NATIONAL URANIUM RESOURCE EVALUATION
AERIAL RADIOMETRIC AND MAGNETIC SURVEY
NATIONAL TOPOGRAPHIC MAP

GJBX-228 '80

HOBBS
TEXAS, NEW MEXICO

FINAL REPORT

MAY 1980

MASTER

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
HOBBS NATIONAL TOPOGRAPHIC MAP
NEW MEXICO/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 Hobbs National Topographic Map NI13-12 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 Hobbs 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 116.4 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 Hobbs map sheet area (Figure I.2) is located in westcentral Texas and southeastern New Mexico at latitudes 32°00' to 33°00' north and longitudes 102°00' to 104°00' west. The map area is included in the Great Plains physiographic province. Exposures of Permian rock are limited to the Pecos Valley section of the province, whereas outcrops of the Triassic-, Cretaceous-, Tertiary- and Quaternary-aged rock are present in both the Pecos Valley section and the High Plains section (northeastern portion of the map).

The Delaware Basin and Central Basin Platform are structural elements which affected deposition in the map area until they were buried by Cenozoic deposits.

Figure I.1 Survey Index Map

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

NATIONAL GAMMA RAY MAP SERIES

Hobbs, New Mexico; Texas

GEOLOGY BASE

REF. NTMS, NI 13-12
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

I-3

Figure I.2 Geologic Base Map

SECTION II

FLIGHT OPERATIONS

SECTION II.

FLIGHT OPERATIONS

A. SURVEY TIME SUMMARY

The Hobbs map sheet was flown between April 18 and 23, 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

Hobbs, New Mexico; Texas

FLIGHT BASE

REF. NTMS, NI 13-12
PREPARED FOR
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II-2

Figure II.1 NTMS Showing Flight Line Location

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 western Texas and southeastern New Mexico. The Hobbs National Topographic Map Sheet area (N.T.M.S., 1954) is bounded by latitudes 32°00' to 33°00' north and longitudes 102°00' to 104°00' west. The surveyed area includes all or portions of the following counties: Andrews, Ector, Eddy, Chaves, Dawson, Gaines, Lea, Lynn, Martin, Midland, Terry, Yoakum and Winkler.

The Hobbs map sheet area lies within the Great Plains physiographic province (Fenneman, 1931), and corresponds with the High Plains and Pecos Valley sections. The High Plains section includes the eastern half of the map sheet area, and is characterized by broad, intervalley remnants of smooth, fluvial plains. The Pecos Valley section is represented in part by the western half of the map area, and is described as a late-mature to old plain.

No major rivers drain the Hobbs map sheet area. There are numerous ephemeral rivers and creeks in the area.

B. GEOLOGY

The depositional and structural history of the Hobbs map sheet area (Figure I.2) has been reported by Mansfield and Lang (1934), Haigh (1952), Huffington et.al. (1951), Helmig (1952), Kornfeld (1952), and Jones (1953). These data are summarized as follows.

Paleozoic Era

The rock-record for the survey area begins with the Upper Permian Dewey Lake Redbeds and Rustler Formation. Prior to their formation, a widespread epicontinental sea covered the region in the Pennsylvanian and Early Permian. Regression of this sea to the southwest was begun at the close of the Pennsylvanian Period, and it was responsible for deposition of the anhydrites, salt and gypsum, as well as the iron-oxidized components of the Permian units.

The Delaware Basin and Central Basin Platform, both sub-elements of the structural Permian Basin, were well established by Permian time and controlled sedimentation throughout the period. During the Wolfcamp and Leonard epochs, reef-type dolomite and limestone, including very fine-grained sandstone and dark-grey siliceous shale, were deposited over the Central Basin platform while very fine-grained sandstone and dark-grey siliceous shale were deposited in the Delaware Basin (Kornfeld, 1952).

During the Late Permian, the Capitan Reef grew around the edges of the Delaware Basin. Following deposition of the clastic red sands and shales into the basin, subsidence was halted. The basin area was filled by the close of the Permian Period.

Mesozoic Era

The Triassic Period saw the resumption of subsidence of the Permian Basin. The margins of the basin served as source areas for the shale, sandstone, and conglomerate clastics that were introduced into the basin at this time.

During the Late Triassic, the Hobbs map sheet area was uplifted above sea level by epeirogenic movement. The slope of the exposed surface platform was to the southwest. The area remained above sea level for the duration of the Jurassic Period.

Deposition resumed with subsidence of the area and introduction of the Antlers Sand clastics. The Fredericksburg Sea covered the study area, and subsequently transgressed further to produce the chemical deposits of the Fort Terrett Formation and the Fredericksburg Group.

Cenozoic Era

The inception of the Cenozoic Era in the Hobbs map sheet area is marked by renewed uplift of the sedimentary basin. The Cretaceous units were then eroded substantially (Huffington et.al., 1951).

Tertiary deposition was initiated during the Pliocene with deposition of the fluvial Ogallala Formation. During this time, streams flowing eastward from the mountains of New Mexico were captured by the Pecos River headwater as it cut northward. To the east in Texas and in extreme southeastern New Mexico, the river produced as an erosional remnant a relatively broad plain with a caliche caprock referred to as the Llano Estacado (Jones, 1953).

Pleistocene- and Holocene-aged, continental clastics, and, to a much lesser extent, limestones, were subsequently deposited in the map area.

C. DESCRIPTION of GEOLOGIC MAP UNITS

The following brief descriptions of outcropping geologic units in the Hobbs map sheet area (Figure I.2) are given, based on data reported by: Jones (1953), N.T.M.S. (1954), Kelley (1971) and the University of Texas Bureau of Economic Geology (1976). Thicknesses are reported where known.

Cenozoic Era

Quaternary

Mw: Mine Waste

Dumps and storage areas for waste materials produced during recovery of potash minerals. They are confined to the state of New Mexico.

Qal: Alluvium

This unit contains floodplain and pediment deposits. It includes low terrace deposits along streams, and bedrock localized in stream channels. The pediment deposits of sandy silt are locally modified by sheetwash action.

Qcd: Eolian Deposits

These deposits are comprised of sand which is calcareous and predominantly brown to greyish-brown in color. The unit is generally derived from and underlain by lacustrine deposits. Confined to New Mexico.

Qs; Qsu: Windblown Sand

The unit Qs is comprised of sand and silt in sheets, dunes, and dune ridges. It locally includes cover sand, and it is derived from lacustrine, fluvial and eolian deposits. The unit generally rests on lacustrine deposits.

Unit Qsu is made up of sand sheets, dunes and dune ridges, undivided. It is light-brown to reddish in color. It overlies windblown cover sand, unit Qcs, in the western portion of the map area, where it is derived predominantly from the Gatuña Formation, unit Qg. The thickness of the deposit ranges from 5 to 10 feet.

Qp: Playa Deposits

Clay and silt deposited in shallow depressions. The deposits are light- to dark-grey in color. Those of Wisconsinian age are usually covered by a thin layer of Recent sediment.

Qcc: Caliche

Caliche that is stripped of covering materials and mapped separately. The thickness of the unit ranges up to 10 feet.

Qau: Alluvium and Other Quaternary Deposits

These deposits consist of intimately associated alluvium and Qao deposits, undivided. They occur in dissected areas in Texas.

Qsgc: Colluvial Deposits

This unit is composed of: 1) sand, silt and gravel deposited by slopewash and 2) red- to grey-colored talus from Ogallala exposures. It is partly calichified; the caliche ranges from 1 to 20 feet thick. The deposits may include weathered clastics from the Gatuña Formation (unit Qg) locally, and they generally overlie Triassic- and Permian-aged rocks.

Qt: Fluvatile Terrace Deposits

These deposits consist of gravel, sand and silt and commonly contain pebbles and cobbles of limestone, sandstone and chert.

Qun: Pond Deposits

Gastropod-bearing sandy silt and silty clay, grey to light-grey color. The deposits are found in ponds and shallow swales. Locally, the unit may include the upper portion of Tahoka Formation deposits (Qta).

Qu: Pleistocene Surficial Deposits, Undivided

Silty sand and sandy silt, deposited mainly by sheetwash action.

Qao: Other Quaternary Deposits

These deposits are comprised predominantly of boulders, cobbles and pebbles of Cretaceous limestone and chert. Locally, the unit is overlain by brown silt. Presumably equivalent to a portion of the Seymour Formation, which outcrops to the east of the map sheet area.

Qg: Gatuña Formation

The unit is comprised predominantly of sand and, to a lesser extent, of conglomerate, gypsum, limestone and siltstone. The sand is yellowish- to reddish-orange and red. The siltstone is grey, purplish and red in color. The shale is a greenish color. The upper few feet of the formation is calichified. The formation itself may exceed 300 feet in thickness at the head of Cedar Canyon, although in many locations it is only a few feet thick. The Gatuña Formation probably underlies portions of the Querecho Plains, Mescalero Sands, San Simon Swale and Monument Draw. It is confined to New Mexico.

Qta: Tahoka Formation

Lacustrine clay, silt, sand and gravel that are locally calcareous and selenitic. The clay and silt components are sandy, indistinctly

bedded to massive, weakly coherent and various shades of light-grey and bluish-grey. The sand is comprised of fine- to coarse-grained quartz that is indistinctly bedded to massive, friable, and grades to a gravel at the margins of the deposits. Molluscan and vertebrate fossils are present in the formation.

Qcs: Windblown Cover Sand

This unit is comprised of fine- to medium-grained quartz that is silty and calcareous. Caliche nodules are common. The deposit is massive, has a distinct soil profile associated with it and is greyish-red in color. Up to 10 feet thick; feathers out locally.

Tertiary

To: Ogallala Formation

Fluvatile sand, silt, clay and gravel that are capped by caliche. The sand constituent is fine- to medium-grained quartz that is, in part, silty and calcareous. Clay balls are common; the sand unit is clayey in its upper portion. It is indistinctly bedded to massive, cross-bedded, unconsolidated to weakly cohesive, contains localized quartzite lenses, and is various shades of grey and red. The silt and clay components contain caliche nodules and are reddish-brown, dusky red and pink in color. The gravel is not present everywhere; it is composed predominantly of quartz, with some quartzite, sandstone, limestone, chert, igneous rock, metamorphic rock, and worn *Gryphea* in intraformational channel deposits and in the basal conglomerate. The caliche is sandy, pisolitic at the top, hard, and produces a caprock along the Mescalero Ridge. Fossil plants vertebrates are scarce. The maximum thickness ranges up to 100 feet thick.

Mesozoic Era

Cretaceous

Kft: Fort Terrett Formation

This unit is composed of limestone and shale. The limestone is generally fine-grained, argillaceous, thin- to thick-bedded and massive. It is, in part, nodular, and greyish-yellow and light-grey in color. The shale is calcareous, thinly laminated, and dusky yellow, yellowish-grey, light olive-grey and dark-grey in color. Marine megafossils abundant in some beds of the formation. It is 53 feet thick in outcrops at the northwestern margin of McKenzie Lake.

Kfr: Fredericksburg Group, Undivided

Limestone, dolomite, chert and minor marl components. The limestone is nodular, aphanitic, marly, and grey-, yellow-, white- and

pink-colored. The dolomite is fine-grained and grey. The chert is thin-layered and nodular. The marl is locally gypsiferous, and grey and yellowish-grey in color, with abundant *Exogyra texana* fossils. Some marl beds are made up almost entirely of *Gryphaea* species. The thickness of the unit in exposures is 50 feet.

Ka: Antlers Sand

This unit is comprised of medium-grained sand that is in part loosely consolidated, in part cemented by opal, in part ferruginous, and massive. Lenses of quartz gravel are common. The unit is greyish-pink to moderate reddish-brown in color. The thickness of the unit in outcrop is 6 to 10 feet.

Triassic

TRc: Chinle Formation

The formation is comprised of micaceous claystone that is a greenish-color with red reduction spots. The claystone is interbedded with thin-bedded, fine-grained sandstone. Up to 300 feet thick.

TRs: Santa Rosa Sandstone

This unit consists predominantly of cross-bedded sandstone, conglomerate, some clay, claystone and siltstone. It is pale red- to reddish brown-colored, and 50 to 70 feet thick.

TRd: Dockum Group, Undivided

Shale, sandstone, siltstone, limestone and gravel. The Dockum Group is comprised predominantly of micaceous shale that is thin-bedded and variegated. Up to 300 feet thick.

Permian

Pdr: Dewey Lake Redbeds and Rustler Formation, Undivided

Pdl: Dewey Lake Redbeds

This unit consists of siltstone and fine-grained quartz sandstone that is laminated, locally cross-bedded, and reddish-orange, reddish-brown and brownish-yellow in color with greenish-grey reduction spots up to an inch in size. The thickness of the unit ranges from 200 to 250 feet.

Pru: Rustler Formation

This formation is comprised of limestone, siltstone, sandstone, gypsum, marl and clay. The upper portion of the unit contains

limestone and dolomitic limestone, and is 50 feet thick or thicker. The middle portion is composed of siltstone and sandstone, and is yellowish-grey-colored; it is 50 to 70 feet thick. The lower portion contains siltstone and fine-grained sandstone. It is thin-to medium-bedded, red with interbeds of earthy to sparry red gypsum, with a few beds of red and greenish-grey marl and clay; it is 50 feet thick or thicker.

Unkl: Unlabeled Outcrop

This rock outcrops in the region labeled Cedar Lake, which presumably is dry (N.T.M.S., 1954).

D. RADIOACTIVE MINERAL PROSPECTS in the SURVEYED AREA

Butler and Schnabel (1956) report uranium occurrences from Upper Paleozoic rocks marginal to the Permian Basin in both Texas and New Mexico. As of the date of this publication, the deposits had not produced ore. They are apparently localized in asphaltite in Eddy County, New Mexico.

Eargle (1956) describes several uranium deposits in the region southeast of the map sheet area, in Reeves and Hudspeth counties.

In his report correlating the geology and aeroradioactivity of the Gnome (Carlsbad) area, Mackellor (1964) discovered that the Ogallala Formation (unit To) had a relatively higher overall radioactivity range than the Permian, Cretaceous, or surficial Quaternary exposures of the Hobbs map sheet area. Generally higher radioactivity ranges were recorded in the northeastern region (the northwestern corner of the map sheet) than in the southeastern region (the southwestern corner of the map sheet), according to the survey.

The Southern Interstate Nuclear Board (1969) reports no uranium mineralization in any of the counties in Texas included in the Hobbs map sheet area. Finch (1967) records the occurrence of a relatively low concentration of U_3O_8 from central Lea County, New Mexico.

SECTION IV

RESULTS OF DATA ANALYSIS

SECTION IV.

RESULTS OF DATA ANALYSIS

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.

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)* 1.0 ppm/div; 7.15 c/s = 1 ppm/eTh

BI(^{214}Bi)* .50 ppm/div; 13.52 c/s = 1 ppm/eU

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

BiAir 5.0 c/s/div. 50 seconds averaged

Residual Magnetic Field 50 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 .25/div.

TL/K 1.0 /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: 1.0 $^{\circ}\text{C}$ /div.

Pressure: 3.0 mm of Hg/div.

Base Magnetic Field: 10.0 gammas/div.

Residual Magnetic Field: 10.0 gammas/div.

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 DISTRIBUTION 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 $^{214}\text{Bi}/^{208}\text{Tl}$ (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.

HOHRS
TABLE: B1 PPM X 10

UNIT:	NW	OAL	QCD	US	QSU	GP	QCC	QAU	OSGC	QT	QUN	QAD	QG	QTA	QCS	TO	KFT	KFR	KA
LINE																			
ML 20:		9		7	4		12	8		12	9		9		9	8		13	9
ML 40:		8		7	5	17	11			11	8				9	10			
ML 60:		11		6	5		10		12		10	8			11	12			
ML 80:		7		6	6		14		9						11	10			
ML 100:		13		6	6				11		13		10	23	10	10			
ML 120:		9		6	6				10		11		9	6	7	11			
ML 140:		6		6	6		12		11		12			10	10				
ML 160:		10		6	6	2	14		9					7	9	10			
ML 180:		10		6	6				12					18	9	13			
ML 200:		9		8	8				10				8	12	8	11			
ML 220:		8		7	7				8					10	8	10			
ML 240:		8		7	7				13	7				8	9	8			
ML 260:				7	7				11						8	12			
ML 280:			20	19	4	14			14				6						
ML 281:			14	7	6				7						9	12			
ML 300:				7	6				13				5		8	13			
ML 320:				7	6				12						9	12			
ML 340:				8	6				11					31	10	13			
ML 341:															9				
ML 360:				7	5				6						9	13			
ML 380:				7	6				7					28	9	13			
ML 381:				11	6									47	9	13			
ML 400:				7	6				9					17	9	14			
ML 420:					6				8							14			
ML 421:				6											8	14			
ML 440:				7	8				7	8					7	13			
ML 460:				6	4				6	9					6	13			
TL 5020:				7			8			15	8				9	7			
TL 5040:				7	3						13			47	9	13	20		
TL 5060:				6	6		15				12				8	8			
TL 5080:		10		6	5		11				11			10	7	9			
TL 5100:				6	4										9	10			
TL 5120:		9		5	5				13						6	12			
TL 5140:					14				13							14			
TL 5141:				7	7				10		6					12			
TL 5160:				7	5		11		9							11			
TL 5180:				9	5		9		10							11			
TL 5200:		8		8	6	4	9		9				10						

HOBBS
TABLE: B1 PPM X 10

UNIT:	TRC	TRS	TRD	PDR	PDL	PRU	UNK1
LINE							
ML 20:							
ML 40:			10				
ML 60:						11	
ML 80:	10					10	
ML 100:							
ML 120:							
ML 140:						8	
ML 160:						8	
ML 180:			31			9	
ML 200:		9					
ML 220:							
ML 240:					11		
ML 260:							
ML 280:						7	
ML 281:							
ML 300:						6	
ML 320:			12				
ML 340:				13			
ML 341:							
ML 360:							
ML 380:						117	
ML 381:						96	
ML 400:							
ML 420:							
ML 421:							
ML 440:							
ML 460:							
TL 5020:							
TL 5040:							90
TL 5060:							
TL 5080:							
TL 5100:							
TL 5120:							
TL 5140:							
TL 5141:							
TL 5160:							
TL 5180:							
TL 5200:				8	10	9	

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

HOBBS TABLE: K PC X 100																			
UNIT:	HW	UAL	UCB	US	QSU	UP	UCC	QAU	QSGC	QT	UHN	QAO	QG	QTA	QCS	TO	KFT	KFR	KA
20:		77		72	37		97	83		93	95		84		81	77		109	87
40:		78		62	43	106	94			103	83				83	84			
60:		75		64	41		84		86		96	76			89	86			
80:		63		55	51		88		72						82	74			
100:		105		45	58				89		94		80	99	80	85			
120:		68		57	66				96		98		91	77	65	87			
140:		57		52	56		92		86		110			81	80				
160:		82		55	58	92	87		86					72	79	90			
180:		76		57	62				86					92	74	91			
200:		77		58	66				97				97	94	69	89			
220:		151		58	60				66					83	72	81			
240:		138		65	67				87	68				77	71	75			
260:				62	60				109						75	85			
280:			98	101	63	180			99				63						
300:			62	62	55				79						73	84			
320:				61	67				99				60		82	99			
340:				65	74				102						84	86			
360:				68	66				87					101	80	94			
380:															82				
400:				63	68				77						77	96			
420:				67	65				80					98	89	99			
440:				75	54									111	81	98			
460:				62	72				84					105	78	99			
480:					68				85							95			
500:				63											79	107			
520:				64	71				78	53					75	104			
540:				64	65				85	91					71	103			
560:				63			81			88	81				82	70			
580:				57	46						80			102	80	83	82		
600:				58	54		94				82				65	67			
620:		73		57	27		96				90			85	68	86			
640:				54	34										76	95			
660:		83		57	46				99						65	93			
680:					73				91							98			
700:				61	58				90		58					89			
720:				65	59		78		91							90			
740:				75	62		81		94							85			
760:	51	91		86	74	57	87		93				84						

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

HOBBS TABLE: BI/TL X 100																				
LINE	UNIT:	HW	UAL	UCD	US	QSU	OP	QCC	QAU	QSGC	QT	QUIN	QAO	QG	QTA	QCS	TO	KFT	KFR	KA
HL 20:			24		27	29		28	21		34	22		28		24	27		32	26
HL 40:			32		30	29	32	28			25	25				25	26			
HL 60:			52		26	37		29		33		22	27			25	31			
HL 80:			28		29	33		38		33						26	31			
HL 100:			30		32	28				27		33		32	66	28	28			
HL 120:			33		28	25				23		26		24	19	24	28			
HL 140:			41		30	26		25		32		24			30	25				
HL 160:			32		27	29	34	30		31					27	24	26			
HL 180:			38		24	30				34					43	26	32			
HL 200:			34		33	31				27				27	29	27	30			
HL 220:			18		29	31				33					32	25	31			
HL 240:			18		26	30				35	21				25	29	27			
HL 260:					28	31				29						26	36			
HL 280:				65	49	27	44			35				31						
HL 281:				68	25	32				24						27	34			
HL 300:					25	28				32				29		23	29			
HL 320:					26	30				30						25	32			
HL 340:					25	28				31					81	29	31			
HL 341:																25				
HL 360:					23	27				23						26	29			
HL 380:					25	30				26					69	26	30			
HL 381:					35	28									104	27	34			
HL 400:					25	26				30					41	24	31			
HL 420:						26				27							30			
HL 421:					21											22	27			
HL 440:					23	31				28	27					21	25			
HL 460:					21	21				19	25					19	26			
TL 5020:					24			21			45	24				23	23			
TL 5040:					25	15						36			112	22	36			
TL 5060:					24	24		31				30				25	27		57	
TL 5080:			30		24	44		24				27			28	24	26			
TL 5100:					25	26										30	25			
TL 5120:			26		22	30				33						22	28			
TL 5140:						55				34							31			
TL 5141:					29	29				27		24					31			
TL 5160:					25	26		32		23							26			
TL 5180:					32	27		29		28							28			
TL 5200:			27		27	25	26	30		25				30						

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

HOBBS
TABLE: BI/K X 1000

UNIT:	TRC	TRS	TRD	PDR	PDL	PRU	UNK1
20:					795		
40:			1219				
60:					1388		
80:	1320				1137		
100:							
120:							
140:					925		
160:					1120		
180:					887		
200:		968	4251				
220:							
240:					564		
260:							
280:					895		
300:						1018	
320:			1638				
340:				942			
360:							
380:						10492	
400:						9960	
420:							
440:							
460:							
5020:							8727
5040:							
5060:							
5080:							
5100:							
5120:							
5140:							
5160:							
5180:							
5200:							

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

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HOBBS
TABLE: TL/K X 1000

UNIT:	TRC	TRS	TRD	PDR	PDL	PRU	UNK1
20:							
40:			3814		4688		
60:						4224	
80:	4698					4100	
100:							
120:							
140:						3580	
160:						3693	
180:			4634			2843	
200:		3925					
220:							
240:					2462		
260:							
280:						2807	
300:							3494
320:			3610				
340:				3207			
360:							
380:						2893	
400:						3249	
420:							
440:							
460:							
5020:							3768
5040:							
5060:							
5080:							
5100:							
5120:							
5140:							
5160:							
5180:							
5200:							

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

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eTh	eU			K		eU/eTh		eU/K		eTh/K		MAX. NO. EVENTS	GEOL. UNIT
	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$		
29	3.47	0.1291	0.90	0.0645	0.88	0.0419	0.2630	0.1306	1.0390	0.1632	3.9580	10.0	KA
57	4.20	0.2470	1.35	0.1140	1.09	0.0350	0.3267	0.0844	1.2483	0.2376	3.8367	6.0	KFR
98	3.58	0.3245	2.03	0.0658	0.83	0.1038	0.5706	0.5060	2.4941	0.2089	4.3524	17.0	KFT
29	0.54	0.0000	0.00	0.4016	0.51	0.0000	0.0000	0.0000	0.0000	0.8611	1.4939	40.0	MW
58	4.75	0.3457	1.03	0.5787	1.61	0.0773	0.2189	0.2495	0.6782	1.1261	3.2869	108.0	PDL
32	3.45	0.2702	0.89	0.2142	0.98	0.0661	0.2600	0.2622	0.9266	0.6242	3.5735	74.0	PDR
44	2.80	0.3883	0.89	0.3492	0.92	0.1201	0.3142	0.4666	1.0905	1.3673	3.3366	610.0	PRU
62	3.83	0.3564	1.06	0.2885	0.92	0.0896	0.2840	0.3658	1.1913	0.7746	4.2636	878.0	QAL
29	3.37	0.1106	0.89	0.0768	0.77	0.0545	0.2711	0.1446	1.1706	0.6626	4.4106	18.0	QAO
41	3.91	0.1226	0.84	0.1171	0.84	0.0419	0.2155	0.2229	1.0200	0.7221	4.7581	31.0	QAU
99	4.14	0.3534	1.18	0.1506	0.92	0.0946	0.2941	0.4066	1.3088	0.6843	4.5014	1684.0	QCC
32	2.65	0.3854	1.75	0.1931	0.79	0.1069	0.6670	0.3035	2.2400	0.3639	3.3826	23.0	QCD
29	3.77	0.3663	0.93	0.1800	0.78	0.0951	0.2519	0.4382	1.2048	0.7516	4.8603	17874.0	QCS
51	3.31	0.3551	0.95	0.1473	0.84	0.1035	0.2933	0.4850	1.1676	0.6381	3.9639	169.0	QG
06	2.27	0.8065	1.12	0.9085	1.30	0.1574	0.3697	0.6419	1.0992	1.6315	2.3691	136.0	QP
77	2.84	0.3103	0.72	0.1432	0.62	0.1158	0.2654	0.4973	1.2065	0.8838	4.6654	25238.0	QS
21	3.75	0.3805	1.09	0.1844	0.91	0.1052	0.2983	0.4374	1.2271	0.6884	4.1540	2780.0	QSGC
46	2.34	0.2811	0.66	0.2113	0.61	0.1325	0.2941	0.5277	1.1412	0.9618	3.9737	21422.0	QSU
45	4.06	0.3031	1.14	0.1676	0.94	0.0916	0.2909	0.3438	1.2388	0.5705	4.3293	129.0	QT
73	3.62	1.5243	1.59	0.1747	0.88	0.3587	0.4254	1.3101	1.7066	0.6162	4.1511	730.0	QTA
97	4.27	0.3955	1.12	0.1664	0.94	0.1012	0.2679	0.4355	1.2050	0.6476	4.5682	750.0	QUN
09	4.59	0.3759	1.31	0.1795	0.96	0.0906	0.2917	0.4009	1.3838	0.6500	4.8068	12621.0	TO
28	3.75	0.3698	1.07	0.0849	0.80	0.0888	0.2829	0.3902	1.3209	0.3732	4.6983	35.0	TRC
02	3.38	0.7969	1.42	0.0908	0.87	0.2382	0.4264	1.1656	1.7327	0.4657	3.9233	64.0	TRD
39	3.98	0.2338	0.97	0.0838	1.02	0.0528	0.2467	0.1984	0.9883	0.3789	3.9250	6.0	TRG
87	3.71	3.6803	9.96	0.1875	1.08	1.3496	2.9685	3.2516	9.4217	0.8189	3.4321	157.0	UNK1

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	878	none
Qcc	1684	none
Qsgc	2780	none
Qun	750	none
Qta	730	none
Qcs	17871	none
To	12621	none

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

(C I A B L E I V . 9 C O N T ' D)

		206		214		214	206
		FL		BI		BI	FL
AL220	QS	4876	QSU	4246	QSU	4386-	4391
		4966	QS	4891- 4896	TO	5031	
		5006- 5011		5006- 5011	QSU	5196	
	QSU	5136- 5141	QSU	5506		5486	
			TO	6591	TO	5496-	5501
					QS	5926	
					QCS	6261	
					TO	6591	
AL240	QS	1511- 1516	QS	1541	QCS	1756-	1761
	QSU	2701- 2741	QCS	1756- 1761		1821-	1826
		2916	QSU	2696- 2741	QS	2096-	2101
	QS	2951- 2966		2836		2266-	2271
		3021- 3026		2921		2406	
		3036	QS	2961- 2966	QSU	2461	
		3126- 3131	QSU	3551- 3556		2586-	2591
		3161		3566- 3571		2616	
		3191- 3206					
		3221- 3231					
		3261- 3271					
	QSU	3566- 3571					
		3646- 3651					
AL260			TO	5753- 5758	QSU	3926-	3933
					QSGC	3963	
					QSU	5053-	5058
						5076	
						5113-	5118
						5153-	5163
					QS	5256-	5266
						5303-	5308
					TO	5753-	5763
					QS	6353	
AL281	QS	2723- 2728	QSU	2858- 2868	TO	2613	
		2793- 2798		2898	QCS	2673	
				2923	QSU	2896	
				2948		2923	
						3178	
AL260	QS	2148	QSGC	2143	QSU	1753	
			QS	2148- 2158		1768	
						1926-	1933
					QS	2158	
AL300	QSU	3364- 3369	QSU	2629- 2634	TO	3564	
		3424- 3429		3364- 3369	QSGC	3600-	3609

(...) DENOTES NEGATIVE ANOMALY

TABLE IV.9 (CONT'D)

		208 TL		214 BI		214 BI/	208 TL
0	QSGC	3444- 3454	QSU	3584- 3589			
	QSU	3494- 3499	QSGC	3604- 3609			
		3574- 3579					
	QSGC	3689- 3699					
0	QS	1911- 1916	QSU	3836- 3846	QCS	1306- 1311	
	QSU	3791- 3796			TO	(2656- 2661)	
		3831- 3856				2806- 2811	
					USU	2846	
						3396	
						3646	
0	QSU	4060- 4070	PDR	4075	TO	4765	
		4080	QCS	6096- 6101		5240- 5245	
		4415- 4420	QSU	6161- 6166		5270	
		6156- 6161	TO	6446-6475		6491-6496	
	QS	6446- 6456			QCS	6501	
			QCS	6501- 6506		6781- 6786	
				6831- 6836			
1					QCS	1447- 1452	
0	QS	2082	QS	1446- 1451	TO	2792- 2797	
	QSU	3447- 3452	QSU	1466- 1471	QSU	3752- 3757	
				3447			
0	QS	5532- 5537	QTA	6562- 6572	QSU	4212	
		5547- 5552	QS	6577- 6587		4237	
		5882				4257	
		5977			TO	4542	
						4777- 4782	
						4832- 4837	
					QTA	6562- 6572	
					QS	6577- 6587	
						6652- 6657	
1			QTA	1034- 1039	QTA	1034- 1039	
			QS	1044- 1054	QS	1044- 1054	
					QCS	1219- 1224	
0	QS	1430	TO	1620- 1625	TO	1620- 1625	
	TO	3196- 3201		3191- 3196			
0							
1	TO	5539- 5549			TO	5924- 5929	
	QS	6724- 6729					

(....) DENOTES NEGATIVE ANOMALY

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(TABLE IV.9 (CONT'D))

		208 TL		214 BI		214 BI/	208 TL
	AL440	TO	2689- 2699	QSU	3879- 3884		
			3199- 3204				
		QSU	3839- 3849				
	AL460	TO	4605	TO	5195- 5200		
			4795- 4800				
			4995- 5000				
			5125- 5130				
			5320- 5325				
		QS	5645				
			6105- 6110				
			6940- 6945				
	TL5020	QCS	1427- 1432	QCS	1342		
			1442- 1457		1532- 1537		
			1472- 1492		1727- 1737		
			1502- 1532				
			1542- 1552				
			1582- 1592				
			1777- 1797				
			1817- 1832				
	TL5040	QCS	3354- 3359	QTA	3434- 3439	QCS	3089
		QCS	4304- 4309	QS	4414- 4434	QTA	3434- 3439
			4574- 4579	TO	4439- 4449	TO	4409
				QCS	4464- 4479	QS	4419- 4429
						TO	4439
						QCS	4464- 4469
	TL5060			QCC	4801- 4806	QCS	5231- 5241
							5261
	TL5080	QS	1686- 1691			QCS	2361- 2366
							2401
						QSU	2511
							2541
	TL5100	QS	4200- 4210	QS	3080	QS	2830
				QCS	3095- 3100		3075- 3080
					4075- 4080	QCS	3085- 3100
							3115
	TL5120	TO	4674	QSU	5489- 5494	QSU	5869
				TO	6145- 6155	QCS	6110- 6115
						TO	6140- 6155
						QSU	6225

(....) DENOTES NEGATIVE ANOMALY

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(TABLE IV.9 (CONT'D))

		208 TL		214 BI		214 BI/	208 TL
	TL5141	QSU	1468- 1473	QSU	1423- 1428	QSU	2083
			2168- 2183		1938		2098- 2103
					2098- 2103		2113- 2118
					2113- 2118	TO	2208- 2213
					2128		
					2158- 2168		
					2178- 2183		
	TL5140	TO	1542- 1547	QSU	1047	QSU	1047
			1647- 1652		1067- 1077		1067- 1072
					1112- 1122	TO	1152
	TL5160	TO	3004- 3009	QS	3774- 3779	QSU	3579- 3584
		QS	3779- 3784				
			3809				
	TL5180			QS	5693- 5718	QSU	5468
				QSU	6133- 6138	QS	5698- 5718
	TL5200	QSU	7115- 7125	QSU	7110- 7130	QSGC (	7725- 7736)
		MW	7135- 7150		7935	QCC	8175
			7590				

(....) DENOTES NEGATIVE ANOMALY

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TABLE IV.10 Radioactivity Anomalies per Geologic Map Unit

Geologic Unit	²⁰⁸ Tl	²¹⁴ Bi	²¹⁴ Bi/ ²⁰⁸ Tl
Quaternary			
Mw	1	0	0
Qal	2	0	2
Qs	42	24	54
Qsu	36	40	53
Qcc	1	1	4
Qsgc	2	3	4 (1)
Qt	1	0	0
Qun	1	1	1
Qta	0	3	3
Qcs	29	22	34
Tertiary			
To	13	8	25 (1)
Permian			
Pdr	0	1	0
Pru	1	1	1
Unknown			
Unkl	1	0	0

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	9	8	9
No. of Anomalies	115	95	156 (1)
Tertiary			
No. of Units w/Anomalies	1	1	1
No. of Anomalies	13	8	25 (1)
Permian			
No. of Units w/Anomalies	1	2	1
No. of Anomalies	1	2	1
Unknown			
No. of Units w/Anomalies	1	0	0
No. of Anomalies	1	0	0
Total Sample			
No. of Units w/Anomalies	12	11	11
No. of Anomalies	130	105	182 (2)

Quaternary Geologic Units: Mw,Qal,Qs,Qsu,Qcc,Qsgc,Qt,Qun,Qta,Qcs

²⁰⁸Tl Anomalies

Eighty-eight percent of all the ²⁰⁸Tl anomalies recorded in the Hobbs map sheet area are from the Quaternary units, with the exception of unit Qta. Of these anomalies, over one-third (approximately 36%) are found in the unit Qs. The Quaternary-aged exposures constitute roughly seventy-eight percent of the map sheet area. Many of the ²⁰⁸Tl anomalies in the Quaternary presumably are related to lithologic changes within the units (see Table IV.8).

²¹⁴Bi and ²¹⁴Bi/²⁰⁸Tl Anomalies

Eighty-nine percent of the ²¹⁴Bi anomalies and eighty-six percent of the positive ratio anomalies are reported from the Quaternary units, exclusive of units Mw and Qt. Of these ²¹⁴Bi anomalies, almost one-half (42%) are recorded in the unit Qsu. Greater than one-third (35%) of the Quaternary-aged, positive ratio anomalies are from the unit Qs.

There are 34 loci of geographical coincidence between the ²¹⁴Bi and ²¹⁴Bi/²⁰⁸Tl anomalies. These are: ML40, stations 2172-2177 (Qcs) and 2442-2447, 2458, 2468, 4003-4013 (Qs); ML60, stations 5452 (Qsu) and 5497 (Qsgc); ML100, stations 6665-6675 and 6685-6690 (Qcs); ML120, station 1161 (Qun); ML160, station 2291 (Qs); ML180, stations 6176-6181 (Qcs); ML200, stations 2362-2367 (Qsl); ML240, stations 1756-1761 (Qcs); ML260, stations 3928-3933 (Qsu); ML280, station 2158 (Qs); ML281, stations 2898 and 2923 (Qsu); ML300, stations 3604-3609 (Qsgc); ML340, stations 6491-6496 (Qs) and 6501 (Qcs); ML380, stations 6562-6572 (Qta) and 6577-6587 (Qs); ML381, stations 1034-1039 (Qta) and 1044-1054 (Qs); TL5040, stations 3434-3439 (Qta) and 4464-4469 (Qcs); TL5100, stations 3080 (Qs) and 3095-3100 (Qcs); TL5140, stations 1047 and 1067-1072 (Qsu); TL5141, stations 2098-2103 and 2113-2118 (Qsu); and TL5180, stations 5698-5718 (Qs).

Coincident loci may represent epigenetic concentrations of uranyl ions within the Quaternary units.

Tertiary Geologic Unit: To

²⁰⁸Tl Anomalies

Ten percent of the ²⁰⁸Tl anomalies are reported from the unit To, which occupies approximately twenty percent of the Hobbs map sheet area.

(...) denotes negative anomaly

(...) denotes negative anomaly IV-12

214Bi and 214Bi/208Tl Anomalies

Approximately eight percent of the 214Bi anomalies and fourteen percent of the positive ratio anomalies are found in the unit To. One negative ratio anomaly occurs in To. There are four points of geographic coincidence between the 214Bi and ratio anomalies: ML220, station 6591; ML260, stations 5753-5758; ML400, stations 1620-1625; and TL5120, stations 6145-6155.

The Ogallala Formation is reported (Finch, 1967) to contain carnotite deposits in Lea County, New Mexico. The 214Bi and positive ratio anomalies in the unit To are thought to reflect epigenetic concentrations of uranium minerals, particularly where the two anomalous types coincide.

Permian Geologic Units: Pdr, Pru

208Tl Anomaly

Approximately three-fourths of one percent of the 208Tl anomalies are found in the unit Pru. The Permian units comprise roughly one percent of the total surface-rock exposures in the map sheet area.

214Bi and 214Bi/208Tl Anomalies

Approximately two percent of the 214Bi anomalies and one-half of one percent of the positive ratio anomalies are reported from units Pdr and Pru. There are no geographically coincident 214Bi and 214Bi/208Tl anomalies recorded. These anomalies are not considered to be economically significant.

Unknown Geologic Unit: Unkl

208Tl Anomaly

Approximately three-fourths of one percent of the 208Tl anomalies is recorded from the area labeled Cedar Lake (dry).

Trends

208Tl Anomalies

There are four regions on the Hobbs map sheet that are generally more concentrated with respect to the 208Tl anomalies. These are: 1) the southeastern corner of the map, 2) a loose distribution in the northeastern quarter, 3) the westcentral portion of the map, which generally follows the western margin of the Llano Estacado in the map sheet area, and 4) the extreme western corner of the map.

214Bi Anomalies

The 214Bi anomalies approximately follow the distribution patterns of the 208Tl anomalies in the map sheet area.

214Bi/208Tl Anomalies

With a few exceptions, the ratio anomalies in the Hobbs map sheet area are clustered in the central and eastcentral regions.

Relationship between Radioactivity Anomalies and Cultural Features in the Surveyed Area

The cultural features in the Hobbs map sheet area which could have an effect on the radioactivity data are the following: 1) the cities of Midland, Hobbs, Andrews, Lovington and Seminole, 2) the towns of Jal, Eunice, Seagraves, Denver City, Bennett and Gardendale, 3) Laguna Plata, McKenzie, Walters, Whalen and Salt lakes, as well as the intermittently dry Shafter, Lindsey and Cedar lakes, 4) various intermittent creeks in the map sheet area, and 5) dumps and storage areas for waste materials produced during recovery of potash materials.

Two 208Tl anomalies, ML340, stations 4060-4070 and 4080 (Qsu), are associated with Walters Lake. Due to fluctuations in lake-level and the accuracy of the survey with respect to ground location, the anomalies are presumed to be within the unit Qsu.

There is one 208Tl anomaly recorded over "Cedar Lake" at TL5040, stations 3354-3359 (Unkl). The lake is reportedly intermittently dry (N.T.M.S., 1954), and is thought to have been dry during the data collection. Since the rock exposure(s) in this area is(are) not described (University of Texas Bureau of Economic Geology, 1976), the anomaly is assigned to the unknown "unit", Unkl (see Section III.C.).

There are three relatively large 214Bi anomalies in the vicinity of "Cedar Lake". These are: ML380, stations 6562-6572 (Qta) and 6577-6587 (Qs) and ML400, stations 1620-1625 and 3191-3196 (To).

There is one 214Bi anomaly and one positive ratio anomaly to the east of McKenzie Lake at ML340, stations 6446-6475 (To). Here they appear to be recorded over the lake. The anomaly is presumed to be within the unit To, however, allowing for the accuracy of the survey. Just east of the town of Jal is a 214Bi anomaly: ML80, station 5497 (Qsgc).

Three positive ratio anomalies are associated with "Cedar Lake" on ML400, stations 1620-1625, and ML380, stations 6562-6572 (Qta) and stations 6577-6587 (Qs). One positive ratio anomaly: ML60, stations 5497-5502 (Qsgc), is due east of Jal.

Relationship between Radioactivity Anomalies and Known Radioactive Mineral Deposits

There are a few geographically coincident 214Bi and 214Bi/208Tl anomalies within the unit To in the central portion of Lea County. These anomalies are thought to correspond with the published location of carnotite deposits in the Ogallala Formation in this area (see Section III.D.).

3. Summary and Recommendations

The 208Tl, 214Bi and 214Bi/208Tl anomalies in the Hobbs map sheet area (Figure I.2) are recorded predominantly over the Quaternary-aged units whose exposures comprise most of the area. The Quaternary units are relatively heterogeneous in composition. Where 214Bi and positive ratio anomalies coincide geographically, these units may contain significant, epigenetic concentrations of uranium.

There is a general correspondence between: 1) the geographically coincident 214Bi and positive ratio anomalies in the Tertiary Ogallala Formation (unit To) and 2) the reported occurrence of uranium within the unit in central Lea County. More detailed inspection of surface exposures of the Ogallala along the physiographic boundary between the Llano Estacado and the Pecos Valley regions might prove to be profitable.

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:

* 208Tl
* 214Bi
* 40K
* 214Bi/208Tl Ratio
* 214Bi/40K Ratio
* 208Tl/40K 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 FWY DALLAS, TEXAS 75247

NATIONAL GAMMA RAY MAP SERIES

Hobbs, New Mexico; Texas

206 TR - STANDARD DEVIATIONS

REF NTMS, NI 13-12
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

IV-19a

Figure IV.1 National Gamma Ray Map Series

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

NATIONAL GAMMA RAY MAP SERIES

Hobbs, New Mexico; Texas

Bi-STANDARD DEVIATIONS

REF. NTMS, N. 13-12
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

IV-19b

Figure IV.2 National Gamma Ray Map Series

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

NATIONAL GAMMA RAY MAP SERIES

Hobbs, New Mexico; Texas

K- STANDARD DEVIATIONS

REF. NTMS, N1 13-12
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

IV-19c

Figure IV.3 National Gamma Ray Map Series

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

NATIONAL GAMMA RAY MAP SERIES

Hobbs, New Mexico; Texas

Di/T₂ = T₂ - STANDARD DEVIATIONS

REF NTMS, N1 13-12
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

IV-19d

Figure IV.4 National Gamma Ray Map Series

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

NATIONAL GAMMA RAY MAP SERIES

Hobbs, New Mexico; Texas

2σ $B_1/4$ K-STANDARD DEVIATIONS

REF NTMS, NI 3-2
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

IV-19e

Figure IV.5 National Gamma Ray Map Series

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

NATIONAL GAMMA RAY MAP SERIES

Hobbs, New Mexico; Texas

TR/K-STANDARD DEVIATIONS

REF. NTMS, NI 13-12
PREPARED FOR
U.S. DEPARTMENT OF ENERGY

IV-19f

Figure IV.6 National Gamma Ray Map Series

H. STACKED DATA PROFILES AND GEOLOGIC HISTOGRAMS

AG
GAMMA/DIV
E = -900.0

AG
GAMMA/DIV
E = 43300.0

AG
GAMMA/DIV
E = 645.0

MP
GAMMA/DIV
E = 15.0

T
FT/DIV

G
RMMA/DIV
= -800.0

G
RMMA/DIV
= 49900.0

HG/DIV
= 645.0

P
C/DIV
= 15.0

FT/DIV

ML 40 HOBBS

/K
/DIV

/K
5 /DIV

/TL
/DIV

C/S/DIV

AG
GRAVITY/DIV
E = -350.0

AIR
C/S/DIV

PC/DIV

FFP/DIV

PPW/DIV

T
FT/DIV

W LONG 104.000 LONG 103.750 LONG 103.500 LONG 103.250 LONG 103.000 LONG 102.750 LONG 102.500 LONG 102.250 LONG 102.000
ML 140 HOBBS

MAG
GAMMA/DIV
BASE = -800.0

MAG
GAMMA/DIV
BASE = 43300.0

P
MM MS/DIV
BASE = 645.0

EMP
DES C/DIV
BASE = 15.0

T
0 FT/DIV

3G
30MM/DIV
E = -800.0

3G
30MM/DIV
E = 13900.0

1P
166/DIV
E = 645.0

1P
166 C/DIV
E = 15.0

FT/DIV

RG
GMM/DIV
E = -900.0

RG
GMM/DIV
E = 9990.0

MS/DIV
E = 645.0

MP
GMM/DIV
E = 15.0

T
FT/DIV

W LONG 104.000 LONG 103.750 LONG 103.500 LONG 103.250 LONG 103.000 LONG 102.750 LONG 102.500 LONG 102.250 LONG 102.000
ML 200 HOBBS

G
WAVE/DIV
= 900.0

G
WAVE/DIV
= 13900.0

HQ/DIV
= 695.0

P
S C/DIV
= 15.0

FT/DIV

L/K
0 /DIV

I/K
25 /DIV

I/TL
5 /DIV

C
0 C/S/DIV

MAG
0 GRAMS/DIV
BASE = -350.0

IAIR
0 C/S/DIV

5 PC/DIV

I
0 PPH/DIV

L
0 PPH/DIV

LT
0 FT/DIV

96
SWATH/DIV
E = -800.0

96
SWATH/DIV
E = 9990.0

M H2O/DIV
E = 645.0

MP
ES C/DIV
E = 15.0

T
FT/DIV

ML 220 HOBBS

/K
/DIV

/K
/DIV

/TL
/DIV

C/S/DIV

IRG
GRAVITY/DIV
SE = -350.0

AIR
C/S/DIV

PC/DIV

PPM/DIV

PPM/DIV

LT
FT/DIV

AG
GAMMA/DIV
E = -900.0

AG
GAMMA/DIV
E = 43900.0

IM H6/DIV
E = 645.0

MP
DEG C/DIV
E = 15.0

T
FT/DIV

IRG
GAMMA/DIV
SE = -800.0

IRG
GAMMA/DIV
SE = 43900.0

MP
H8/DIV
SE = 645.0

MP
DES C/DIV
SE = 15.0

T
FT/DIV

ML 340 HOBBS

E

RG
341/DIV
E = -800.0

RG
341/DIV
E = 43900.0

1 MB/DIV
E = 645.0

1P
ES C/DIV
E = 15.0

T
FT/DIV

AG
SARMA/DIV
E = -800.0

AG
SARMA/DIV
E = 43300.0

M HS/DIV
E = 645.0

MP
ES C/DIV
E = 15.0

T
FT/DIV

L/K
0 /DIV

L/K
25 /DIV

L/TL
5 /DIV

C
0 C/S/DIV

MAG
GAMMAS/DIV
BASE = -350.0

IAIR
0 C/S/DIV

5 PC/DIV

I
0 PPH/DIV

0 PPH/DIV

LT
00 FT/DIV

/K
/DIV

/K
/DIV

/TL
/DIV

C/S/DIV

AG
C/S/DIV
E = -350.0

AIR
C/S/DIV

PC/DIV

PPH/DIV

PPH/DIV

FT/DIV

W ML 460 LONG 104.000 LONG 103.750 LONG 103.500 LONG 103.250 LONG 103.000 LONG 102.750 LONG 102.500 LONG 102.250 LONG 102.000

G
MMR/DIV
= -800.0

G
MMR/DIV
= 49900.0

HG/DIV
= 645.0

P
S C/DIV
= 15.0

FT/DIV

S | LAT 32.000 | LAT 32.250 | LAT 32.500 | LAT 32.750 | LAT 33.000 | N

TL 5080 HOBBS

RG
GAMMA/DIV
E = -800.0

RG
GAMMA/DIV
E = 13900.0

MP
G C/DIV
E = 645.0

MP
G C/DIV
E = 15.0

FT/DIV

G
ARMMA/DIV
= -800.0

G
ARMMA/DIV
= 49300.0

HG/DIV
= 645.0

P
S C/DIV
= 15.0

FT/DIV

S
WPR/DIV
= -900.0

G
WPR/DIV
= 9900.0

MS/DIV
= 645.0

P
S C/DIV
= 15.0

T/DIV

A 1

HOBBS

A 2

A 7

A 8

A 9

A 10

GEOLUBIC UNIT KFT

GEOLUBIC UNIT KFR

A 19

A 20

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 ²¹⁴Pb 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 system 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 ¹³⁷Cs 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 ⁴⁰K 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

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

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

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

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

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

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

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

CALIBRATE, which allows proper gain calibration for the detectors;

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

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 4 π and 2 π 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:

$$a_{COS} + 1.0_{TL} + f_{BI} + 0.0_{K} = M_{TL}$$

where M_{TL} 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 M_{COS}, M_{BI} and M_K, as shown below in matrix notation by

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

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,

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

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

$$\begin{aligned} \overline{\text{TLI}} &= \text{TL1} - B_{TL} \\ \overline{\text{BII}} &= \text{BI1} - B_{BI} \\ \overline{\text{KI}} &= \text{K1} - B_K \end{aligned}$$

The resulting counting rates for $\overline{\text{TLI}}$ and $\overline{\text{KI}}$ represent the counts contributed only by the sources below the aircraft on the earth's surface. In the case of $\overline{\text{BII}}$, 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:

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

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,

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

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.

$\overline{\text{TLI}}$, $\overline{\text{BII}}$ and $\overline{\text{KI}}$ 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

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

Briefly summarizing, $\overline{\text{TLI}}$, BISUR and $\overline{\text{KI}}$ 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:

$$\text{TLS} = \overline{\text{TLI}} \cdot e^{-\mu_1(400 - \frac{\rho}{\rho_0} x)}$$

$$\text{BIS} = \text{BISUR} \cdot e^{-\mu_2(400 - \frac{\rho}{\rho_0} x)}$$

$$\text{KS} = \overline{\text{KI}} \cdot e^{-\mu_3(400 - \frac{\rho}{\rho_0} x)}$$

and

$$\text{GC(gross count)} = (\overline{\text{GC}} - B_{GC} - S \cdot \text{BIAIR}) \cdot e^{-\mu_4(400 - \frac{\rho}{\rho_0} x)}$$

where

$\overline{\text{GC}}$ 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_0 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, 4 π and 2 π spectral

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

AIRCRAFT BACKGROUNDS				COSMIC CORRECTION RATIOS	
Detector	Parameter	Window	Value (CPS)	Parameter	Value
Terrestrial (4 π)	B _K	Potassium	29.98	c	0.2069
	B _{Bi}	Uranium	9.40	b	0.1651
	B _{Th}	Thorium	5.83	a	0.2202
	B _{GC}	Gross	286.69	-	-
Atmospheric (2 π)	B _{2π}	Uranium	8.33	C _{2π}	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			MAGNETIC HEADING CORRECTION	
Radio Element	Parameter	Value (x10 ⁻³ per ft.)	Flight Direction	Correction (gammas)
Potassium	μ_1	2.448	West to East	+3.56
Uranium	μ_2	1.329	East to West	-3.56
Thorium	μ_3	1.899	North to South	-1.0
Gross	μ_4	1.430	South to North	+1.0

RADIOELEMENT	SYSTEM SENSITIVITIES AT 400 FEET
Potassium (cps/%K)	98.05
Uranium (cps/ppm eU)	13.52
Thorium (cps/ppm eTh)	7.15

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 ($^{214}\text{Bi}/^{208}\text{Tl}$) ratio
9. eU/K ($^{214}\text{Bi}/^{40}\text{K}$) ratio
10. eTh/K ($^{208}\text{Tl}/^{40}\text{K}$) 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:

$$\begin{aligned}
 (1) \quad T\bar{L}I < 1.5 & \quad \sqrt{\frac{T\bar{L}W - T\bar{L}I}{T\bar{L}I}} = 1.5\sigma T \\
 (2) \quad B\bar{I}S\bar{U}R < 1.5 & \quad \sqrt{\frac{B\bar{I}W - B\bar{I}S\bar{U}R}{B\bar{I}S\bar{U}R}} = 1.5\sigma B \\
 (3) \quad K\bar{I} < 1.5 & \quad \sqrt{\frac{K\bar{W} - K\bar{I}}{K\bar{I}}} = 1.5\sigma K
 \end{aligned}$$

where the "w" subscript refers to the respective window counting rates from the raw data and $\overline{T_{21}}$, BISUR and $\overline{KI}$ 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.

AI.D EXPLANATORY NOTES

On days 4/21/80 and 4/23/80, the voltage from the temperature sensor was locked, and sensed changes in the outside air temperature of one degree increments. The lines on these days appear to be flat on RM plots, but are accurate to $\pm 2^{\circ}\text{C}$.

AI.E AVERAGE SPEED AND ALTITUDE DATA SUMMARY

LINE	AVERAGE		LINE	AVERAGE	
	SPEED (MPH)	ALTITUDE (FEET)		SPEED (MPH)	ALTITUDE (FEET)
ML 20	141	416	ML 360	149	402
ML 40	141	405	ML 380	140	396
FL 60	141	413	ML 381	135	406
ML 80	142	399	ML 400	135	399
ML 100	140	402	ML 420	150	399
ML 120	143	412	ML 421	146	389
ML 140	138	402	ML 440	138	405
ML 160	144	403	ML 460	143	407
ML 180	138	411	TL 5020	140	415
ML 200	149	405	TL 5040	148	412
ML 220	148	406	TL 5060	146	413
ML 240	149	400	TL 5080	144	413
ML 260	144	405	TL 5100	140	401
ML 281	150	399	TL 5120	144	422
ML 280	150	413	TL 5141	141	396
ML 300	140	400	TL 5140	152	395
ML 320	148	411	TL 5160	139	408
ML 340	138	428	TL 5180	144	406
ML 341	135	443	TL 5200	139	414

APPENDICES

I PRODUCTION SUMMARY

II TAPE FORMAT STATEMENTS

III COMPUTER LISTINGS

IV LINE PRINTER CONTOURS

PRODUCTION SUMMARY - SURVEY TIME PERIOD

ML/TL	DATE FLOWN	SURVEY LINE MILES	AVERAGE SPEED/DAY	AVERAGE ALTITUDE/DAY
5020- 41,5160- 00	4/18/80	788.4	142	409
-180	4/19/80	936.2	141	406
0-281	4/20/80	550.6	146	402
0-380, 40	4/21/80	623.4	143	406
0-460	4/23/80	470.6	141	401
		3,369.2		

AI-1

AI.B TEST LINE RESULTS

April, 1980					
UNIT	18	19	20	21*	23
PRE COS	45.93	46.12	45.52	47.26	46.01
POS COS	46.19	46.05	-	47.51	46.39
T1	28.93	29.37	29.57	28.10	27.46
T1	28.59	29.22	-	28.31	28.83
B1	18.55	18.73	1.90	15.03	15.37
B1	19.01	18.19	-	15.87	16.03
K	88.83	89.14	89.33	80.52	80.91
K	89.00	89.48	-	81.09	80.61
GC	1203.61	1231.69	1252.76	1139.54	1167.23
GC	1211.72	1217.52	-	1152.61	1170.99
B1A1r	17.05	15.12	20.38	16.24	10.25
B1A1r	6.99	7.23	-	6.91	5.03
ALT	404.35	401.29	401.42	377.62	395.67
ALT	389.37	409.62	-	398.01	409.89

*New Test Line

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AI.C DIURNAL CORRECTIONS TO LINE DATA

LINE	DIURNAL CORRECTIONS IN GAMMAS	LINE	DIURNAL CORRECTIONS IN GAMMAS	LINE	DIURNAL CORRECTIONS IN GAMMAS
ML 20	-19	ML 120	1	ML 220	9
ML 40	30	ML 140	-20	ML 240	0
ML 60	31	ML 160	-19	ML 260	0
ML 80	3	ML 180	-24	ML 281	5
ML 100	-10	ML 200	2		
ML 280	1	ML 360	-1	ML 420	0
ML 300	31	ML 380	-20	ML 421	32
ML 320	4	ML 381	-24	ML 440	-3
ML 340	-11	ML 400	0	ML 460	-1
ML 341	-18				
TL 5020	11	TL 5100	4	TL 5160	3
TL 5040	0	TL 5120	-3	TL 5180	-14
TL 5060	1	TL 5141	-13	TL 5200	10
TL 5080	0	TL 5140	9		

AI-3

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 Number	Character Number
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 14 APPROXIMATE DATE OF SURVEY (MONTH, YEAR)

A11-1

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

A11-2

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.

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.

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

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

0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

Line Number	Character Number
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 THIS QUADRANGLE
12	
13	5 I1 AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
14	6 A20 AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR FIRST SYSTEM
15	
16	7 F6.1 NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE IN CPS PER PERCENT K FOR FIRST SYSTEM
17	
18	8 F6.1 NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE IN CPS PER PPM EQUIVALENT U
19	
20	9 F6.1 NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE IN CPS PER PPM EQUIVALENT TH
21	
22	10 I6 BLANK FIELD (999999)
23	11 F6.3 4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL PLACES IN SECONDS FOR FIRST SYSTEM
24	
25	12 F6.3 2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL PLACES IN SECONDS FOR FIRST SYSTEM
26	
27	13 I3 NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST AERIAL SYSTEM
28	
29	14 I3 NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST AERIAL SYSTEM
30	
31	15-24 (SAME) REPEAT OF ITEMS 5-14 FOR SECOND AERIAL SYSTEM
32	* * *
33	* * *
34	* * *
35	
36	85-94 (SAME) REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
37	
38	95 I3 NUMBER OF FLIGHT LINES ON THIS TAPE
39	
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 COLLECTED
43	
44	99-101 I4,I6,I3 REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS TAPE
45	
46	* * *
47	* * *
48	* * *
49	390-392 I4,I6,I3 REPEAT OF ITEMS 96-98 FOR 99TH FLIGHT LINE ON THIS TAPE
50	
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 Number	Character Number		
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

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 Number	Character Number
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 THIS QUADRANGLE
12	5 I1 AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
13	6 A20 AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR FIRST SYSTEM
14	7 F6.1 NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE IN CPS PER PERCENT K
15	8 F6.1 NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE IN CPS PER PPM EQUIVALENT U
16	9 F6.1 NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE IN CPS PER PPM EQUIVALENT TH
17	10 I6 BLANK FIELD (999999)
18	11 F6.3 4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL PLACES IN SECONDS FOR FIRST SYSTEM
19	12 F6.3 2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL PLACES IN SECONDS FOR FIRST SYSTEM

Line Number	Character Number
30	13 I3 NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST AERIAL SYSTEM
31	
32	14 I3 NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST AERIAL SYSTEM
33	
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 COLLECTED
43	
44	99-101 I4,I6,I3 REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS TAPE
45	
46	* * *
47	* * *
48	* * *
49	390-392 I4,I6,I3 REPEAT OF ITEMS 96-98 FOR 99TH FLIGHT LINE ON THIS TAPE
50	
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 TO ONE DECIMAL PLACE IN GAMMAS
63	
64	9 A8 SURFACE GEOLOGIC MAP UNIT CODE
65	10 I5 QUALITY FLAG CODES
66	11 F6.1 AVERAGED CONCENTRATION OF TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE IN PERCENT K
67	
68	12 F4.1 UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL PLACE IN PERCENT K
69	
70	13 F5.1 POTASSIUM STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
71	
72	14 F6.1 AVERAGED CONCENTRATION OF TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
73	
74	15 F4.1 UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
75	
76	16 F5.1 URANIUM STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
77	
78	17 F6.1 AVERAGED CONCENTRATION OF TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
79	
80	18 F4.1 UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
81	

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

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	1234567890123456789012345678901234567890123456789012
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 QUADRANGLE
12		
13		
14		FORMAT FOR STATISTICAL ANALYSIS SUMMARY DATA RECORD (THIRD THRU LAST BLOCK)
15		
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 UNIT
21		
22	4	F6.1 POTASSIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN PERCENT K
23		
24	5	F6.1 POTASSIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PERCENT K
25		
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 IN PPM EQUIVALENT U
29		
30	9	F6.1 URANIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
31		
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 PPM EQUIVALENT TH
35		
36	13	F6.1 THORIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
37		

Line Number	Character Number	1234567890123456789012345678901234567890123456789012
38	14	A3 THORIUM CONCENTRATION DISTRIBUTION CODE
39	15	I6 NUMBER OF URANIUM-TO-THORIUM RATIO RECORDS COMPUTED FOR GEOLOGIC UNIT
40		
41	16	F6.1 URANIUM-TO-THORIUM RATIO MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
42		
43	17	F6.1 URANIUM-TO-THORIUM RATIO STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
44		
45		
46	18	A3 URANIUM-TO-THORIUM RATIO DISTRIBUTION CODE
47	19	I6 NUMBER OF URANIUM-TO-POTASSIUM RATIO RECORDS COMPUTED FOR GEOLOGIC UNIT
48		
49	20	F6.1 URANIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
50		
51	21	F6.1 URANIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
52		
53	22	A3 URANIUM-TO-POTASSIUM RATIO DISTRIBUTION CODE
54	23	I6 NUMBER OF THORIUM-TO-POTASSIUM RATIO RECORDS COMPUTED FOR GEOLOGIC UNIT
55		
56	24	F6.1 THORIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
57		
58	25	F6.1 THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
59		
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	1234567890123456789012345678901234567890123456789012
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 COLLECTED
15		
16	8	F8.4 LATITUDE OF GROUND BASE STATION TO FOUR DECIMAL PLACES IN DEGREES FOR FIRST FLIGHT LINE
17		
18	9	F8.4 LONGITUDE OF GROUND BASE STATION TO FOUR DECIMAL PLACES IN DEGREES FOR FIRST FLIGHT LINE
19		
20	10-14	(SAME) REPEAT OF ITEMS 5-9 FOR SECOND FLIGHT LINE ON THIS TAPE
21		
22	*	*
23	*	*
24	*	*
25	495-499	(SAME) REPEAT OF ITEMS 5-9 FOR 99TH FLIGHT LINE ON THIS TAPE
26		
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 IN GAMMAS
41		
42	11	F7.1 RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE IN GAMMAS
43		
44	12	F7.1 DIURNAL MAGNETIC INTENSITY VARIATION TO ONE DECIMAL PLACE IN GAMMAS
45		
46	13	F7.1 MAGNETIC DEPTH-TO-BASEMENT TO ONE DECIMAL PLACE IN METERS (IF REQUIRED)
47		

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 (°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

Tl
Rank
Bi
Rank
K
Rank
Bi/Tl
Rank
Bi/K
Rank
Tl/K
Rank

DESCRIPTION

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

INC. SINGLE REC LISTING																	GEODATA INT. INC. AVERAGE REC LISTING																
N1 13-12																	N1 13-12																
1980																	1980																
MAPLINE 20																	MAPLINE 20																
HORRS																	HORRS																
MIT	AKUT	LAT	LONG	RHAG	CUS	GC	BLAIR	20	ALT	TEMP	BP	TL	BT	K	BI/TL	BI/K	TL/K	RCG	GEOUNIT	AKUT	LAT	LONG	RHAG	CUS	GC	BLAIR	20	TL RANK	BT RANK	K RANK	BI/TL RANK	BI/K RANK	TL/K RANK
0000		32.0226	104.0370	-175.6	60	1488	-0.8	552	27.1	666.8	4.3	2.5	0.9	0.58	2.90	5.00		1001	ZNA	0000	32.0226	104.0370	-175.6	60	1488	-0.8	4.3+ 1	2.5+ 3	0.9+ 0	0.58+ 1	2.90+ 2	5.00+ 0	
0011		32.0226	104.0363	-144.8	22	144	-0.8	-61	27.5	670.3	0.0	0.0	0.1	1.00	1.63	1.63		1002	ZNA	0011	32.0226	104.0363	-144.8	22	144	-0.8	0.0- 3	0.0- 3	0.1- 3	1.00+ 4	1.63+ 0	1.63- 3	
0000		32.0226	104.0357	-143.6	50	1845	-0.8	442	27.5	669.8	2.9	2.1	1.4	0.73	1.56	2.13		1003	ZNA	0000	32.0226	104.0357	-143.6	50	1845	-0.8	2.9- 1	2.1+ 2	1.4+ 3	0.73+ 2	1.56- 0	2.13- 2	
0000		32.0225	104.0350	-143.8	45	1740	-0.8	445	27.4	668.3	4.2	2.4	1.2	0.58	2.06	3.55		1004	ZNA	0000	32.0225	104.0350	-143.8	45	1740	-0.8	3.9+ 0	1.7+ 1	1.1+ 1	0.44+ 0	1.60+ 0	3.61- 1	
0000		32.0225	104.0343	-141.0	42	1657	0.0	452	27.4	670.8	5.2	0.9	1.2	0.17	0.74	4.34		1005	ZNA	0000	32.0225	104.0343	-141.0	42	1657	0.0	4.5+ 1	1.7+ 1	1.2+ 2	0.39+ 0	1.50- 0	3.87- 1	
0000		32.0225	104.0337	-143.5	57	1740	0.0	452	27.5	669.3	4.9	2.1	1.3	0.42	1.59	3.75		1006	ZNA	0000	32.0225	104.0337	-143.5	57	1740	0.0	5.0+ 1	1.9+ 1	1.2+ 2	0.39+ 0	1.56- 0	4.02- 0	
0000		32.0225	104.0330	-144.8	69	1808	0.0	456	27.4	670.3	6.9	2.0	1.2	0.29	1.73	5.95		1007	ZNA	0000	32.0225	104.0330	-144.8	69	1808	0.0	5.2+ 1	2.0+ 2	1.3+ 2	0.38+ 0	1.58+ 0	4.14- 0	
0000		32.0225	104.0323	-145.9	44	1657	0.0	461	27.4	669.8	4.3	2.5	1.2	0.58	2.05	3.54		1008	ZNA	0000	32.0225	104.0323	-145.9	44	1657	0.0	5.0+ 1	2.1+ 2	1.3+ 2	0.41+ 0	1.62+ 0	3.93- 1	
0000		32.0225	104.0317	-145.4	50	1772	0.0	463	27.7	670.3	4.3	2.0	1.5	0.46	1.36	2.95		1009	ZNA	0000	32.0225	104.0317	-145.4	50	1772	0.0	4.9+ 1	2.1+ 2	1.3+ 2	0.44+ 0	1.63+ 0	3.71- 1	
0000		32.0225	104.0310	-145.7	52	1729	0.0	466	27.5	671.3	5.0	1.9	1.4	0.38	1.36	3.55		1010	ZNA	0000	32.0225	104.0310	-145.7	52	1729	0.0	4.7+ 1	2.2+ 2	1.3+ 2	0.46+ 1	1.65+ 0	3.58- 1	
0000		32.0225	104.0304	-140.2	49	1598	0.0	466	27.3	670.3	4.8	2.3	1.1	0.48	2.03	4.20		1011	ZNA	0000	32.0225	104.0304	-140.2	49	1598	0.0	4.6+ 1	2.2+ 2	1.3+ 2	0.47+ 1	1.70+ 0	3.59- 1	
0000		32.0225	104.0297	-141.8	47	1632	0.0	466	27.4	670.8	4.2	2.3	1.3	0.55	1.76	3.21		1012	ZNA	0000	32.0225	104.0297	-141.8	47	1632	0.0	4.7+ 1	2.3+ 2	1.3+ 2	0.49+ 1	1.80+ 0	3.67- 1	
0000		32.0225	104.0290	-141.8	48	1676	0.0	466	27.4	670.8	4.1	2.6	1.4	0.64	1.89	2.97		1013	ZNA	0000	32.0225	104.0290	-141.8	48	1676	0.0	4.7+ 1	2.3+ 2	1.2+ 2	0.50+ 1	1.89+ 0	3.80- 1	
0000		32.0225	104.0284	-141.5	47	1577	0.0	467	27.4	668.3	6.3	1.7	1.1	0.27	1.60	5.93		1014	ZNA	0000	32.0225	104.0284	-141.5	47	1577	0.0	4.7+ 1	2.3+ 2	1.2+ 2	0.50+ 1	1.97+ 1	3.96- 1	
0000		32.0225	104.0277	-142.3	48	1698	0.0	463	27.3	671.8	4.6	3.7	1.2	0.80	3.00	3.74		1015	ZNA	0000	32.0225	104.0277	-142.3	48	1698	0.0	4.5+ 1	2.3+ 2	1.2+ 2	0.52+ 1	2.00+ 1	3.86- 1	
0000		32.0225	104.0270	-143.4	68	1569	0.0	462	27.4	669.8	3.6	1.2	1.0	0.33	1.14	3.50		1016	ZNA	0000	32.0225	104.0270	-143.4	68	1569	0.0	4.4+ 1	2.1+ 2	1.1+ 1	0.48+ 1	1.88+ 0	3.95- 1	
0000		32.0225	104.0264	-143.7	49	1548	0.0	457	27.3	670.3	3.5	2.4	1.1	0.70	2.20	3.15		1017	ZNA	0000	32.0225	104.0264	-143.7	49	1548	0.0	4.3+ 1	2.0+ 2	1.1+ 1	0.47+ 1	1.84+ 0	3.95- 1	
0000		32.0225	104.0257	-143.2	56	1565	0.0	454	27.4	670.3	4.3	1.5	1.1	0.34	1.34	3.94		1018	ZNA	0000	32.0225	104.0257	-143.2	56	1565	0.0	4.2+ 1	1.9+ 1	1.1+ 1	0.45+ 1	1.73+ 0	3.82- 1	
0000		32.0225	104.0250	-143.9	58	1631	0.0	450	27.4	670.8	6.3	1.5	0.9	0.24	1.56	6.64		1019	ZNA	0000	32.0225	104.0250	-143.9	58	1631	0.0	4.2+ 0	1.9+ 1	1.1+ 1	0.45+ 1	1.68+ 0	3.73- 1	
0000		32.0224	104.0244	-146.2	51	1587	0.0	456	27.2	669.8	3.2	2.5	1.2	0.78	2.02	2.59		1020	ZNA	0000	32.0224	104.0244	-146.2	51	1587	0.0	3.9+ 0	2.0+ 2	1.1+ 2	0.52+ 1	1.78+ 0	3.43- 1	
0000		32.0224	104.0237	-148.9	59	1712	0.0	449	27.4	670.3	2.8	2.0	1.4	0.71	1.45	2.03		1021	ZNA	0000	32.0224	104.0237	-148.9	59	1712	0.0	3.7+ 0	2.1+ 2	1.2+ 2	0.57+ 1	1.85+ 0	3.24- 1	
0000		32.0224	104.0230	-150.3	60	1495	0.0	447	27.4	670.8	2.7	2.1	1.0	0.78	2.03	2.61		1022	ZNA	0000	32.0224	104.0230	-150.3	60	1495	0.0	3.6+ 0	2.3+ 2	1.1+ 1	0.62+ 2	1.99+ 1	3.18- 1	
0000		32.0224	104.0224	-149.8	45	1633	0.0	440	27.4	669.8	5.2	2.6	1.0	0.50	2.56	5.13		1023	ZNA	0000	32.0224	104.0224	-149.8	45	1633	0.0	3.7+ 0	2.4+ 2	1.1+ 2	0.65+ 2	2.10+ 1	3.21- 1	
0000		32.0224	104.0217	-149.6	54	1764	0.0	438	27.3	670.8	3.6	2.7	1.1	0.75	2.40	3.18		1024	ZNA	0000	32.0224	104.0217	-149.6	54	1764	0.0	3.7+ 0	2.5+ 2	1.2+ 2	0.66+ 2	2.12+ 1	3.23- 1	
0000		32.0224	104.0210	-147.6	59	1695	0.0	434	27.3	670.3	3.2	2.1	1.2	0.64	1.71	2.65		1025	ZNA	0000	32.0224	104.0210	-147.6	59	1695	0.0	3.9+ 0	2.4+ 2	1.2+ 2	0.62+ 2	2.02+ 1	3.24- 1	
0000		32.0224	104.0204	-145.3	68	1821	0.0	432	27.4	670.3	3.9	2.9	1.3	0.74	2.18	2.95		1026	ZNA	0000	32.0224	104.0204	-145.3	68	1821	0.0	4.1+ 0	2.3+ 2	1.2+ 2	0.57+ 1	1.89+ 0	3.35- 1	
0000		32.0224	104.0197	-143.8	49	1738	0.0	429	27.4	670.8	4.2	2.5	1.2	0.60	2.07	3.46		1027	ZNA	0000	32.0224	104.0197	-143.8	49	1738	0.0	4.3+ 1	2.1+ 2	1.2+ 2	0.50+ 1	1.74+ 0	3.51- 1	
0000		32.0224	104.0190	-142.8	43	1564	7.7	424	27.4	670.3	4.8	1.1	1.3	0.23	0.84	3.61		1028	ZNA	0000	32.0224	104.0190	-142.8	43	1564	7.7	4.5+ 1	1.9+ 1	1.2+ 2	0.41+ 0	1.57- 0	3.84- 1	
0000		32.0224	104.0184	-142.1	49	1480	7.7	422	27.4	671.3	5.7	1.6	1.1	0.27	1.42	5.26		1029	ZNA	0000	32.0224	104.0184	-142.1	49	1480	7.7	4.7+ 1	1.7+ 1	1.1+ 1	0.37+ 0	1.50- 0	4.09- 0	
0000		32.0224	104.0177	-141.8	44	1453	7.7	417	27.5	669.8	4.1	1.8	1.0	0.46	1.93	4.23		1030	ZNA	0000	32.0224	104.0177	-141.8	44	1453	7.7	4.6+ 1	1.6+ 1	1.1+ 1	0.36+ 0	1.49- 0	4.20- 0	
0000		32.0224	104.0170	-142.1	48	1458	7.7	402	27.5	670.8	4.8	1.6	1.0	0.34	1.64	4.81		1031	ZNA	0000	32.0224	104.0170	-142.1	48	1458	7.7	4.4+ 1	1.7+ 1	1.0+ 1	0.38+ 0	1.58+ 0	4.20- 0	
0000		32.0224	104.0164	-141.8	54	1409	7.7	395	27.5	672.3

Line Printer Contour

ATV-2 Line Printer Contour

CONTOUR INTERVAL= 1.00
BILLY, TEXAS

AC 0.30	0.60000 0.90	1.20000 1.50	1.80000 2.10	2.40000 2.70	3.00000 3.30
	3.60000 3.90	4.20000 4.50	4.80000 5.10	5.40000 5.70	6.00000 6.30
	6.60000 6.90	7.20000 7.50	7.80000 8.10	8.40000 8.70	9.00000 9.30
	9.60000 9.90

GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

A < 0.20 0.40 < 0.60 0.80 < 1.00 1.20 < 1.40 1.60 < 1.80 2.00 < 2.20
2.40 < 2.60

ATV-4 Line Printer Contour

GEODATA INTERNATIONAL, Inc.
DALLAS, TEXAS

AS 0.050	0.100<K< 0.150	0.200<K< 0.250	0.300<K< 0.350	0.400<K< 0.450	0.500<K< 0.550
0.600<K< 0.650	0.700<K< 0.750	0.800<K< 0.850	0.900<K< 0.950	1.000<K< 1.050	1.100<K< 1.150
1.200<K< 1.250	1.300<K< 1.350	1.400<K< 1.450	1.500<K< 1.550	1.600<K< 1.650	1.700<K< 1.750
1.800<K< 1.850	1.900<K< 1.950	2.000<K< 2.050	2.100<K< 2.150	2.200<K< 2.250	2.300<K< 2.350
2.400<K< 2.450	2.500<K< 2.550	2.600<K< 2.650	2.700<K< 2.750	2.800<K< 2.850	2.900<K< 2.950

AIV-5 Line Printer Contour

SPUDATA INTERNATIONAL, INC.
DALLAS, TEXAS

A < 0.25	0.50 < 0.75	1.00 < 1.25	1.50 < 1.75	2.00 < 2.25	2.50 < 2.75
3.00 < 3.25	3.50 < 3.75	4.00 < 4.25	4.50 < 4.75	5.00 < 5.25	
5.50 < 5.75	6.00 < 6.25	6.50 < 6.75	7.00 < 7.25	7.50 < 7.75	
8.00 < 8.25	8.50 < 8.75	9.00 < 9.25

GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

K 0.35

0.70K 1.05

1.40K 1.75

2.10K 2.45

2.80K 3.15

3.50K 3.85

4.20K 4.55

4.90K 5.25

5.60K 5.95

ALV-7 Line Printer Contour

GEODATA INTERNATIONAL, INC.
DALLAS, TEXAS

AC -700. -650.<K -600. -550.<K -500. -450.<K -400. -350.<K -300. -250.<K -200.

-150.<K -100. -50.<K 0. 50.<K 100. 150.<K 200.

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