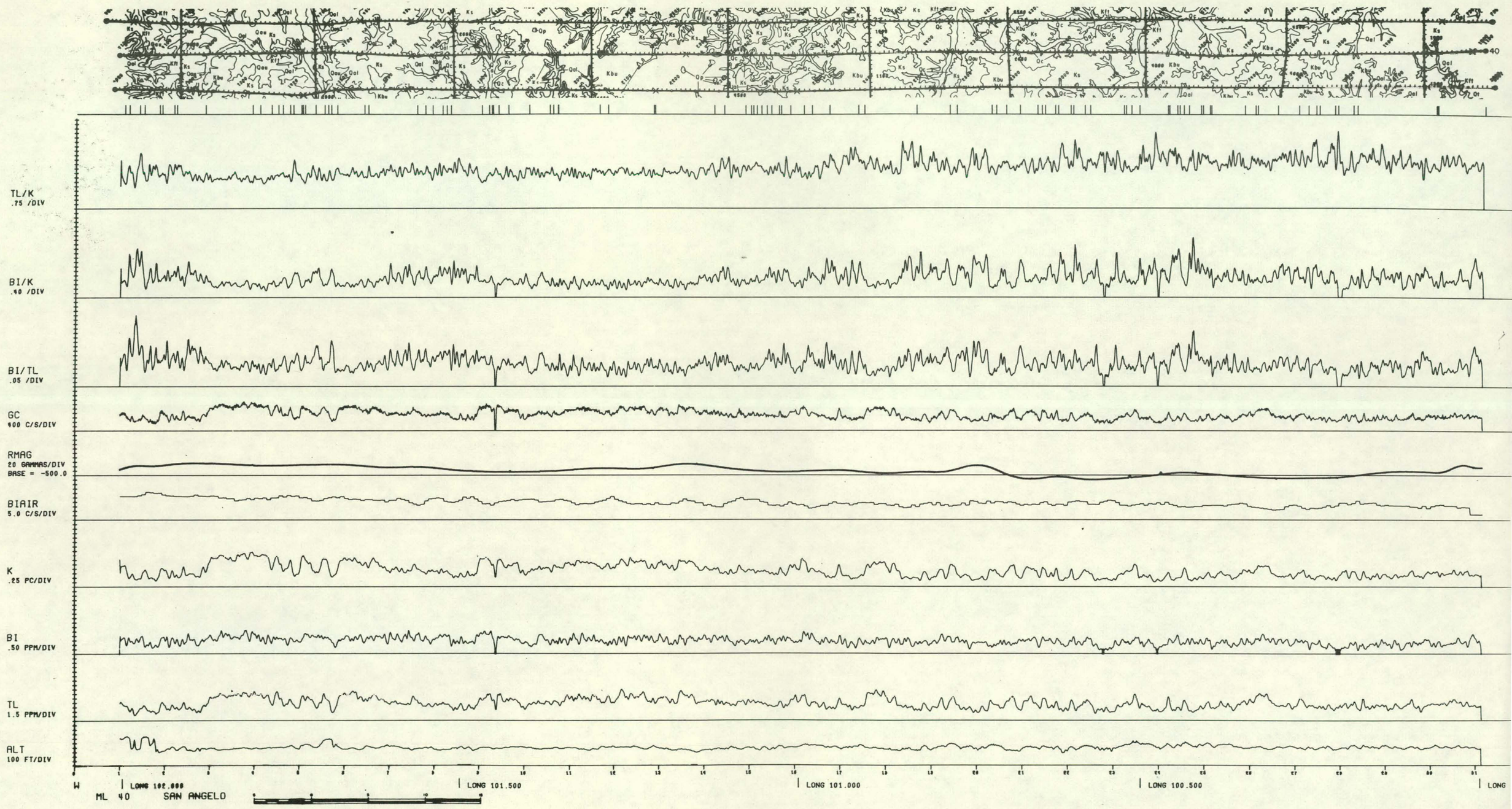
ALT
100 FT/DIV

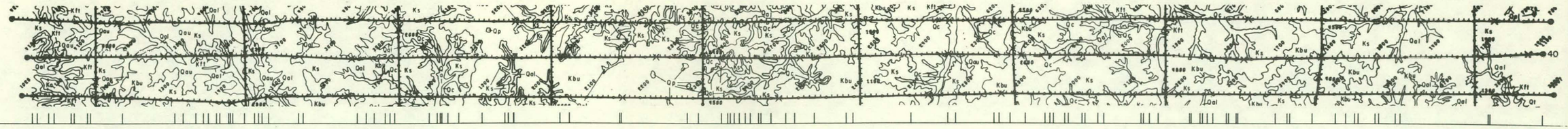
W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG 10

ML 20 SAN ANGELO




RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALI
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
20 SAN ANGELO


TL/K
.75 /DIV
BI/K
.40 /DIV
BI/TL
.05 /DIV
GC
400 C/S/DIV
RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
TL
1.5 PPM/DIV
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
LONG
ML 40 SAN ANGELO



RMAG
10 GAMMA/DIV
BASE = -800.0

BMAG
10 GAMMA/DIV
BASE = 51020.0

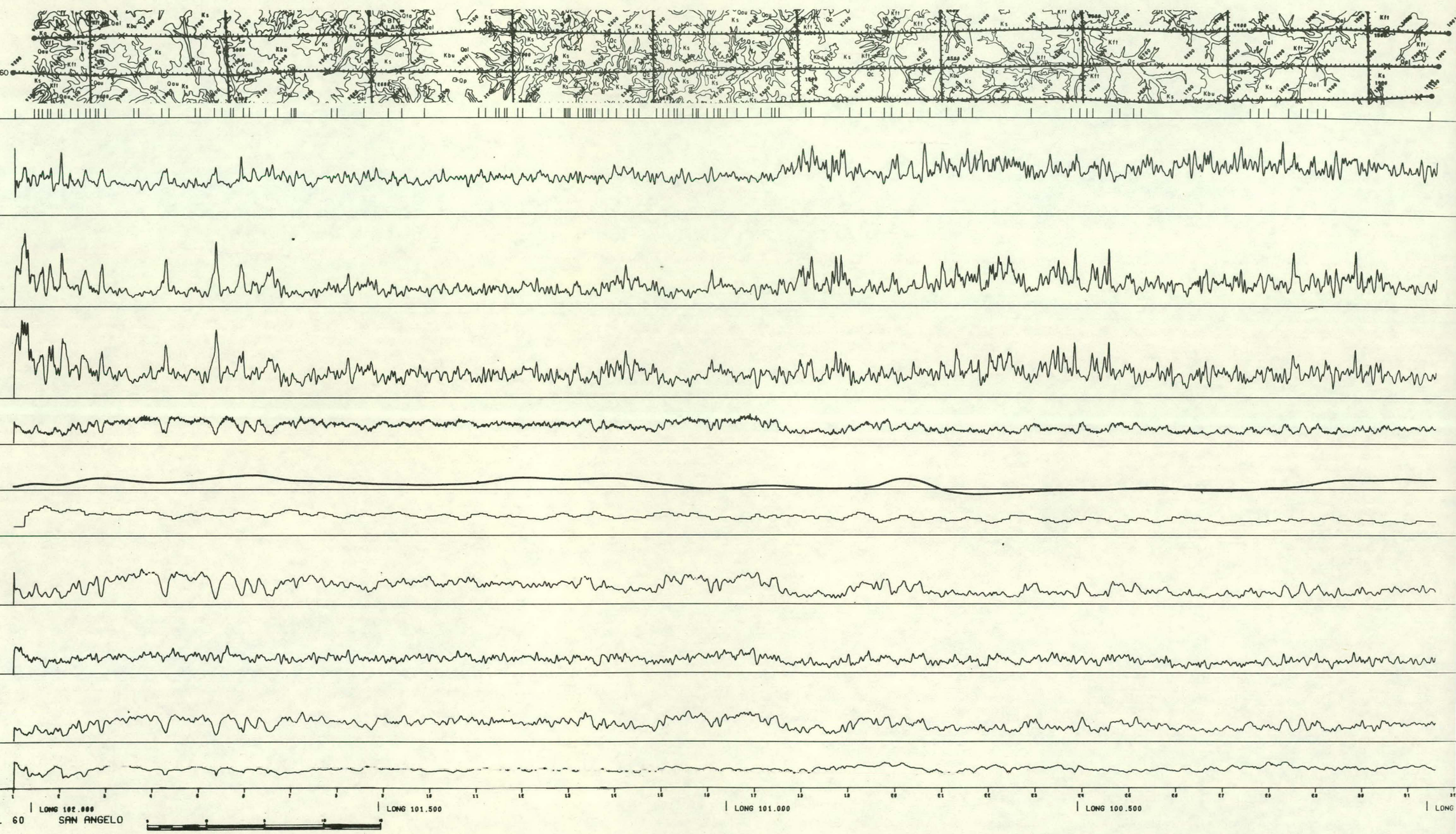
BP
3 MM HG/DIV
BASE = 650.0

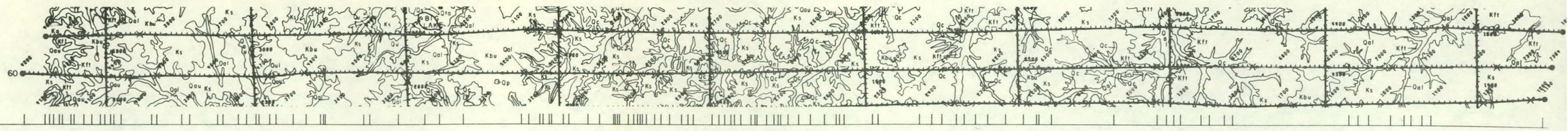
TEMP
1 DEG C/DIV
BASE = 10.0

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 40 SAN ANGELO


TL/K
.75 /DIV
BI/K
.40 /DIV
BI/TL
.05 /DIV
GC
400 C/S/DIV
RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
TL
1.5 PPM/DIV
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 60 SAN ANGELO



RMAG
10 GAMMA/DIV
BASE = -800.0

BMAG
10 GAMMA/DIV
BASE = 51020.0

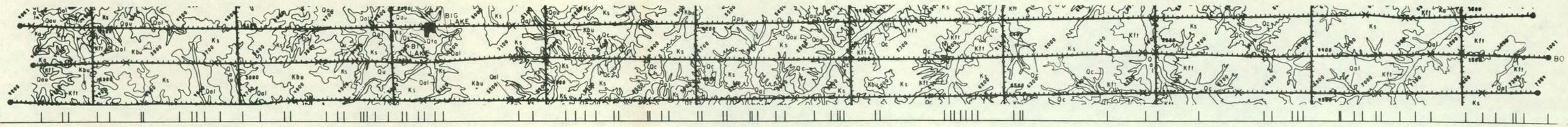
BP
3 MM HG/DIV
BASE = 650.0

TEMP
1 DEG C/DIV
BASE = 10.0

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 60 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

BI
.50 PPM/DIV

TL
1.5 PPM/DIV

ALT
100 FT/DIV

W

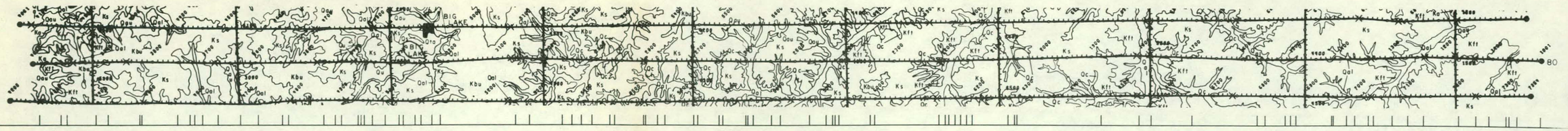
LONG 101.500

LONG 101.000

LONG 100.500

LONG 100

ML 80 SAN ANGELO



RMAG
10 GAMMA/DIV
BASE = -800.0

BMAG
10 GAMMA/DIV
BASE = 51020.0

BP
3 MM HG/DIV
BASE = 650.0

TEMP
1 DEG C/DIV
BASE = 10.0

ALT
100 FT/DIV

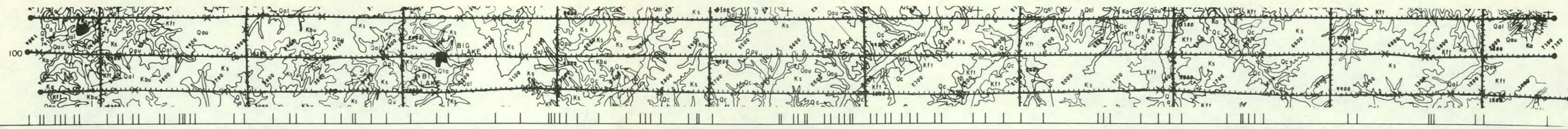
W

LONG 101.500

LONG 101.000

LONG 100.500

ML 80 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

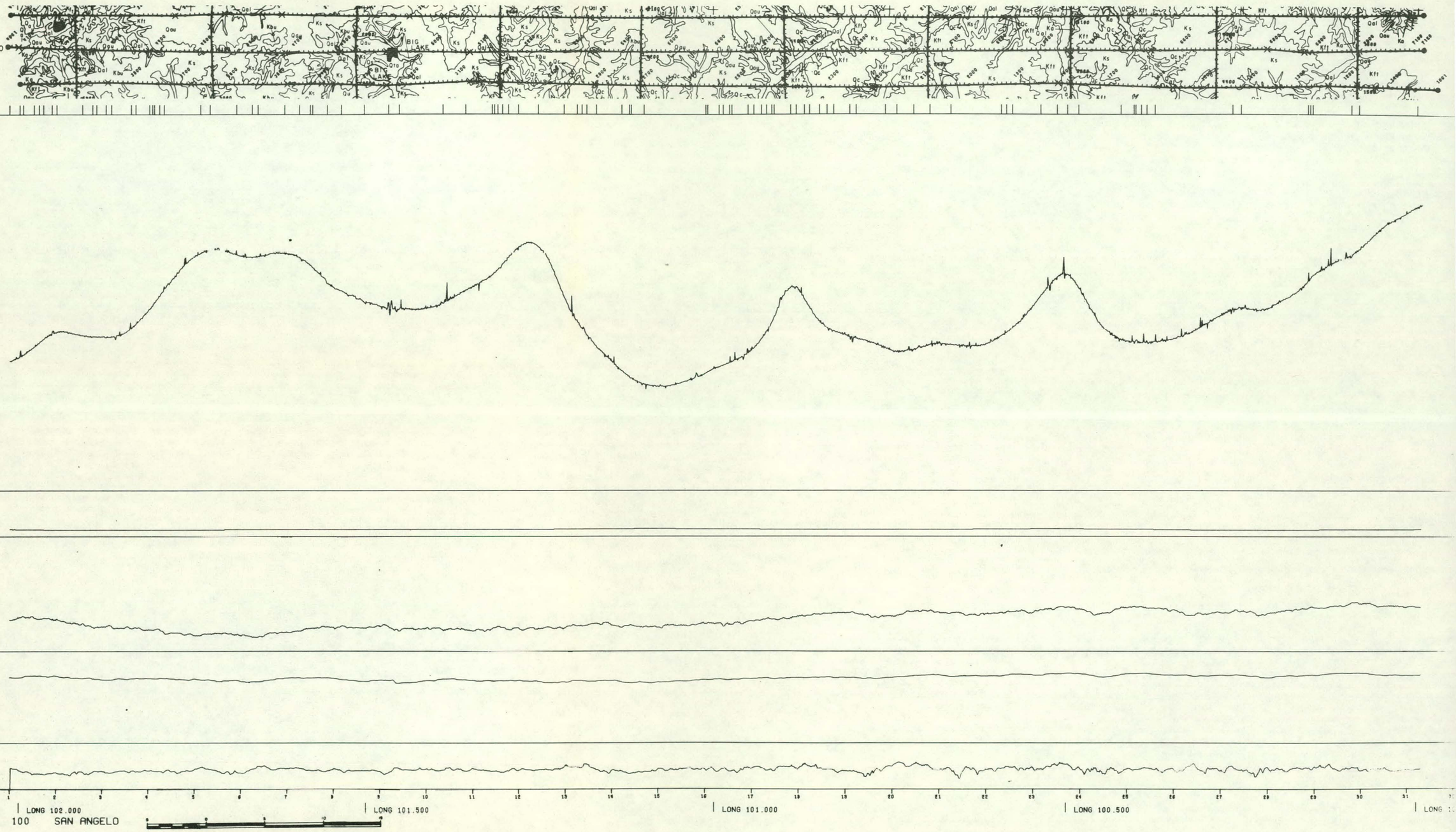
BI
.50 PPM/DIV

TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 100 SAN ANGELO


RMAG
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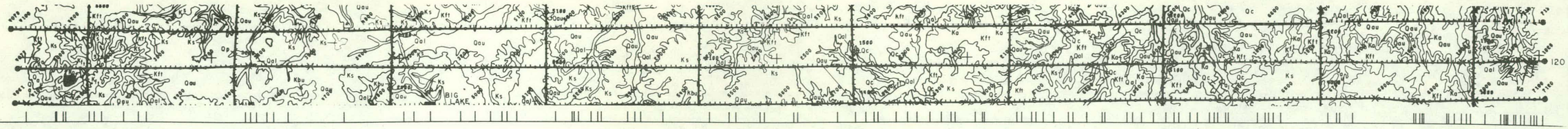
BASE = -900.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 100 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

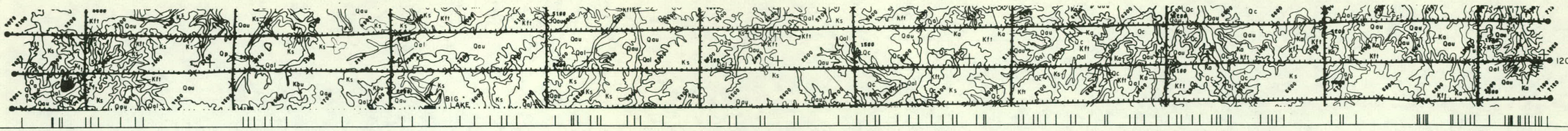
BI
.50 PPM/DIV

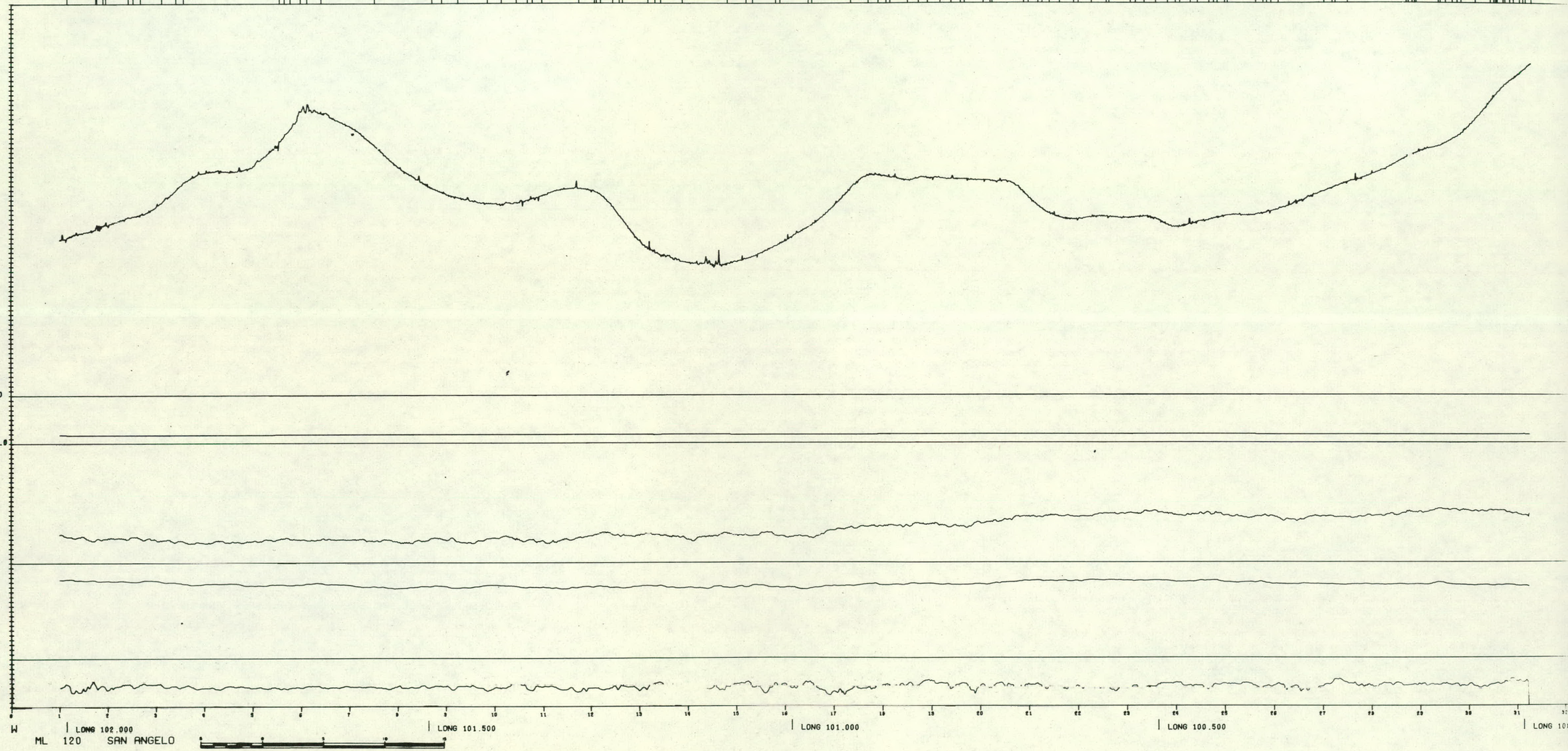
TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG 100

ML 120 SAN ANGELO


BIG LAKE
120


RMAG
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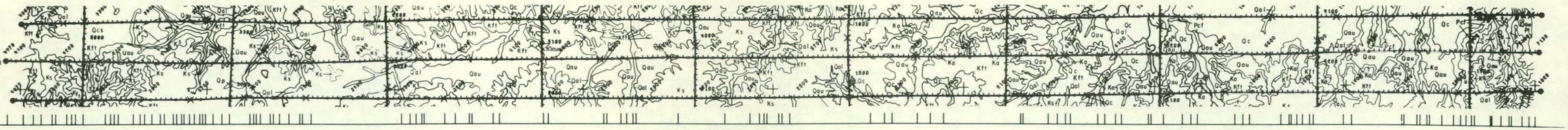
BASE = -900.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 120 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

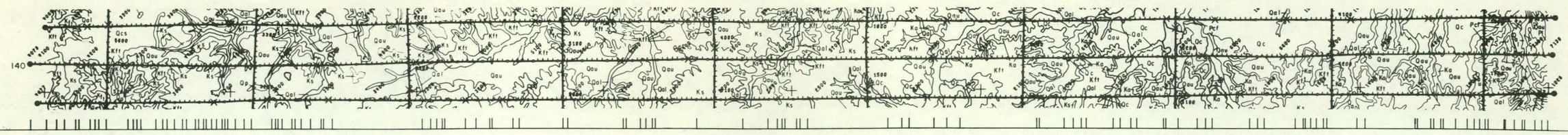
BI
.50 PPM/DIV

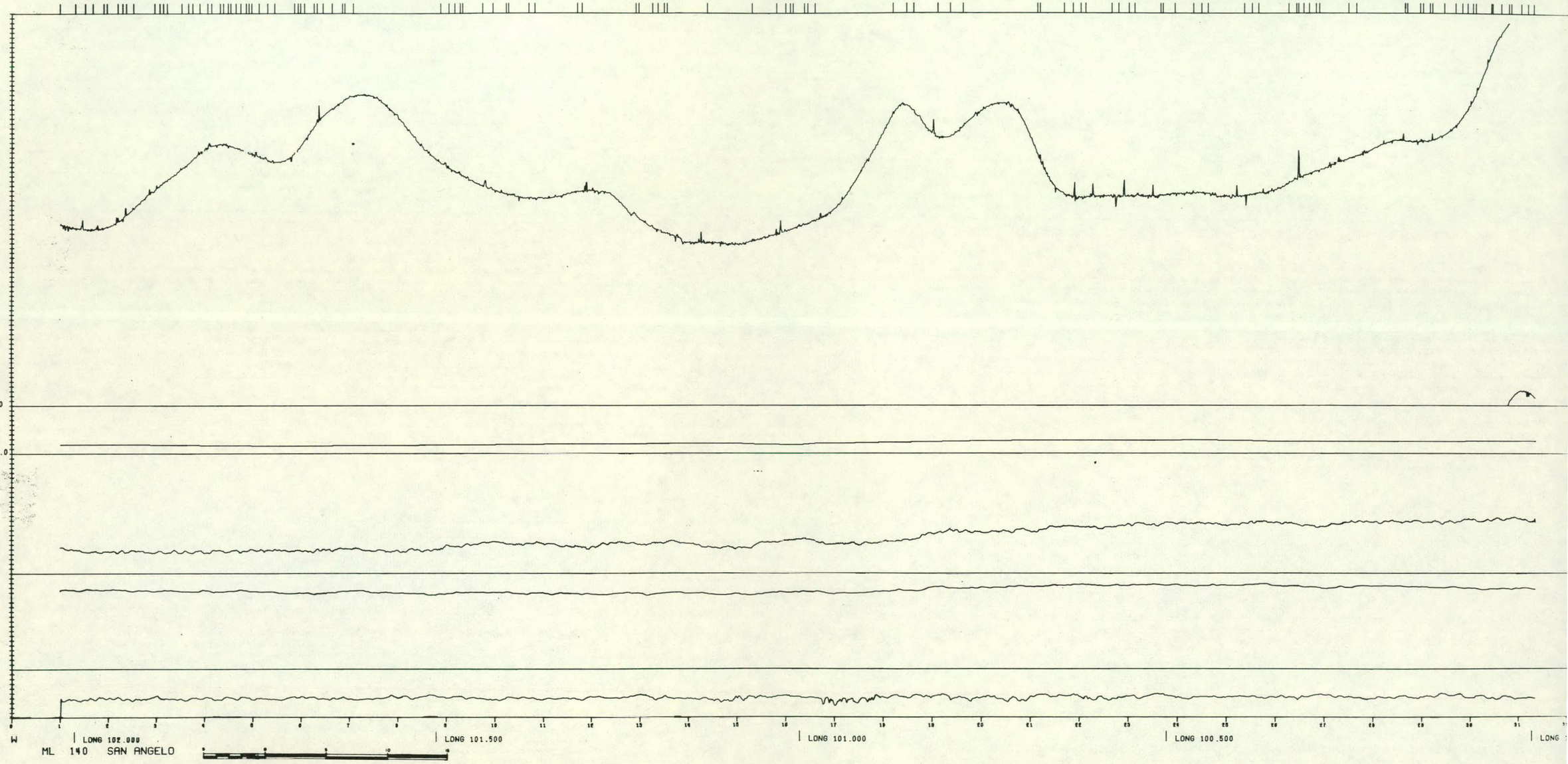
TL
1.5 PPM/DIV

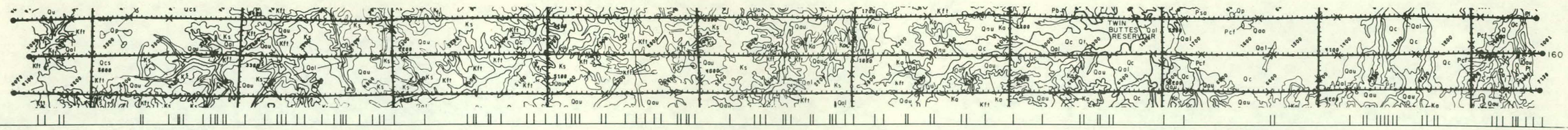
ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 140 SAN ANGELO


140


RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 140 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

BI
.50 PPM/DIV

TL
1.5 PPM/DIV

ALT
100 FT/DIV

W

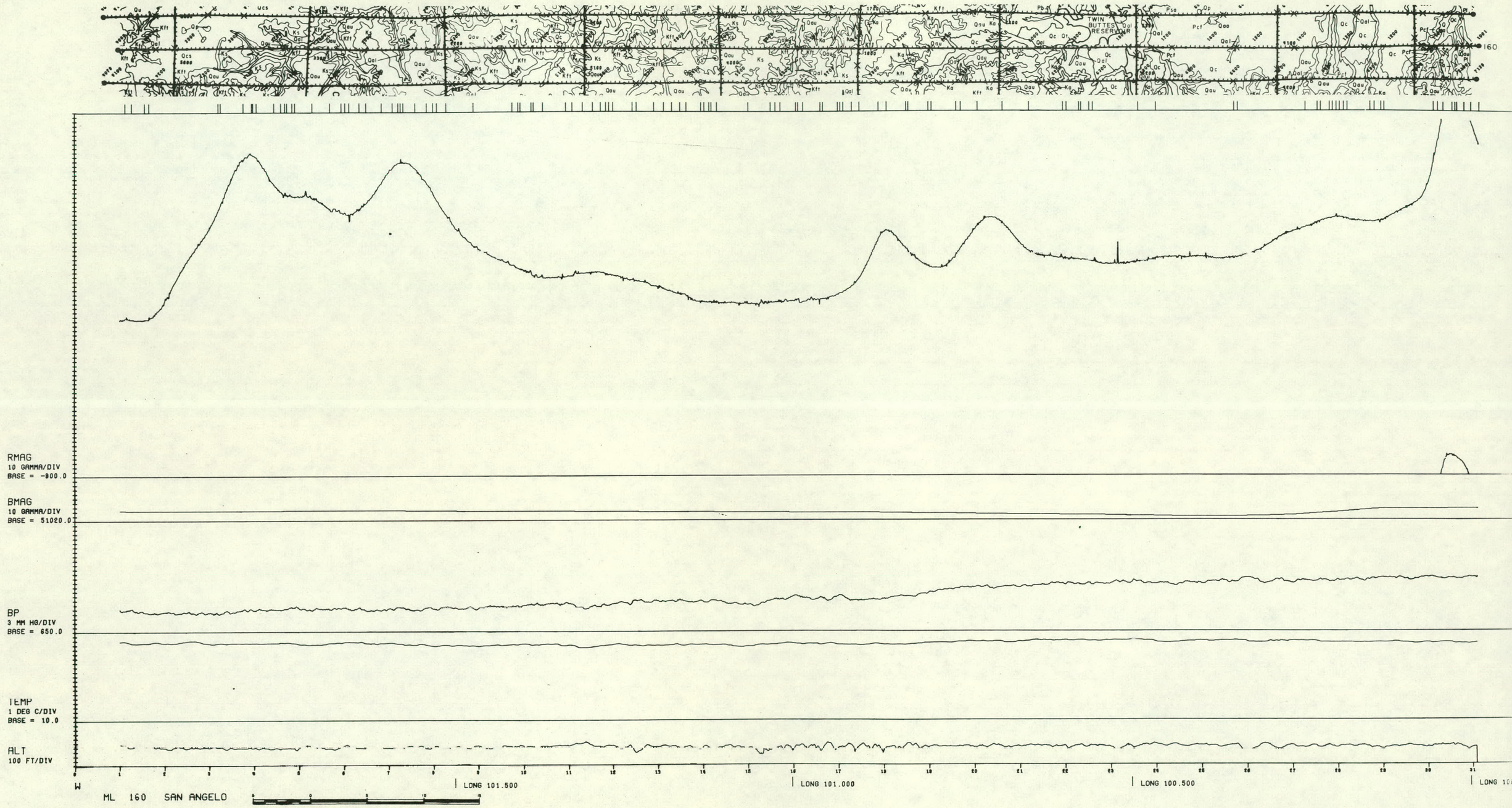
LONG 101.500

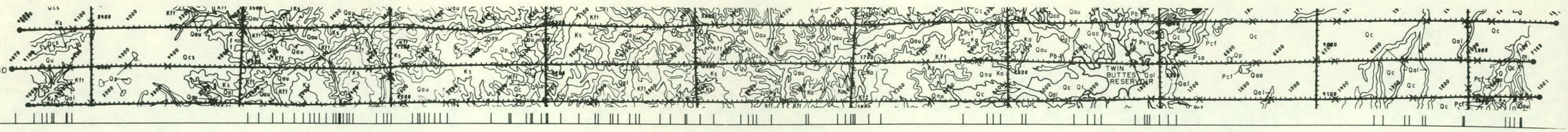
LONG 101.000

LONG 100.500

LONG 100

ML 160 SAN ANGELO


TWIN BUTTES RESERVOIR
160
RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 101.500
LONG 101.000
LONG 100.500
LONG 100
ML 160 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

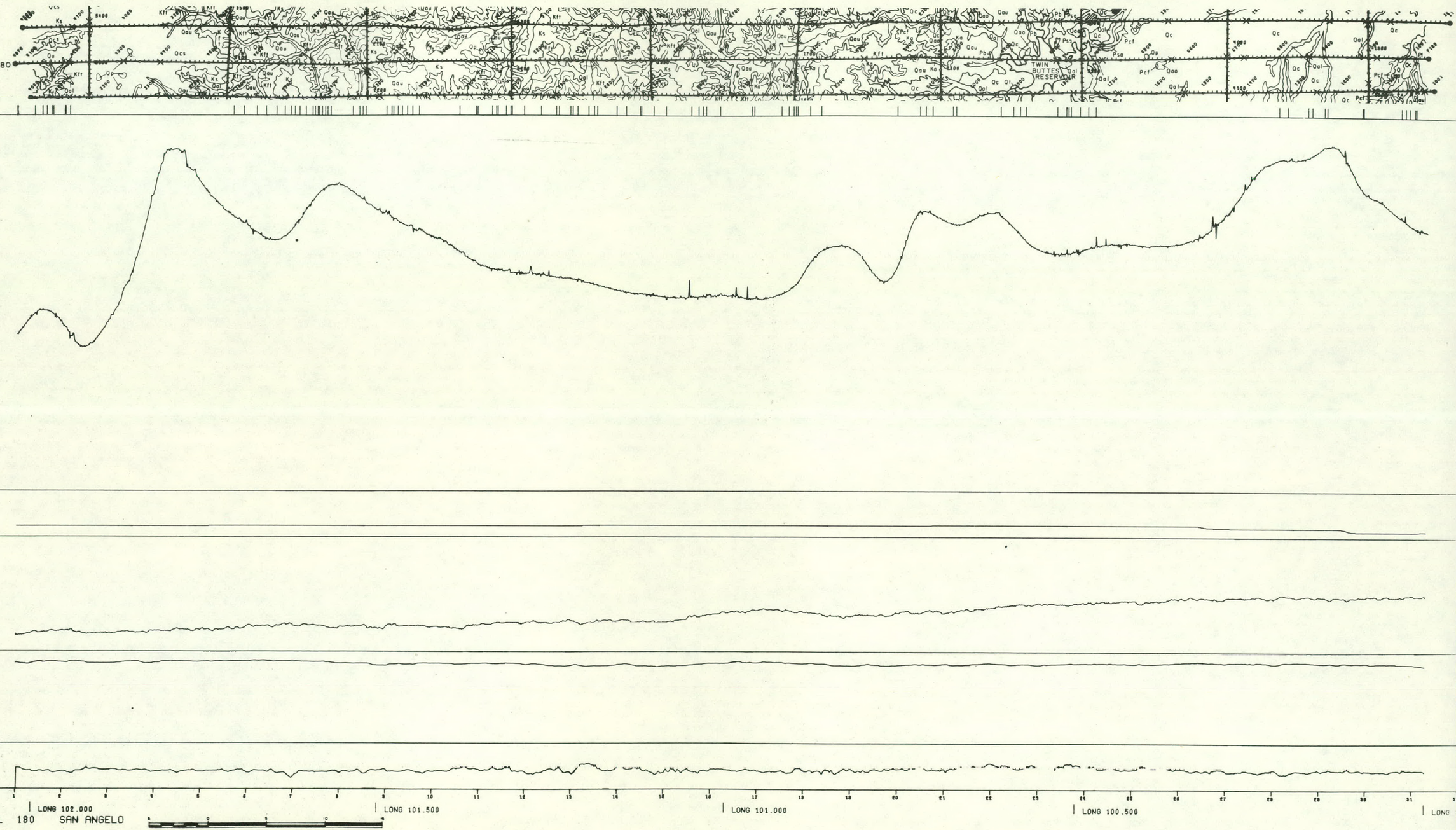
BI
.50 PPM/DIV

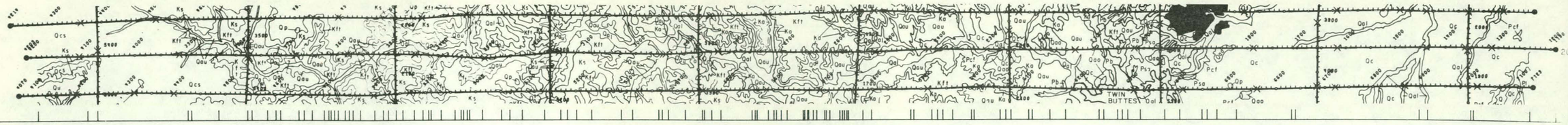
TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 180 SAN ANGELO


180
TWIN BUTTES RESERVOIR
RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
LONG
ML 180 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

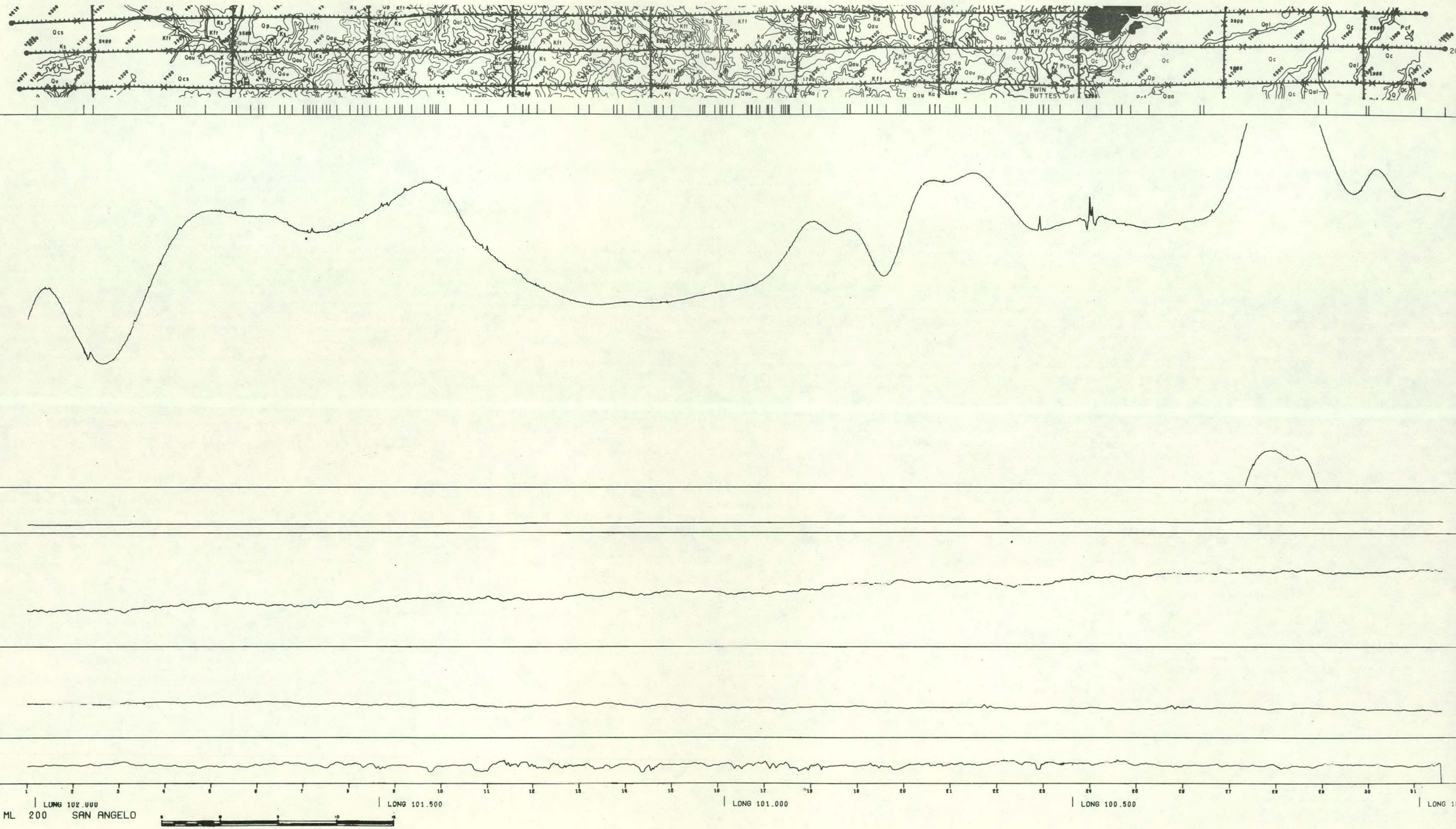
BI
.50 PPM/DIV

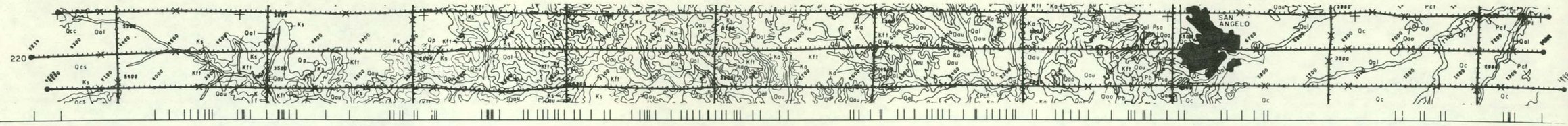
TL
1.5 PPM/DIV

HLT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 200 SAN ANGELO


RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 200 SAN ANGELO
TWIN BUTTES



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

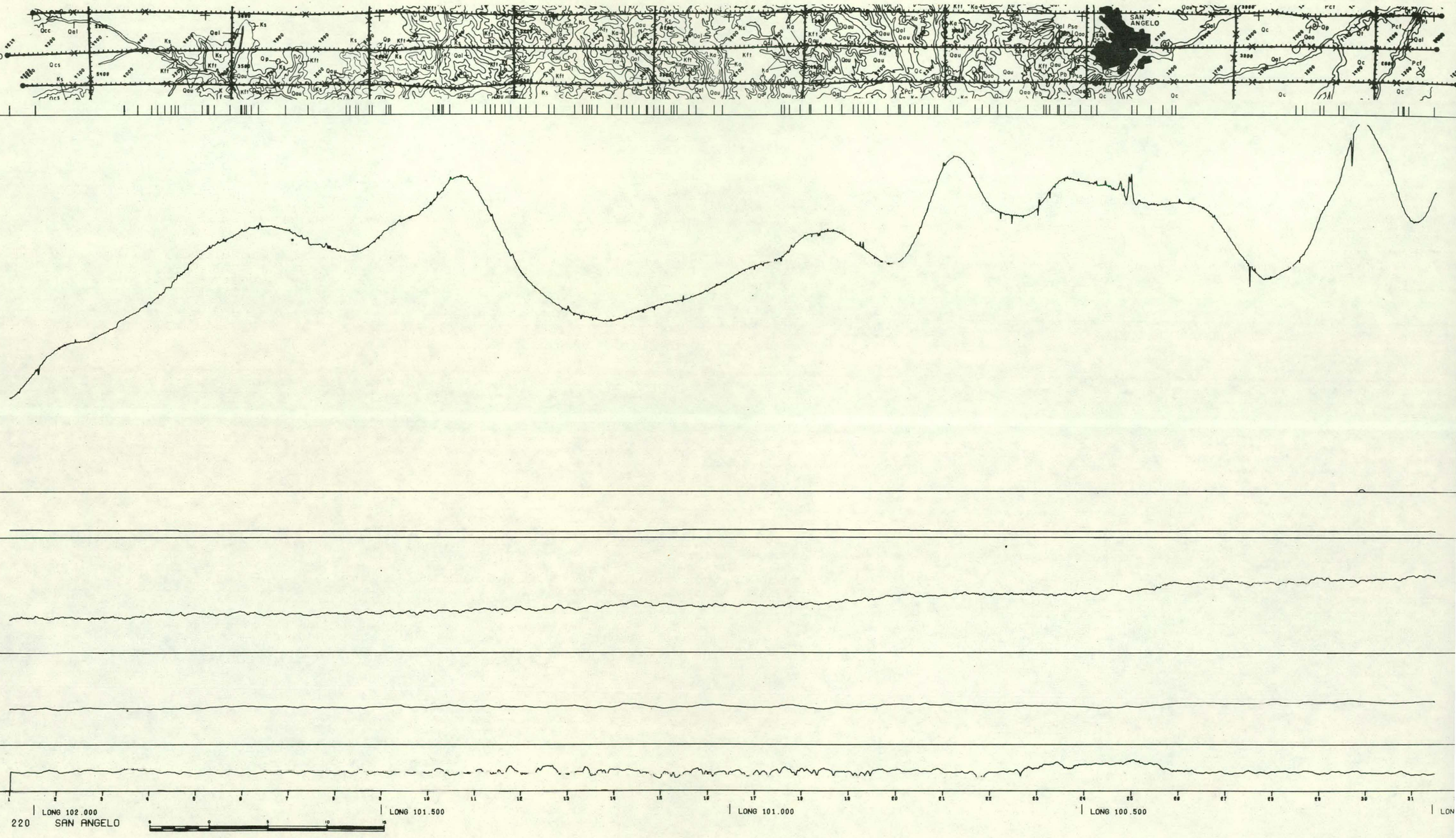
BI
.50 PPM/DIV

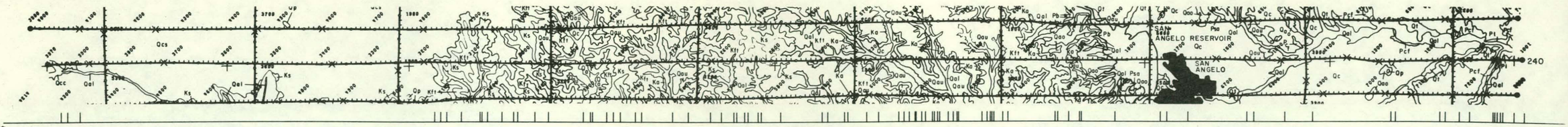
TL
1.5 PPM/DIV

AI T
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 220 SAN ANGELO


220
SAN ANGELO
RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 220 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

BI
.50 PPM/DIV

TL
1.5 PPM/DIV

ALT
100 FT/DIV

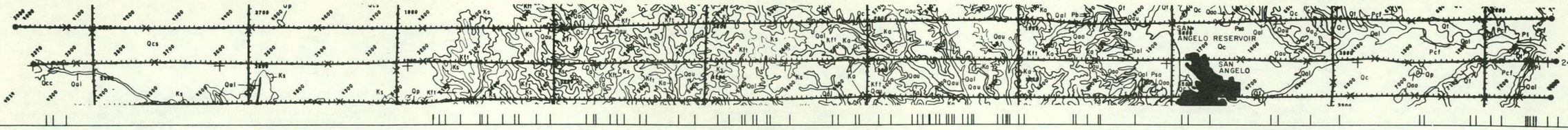
W

LONG 101.500

LONG 101.000

LONG 100.500

ML 240 SAN ANGELO



RMAG
10 GAMMA/DIV
BASE = -800.0

BMAG
10 GAMMA/DIV
BASE = 51020.0

BP
3 MM HG/DIV
BASE = 650.0

TEMP
1 DEG C/DIV
BASE = 10.0

ALT
100 FT/DIV

W

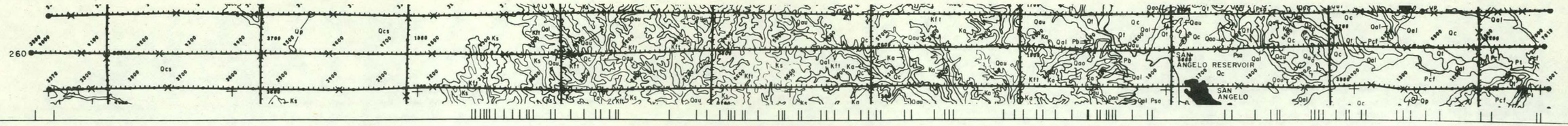
LONG 101.500

LONG 101.000

LONG 100.500

LONG 100

ML 240 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

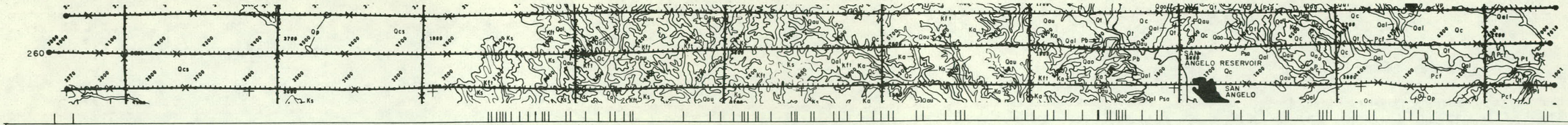
BI
.50 PPM/DIV

TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 260 SAN ANGELO



RMAG
10 GAMMA/DIV
BASE = -900.0

BMAG
10 GAMMA/DIV
BASE = 51020.0

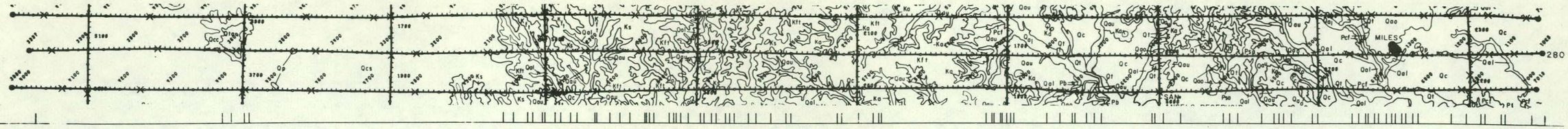
BP
3 MM HG/DIV
BASE = 650.0

TEMP
1 DEG C/DIV
BASE = 10.0

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 260 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

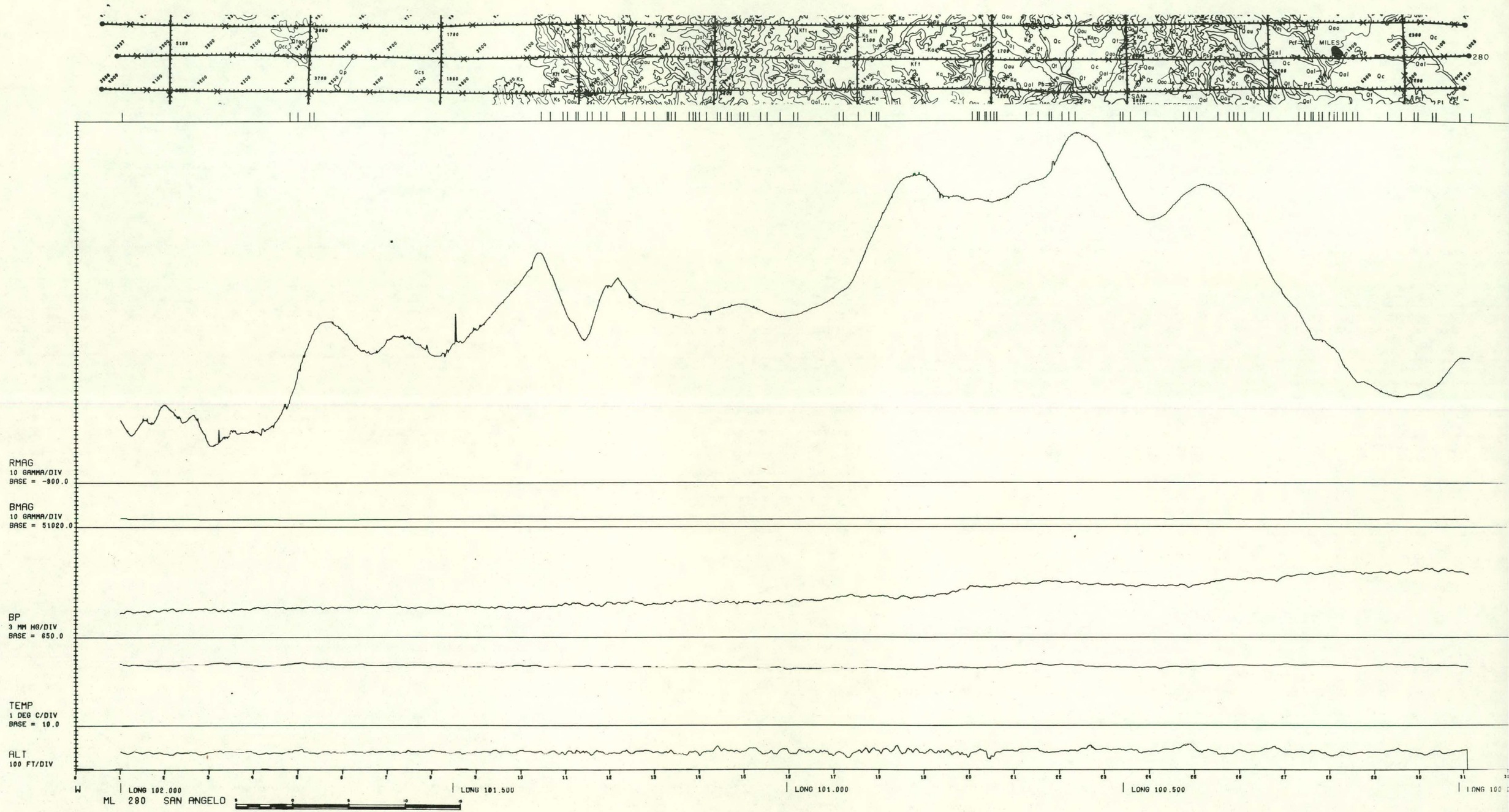
BI
.50 PPM/DIV

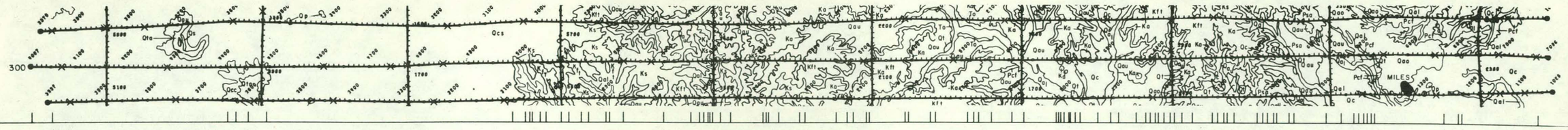
TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG 100

ML 280 SAN ANGELO


MILES
280
RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 280 SAN ANGELO



TI /K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

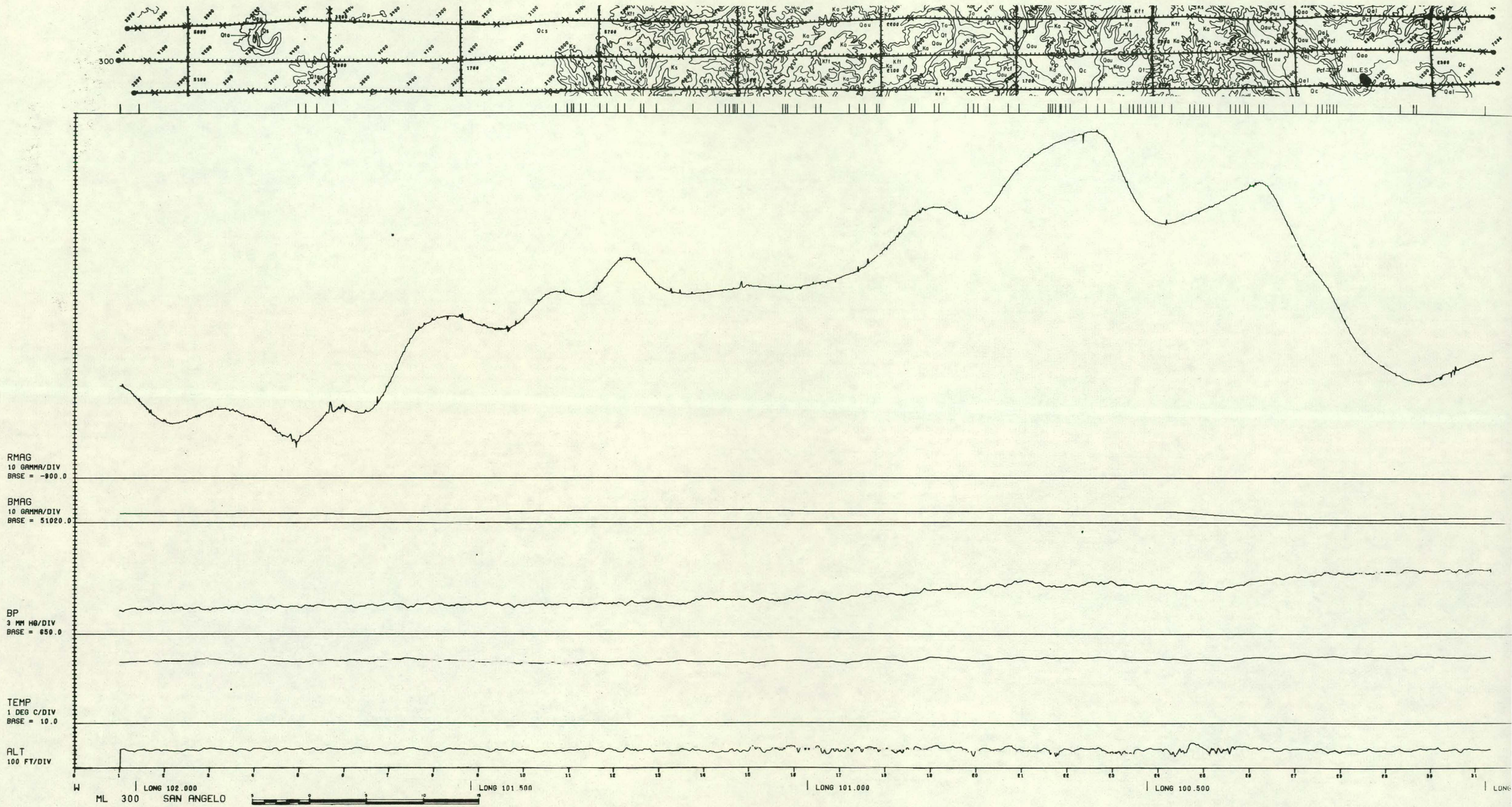
BI
.50 PPM/DIV

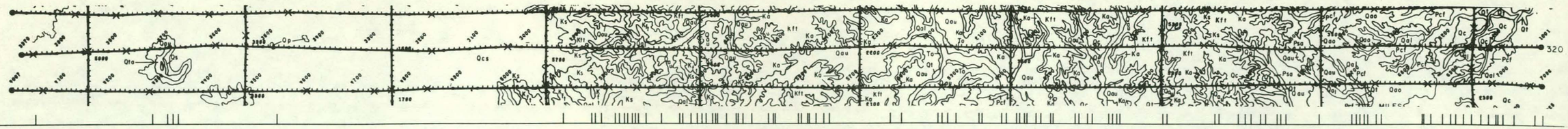
TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 300 SAN ANGELO


300
MILES
RMAG
10 GAMMA/DIV
BASE = -900.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 300 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

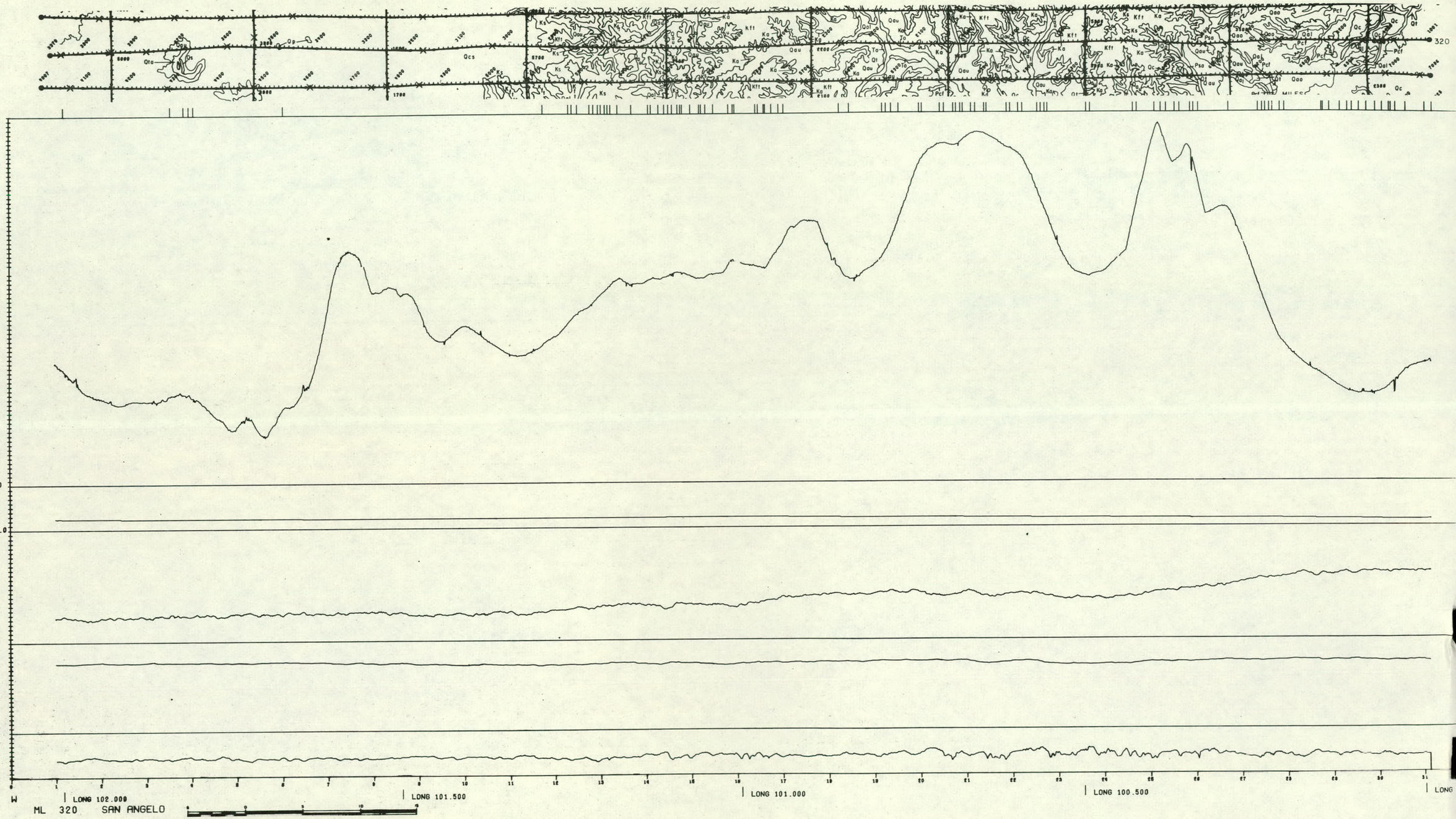
BI
.50 PPM/DIV

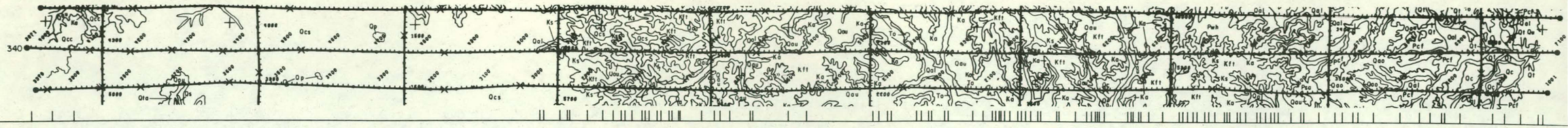
TL
1.5 PPM/DIV

HLI
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 320 SAN ANGELO


RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 320 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

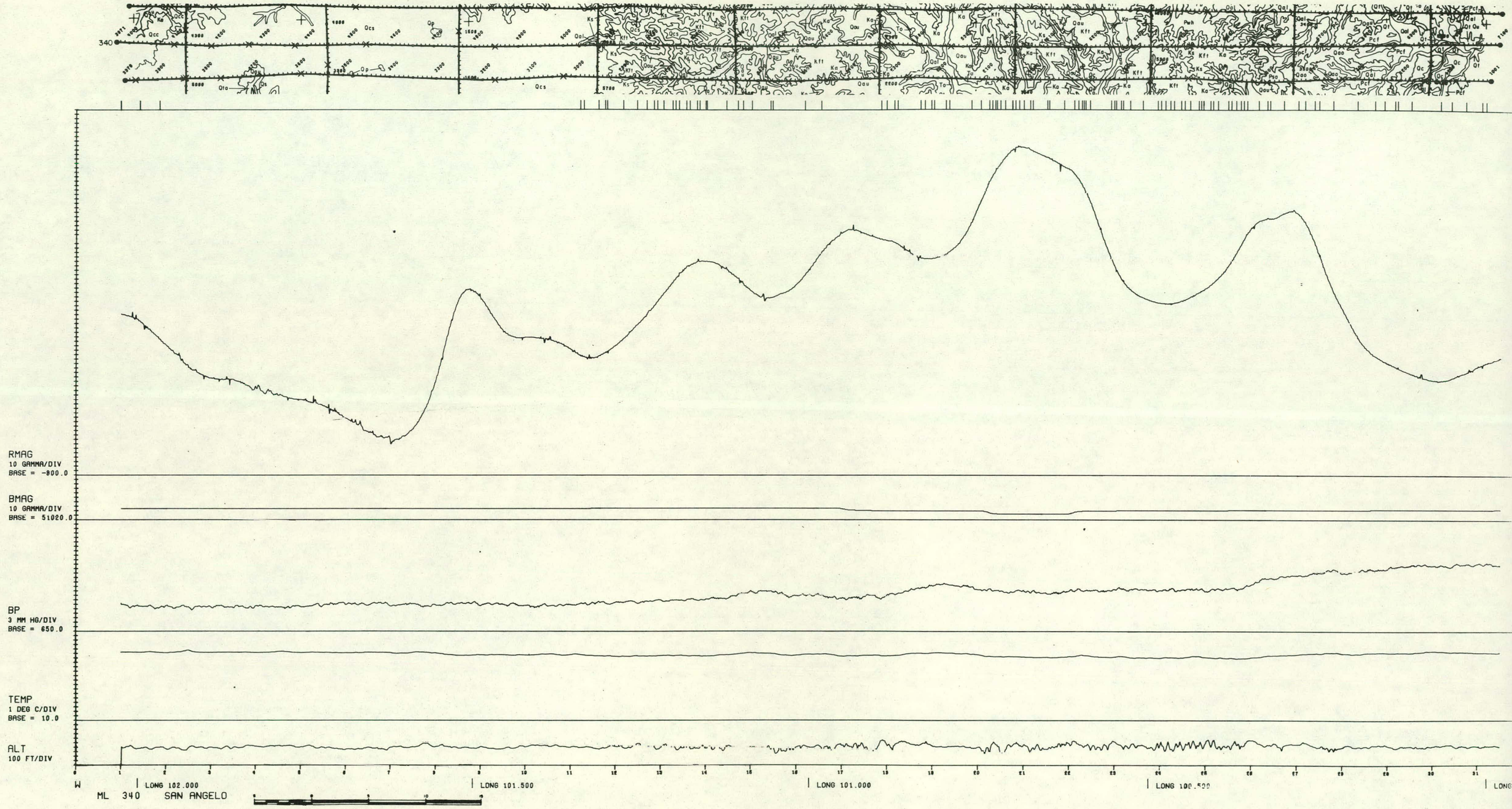
BI
.50 PPM/DIV

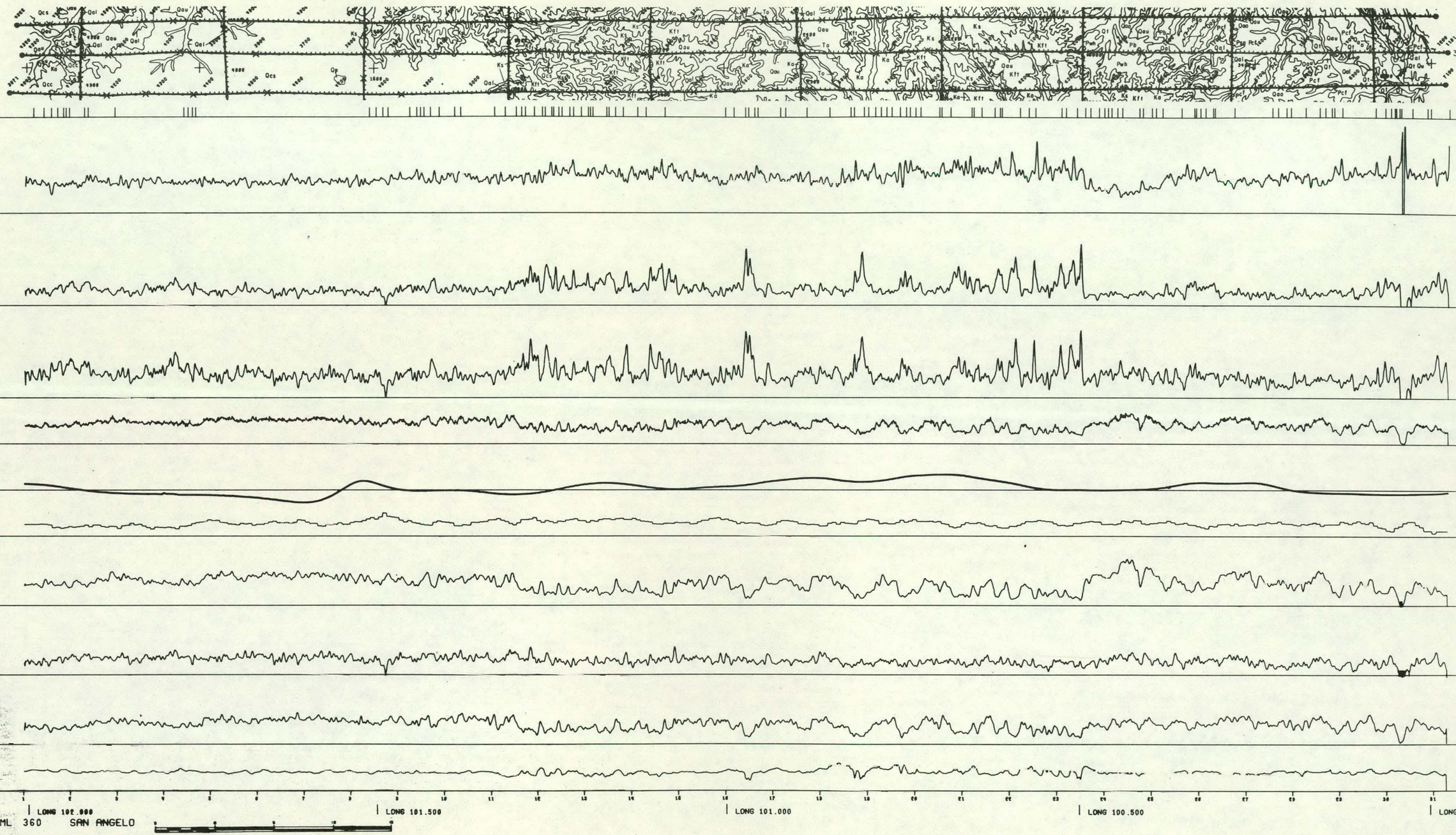
TL
1.5 PPM/DIV

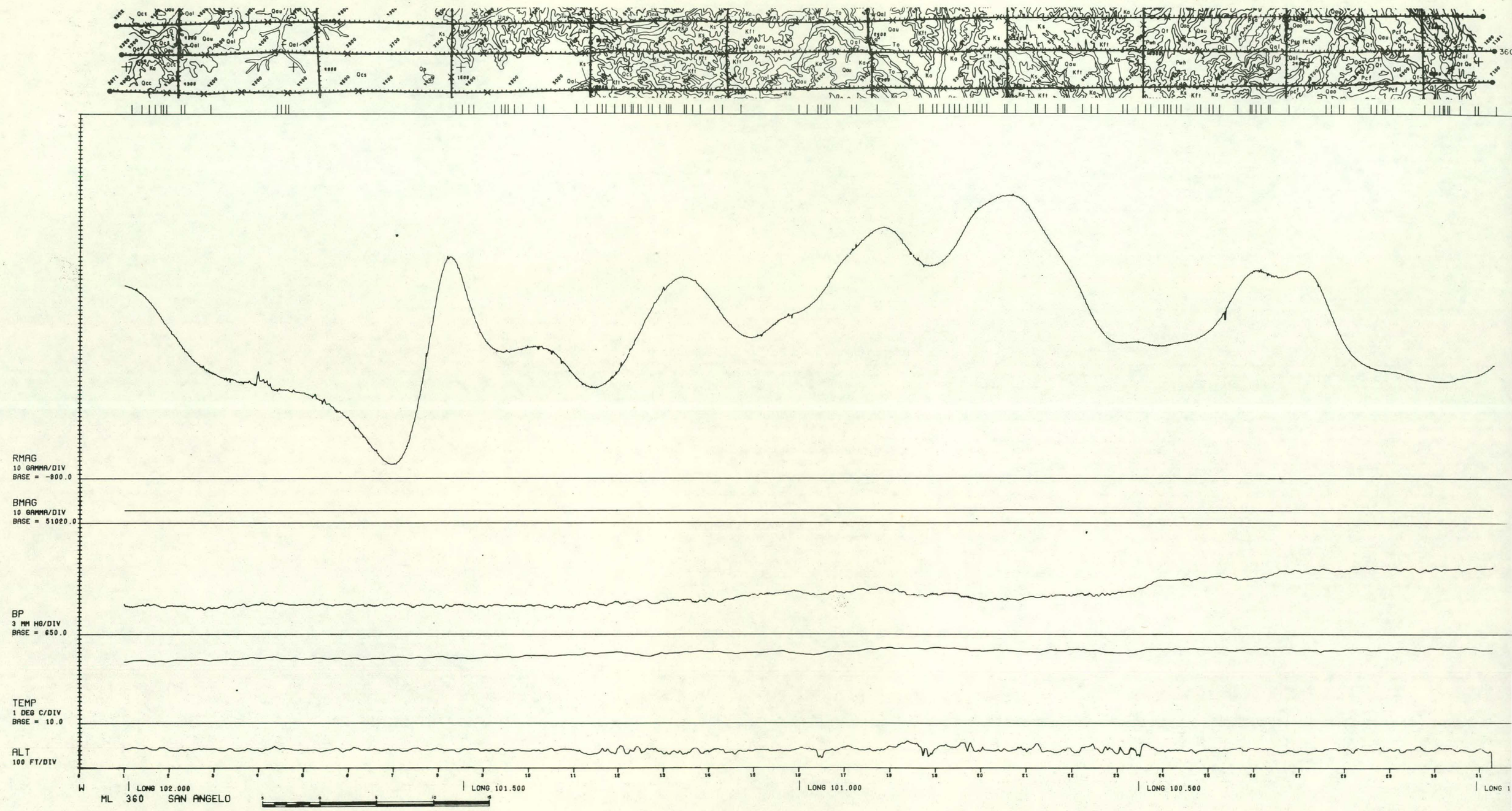
ALT
100 FT/DIV

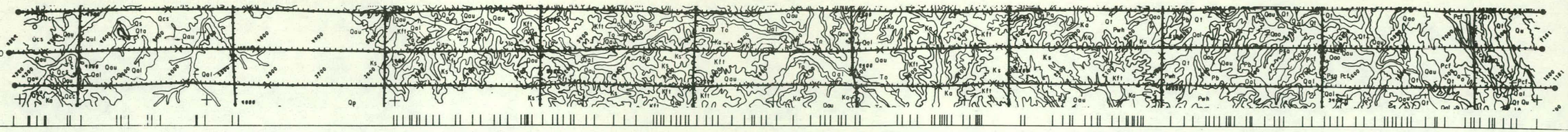
W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 340 SAN ANGELO


340
RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 340 SAN ANGELO


TL/K
.75 /DIV
BI/K
.40 /DIV
BI/TL
.05 /DIV
GC
400 C/S/DIV
RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
TL
1.5 PPM/DIV
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 360 SAN ANGELO


RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 360 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

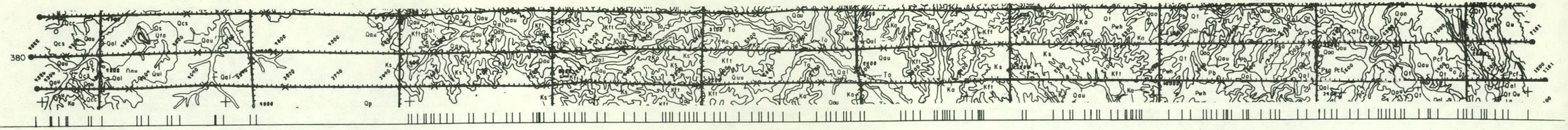
BI
.50 PPM/DIV

TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 380 SAN ANGELO



RMAG
10 GAMMA/DIV
BASE = -800.0

BMAG
10 GAMMA/DIV
BASE = 51020.0

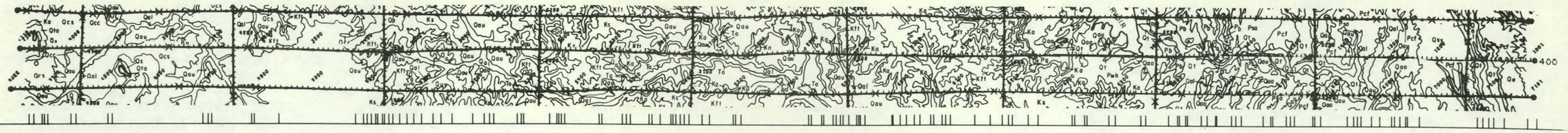
BP
3 MM HG/DIV
BASE = 650.0

TEMP
1 DEG C/DIV
BASE = 10.0

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG

ML 380 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

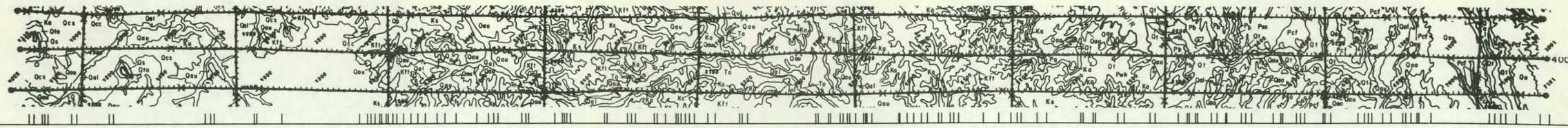
BI
.50 PPM/DIV

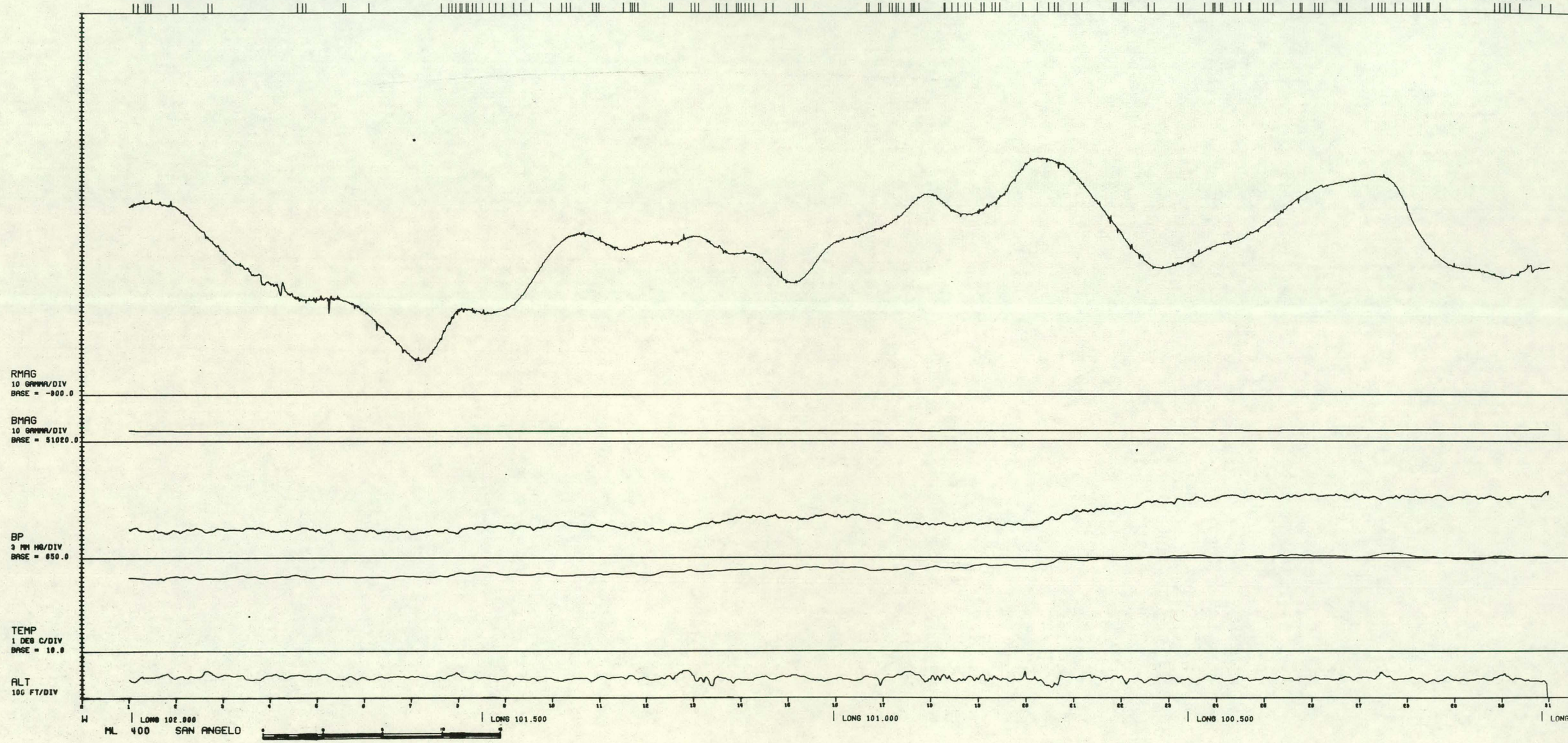
TL
1.5 PPM/DIV

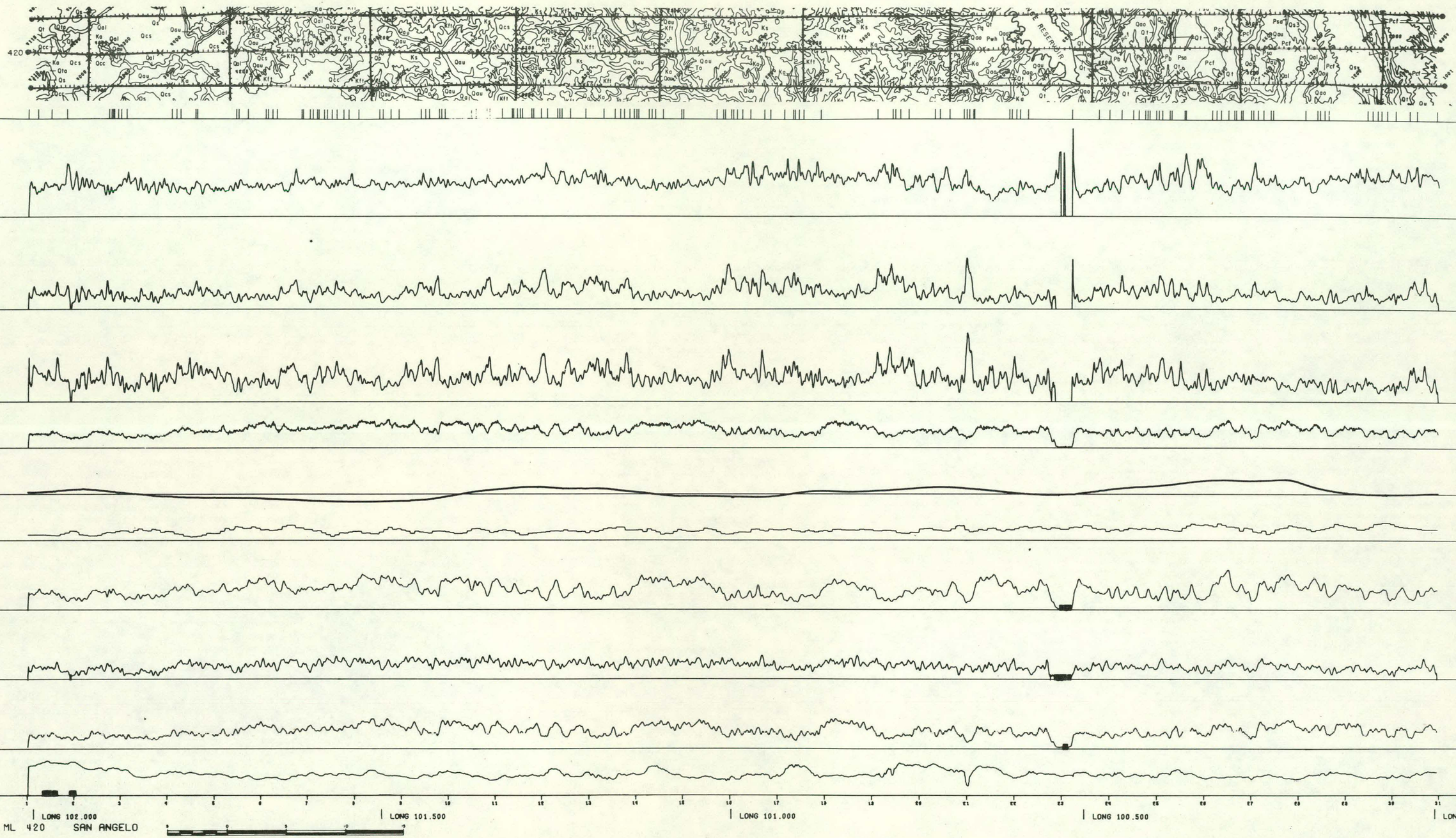
ALT
100 FT/DIV

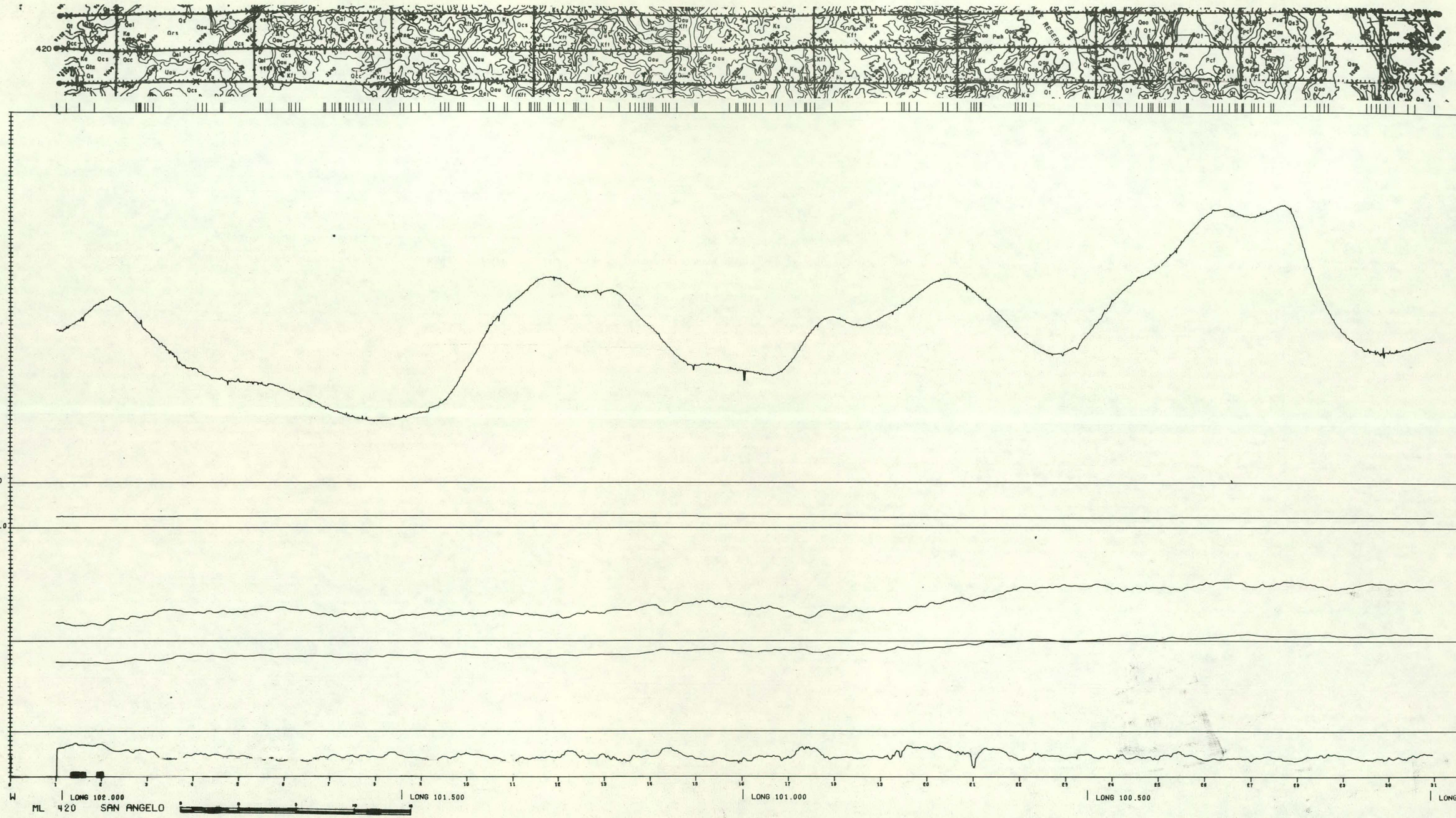
W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG 10

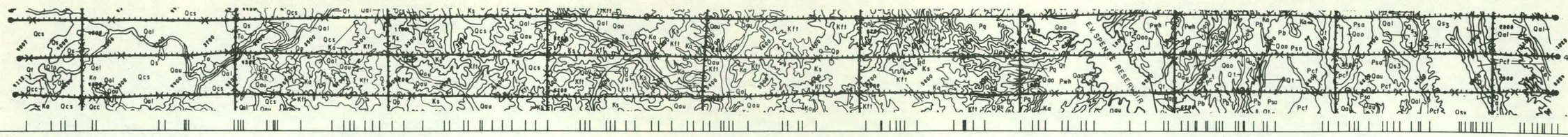
ML 400 SAN ANGELO




RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 400 SAN ANGELO


420
TL/K
.75 /DIV
BI/K
.40 /DIV
BI/TL
.05 /DIV
GC
400 C/S/DIV
RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
TI
1.5 PPM/DIV
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 420 SAN ANGELO


420
RESERVOIR
RMAG
10 GAMMA/DIV
BASE = -800.0
BMAG
10 GAMMA/DIV
BASE = 51020.0
BP
3 MM HG/DIV
BASE = 650.0
TEMP
1 DEG C/DIV
BASE = 10.0
ALT
100 FT/DIV
W
LONG 102.000
LONG 101.500
LONG 101.000
LONG 100.500
ML 420 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

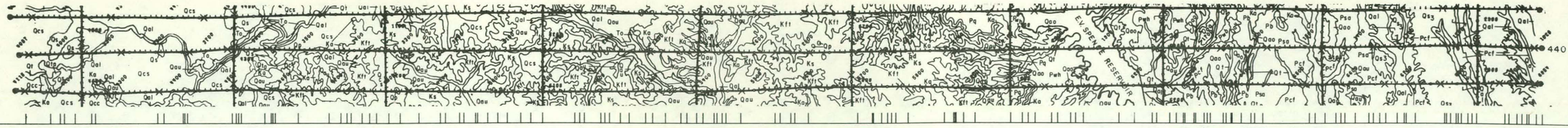
BI
.50 PPM/DIV

TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG 100

ML 440 SAN ANGELO



RMAG
10 GAMMA/DIV
BASE = -800.0

BMAG
10 GAMMA/DIV
BASE = 51020.0

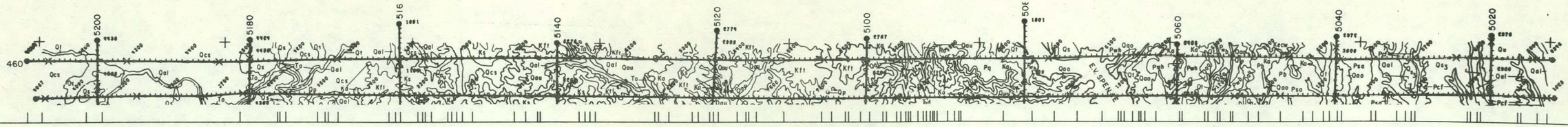
BP
3 MM HG/DIV
BASE = 650.0

TEMP
1 DEG C/DIV
BASE = 10.0

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG 100

ML 440 SAN ANGELO



TL/K
.75 /DIV

BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

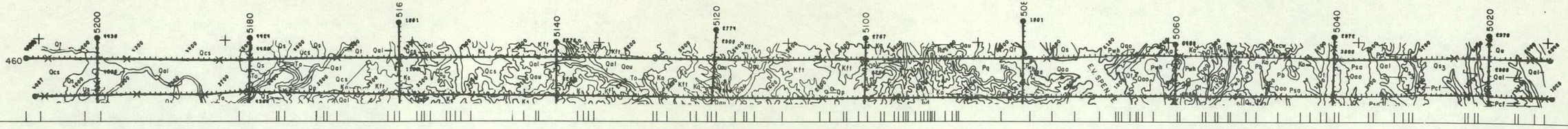
BI
.50 PPM/DIV

TL
1.5 PPM/DIV

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG 1

ML 460 SAN ANGELO



RMAG
10 GAMMA/DIV
BASE = -800.0

BMAG
10 GAMMA/DIV
BASE = 51020.0

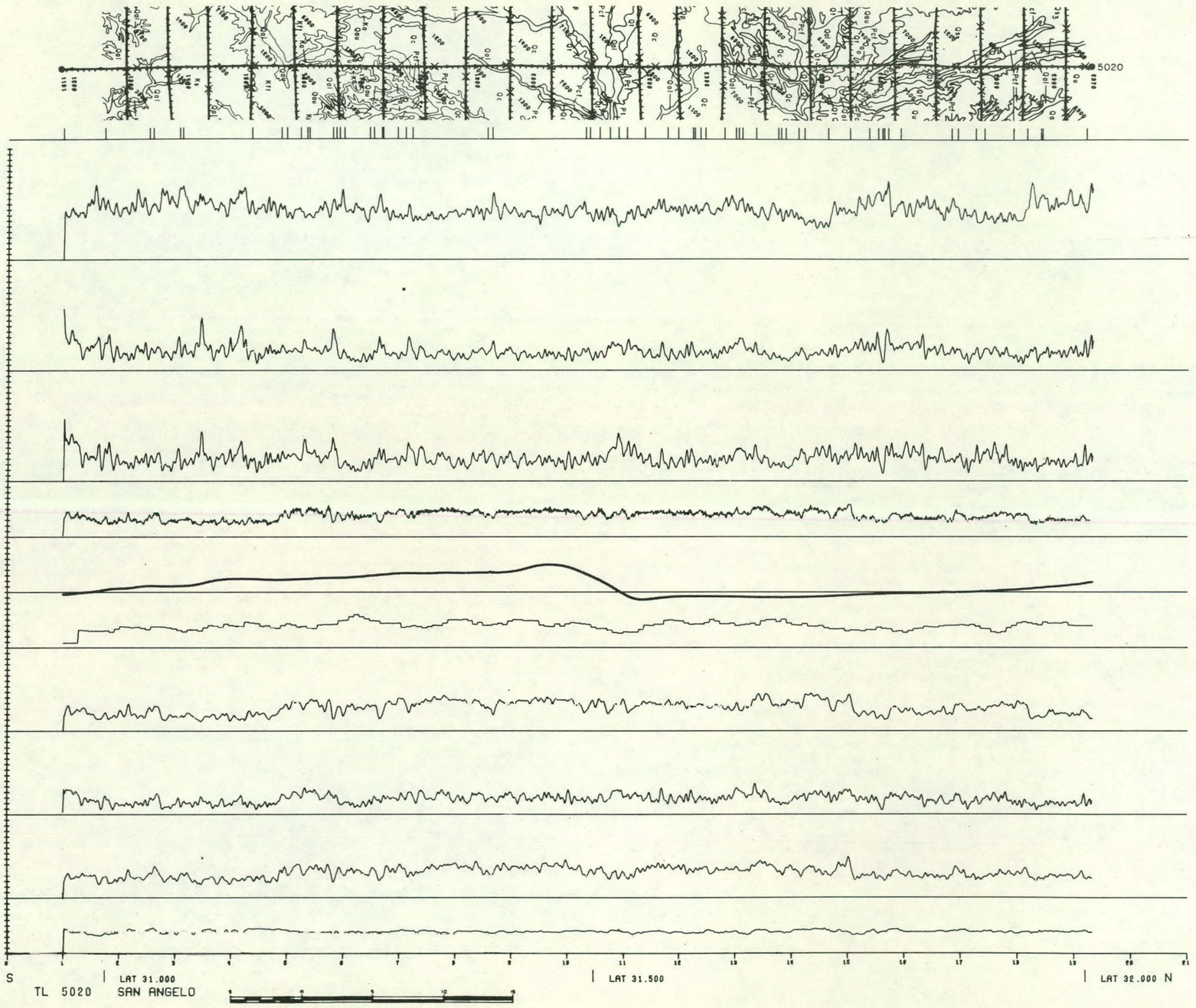
BP
3 MM HG/DIV
BASE = 650.0

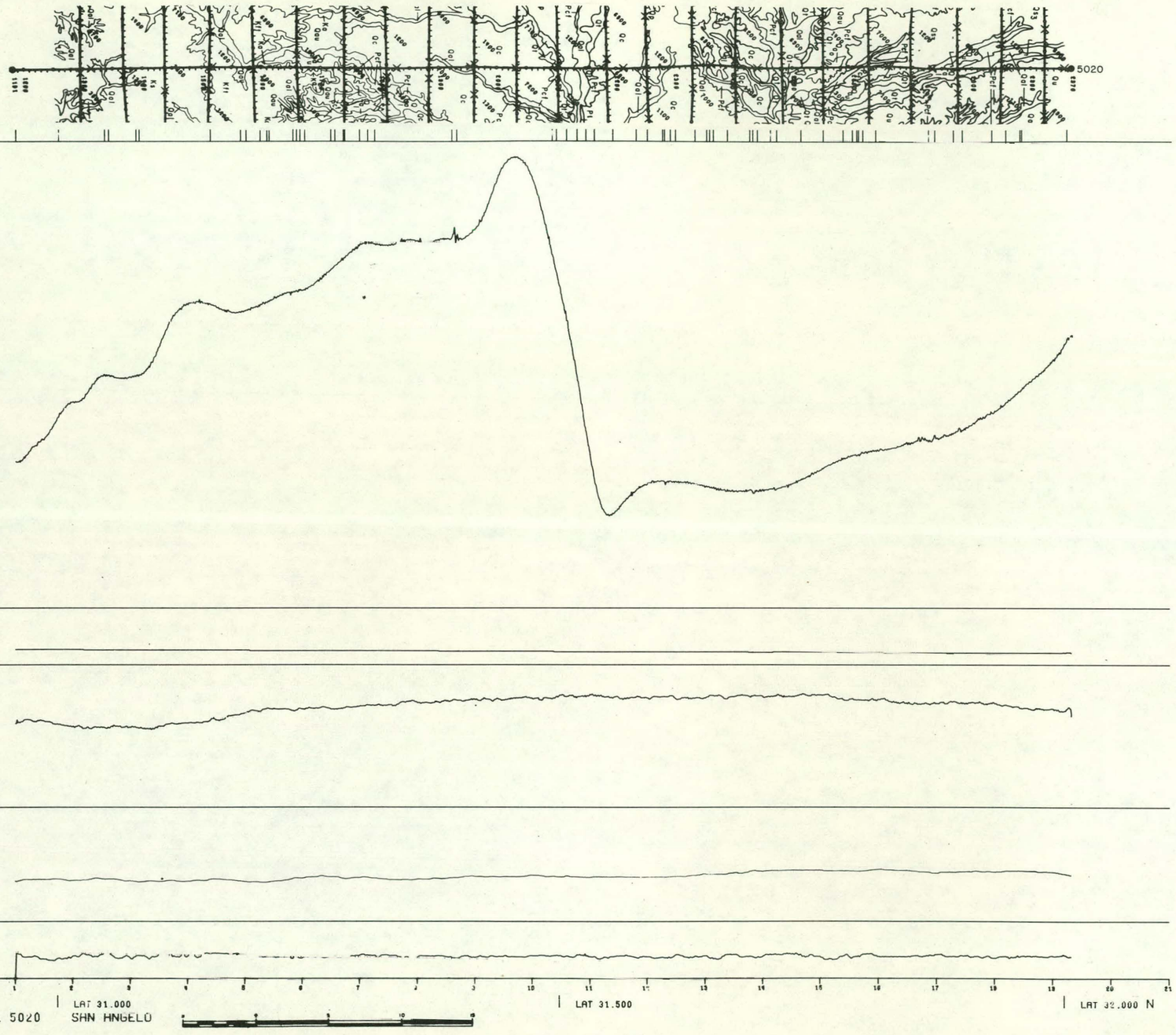
TEMP
1 DEG C/DIV
BASE = 10.0

ALT
100 FT/DIV

W | LONG 102.000 | LONG 101.500 | LONG 101.000 | LONG 100.500 | LONG 1

ML 460 SAN ANGELO


5020
TL/K
.75 /DIV
BI/K
.40 /DIV
BI/TL
.05 /DIV
GC
400 C/S/DIV
RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
TL
1.5 PPM/DIV
HLI
100 FT/DIV
S
LAT 31.000
LAT 31.500
LAT 32.000 N
TL 5020 SAN ANGELO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TEMP
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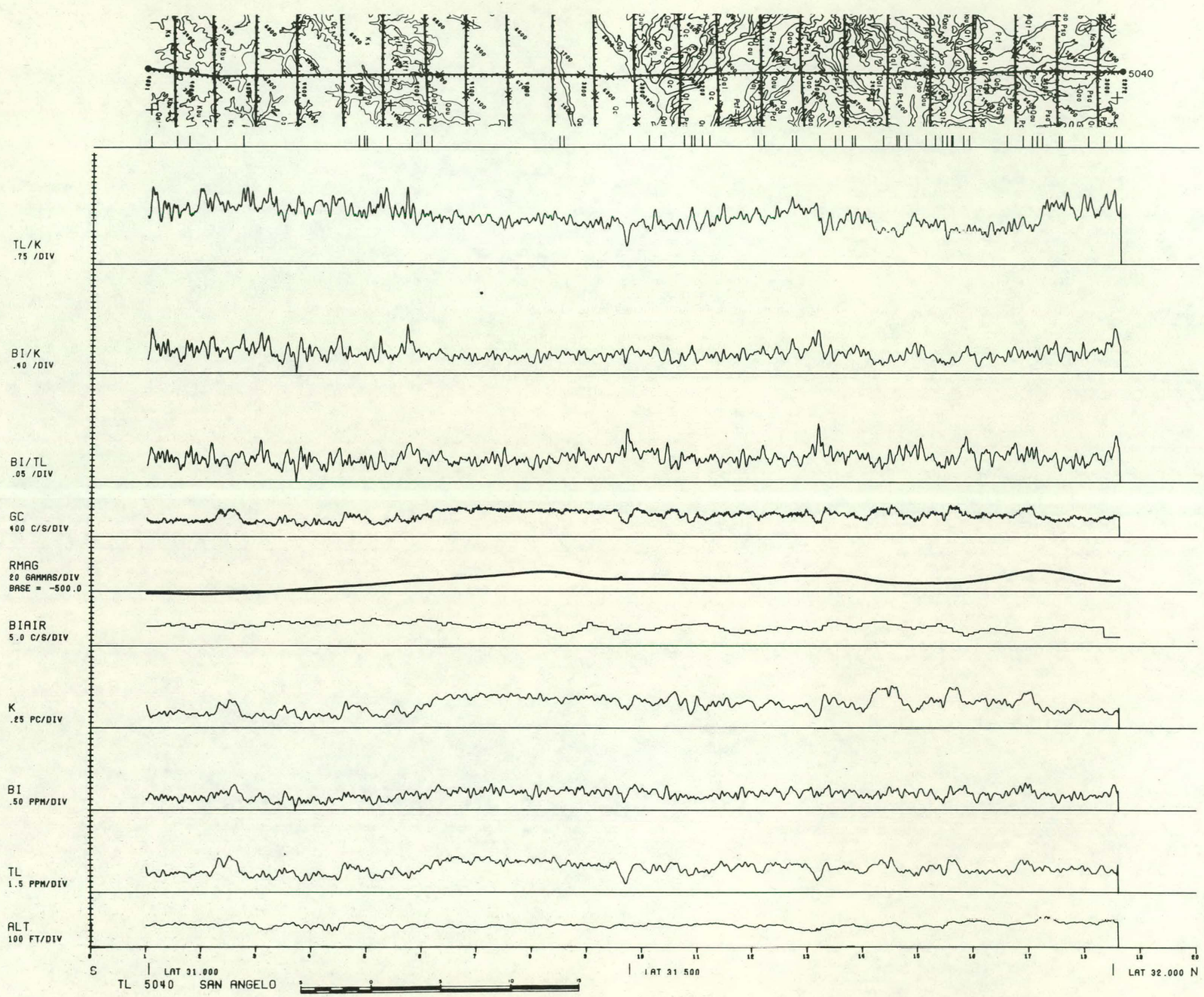
S
LAT 31.000
LAT 31.500
LAT 32.000 N
TL 5020
SAN ANGELO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BI/K
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BI/TL
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GC
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RMAG
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BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
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ALT
100 FT/DIV
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LAT 31.000
LAT 31.500
LAT 32.000 N
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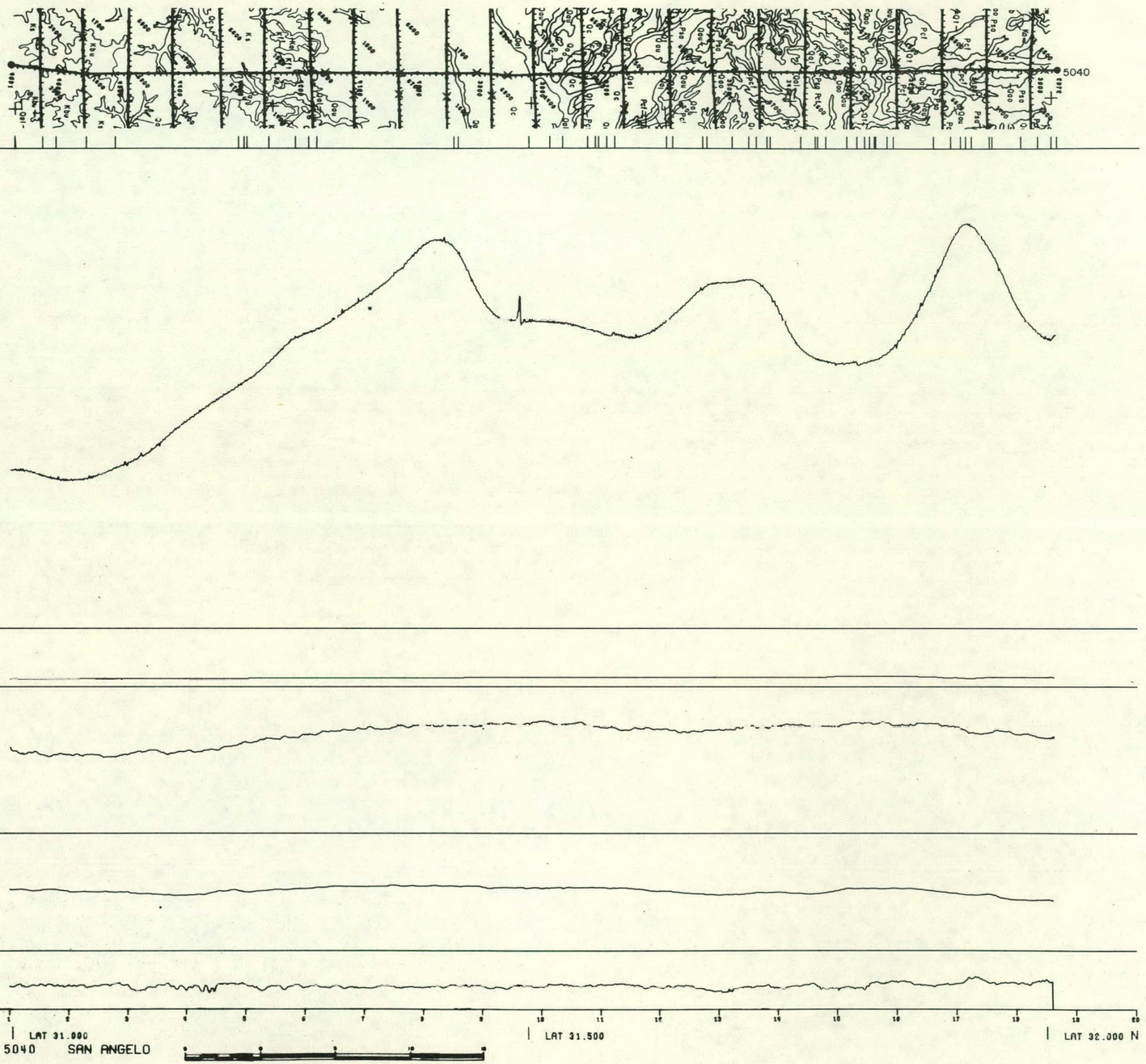
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BMAG
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BP
3 MM HG/DIV
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TEMP
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ALT
100 FT/DIV
S
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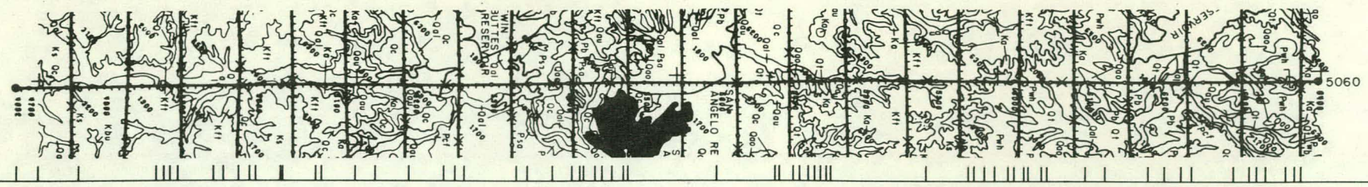
LAT 31.500
LAT 32.000 N
TL 5040 SAN ANGELO



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BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

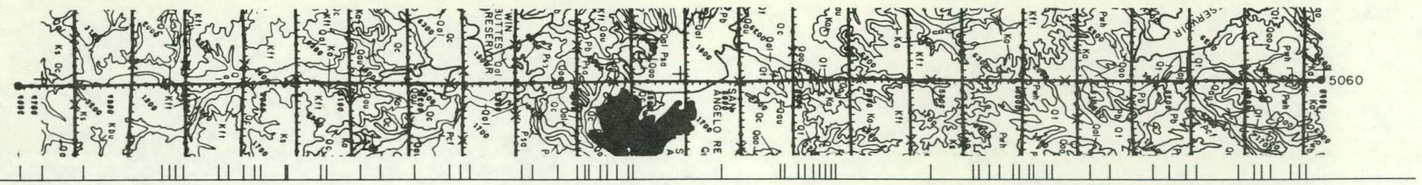
BI
.50 PPM/DIV

IL
1.5 PPM/DIV

NLT
100 FT/DIV

S LAT 31.000 LAT 31.500 N

TL 5060 SAN ANGELO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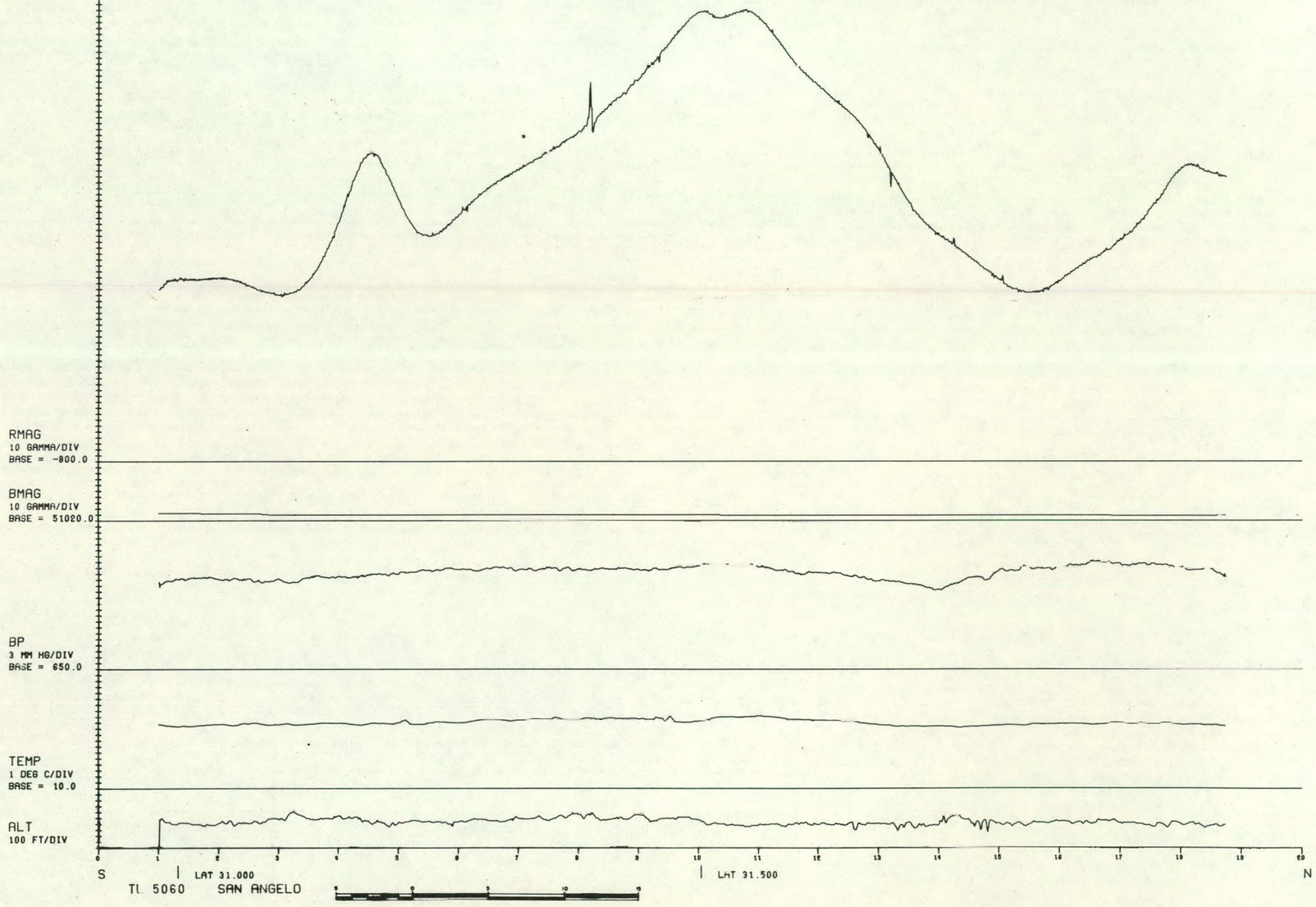
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BP
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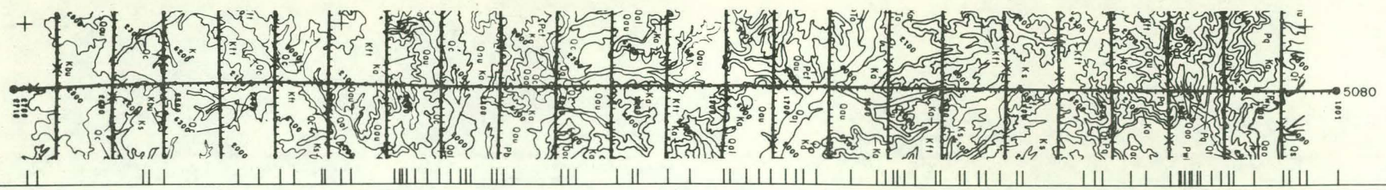
LAT 31.500
N
TL 5060 SAN ANGELO



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BI/K
.40 /DIV

BI/TL
.05 /DIV

GC
400 C/S/DIV

RMAG
20 GAMMAS/DIV
BASE = -500.0

BIAIR
5.0 C/S/DIV

K
.25 PC/DIV

BI
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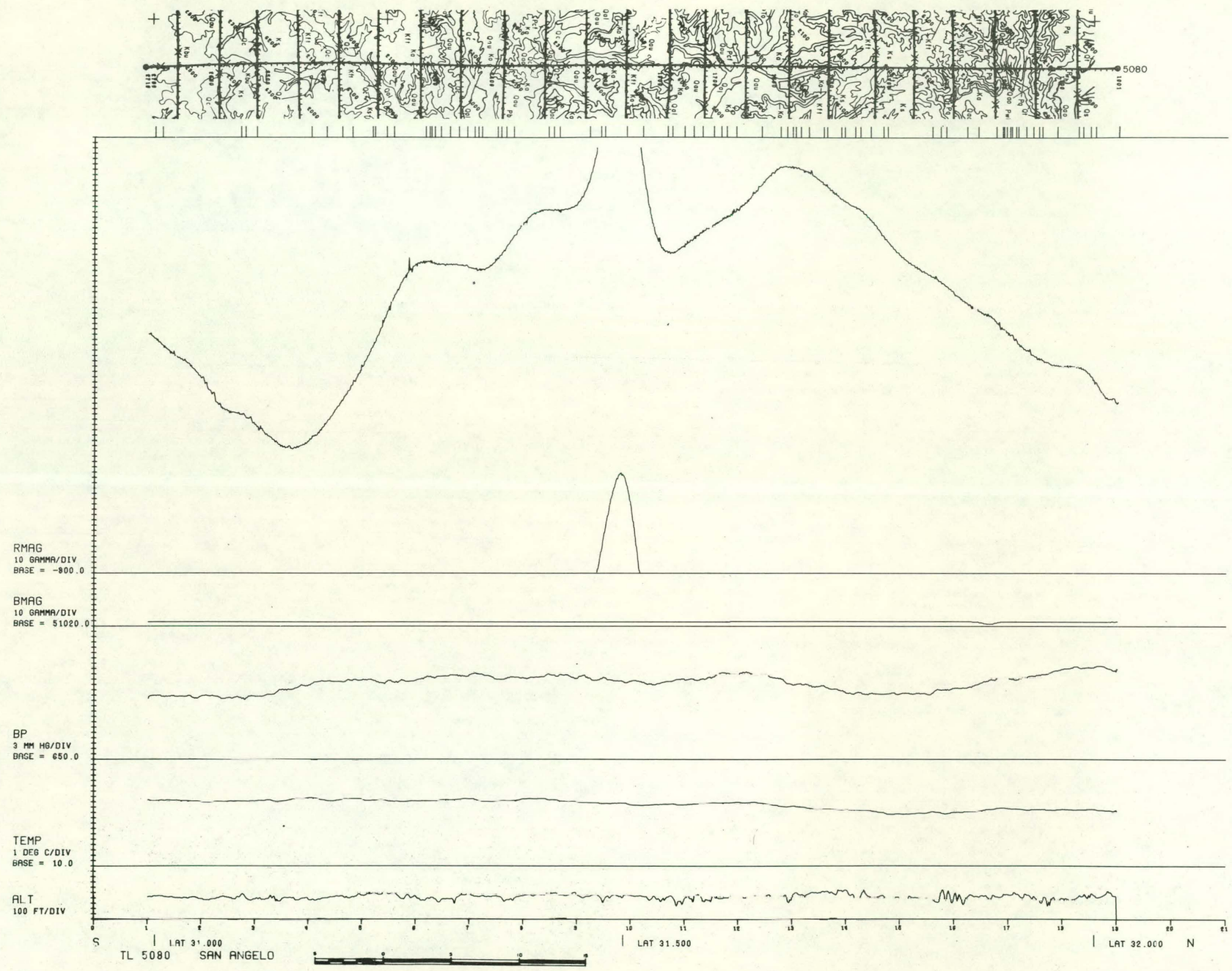
TL
1.5 PPM/DIV

HLT
100 FT/DIV

S | LAT 31.000 | LAT 31.500 | LAT 32.000 N

TL 5080 SAN ANGELO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BMAG
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BP
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TEMP
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BASE = 10.0
ALT
100 FT/DIV
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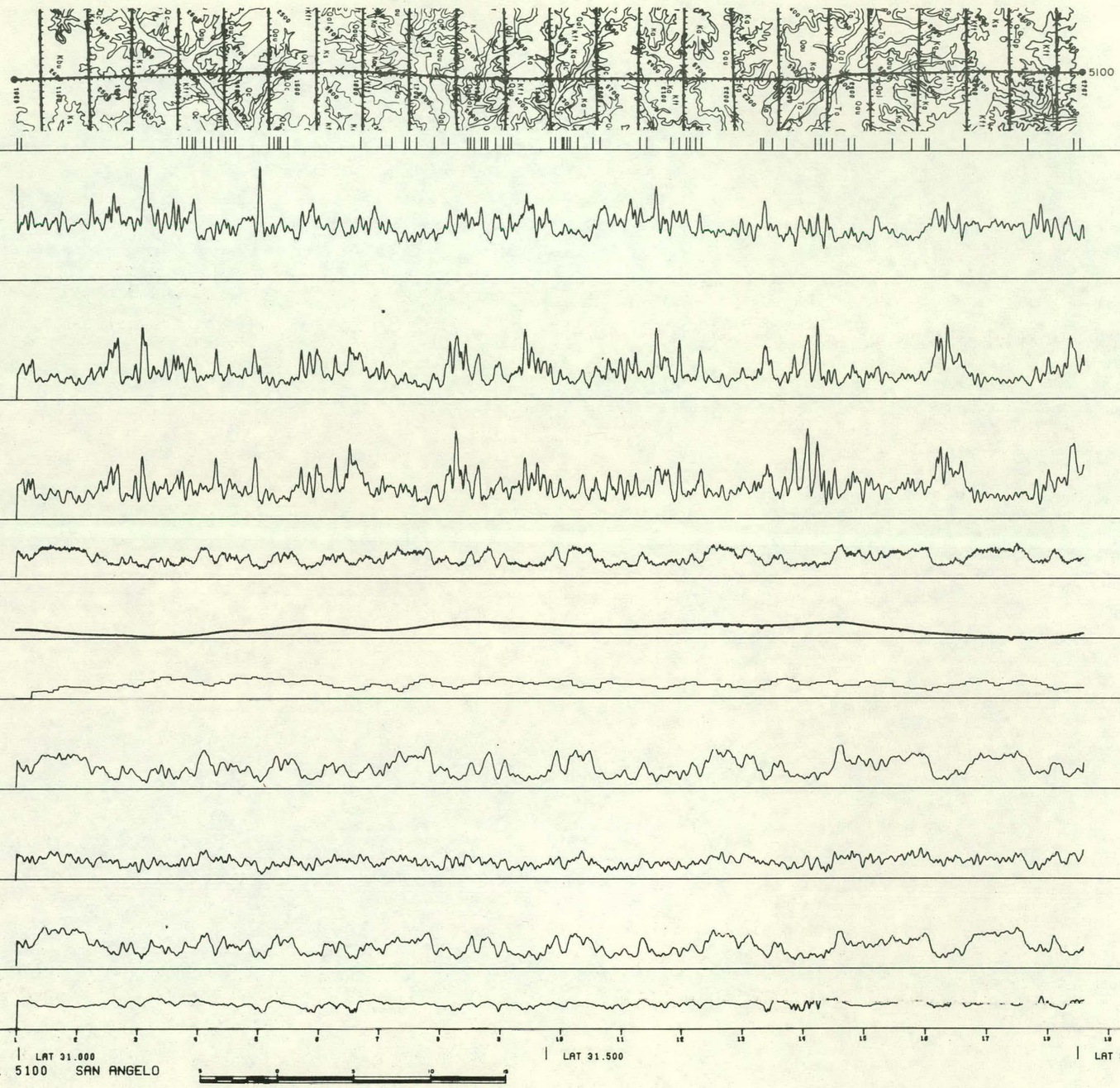
LAT 31.500
LAT 32.000
N
TL 5080 SAN ANGELO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BI/K
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BI/TL
.05 /DIV
GC
400 C/S/DIV
RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
TL
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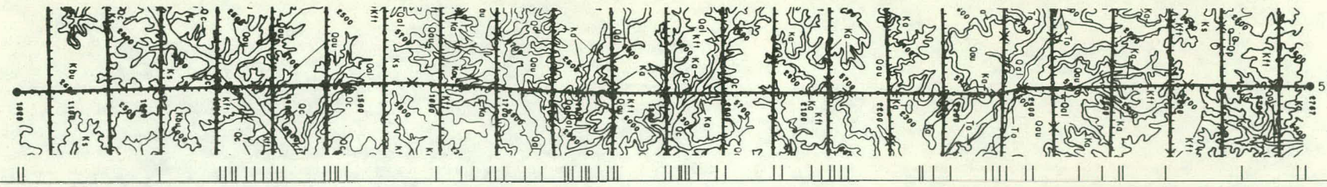
ALT
100 FT/DIV
S
LAT 31.000
LAT 31.500
LAT 32.000 N
TL 5100 SAN ANGELO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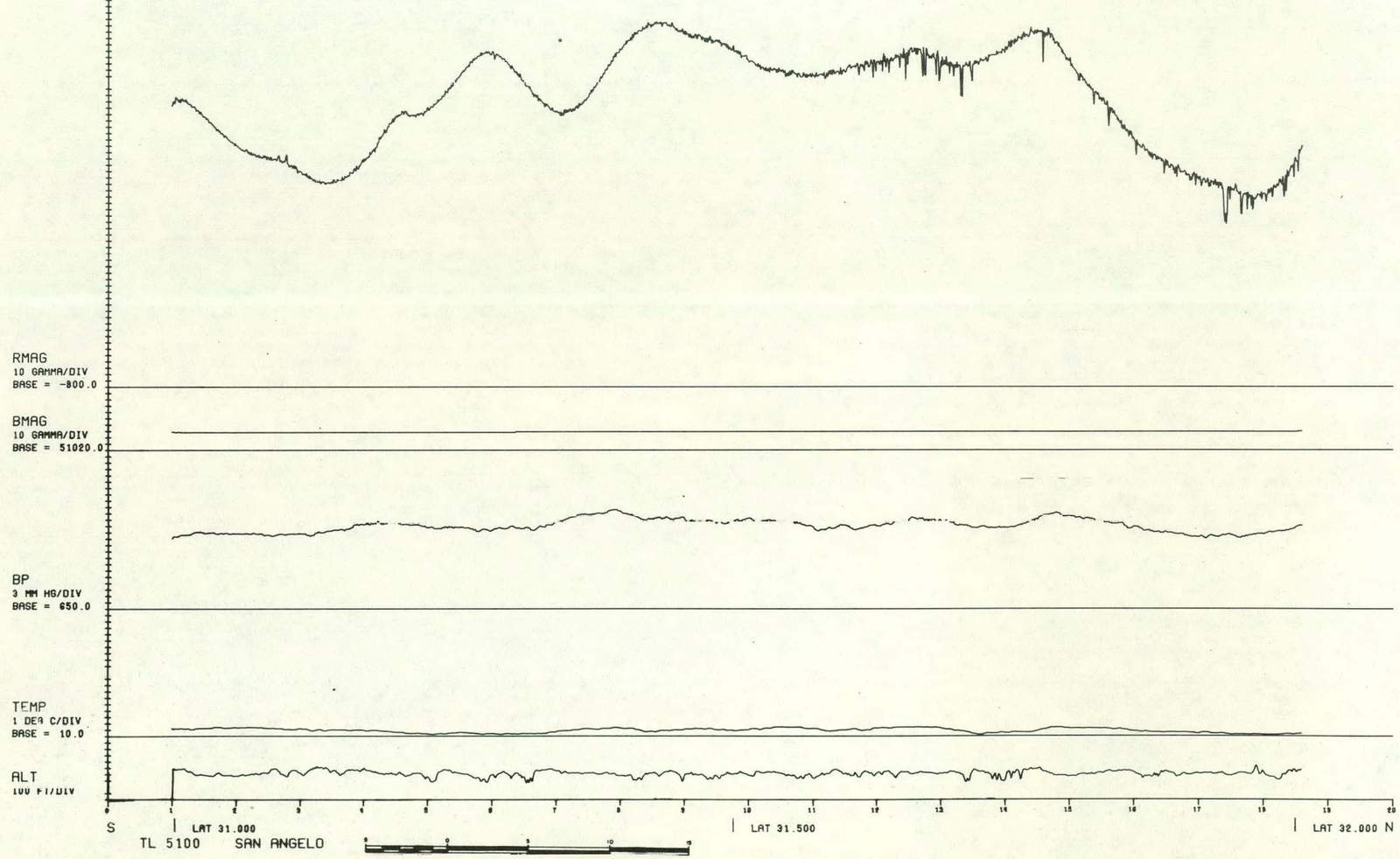
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BP
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ALT
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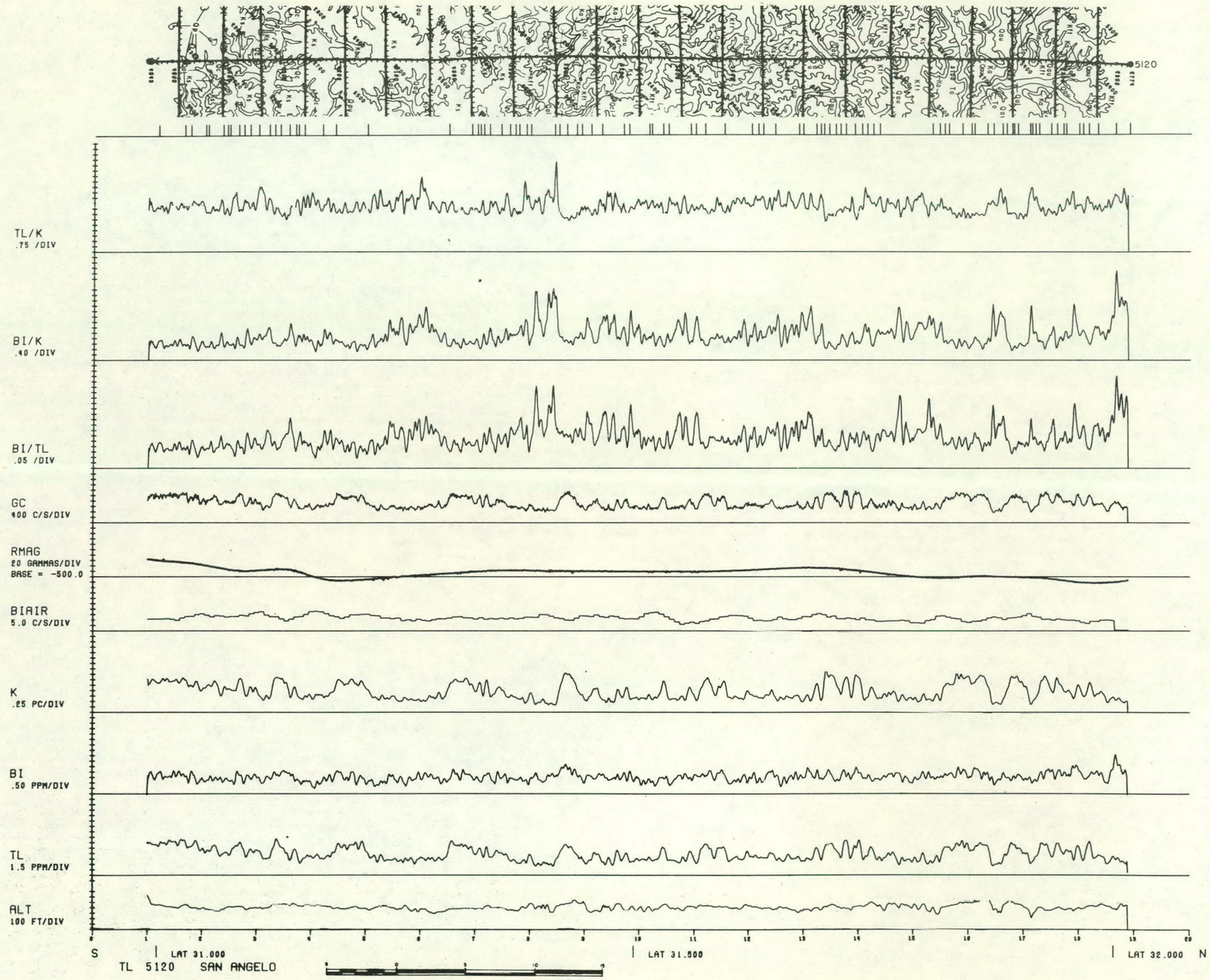
LAT 31.500
LAT 32.000 N
TL 5100 SAN ANGELO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BI/TL
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GC
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RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
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ALT
100 FT/DIV
S
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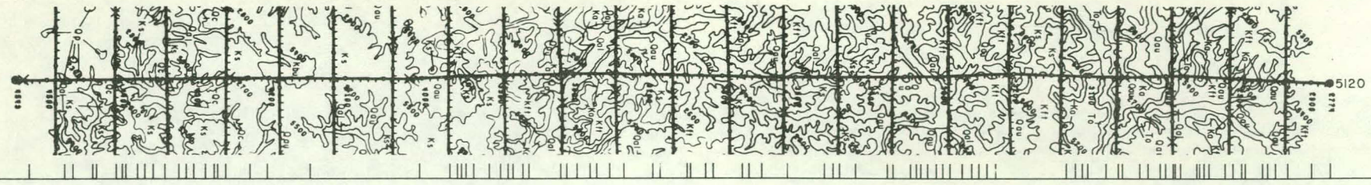
LAT 31.500
LAT 32.000
N
TL 5120 SAN ANGELO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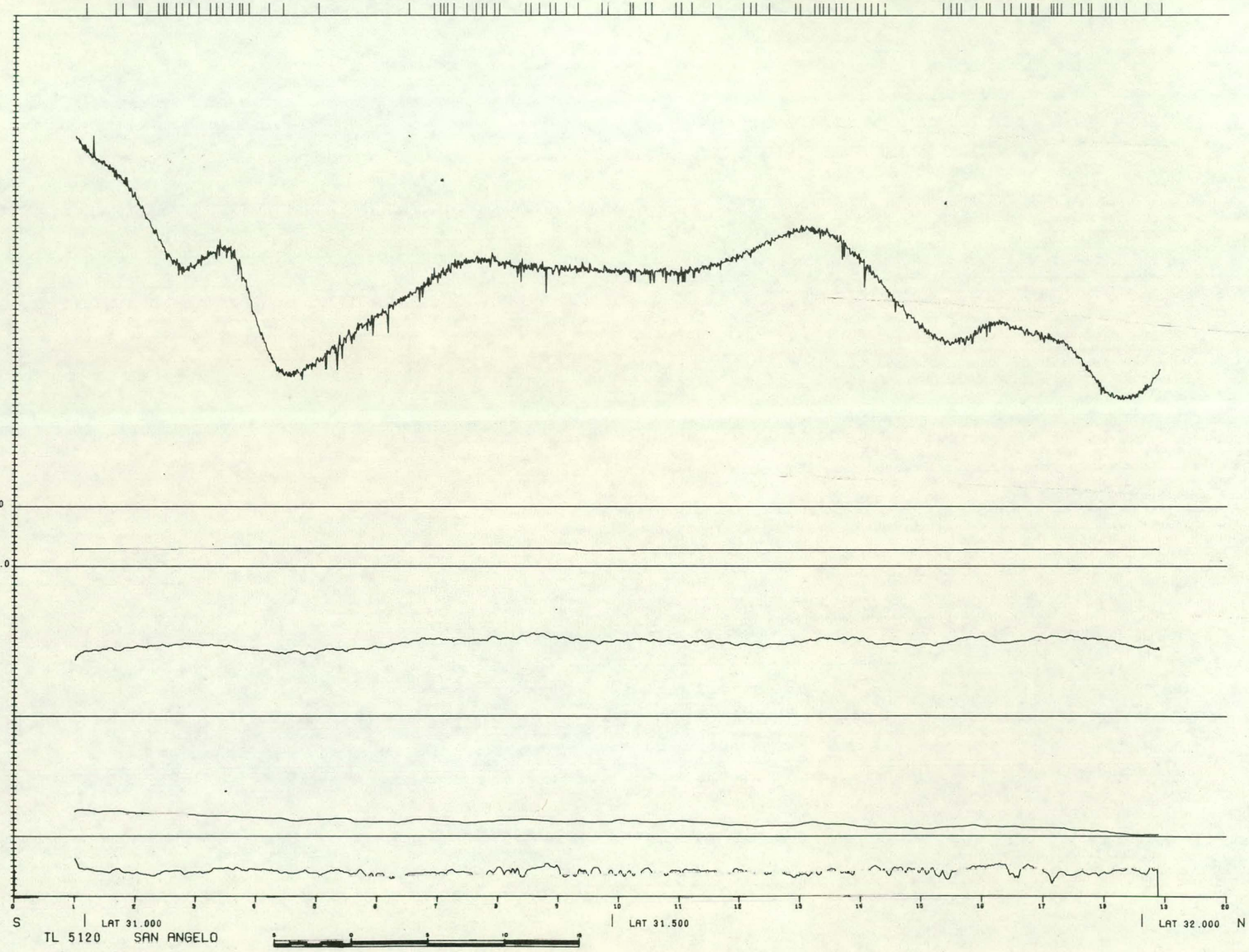
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BMAG
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BP
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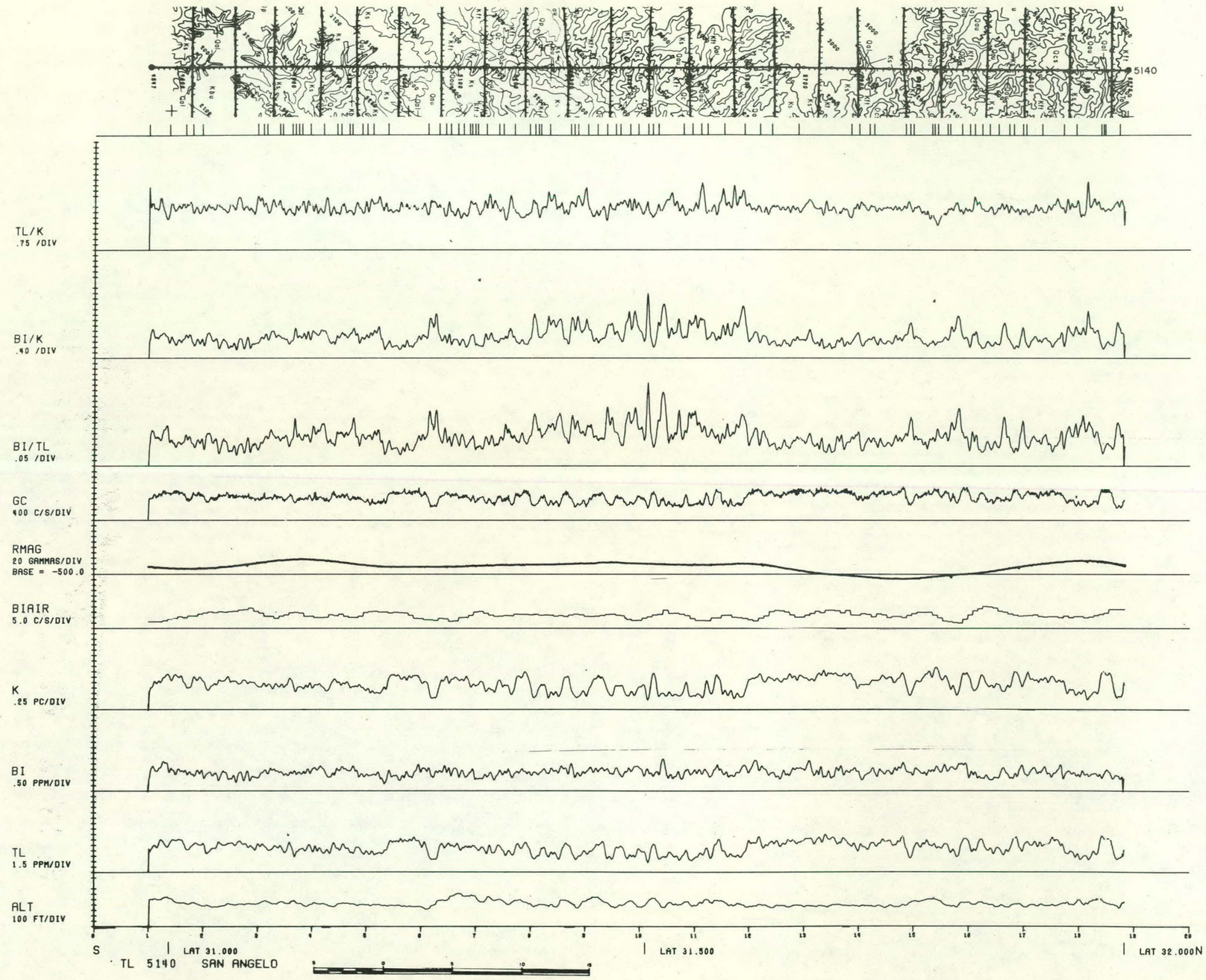
LAT 31.500
LAT 32.000
N
TL 5120 SAN ANGELO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BI/TL
.05 /DIV
GC
400 C/S/DIV
RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
TL
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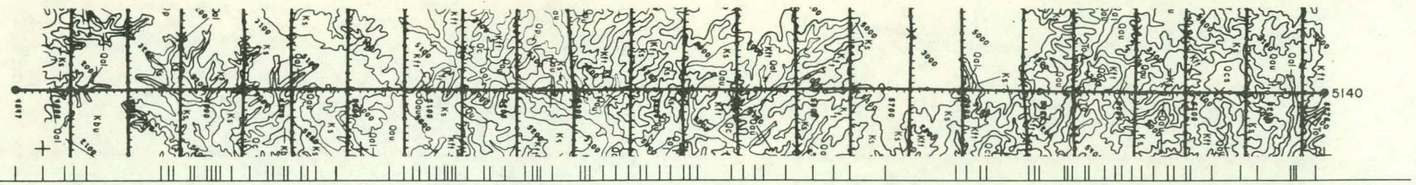
ALT
100 FT/DIV
S
LAT 31.000
LAT 31.500
LAT 32.000N
TL 5140 SAN ANGELO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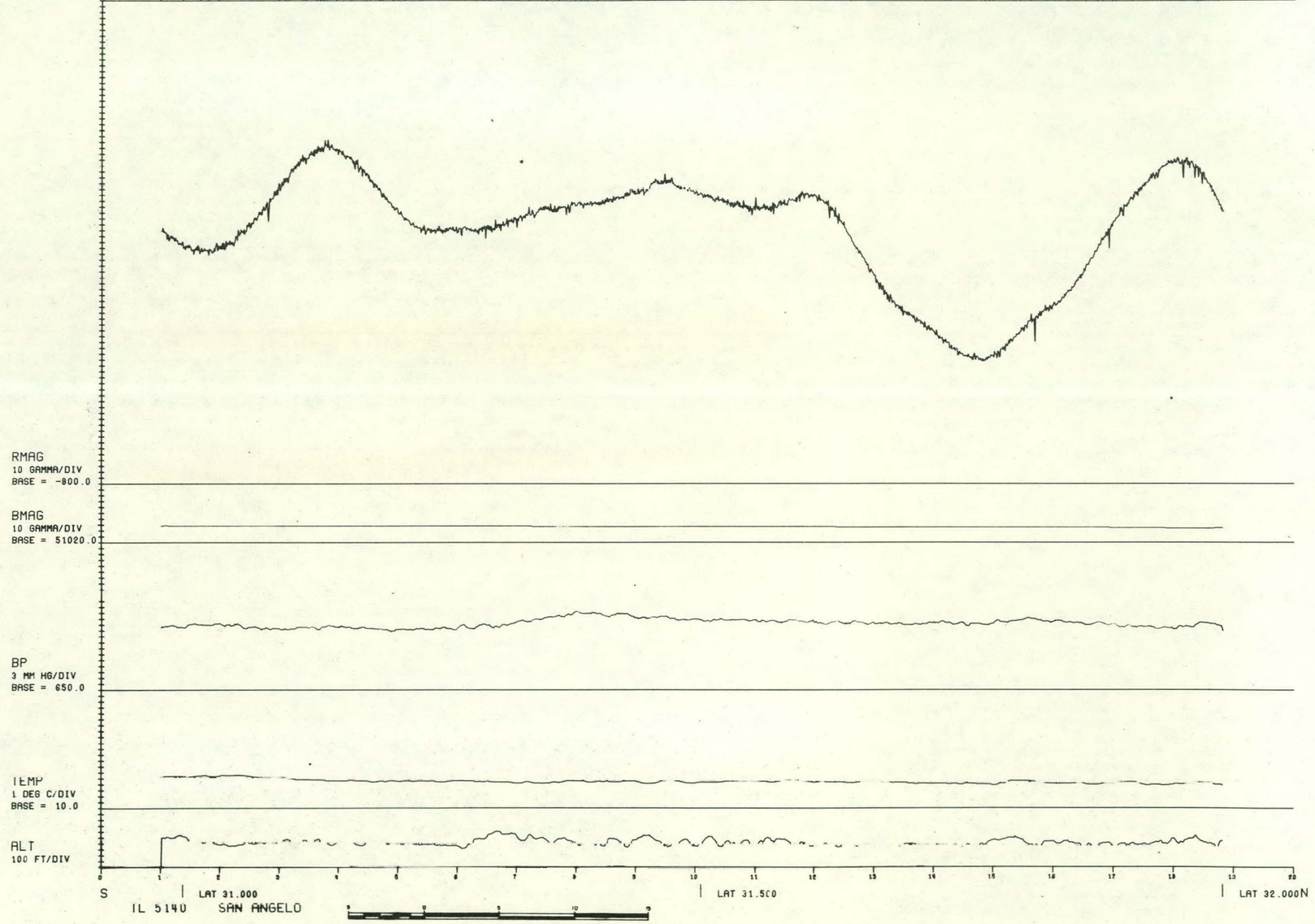
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ALT
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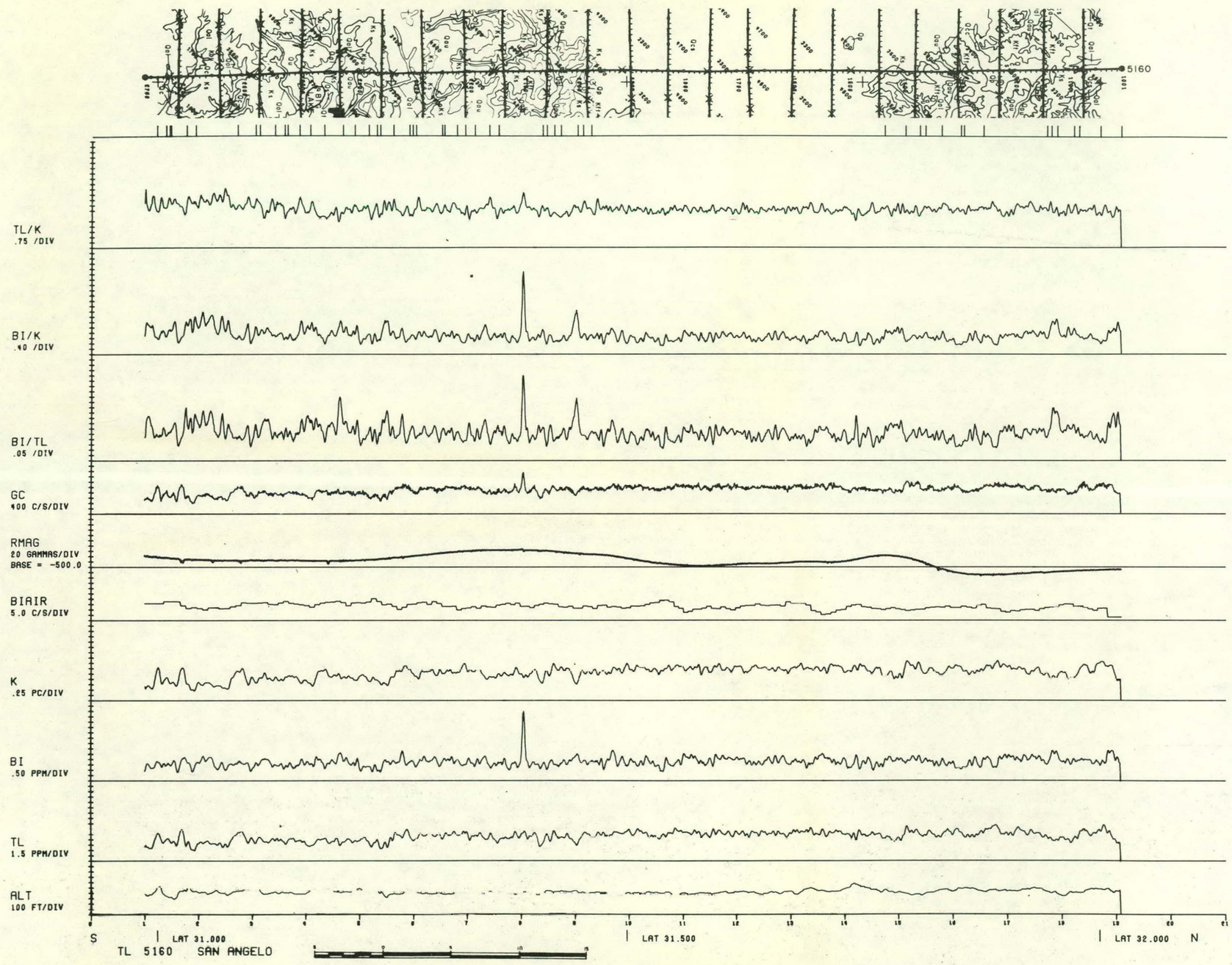
LAT 31.500
LAT 32.000N
IL 5140 SAN ANGELO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BI/TL
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GC
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RMAG
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BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
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ALT
100 FT/DIV
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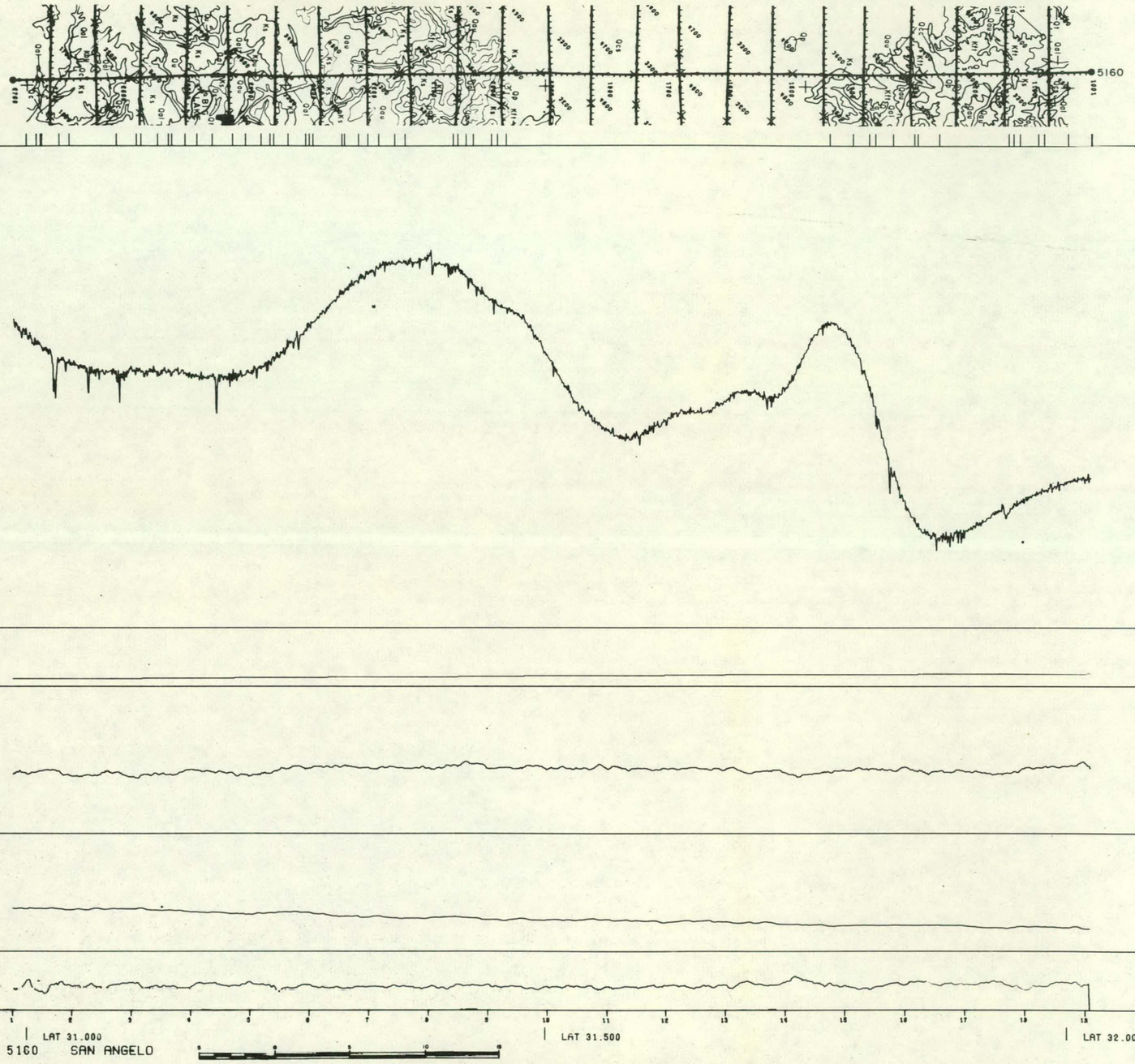
LAT 31.500
LAT 32.000
N
TL 5160 SAN ANGELO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TEMP
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LAT 32.000
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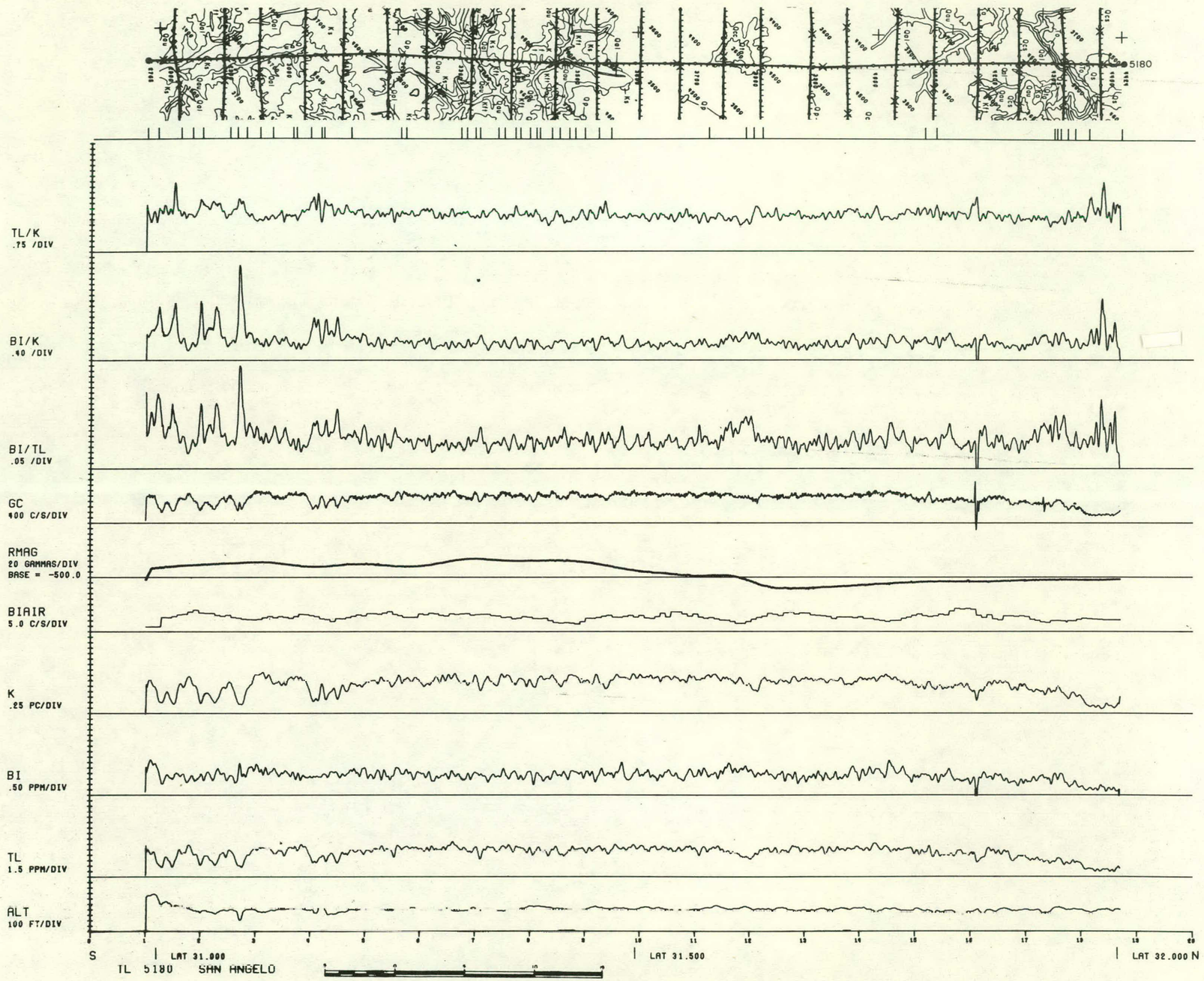
TL 5160 SAN ANGELO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BI/TL
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RMAG
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BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
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ALT
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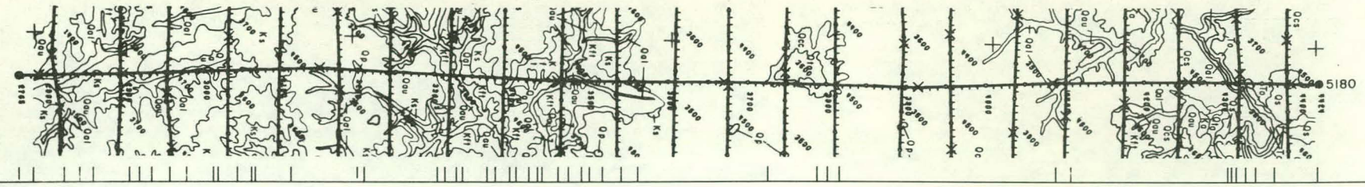
LAT 32.000 N
TL 5180 SAN ANGELO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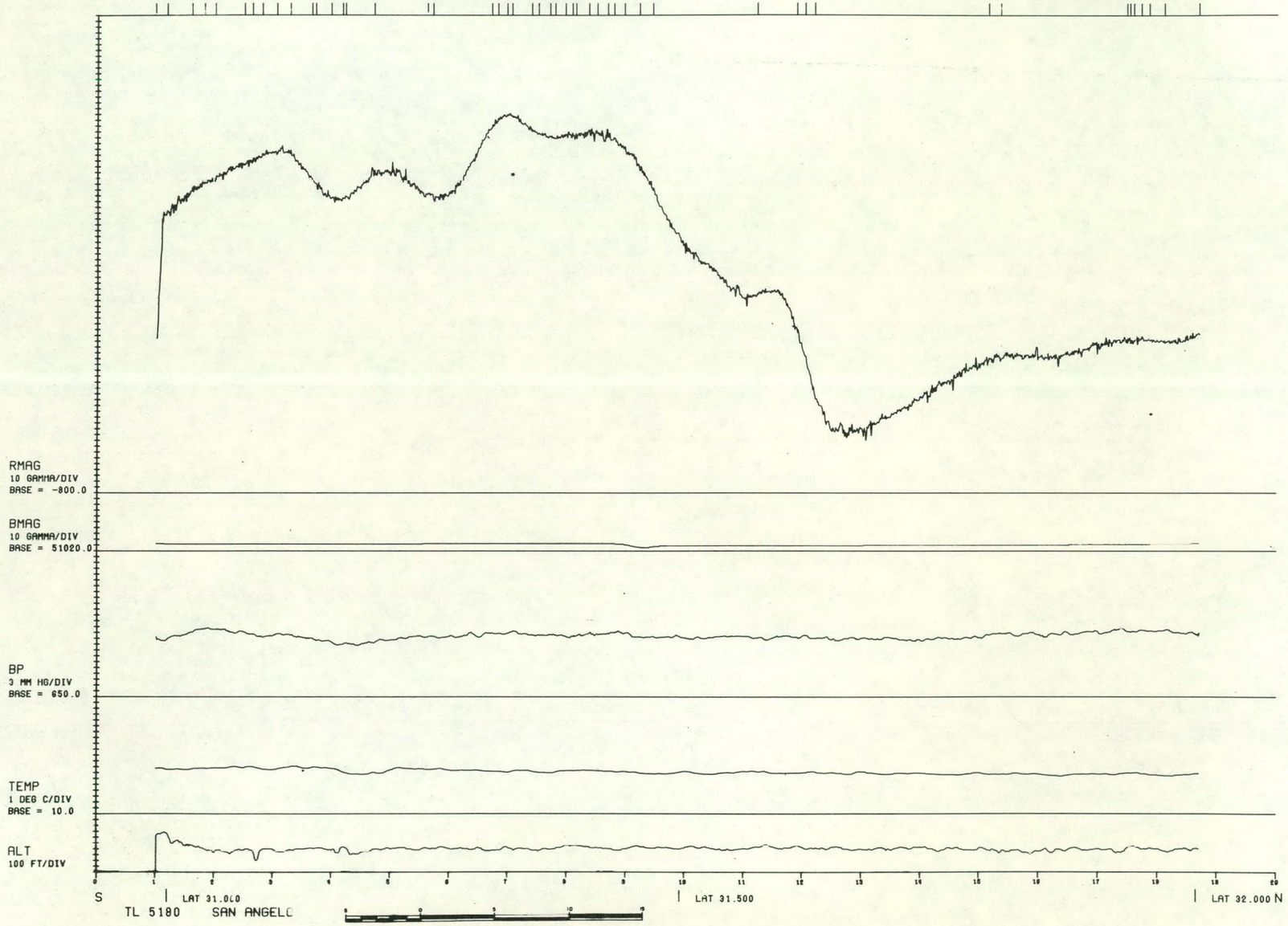
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BP
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BASE = 650.0
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ALT
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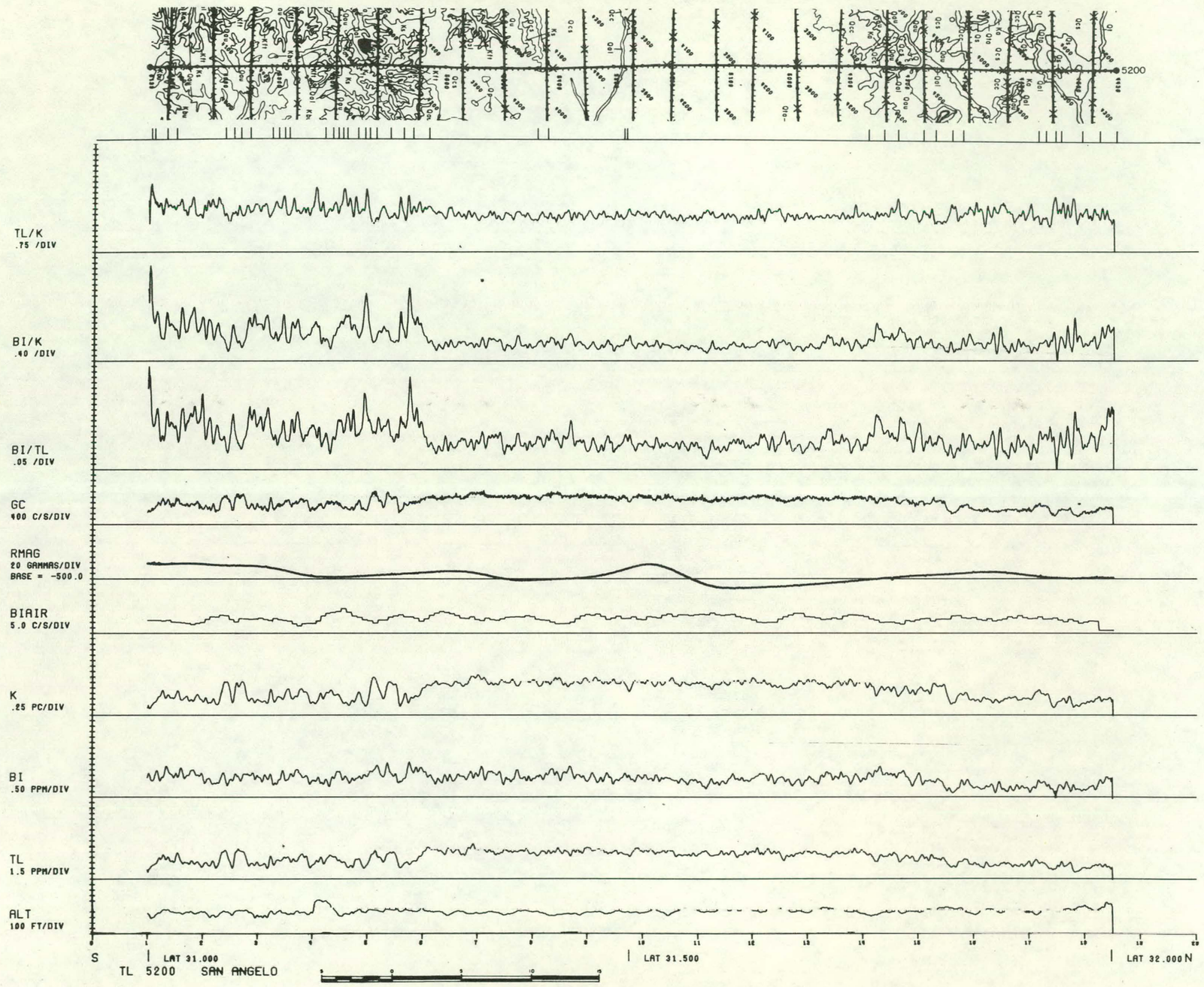
LAT 31.500
LAT 32.000 N
TL 5180 SAN ANGELO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BI/K
.40 /DIV
BI/TL
.05 /DIV
GC
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RMAG
20 GAMMAS/DIV
BASE = -500.0
BIAIR
5.0 C/S/DIV
K
.25 PC/DIV
BI
.50 PPM/DIV
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ALT
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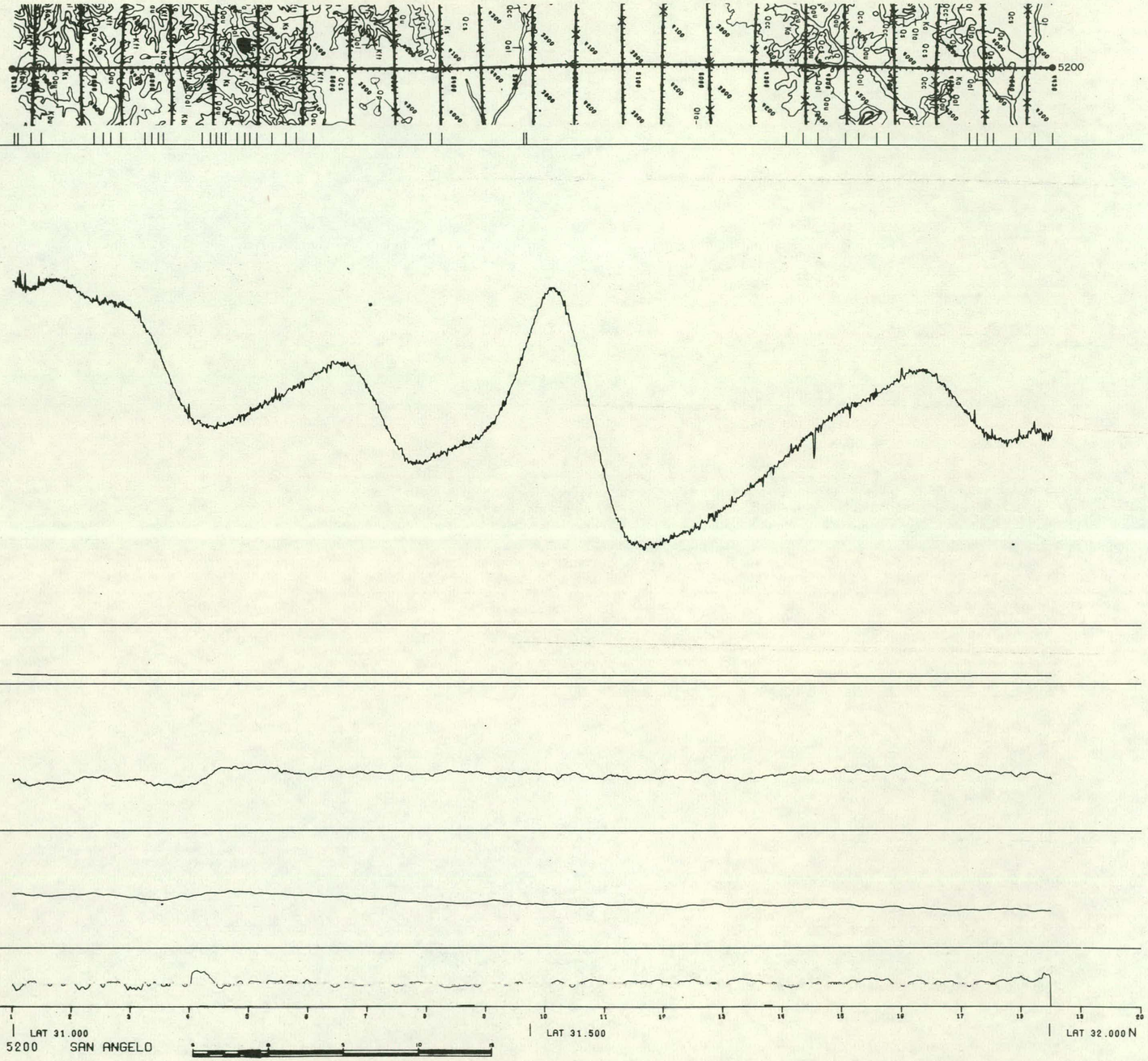
LAT 31.500
LAT 32.000 N
TL 5200 SAN ANGELO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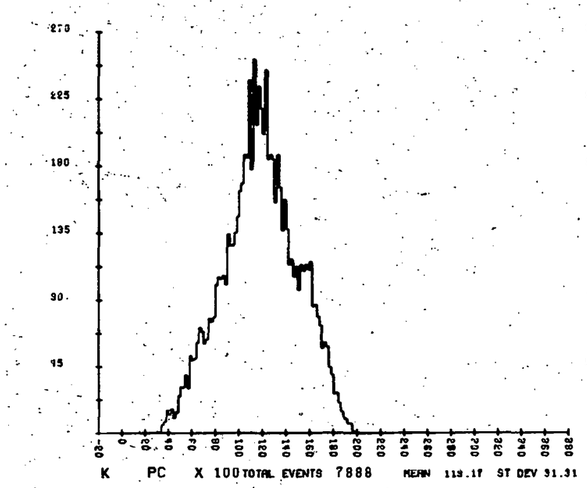
LAT 31.500
LAT 32.000 N
TL 5200 SAN ANGELO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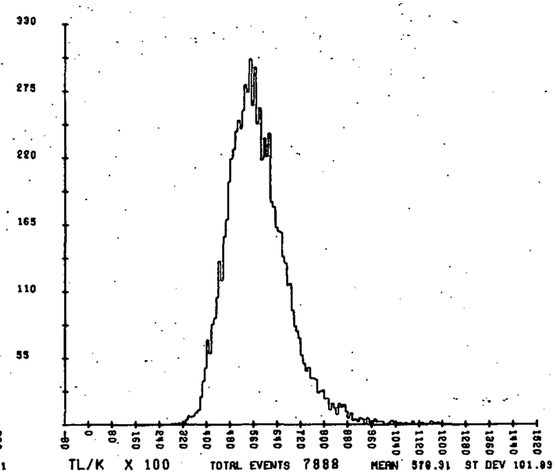
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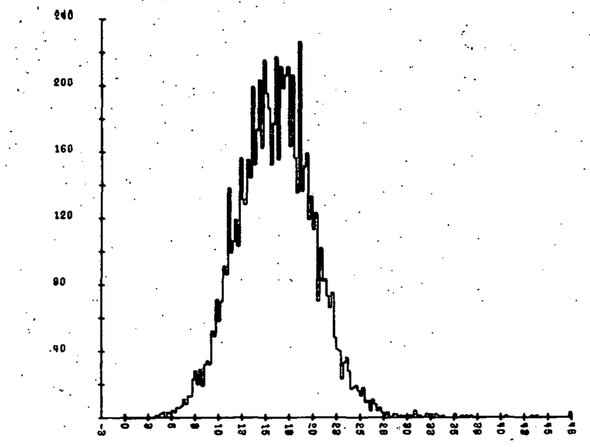
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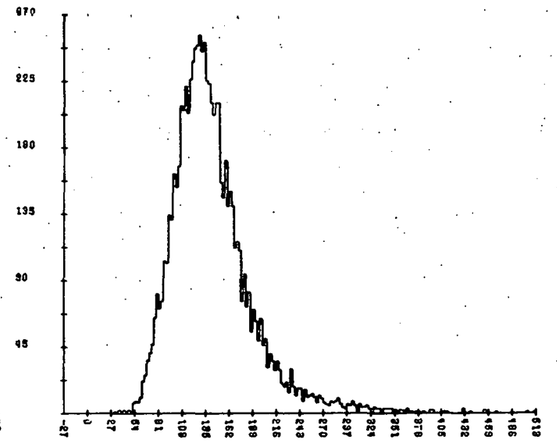
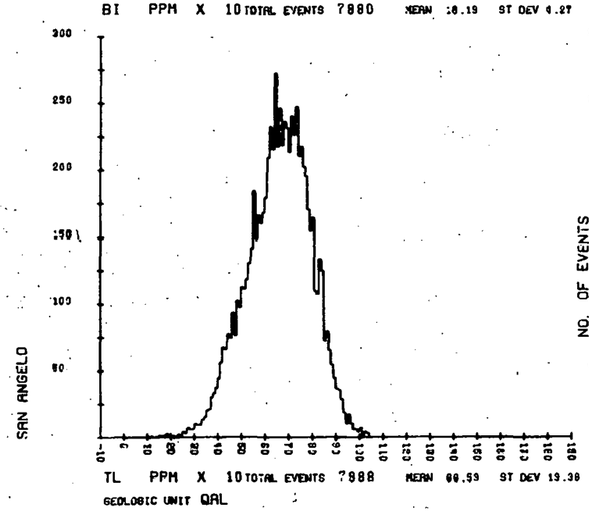

BI/K X 100 TOTAL EVENTS 7880 MEAN 143.22 ST DEV 46.72


SAN ANGELO
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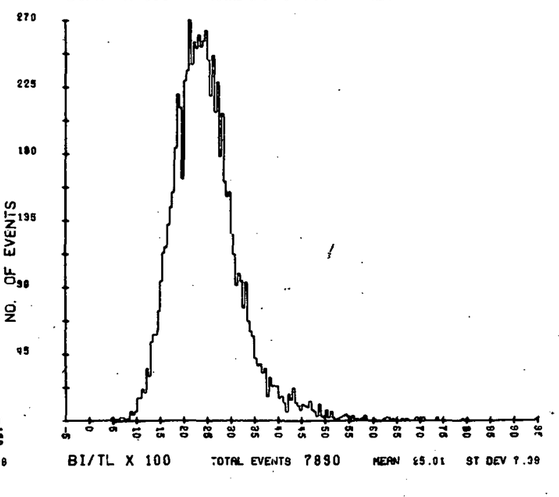
GEOLOGIC UNIT QAL


NO. OF EVENTS
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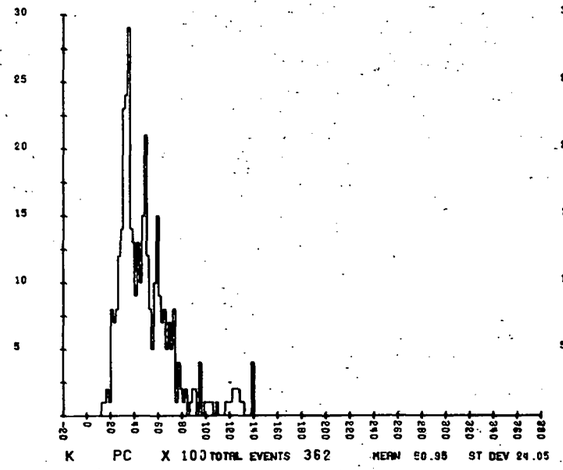
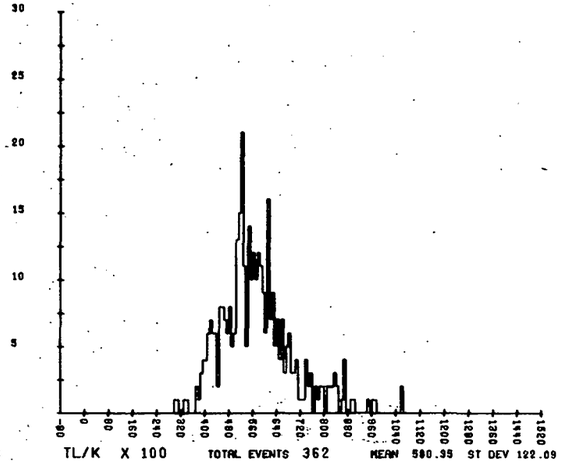
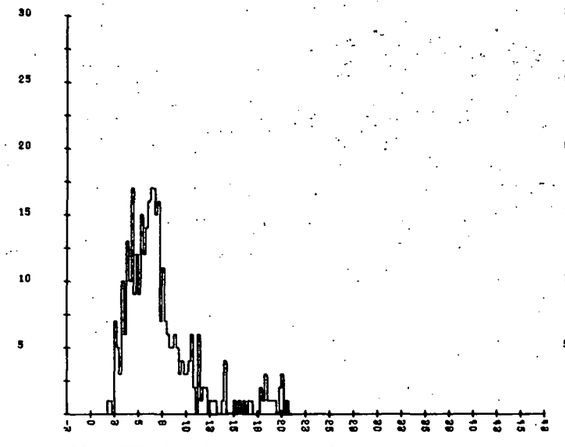
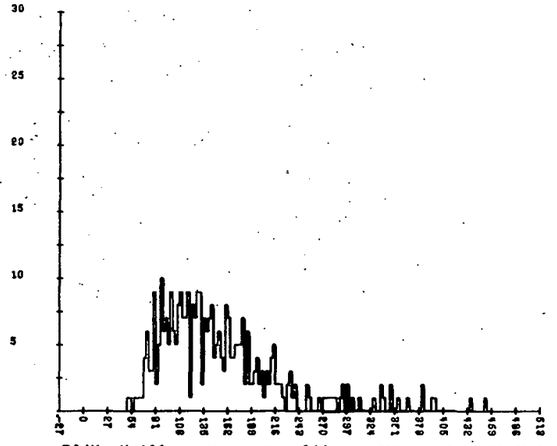
A 1


K PC X 100 TOTAL EVENTS 362 MEAN 50.35 ST DEV 24.05


TL/K X 100 TOTAL EVENTS 362 MEAN 580.35 ST DEV 122.09


BI PPM X 10 TOTAL EVENTS 341 MEAN 7.30 ST DEV 3.70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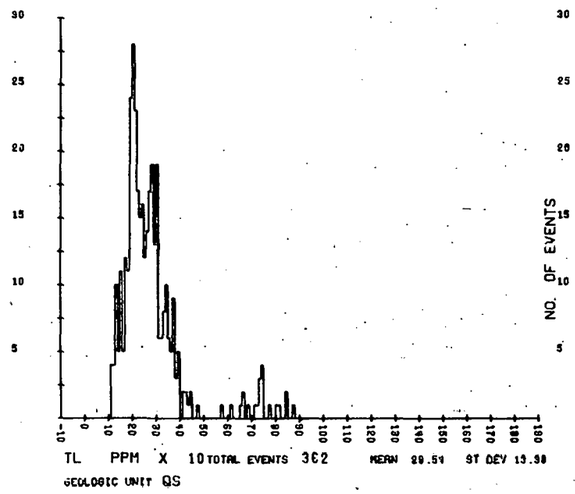
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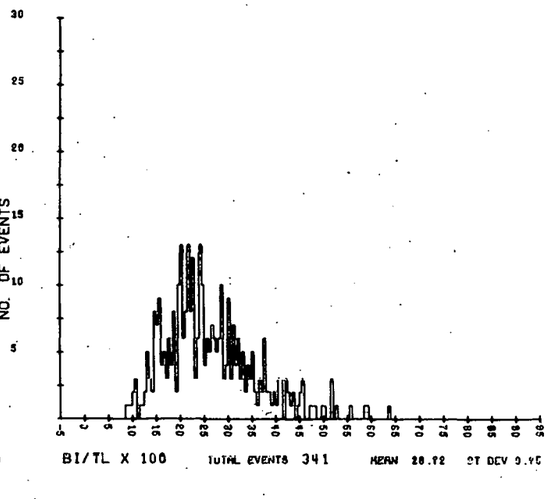
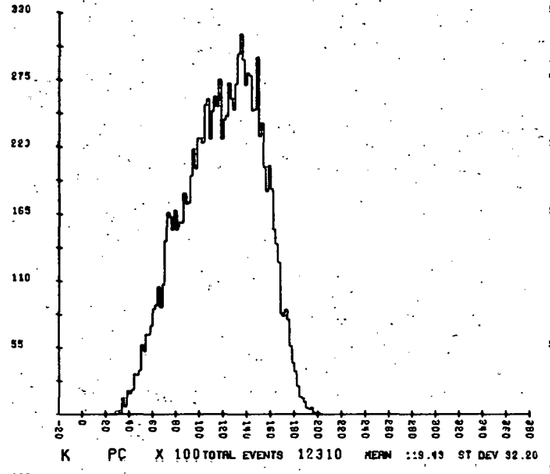
TL PPM X 10 TOTAL EVENTS 362 MEAN 29.54 ST DEV 13.58
GEOLOGIC UNIT QS


NO. OF EVENTS
BI/TL X 100 TOTAL EVENTS 341 MEAN 28.72 ST DEV 9.90

A 2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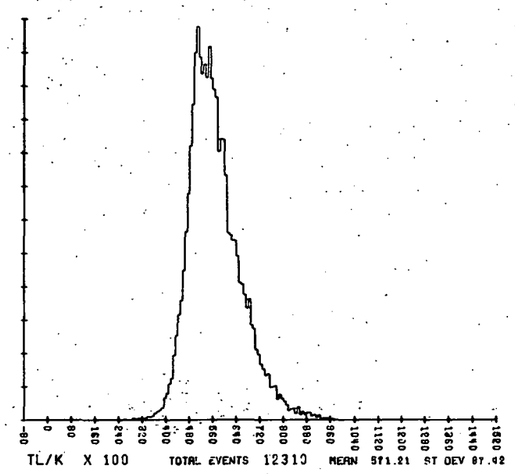
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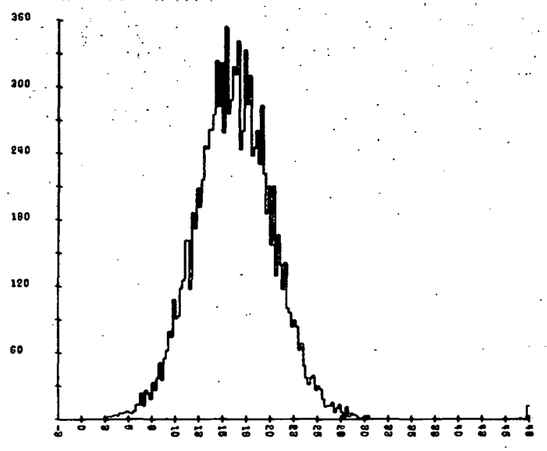
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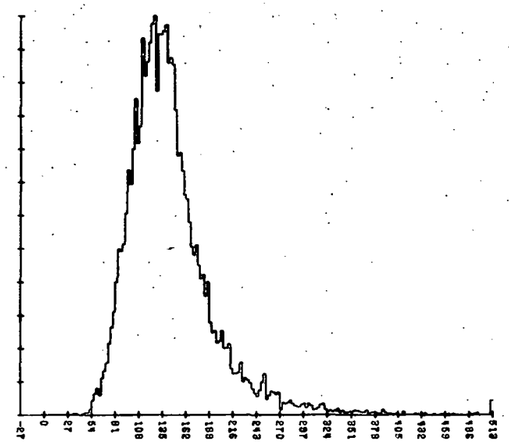
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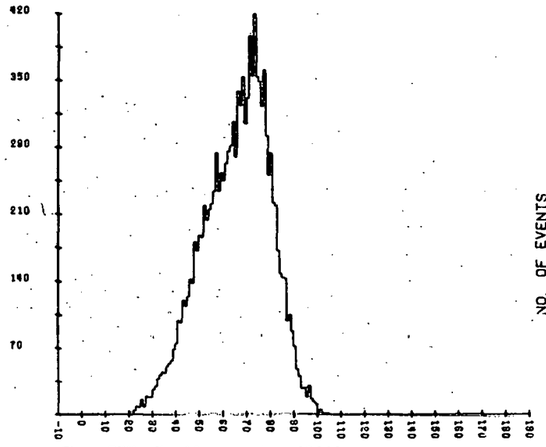
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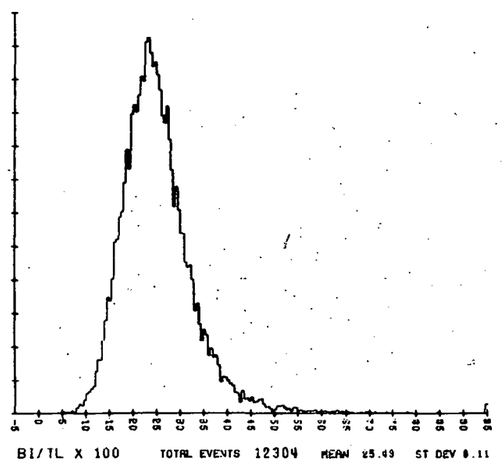
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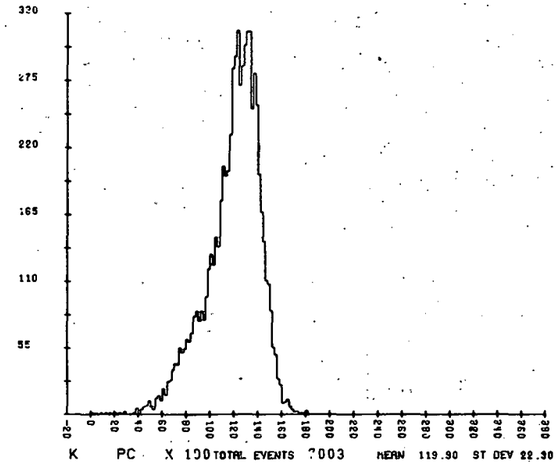
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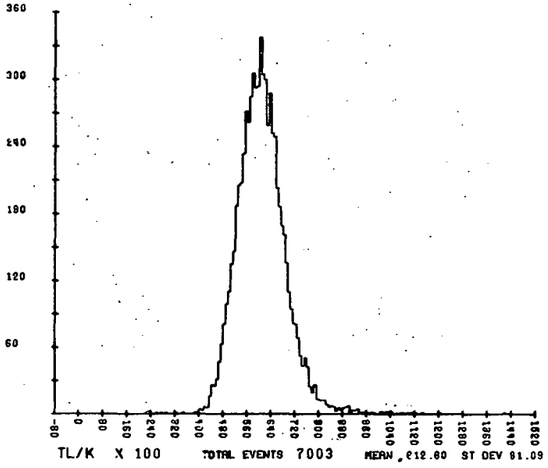
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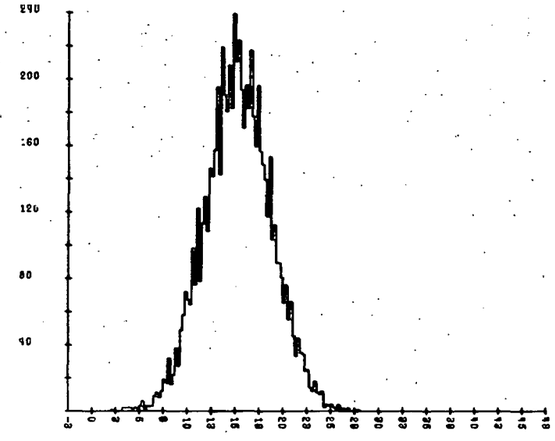
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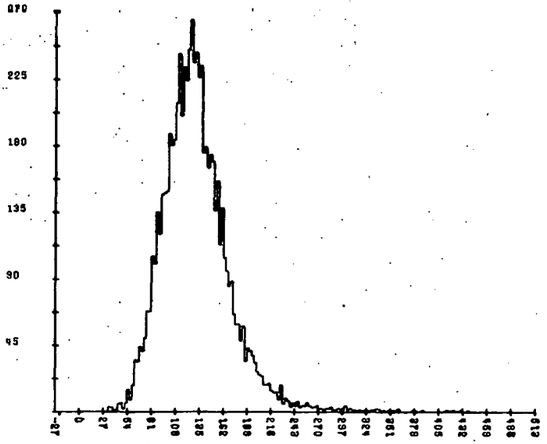
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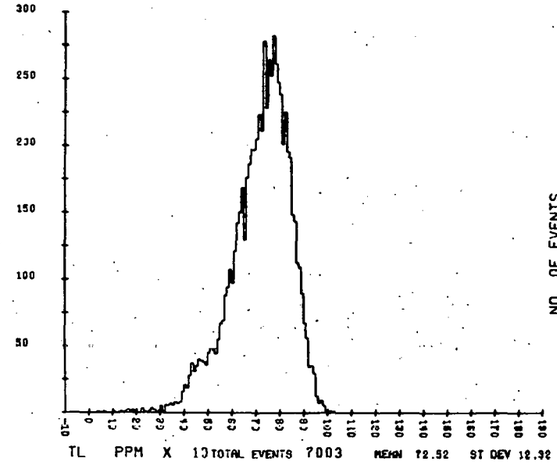
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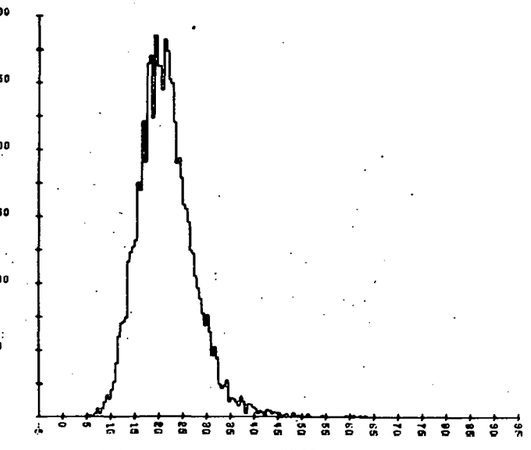
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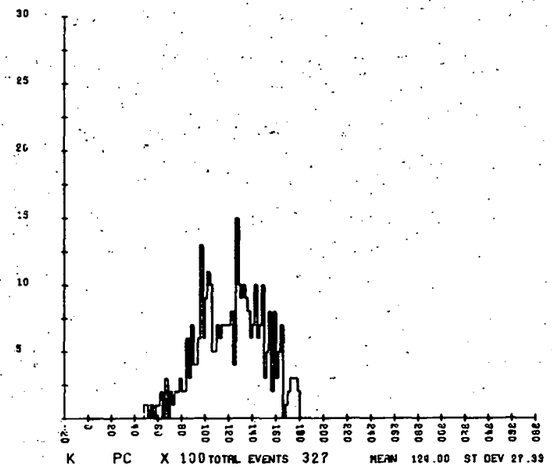
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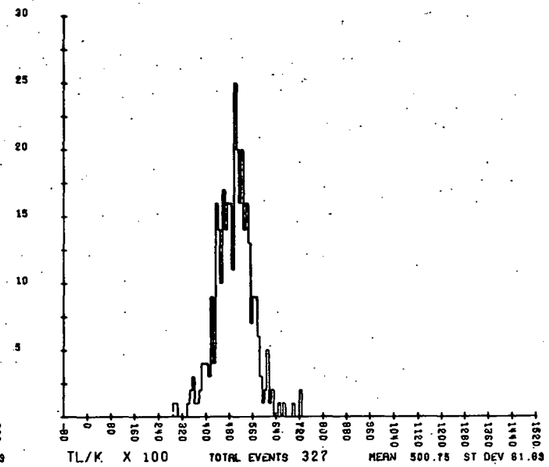
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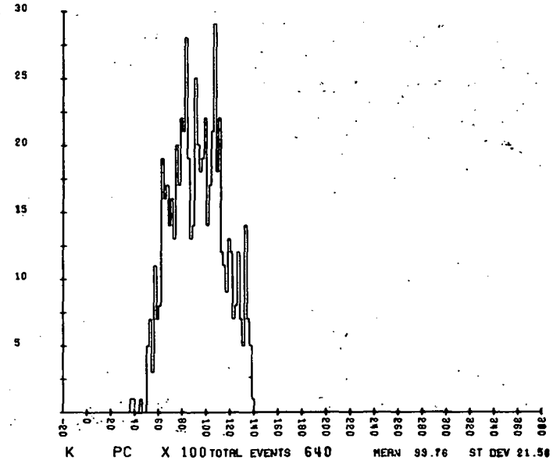
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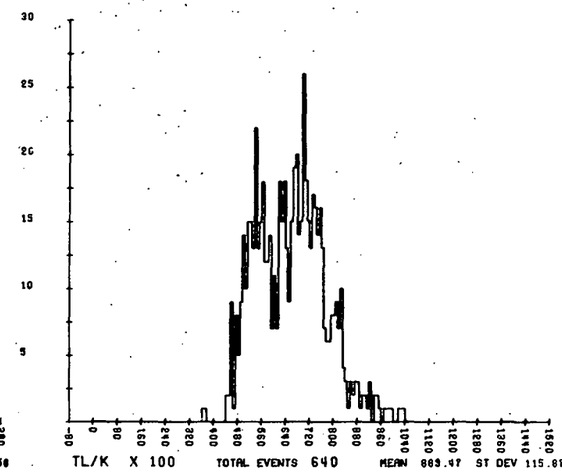
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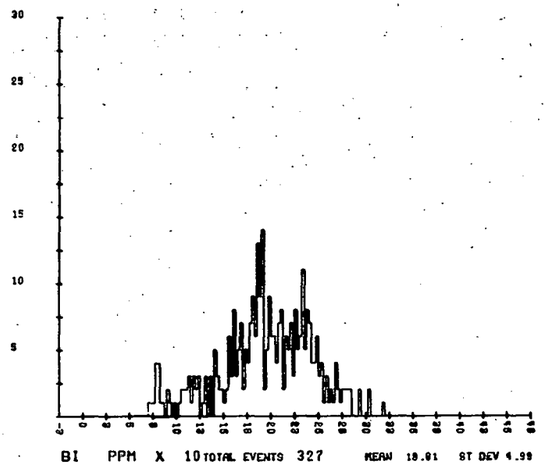
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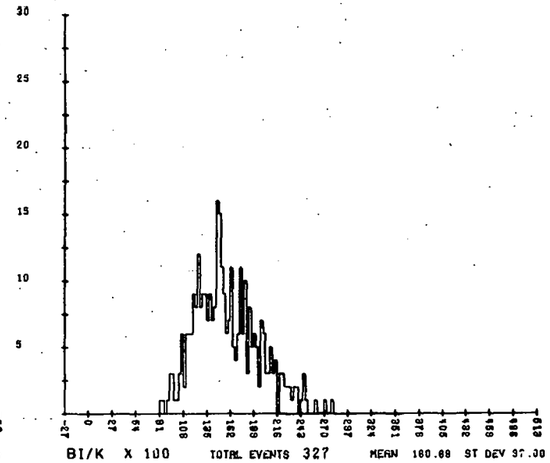
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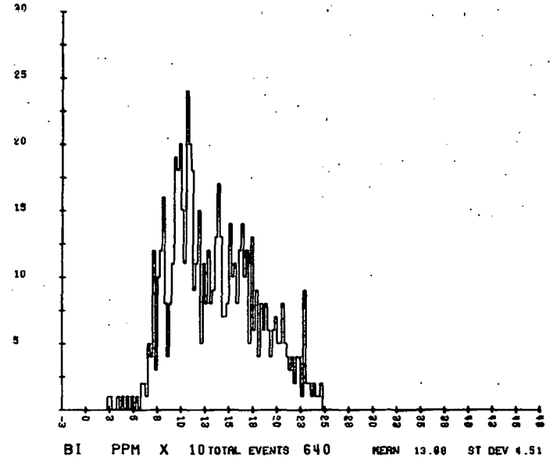
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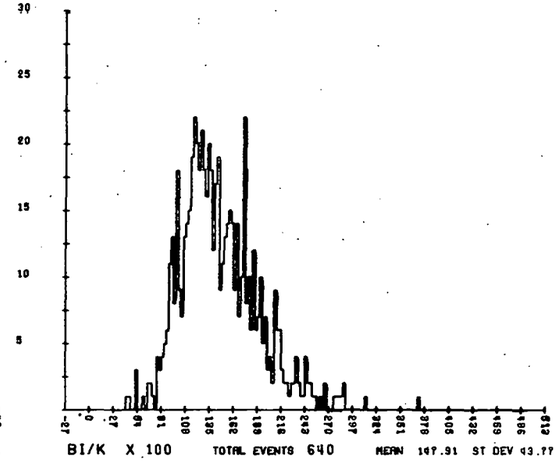
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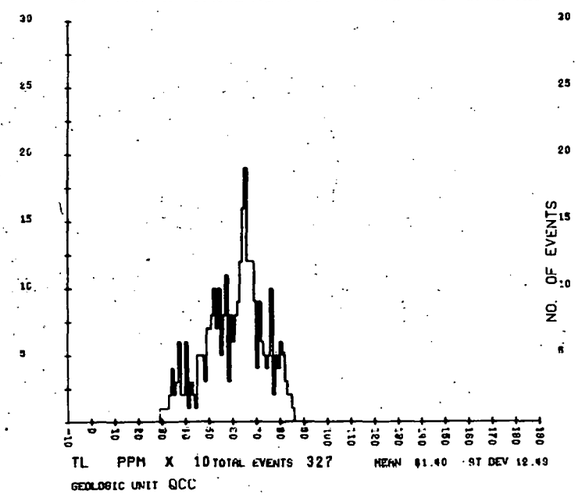
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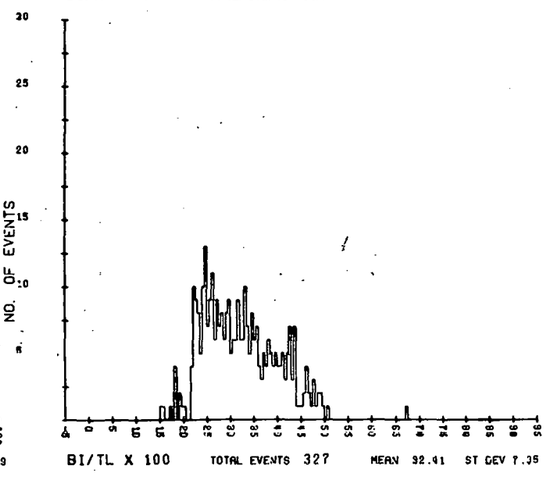
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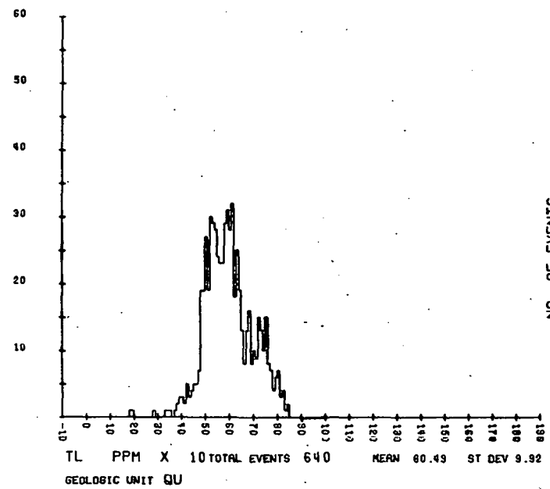
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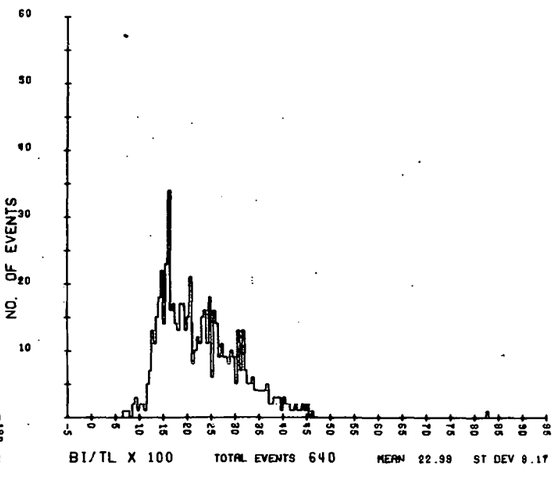
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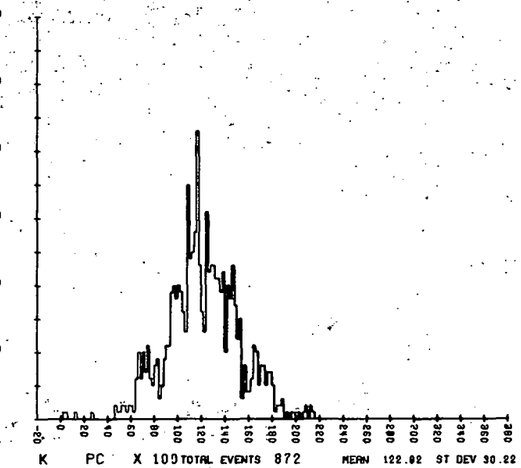
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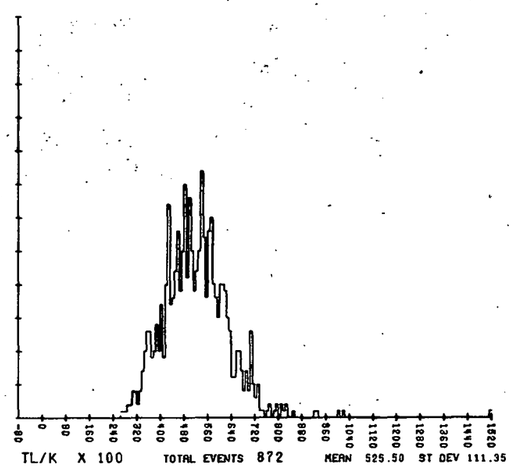
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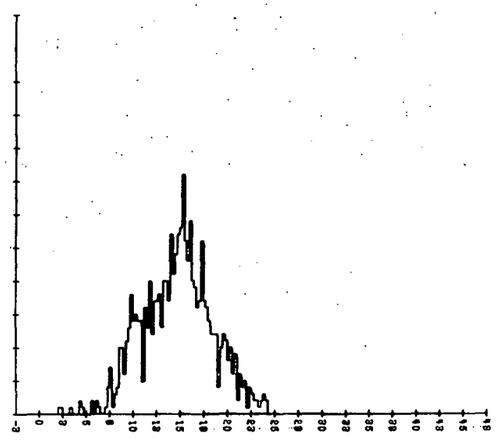
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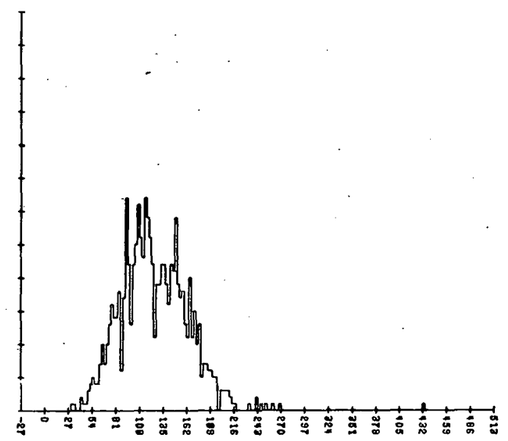
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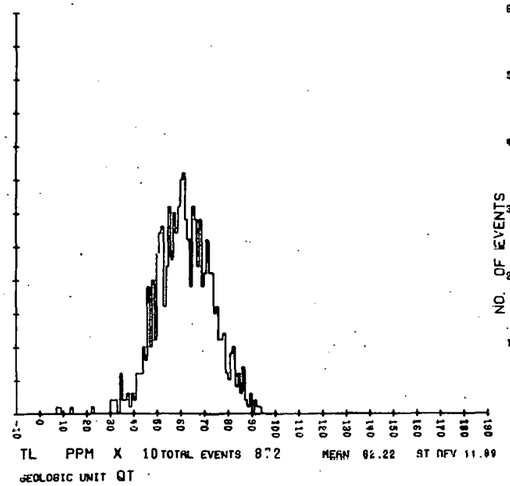
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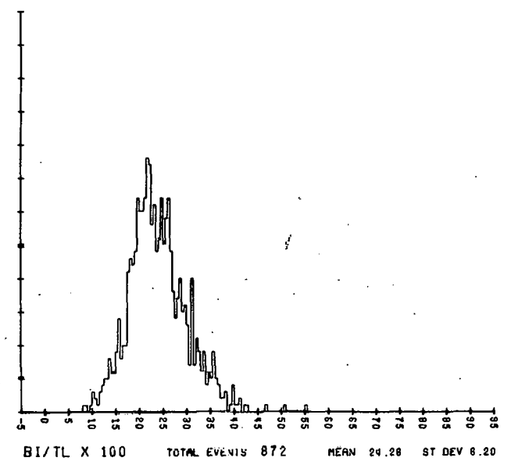
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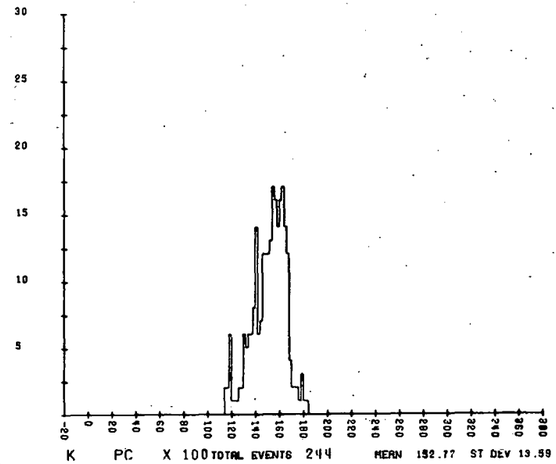
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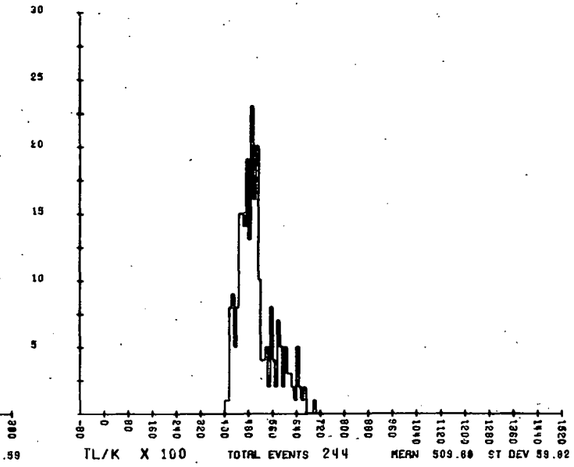
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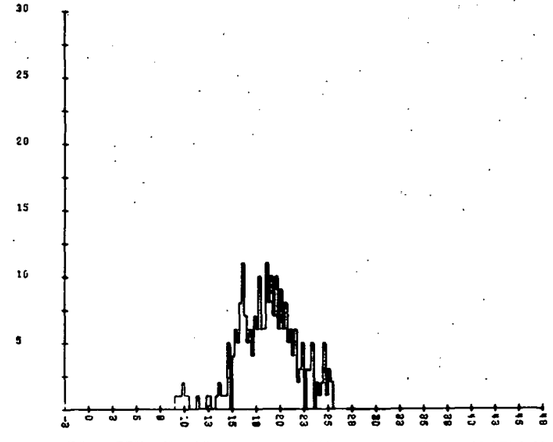
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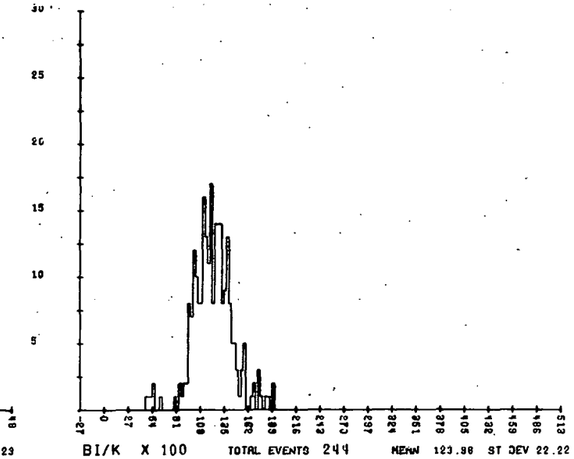
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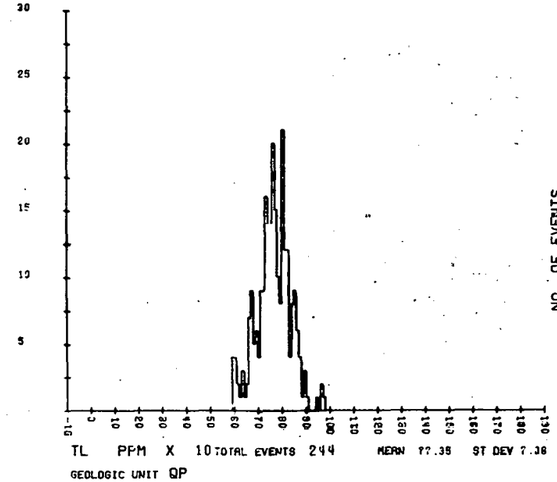
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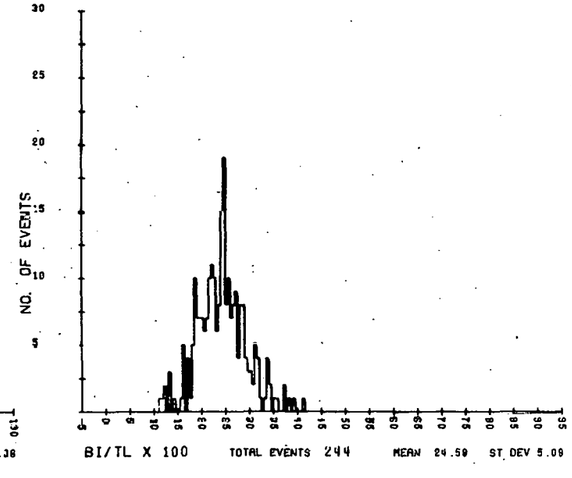
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K PC X 100 TOTAL EVENTS 592 MEAN 100.49 ST DEV 21.09

TL/K X 100 TOTAL EVENTS 592 MEAN 643.89 ST DEV 77.74

BI PPM X 10 TOTAL EVENTS 592 MEAN 19.08 ST DEV 3.47

BI/K X 100 TOTAL EVENTS 592 MEAN 135.96 ST DEV 45.05

SAN ANGELO
TL PPM X 10 TOTAL EVENTS 592 MEAN 63.91 ST DEV 12.11
GEOLOGIC UNIT QS3

NO. OF EVENTS
BI/TL X 100 TOTAL EVENTS 592 MEAN 21.20 ST DEV 6.84

K PC X 100 TOTAL EVENTS 1332 MEAN 95.26 ST DEV 20.55

TL/K X 100 TOTAL EVENTS 1332 MEAN 609.97 ST DEV 121.11

BI PPM X 10 TOTAL EVENTS 1328 MEAN 19.10 ST DEV 3.68

BI/K X 100 TOTAL EVENTS 1328 MEAN 140.08 ST DEV 47.24

SAN ANGELO
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GEOLOGIC UNIT QAO

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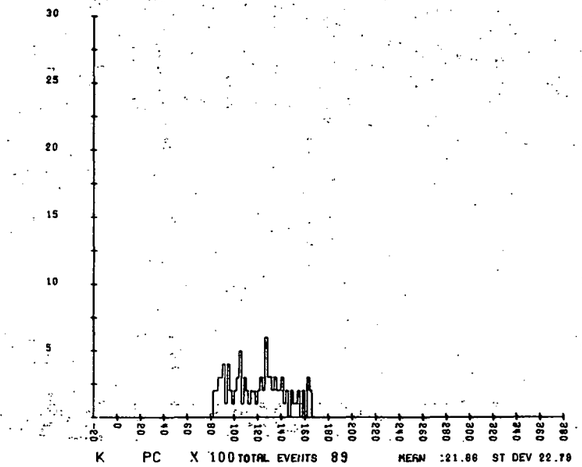
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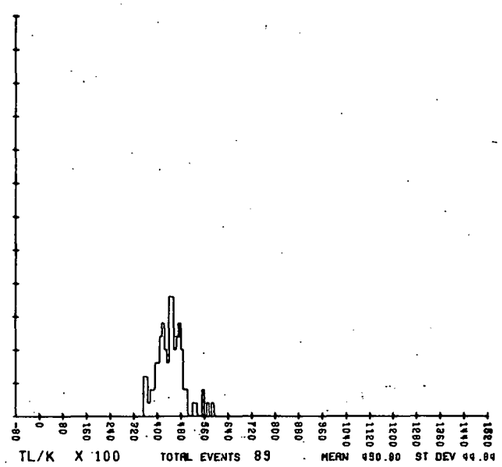
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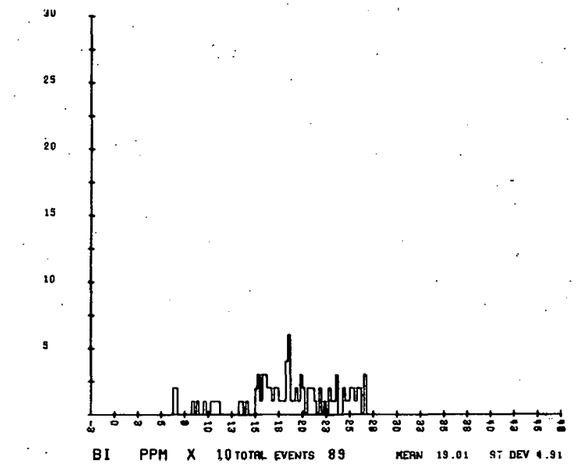
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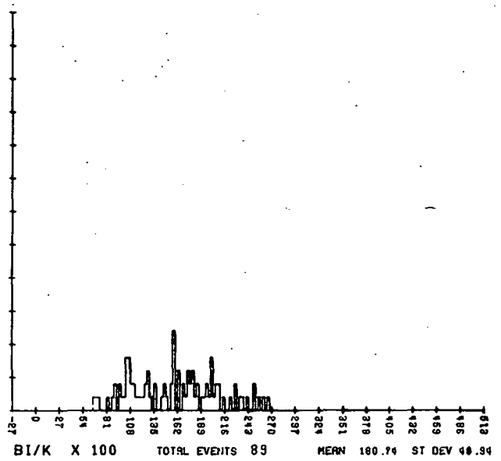
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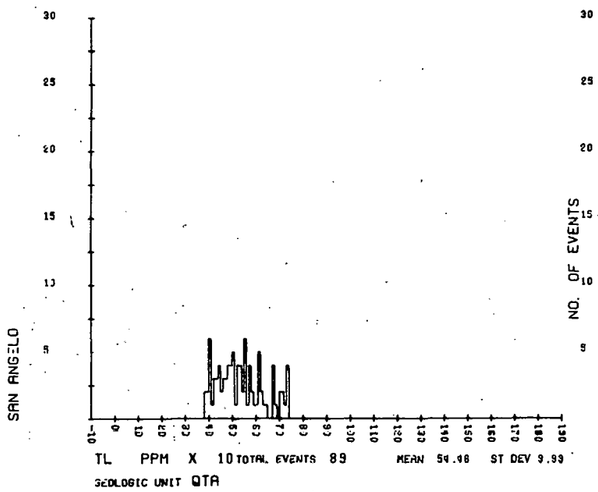
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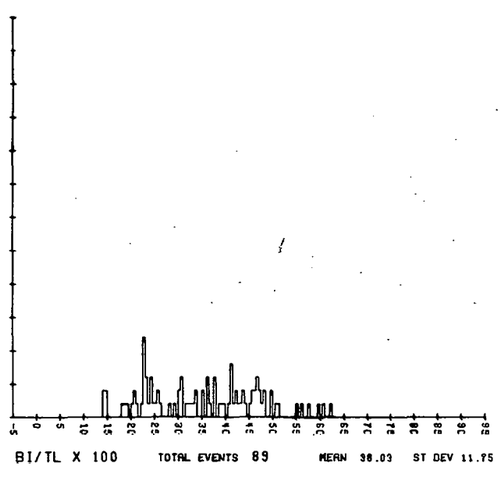
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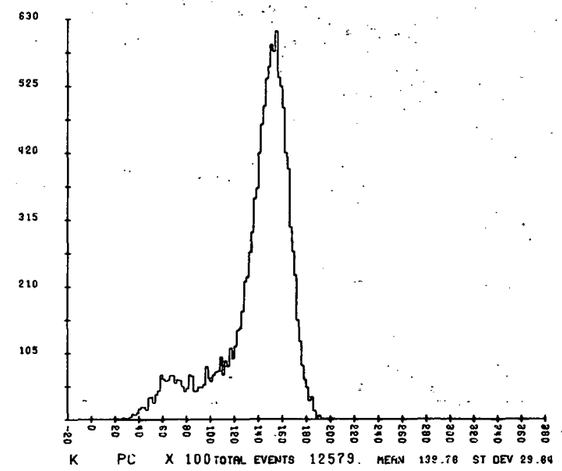
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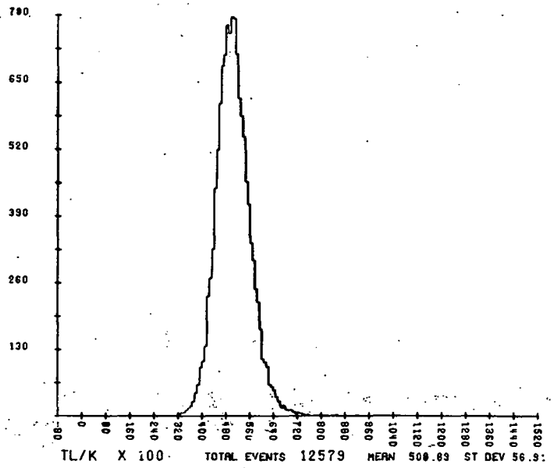
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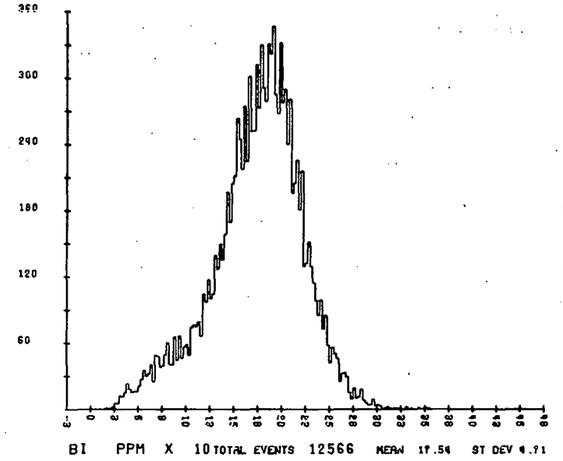
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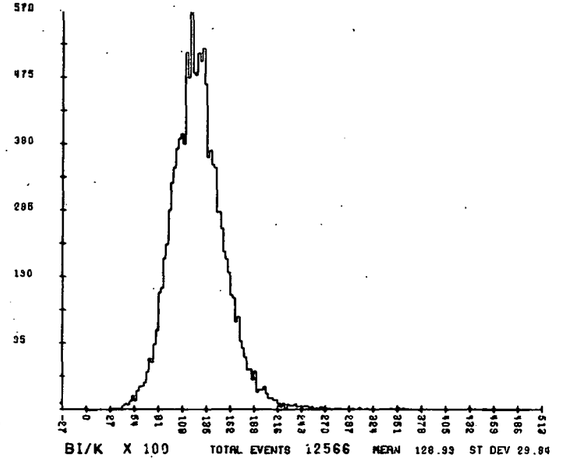
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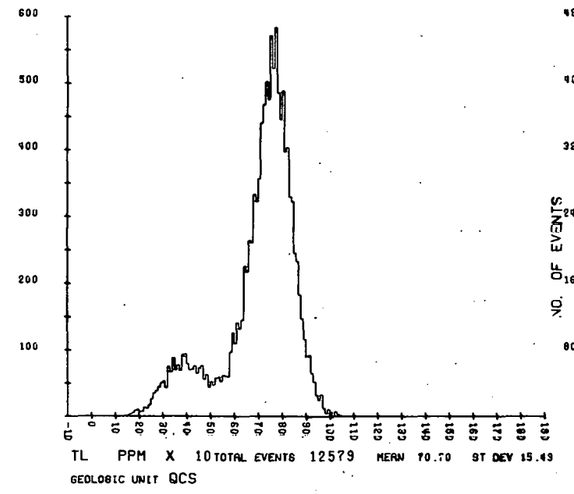
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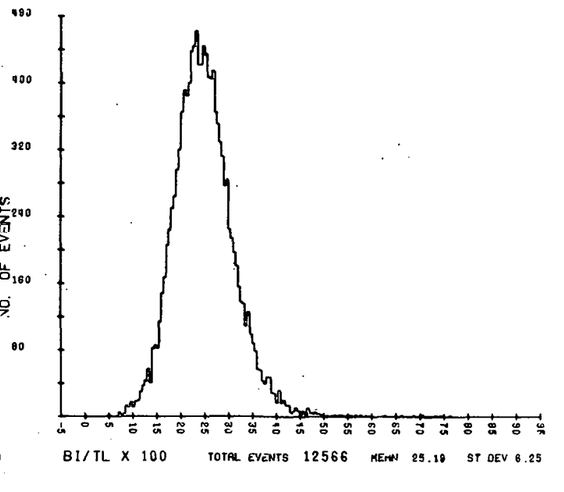
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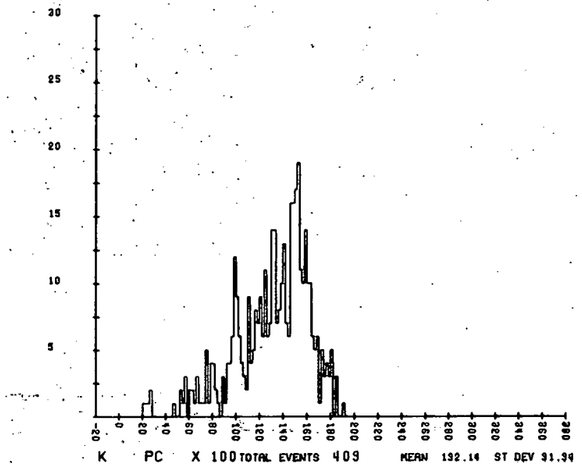
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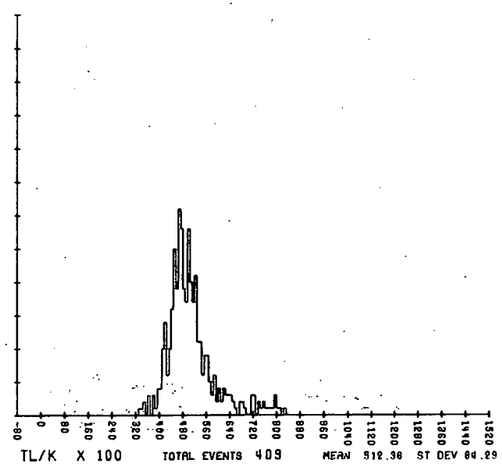
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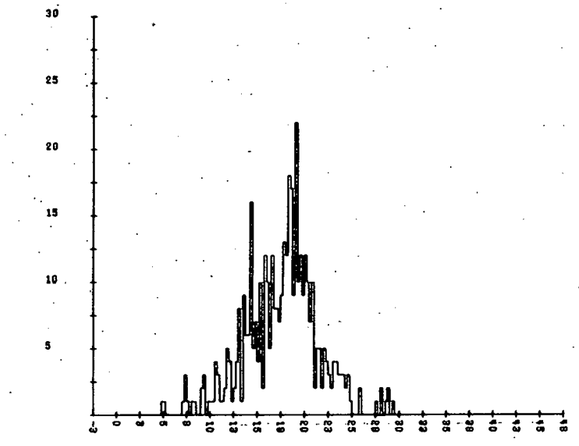
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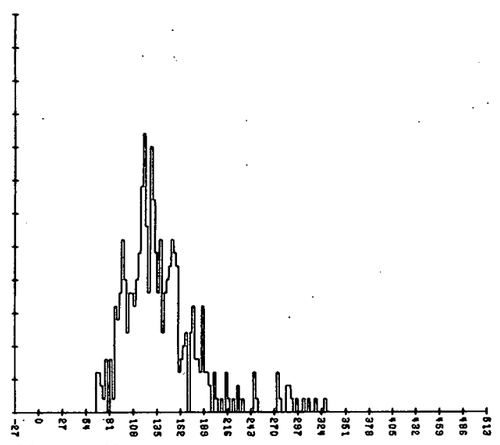
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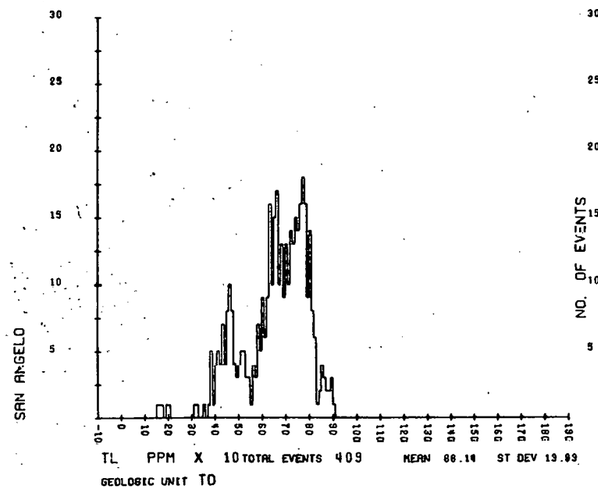
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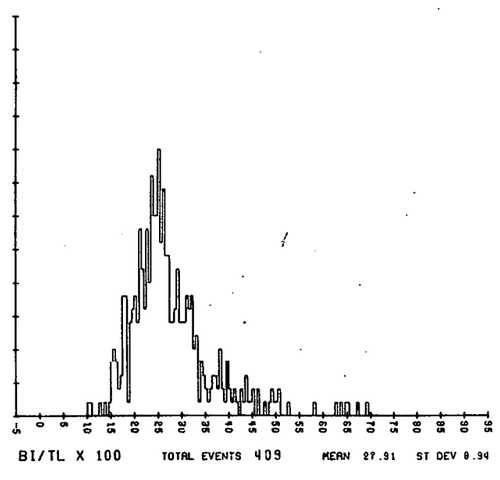
GEOLOGIC UNIT TO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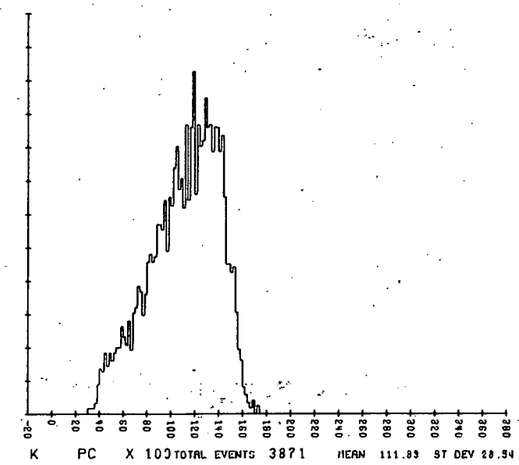
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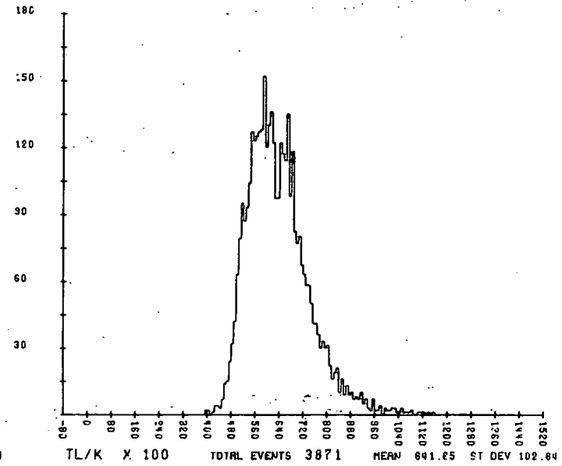
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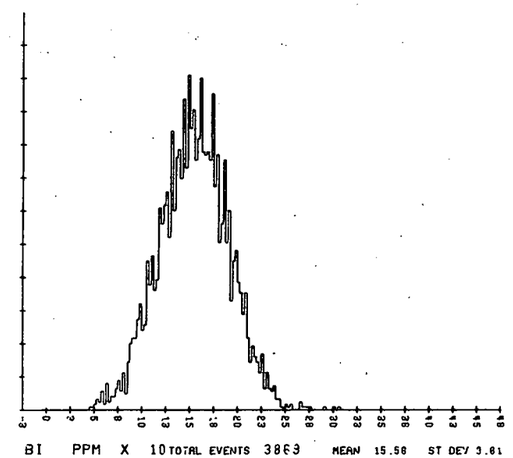
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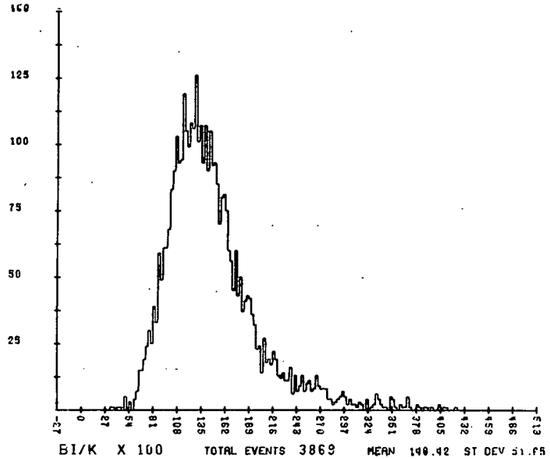
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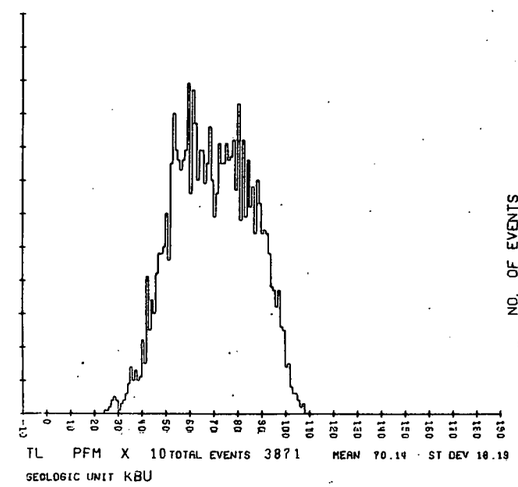
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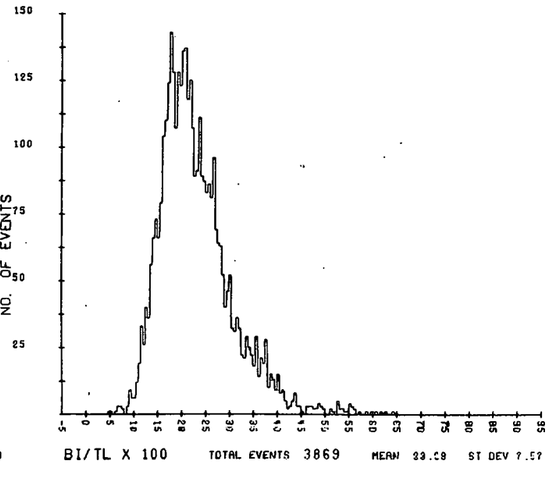
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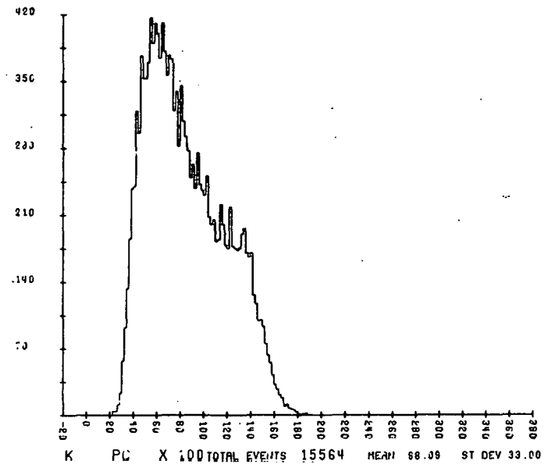
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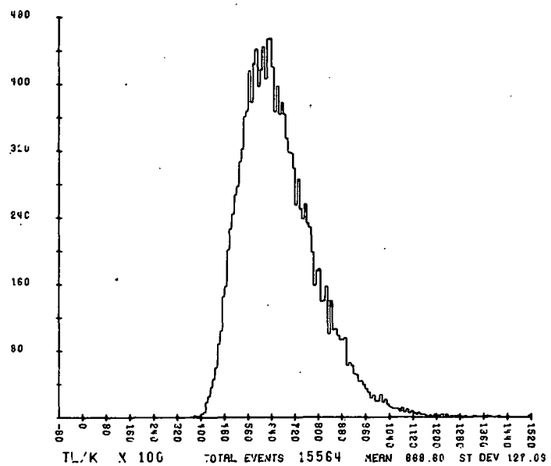
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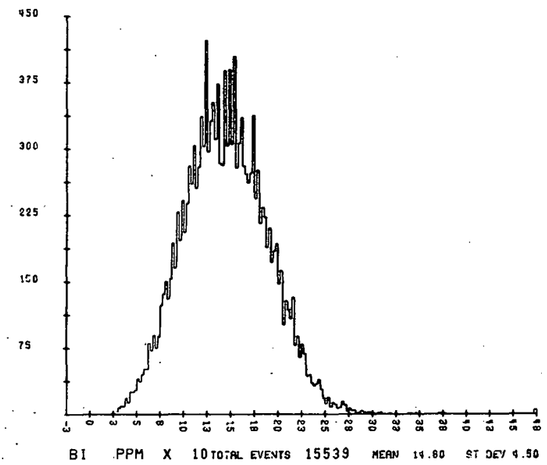
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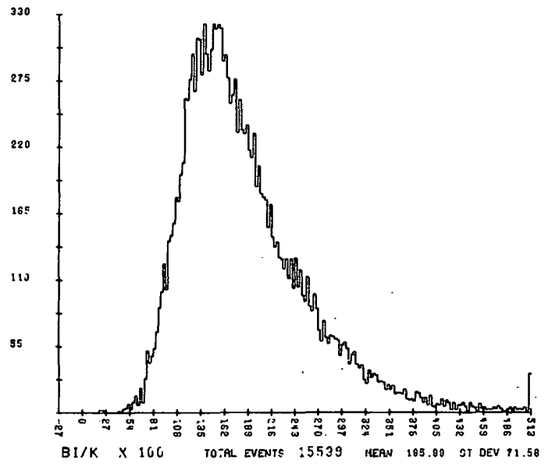
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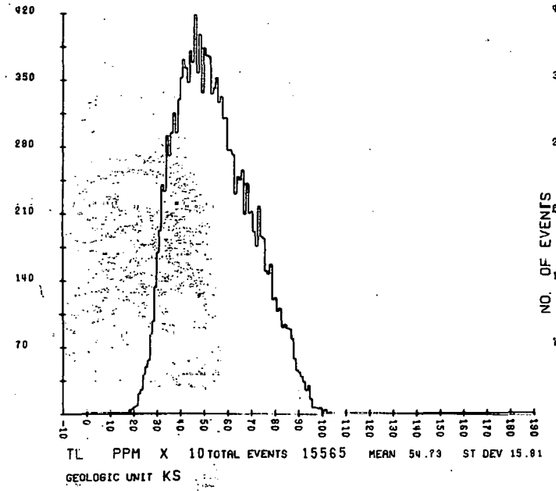
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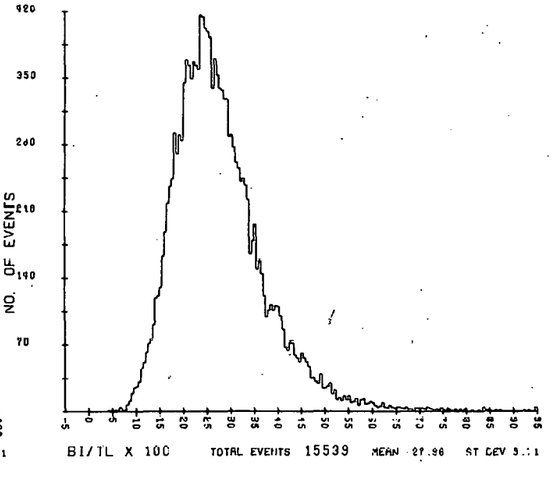
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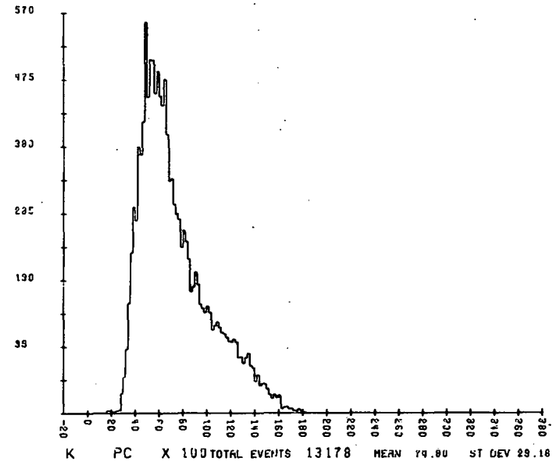
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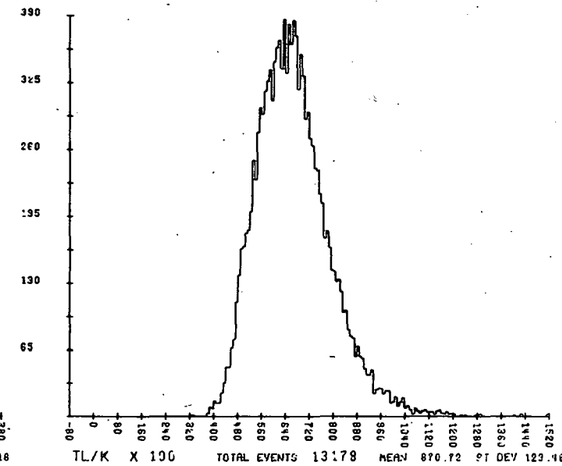
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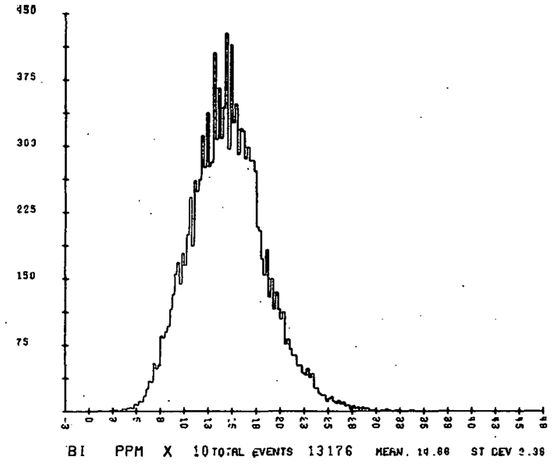
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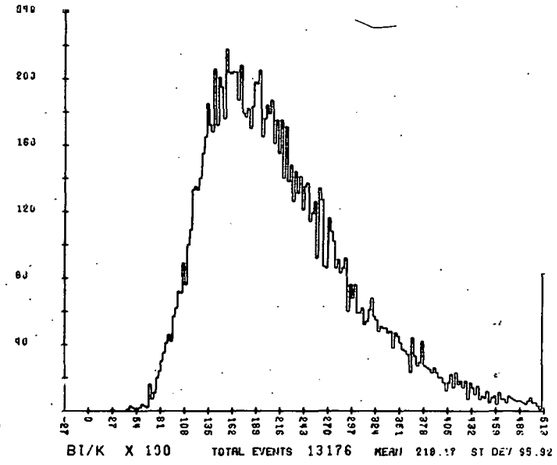
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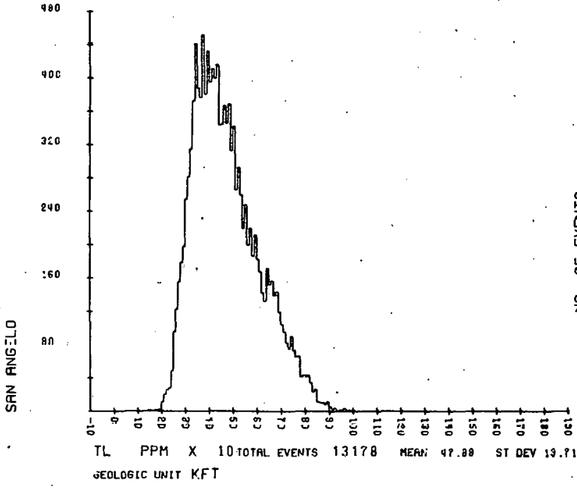
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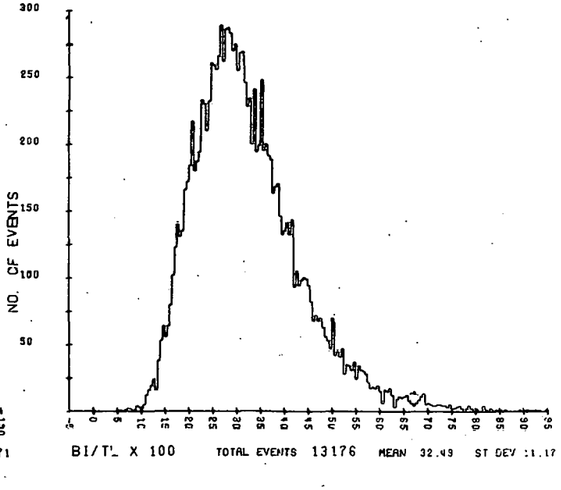
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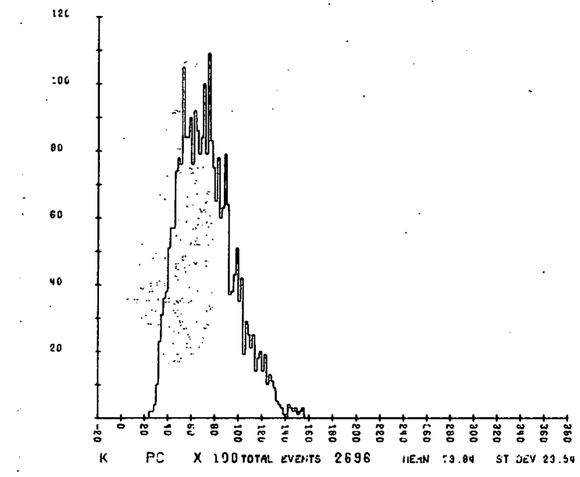
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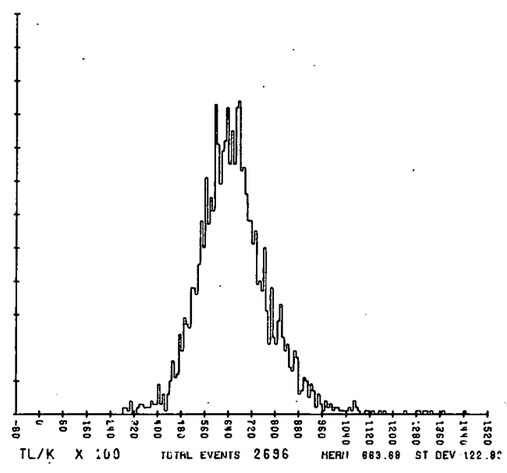
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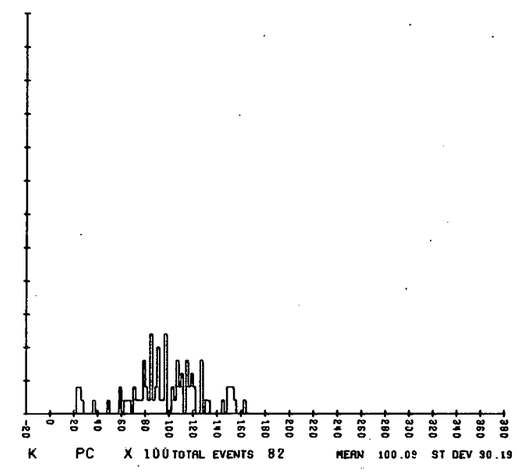
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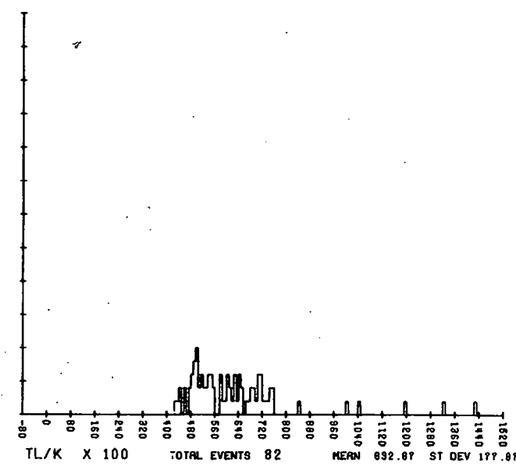
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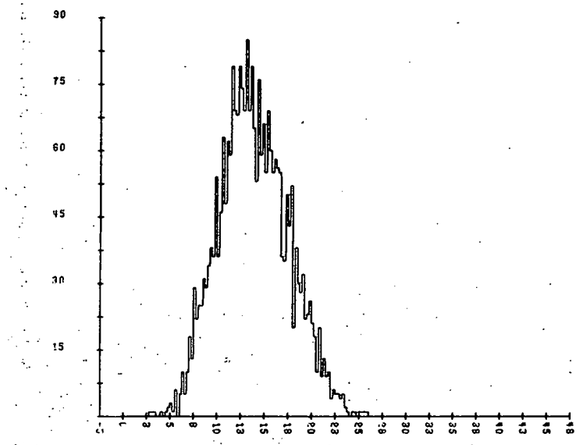
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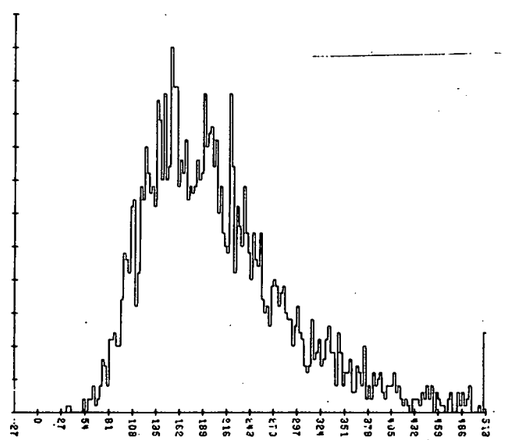
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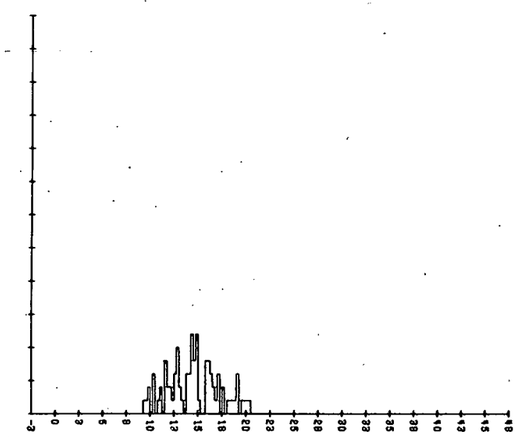
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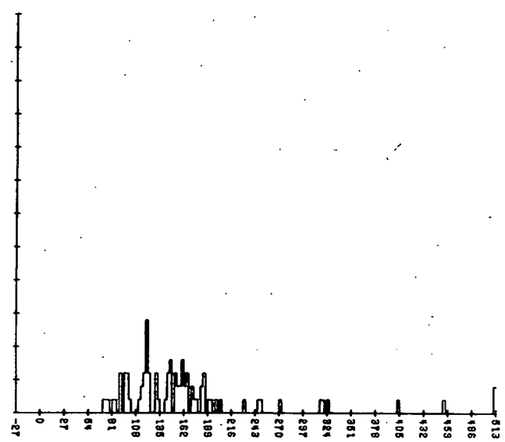
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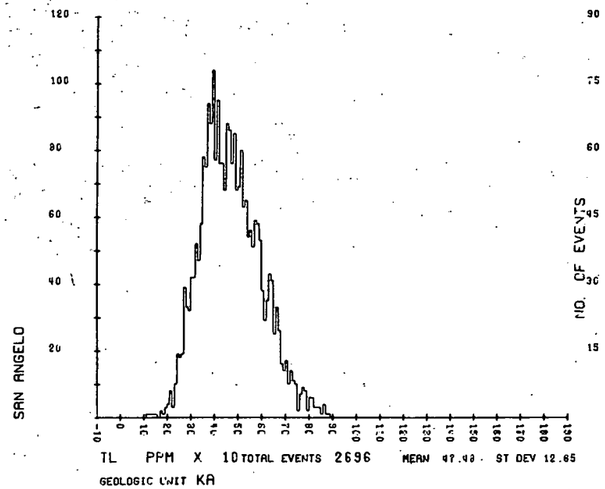
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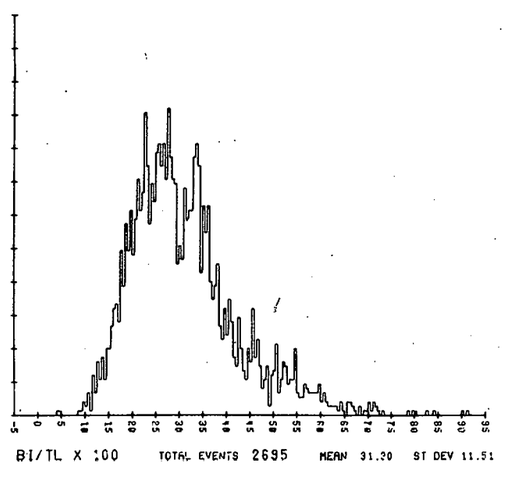
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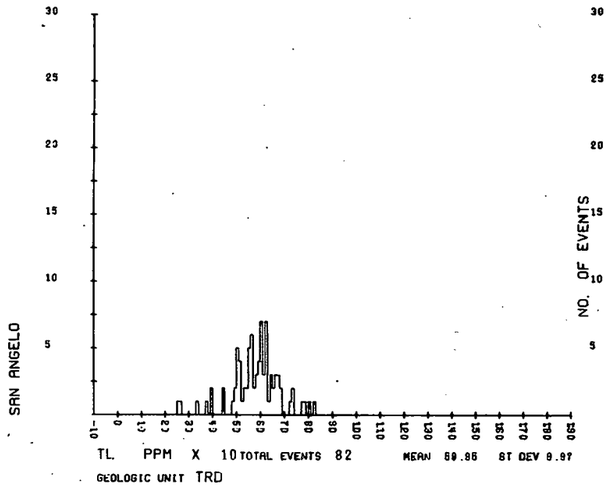
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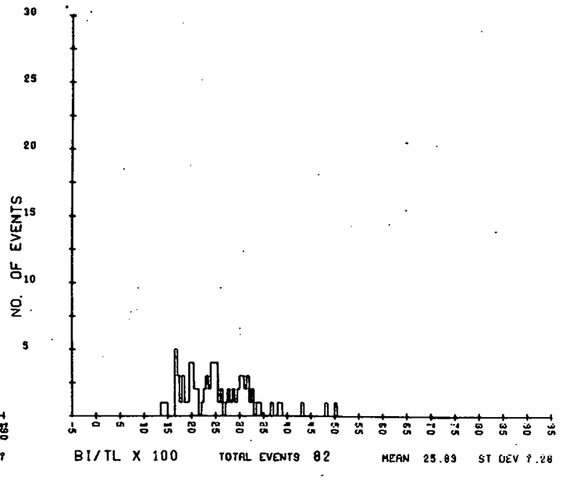
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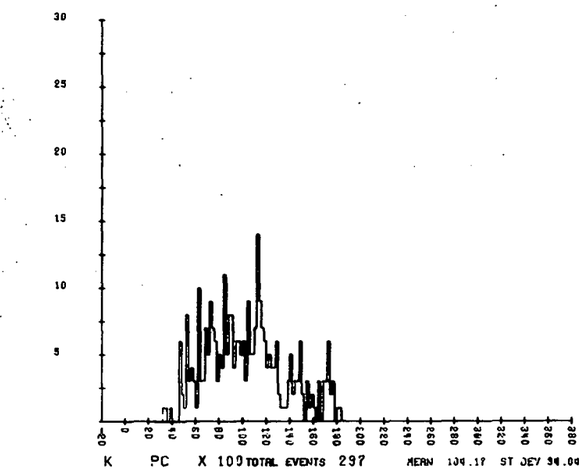
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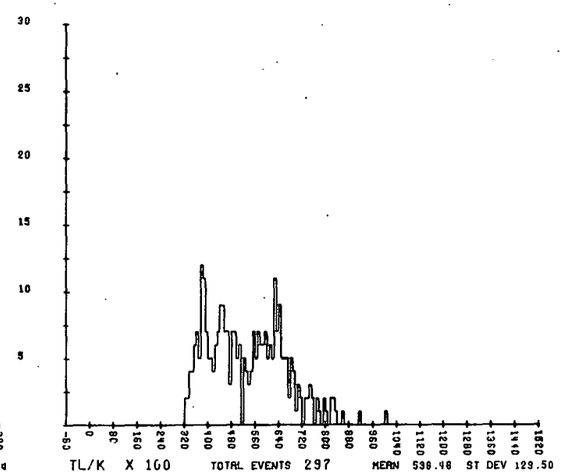
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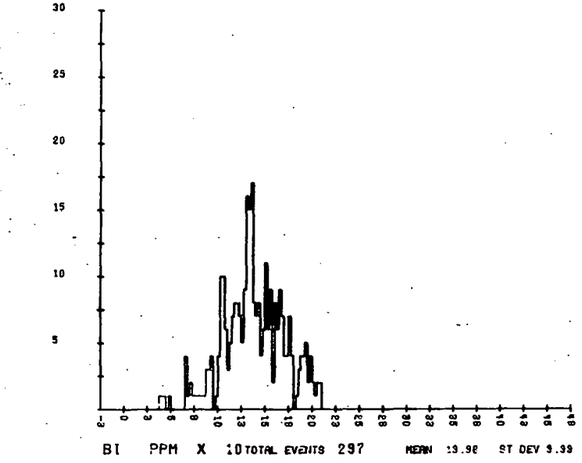
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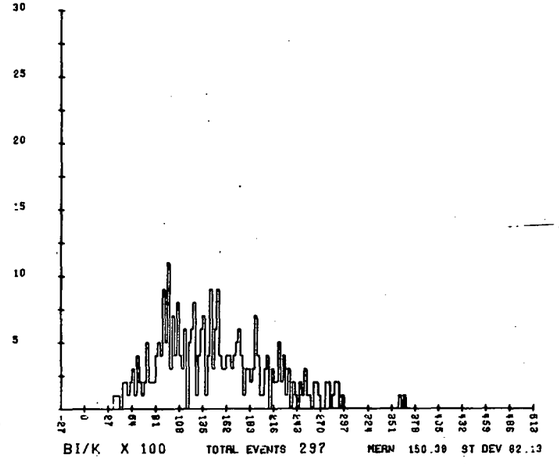
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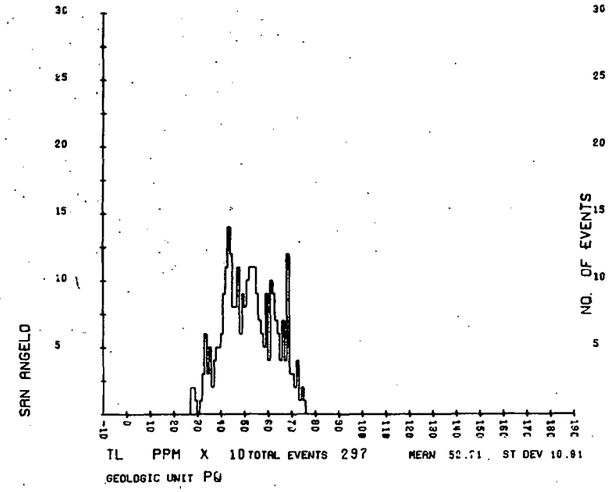
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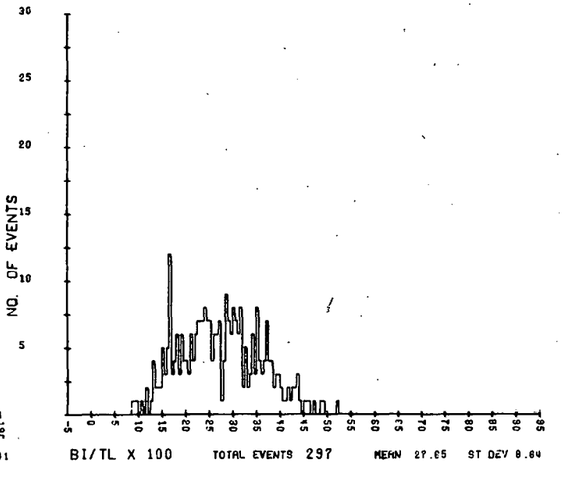
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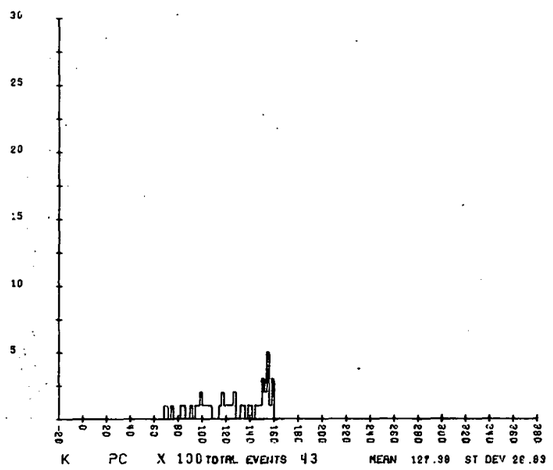
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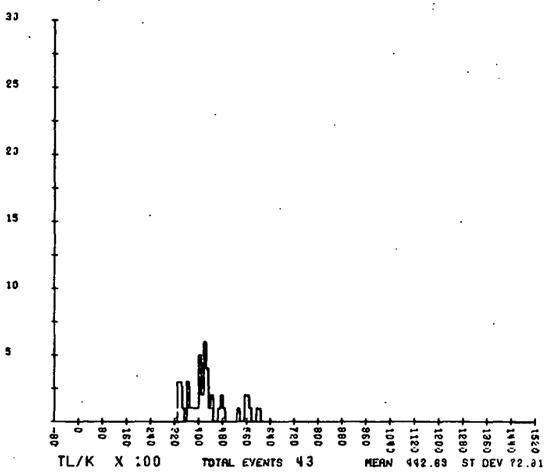
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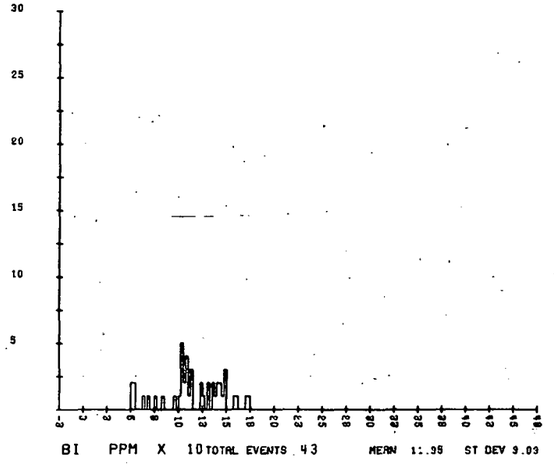
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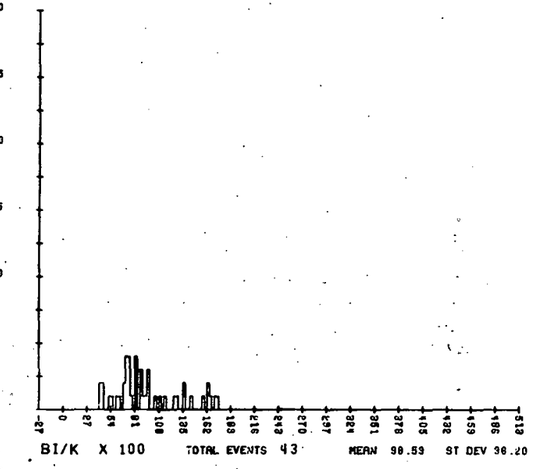
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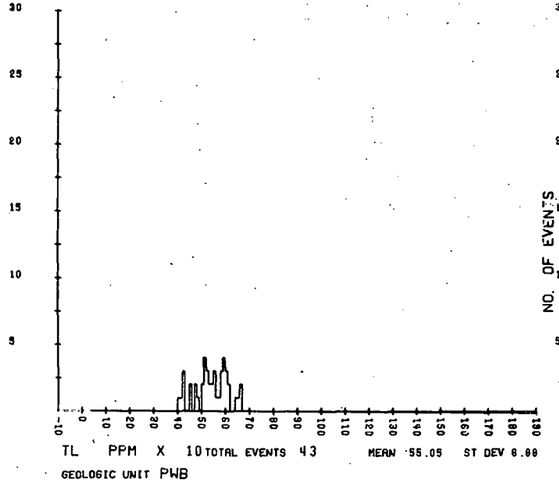
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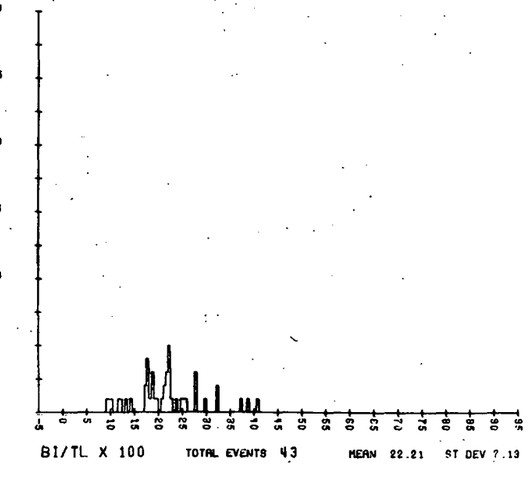
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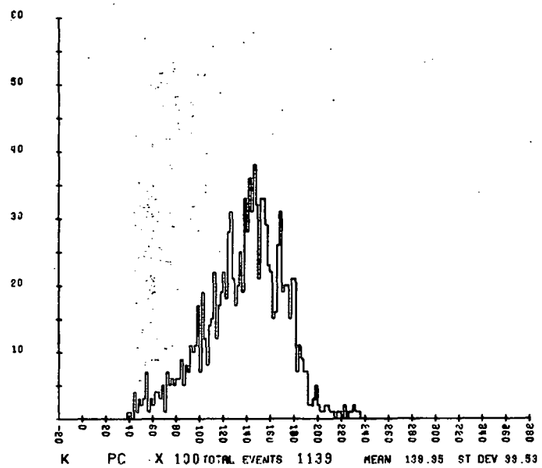
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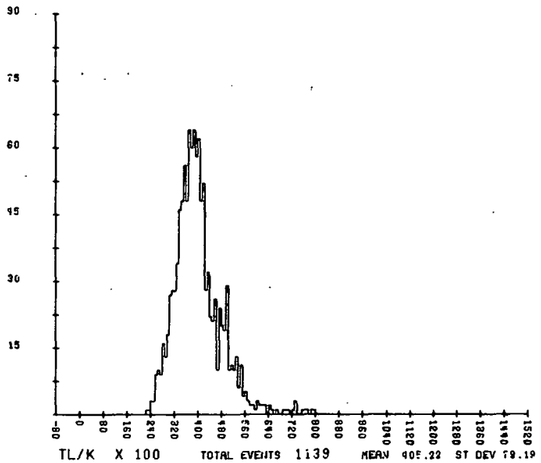
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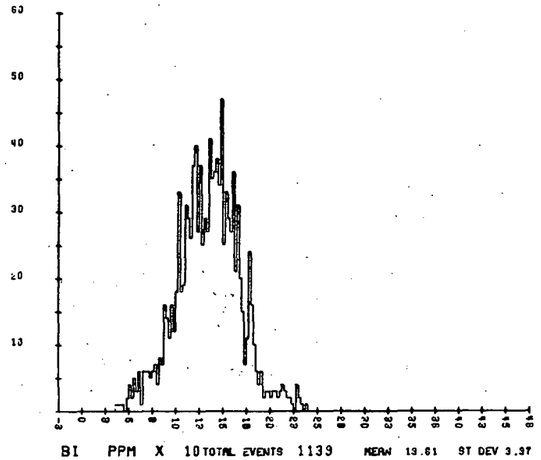
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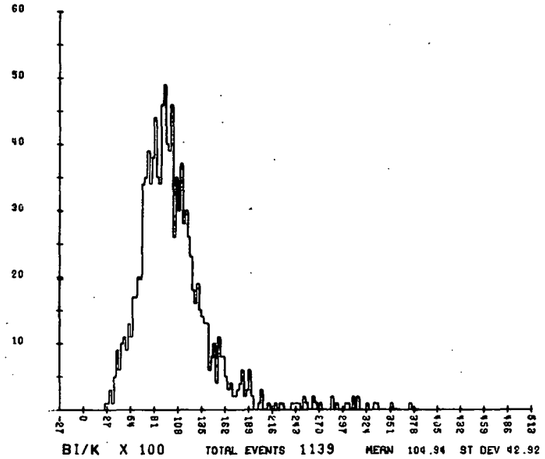
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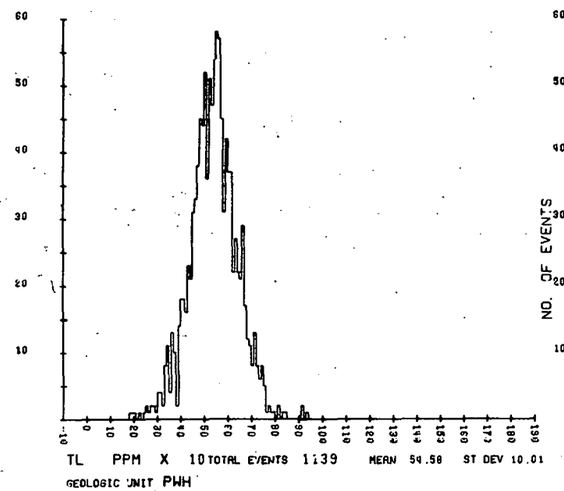
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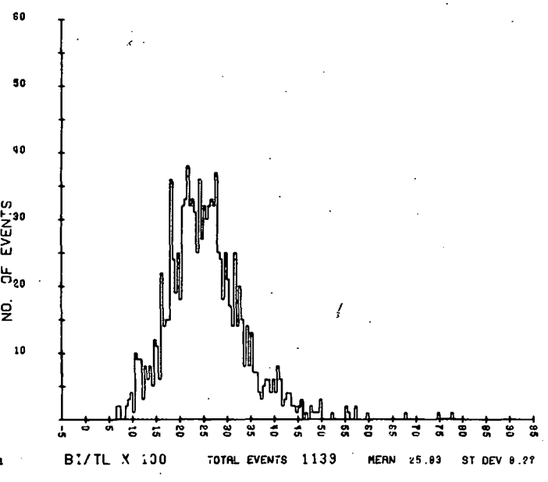
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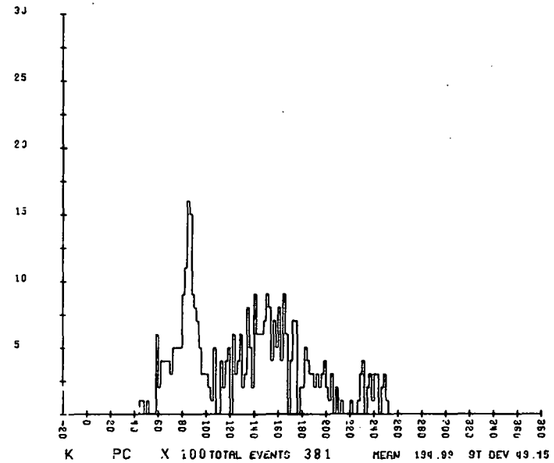
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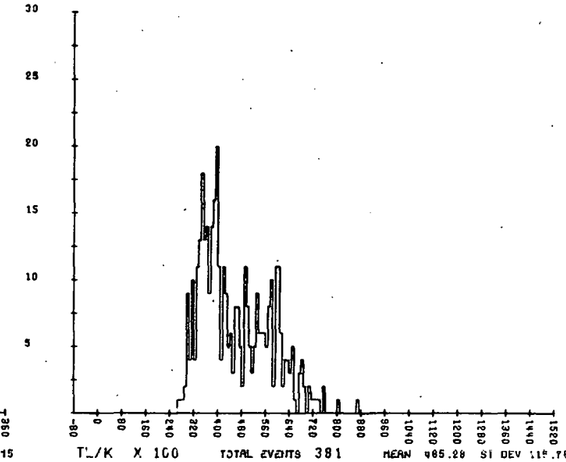
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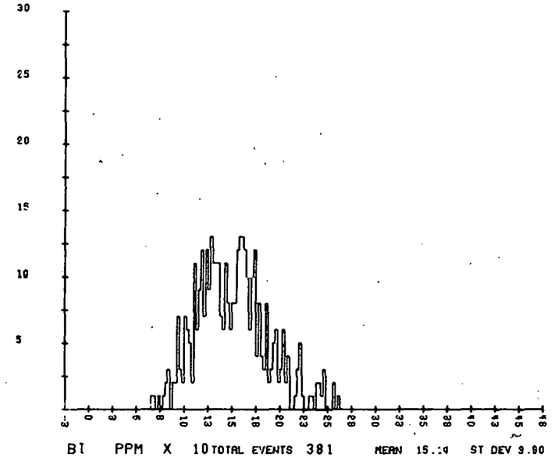
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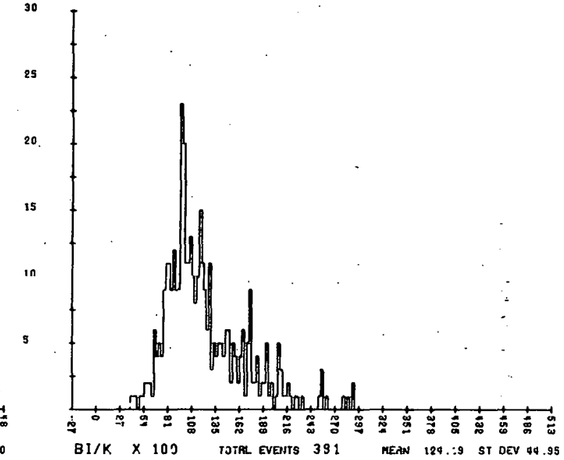
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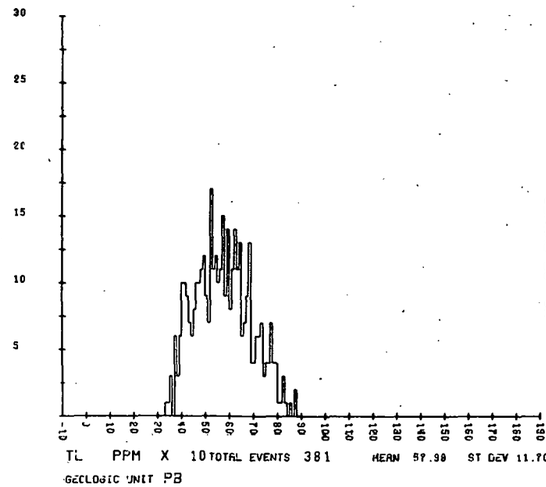
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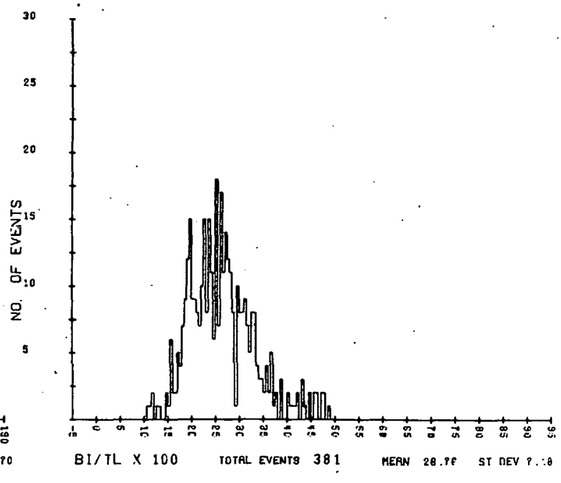
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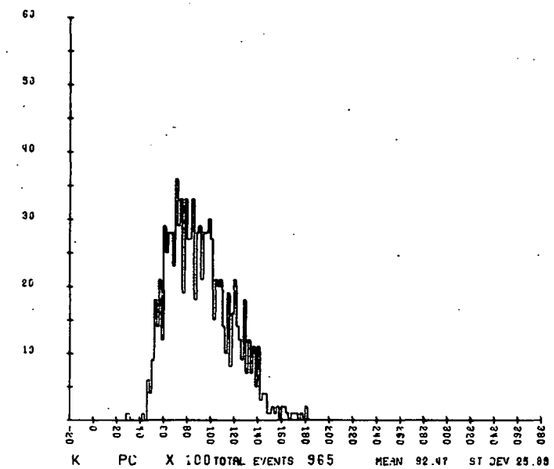

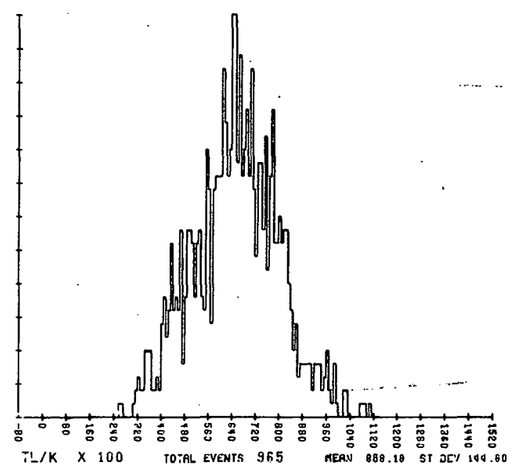

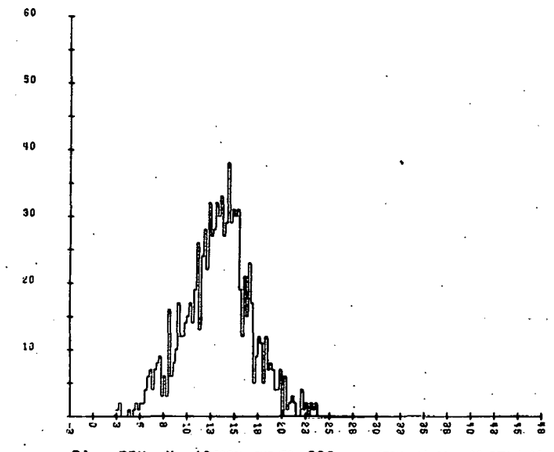

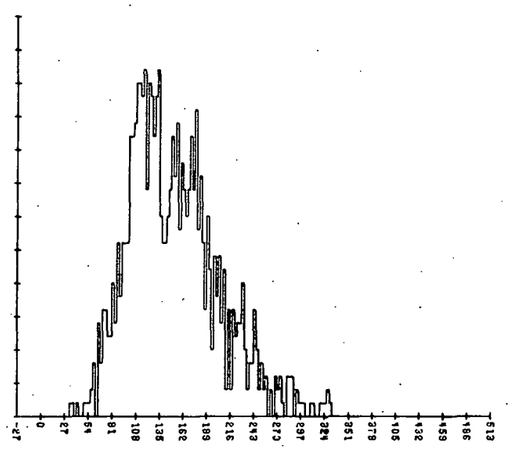

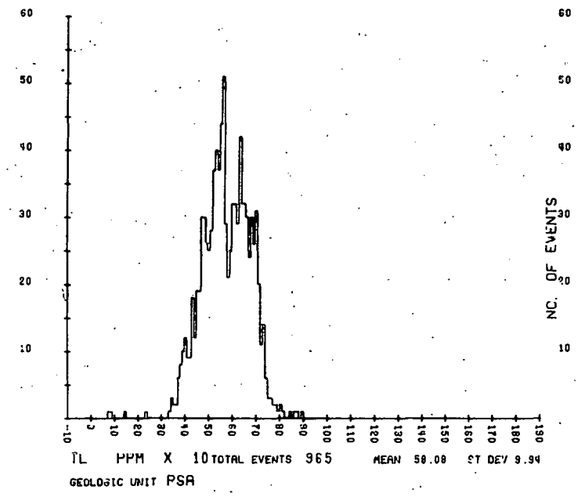

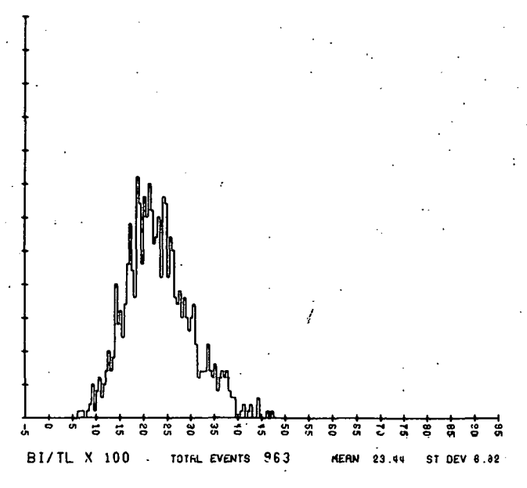

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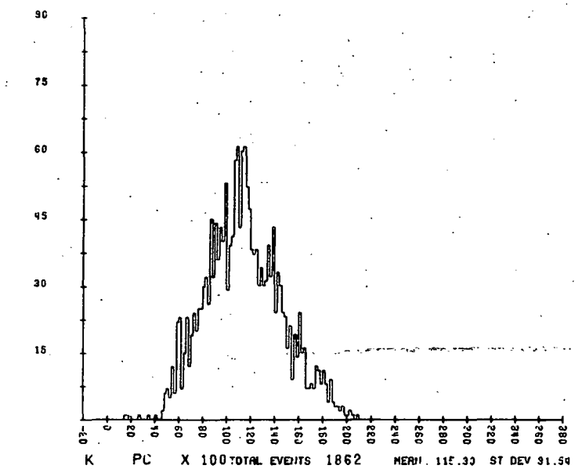

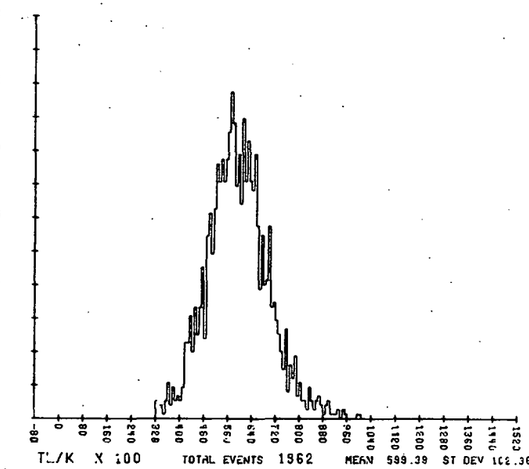

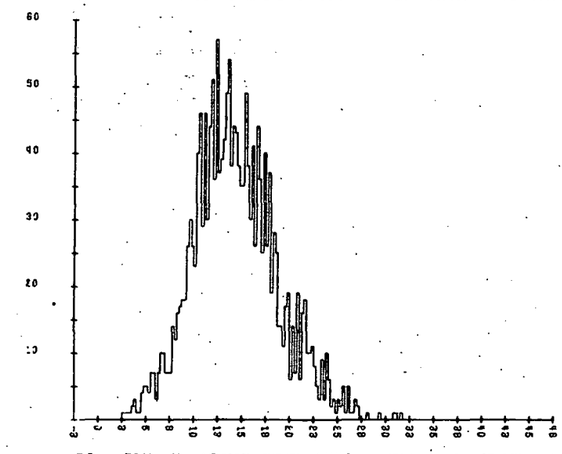

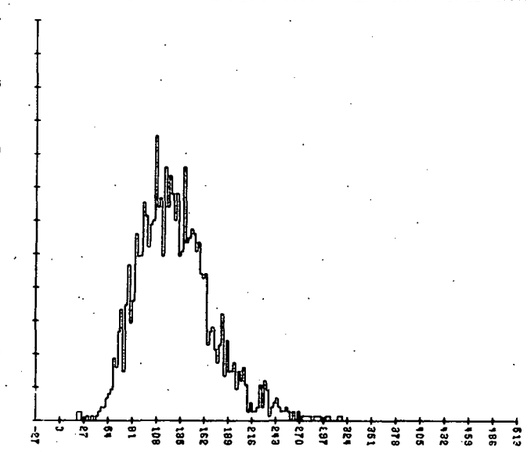

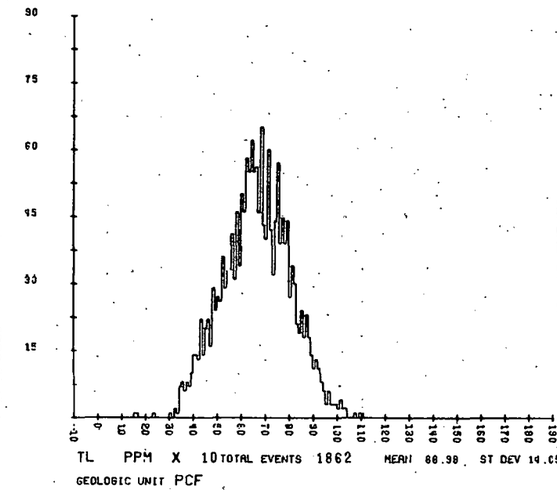

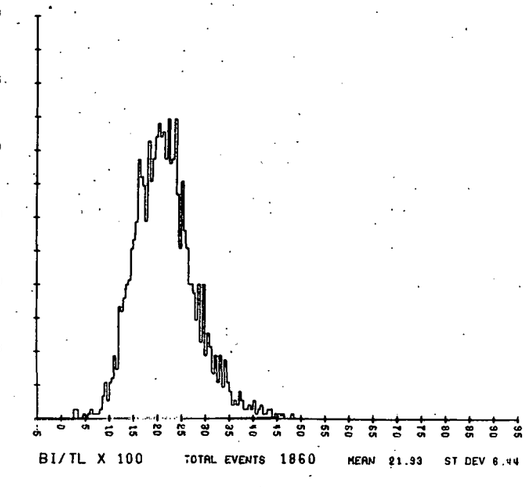

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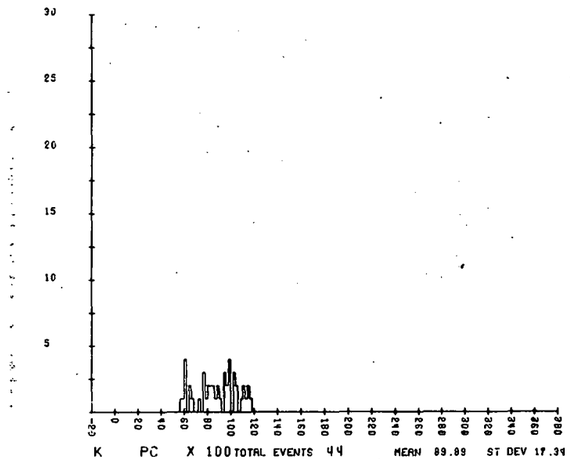
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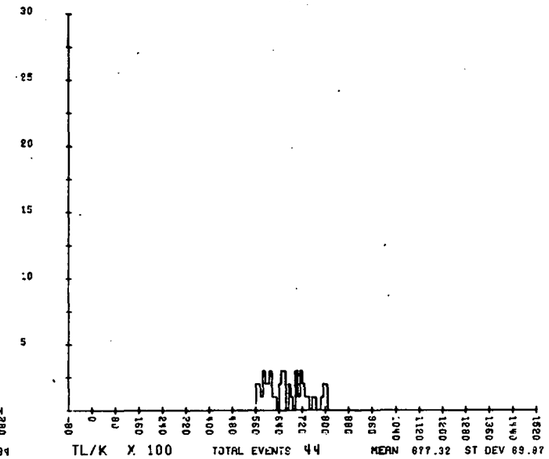
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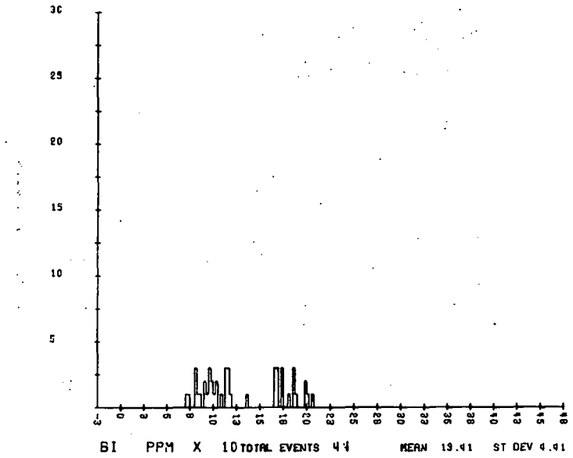
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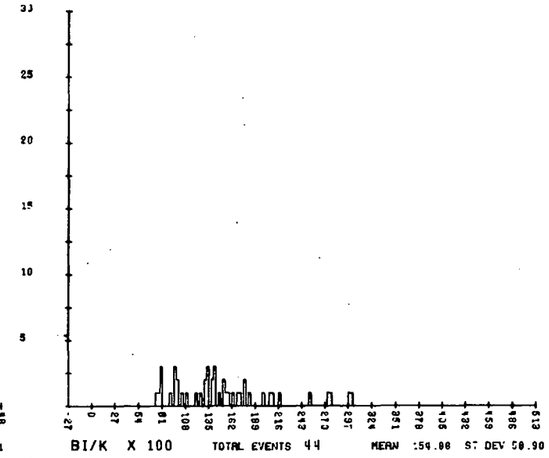
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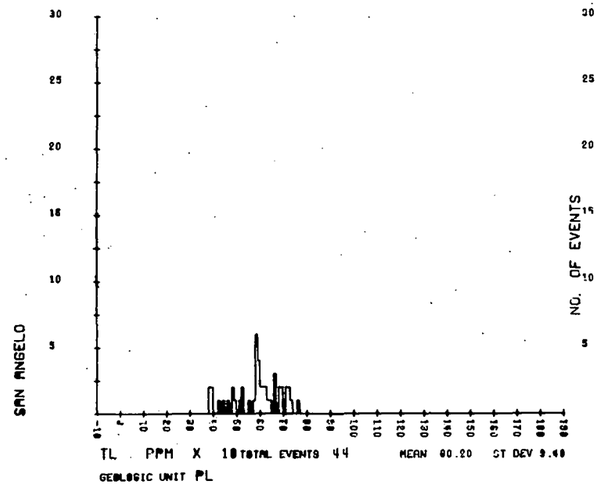
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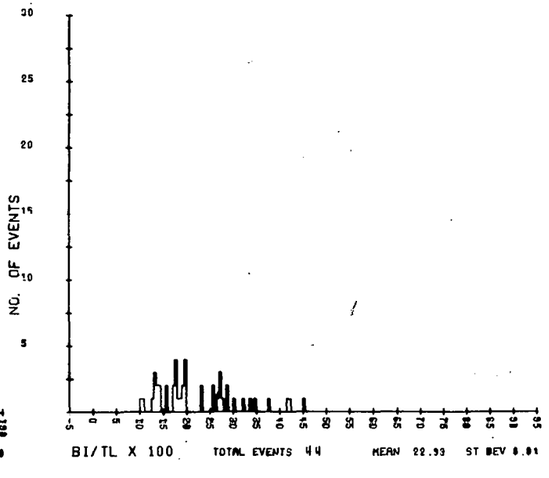
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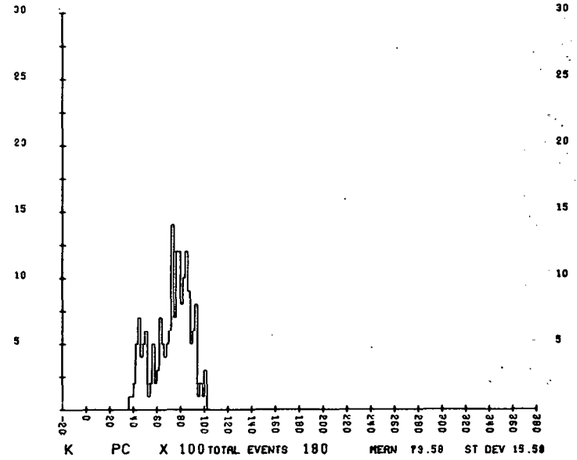
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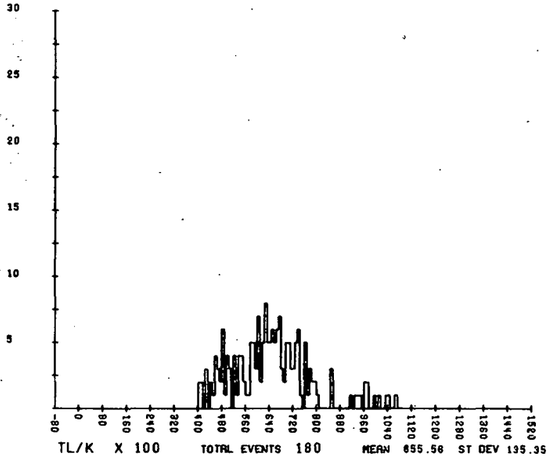
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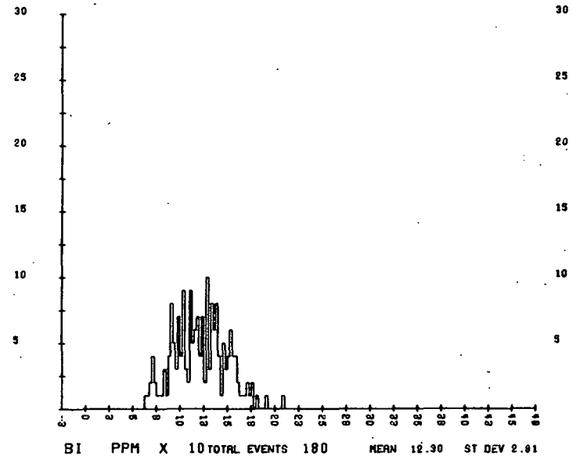
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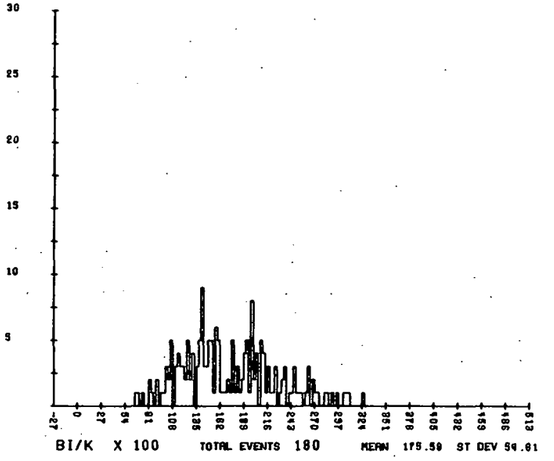
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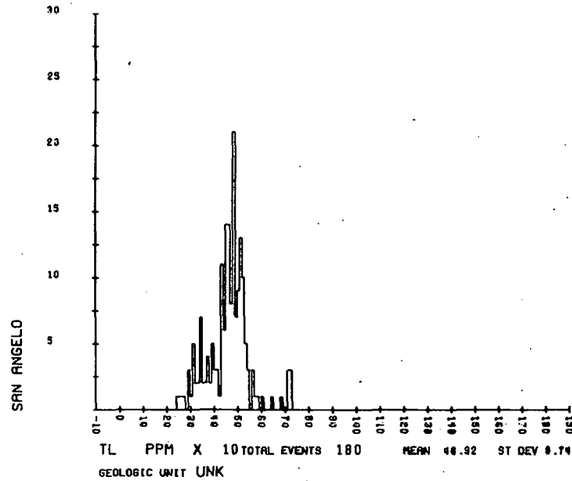
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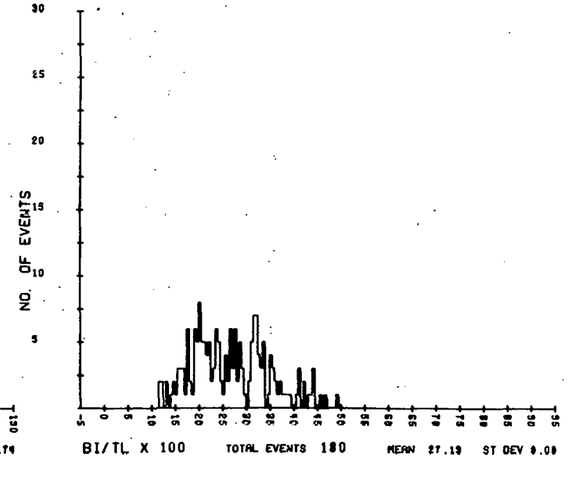
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SECTION V

GEODATA DATA AQUISITION AND PROCESSING

SECTION V.

GEODATA DATA ACQUISITION AND PROCESSING

A. DATA ACQUISITION SYSTEM

A brief description of the computer-linked Geodata Data Acquisition System (GDAS), used in the present survey, is presented here. The five primary components of the GDAS, which are mounted aboard a Douglas Super DC-3 aircraft, Figure V.1, are:

1) An array of nine (9) 11½" dia. by 4" thick NaI(Tℓ) detectors;

2) a NOVA mini-computer system

3) a Collins ALT-50 radar altimeter system;

4) a proton precession magnetometer; and

5) a Bendix DRA-12C doppler navigation system.

The nine-crystal detector array has been calibrated to measure the gamma radiation spectrum between 0-6 MeV. The contents of the 3 to 6 MeV interval is monitored in order to reduce the contributions of the cosmic events in the 0-3 MeV interval, which is of primary interest in this survey. Eight of the nine detectors are mounted to measure the 4π solid angle gamma radiation spectrum emanating from the earth's surface. The ninth detector, which is partially shielded underneath by a 3.5-inch lead plate, is situated to measure the ^{214}Bi radiation incoming from the upper 2π solid angle.

Each crystal detector has an estimated volume of 415.5 cubic inches, resulting in a total volume for the entire 4π system of 3324 cubic inches. The estimated volume to velocity ratio for this sytem is 23.7, where the average speed for the DC3-S is approximately 140 mph.

The energy resolution of the GDAS as calculated from the ^{137}Cs 662 keV photopeak was 10.7%, where each individual crystal was 9.0% or better. Automatic digital gain calibration for the eight detector array and the single detector system was accomplished by stabilizing on the ^{40}K photopeak data.

The NOVA computer, shown in the system block diagram of Figure V.2. is the control center of the GDAS. The data is gathered by the computer for every one-second period in a manner giving no dead time when readout to the magnetic tapes for storage. Two magnetic tape recorders are used; one to record the total spectral data and the computer tabulated results (LDT), and the other to record only the computer tabulated results (CDT).

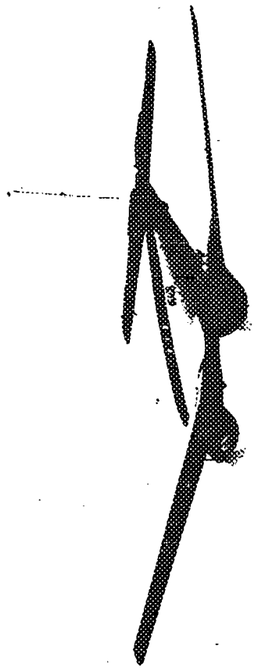


Figure V.1 Survey Aircraft

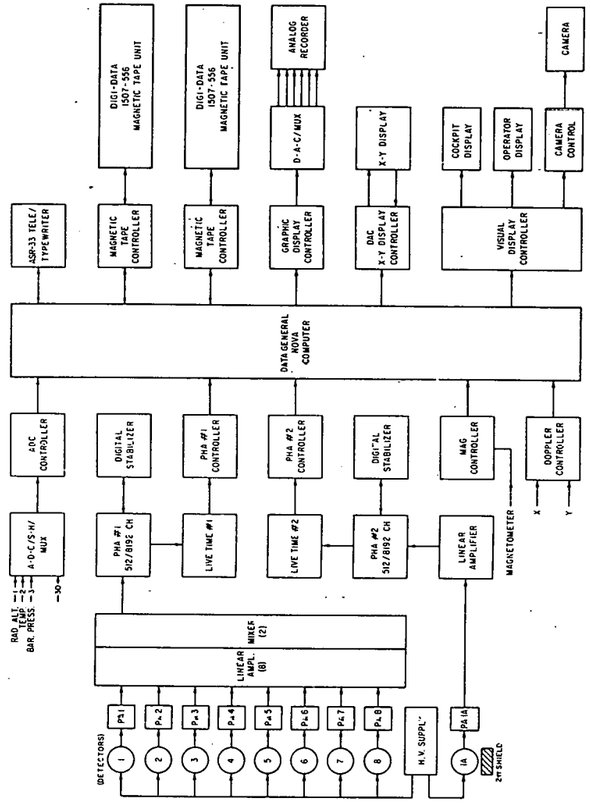


Figure V.2 System Block Diagram

Digital-to-analog conversion of the resultant intensities, their ratios and the magnetic field data are plotted on multi-track paper, allowing immediate examination for anomalous data.

The spectral data from the single detector system gathers and records the 2π spectral data every nine seconds. This 2π data is necessary to determine the amount of atmospheric ^{214}Bi radiation in the 4π spectral data. A third segment of the computer's core gathers and sums the total 2π and 4π gamma radiation spectra for each flight line, which can then be plotted as shown in Figure V.3 (EOFL spectrum).

Due to the dependence of the gamma ray data on altitude, a highly accurate radar altimeter is used. The Collins ALT-50 system is designed to make a series of 8 measurements per second, where the resulting altitude is the average.

Since the gathered data are dependent on the current ambient temperature and pressure readings, a Senso-Tek barometric pressure sensor and a Hy-Col thermocouple sensor were used to monitor conditions outside the aircraft.

A proton precession magnetometer sensor, having a 0.25 gamma readout resolution and less than a 1.0 gamma noise envelope, is sampled every second to yield a measurement of the total intensity of the earth's magnetic field below the aircraft. The sensor is carried as a "bird" on a 100-foot cable in order to minimize the magnetic effects of the aircraft.

A Bendix DRA-12C navigation system with a ±100th/nautical mile accuracy provides a doppler navigation cross-track and along-track analog signal to be recorded each second onto magnetic tape. Two other methods are used to properly locate the aircraft's track: visual sightings and photography. The first method is employed by the navigator who marks flight map location reference points with computer-displayed record numbers. The second method is a 35mm film that records a continuous, recoverable track which has a 20% overlap/frame at an elevation of 400 feet.

There are three basic operating modes of the GDAS that the operator can manipulate:

1) CALIBRATE, which allows proper gain calibration for the detectors;

2) OPERATE, which allows data to be collected, summed and recorded; and

3) PLAYBACK, which allows the operator to examine the newly acquired data.

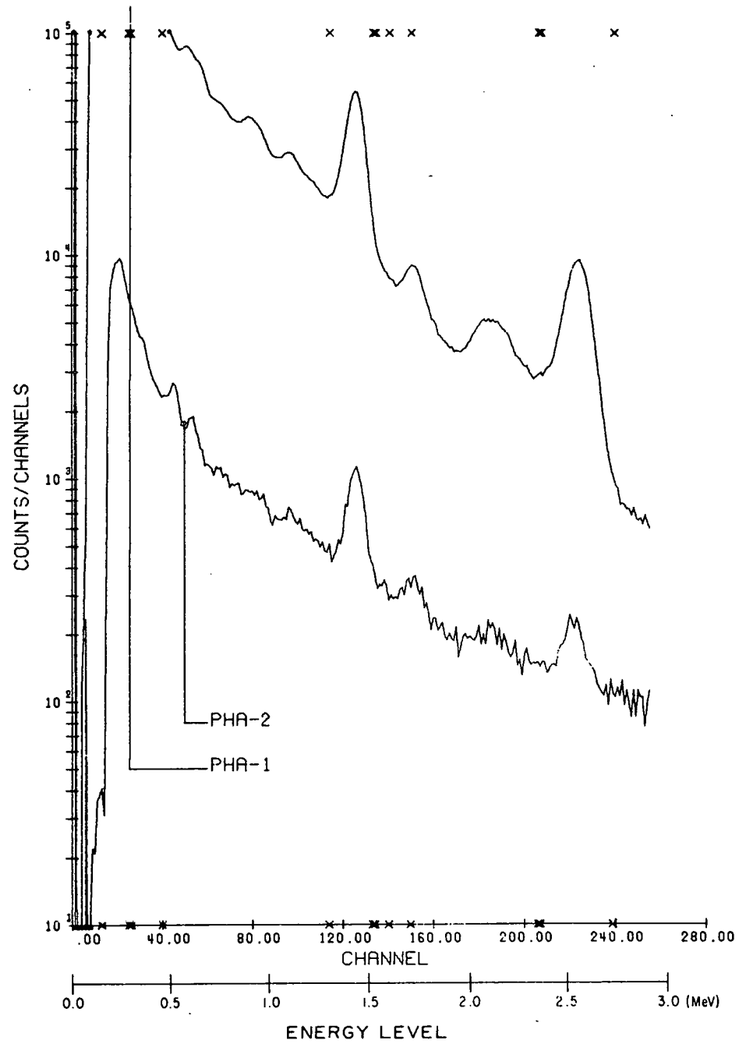


Figure V.3 Typical End-of-Flight-Line Spectral Plot

B. DATA PROCESSING

1. Data Reduction

The field data tapes produced by the data acquisition system (Section V.A) contain the 4π and 2π gamma radiation spectra, measured between 0 to 6 MeV. The resulting gamma ray spectra are composite spectra of the several different isotopes that emit gamma rays within the detectors' energy range. The method used in this work to determine the concentrations of the different isotopes monitored is discussed in this section.

In this work, there are four different isotopes which contributed to the resultant composite spectra under consideration. In order of the highest to lowest energy emitter, they are: cosmic, eTh, eU and K counting rates.

Isotope	Energy Interval (MeV)
Cosmic	3.0 to 6.0
$^{208}Tℓ$	2.410 to 2.796
^{214}Bi	1.661 to 1.860
^{40}K	1.357 to 1.556

Due to the occurrence of Compton scatter at all gamma ray energy intervals, a 4 x 4 matrix method approach is used to "spectrally strip" the group summed counting rates into their individual counting rates attributed only to the isotope associated with that energy interval.

This matrix method approach is theoretically applicable to a spectrum containing any number of isotopic gamma rays. For convenience, the four isotopes will be denoted as: COS, TL, BI and K. The channel group sum for each energy interval can be considered to consist of fractional components of each of its constituents. For instance, one can write for the TL channel group sum:

aCOS + 1.0TL + fBI + 0.0K = MTL

where MTL is the channel group sum count;

and the coefficients, which are known as Compton coefficients, for each variable represent the responses of the data gathering system to each isotope over the entire energy spectrum.

Similarly, equations can be written for the energy interval group sums for MCOS, MBI and MK, as shown below in matrix notation by

$$\begin{bmatrix} 1.0 & 0.0 & 0.0 & 0.0 \\ a & 1.0 & f & 0.0 \\ b & \alpha & 1.0 & g \\ c & \beta & \gamma & 1.0 \end{bmatrix} \cdot \begin{bmatrix} COS \\ TL \\ BI \\ K \end{bmatrix} = \begin{bmatrix} MCOS \\ MTL \\ MBI \\ MK \end{bmatrix}$$

where each element of the 4 x 4 matrix is a Compton coefficient. By inverting the 4 x 4 matrix and multiplying on the left by the channel group sum matrix, the resulting column matrix, whose elements are COS, TL, BI, and K, represents the counts in each energy interval attributed only to the indicated isotope source.

Table V.1 contains the data reduction parameters, coefficients and backgrounds used in this survey. The listed Compton coefficients were determined from data acquired during high altitude flights and from "known" test pad data concentrations in Grand Junction, Colorado.

The resulting reduced counting rates for COS, TL, BI and K must then be normalized with respect to the measured live time counting rate of the data acquisition system. This is necessary in order to restore the linear relationship between the photopeak counts and the source's intensity. This procedure is accomplished by dividing the reduced counts by the live time, LTC1:

thus,

$$\begin{aligned} COS1 &= COS/LTC1 \\ TL1 &= TL/LTC1 \\ BI1 &= BI/LTC1 \\ K1 &= K/LTC1 \end{aligned}$$

The next step in the data processing involves the subtraction of the background counts present onboard the aircraft. The background counts, which exist in the aircraft and its equipment, are determined from high altitude data where the data acquisition is free from all ground sources and atmospheric ^{214}Bi contamination. The background counts, denoted as B_{Tl}, B_{BI} and B_K, used in this work are listed in Table V.1. During the processing, the backgrounds are checked by observing the resulting counting rates over large bodies of water, where the rates would have near zero intensities. The gross count's background counting rate, B_{GC}, over channels 35-239, is also given in Table V.1.

After the backgrounds have been subtracted from the live time corrected photopeak counts, thus

$$\begin{aligned} \overline{TLI} &= TL1 - B_{Tl} \\ \overline{BII} &= BI1 - B_{Bi} \\ \overline{KI} &= K1 - B_K \end{aligned}$$

The resulting counting rates for $\overline{TLI}$ and $\overline{KI}$ represent the counts contributed only by the sources below the aircraft on the earth's surface. In the case of $\overline{BII}$, an additional source of ^{214}Bi radiation, which is caused by atmospheric ^{214}Bi, BIAIR, is still eminent.

The 2π detector system data is used to determine the magnitude of the BIAIR to be subtracted. Since the predominate variable source affecting the 2π detector is the atmospheric ^{214}Bi, it is possible to utilize most of the 2π spectrum in the BIAIR determination, and thereby produce some improvement in the statistical error. The energy interval used for the 2π crystal is between 1.05 to 2.79 MeV. Within this interval, the aircraft's background, $B_{2\pi}$, and its Compton coefficient, $C_{2\pi}$, have been determined from the high altitude data. (See Table V.1).

The BIAIR associated with the unshielded detector array is determined, using the shielded detector by the relation:

$$BIAIR = \left(\frac{G(x)}{1 - k_2 G(x)}\right) [VC - C_{2\pi} \cdot COS1 - B_{2\pi} - RVALM]$$

where

G(x) is the relationship between the 4π and 2π solid angles, the channel group sums and the number of detectors in the detector arrays;

VC is the 2π total count group sum of channels 91-239, c/s:

COS1 is the 4π cosmic count, greater than 3.0 MeV, c/s,

and,

$$RVALM = k_1 \overline{TLI} + k_2 \overline{BII} + k_3 \overline{KI}$$

where k_1, k_2, k_3 are constant factors that correct for the penetration/spill of the emanated surface radiation. These penetration/spill constants are dependent on the amount of lead shielding used on the 2π crystal. The values used in this work are listed in Table V.1.

$\overline{TLI}$, $\overline{BII}$ and $\overline{KI}$ have already been defined as the 4π reduced data counting rates, c/s.

Finally, the ^{214}Bi counting rate caused only by the surface sources is given by

$$BISUR = \overline{BII} - BIAIR$$

Briefly summarizing, $\overline{TLI}$, BISUR and $\overline{KI}$ are the counting rates as measured at the height of the aircraft. All interfering counts from cosmic, backgrounds and atmospheric ^{214}Bi have been removed.

Since the various counting rates are dependent upon the height of the aircraft above the surface terrain, it is necessary to correct the associated isotope's counting rate to an altitude of 400 feet above the surface terrain. This is accomplished through the equations indicated below:

$$TLS = \overline{TLI} \cdot e^{-\mu_1 (400 - \frac{\rho}{\rho_o} x)}$$

$$BIS = BISUR \cdot e^{-\mu_2 (400 - \frac{\rho}{\rho_o} x)}$$

$$KS = \overline{KI} \cdot e^{-\mu_3 (400 - \frac{\rho}{\rho_o} x)}$$

and

$$GC(\text{gross count}) = (\overline{GC} - B_{GC} - S \cdot BIAIR) \cdot e^{-\mu_4 (400 - \frac{\rho}{\rho_o} x)}$$

where

$\overline{GC}$ is the live time corrected gross count, channels 35-239,

S is the ratio of the BI data, channels 35-239 to channels 143-159,

B_{GC} is the gross count background,

TLS,BIS,KS	are the respective photopeak's counting rates at 400 feet;
ρ_o	is the air density at standard temperature and pressure; 0.001293 gm/cc
ρ	is the air density at the time the survey data was flown;
$\mu_1, \mu_2, \mu_3, \mu_4$	are the respective linear attenuation coefficients;
x	is the aircraft's height above the surface terrain in feet.

The attenuation coefficients and other constants used in the altitude normalization are listed in Table V.1.

After each flight line of data has undergone the above data reduction, the average values for each radiation variable and variable ratios for each of the flight lines were plotted to demonstrate the consistency of the average values and that a smooth flow continues from day to day, and from the start to the finish of each day.

Diurnal variations of the magnetic field base station intensity were measured and applied to the field data. (See Section II.D and Appendix I.C). The magnetic heading corrections for the aircraft and its equipment used in this survey were determined by flying a predetermined path at a survey altitude in first an east to west direction, then in a west to east direction. The same procedure is used on a north to south path. Based on the data obtained in this fashion, see Table V.1, the heading corrections were removed from all the data. The magnetic field data were then IGRF corrected to give the residual magnetic field. The International Geomagnetic Reference Field subtracted was provided by the U.S. Geological Survey with reference to the IAGA Bulletin #38, "Grid Values and Charts by the IGRF 1975.0", National Technical Information Service Report #PB265483.

The system sensitivities at 400 feet used in this survey are shown in Table V.1.

2. Description of the Data Processing

The processing flow chart representative of the work performed in this survey is shown in Figure V.4.

As stated in Section V.A., the original field data tapes were recorded to contain the various tag words, 4π and 2π spectral

TABLE V-1. DATA REDUCTION PARAMETERS AND CONSTANTS - N540S - 1980

AIRCRAFT BACKGROUNDS				COSMIC CORRECTION RATIOS	
Detector	Parameter	Window	Value (CPS)	Parameter	Value
Terrestrial (4π)	B_K	Potassium	29.98	c	0.2069
	B_{Bi}	Uranium	9.40	b	0.1651
	$B_{T\ell}$	Thorium	5.83	a	0.2202
	B_{GC}	Gross	286.69	-	-
Atmospheric (2π)	$B_{2\pi}$	Uranium	8.33	$C_{2\pi}$	0.2232

DERIVED STRIPPING COEFFICIENTS AND RATIOS			
Coefficient	Value	Coefficient	Value
α	0.2755	k_1	0.030
β	0.4058	k_2	0.0
γ	0.8595	k_3	0.0
f	0.0693	S	17.5
g	0.0156	-	-

LINEAR ABSORPTION COEFFICIENTS		
Radio Element	Parameter	Value ($\times 10^{-3}$ per ft.)
Potassium	μ_1	2.448
Uranium	μ_2	1.329
Thorium	μ_3	1.899
Gross	μ_4	1.430

MAGNETIC HEADING CORRECTION	
Flight Direction	Correction (gammas)
West to East	+3.56
East to West	-3.56
North to South	-1.0
South to North	+1.0

RADIOELEMENT	SYSTEM SENSITIVITIES AT 400 FEET
Potassium (cps/%K)	98.06
Uranium (cps/ppm eU)	13.52
Thorium (cps/ppm eTh)	7.15

DATA FLOW DIAGRAM

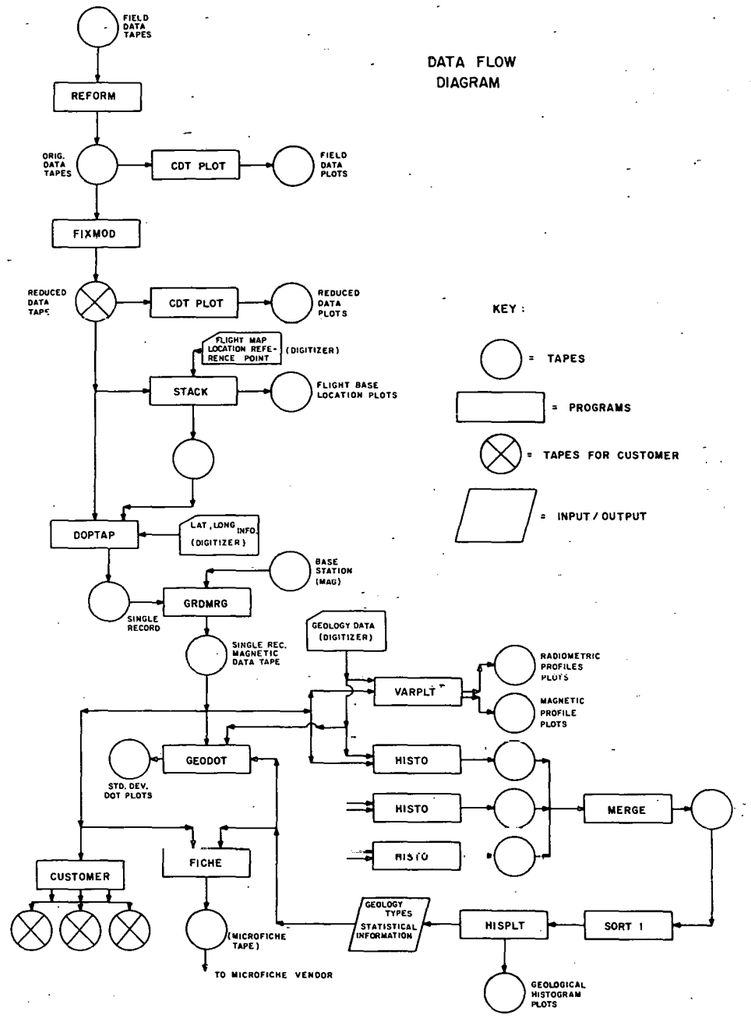


Figure V.4 Data Reduction Flow Chart

data and the trailer record sums for each flight line. The purpose of the REFORM program is to sum the raw spectral data (LDT) into the proper group sum energy intervals for each second for each line. The CDTPLT program is a data certification program that produces the EOFL spectral plots, Figure V.3, and profiles of each of the channel group sums, which are plotted as a function of each line's record numbers.

A brief summary of each program and its uses is given below:

PROGRAM	FUNCTION
REFORM	Produces energy group sums and EOFL spectra.
FIXMOD	Primary processing for "spectral stripping" matrix reduction, live time normalization, background and BIAIR subtraction, and altitude corrections.
STACK	Flight path recovery to produce record location map at a scale of 1:250,000.
DOPTAP	Single record processing with latitude/longitude positioning, IGRF and single point statistical adequacy computations, and magnetic heading corrections.
GNDMRG	Merges aircraft magnetometer and ground magnetometer in proper time sequence and applies diurnal corrections to the field data.
VARPLT	Produces radiometric and magnetic stacked profile plot tapes.
HISTO,MERGE, and SORT1	Preliminary programs to prepare/sort data as a function of geologic type for the entire area.
HISPLT	Produces geological histograms, mean and standard deviation tables, and plot tape for the entire area.
GEODOT	Produces plot tape for standard deviation "dot plots" related to geologic type.
FICHE	Produces average record and single record reduced data listings and microfiche tapes, which are sent to microfiche vendor.
CUSTOMER	Produces all customer required tapes.

3. Data Presentation

The surveyed area was positioned geographically to completely cover the specific National Topographic Map. Each topographic map has been used as the flight base and sufficient geographical and 15' location information has been shown. The flight line pattern has been superpositioned onto these created base maps, where the standard deviation levels for each independent variable and each ratio of these variables have been plotted (NGRMS), based on the data contained within the total map area. Every fifth data point along each map line has its standard deviation value shown at the location of that value. Therefore, there are six NGRMS sheets which indicate the location and magnitude of anomalous data.

The multivariable map line profile, which represents 10 variables as a function of their latitude and longitude location for each line, is presented at a scale of 1:500,000. Each profile presents:

1. Aircraft altitude above the surface
2. eTh (^{208}Tl from ^{232}Th decay series)
3. eU (^{214}Bi from ^{238}U decay series)
4. K (^{40}K from natural potassium)
5. BIAIR (atmospheric ^{214}Bi)
6. Residual magnetic field
7. Gross count (greater than 400 keV)
8. eU/eTh ($^{214}Bi/^{208}Tl$) ratio
9. eU/K ($^{214}Bi/^{40}K$) ratio
10. eTh/K ($^{208}Tl/^{40}K$) ratio
11. Geologic data, including aircraft flight path

The residual magnetic field map line profile, which represents five variables as a function of their latitude and longitude location for each line, plus geologic data at a scale of 1:500,000 is presented as:

1. Aircraft altitude
2. Atmospheric temperature
3. Atmospheric pressure
4. Residual magnetic field data
5. Magnetic field base line station data
6. Geological data, including aircraft flight path

The output of these various computations supplies, beyond two profile sets, the following data:

* Histograms of the radiation data distribution within each geologic unit.

* Histograms of the average velocity distribution for each one-second record for each map and tie line.
* Histograms of the average altitude distribution for each one-second record for each map and tie line.
* Tables giving the average radiation concentration of each geologic unit for each flight line.
* Average radiation concentration for each variable as a function of flight line, including the atmospheric ^{214}Bi.
* Set of maps showing the standard deviation data as a function of location and radiation variable.
* Printer plot contour maps of eTh, eU, K, eU/K, eU/eTh, eTh/K and the magnetics at a scale of 1:500,000.

4. Statistical Analysis Procedures

It is necessary to exclude from the statistical analysis all variables which have too low a counting rate to be statistically valid, and data which were obtained at altitudes above 1,000 feet. To this end, a statistical adequacy test was run on all data for each data record. If a given value of Tℓ, Bi or K failed the test, that variable value, and any ratio value associated with it, were not used in the statistical determinations of mean and standard deviation values. In addition, such values are indicated on the radiometric profiles by a vertical (tick) mark along the base line for the variable, and are flagged in the single record and averaged record listings (microfiche). The ratio values are set to zero in the Radiometric Profile Plots. The flags in the listings appear under the heading AKUT for altitude, ^{40}K, ^{214}Bi and ^{208}Tl, respectively. The flags are zero for statistically valid data, and one for rejected data in the case of K, U and T. For altitude (A), a zero indicates altitudes to 700 feet, a one (1) indicates altitudes between 700 and 1,000 feet, and a two (2) indicates altitudes above 1,000 feet.

The tests used to reject data were as follows:

(1) $\overline{Tl}I < 1.5 \sqrt{Tlw - \overline{Tl}I} = 1.5\sigma T$

(2) $BISUR < 1.5 \sqrt{Biw - BISUR} = 1.5\sigma B$

(3) $\overline{K}I < 1.5 \sqrt{Kw - \overline{K}I} = 1.5\sigma K$

where the "w" subscript refers to the respective window counting rates from the raw data and $\overline{T\ell 1}$, BISUR and $\overline{K1}$ have previously been defined. If any of the above inequalities were true, the associated variable was flagged, and that value was rejected in all statistical determinations.

The values of the radicals in the above equations, which are indicated as σT, σB, σK and the barred values, were calculated on the basis of a single record value for determining flags in the single record listings and the 7-point weighted values for determining flags in the averaged records listings.

The mean value and standard deviations were calculated assuming the data to have a normal distribution within a geologic type. The equation used in determining the variance is:

$$\sigma^2 = \frac{1}{N-1}\left\{\sum_{i=1}^{N} x_i^2 - N\overline{x}^2\right\}$$

where N is the number of statistically valid samples for a given geologic type, x_i is the value of the variable for sample number i, and $\overline{x}$ is the mean value of the variable for the geologic type. Values from the entire survey of the area are used in these computations.

APPENDICES

I PRODUCTION SUMMARY

II TAPE FORMAT STATEMENTS

III COMPUTER LISTINGS

IV LINE PRINTER CONTOURS

AI.A PRODUCTION SUMMARY - SURVEY TIME PERIOD

ML/TL	DATE FLOWN	SURVEY LINE MILES	AVERAGE SPEED/DAY	AVERAGE ALTITUDE/DAY
ML20	March 30, 1980	120	151	411
ML40,60,80 100,120,140 160,180	March 31, 1980	955	141	407
ML200,220, 240,260, 280,300, 320,340	April 1, 1980	952	142	412
ML360,380, 400,420, 440,460	April 2, 1980	708	143	429
ML5020, 5040,5060 5080	April 3, 1980	280	148	413
ML5100,5120 5140,5160 5180,5200	April 4, 1980	417	147	411

AI.B TEST LINE RESULTS

		March, 1980			April, 1980		
	UNIT	*30	**31	***1	****2	**3	**4
	PRE COS	41.38	40.47	38.52	41.33	38.27	39.45
	POS COS	44.34	40.79	39.42	41.74	*****	40.04
	T1	35.86	58.11	54.07	42.79	60.22	59.24
	T1	33.55	58.36	53.75	40.61	21.77	59.52
	Bi	16.78	24.16	21.48	16.12	21.77	22.21
	Bi	16.80	19.95	25.09	20.85	131.70	23.10
	K	65.50	124.72	103.29	85.80	131.70	129.71
	K	65.17	129.88	103.27	86.89	1846.01	132.16
	GC	1190.93	1884.75	1629.83	1387.83	1846.01	1867.11
	GC	1208.78	1876.06	1684.45	1455.93	21.07	1878.76
	BiAir	5.88	12.90	12.77	11.51	21.07	11.86
	BiAir	12.34	16.84	14.81	7.13	383.40	13.52
	ALT	408.84	401.59	405.25	375.87	383.40	405.87
	ALT	415.49	404.02	417.63	396.67	1846.01	407.61

* Menard Test Line
** Vancourt Test Line
*** Rowena Test Line
**** Small Lakes Test Line
***** Equipment Failure

AI.C DIURNAL CORRECTIONS TO LINE DATA

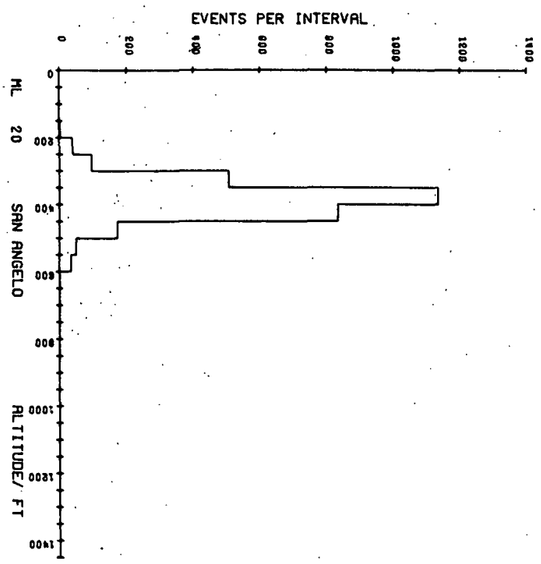
LINE	DIURNAL CORRECTIONS IN GAMMAS	LINE	DIURNAL CORRECTIONS IN GAMMAS	LINE	DIURNAL CORRECTIONS IN GAMMAS
ML 20	-9	ML 180	-2	ML 340	-1
ML 40	-4	ML 200	0	ML 360	-7
ML 60	4	ML 220	6	ML 380	-5
ML 80	6	ML 240	6	ML 400	-1
ML 100	5	ML 260	5	ML 420	-3
ML 120	3	ML 280	3	ML 440	-11
ML 140	0	ML 300	0	ML 460	-9
ML 160	3	ML 320	0		
TL 5020	-2	TL 5100	-7	TL 5160	3
TL 5040	5	TL 5120	-7	TL 5180	9
TL 5060	11	TL 5140	-5	TL 5200	6
TL 5080	12				

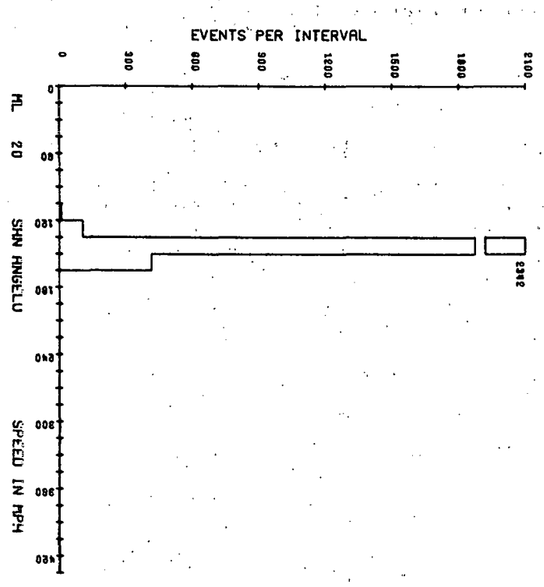
AI.D EXPLANATORY NOTES

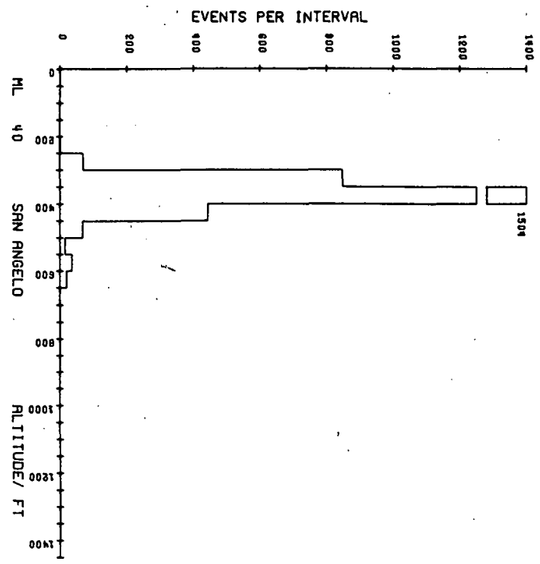
There were no problems with the San Angelo quad.

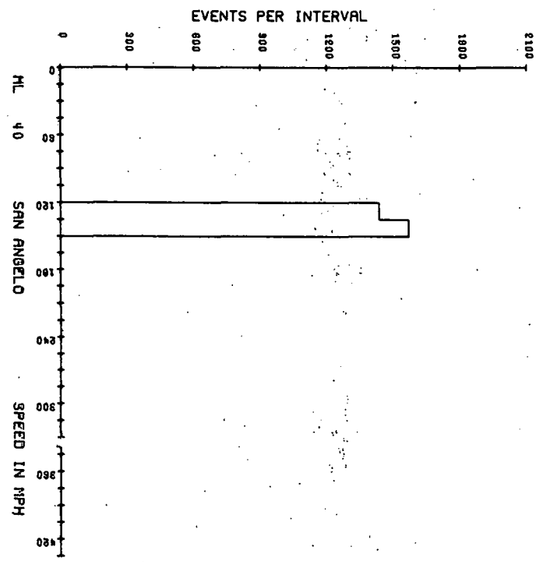
AI.E AVERAGE SPEED AND ALTITUDE DATA SUMMARY

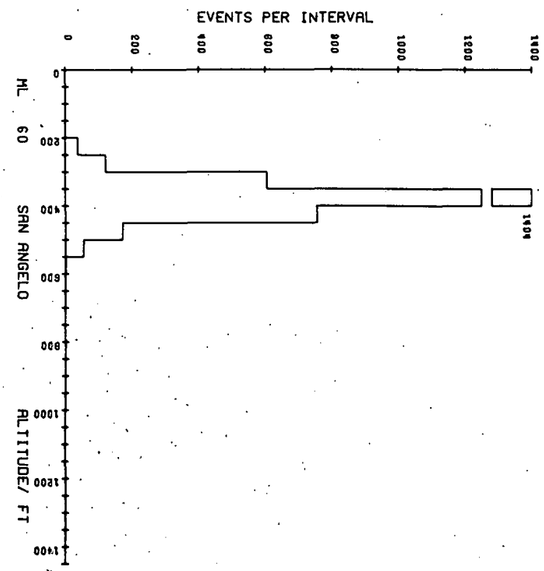
LINE	AVERAGE SPEED (MPH)	AVERAGE ALTITUDE (FEET)	LINE	AVERAGE SPEED (MPH)	AVERAGE ALTITUDE (FEET)
ML 20	152	411	ML 360	135	406
ML 40	143	398	ML 380	150	425
ML 60	138	405	ML 400	137	418
ML 80	141	406	ML 420	151	459
ML 100	141	421	ML 440	136	417
ML 120	142	407	ML 460	151	451
ML 140	141	403	TL 5020	148	393
ML 160	139	401	TL 5040	147	400
ML 180	142	419	TL 5060	146	440
ML 200	145	398	TL 5080	150	420
ML 220	139	422	TL 5100	142	408
ML 240	145	419	TL 5120	145	411
ML 260	141	417	TL 5140	150	420
ML 280	143	407	TL 5160	146	419
ML 300	137	407	TL 5180	150	403
ML 320	147	412	TL 5200	147	405
ML 340	138	415			

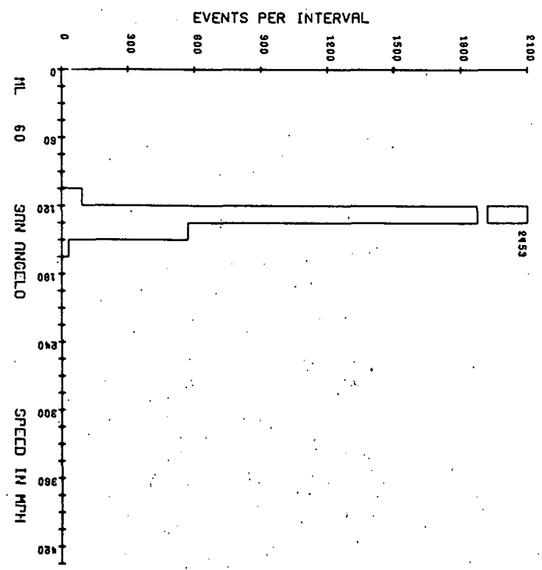

EVENTS PER INTERVAL
ML 20
SAN ANGELO
ALTITUDE/ FT

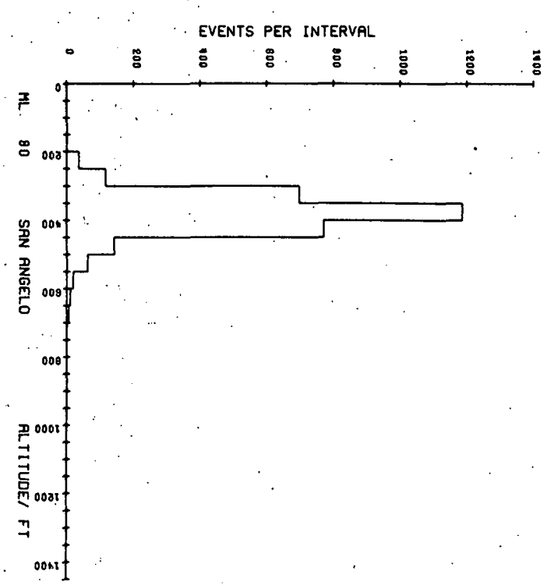

EVENTS PER INTERVAL
ML 20
SAN ANGELO
SPEED IN MPH


EVENTS PER INTERVAL
ML 40
SAN ANGELO
ALTITUDE/ FT


EVENTS PER INTERVAL
ML 40
SAN ANGELO
SPEED IN MPH


EVENTS PER INTERVAL
ML 60
SAN ANGELO
ALTITUDE/ FT


EVENTS PER INTERVAL
ML 60
SAN ANGELO
SPEED IN MPH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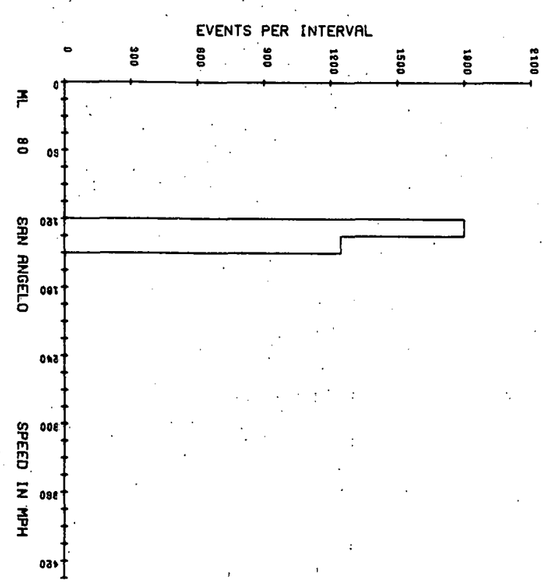
ML 80
SAN ANGELO
ALTITUDE/ FT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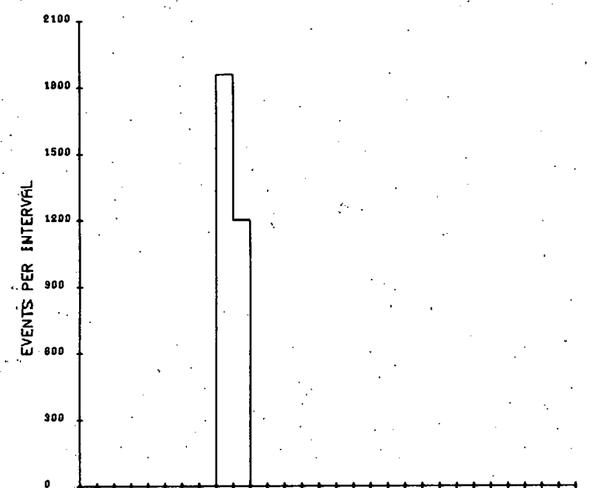
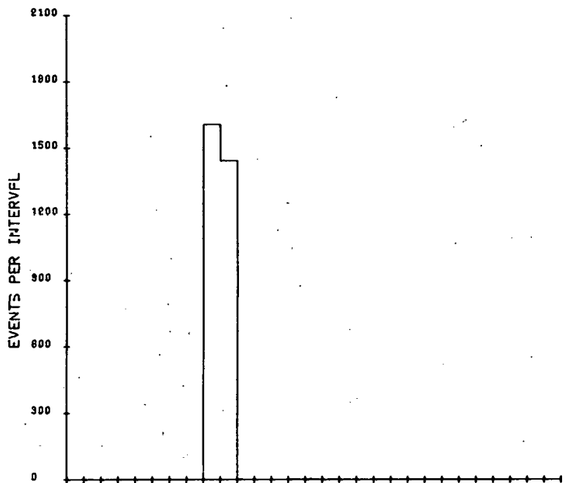
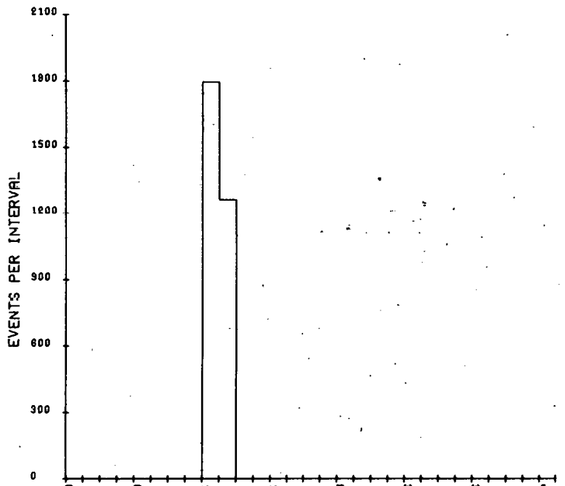
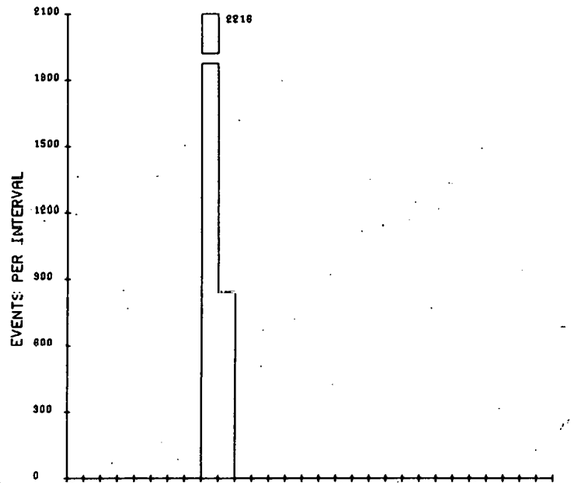
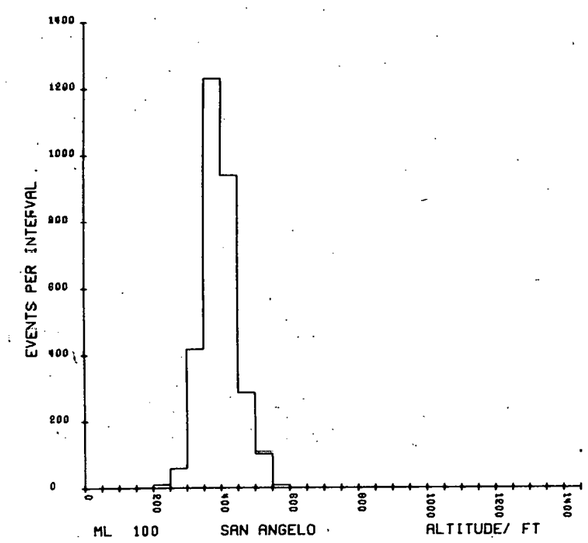
ML 80
SAN ANGELO
SPEED IN MPH

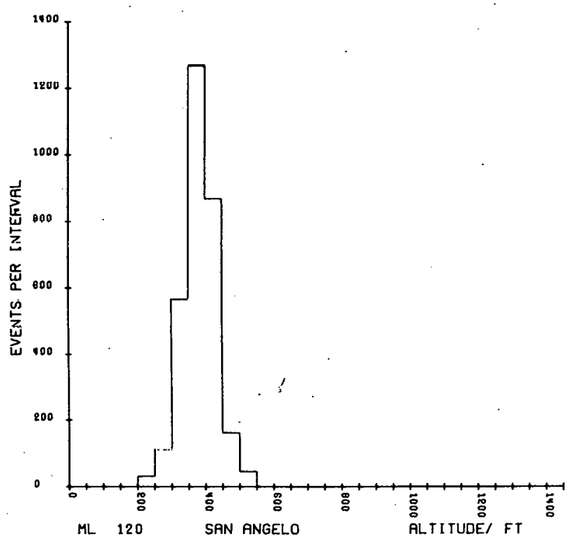

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 100 SAN ANGELO SPEED IN MPH

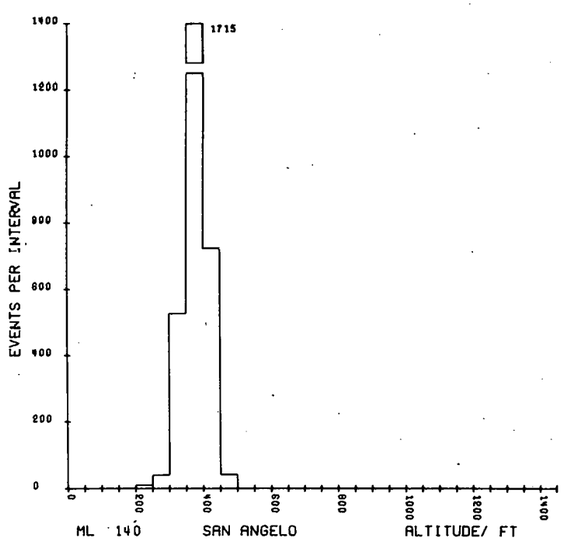

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 120 SAN ANGELO SPEED IN MPH

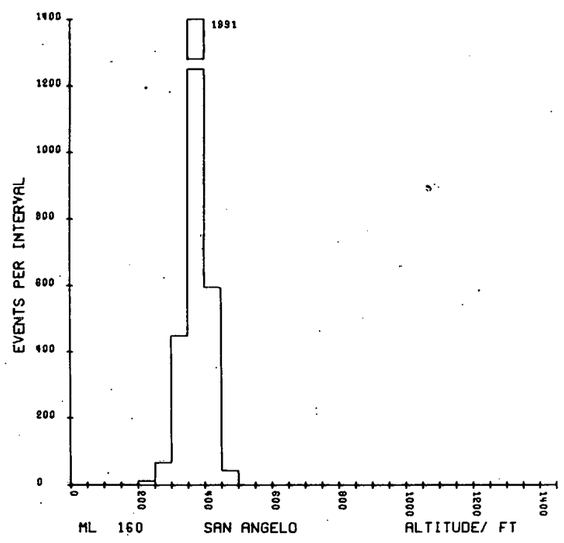

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 140 SAN ANGELO SPEED IN MPH

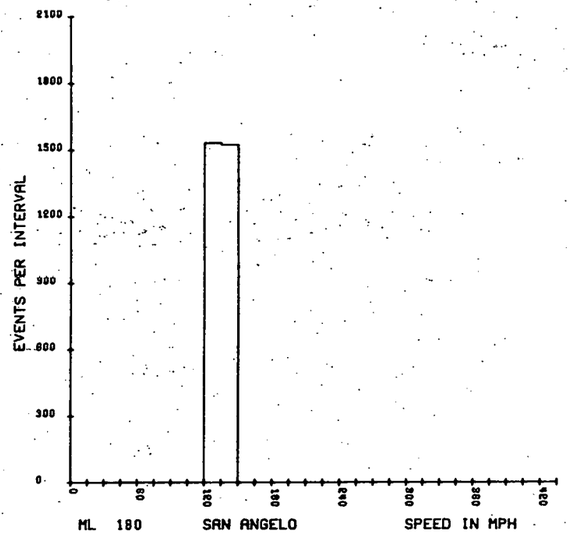

2218
EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 160 SAN ANGELO SPEED IN MPH

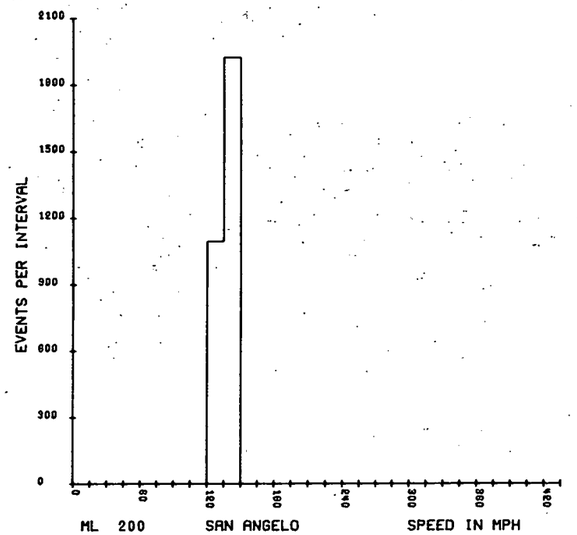

EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 100 SAN ANGELO ALTITUDE/ FT

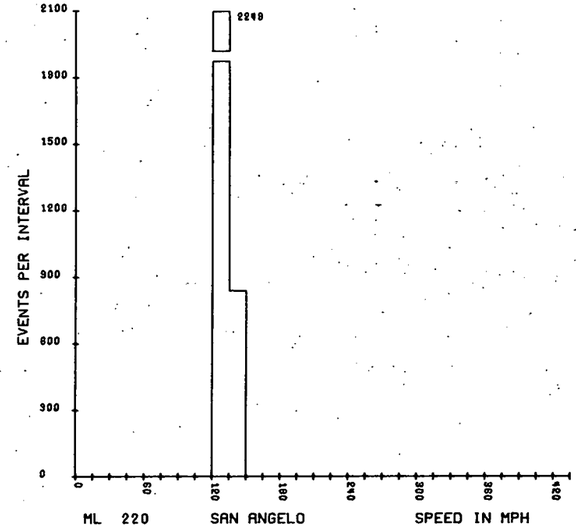

EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 120 SAN ANGELO ALTITUDE/ FT

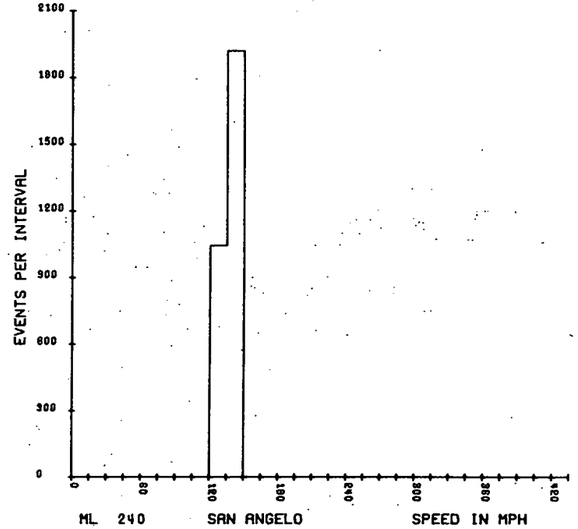

1715
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 140 SAN ANGELO ALTITUDE/ FT

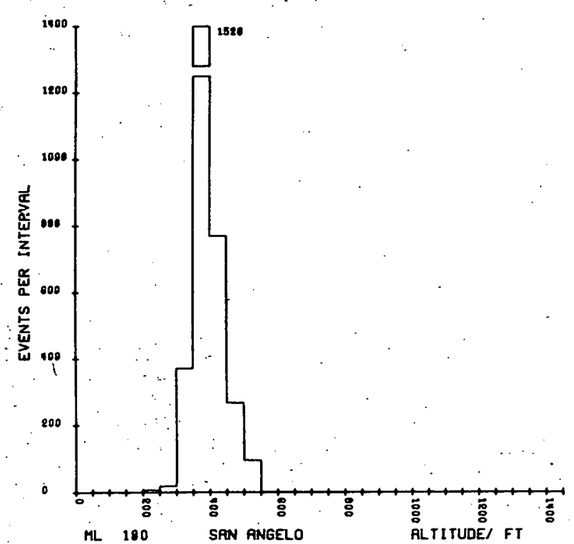

1991
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 160 SAN ANGELO ALTITUDE/ FT

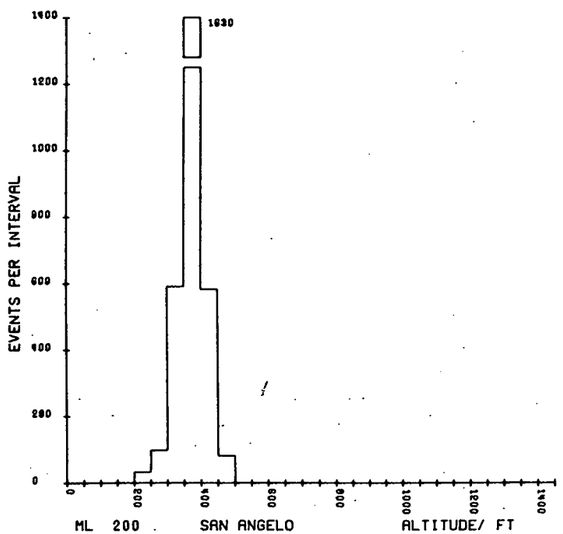

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 180 SAN ANGELO SPEED IN MPH

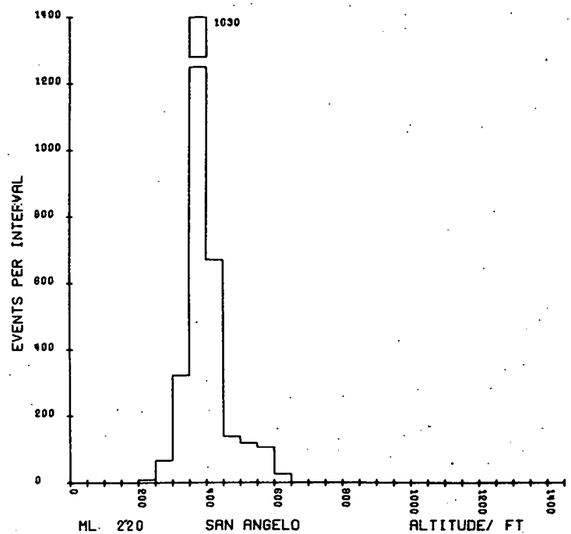

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 200 SAN ANGELO SPEED IN MPH

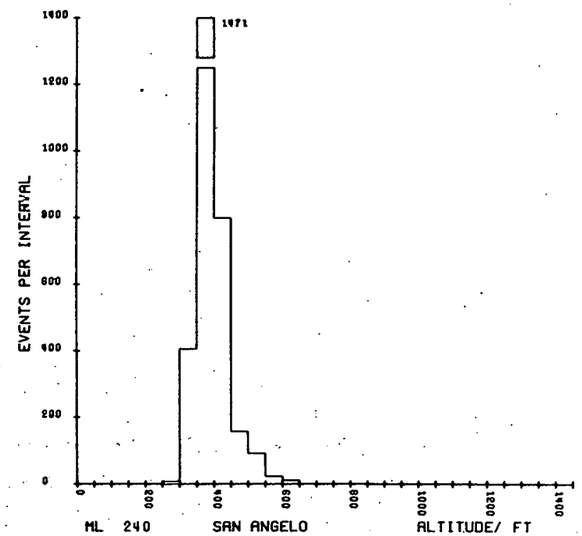

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
2249
0
60
120
180
240
300
360
420
ML 220 SAN ANGELO SPEED IN MPH


EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 240 SAN ANGELO SPEED IN MPH


EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
1520
0
200
400
600
800
1000
1200
1400
ML 180 SAN ANGELO ALTITUDE/ FT


EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
1630
0
200
400
600
800
1000
1200
1400
ML 200 SAN ANGELO ALTITUDE/ FT


EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
1030
0
200
400
600
800
1000
1200
1400
ML 220 SAN ANGELO ALTITUDE/ FT


EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
1471
0
200
400
600
800
1000
1200
1400
ML 240 SAN ANGELO ALTITUDE/ FT

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 260 SAN ANGELO SPEED IN MPH

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 280 SAN ANGELO SPEED IN MPH

2577
EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 300 SAN ANGELO SPEED IN MPH

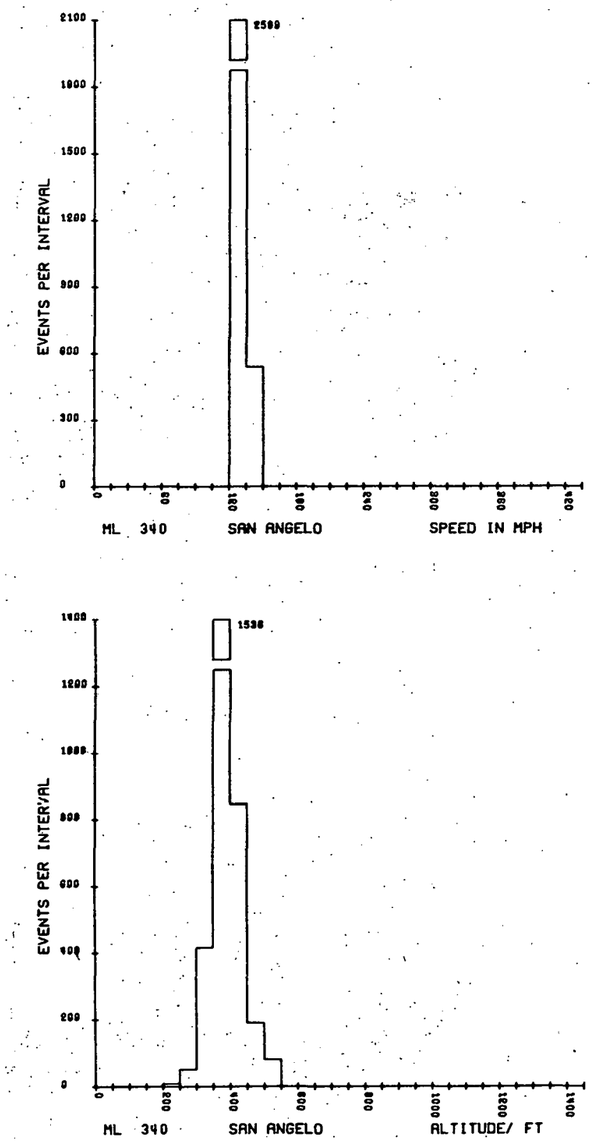
2295
EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
ML 320 SAN ANGELO SPEED IN MPH

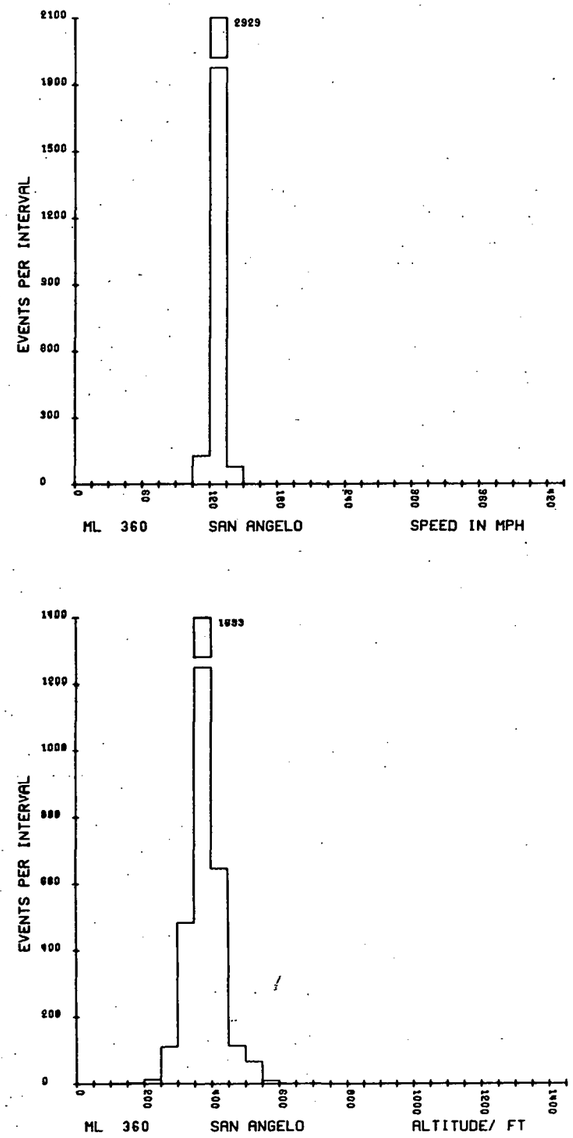
1710
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 260 SAN ANGELO ALTITUDE/ FT

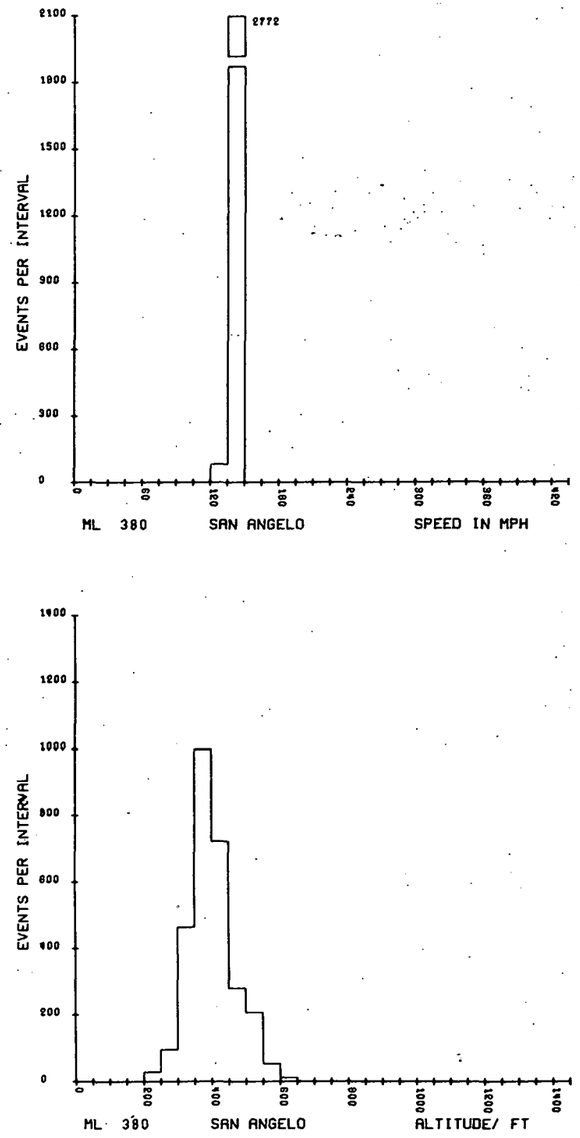
1826
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 280 SAN ANGELO ALTITUDE/ FT

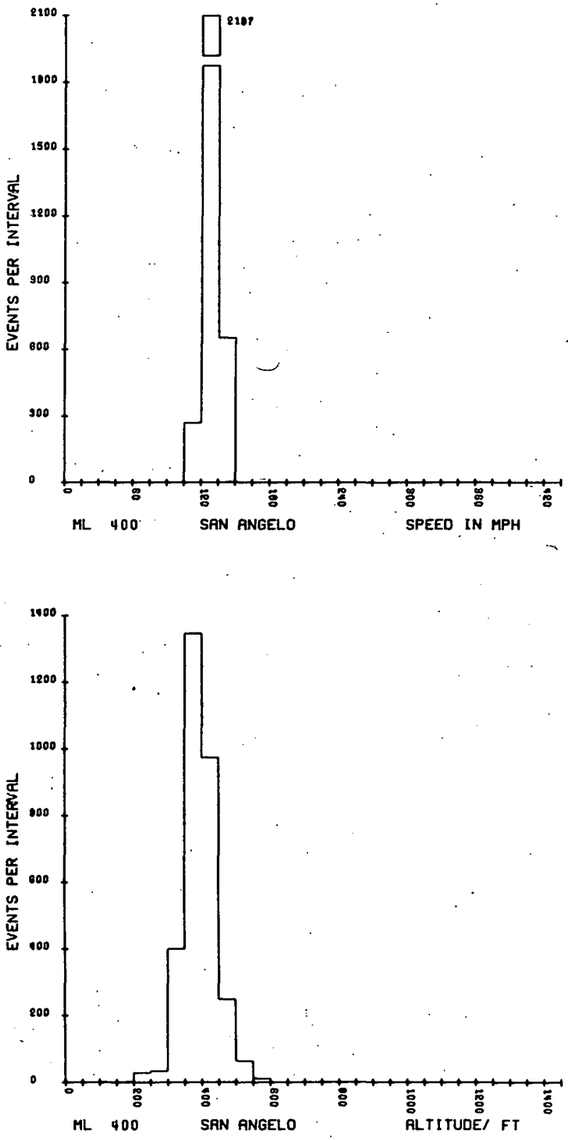
1932
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 300 SAN ANGELO ALTITUDE/ FT

1519
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 320 SAN ANGELO ALTITUDE/ FT


2589
EVENTS PER INTERVAL
ML 340 SAN ANGELO SPEED IN MPH
1536
ML 340 SAN ANGELO ALTITUDE/ FT


2929
EVENTS PER INTERVAL
ML 360 SAN ANGELO SPEED IN MPH
1693
ML 360 SAN ANGELO ALTITUDE/ FT


2772
EVENTS PER INTERVAL
ML 380 SAN ANGELO SPEED IN MPH
ML 380 SAN ANGELO ALTITUDE/ FT


2187
EVENTS PER INTERVAL
ML 400 SAN ANGELO SPEED IN MPH
ML 400 SAN ANGELO ALTITUDE/ FT

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
2630
0
60
120
180
240
300
360
420
ML 420 SAN ANGELO SPEED IN MPH

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
2915
0
60
120
180
240
300
360
420
ML 440 SAN ANGELO SPEED IN MPH

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
2727
0
60
120
180
240
300
360
420
ML 460 SAN ANGELO SPEED IN MPH

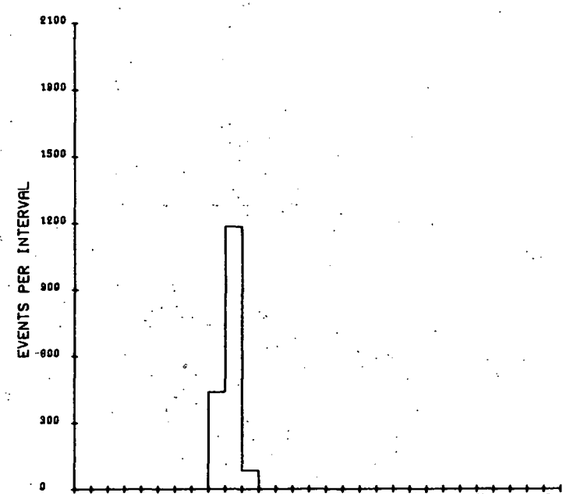
EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
TL 5020 SAN ANGELO SPEED IN MPH

EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 420 SAN ANGELO ALTITUDE/ FT

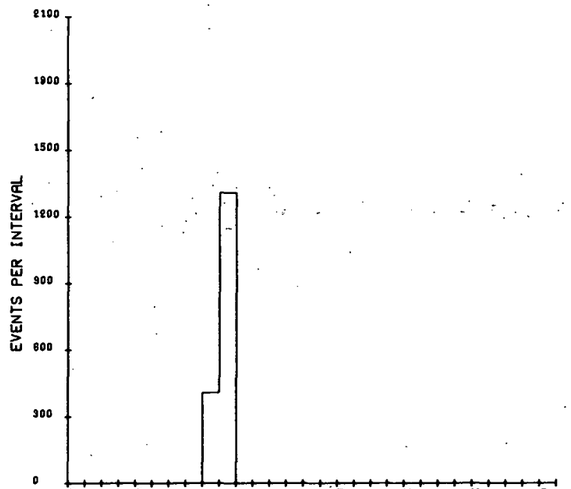
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
1572
0
200
400
600
800
1000
1200
1400
ML 440 SAN ANGELO ALTITUDE/ FT

EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
ML 460 SAN ANGELO ALTITUDE/ FT

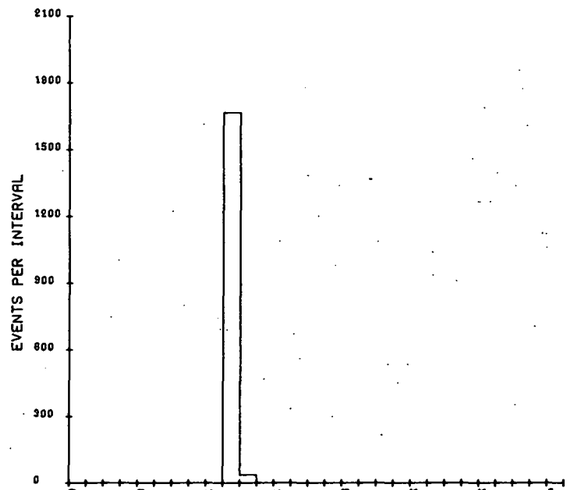
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
TL 5020 SAN ANGELO ALTITUDE/ FT



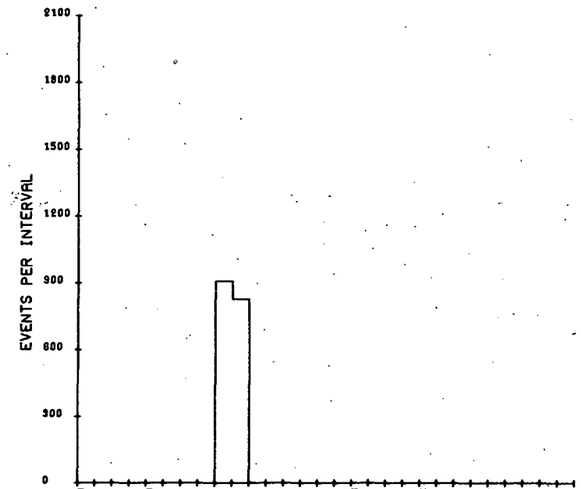
TL 5040 SAN ANGELO SPEED IN MPH



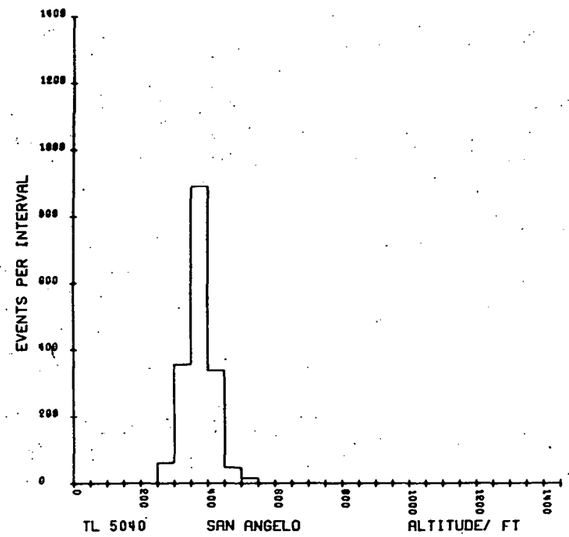
TL 5060 SAN ANGELO SPEED IN MPH



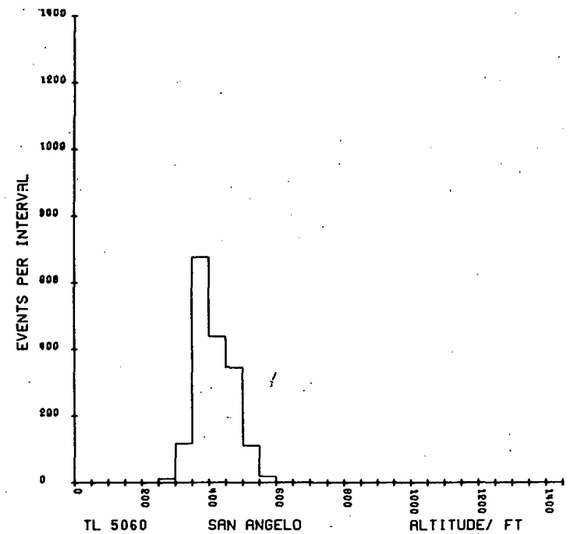
TL 5080 SAN ANGELO SPEED IN MPH



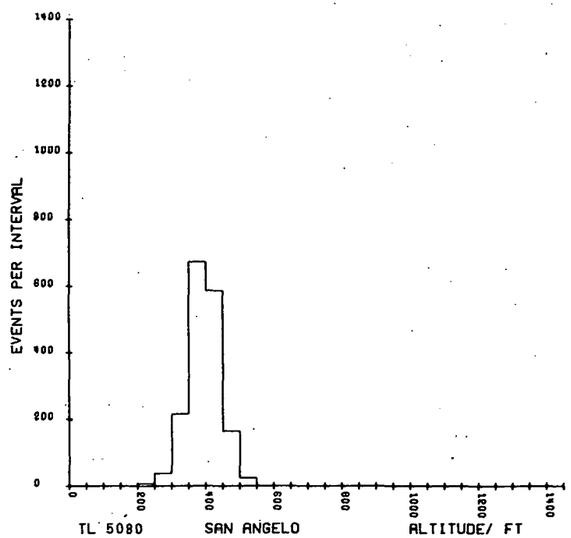
TL 5100 SAN ANGELO SPEED IN MPH



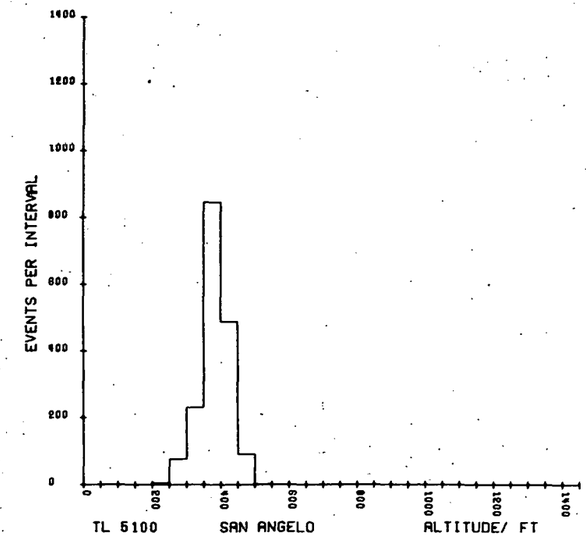
TL 5040 SAN ANGELO ALTITUDE/ FT



TL 5060 SAN ANGELO ALTITUDE/ FT



TL 5080 SAN ANGELO ALTITUDE/ FT



TL 5100 SAN ANGELO ALTITUDE/ FT

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
TL 5120 SAN ANGELO SPEED IN MPH

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
TL 5140 SAN ANGELO SPEED IN MPH

EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
TL 5160 SAN ANGELO SPEED IN MPH

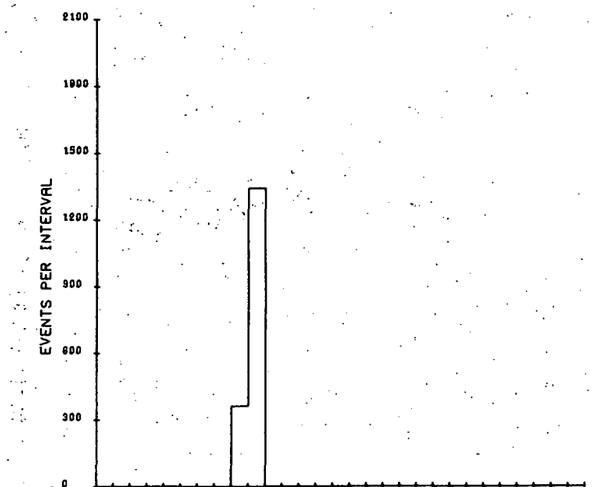
EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
TL 5180 SAN ANGELO SPEED IN MPH

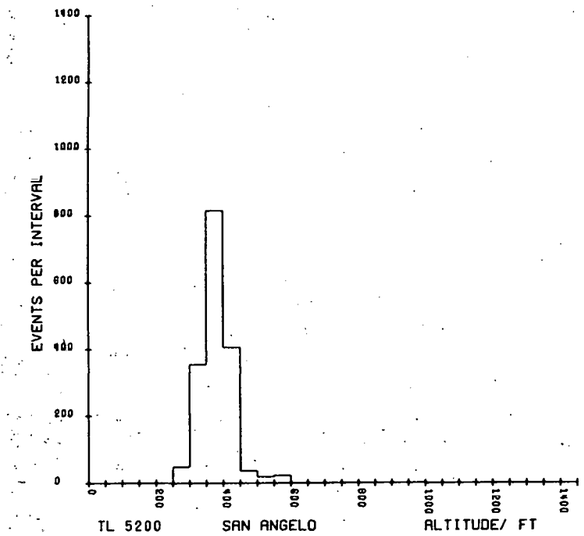
EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
TL 5120 SAN ANGELO ALTITUDE/ FT

EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
TL 5140 SAN ANGELO ALTITUDE/ FT

EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
TL 5160 SAN ANGELO ALTITUDE/ FT

EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
TL 5180 SAN ANGELO ALTITUDE/ FT


EVENTS PER INTERVAL
2100
1800
1500
1200
900
600
300
0
0
60
120
180
240
300
360
420
TL 5200
SAN ANGELO
SPEED IN MPH


EVENTS PER INTERVAL
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
TL 5200
SAN ANGELO
ALTITUDE/ FT

APPENDIX II

TAPE FORMAT STATEMENTS

A. DESCRIPTION OF DATA TAPES

A1. General

All data tapes are 9-track, 800 BPI (NRZI), odd parity, EBCDIC code. Each tape contains a gum label giving the survey project name, month and year of survey, tape type, subcontractor name, date tape created, tape reel count, tape recording characteristics, block size in Bytes and location of tape format information.

The general description for each of the tape types is as follows:

Block Number	Description
1	Format Description
2	Tape Identification
3	First Data Block
4	Second Data Block
.	.
.	Last Data Block
EOF	

A2. Raw Spectral Data Tapes

Block Size (Physical Record): 6600 characters
Logical Record, Data : 1100 characters

1. Format Description Block (Block 1)

The Format Description utilizes 4248 characters. The remaining 2352 characters of this block are blanks.

```
Line                                        Character Number
Number  12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
1       01 0978  (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)
2
3       RAW SPECTRAL DATA TAPE
4
5       FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK ON TAPE)
6
7       ITEM  FORMAT   DESCRIPTION
8       1     A40      QUADRANGLE NAME AS PROJECT IDENTIFICATION
9       2     A20      NAME OF SUBCONTRACTOR
10      3     I4       APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
```



```
Line                                        Character Number
Number  12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
11      4     I1       AERIAL SYSTEM IDENTIFICATION CODE
12      5     A20      AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER
13      6     I3       BFEC CALIBRATION REPORT NUMBER
14      7     F6.3     4PI SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
15                     PLACES IN SECONDS
16      8     F6.3     2PI SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
17                     PLACES IN SECONDS
18      9     I3       NUMBER OF CHANNELS (0-3 MEV) FOR 4PI SYSTEM
19      10    I3       NUMBER OF CHANNELS (0-3 MEV) FOR 2PI SYSTEM
20      11    I3       NUMBER OF FLIGHT LINES ON THIS TAPE
21      12    I4       FIRST FLIGHT LINE NUMBER ON THIS TAPE
22      13    I6       FIRST RECORD NUMBER OF FIRST FLIGHT LINE
23      14    I3       JULIAN DATE (DAY OF YEAR) FIRST FLIGHT LINE WAS
24                     COLLECTED
25      15-17 I4,I6,I3 REPEAT OF ITEMS 12-14 FOR SECOND FLIGHT LINE ON THIS
26                     TAPE
27      *     *                *
28      *     *                *
29      *     *                *
30      306-308 I4,I6,I3 REPEAT OF ITEMS 12-14 FOR 99TH FLIGHT LINE ON THIS
31                     TAPE
32
33      FORMAT FOR RAW SPECTRAL DATA RECORD (THIRD THRU LAST BLOCK ON TAPE)
34
35      ITEM  FORMAT   DESCRIPTION
36      1     I1       AERIAL SYSTEM IDENTIFICATION CODE
37      2     I4       FLIGHT LINE NUMBER
38      3     I6       RECORD IDENTIFICATION NUMBER
39      4     I6       GMT TIME OF DAY (HHMMSS)
40      5     F8.4     LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
41      6     F8.4     LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
42      7     F6.1     TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
43      8     F7.1     TOTAL MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE
44                     IN GAMMAS
45      9     A8       SURFACE GEOLOGIC MAP UNIT CODE
46      10    I4       QUALITY FLAG CODES
47      11    F4.1     OUTSIDE AIR TEMPERATURE TO ONE DECIMAL PLACE IN
48                     DEGREES CELSIUS
49      12    F5.1     OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
50      13    F5.3     LIVE TIME COUNTING PERIOD TO THREE DECIMAL PLACES IN
51                     SECONDS
52      14    I4       SUMMED RAW OUTPUT FROM COSMIC CHANNELS (3-6 MEV) IN
53                     COUNTS
54      15    I4       RAW OUTPUT FROM CHANNEL 1 IN COUNTS
55      16    I4       RAW OUTPUT FROM CHANNEL 2 IN COUNTS
56      *     *                *
57      *     *                *
58      *     *                *
59      270   I4       RAW OUTPUT FROM CHANNEL 256 IN COUNTS
-       -     -        2352 BLANK CHARACTERS
```

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 30 of the Format Description Block A2.1, and 1396 characters are produced. The remaining 5204 characters in this block are blanks.

If fewer than 99 flight lines exist, the unused flight line information, 13 characters per flight line, is filled with 9's through the 99th flight line.

3. Raw Spectral Data Blocks

The information and format for the logical records in these blocks are indicated in lines 36 through 59 of the Format Description Block A2.1. One logical record contains 1100 characters. There are six such logical records per 6600 character physical record or block.

The 2π data logical record is recorded after the corresponding 4π data collection intervals at a frequency dependent on the 2π system data collection interval. For example, if the 4π data collection interval is 1 second and the 2π data collection interval is 10 seconds, then 10 records of 4π data are recorded followed by 1 record of the 2π data which was collected during the preceding 10 seconds. The format for the 2π data is identical to that of the 4π data, except for lines 40 through 49 of the Format Description Block given above. These variables are expressed in the 2π record as all nines in the format specified for I and F fields, and all zeros for A fields.

A3. Single Record Reduced Data Tapes

Block Size (Physical Record): 6900 characters
Logical Record, Data : 138 characters

1. Format Description Block (Block 1)

The Format Description utilizes 6768 characters. The remaining 132 characters of this block are blanks.

```
Line                                  Character Number
Number  12345678901234567890123456789012345678901234567890123456789C123456789012

1       02  0978  (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)
2
3       SINGLE RECORD REDUCED DATA TAPE
4
5       FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)
6
```



```
Line                                  Character Number
Number  12345678901234567890123456789012345678901234567890123456789012345678901234567890

7       ITEM    FORMAT    DESCRIPTION
8       1       A40       QUADRANGLE NAME AS PROJECT IDENTIFICATION
9       2       A20       NAME OF SUBCONTRACTOR
10      3       I4        APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
11      4       I1        NUMBER OF AERIAL SYSTEMS USED TO COLLECT DATA FOR
12                        THIS QUADRANGLE
13      5       I1        AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
14      6       A20       AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR
15                        FIRST SYSTEM
16      7       F6.1      NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
17                        TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE
18                        IN CPS PER PERCENT K FOR FIRST SYSTEM
19      8       F6.1      NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
20                        TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE
21                        IN CPS PER PPM EQUIVALENT U
22      9       F6.1      NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
23                        TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE
24                        IN CPS PER PPM EQUIVALENT TH
25      10      I6        BLANK FIELD (999999)
26      11      F6.3      4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
27                        PLACES IN SECONDS FOR FIRST SYSTEM
28      12      F6.3      2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
29                        PLACES IN SECONDS FOR FIRST SYSTEM
30      13      I3        NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST
31                        AERIAL SYSTEM
32      14      I3        NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST
33                        AERIAL SYSTEM
34      15-24   (SAME)    REPEAT OF ITEMS 5-14 FOR SECOND AERIAL SYSTEM
35      *       *                          *
36      *       *                          *
37      *       *                          *
38      85-94   (SAME)    REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
39      95      I3        NUMBER OF FLIGHT LINES ON THIS TAPE
40      96      I4        FIRST FLIGHT LINE NUMBER ON THIS TAPE
41      97      I6        FIRST RECORD NUMBER OF FIRST FLIGHT LINE
42      98      I3        JULIAN DATE (DAY OF YEAR) FIRST FLIGHT-LINE DATA WAS
43                        COLLECTED
44      99-101  I4,I6,I3  REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS
45                        TAPE
46      *       *                          *
47      *       *                          *
48      *       *                          *
49      390-392 I4,I6,I3  REPEAT OF ITEMS 96-98 FOR 99TH FLIGHT LINE ON THIS
50                        TAPE
51
52      FORMAT FOR SINGLE RECORD REDUCED DATA RECORD (THIRD THRU LAST BLOCK)
53
54      ITEM    FORMAT    DESCRIPTION
55       1      I1        AERIAL SYSTEM IDENTIFICATION CODE
56       2      I4        FLIGHT LINE NUMBER
57       3      I6        RECORD IDENTIFICATION NUMBER
58       4      I6        GMT TIME OF DAY (HHMMSS)
59       5      F8.4      LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
```



```
Line                                  Character Number
Number  12345678901234567890123456789012345678901234567890123456789012345678901234567890

60      6       F8.4      LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
61      7       F6.1      TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
62      8       F7.1      RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY
63                        TO ONE DECIMAL PLACE IN GAMMAS
64      9       A8        SURFACE GEOLOGIC MAP UNIT CODE
65      10      I4        QUALITY FLAG CODES
66      11      F6.1      APPARENT CONCENTRATION OF TERRESTRIAL POTASSIUM
67                        (K-40) TO ONE DECIMAL PLACE IN PERCENT K
68      12      F4.1      UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL
69                        PLACE IN PERCENT K
70      13      F6.1      APPARENT CONCENTRATION OF TERRESTRIAL URANIUM
71                        (BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
72      14      F4.1      UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL
73                        PLACE IN PPM EQUIVALENT U
74      15      F6.1      APPARENT CONCENTRATION OF TERRESTRIAL THORIUM
75                        (TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
76      16      F4.1      UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL
77                        PLACE IN PPM EQUIVALENT TH
78      17      F6.1      URANIUM-TO-THORIUM RATIO TO ONE DECIMAL PLACE IN
79                        PPM EQUIVALENT U PER PPM EQUIVALENT TH
80      18      F6.1      URANIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN
81                        PPM EQUIVALENT U PER PERCENT K
82      19      F6.1      THORIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN
83                        PPM EQUIVALENT TH PER PERCENT K
84      20      F8.1      GROSS GAMMA (0.4-3.0 MEV) COUNT RATE TO ONE DECIMAL
85                        PLACE IN COUNTS PER SECOND
86      21      F6.1      UNCERTAINTY IN GROSS GAMMA COUNT RATE TO ONE DECIMAL
87                        PLACE IN COUNTS PER SECOND
88      22      F5.1      ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL
89                        PLACE IN PPM EQUIVALENT U
90      23      F4.1      UNCERTAINTY IN ATMOSPHERIC BI-214 4PI CORRECTION
91                        TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
92      24      F4.1      OUTSIDE AIR TEMPERATURE TO ONE DECIMAL PLACE IN
93                        DEGREES CELSIUS
94      25      F5.1      OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
```

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 49 of the Format Description Block A3.1, and 1922 characters are produced. The remaining 4978 characters of this block are blanks.

If less than nine aerial systems are used, the space allocated for additional systems is filled with 9's in the format specified for each item using I and F fields, and with zeros for A fields.

Similarly, if fewer than 99 flight lines exist, the unused flight line information, 13 characters per flight line, is filled with 9's through the 99th flight line.

3. Single Record Reduced Data Blocks

The information and format for the logical records in these blocks are indicated in lines 55 through 94 of the Format Description Block A3.1. One logical record contains 138 characters. There are 50 such logical records per 6900 character physical record or block.

The data appearing in locations specified by lines 68, 72, 76, 86 and 90 of the Format Description Block A3.1 are 9's in the format specified in each case.

A4. Statistical Analysis Tapes (Data and Summary)
File 1: Statistical Analysis Data

Block Size (Physical Record): 8000 characters
Logical Record, Data : 160 characters

1. Format Description Block (Block 1)

The Format Description utilizes 7560 characters. The remaining 440 characters are blanks.

```
Line                                    Character Number
Number  12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012

1       03  0978  (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)
2
3       STATISTICAL ANALYSIS DATA TAPE
4
5       FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)
6
7       ITEM   FORMAT    DESCRIPTION
8       1      A40       QUADRANGLE NAME AS PROJECT IDENTIFICATION
9       2      A20       NAME OF SUBCONTRACTOR
10      3      I4        APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
11      4      I1        NUMBER OF AERIAL SYSTEMS USED TO COLLECT DATA FOR
12                       THIS QUADRANGLE
13      5      I1        AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
14      6      A20       AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR
15                       FIRST SYSTEM
16      7      F6.1      NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
17                       TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE
18                       IN CPS PER PERCENT K
19      8      F6.1      NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
20                       TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE
21                       IN CPS PER PPM EQUIVALENT U
22      9      F6.1      NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
23                       TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE
24                       IN CPS PER PPM EQUIVALENT TH
25      10     I6        BLANK FIELD (999999)
26      11     F6.3      4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
27                       PLACES IN SECONDS FOR FIRST SYSTEM
28      12     F6.3      2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
29                       PLACES IN SECONDS FOR FIRST SYSTEM
```



```
Line                                    Character Number
Number  12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012

30      13     I3        NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST
31                       AERIAL SYSTEM
32      14     I3        NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST
33                       AERIAL SYSTEM
34      15-24  (SAME)    REPEAT OF ITEMS 5-14 FOR SECOND AERIAL SYSTEM
35      *      *                          *
36      *      *                          *
37      *      *                          *
38      85-94  (SAME)    REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
39      95     I3        NUMBER OF FLIGHT LINES ON THIS TAPE
40      96     I4        FIRST FLIGHT LINE NUMBER ON THIS TAPE
41      97     I6        FIRST RECORD NUMBER OF FIRST FLIGHT LINE
42      98     I3        JULIAN DATE (DAY OF YEAR) FIRST FLIGHT LINE DATA WAS
43                       COLLECTED
44      99-101 I4,I6,I3  REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS
45                       TAPE
46      *      *                          *
47      *      *                          *
48      *      *                          *
49      390-392 I4,I6,I3 REPEAT OF ITEMS 96-98 FOR 99TH FLIGHT LINE ON THIS
50                       TAPE
51
52      FORMAT FOR STATISTICAL ANALYSIS DATA RECORD (THIRD THRU LAST BLOCK)
53
54      ITEM   FORMAT    DESCRIPTION
55      1      I1        AERIAL SYSTEM IDENTIFICATION CODE
56      2      I4        FLIGHT LINE NUMBER
57      3      I6        RECORD IDENTIFICATION NUMBER
58      4      I6        GMT TIME OF DAY (HHMMSS)
59      5      F8.4      LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
60      6      F8.4      LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
61      7      F6.1      TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
62      8      F7.1      RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY
63                       TO ONE DECIMAL PLACE IN GAMMAS
64      9      A8        SURFACE GEOLOGIC MAP UNIT CODE
65      10     I5        QUALITY FLAG CODES
66      11     F6.1      AVERAGED CONCENTRATION OF TERRESTRIAL POTASSIUM
67                       (K-40) TO ONE DECIMAL PLACE IN PERCENT K
68      12     F4.1      UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL
69                       PLACE IN PERCENT K
70      13     F5.1      POTASSIUM STANDARD DEVIATION FROM THE MEAN TO ONE
71                       DECIMAL PLACE AND ALGEBRAICALLY SIGNED
72      14     F6.1      AVERAGED CONCENTRATION OF TERRESTRIAL URANIUM
73                       (BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
74      15     F4.1      UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL
75                       PLACE IN PPM EQUIVALENT U
76      16     F5.1      URANIUM STANDARD DEVIATION FROM THE MEAN TO ONE
77                       DECIMAL PLACE AND ALGEBRAICALLY SIGNED
78      17     F6.1      AVERAGED CONCENTRATION OF TERRESTRIAL THORIUM
79                       (TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
80      18     F4.1      UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL
81                       PLACE IN PPM EQUIVALENT TH
```



```
Line                                    Character Number
Number  12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012

82      19     F5.1      THORIUM STANDARD DEVIATION FROM THE MEAN TO ONE
83                       DECIMAL PLACE AND ALGEBRAICALLY SIGNED
84      20     F8.1      GROSS GAMMA (0.4-3.0 MEV) COUNT RATE TO ONE DECIMAL
85                       PLACE IN COUNTS PER SECOND
86      21     F6.1      UNCERTAINTY IN GROSS GAMMA COUNT RATE TO ONE DECIMAL
87                       PLACE IN COUNTS PER SECOND
88      22     F5.1      ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL
89                       PLACE IN PPM EQUIVALENT U
90      23     F4.1      UNCERTAINTY IN ATMOSPHERIC BI-214 4PI CORRECTION
91                       TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
92      24     F6.1      AVERAGED URANIUM-TO-THORIUM RATIO TO ONE DECIMAL
93                       PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
94      25     F5.1      URANIUM-TO-THORIUM RATIO STANDARD DEVIATION FROM THE
95                       MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
96      26     F6.1      AVERAGED URANIUM-TO-POTASSIUM RATIO TO ONE DECIMAL
97                       PLACE IN PPM EQUIVALENT U PER PERCENT K
98      27     F5.1      URANIUM-TO-POTASSIUM RATIO STANDARD DEVIATION FROM
99                       THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
100                      SIGNED
101     28     F6.1      AVERAGED THORIUM-TO-POTASSIUM RATIO TO ONE DECIMAL
102                      PLACE IN PPM EQUIVALENT TH PER PERCENT K
103     29     F5.1      THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION FROM
104                      THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY
105                      SIGNED
```

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 49 of the Format Description Block A4.1, and 1922 characters are produced. The remaining 6078 characters of this block are blanks.

If less than nine aerial systems are used, the space allocated for additional systems is filled with 9's in the format specified for each item using I and F fields, and with zeros for A fields.

Similarly, if fewer than 99 flight lines exist, the unused flight line information, 13 characters per flight line, is filled with 9's through the 99th flight line.

3. Statistical Analysis Data Blocks

The information and format for the logical records in these blocks are indicated in lines 55 through 103 of the Format Description Block A4.1. One logical record contains 160 characters. There are 50 such logical records per 8000 character physical record or block.

The data appearing in locations specified by lines 68, 74, 80, 86 and 90 of the Format Description Block A4.1 are 9's in the format specified in each case.

File 2: Statistical Analysis Summary

Block Size (Physical Record): 7000 characters
Logical Record (Data) : 140 characters

1. Format Description Block (Block 1)

The Format Description utilizes 4320 characters. The remaining 2680 characters are blanks.

Line Number	Character Number 12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
1	05 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODE)
2	
3	STATISTICAL ANALYSIS SUMMARY TAPE (OR FILE)
4	
5	FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)
6	

7	ITEM	FORMAT	DESCRIPTION
8	1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
9	2	A20	NAME OF SUBCONTRACTOR
10	3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
11	4	I6	NUMBER OF GEOLOGIC MAP UNITS USED FOR THIS
12			QUADRANGLE
13			
14	FORMAT FOR STATISTICAL ANALYSIS SUMMARY DATA RECORD (THIRD THRU LAST		
15	BLOCK)		
16			
17	ITEM	FORMAT	DESCRIPTION
18	1	A8	SURFACE GEOLOGIC MAP UNIT IDENTIFYING CODE
19	2	I6	TOTAL RECORDS FOR GEOLOGIC MAP UNIT
20	3	I6	NUMBER OF POTASSIUM RECORDS COMPUTED FOR GEOLOGIC
21			UNIT
22	4	F6.1	POTASSIUM CONCENTRATION MEAN TO ONE DECIMAL
23			PLACE IN PERCENT K
24	5	F6.1	POTASSIUM CONCENTRATION STANDARD DEVIATION TO ONE
25			DECIMAL PLACE IN PERCENT K
26	6	A3	POTASSIUM CONCENTRATION DISTRIBUTION CODE
27	7	I6	NUMBER OF URANIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
28	8	F6.1	URANIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE
29			IN PPM EQUIVALENT U
30	9	F6.1	URANIUM CONCENTRATION STANDARD DEVIATION TO ONE
31			DECIMAL PLACE IN PPM EQUIVALENT U
32	10	A3	URANIUM CONCENTRATION DISTRIBUTION CODE
33	11	I6	NUMBER OF THORIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
34	12	F6.1	THORIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN
35			PPM EQUIVALENT TH
36	13	F6.1	THORIUM CONCENTRATION STANDARD DEVIATION TO ONE
37			DECIMAL PLACE IN PPM EQUIVALENT TH

38	14	A3	THORIUM CONCENTRATION DISTRIBUTION CODE
39	15	I6	NUMBER OF URANIUM-TO-THORIUM RATIO RECORDS COMPUTED
40			FOR GEOLOGIC UNIT
41	16	F6.1	URANIUM-TO-THORIUM RATIO MEAN TO ONE DECIMAL PLACE
42			IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
43	17	F6.1	URANIUM-TO-THORIUM RATIO STANDARD DEVIATION TO ONE
44			DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT
45			TH
46	18	A3	URANIUM-TO-THORIUM RATIO DISTRIBUTION CODE
47	19	I6	NUMBER OF URANIUM-TO-POTASSIUM RATIO RECORDS
48			COMPUTED FOR GEOLOGIC UNIT
49	20	F6.1	URANIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE
50			IN PPM EQUIVALENT U PER PERCENT K
51	21	F6.1	URANIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE
52			DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
53	22	A3	URANIUM-TO-POTASSIUM RATIO DISTRIBUTION CODE
54	23	I6	NUMBER OF THORIUM-TO-POTASSIUM RATIO RECORDS
55			COMPUTED FOR GEOLOGIC UNIT
56	24	F6.1	THORIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE
57			IN PPM EQUIVALENT TH PER PERCENT K
58	25	F6.1	THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE
59			DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
60	26	A3	THORIUM-TO-POTASSIUM RATIO DISTRIBUTION CODE

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 11 of the Format Description Block A6.1, and 70 characters are produced. The remaining 6930 characters of this block are blanks.

3. Statistical Analysis Summary Data Blocks

The information and format for the logical records in these blocks are indicated in lines 18 through 60 of the Format Description Block A6.1. One logical record contains 140 characters. There are 50 such logical records per 7000 character physical record or block.

A5. Magnetic Data Tapes

Block Size (Physical Record): 8000 characters
Logical Record (Data) : 80 characters

1. Format Description Block (Block 1)

The Format Description utilizes 3384 characters. The remaining 4616 characters are blanks.

Line Number	Character Number 12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
1	04 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)
2	
3	MAGNETIC DATA TAPE
4	
5	FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)
6	

7	ITEM	FORMAT	DESCRIPTION
8	1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
9	2	A20	NAME OF SUBCONTRACTOR
10	3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
11	4	I3	NUMBER OF FLIGHT LINES ON THIS TAPE
12	5	I4	FIRST FLIGHT LINE ON THIS TAPE
13	6	I6	FIRST RECORD NUMBER OF FIRST FLIGHT LINE
14	7	I3	JULIAN DATE (DAY OF YEAR) FIRST FLIGHT LINE DATA WAS
15			COLLECTED
16	8	F8.4	LATITUDE OF GROUND BASE STATION TO FOUR DECIMAL
17			PLACES IN DEGREES FOR FIRST FLIGHT LINE
18	9	F8.4	LONGITUDE OF GROUND BASE STATION TO FOUR DECIMAL
19			PLACES IN DEGREES FOR FIRST FLIGHT LINE
20	10-14	(SAME)	REPEAT OF ITEMS 5-9 FOR SECOND FLIGHT LINE ON THIS
21			TAPE
22	*	*	*
23	*	*	*
24	*	*	*
25	495-499	(SAME)	REPEAT OF ITEMS 5-9 FOR 99TH FLIGHT LINE ON THIS
26			TAPE
27			
28	FORMAT FOR MAGNETIC DATA RECORD (THIRD THRU LAST BLOCK)		
29			

30	ITEM	FORMAT	DESCRIPTION
31	1	I1	AERIAL SYSTEM IDENTIFICATION CODE
32	2	I4	FLIGHT LINE NUMBER
33	3	I6	RECORD IDENTIFICATION NUMBER
34	4	I6	GMT TIME OF DAY (HHMMSS)
35	5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
36	6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
37	7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
38	8	F5.1	OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
39	9	A8	SURFACE GEOLOGIC MAP UNIT CODE
40	10	F7.1	TOTAL MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE
41			IN GAMMAS
42	11	F7.1	RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY
43			TO ONE DECIMAL PLACE IN GAMMAS
44	12	F7.1	DIURNAL MAGNETIC INTENSITY VARIATION TO ONE DECIMAL
45			PLACE IN GAMMAS
46	13	F7.1	MAGNETIC DEPTH-TO-BASEMENT TO ONE DECIMAL PLACE
47			IN METERS (IF REQUIRED)

2. Tape Identification Block (Block 2)

The information and format for this block are indicated in lines 8 through 25 of the Format Description Block A5.1, and 2938 characters are produced. The remaining 5062 characters of this block are blanks.

If fewer than 99 flight lines exist, the unused flight line information, 29 characters per flight line, is filled with 9's through the 99th flight line in the format indicated.

3. Magnetic Data Blocks

The information and format for the logical records in these blocks are indicated in lines 31 through 46 of the Format Description Block A5.1. One logical record contains 80 characters. There are 100 such logical records per 8000 character physical record or block.

If the magnetic depth-to-basement is not required, this item is expressed as 99999.9.

B. DESCRIPTION OF LISTINGS

B1. Single record reduced data listings: include the following information on Microfiche:

ITEM	DESCRIPTION
REC	Sequential record number
Lat	Location Y in latitude
Long	Location X in longitude
RMag	Residual magnetic field, gammas
Alt	Surface altitude
GEO UNIT	Geologic Type
AKUT	A=Altitude; K=Potassium; U=Uranium T=Thorium - Results of statistical adequacy test
COS	Cosmic c/s
BiAir	Airborne ^{214}Bi, 4π data
GC	Gross count, .4 MeV - 2.8 MeV
Tℓ	^{208}Tℓ c/s
Bi	^{214}Bi c/s
K	^{40}K c/s
BI:Tℓ	Ratio
BI:k	Ratio
Tℓ:K	Ratio
TEMP	Outside Air Temperature (^{o}C)
BP	Atmospheric Pressure (In. Hg)

B2. Averaged record data listings: include the following information on Microfiche:

ITEM	DESCRIPTION
REC	Sequential Record number
GEO UNIT	Geologic type
AKUT	A=Altitude; K=Potassium; U=Uranium; T=Thorium - Results of statistical adequacy test
Long	Longitude of X location of geologic type
Lat	latitude of Y location of geologic type
RMag	Residual magnetic field, gammas
COS	Cosmic, 4π
BiAir	Atmospheric Bi, 4π
GC	Gross count, c/s

ITEM	DESCRIPTION
Tℓ	Tℓ value, c/s
Rank	Tℓ standard deviation rank
Bi	Bi value, c/s
Rank	Bi standard deviation rank
K	K value, c/s
Rank	K standard deviation rank
Bi/Tℓ	Ratio value
Rank	Bi/Tℓ standard deviation rank
Bi/K	Ratio value
Rank	Bi/K standard deviation rank
Tℓ/K	Ratio value
Rank	Tℓ/K standard deviation rank

IGEODATA INT. INC. SINGLE REC LISTING 1980
SAN ANGELO NM 14-1 MAPLINE 20

1 SAN ANGELO MAPLINE 20

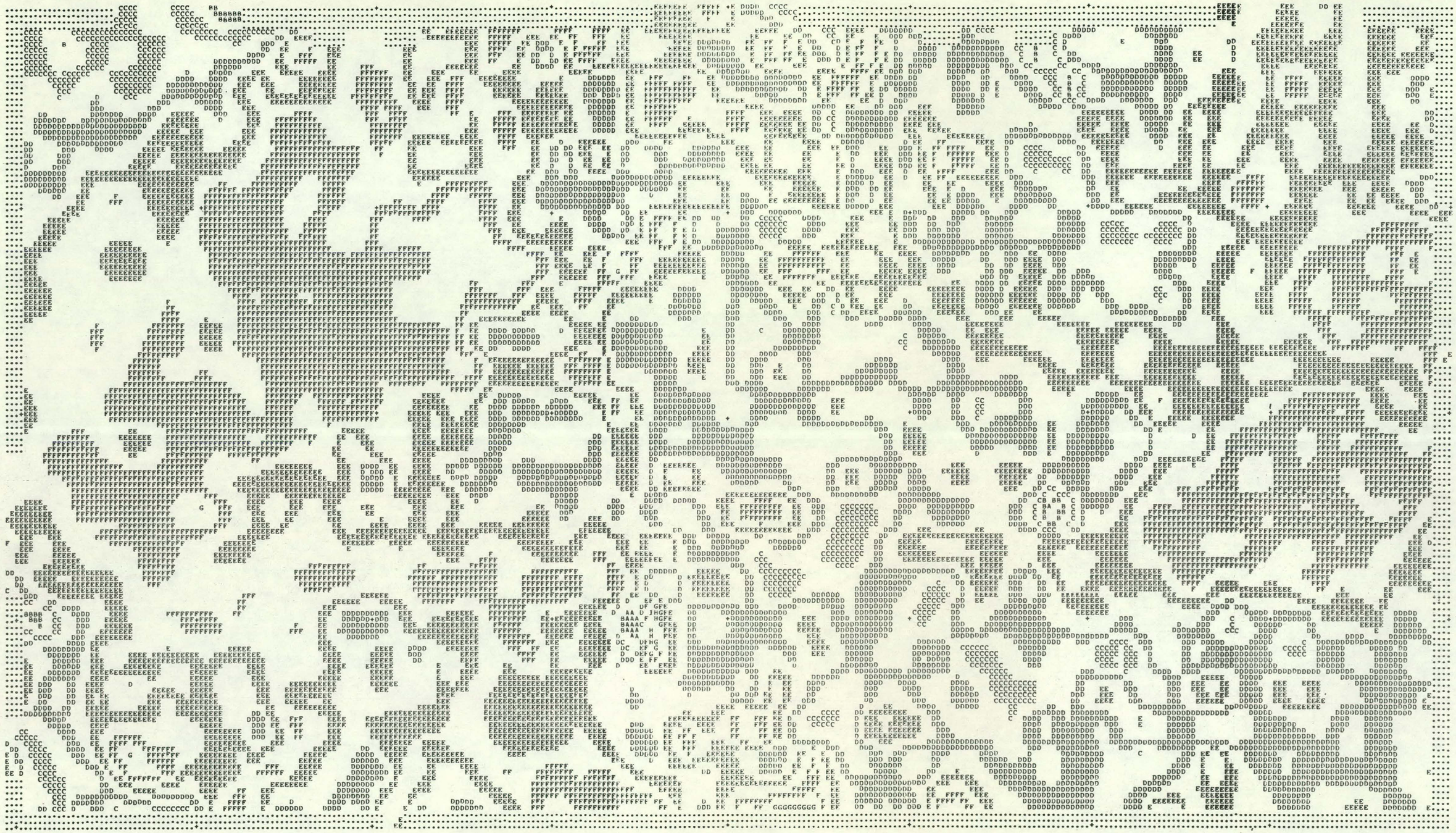
RCN	GEOUNIT	AKUT	LAT	LONG	RMAG	CUS	GC	BIAIR	ALT	TEMP	BP	TL	BI	K	BI/TL	BI/K	TL/K
1028	ZNA	0000	31.0200	102.0112	-459.2	54	2006	6.1	535	21.8	676.4	4.6	2.7	1.4	0.58	1.91	3.30
1029	ZNA	0010	31.0200	102.0106	-477.9	21	139	6.1	-61	21.8	677.9	0.4	0.0	0.1	0.24	1.63	6.86
1030	ZNA	0000	31.0200	102.0100	-480.2	51	1518	6.1	573	21.6	678.4	2.1	2.4	1.0	1.16	2.37	2.04
1031	ZNA	0000	31.0200	102.0094	-480.2	51	1623	6.1	577	21.6	678.4	3.9	3.0	1.1	0.77	2.89	3.73
1032	ZNA	0000	31.0200	102.0088	-480.7	50	1492	6.1	573	21.7	677.4	2.2	1.6	1.1	0.73	1.49	2.05
1033	ZNA	0000	31.0200	102.0082	-482.0	40	1508	6.1	585	21.6	676.4	4.5	2.1	1.2	0.48	1.83	3.82
1034	ZNA	0000	31.0200	102.0076	-483.2	43	1583	6.1	589	21.8	676.4	4.9	1.7	1.1	0.35	1.50	4.32
1035	ZNA	0000	31.0200	102.0070	-483.7	44	1431	6.1	589	21.6	676.4	3.4	1.9	1.2	0.57	1.67	2.91
1036	ZNA	0000	31.0200	102.0064	-481.8	53	1601	6.1	581	21.6	677.4	5.9	1.4	1.1	0.24	1.24	5.19
1037	ZNA	0000	31.0200	102.0058	-481.3	47	1489	6.1	573	21.5	677.4	5.6	2.7	0.7	0.48	3.68	7.73
1038	ZNA	0000	31.0200	102.0052	-476.3	47	1506	6.1	564	21.4	676.9	4.5	2.3	1.0	0.51	2.29	4.48
1039	ZNA	0000	31.0200	102.0046	-471.2	61	1427	6.1	560	21.5	677.4	4.9	3.6	0.7	0.74	5.00	6.76
1040	ZNA	0000	31.0200	102.0040	-471.8	45	1257	6.1	548	21.5	676.9	3.2	1.0	1.0	0.32	1.01	3.12
1041	ZNA	0000	31.0200	102.0034	-469.3	55	1413	6.1	535	21.5	677.4	4.1	1.9	1.0	0.47	1.96	4.14
1042	ZNA	0000	31.0200	102.0028	-469.0	45	1295	6.1	523	21.5	677.9	4.1	1.4	0.8	0.35	1.66	4.79
1043	ZNA	0000	31.0200	102.0022	-468.9	50	1282	6.1	500	21.4	678.4	2.8	1.5	0.8	0.53	1.91	3.61
1044	ZNA	0000	31.0200	102.0016	-468.1	53	1232	6.1	488	21.3	678.4	4.6	1.3	0.7	0.27	1.81	6.66
1045	ZNA	0010	31.0200	102.0010	-466.4	37	1149	6.1	472	21.4	678.4	3.8	0.4	0.7	0.12	0.61	5.22
1046	ZNA	0000	31.0200	102.0004	-463.5	52	1265	6.1	455	21.4	677.9	5.3	1.5	0.6	0.28	2.38	8.54
1047	ZNA	0000	31.0200	101.9998	-461.2	30	1140	6.1	441	21.3	676.9	4.8	0.9	0.7	0.19	1.21	6.48
1048	ZNA	0000	31.0200	101.9992	-456.9	44	1076	6.1	432	21.3	677.4	2.4	2.5	0.3	1.06	9.86	9.32
1049	ZNA	0000	31.0200	101.9986	-456.3	60	1060	6.1	423	21.3	678.4	2.9	0.7	0.6	0.23	1.13	4.97
1050	KA	0000	31.0200	101.9980	-453.5	62	1070	6.1	408	21.3	680.2	3.4	2.0	0.6	0.59	3.38	5.67
1051	KA	0000	31.0200	101.9974	-451.4	57	1113	6.1	399	21.3	678.9	2.1	2.1	0.6	0.99	3.76	3.81
1052	KA	0000	31.0200	101.9968	-450.6	45	997	6.1	391	21.3	679.4	3.8	1.3	0.4	0.35	3.53	10.01
1053	KA	0000	31.0200	101.9962	-449.8	45	1045	6.1	386	21.3	678.4	3.5	1.5	0.4	0.42	3.30	7.79
1054	KA	0000	31.0200	101.9956	-447.9	53	1161	6.1	388	21.3	678.9	1.4	1.3	0.4	0.95	3.35	3.52
1055	KA	0000	31.0200	101.9950	-447.7	56	990	14.3	391	21.2	678.4	2.2	1.6	0.5	0.73	3.13	4.30
1056	KA	0000	31.0200	101.9944	-445.9	40	1124	14.3	396	21.3	678.4	3.8	1.6	0.6	0.41	2.50	6.07
1057	KA	0000	31.0200	101.9938	-443.5	60	1174	14.3	399	21.3	678.4	2.9	2.1	0.5	0.71	4.51	6.40
1058	KA	0000	31.0200	101.9932	-441.1	48	1280	14.3	402	21.3	678.4	3.1	1.7	0.7	0.55	2.53	4.57
1059	GAL	0000	31.0200	101.9926	-439.4	57	1387	14.3	406	21.3	676.9	4.8	1.3	0.8	0.26	1.67	6.30
1060	GAL	0010	31.0200	101.9920	-439.5	45	1404	14.3	411	21.1	677.9	5.6	0.1	0.7	0.03	0.20	7.73
1061	GAL	0000	31.0200	101.9914	-439.5	55	1350	14.3	417	21.2	678.4	3.9	1.4	0.8	0.36	1.68	4.68
1062	GAL	0000	31.0200	101.9908	-435.2	45	1469	14.3	419	21.3	678.9	4.3	2.4	0.7	0.55	3.57	6.54
1063	GAL	0000	31.0200	101.9902	-433.7	44	1401	14.3	421	21.1	678.4	4.8	2.4	0.8	0.51	3.03	5.90
1064	GAL	0000	31.0200	101.9896	-430.7	51	1436	15.9	422	21.3	678.4	5.0	0.8	1.1	0.16	0.73	4.53
1065	GAL	0000	31.0200	101.9890	-430.0	49	1484	15.9	425	21.3	678.4	3.9	2.1	1.0	0.55	2.24	4.09
1066	GAL	0000	31.0200	101.9884	-427.2	47	1528	15.9	425	21.3	678.4	5.0	2.5	1.1	0.50	2.20	4.41
1067	GAL	0000	31.0200	101.9878	-426.0	44	1687	15.9	423	21.3	678.4	6.0	2.8	1.1	0.47	2.48	5.31
1068	GAL	0010	31.0200	101.9872	-423.7	46	1662	15.9	420	21.1	678.4	8.4	0.5	1.3	0.06	0.40	6.48
1069	GAL	0000	31.0200	101.9866	-420.7	50	1640	15.9	418	21.2	678.4	7.3	2.0	0.9	0.27	2.28	8.29
1070	GAL	0000	31.0200	101.9860	-417.7	49	1591	15.9	418	21.3	676.9	5.7	1.0	1.0	0.17	0.94	5.62
1071	GAL	0000	31.0200	101.9854	-415.6	43	1665	15.9	418	21.2	678.4	5.2	2.1	1.1	0.41	1.89	4.57
1072	GAL	0000	31.0200	101.9848	-413.4	62	1691	15.9	420	21.3	677.4	4.1	2.8	1.2	0.69	2.38	3.43
1073	GAL	0000	31.0200	101.9842	-413.4	65	1690	14.8	422	21.2	676.9	7.0	0.7	1.3	0.11	0.59	5.57
1074	GAL	0000	31.0200	101.9836	-410.4	39	1712	14.8	424	21.1	678.9	8.7	1.6	1.3	0.18	1.24	6.91
1075	GAL	0000	31.0200	101.9830	-405.5	51	1633	14.8	429	21.3	677.4	6.3	0.9	1.3	0.14	0.70	4.98
1076	GAL	0000	31.0200	101.9825	-405.3	51	1649	14.8	433	21.3	678.4	6.4	1.4	1.0	0.22	1.45	6.64
1077	GAL	0000	31.0200	101.9819	-400.5	51	1715	14.8	432	21.2	676.4	4.8	3.1	1.2	0.65	2.67	4.09
1078	GAL	0000	31.0200	101.9813	-400.1	40	1756	14.8	428	21.2	676.9	7.7	0.8	1.6	0.11	0.52	4.93
1079	GAL	0000	31.0200	101.9807	-399.7	55	1725	14.8	422	21.3	677.9	7.7	1.1	1.5	0.14	0.76	5.24
1080	GAL	0000	31.0200	101.9801	-399.2	44	1594	14.8	417	21.3	677.4	4.5	1.3	1.2	0.28	1.03	3.66
1081	GAL	0000	31.0200	101.9795	-392.9	36	1643	14.8	415	21.3	678.9	6.6	1.5	1.2	0.23	1.19	5.28
1082	GAL	0000	31.0201	101.9789	-391.1	37	1696	16.6	413	21.3	676.9	6.3	1.3	1.3	0.20	0.97	4.86
1083	GAL	0000	31.0201	101.9783	-388.5	28	1605	16.6	413	21.1	676.9	7.8	1.6	1.2	0.20	1.31	6.62
1084	GAL	0000	31.0201	101.9777	-389.0	42	1428	16.6	421	21.3	677.4	3.5	1.3	1.1	0.38	1.26	3.30

IGEODATA INT. INC. AVERAGE REC LISTING 1980
SAN ANGELO NM 14-1 MAPLINE 20

1 SAN ANGELO MAPLINE 20

RCN	GEOUNIT	AKUT	LAT	LONG	RMAG	CUS	GC	BIAIR	TL RANK	BI RANK	K RANK	BI/TL RANK	BI/K RANK	TL/K RANK
1028	ZNA	0000	31.0200	102.0112	-459.2	54	2006	6.1	4.6- 1	2.7+ 1	1.4+ 1	0.58+ 1	1.91- 0	3.30- 2
1029	ZNA	0010	31.0200	102.0106	-477.9	21	139	6.1	0.4- 3	0.0- 3	0.1- 3	0.24- 1	1.63- 1	6.86+ 1
1030	ZNA	0000	31.0200	102.0100	-480.2	51	1518	6.1	2.1- 2	2.4+ 1	1.0- 0	1.16+ 5	2.37+ 0	2.04- 3
1031	ZNA	0000	31.0200	102.0094	-480.2	51	1623	6.1	3.0- 2	2.1- 0	1.0- 0	0.69+ 2	2.12- 0	3.08- 2
1032	ZNA	0000	31.0200	102.0088	-480.7	50	1492	6.1	3.2- 1	2.0- 0	1.0- 0	0.62+ 1	1.95- 0	3.13- 2
1033	ZNA	0000	31.0200	102.0082	-482.0	40	1508	6.1	3.9- 1	2.0- 0	1.1+ 0	0.52+ 1	1.80- 0	3.45- 2
1034	ZNA	0000	31.0200	102.0076	-483.2	43	1583	6.1	4.3- 1	1.9- 0	1.1+ 0	0.45+ 0	1.74- 0	3.88- 2
1035	ZNA	0000	31.0200	102.0070	-483.7	44	1431	6.1	4.5- 1	1.9- 0	1.1+ 0	0.42+ 0	1.77- 0	4.20- 1
1036	ZNA	0000	31.0200	102.0064	-481.8	53	1601	6.1	4.9- 1	2.1- 0	1.0- 0	0.42+ 0	2.03- 0	4.81- 1
1037	ZNA	0000	31.0200	102.0058	-481.3	47	1489	6.1	4.9- 1	2.2+ 0	1.0- 0	0.46+ 0	2.34+ 0	5.13- 1
1038	ZNA	0000	31.0200	102.0052	-476.3	47	1506	6.1	4.7- 1	2.3+ 0	0.9- 0	0.49+ 1	2.48+ 0	5.07- 1
1039	ZNA	0000	31.0200	102.0046	-471.2	61	1427	6.1	4.5- 1	2.3+ 0	0.9- 0	0.51+ 1	2.54+ 0	5.00- 1
1040	ZNA	0000	31.0200	102.0040	-471.8	45	1257	6.1	4.1- 1	2.0- 0	0.9- 0	0.50+ 1	2.24+ 0	4.52- 1
1041	ZNA	0000	31.0200	102.0034	-469.3	55	1413	6.1	3.9- 1	1.8- 0	0.9- 0	0.46+ 0	2.02- 0	4.39- 1
1042	ZNA	0000	31.0200	102.0028	-469.0	45	1295	6.1	3.8- 1	1.5- 1	0.8- 1	0.40+ 0	1.81- 0	4.51- 1
1043	ZNA	0000	31.0200	102.0022	-468.9	50	1282	6.1	3.8- 1	1.3- 1	0.8- 1	0.34- 0	1.66- 1	4.81- 1
1044	ZNA	0000	31.0200	102.0016	-468.1	53	1232	6.1	4.1- 1	1.2- 1	0.7- 1	0.29- 0	1.63- 1	5.51- 0
1045	ZNA	0000	31.0200	102.0010	-466.4	37	1149	6.1	4.2- 1	1.2- 1	0.7- 1	0.28- 1	1.70- 0	6.06+ 0
1046	ZNA	0000	31.0200	102.0004	-463.5	52	1265	6.1	4.2- 1	1.2- 1	0.6- 1	0.29- 0	1.94- 0	6.57+ 1
1047	ZNA	0000	31.0200	101.9998	-461.2	30	1140	6.1	4.0- 1	1.3- 1	0.6- 1	0.33- 0	2.21+ 0	6.69+ 1
1048	ZNA	0000	31.0200	101.9992	-456.9	44	1076	6.1	3.5- 1	1.5- 1	0.5- 1	0.43+ 0	2.78+ 1	6.41+ 0
1049	ZNA	0000	31.0200	101.9986	-456.3	60	1060	6.1	3.2- 1	1.6- 1	0.5- 1	0.48+ 1	2.94+ 1	6.11+ 0
1050	KA	0000	31.0200	101.9980	-453.5	62	1070	6.1	3.1- 1	1.6+ 1	0.5- 1	0.53+ 2	3.19+ 1	5.96- 1
1051	KA	0000	31.0200	101.9974	-451.4	57	1113	6.1	2.9- 1	1.7+ 1	0.5- 1	0.57+ 2	3.37+ 2	5.92- 1
1052	KA	0000	31.0200	101.9968	-450.6	45	997	6.1	2.9- 1	1.6+ 0	0.5- 1	0.54+ 2	3.28+ 1	6.13+ 0
1053	KA	0000	31.0200	101.9962	-449.8	45	1045	6.1	2.8- 2	1.6+ 0	0.5- 1	0.55+ 2	3.32+ 1	6.06+ 0
1054	KA	0000	31.0200	101.9956	-447.9	53	1161	6.1	2.7- 2	1.5+ 0	0.5- 1	0.57+ 2	3.27+ 1	5.72- 1
1055	KA	0000	31.0200	101.9950	-447.7	56	990	14.3	2.8- 2	1.6+ 0	0.5- 1	0.57+ 2	3.16+ 1	5.52- 1
1056	KA	0000	31.0200	101.9944	-445.9	40	1124	14.3	3.0- 1	1.6+ 1	0.5- 1	0.55+ 2	2.98+ 1	5.45- 1
1057	KA	0000	31.0200	101.9938	-443.5	60	1174	14.3	3.3- 1	1.6+ 0	0.6- 1	0.47+ 1	2.69+ 1	5.67- 1
1058	KA	0000	31.0200	101.9932	-441.1	48	1280	14.3	3.8- 1	1.5+ 0	0.6- 0	0.39+ 1	2.24+ 0	5.81- 1
1059	GAL	0000	31.0200	101.9926	-439.4	57	1387	14.3	4.2- 2	1.3- 1	0.7- 2	0.32+ 1	1.93+ 1	6.03+ 0
1060	GAL	0000	31.0200	101.9920	-439.5	45	1404	14.3	4.4- 2	1.3- 1	0.7- 1	0.30+ 1	1.83+ 1	6.11+ 0
1061	GAL	0000	31.0200	101.9914	-439.5	55	1350	14.3	4.5- 2	1.4- 0	0.8- 1	0.32+ 1	1.86+ 1	5.85+ 0
1062	GAL	0000	31.0200	101.9908	-435.2	45	1469	14.3	4.6- 2	1.6+ 0	0.8- 1	0.36+ 1	2.03+ 1	5.65- 0
1063	GAL	0000	31.0200	101.9902	-433.7	44	1401	14.3	4.6- 2	1.8+ 0	0.9- 1	0.40+ 2	2.08+ 1	5.24- 1
1064	GAL	0000	31.0200	101.9896	-430.7	51	1436	15.9	4.7- 1	1.9+ 1	1.0- 1	0.41+ 2	2.02+ 1	4.88- 1
1065	GAL	0000	31.0200	101.9890	-430.0	49	1484	15.9	5.0- 1	2.0+ 1	1.0- 1	0.40+ 2	1.94+ 1	4.88- 1
1066	GAL	0000	31.0200	101.9884	-427.2	47	1528	15.9	5.6- 1	2.0+ 1	1.1- 0	0.36+ 1	1.85+ 1	5.12- 1
1067	GAL	0000	31.0200	101.9878	-426.0	44	1687	15.9	6.1- 0	1.9+ 1	1.1- 0	0.31+ 1	1.72+ 1	5.53- 0
1068	GAL	0000	31.0200	101.9872	-423.7	46	1662	15.9	6.5- 0	1.7+ 0	1.1- 0	0.27+ 0	1.57+ 0	5.90+ 0
1069	GAL	0000	31.0200	101.9866	-420.7	50	1640	15.9	6.4- 0	1.7+ 0	1.1- 0	0.27+ 0	1.60+ 0	5.95+ 0
1070	GAL	0000	31.0200	101.9860	-417.7	49	1591	15.9	6.1- 0	1.7+ 0	1.1- 0	0.27+ 0	1.52+ 0	5.63- 0
1071	GAL	0000	31.0200	101.9854	-415.6	43	1665	15.9	6.0- 1	1.7+ 0	1.1- 0	0.29+ 0	1.53+ 0	5.33- 0
1072	GAL	0000	31.0200	101.9848	-413.4	62	1691	15.9	5.9- 1	1.7+ 0	1.2- 0	0.29+ 1	1.50+ 0	5.12- 1
1073	GAL	0000	31.0200	101.9842	-413.4	65	1690	14.8	6.3- 0	1.5- 0	1.2+ 0	0.24- 0	1.28- 0	5.30- 0
1074	GAL	0000	31.0200	101.9836	-410.4	39	1712	14.8	6.6- 0	1.5- 0	1.2+ 0	0.23- 0	1.29- 0	5.50- 0
1075	GAL	0000	31.0200	101.9830	-405.5	51	1633	14.8	6.6- 0	1.5- 0	1.2+ 0	0.22- 0	1.23- 0	5.48- 0
1076	GAL	0000	31.0200	101.9825	-405.3	51	1649	14.8	6.6- 0	1.5- 0	1.2+ 0	0.23- 0	1.24- 0	5.45- 0
1077	GAL	0000	31.0200	101.9819	-400.5	51	1715	14.8	6.4- 0	1.6- 0	1.3+ 0	0.25+ 0	1.28- 0	5.08- 1
1078	GAL	0000	31.0200	101.9813	-400.1	40	1756	14.8	6.4- 0	1.5- 0	1.3+ 0	0.23- 0	1.12- 1	4.89- 1
1079	GAL	0000	31.0200	101.9807	-399.7	55	1725	14.8	6.4- 0	1.4- 1	1.3+ 0	0.22- 0	1.06- 1	4.82- 1
1080	GAL	0000	31.0200	101.9801	-399.2	44	1594	14.8	6.3- 0	1.3- 1	1.3+ 0	0.21- 0	1.02- 1	4.80- 1
1081	GAL	0000	31.0200	101.9795	-392.9	36	1643	14.8	6.3- 0	1.3- 1	1.3+ 0	0.21- 1	1.02- 1	4.93- 1
1082	GAL	0000	31.0201	101.9789	-391.1	37	1696	16.6	6.1- 0	1.4- 1	1.2+ 0	0.22- 0	1.12- 1	5.03- 1
1083	GAL	0000	31.0201	101.9783	-388.5	28	1605	16.6	5.9- 1	1.4- 1	1.1- 0	0.24- 0	1.22- 0	5.14- 1
1084	GAL	0000	31.0201	101.9777	-389.0	42	1428	16.6	5.4- 1	1.4- 0	1.1- 0	0.26+ 0	1.31- 0	5.03- 1

CONTOUR INTERVAL= 0.75 ETH LAT 31.000 LONG-102.000



GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

A< 0.75 1.50<B< 2.25 3.00<C< 3.75 4.50<D< 5.25 6.00<E< 6.75 7.50<F< 8.25
9.00<G< 9.75 10.50<H< 11.25 12.00<I< 12.75

AIV-1 Line Printer Contour

CONTOUR INTERVAL= 0.26 FT LAT 31.000 LONG-102.000

AIV-2 Line Printer Contour

GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

A< 0.26 | 0.52<B< 0.78 | 1.04<C< 1.30 | 1.56<D< 1.82 | 2.08<E< 2.34 | 2.60<F< 2.86
3.12<G< 3.38 | 3.64<H< 3.90 | 4.16<I< 4.42 | 4.68<J< 4.94

CONTOUR INTERVAL= 0.15 %K LAT 31.000 LONG-102.000

GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

A< 0.15	0.30<B< 0.45	0.60<C< 0.75	0.90<D< 1.05	1.20<E< 1.35	1.50<F< 1.65
	1.80<G< 1.95	2.10<H< 2.25	2.40<I< 2.55		

AIV-3 Line Printer Contour

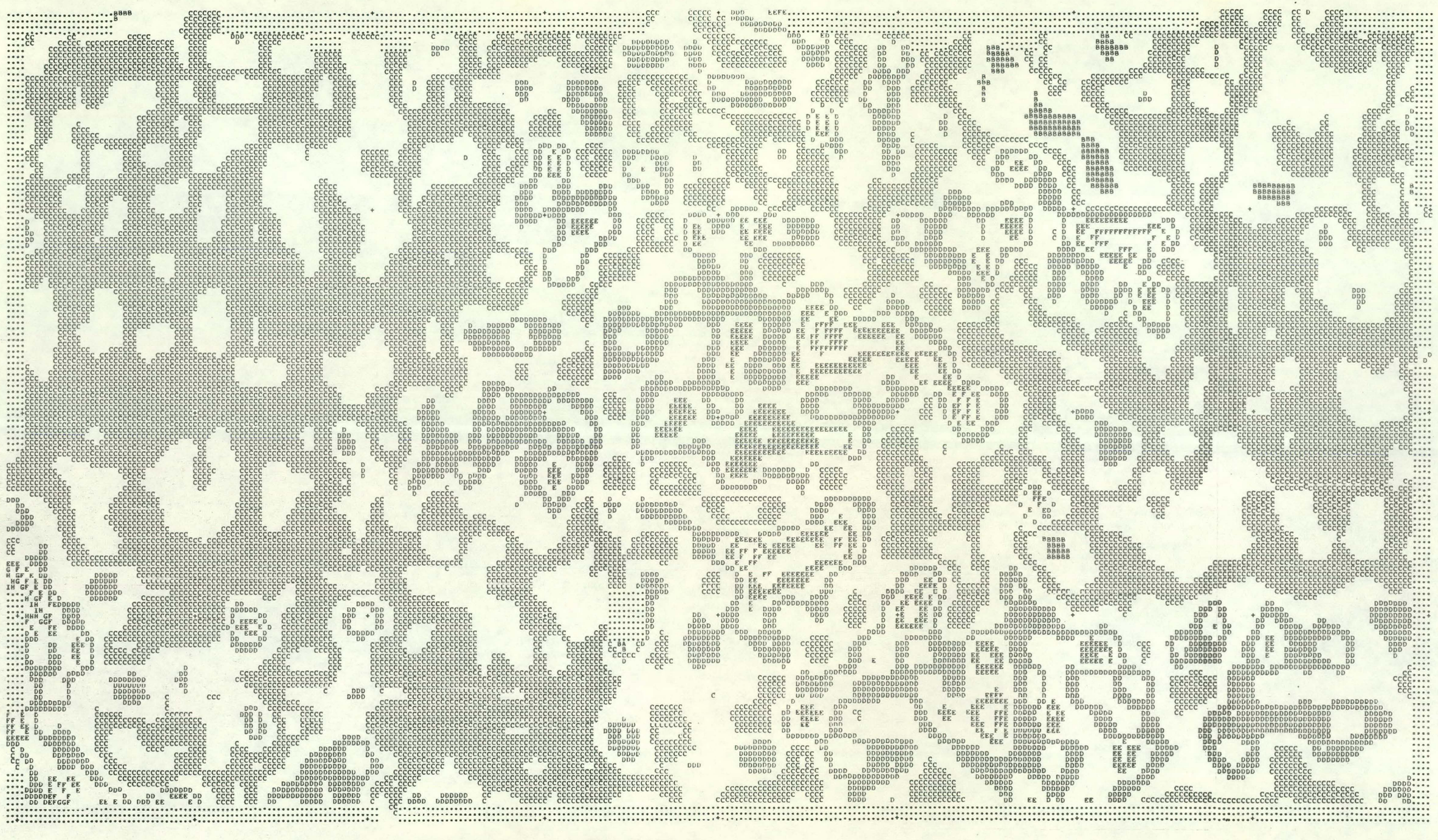
CONTOUR INTERVAL= 0.04 EQ/ETH LAT 31.000 LONG-102.000

AIV-4 Line Printer Contour

GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

A< .040 .080<B< .120 .160<C< .200 .240<D< .280 .320<E< .360 .400<F< .440
.480<G< .520 .560<H< .600 .640<I< .680 .720<J< .760

CONTOUR INTERVAL= 0.30 EQ/K LAT 31.000 LONG-102.000

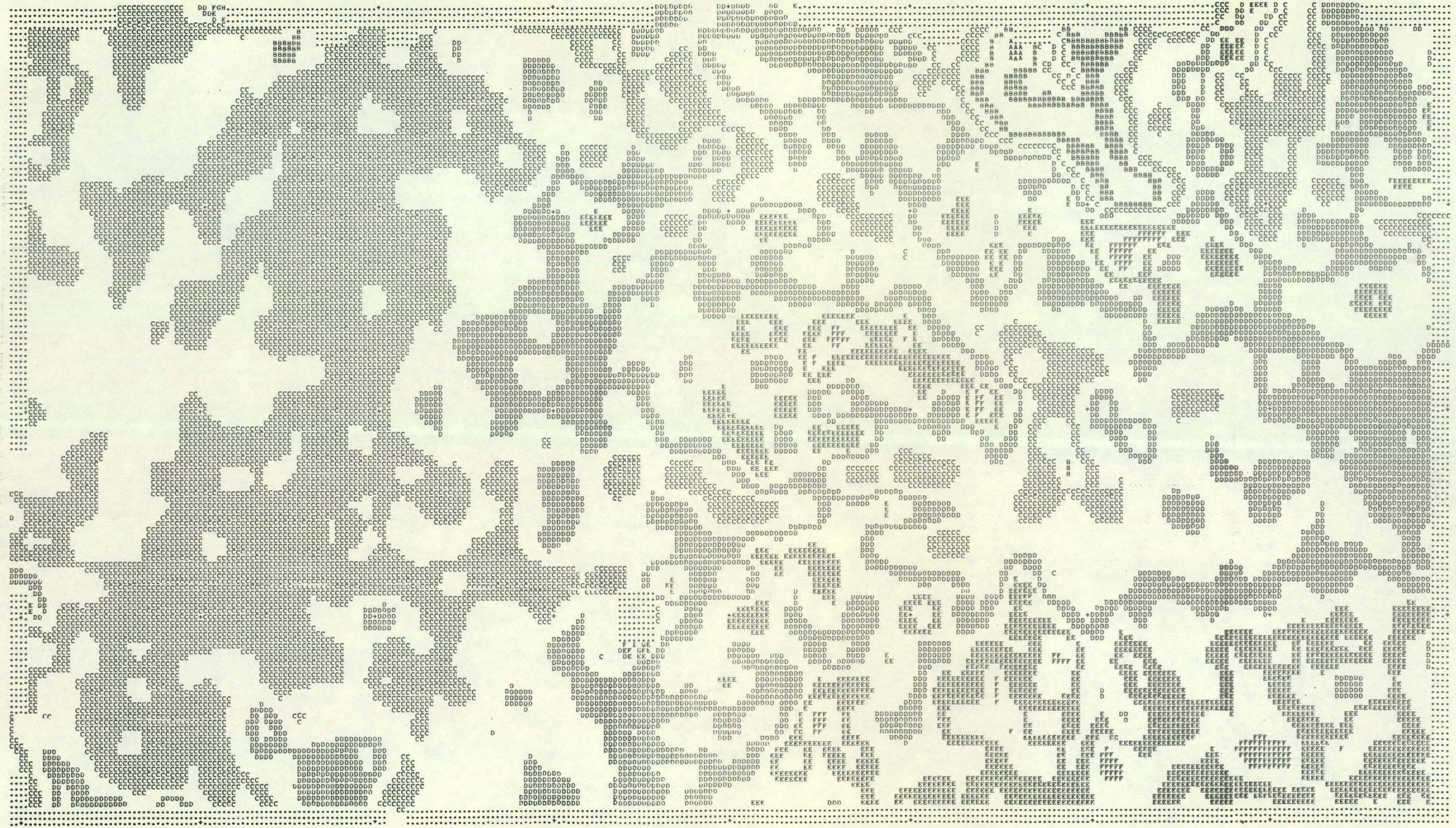


AIV-5 Line Printer Contour

GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

A< 0.30	0.60<B< 0.90	1.20<C< 1.50	1.80<D< 2.10	2.40<E< 2.70	3.00<F< 3.30
	3.60<G< 3.90	4.20<H< 4.50	4.80<I< 5.10	5.40<J< 5.70	6.00<K< 6.30

CONTOUR INTERVAL= 0.55 ETH/X LAT 31.000 LONG=102.000

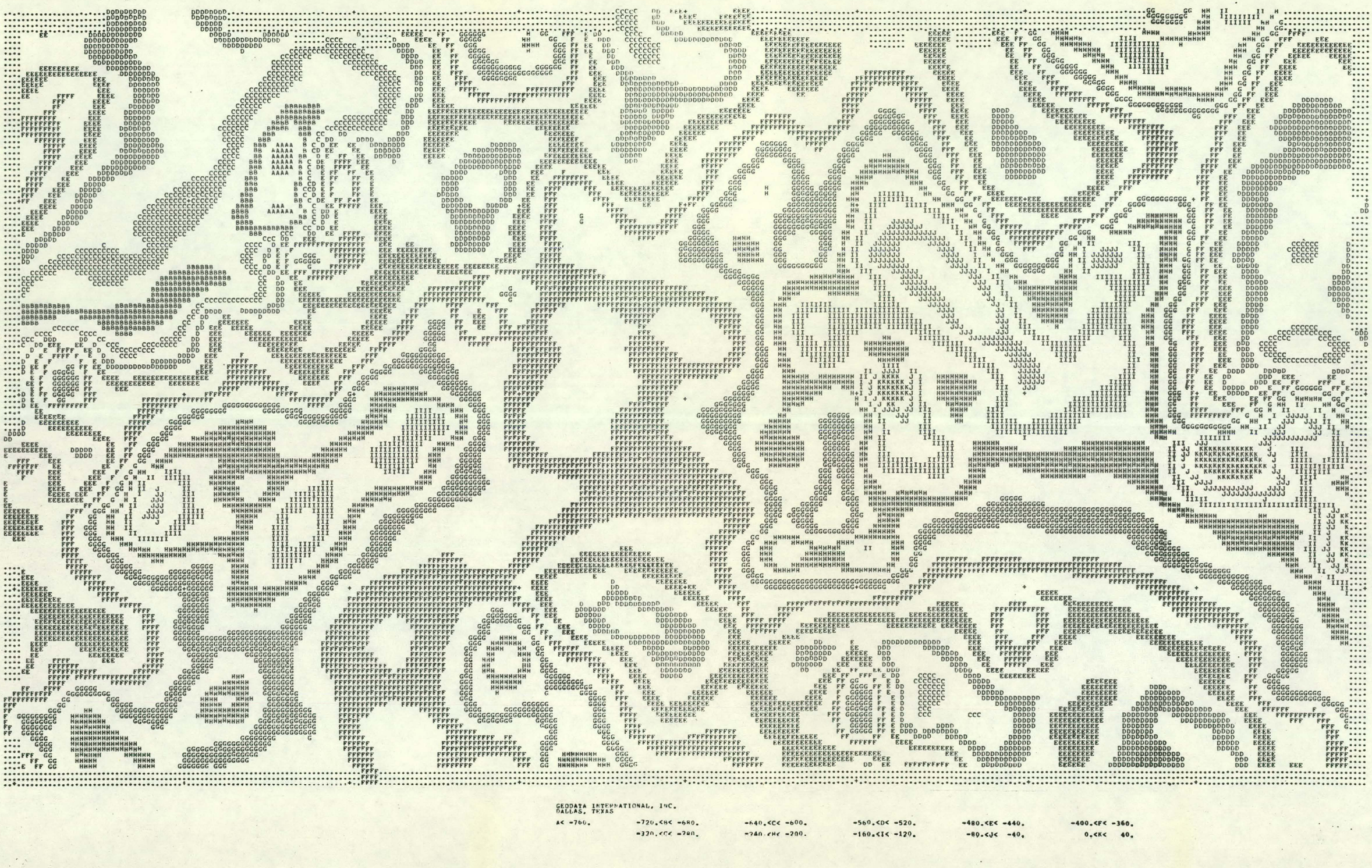


GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

A< 3.30 3.85<B< 4.40 4.95<C< 5.50 6.05<D< 6.60 7.15<E< 7.70 8.25<F< 8.80
9.35<G< 9.90 10.45<H< 11.00 11.55<I< 12.10

ATV-6 Line Printer Contour

CONTOUR INTERVAL= 40.00 LAT 31.000 LONG-102.000



GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

A< -760.	-720.<B< -680.	-640.<C< -600.	-560.<D< -520.	-480.<E< -440.	-400.<F< -360.		
	-320.<G< -280.	-240.<H< -200.	-160.<I< -120.	-80.<J< -40,	0.<K< 40.		

AIV-7 Line Printer Contour

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