Airborne Gamma-Ray Spectrometer and Magnetometer Survey

Sleetmute Quadrangle
(Alaska)

Final Report
Volume I

Prepared For The Department Of Energy
Grand Junction Office
Grand Junction, Colorado 81501
Under
Bendix Field Engineering Corporation
Grand Junction Operations, Grand Junction, Colorado

Subcontract No. 79-321-L
Project No. 40-79-4179
March 1980

by
Aero Service Division
Western Geophysical Company of America
Houston, Texas 77001

AERO SERVICE
Litton

AIRBORNE GAMMA-RAY SPECTROMETER

AND

MAGNETOMETER SURVEY

SLEETMUTE QUADRANGLE

(Alaska)

FINAL REPORT

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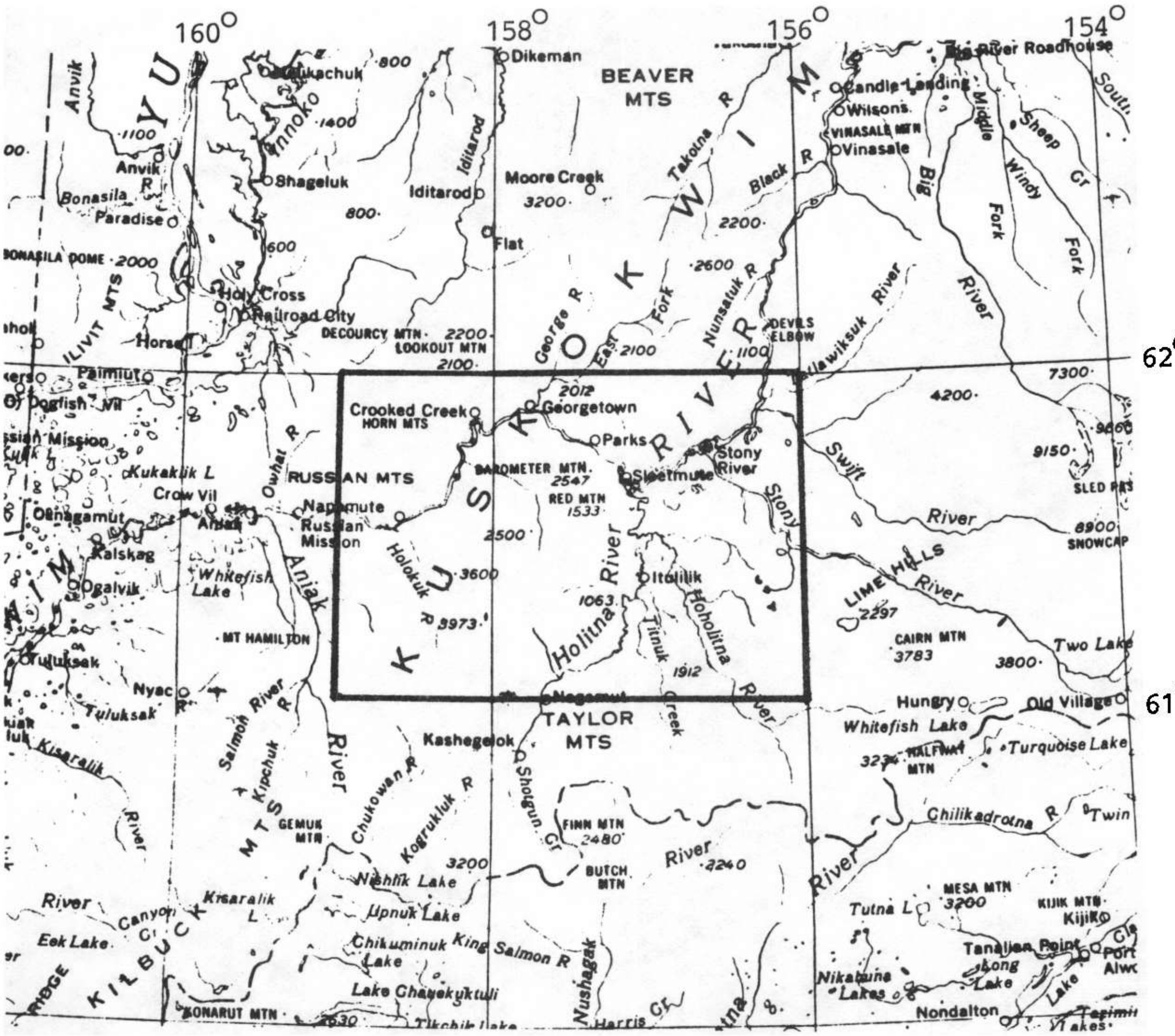

FIGURE 1

SLEETMUTE

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INTRODUCTION

During the months of July, August and September of 1979, Aero Service Division Western Geophysical Company of America conducted an airborne high sensitivity gamma-ray spectrometer and magnetometer survey over (10) ten 3° x 1° NTMS quadrangles of West-Central Alaska. This report discusses the results obtained over the Sleetmute map area.

Traverse and tie-line directions were east-west and north-south respectively. Traverse spacing was approximately 6.25 miles, while tie-lines were flown approximately 25 miles apart. A total of 13,960.5 line miles of geophysical data were acquired, compiled and interpreted during the survey, of which 1434.4 line miles are in this quadrangle.

The study was carried out on behalf of the Department of Energy under Bendix Field Engineering Corporation, Subcontract No. 79-321-L, Project No. 40-79-4179, as part of the Aerial Radiometric and Magnetic Reconnaissance Survey Program, designed to map the regional distribution of the natural radioelements for the principal rock units of the United States in support of the National Uranium Resource Evaluation (NURE) program.

The data were reduced and compiled in accordance with the technical specifications of the contract as stated in BFEC 1200-C and BFEC 1250-A. The parameters used in the processing of the radiometric data have been substantiated in a previously submitted calibration report of the Sikorsky installed airborne gamma-ray spectrometer system.

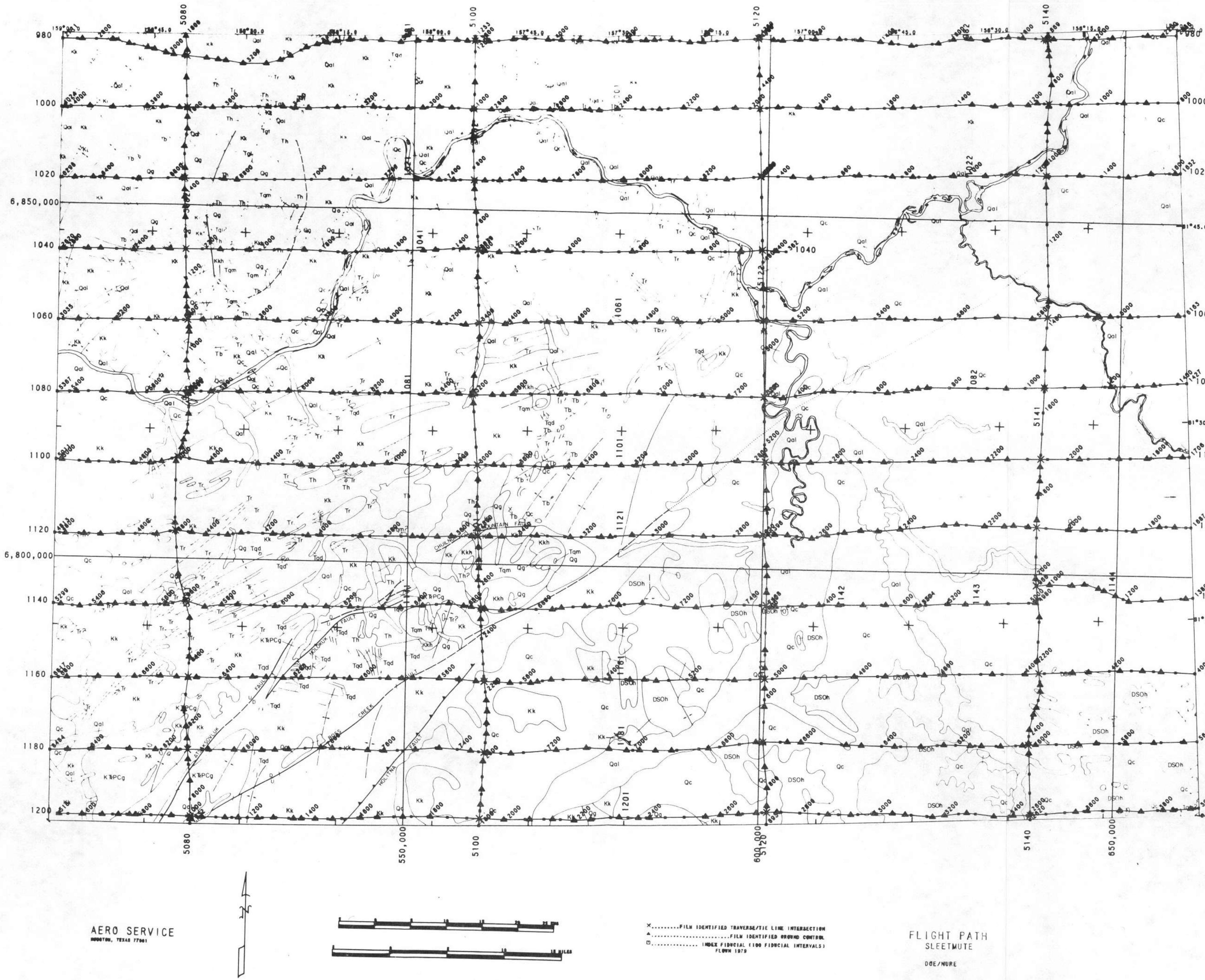


FIGURE 2

DATA ACQUISITION

Aircraft

The survey was carried out using a Sikorsky S-58T helicopter, registration N 95423, owned and operated by Carson Helicopters, Inc., Perkasie, Pennsylvania. The flight crew included a pilot (Carson), a navigator (Carson) and an electronic operator (Aero Service). Some of the more pertinent characteristics and specifications of the aircraft are listed below:

TABLE I

Aircraft	-	Sikorsky Model S-58T, Registration N 95423
Engine	-	Pratt - Whitney PT 6T Twinpack
Take off power	-	1875 Shaft HP.
Fuel Capacity	-	350 U. S. Gal.
Hourly Fuel Consumption	-	100 U. S. Gal.
Range Cruise Speed	-	300 Miles
Rate of Climb	-	1200 Feet per Min.
Service Ceiling	-	12500 Feet
Maximum Gross Weight	-	13000 Lbs.
Empty Weight	-	7200 Lbs.
Useful Load	-	5800 Lbs.
Pay Load	-	1700 Lbs.

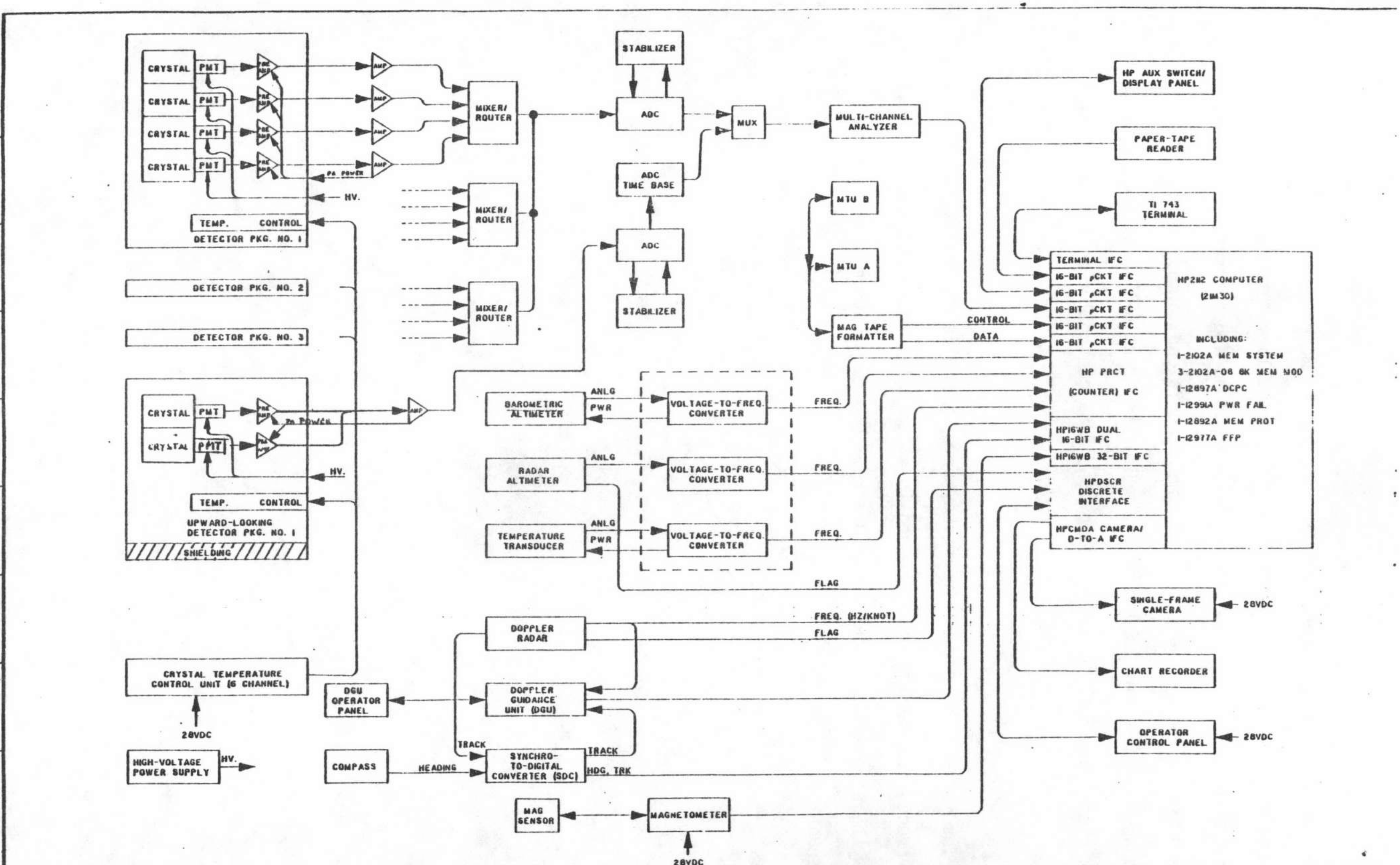
Gamma-Ray Spectrometer System

The survey was conducted using Aero Service's HISENS Airborne Gamma-ray Spectrometer 3000-F System, shown in block diagrammatic form in Figure 3, page 5.

The primary detector package consists of 13 logs of 4" x 4" x 15" of Polyscin(R), NaI(Tl), each log hermetically sealed in a stainless steel container and coupled to a high quality photo-multiplier tube. The logs are assembled in three slabs of respectively 4, 4 and 5 logs each. Each slab is enclosed in a heated and thermally stabilized container. Total volume of the primary detector is 3120 cubic inches (51.13 liters). The upward looking (2π) detector consists of two 4" x 4" x 16" logs of Polyscin(R), NaI(Tl), also hermetically sealed in a steel container and coupled to high quality photo-multiplier tubes. The two logs are enclosed as a slab in the same container that houses the slab of 5 logs of Polyscin. The upward looking crystals are mounted on top of the 4π sensor, separated by a 0.75" slab of lead shielding, in order to obtain the prescribed shielding effect of 85% @ 3000KeV.

The preamplifiers, which with the photo-multipliers provide virtually the total signal amplification, are also enclosed in the thermally stabilized packages, to ensure maximum signal stability. The output of the preamplifiers is fed into the amplifiers, whose main function is to shape the incoming pulses into a bipolar gaussian form.

The mixer-router, the 50 MHz Wilkinson ramp analog to digital converter and the multi-channel analyzer of both the primary and 2π spectrometer systems are commercially available units, supplied by Canberra Industries. The data from the two spectrometers are output to the data controller, formed by a Hewlett Packard 21 MX minicomputer system, which stores the data, formats them, outputs them on tape and compares the tape recorded data with the data stored in memory. Additional data recorded on tape are radar altitude, baro-



AERO SERVICE DIVISION
WESTERN GEOPHYSICAL
Litton HOUSTON, TEXAS 77042

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TITLE BLOCK DIAGRAM, HISENS AGRS 3000F SYSTEM

SIZE B | DRAWING NO. 230-548-002 | REV | SHEET

16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

FIGURE 3

metric pressure, atmospheric temperature, magnetometer data, real time, gamma-ray spectrometer system live-time and other ancillary data such as additional navigational data. Two tape drives were employed and automatic switching between the two occurs as each tape ends. Additional ancillary equipment includes a cathode ray tube display, a Clevite Brush 6-channel analog recorder and a 35mm frame camera, triggered by the data controller at a preset interval.

Magnetometer

The magnetic sensor used for the survey was a Geometrics G-803 proton free-precession magnetometer, housed in a fiberglass bird and towed 75 feet below the aircraft in order to assure reliable data with minimal aircraft compensation.

PRODUCTION SUMMARY

The 3° x 1° NTMS quadrangle of Sleetmute, Alaska, was surveyed as part of a subcontract covering the nine quadrangles of Norton Bay, Nulato, Ruby, Unalakleet, Ophir, Medfra, Iditarod, McGrath and Sleetmute. An extension to the same subcontract covered the reconnaissance survey of the 3° x 1° NTMS quadrangle of Kantishna River and the detailed survey of the Four Corners area, located at the four corners of the Ruby, Kantishna River, Medfra and Mt. McKinley quadrangles. The main subcontract covered the flying of a total of 11,925.7 line miles of geophysical data, of which 1434.4 miles are in the Sleetmute quadrangle. The extension subcontract covered the flying of 1346.8 line miles of reconnaissance surveying and 688 line miles of detailed survey.

The main bases of operation were, for the original subcontract, Galena, Alaska, in the Nulato quadrangle, for the northern portion of the survey, and McGrath, Alaska, in the McGrath quadrangle, for the southern portion of the survey. For the additional subcontract Manley, Alaska, in the Kantishna River Quadrangle was used as the main base of operations.

Throughout the survey extensive use was made of the many small landing strips distributed within the area. A small, twin engine fixed wing aircraft was used to ferry fuel supplies to these landing strips. These fuel caches were then subsequently used to allow refuelling stops by the helicopter.

The first production flight was made on July 12, 1979. The final production flight of the original subcontract was flown on September 12, 1979. Maps covering the survey areas of the additional subcontract were received in McGrath on September 18, 1979, on which day the helicopter was ferried to Manley, Alaska. The last production flight of the additional subcontract was flown on September 27, 1979.

Between July 12 and September 12, the end of the flying of the original subcontract, a total 67 sorties were made on 27 production days. Total flying time of the helicopter amounted to 191.6 hours. Fourteen days were lost due to aircraft repair and maintenance, mainly because of an engine failure in the beginning of the survey and a fracture of the tail rotor near the end of the survey. Inclement weather prevented production on 21 days and one (1) day of production was lost due to inadequate fuel supplies in McGrath.

For the original contract average production per hour actual flying time was 62.2 miles. An average of 441.7 line miles of data was acquired each actual production day. When counted over the entire 78 days duration of the survey, average production was 152.9 line miles per day.

The flying of the extension survey mileage was accomplished on September 27, 1979. The extension survey took a total of ten (10) production flights on four (4) days. A total of 1346.8 line miles of reconnaissance data and 688 line miles of detailed survey data were gathered in 33.4 hours of flying. Inclement weather prevented production flying during five (5) days. Average production for the extension subcontract was 60.92 line miles per hour actual flying time. Progress averaged 508.7 line miles of data per production day and 226.1 line miles over the duration of the extension survey.

Time lost due to electronic equipment repair or maintenance during both the original survey and its extension was negligeable. A complete summary of daily production for both the original survey and its extension is given in Table II, page 9.

The projected spacing for the Sleetmute quadrangle was 6.25 miles for traverse lines and 25 miles for tie lines. The specified terrain clearance for the survey was 400 feet. Figure 4 shows a histogram of the terrain clearance of the aircraft as recorded by the radar altimeter. The histogram

TABLE II

DAILY PRODUCTION SUMMARY

Sleetmute Quadrangle

DATE	BASE	ACTIVITY	FLIGHT NO.
07/12/79	Galena, Alaska	Production	2,3,4
07/13/79	Galena, Alaska	Production	5,6
07/14/79	Galena, Alaska	Aircraft engine repair	
07/15/79	Galena, Alaska	Aircraft engine repair	
07/16/79	Galena, Alaska	Aircraft engine repair	
07/17/79	Galena, Alaska	Aircraft engine repair	
07/18/79	Galena, Alaska	Aircraft engine repair	
07/19/79	Galena, Alaska	Aircraft engine repair	
07/20/79	Galena, Alaska	Aircraft engine repair	
07/21/79	Galena, Alaska	Engine test	
07/22/79	Galena, Alaska	Production	8,9
07/23/79	Galena, Alaska	Rain	
07/24/79	Galena, Alaska	Rain	
07/25/79	Galena, Alaska	Production	10,11
07/26/79	Galena, Alaska	Production	12,14,15
07/27/79	Galena, Alaska	Production	16,17
07/28/79	Galena, Alaska	Production	18
07/29/79	Galena, Alaska	Rain	
07/30/79	Galena, Alaska	Production	19
07/31/79	Galena, Alaska	Rain	
08/01/79	Galena, Alaska	Rain	
08/02/79	Galena, Alaska	Production	20
08/03/79	Galena, Alaska	Production	21,22,23,24,25
08/04/79	Galena, Alaska	Rain	
08/08/79	Galena, Alaska	Rain	
08/08/79	Galena, Alaska	Rain, ferry to McGrath	
08/08/79	McGrath, Alaska	Rain	
08/09/79	McGrath, Alaska	High wind, turbulence	
08/10/79	McGrath, Alaska	Production	27,28
08/11/79	McGrath, Alaska	Production	29,30
08/12/79	McGrath, Alaska	Production	31,32
08/13/79	McGrath, Alaska	Production	33,34,35
08/14/79	McGrath, Alaska	Rain	
08/15/79	McGrath, Alaska	Production	36,37
08/16/79	McGrath, Alaska	Rain	
08/17/79	McGrath, Alaska	Rain	
08/18/79	McGrath, Alaska	Production	38
08/19/79	McGrath, Alaska	Rain	
08/20/79	McGrath, Alaska	Rain	

Daily Production Summary
Sleetmute Quadrangle
cont'd.

DATE	BASE (S)	ACTIVITY	FLIGHT
08/21/79	McGrath, Alaska	Production	40,41,42
08/22/79	McGrath, Alaska	Production	43,44,45,46
08/23/79	McGrath, Alaska	Production	47,48,49,50
08/24/79	McGrath, Alaska	Production	52,53
08/25/79	McGrath, Alaska	Production	54,55,56
08/26/79	McGrath, Alaska	Rain	
08/27/79	McGrath, Alaska	Rain	
08/28/79	McGrath, Alaska	Rain	
08/29/79	McGrath, Alaska	Rain	
08/30/79	McGrath, Alaska	Rain	
08/31/79	McGrath, Alaska	Production	57,58,59
09/01/79	McGrath, Alaska	Tail rotor U/S	
09/02/79	McGrath, Alaska	Tail rotor U/S	
09/03/79	McGrath, Alaska	Tail rotor U/S	
09/04/79	McGrath, Alaska	Tail rotor U/S	
09/05/79	McGrath, Alaska	Tail rotor U/S	
09/06/79	McGrath, Alaska	Test flight	
09/07/79	McGrath, Alaska	Production	60,61
09/08/79	McGrath, Alaska	Production	62,63,64,65
09/09/79	McGrath, Alaska	Production	66,67
09/10/79	McGrath, Alaska	Logistics, awaiting fuel supply	
09/11/79	McGrath, Alaska	Production	68,69,70,71
09/12/79	McGrath, Alaska	Last production Original contract	72,73
09/13/79	McGrath, Alaska	Awaiting instructions	
09/14/79	McGrath, Alaska	Awaiting instructions, rain	
09/15/79	McGrath, Alaska	Awaiting instructions, rain	
09/16/79	McGrath, Alaska	Crew moved to Manley	
09/17/79	McGrath, Alaska	Awaiting maps	
09/18/79	McGrath, Alaska	Ferry to Manley	
09/19/79	Manley, Alaska	Rain	
09/20/79	Manley, Alaska	Fog, rain	
09/21/79	Manley, Alaska	Fog, rain	
09/22/79	Manley, Alaska	Production	76,77,78
09/23/79	Manley, Alaska	Production	79,80,81
09/24/79	Manley, Alaska	Fog, rain	
09/25/79	Manley, Alaska	Fog, rain	
09/26/79	Manley, Alaska	Production	83,84
09/27/79	Manley, Alaska	Production, end of project	85,86

takes into account all final samples in the Sleetmute quadrangle. The mean terrain clearance, as observed, is approximately 400 feet. The ground speed of the aircraft, as determined from the distances between consecutive samples, based on their final X-Y positions, is depicted in graphic form in the histogram of Figure 5, page 13.

AERO SERVICE
QUAD SLEETMUTE

TERRAIN CLEARANCE HISTOGRAM
JOB 9608

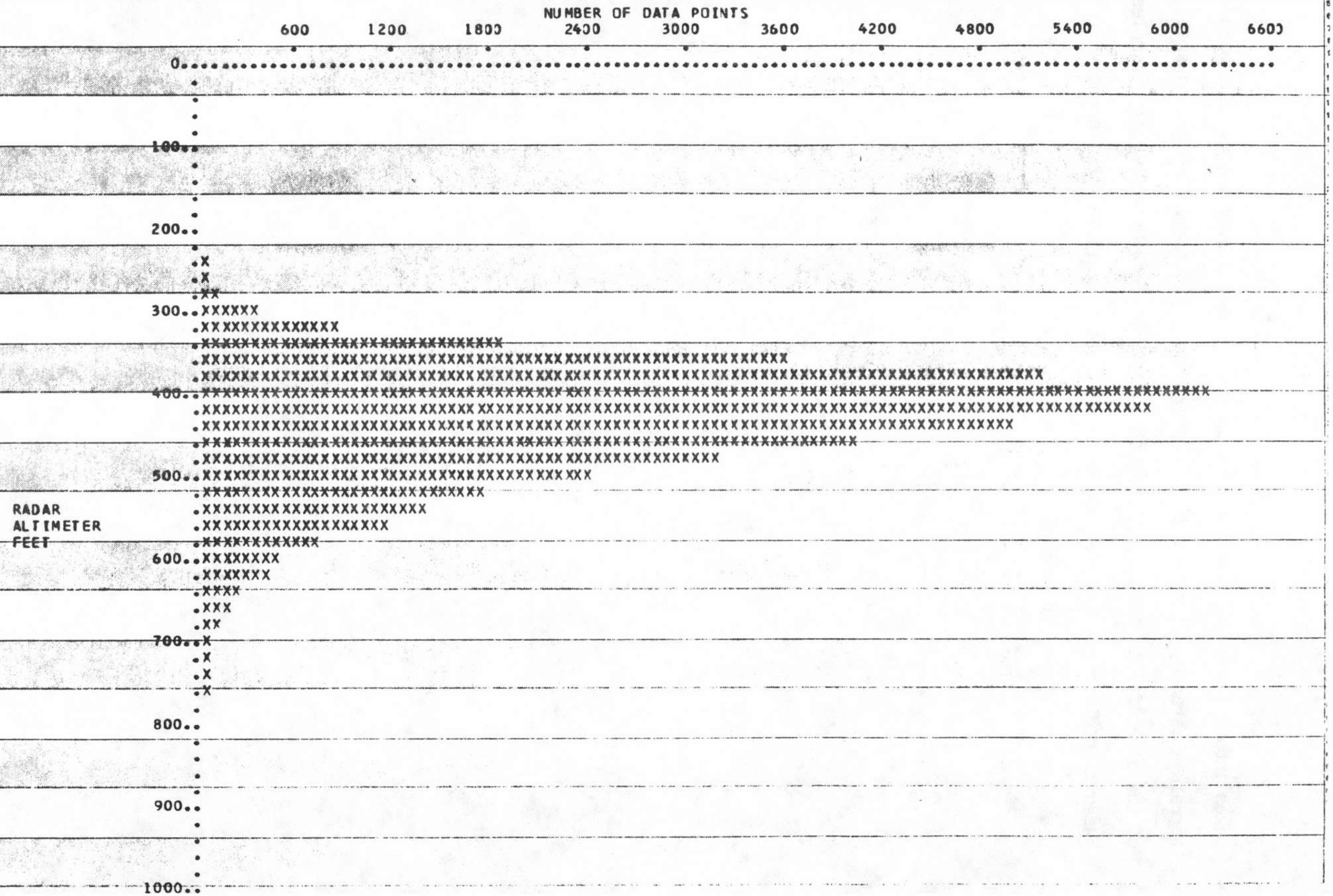

FIGURE 4

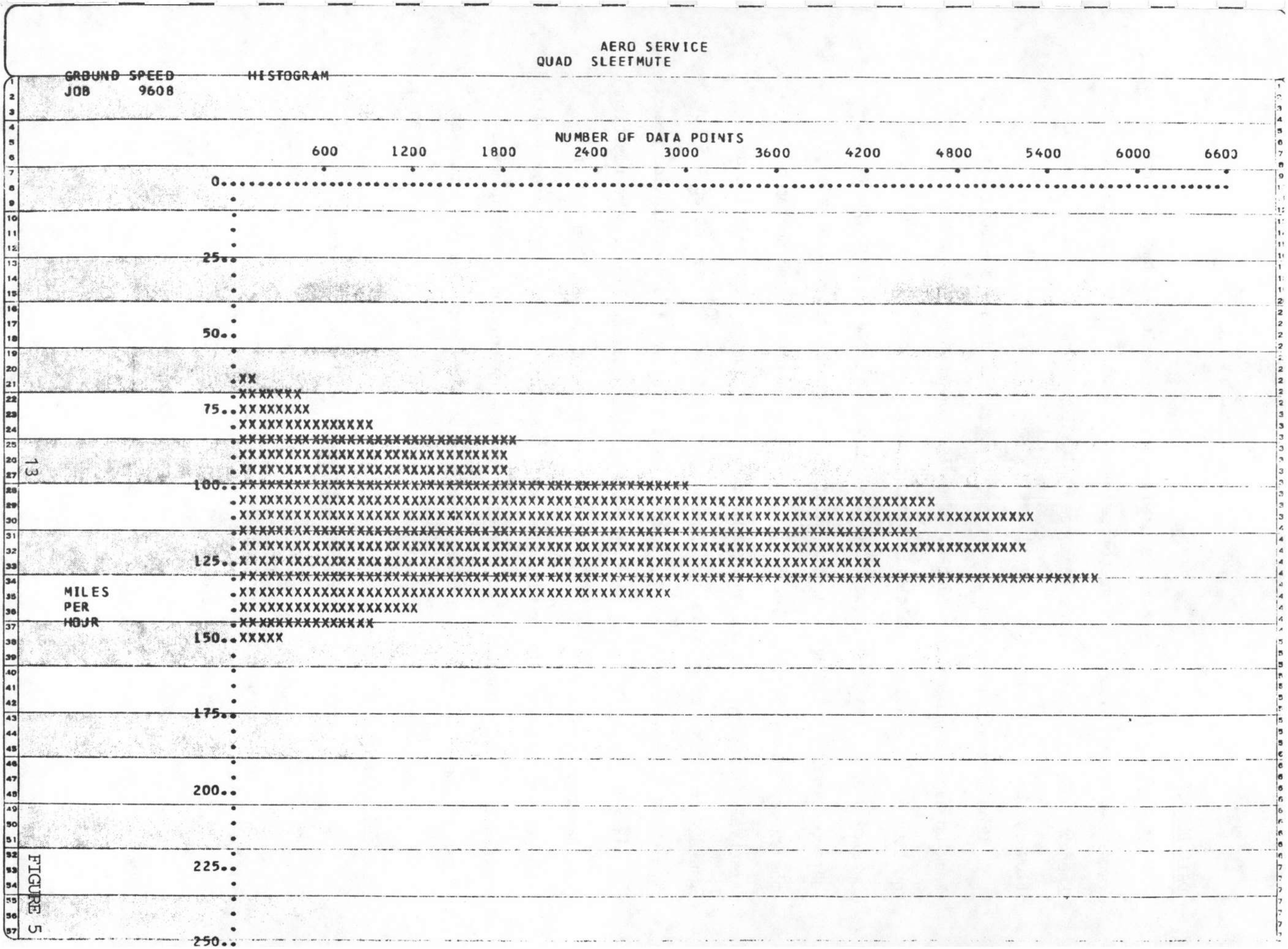
AERO SERVICE
QUAD SLEETMUTE
GROUND SPEED HISTOGRAM
JOB 9608
NUMBER OF DATA POINTS
600 1200 1800 2400 3000 3600 4200 4800 5400 6000 6600
0.
25.
50.
75.
100.
125.
150.
175.
200.
225.
250.
MILES
PER
HOUR

FIGURE 5

DATA REDUCTION

The data reduction process as used in the processing of the airborne gamma-ray spectrometer and magnetometer data obtained within the Department of Energy (DOE) National Uranium Resource Evaluation (NURE) program is shown in flow chart form in Figure 6, page 15.

Upon arrival in the Houston Office, the digital data are edited and a back-up tape is generally produced. The EDIT consists partly of a data quality check, enabling the elimination of single record spikes in any field, outside a specified preselected limit. The EDIT program further checks for data continuity and flags all data acquired at terrain clearances exceeding the survey specification. The EDIT further sums a preselected number of spectral records at the beginning and end of each survey line and fits a gaussian curve to diagnostic photopeaks, such as the Tl^{208} peak at 2614.5 KeV and the K^{40} peak at 1460 KeV for low altitude lines and the annihilation peak at 511 KeV and the K^{40} peak at 1460 KeV for high altitude lines. The position of these photopeaks is determined with an accuracy of better than 0.1 of a channel and is used to determine the exact position of the energy windows with regard to channel numbers. At the same time the calculated standard deviations of the fitted gaussian curves serve to obtain the system resolution at the photopeaks used. The window count rates are normalized for live time and are calculated as follows:

K	:	1362 KeV - 1566 KeV (Channel 114 → 130, @ 12 KeV/Channel)
U	:	1662 KeV - 1866 KeV (Channel 139 → 155, @ 12 KeV/Channel)
T	:	2406 KeV - 2926 KeV (Channel 201 → 235, @ 12 KeV/Channel)
T.C.	:	390 KeV - 2982 KeV (Channel 33 → 248, @ 12 KeV/Channel)
Cosmic	:	2994 KeV - 6138 KeV (Channel 250 → 512, @ 12 KeV/Channel)
$U_{2\pi}$	:	1662 KeV - 1866 KeV (Channel 139 → 155, @ 12 KeV/Channel)

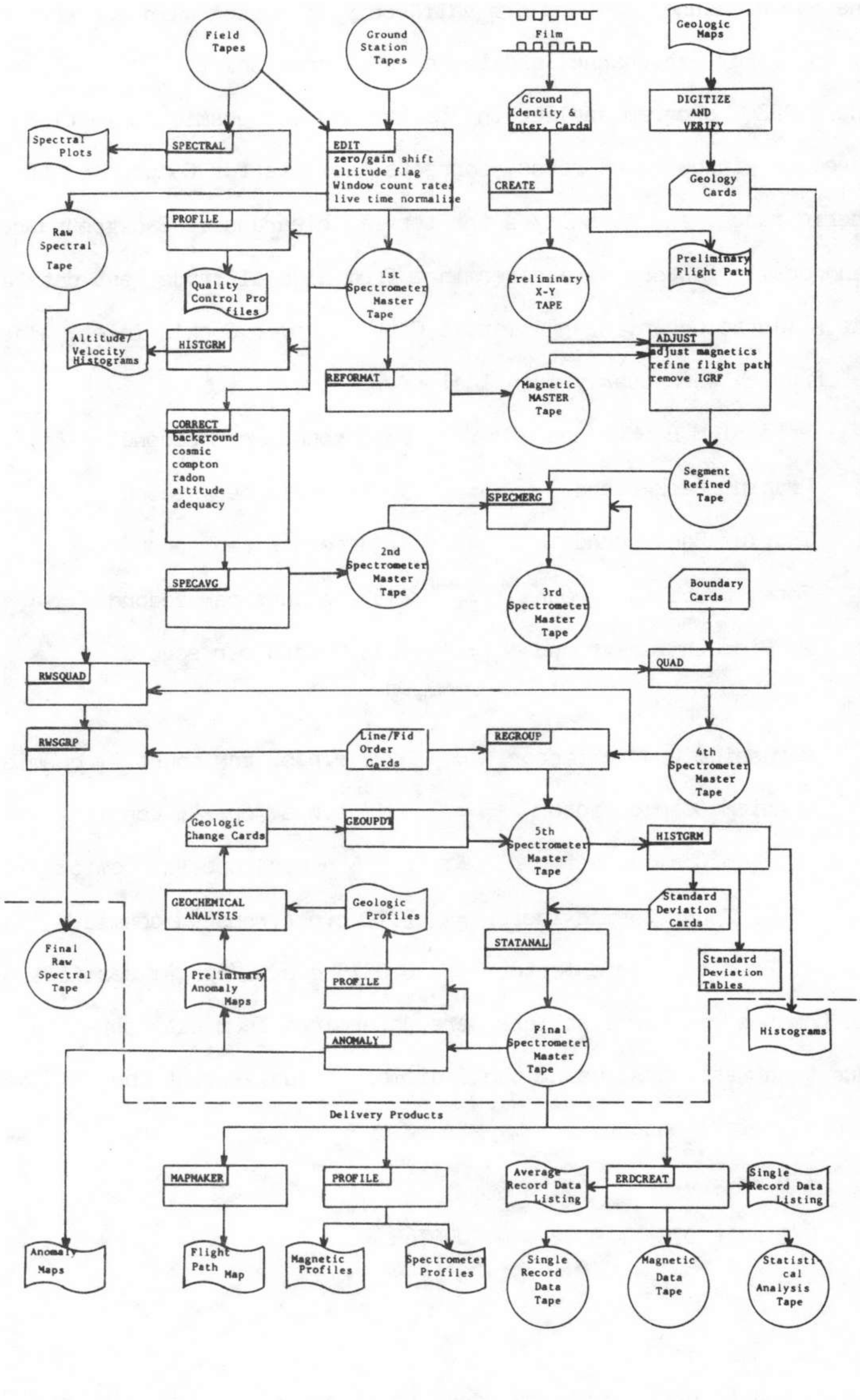
Field Tapes
Ground Station Tapes
Film
Geologic Maps
Spectral Plots
SPECTRAL
EDIT
zero/gain shift
altitude flag
Window count rates
live time normalize
Ground Identity & Inter. Cards
DIGITIZE AND VERIFY
CREATE
Geology Cards
Raw Spectral Tape
PROFILE
Quality Control Profiles
1st Spectrometer Master Tape
Preliminary X-Y TAPE
Preliminary Flight Path
Altitude/ Velocity Histograms
HISTGRM
ADJUST
adjust magnetics
refine flight path
remove IGRF
REFORMAT
Magnetic MASTER Tape
CORRECT
background
cosmic
compton
radon
altitude
adequacy
Segment Refined Tape
SPECMERG
2nd Spectrometer Master Tape
SPECAVG
3rd Spectrometer Master Tape
Boundary Cards
RWSQUAD
QUAD
RWSGRP
Line/Fid Order Cards
REGROUP
4th Spectrometer Master Tape
Geologic Change Cards
GEOUPDT
5th Spectrometer Master Tape
HISTGRM
GEOCHEMICAL ANALYSIS
Geologic Profiles
Standard Deviation Cards
STATANAL
Final Raw Spectral Tape
Preliminary Anomaly Maps
PROFILE
Standard Deviation Tables
Histograms
ANOMALY
Final Spectrometer Master Tape
Delivery Products
MAPMAKER
PROFILE
Average Record Data Listing
ERDCREAT
Single Record Data Listing
Anomaly Maps
Flight Path Map
Magnetic Profiles
Spectrometer Profiles
Single Record Data Tape
Magnetic Data Tape
Statistical Analysis Tape

FIGURE 6

The above channel numbers are valid only if system gain corresponds exactly to 12 KeV per channel and there is no zero shift.

The CORRECT program applies the background and cosmic corrections to the single record window count rates, corrects the data for Compton scatter and atmospheric radon, and normalizes the terrain clearance. Background count rates and cosmic factors were determined from high altitude test data acquired over the Atlantic Ocean, near Atlantic City and over Cook's Inlet, Alaska, the results of which were nearly identical:

Potassium Background	=	25.8 counts per second
Uranium Background	=	5.27 counts per second
Thorium Background	=	8.14 counts per second
Total Count Background	=	215.2 counts per second
2π Bismuth Background	=	1.43 Counts per second
Potassium Cosmic factor	=	0.22 c.p.s. per count 4π cosmic
Uranium Cosmic factor	=	0.17 c.p.s./cps 4π cosmic
Thorium Cosmic factor	=	0.215 c.p.s./cps 4π cosmic
Total Count Cosmic factor	=	3.77 c.p.s./cps 4π cosmic
2π Bismuth Cosmic factor	=	0.0375 c.p.s./cps 4π cosmic

The Compton scatter functions were determined from data obtained over the Grand Junction test pads, using the radiometric analysis of the bulk sample with natural water content.

$T/U = \tau = 0.07$

$U/T = \alpha = 0.35 + 0.02 + 0.000076H$

$K/T = \beta = 0.44$

$K/U = \gamma = 0.99$

The 2π and 4π uranium window count rates are related through the geometric or equivalency factor. For the present system, installed in the Sikorsky S-58T helicopter, this factor, f, = 5.75. Part of the terrestrial radiation of energy higher than 1662 KeV - the lower threshold of the uranium window - is detected in the uranium window of the upward looking detector, due to incomplete shielding, skyshine and shine-around. This shine-through/shine-around effect is assumed to be a function of both the intensity of the terrestrial uranium and thorium radiation and of the aircraft terrain clearance. From multi-altitude data acquired over the Lake Mead Dynamic Test Range the shine-through/shine-around effect was determined for each altitude level. The data provided a best fit for an exponential terrain clearance function as follows:

$$\text{shine-through/shine-around} = 0.06\ (U_{4\pi} + 0.35T_{4\pi})\,e^{-7.0\times10^{-4}H}$$

The shine-through/shine-around corrected Biair Count rate is then:

$$U_{2\pi c} = U_{2\pi} - \frac{(U_{4\pi} + 0.35T)\ 0.06 \times e^{-7.0\times10^{-4}H}}{(1-5.75 \times 0.06 \times e^{-7.0\times10^{-4}H})}$$

The shine-through/shine-around correction is applied to the $U_{2\pi}$ count rate at each single record. The single record $U_{2\pi}$ count rates are then averaged over 35 records to make them statistically compatible with the data of the primary system. The atmospheric radon correction is applied to both the $U_{4\pi}$ and the Total Count count rates. The equivalency factor for the $U_{4\pi}/U_{2\pi}$ = 5.75, for Total Count/$U_{2\pi}$ it is 80.

Within the CORRECT program the data are normalized to a common datum of 400 feet terrain clearance. An exponential formula is used, based on an air column reduced to a standard temperature and pressure of 0°C and 760mm Hg. (32°F and 29.92" Hg). The air absorption coefficients used are those derived from the multiple altitude flight over the Lake Mead Dynamic Test Range for thorium, potassium and Total Count. The air absorption factor for uranium is obtained by straight interpolation between the potassium and thorium air absorption factors. Their values are respectively:

μ_K = 2.71 x 10^{-3} per foot
μ_U = 2.55 x 10^{-3} per foot
μ_T = 2.10 x 10^{-3} per foot
μ_{TC} = 2.12 x 10^{-3} per foot

The formula used for the altitude normalization is:

$$N_{400} = N_{H.} \; \bar{e}^{\mu \left(400 - \frac{273}{273+t} \cdot \frac{P}{29.92} \cdot H\right)}$$

Where N_{400}, N_H are respectively the count rates at 400 feet and at altitude H, μ is air absorption factor, t is temperature in degrees Celsius and P is barometric pressure in inches Hg.

The last operation in the CORRECT program is the determination of statistical adequacy of the data. The criteria for adequacy of the data are based on the work of Lloyd A. Currie (op.cit.). A critical level is recognized, below which all observations made fail to detect a signal, i.e. 95% of all measurements fall within the "normal" distribution of "noise". The detection level is similarly defined as the level above which 95% of the measurements made fall within the normal Poisson distribution of "signal". Currie's critical level has been adopted as the count rate level below which data are inadequate. Data with count rates above the critical level but below the detection level are considered marginal. Above the detection level data are considered adequate. For the single record data the formulas are then:

Count Rate < 2.33 (Sum Corrections $)^{1/2}$: data inadequate

2.33 (Sum Corrections:$)^{1/2}$ Count Rate <2.71 + 4.65 (Sum Corrections$)^{1/2}$: data marginal

Count Rate > 2.71 + 4.65 (Sum Corrections$)^{1/2}$: data adequate

No ratios have been calculated involving inadequate data in either numerator or denominator. Ratios have been calculated when the data in the numerator are marginal, provided the data in the denominator are adequate.

The thorium, uranium and potassium data are subsequently averaged over 9 records in the SPECAVG program. The output is a spectrometer master tape containing both averaged and single record data.

Parallel with the radiometric data reduction process, the magnetic data are edited and processed. Using the recovered film intersections and the established ground identities, preliminary flight paths are prepared. The flight path is refined in the magnetic adjustment program until an accurate final flight path has been obtained. The reduced spectrometer data are then merged with the final X-Y position of the data points, the reduced magnetic data and the digitized geology, and a master tape is produced with data that pertain to each 3° x 1° NTMS quadrangle only. The REGROUP program then eliminates all duplicate line segments, orders the remaining line segments and renumbers the fiducials on the flight lines.

The following processing steps are STATANAL and HISTGRM. HISTGRM groups the radiometric data by geological cell units, determines the distribution of the data as normal or lognormal, calculates the mean (for normally distributed data) or the mode (for lognormal distributions) as well as the standard deviations. The results from HISTGRM are used in the STATANAL program, which calculates the signed standard deviation from the mean for each averaged sample for each of the six radiometric parameters. Its output is the Final Spectrometer Master Tape, from which the anomaly maps, the statistical analysis tape, the averaged record and single record reduced data tapes and listings, the flight path maps and the radiometric and magnetic profiles are produced.

DATA PRESENTATION

General

The final data are presented in four different forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomaly maps, flight path maps, and computer printer maps.

The histograms and the multiparameter profiles are presented with the anomaly maps and flight path map in a separate bound volume. Complete data listings of both the reduced single record and the reduced averaged record data are found in the back of this report. The format of the printout of the microfiches and the format of the magnetic tape is in accordance with the specifications of the BFEC 1200-C and is described in appendices A through N of this report.

Radiometric Multiple-Parameter Stacked Profiles

The radiometric profiles have been prepared at the horizontal scales of 1:250,000 and 1:500,000 on an automated flatbed plotter. Displayed are from top to bottom: total magnetic intensity, IGRF removed, in gammas; radar altimeter, in feet; ratio of eT concentration in ppm/potassium concentration in %; ratio of eU/K; eU/eT ratio, atmospheric radon (BIAC) in counts per second, equivalenced to the 4π count rate; apparent concentration of terrestrial eT in ppm, apparent concentration of terrestrial eU in ppm; apparent concentration of potassium in %; "Total Count" count rate. Flags are indicated, where needed, below the base line of the corresponding parameter. A short flag indicates marginal data, including terrain clearances between 700 and 1000 feet, while a long flag indicates inadequate data. Fiducial markers are plotted every 200 records, along the top of the profile, every 10 records along the bottom.

Geologic formations are shown on the bottom of the radiometric and magnetic multiple-parameter stacked profiles below the fiducial markers. Six tiers of formation identifiers along with short markers are used to indicate changes along the profile with the base of the identifier letters aligned with the corresponding marker. The first identifier found on the westernmost end of the profile applies to the start of the line and this formation continues until the next marker is encountered. Subsequent changes to the geology are similiarily indicated along the profile.

Magnetic and Ancillary Parameter Stacked Profiles

The magnetic profiles have also been plotted at scales of 1:250,000 and 1:500,000 on an automated flatbed plotter. The plotting sequence of the profiles is, from top to bottom: barometric pressure at aircraft altitude in inches Hg; atmospheric ambient temperature in degrees Celsius, terrain clearance in feet; magnetic variations at base station, in ¼ γ less a 50,000 γ bias; total magnetic intensity, IGRF removed, in gammas. Fiducial markers are again plotted every 200 records along the top of the profiles, every 10 records along the bottom.

Histograms

Histograms have been prepared for the six radiometric parameters for each geologic cell unit of the NTMS quadrangle area. The horizontal scale of the plots is constant for each of the parameters. Frequency grouping has generally been done in 100 groups per full scale, although in some cases more groups may have been used for better definition. In all cases the vertical scale was normalized to the number of samples observed in the group with the highest sample frequency.

For each histogram the frequency distribution type (normal or lognormal) is listed, as well as the mean (or mode in case of lognormal distribution) and the signed standard deviations. Note that for both the normal and lognormal distribution curves the standard deviation is given in terms of the parameter value (K, eU, eT, eU/K, eU/eT and eT/K). The actual standard deviation is obtained by subtracting the mean parameter value from the +1 standard deviation figure in case of a normal distribution, by dividing the mode value into the +1 standard deviation figure in case of a lognormal distribution. In case of lognormal distribution curves the standard deviation is thus a multiplication factor.

Each histogram further lists the total number of samples observed in the geologic unit and the number of statistically adequate/marginal data samples in each parameter plot.

Anomaly Maps

The anomaly maps have been prepared at scales of 1:250,000 and 1:500,000 on an automated flatbed plotter. The fiducial numbers along the flight lines match those of the corresponding profiles. Positive signed deviations of the mean are indicated by a plus sign to the north or west of the flight lines, while negative signed deviations are indicated by a minus, plotted to the south or east of the line. The number of pluses or minuses corresponds with the levels of standard deviation from the mean. To avoid crowding standard deviation signs are calculated and plotted for every fifth sample only.

Computer Printer Maps

Computer printer plots are produced for the total field and the six radiometric channels. Upper and lower limits were chosen based on the minimum and maximum values of the gridded data. Ten intervals are represented by the contour values 0 to 9. A minus (-) or a plus (+) sign represents those values less than the lower limit or those values higher than the upper limit.

The interval for each integer contour is further divided into two groups. For those values less than .5, the contour is printed; e.g. for values 4.0 to 4.5, the value 4 is printed, while values of 4.6 through 4.9 are left blank.

GEOLOGY

Introduction

The Sleetmute quadrangle is located in the southwestern part of Alaska. It is bounded by latitudes 61°00' and 62°00' north and longitudes 156°00' and 159°00' west. The Kuskokwim River flows westward across the northern half of the map sheet and its tributary, the Holitna River, flows northward across the east-central part of the sheet. Broad marshy areas are present in the lowlands flanking the river systems, especially in the east.

Mountain ranges, generally oriented northeast-southwest, are present in the west. These features have peaks on the order of three thousand feet above sea level, with relief of two thousand to two thousand five hundred feet above the adjacent lowland areas. The mountains are collectively named the Kuskokwim Mountains.

The Sleetmute quadrangle geology has been compiled by Amuedo and Ivey, Consulting Geologists, from pre-existing U. S. Geological Survey maps and publications, supplemented by a study of Landsat imagery.

Stratigraphy

The rock units recognized on the Sleetmute quadrangle include sediments ranging in age from the lower Paleozoic to the Quaternary. Igneous rocks are present, both intrusive and extrusive in nature, upper Cretaceous to Miocene in age. East and south of the Kuskokwim and Holitna River valleys the bulk of the terrain is covered with a veneer of Quaternary alluvial and colluvial deposits. The area masked by these alluvial/colluvial materials comprises about half of the quadrangle.

The lowland areas of the Sleetmute quadrangle are covered with vegetation, presumably forests; upland areas in the Kuskokwim Mountains are relatively barren.

The following brief description of the rock units mapped on the quadrangle is subdivided by rock class (sedimentary and metasedimentary, intrusive igneous and extrusive igneous) and within each class they are arranged chronologically, beginning with the oldest.

Sedimentary (and Metasedimentary) Rocks

Holitna Group (DSOh)

The Holitna group consists of partly dolomitic limestone, chiefly massive but relatively thin bedded in the upper zones. It includes small reeflike deposits and locally interformational conglomerates and breccias. Its age is indeterminate, ranging through the Ordovician, Silurian and Devonian.

Gemuk Group (KTRPCg)

Chiefly siltstone, interbedded with lesser amounts of chert and volcanic rock, and minor amounts of limestone, graywacke and breccia. The Gemuk group ranges through the Mississippian, Pennsylvanian, Permian, Triassic and Cretaceous.

Kuskokwim Group (Kk and Kkh)

Kk includes interbedded graywacke and shale, intraformational breccia and conglomerate, and local zones of basal breccia and conglomerate. Kkh, the metasedimentary facet, consists of hornfels. It occurs in contact metamorphic zones adjacent to bodies of igneous rock. Its age is Cretaceous.

Glacial deposits (Qg)

Pleistocene morainal till and outwash gravel.

Colluvial deposits (Qc)

Sand, silt and gravel of older terraces and fans, Pleistocene in age.

Alluvial deposits (Qal)

Sand, silt and gravel of present drainage, including marsh deposits.

Extrusive Igneous Rocks

Iditarod Basalt (Ki)

Basalt flows underlain by thin sedimentary breccia; may include some basalt sills. Cretaceous in age.

Getmuna Rhyolite Group (Tgl and Tgt)

Rhyolite lava beds (Tgl) and rhyolite tuff (Tgt). Tertiary in age.

Holokuk Basalt

Basalt flows and interbedded basaltic detritus. Tertiary in age.

Intrusive Igneous Rocks

Albite Rhyolite (Tr)

Rhyolite sheets, dikes and sills. Large bodies are porphyritic and small bodies are non-porphyritic. Eocene in age.

Basalt (Tb)

Basaltic dikes and sills, some of which are columnar in structure. Tertiary in age.

Quartz Diabase (Tqd)

Dikes, sills and small stock-like bodies of quartz diabase and related rocks, which range from basalt to granodiorite. Tertiary in age.

Quartz Monzonite (Tqm)

Stocks, chiefly including quartz monzonite but ranging in composition from granodiorite to granite. Minor facies include basalt, quartz diabase, granite pegmatite and aplite. Tertiary in age.

Structure

The quadrangle is located in the central part of a major structural depression called the Kusokwim Basin. Within this area the regional geologic strike is north 60° east-south 60° west. The dominant feature is a system of faults traversing the center of the quadrangle, from the southwest corner to the northeast corner. The southwestern half of this rupture is exposed and is named the Boss Creek Fault. The northeastern half is concealed beneath the Quaternary alluvial and colluvial deposits and its existence is inferred. On the smaller scale Geological Highway Map of Alaska, this fault system is designated the Farewell Fault. Northwest of this fault system, synclinal and anticlinal structures are exposed and well defined, striking in conformity to the regional geologic trend. Most of the exposed bedrock consists of Kuskokwim group graywackes and shales (Kk). This part of the region is extensively intruded by igneous rocks, principally the Eocene albite rhyolite (Tr). Two large, complex igneous masses of upper Tertiary quartz monzonite and basalt (Tqm and Tb) are exposed, one in the northwest underlying the Horn Mountains, and the other in the south-center underlying the Chuilnuk and Kiokluk Mountains.

Southeast of the major fault system, the terrain is generally masked by a veneer of Quaternary alluvial and colluvial deposits (Qal and Qc). However, there are extensive exposures of the lower Paleozoic Holitna group (DSOh). A broad northwest-southeast striking anticlinal axis is interpreted in the Paleozoic section. The presence of lower Paleozoic bedrock south of the fault system in contrast to Cretaceous bedrock north of it suggests that the south-eastern flank of the fault has been uplifted relative to the northwestern flank.

Economic Geology

No mineral deposits or prospects are currently reported in the area of the Sleetmute quadrangle. It is possible that the contact metamorphic zones in the Kuskokwim hornfels (Kkh) adjacent to the quartz monzonite intrusive plugs of the Horn, Chuilnuk and Kiokluk Mountains are sites of mineralization, particularly along faults associated with the intrusive bodies.

INTERPRETATION

General

The airborne gamma ray spectrometer survey is conducted as part of the Department of Energy's National Uranium Resources Evaluation (NURE) program. The primary purpose of the survey is regional resource evaluation rather than the recognition of discrete local anomalies. The interpretation of the radiometric data is directed towards determining zones of possible depletion of uranium minerals which may have served as possible uranium sources, outlining areas of regional enrichment in uranium and indicating the geological formations which are most likely to be mineralized within a potential uranium province.

The areas of possible uranium depletion/enrichment are outlined with the aid of the anomaly maps. Enrichment or depletion on a regional scale is assumed to have taken place if the U/T and U/K ratio values remain higher/lower than at least one standard deviation above/below the mean for the distance of at least a mile, provided the K, U, and T count rates are at the same time not less than one standard deviation below the mean. One mile equals approximately thirty-five samples.

The probability of a geologic rock unit being mineralized by a given element may be estimated from the dispersion of the geochemical distribution of that element within the formation. The narrower the distribution curve (i.e., the smaller the ratio of the standard deviation over the mean) the less likely it is that an extremely high concentration of that element is present within that formation, and vice versa.

Recognition of the prospective aspects of a formation and of the presence of a regional geochemical anomaly is influenced greatly by the selection of the appropriate geological cell units used in the correlation of the radiometric and geologic data. The radiometric parameters used in this report are concentrations in parts per million of equivalent uranium and equivalent thorium, in percent potassium, and their comparitive ratios. The radiometric count rates of the helicopter-borne A. G. R. S. (Airborne Gamma Ray Spectrometer) system were calibrated at the Lake Mead Dynamic Test Range against sources of known concentrations of potassium, uranium and thorium. The sensitivities of the A. G. R. S. system, normalized to four hundred feet terrain clearance at standard temperature and pressure are:

Radioactive element	Count Rate	Concentration
Potassium	95.26 c.p.s.	1.0 % K
Uranium	9.92 c.p.s	1 ppm eU
Thorium	6.26 c.p.s.	1 ppm eT

Geochemical Analysis

Twelve of the stratigraphic units mapped on the Sleetmute quadrangle were surveyed sufficiently to permit examination of their gamma radiation characteristics from a statistical standpoint. Of these, the sedimentary rocks display well defined histogram peaks and narrow count distribution curves, suggesting relatively homogeneous compositions and decreased likelihood of anomalous concentrations of radioactive minerals. These formations include the Holitna Group (DSOh), the Kuskokwim Group graywackes and shales (Kk), and the Quaternary alluvial material (Qal). The latter formation however, shows indications of possible thorium enrichment in the northeast. The Pleistocene colluvial deposits (Qc) and glacial deposits (Qg) display dual peaks in their intiial histogram distributions, attributable to two different formation conditions in their exposure. Separation into "wet" and "dry" phases, based on their surface distribution with respect to swampy areas and upland dry areas resolves the dual peaking, with lower count concentrations in the moisture prone areas.

The Kuskokwim Group hornfels (Kkh) is characterized by irregular histogram distributions in all three spectral windows. This is consistent with a variably metamorphosed unit, presumably subject to secondary mineralization.

The remaining rock units (igneous intrusive and extrusive rocks) generally display less regular count distributions. The Holokuk basalt (Th) histograms indicate the presence of two poorly defined concentrations on all three spectral channels, suggesting that two distinct basaltic types comprise the formation. The Getmuna rhyolite tuff (Tgt) displays narrow, well defined count distributions but the rock unit is crossed for only about two miles on Traverse 1000 (fiducials 1360-1440) and this encounter provides an inadequate sample. The associated Getmuna rhyolite was not traversed.

Consistent with their general compositions the mafic igneous rocks, the Iditarod and Holokuk basalts (Ki and Th), are characterized by lower count rates on all channels in comparison with the relatively felsic rocks such as the Albite rhyolite (Tr) and the Quartz monzonite and diabase (Tqm and Tqd) bodies.

Anomaly Map Analysis

The most notable regional feature on the uranium and thorium maps is a continuous belt of relatively strong gamma radiation in the southwest, striking northeast-southwest and corresponding in location with an area of exposure of Kuskokwim graywackes and shales (Kk) extensively intruded by dikes and stocks of Eocene albite rhyolite (Tr) in the Buckstock Mountains. The zone of increased level of radioactivity is in alignment with the regional geologic

LEGEND OF **TOTAL FIELD GAMMAS** MAP

CONTOUR VALUE	LOWER LIMIT	UPPER LIMIT
-		55175.0
0	55175.0	55200.0
1	55200.0	55225.0
2	55225.0	55250.0
3	55250.0	55275.0
4	55275.0	55300.0
5	55300.0	55325.0
6	55325.0	55350.0
7	55350.0	55375.0
8	55375.0	55400.0
9	55400.0	55425.0
+	55425.0	

ALASKA SLEETMUTE TOTAL FIELD GRID FILE PRINT

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Y4= 6878552.0

X3= 662560.0
Y3= 6878552.0

X1= 500000.0
Y1= 6760000.0

X2= 662560.0
Y2= 6760000.0

FIGURE 7

LEGEND TO POT AVGE MAP PCT

CONTOUR VALUE	LOWER LIMIT	UPPER LIMIT
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0	0.2	0.4
1	0.4	0.6
2	0.6	0.8
3	0.8	1.0
4	1.0	1.2
5	1.2	1.4
6	1.4	1.6
7	1.6	1.8
8	1.8	2.0
9	2.0	2.2
+	2.2	

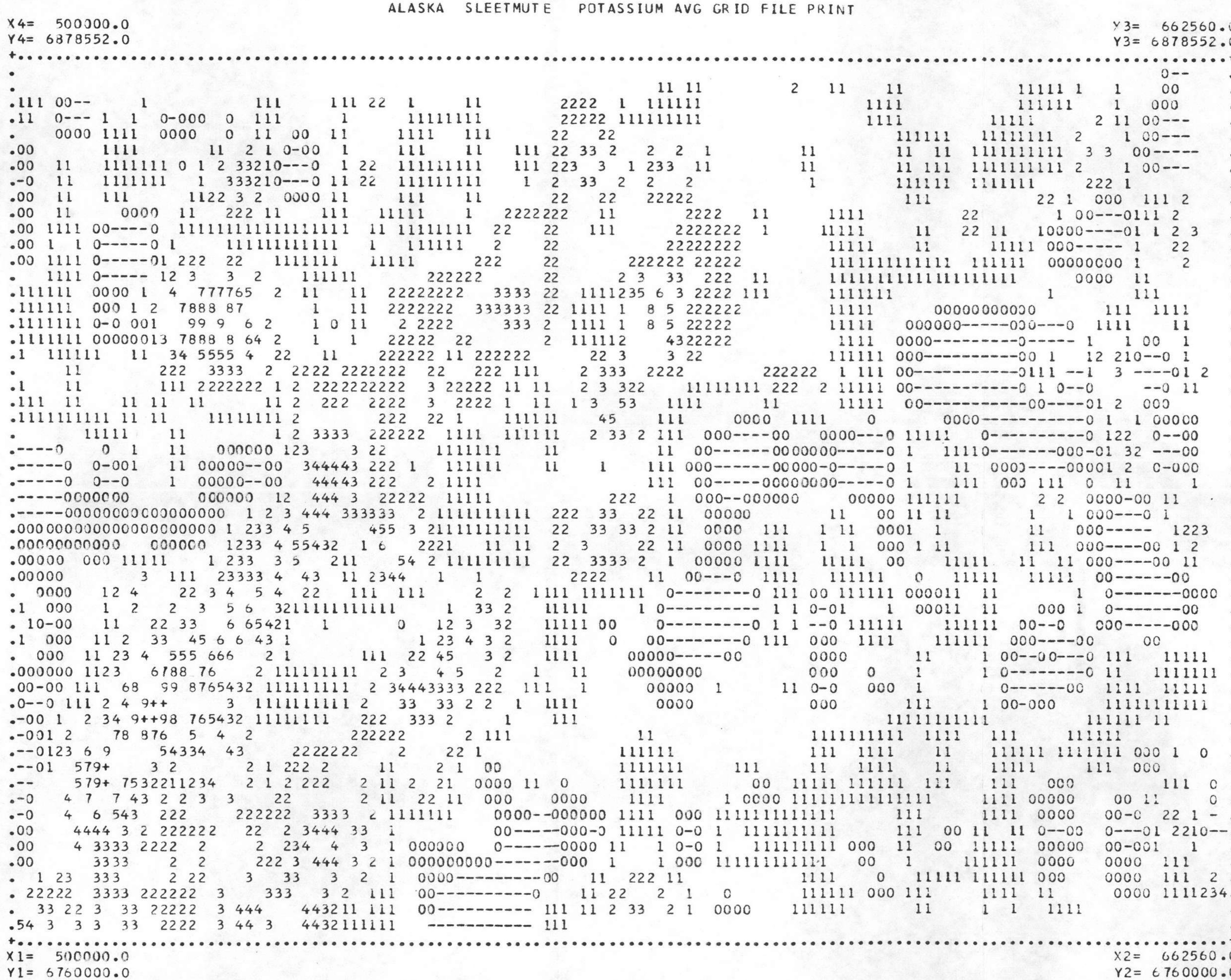
ALASKA SLEETMUTE POTASSIUM AVG GRID FILE PRINT
X4= 500000.0
Y4= 6878552.0
X3= 662560.0
Y3= 6878552.0
X1= 500000.0
Y1= 6760000.0
X2= 662560.0
Y2= 6760000.0

FIGURE 8

LEGEND TO URN AVGE MAP PPM

CONTOUR VALUE	LOWER LIMIT	UPPER LIMIT
-		0.3
0	0.3	0.6
1	0.6	0.9
2	0.9	1.2
3	1.2	1.5
4	1.5	1.8
5	1.8	2.1
6	2.1	2.4
7	2.4	2.7
8	2.7	3.0
9	3.0	3.3
+	3.3	

LASKA SLEETMUTE - URANIUM AVG GRID FILE PRINT

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.0  2 11      22           1 22 1 111112  33  2 2      33   1 1122     333 2 2 3 21111  22  3 2 1  2222      222  22  2 11111                 .
. 11  1 11   11    111111      111111 22 3  2  2      3  2 111 222     3  22 222      222 33 2     2222222222222222 33 2  111                .
. 11   11       11111111     111      222  2   2       222     222222222222     22222222 2 3  3 2   2 2222222 3    4 4 32 111               .
.  11 2    222222   11  222 1111         222222  33333 22222  2   22      22 333  22   2   44    1   22  2223444 55432 1111                 .
.1  1  333 222     2111 2 3        222       2222 2        2   2 1 33 2  111  3  3   2   2 2 444       333 2      3 444    32 1111         .
.1  1  33  22 2    2111 233   1   2222       2222 2     33 2222222 33 22     2 333        22 3 44 32222 333    3333333 4   3 2  11          .
.1111 2   22  22 22    2   2111  222       22222 333333          3333  222  333    1  333333333333     333333      4 4  2          11        .
.11          111  22222222222     22        22222  333333  3333       33   33   33     3    33 3333  333     33  23         1111   11       .
.   22 11       1 2222222222  22 22 11      222222  33 33  3  3 4444 3     4 4 3      3 44 3   333 3333     3  22       1 0 1     3 4     .
.  222 1           22 322222 22  2 11        222 3 3   32     3 4    3     4 4 3 22   3 444    33      3333   33  2    2 11   1 22 33       .
.     11 000000 12    3333     2222 22 111          2 3333     33333 44  33 33   3  11  3       333      3333333          22  111   22  3    .
.     11  000000 12 3      3  22222  111111  111 2                          333333      222222 33  3333                  3  2          2222  .
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.11110---000   1    8 7    6 2 22  0001  10 1 11 22 1 22 11   1 00   3 3       1 222222   22     111111111111  111 22222       2           .
. 11  0000000 1 3 677777 5     1       111  111            11  11   1  3 22            22222 22  11111111          111 11 22 2   11  2      .
.     1111   1122 34      4  2  111    1111111        11111111    11  222222           222  22 11                00000     2 2 3      1 2   .
.0  11   11 1 2222 22 2222  11111111111111     111111  1111      222222222222               2   2 1 000    0000000---0 221 13 3 0-0  2    .
.0001        1   1       11 111111 1  11     1111 22      11  11 1        2  2     22    11111  2 3 211 000      000000---0    0012      00 1 2 .
.0001        1   1   111      1       11111    1111 2 22   11  11 1        2  2          1111111  222  1  00      0   00000   1 11 22 1   1   .
.00  1      1111     11            111             1   2 3 2   1111111        2222          1111        11111 11       111  111 000 1   111     1     1 .
.000  111 1  22 2 1    000      11 22  222        23 3 2                             11  00          0   11 000 11   222 1 000   11    1 22 1 00   .
.---00 11   1 2 3 21 0 C0000     1 23    3 2   111 2   222          1    1111    1  0--00         00000 11 0-0 1   22  2 100   111   0     210000 .
.----0 11   111   3 10-00000          444 32   1111 22 222      22 11   1  1 2 1 0----0            0000 11 0-0 1   2  2 1  1 22 11 1 22 1      .
.----0  1  111   3210-C0000      1 3 444 32   1111 2     2  222         11      1 00--00           00            0  1    2222   11  44     111 11111  2 .
.---00  11111   2221 0000     11 2         3 2  111           2222        2    11            11111      111        1 2222         2        211   0 1 2  3 .
.-0000  111111       111      11  2  3333      222   111111111 22       222       211111      1 2221     1  1        12 3 2          11 4 4 111 000   2 3 .
.0000   11 111      111111111   2 333   2  2     22 1111 111 2 333            3332111 11        2 21 0   22 1      123 32          111        1 11 0--   2  4 .
.00000 1    111 0    1       11 2 3   33 211233 2 2 1 2 1  12 3 3 22     33 2111  1  12 321         22 1   0 123 2              2   2 11   000 12 33 .
. 00    1     11 1    11   222222 333      2     2 22     1      111 2  3  22           2 1    111  33   111        11   1          2222222     2 1   000 1  22 .
. 0    11     11111111   22         3333  22        222  1   1            2222       22222           22222 1111       1111111111 22     22333 21   0000     111 .
.000   1111111              223 4    4 3    2  1           0 12 22      11111111 2222                2  2 1   111 1111 1    11 2 33 2 2   2 1 00000            11 .
.000                111   2222 345   5   3    2 1           11 233 2     1   1        12 2 111          2  21       11  1 1   11 1  2 33 2   222 1 00000               1 .
.000        11   1 2    22          6 3         1 000    00  22 33 2     1                12 2 1111              1            111111    11  22     2   1 111 0000            111 .
.000     1111 2   333 3 4     54       2 1           1 22    3 22  11        11 22  1111    11             11111          22 333   2 1                1111111      .
.000  111   2  3   4   44 555 43  222 1111 2           22      22          1111111    11111    11          11111   2   3 44 32 11             11111      222 .
.0000 11 2 3 4  5      54   222222          111 3 5 43    222222    2222  111111111  11     1   11    0 11111   2 3 4 543211              1 11     2  2 .
.0000 1 222345666    6 5 3211 22             013   643   222   2    2  2 1  11      1        222 11  10001 1111 2 34 55 32 11        1      1 222    222 .
.000 11           4   8   66 43100122 11 22 1        5  32   23321  2 22          111       111 22 111111      11 1   2   3 4   43 2 11          11111 222      22 .
.00   1 2 333      98 66   4       1           22 111       4 32   22   2    2222222                  22 1      1111111      22      3          33 2222222   1111        11111 .
.0     2 3 4 5 6   6 5 4 3 2     22222   2       22       2 2222 2222222                         3 21   1                 2            33333333 3      222 1111 11       11 .
.0 1   34        6    5          22       22        33332 11 2   2       222           2222   333     333333    3           2   2   1   333       33 3333   3 3   22 1         1       11 .
.0 1 3 4 6               2   2   2   1              3 4  1 1 2  22    2   2 33 2222 33 3    3 43   444 344      22   12 333       3333333   3     3 22 1111 11         11 .
. 1        4        6        111 22      1 2 3   3 44 1 1 2222222       23      32222   333    333333    32   2   2222   2                      333             222   111               1 .
. 112 3 45        3 11111                  2   333    3  11   222 1111   2     2     2                     33 2     22222 22222222               2222 11 1          11   2   22 .
. 11 2 333 3 2      111     2222222   333333 2                  111111   11  11      222    111 2   33 22             2             22222222              1   1 2 1 1   33 2 .
.   1 2222       11111 111 2       22 33333333    2 111111       1          000 111    22 1         23333           2 2222   1    222    22    11       10012221 012 3 2 .
.0 1 2 2   1         1   1         333    2 3   33        2 11   111          0000000        1 2222   1 1  233 2 1 2 2222222           2     22222         222 11  2 111 2 3 .
. 11 222 11     0       1          33     22 3333333     2 11       111111                         111 22222  11   22       2222222222222222222                222 3 3 2                2 333 .
.11    222 11      1         1 2   333                          33  2 11            1      1            22              22       22222222               333               33333       3332 1          1 2 33 .
. 2222  111                        2 3       33 22222   333    1               0       1 2        2 3333        32                     2222             33    33       33333 33    33     111  2  111 34 3    6 .
.   3 2 1111      222222223 44  33 2 2  22 3 3      0      0000000  1     3 3 2 3        4   211             2      33       3 44    22333323 3        33   1                .
.44  3 21111    2      2    2    44  333333222      3            1 0000                  4                                                                                 .
+.........................................................................................................................................+
X1=  500000.0                                                                                                                        X2=  662560.0
Y1= 6760000.0                                                                                                                        Y2= 6760000.0
```

FIGURE 9

LEGEND TO THOR AVGE MAPPPM

CONTOUR VALUE	LOWER LIMIT	UPPER LIMIT
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3	3.2	4.0
4	4.0	4.8
5	4.8	5.6
6	5.6	6.4
7	6.4	7.2
8	7.2	8.0
9	8.0	8.8
+	8.8	

ALASKA- SLEETMUTE - THORIUM AVG GRID FILE PRINT

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Y4= 6878552.0

X3= 662560.0
Y3= 6878552.0

```
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.                                                                                                                  2   0-     .
.                                                 3             1   22     22222         333          2222222 22  222  1   1    .
.22  1  0                  222 111  2 3  3 22       222222222222        22  2  22        3     333  2222222 2222222     1       .
. 1 00 111  11    11111  2  111  2  33  2        222222222222       2222222 2222                     22222222    2 11  0      .
.11111   111   11 11111        11111 22    222 1111  22222222222222      2222222222222222    3  2  22         2222 3443  1 00-   .
. 11111111       111  22  2  00  1  2222      11  2222    22    22       2222222222222222222  333 211 2 3          2 4  4 11  0--  .
.0  1   111 222  11   33 3   --0 1  222              22 22   22       1  22222       222222222   33 211 233           33  3  11 000  .
.0  1   111 2222 11 2 33 3   --011 2222   1        22222  222    22   222222   22222222222       2  22            3   33 2  11111  .
.  1 11111          2  33 2 1 0 11 222       1111  2222222222   222222222     22222222222        2                 2  1111   22    .
. 11     111     11  2222222 1111   222       11111 22              2222                222    222222         33    2    22 1  0 1   2    .
. 11 222 1 0000 1 22222           2222222      111 22    333     222            3           2222222  33     33  22222 111   --0122 23 4  .
.  12  2   0--00 1 22222         22  2222 11       22     3 33    2            333    22    22   22            2222 1       00 1 22   3  .
.0 122 2   0--00 12         2222   2222222    1     22222   333    222                222   2222  2222222222222222 1111       1 22    .
.  1 22 1 0000 1 2 33333  222222222             222222         2222222  3333          22222222222222222                 11111111  222   .
.11111111    11      5     43 2      11111111      2222      2222        2 3   3  2222222222222222            11111111       1111111  22    .
.111111  00 122 34 66666  32      1    111111      2222 222222      111    443 2222222222             1111111       0000000        11 1   111111111   .
.111111  0-0    1    7 6 7       22 1 00 1 11         222222222    111112 4432222  2222           1111        0000000    000 1111111  111  .
.111111   00000     45 6666 432      1    111          22222222     11111 23 33 222   22222      11       00000----0000 00-00 1   1    11  .
.1111111      11 22 3 4444 3 2   11111111           22222        11111  2     222   222  2      1      000-----------00 1111 1 221000   1  .
.111  1111111         2222  22   11111            2222  22  111111111   222222        22 22        1      000-----------0 11 00  23 10--001 2  .
.11   11111111 11111       22  1   11             222        2 1 111 11111  22 2  1          2  11  1       0000-----------0     0-0   221 000 11  .
.111  11111111 11 1 1111    11   11   2222        22          2 1111  111 11 2222   11111       1111111       0000000------00000--0       1  0    1  .
.11111111111  2 11      111111111   2222222222222    22  111   11111  22  11111      1          00     11111    00000000000 1 22 1     .
.      111111 222  111            11  2   222222222222222                     2222   111     0000   000000000 1 2222   1 00-00-0000  12   1 000  .
.00000 111   1 222   11      00    11 2 333     222222   222222222 2222222222 11       00000 0000000---  12 3 222 100000--0000 233210000 1  .
.----0 11 00   222  1       000    1 2 3  3     2 2222222   2     2 222      2222 1       0000       000000---    2333 22 1  0 0        1 22 1 0    .
.----0 11 00   222  1        0    1 2    43     22 22222     222 22222       222 11       000      000000000  2       22    1  11    1   111111   11   .
.----0           1      111         11 2   3  3    22222       2222222222            22 111            1                1 2222       11112 3   1 00000   1   2  .
.00000            11111111111111 22 33333   2222222                      2222    3333  2  1111    11 111   1111          1 222         11112   21 000---0 1 2  .
.                   1            11 22 3444  3 2      222222      222            222  333333 2  1111      1        1 11   111 0       2 1      1111     1 000----0  1   34  .
.                111   11    11 2 2     5   3  2 1 2222222 2  2 1  222   33333 2 11111      1 22 111     111 001 22           11     11 00----0 1 2 3  .
.1               111111111   2  2 34  3      11   222   1  22        222    33   2  111          1 2   111     111    11                 2 22 1    00--00 11   .
.              11           22         3 44  3 2 1111     1    1 22           22222222  11     0   11            111              11111 2222   1 2222 11      0---000  .
.     0        11 22222 3 4      4 33 22 1111                1 2222                          1 00---00 11       1 11 22   2 11     2       111   11         100----00    00 .
.1   000          1    222     34 5   5 43 1                      1 22     2       1 1 1111  1 0-----00   1 2 10 12 2     11     2       11111              100----00    .
.11  000        11 22        3 4  666 54 100                0 12 3     2       11111111   1 0-----0    11 2 10C  22       11111 2222   11 00 1111 0000000    .
.1   00       11 2 33     4 5  66 5    21 0                11 23   3   22      11111111111 00---0    11       1     1         111    22 22 11  0000    1111           11  .
.                1 2   4       555      5   321         111   222 34 4    22            1111111                 11111111111   1111111 22           1 0      000 1   11    11111  .
.00000   1     45            5   22    11111111   23      33 4 3 22       22  11      11   11         1111111      111 1111 2     3332100000-0 1   11   1111   .
.00000 1   2 5    8 9986432 111111111 11    2     43 3   222          222 1      1111111 222 1           0 1 1    111 2 3333321000000    1   11 11    .
.0000 1     2      6   ++ 85 21   1111111           23      3 22 22        1       2   11 11111111    22 1   11 11 11111111   2     3  21           11111    11111        11  .
.000 11  2 3 6  +++98    32 11111111             22 3333 2             111             111111111                11111                222222222  11               1111111111  .
.00 1 2   45    88     5   32  11           22222222              22                                222   111111111  22    22   2222           222               2222   11 11  111  .
.-0   2 3 689   654          2          222222  222222     22  1111                     22222  11111  11   2 33 22 22222            222 2           2222221     1     1  .
.-0       3 7 +86   2   2222 1       2     22     2  22      2       11111111     11       22     2   111      11   2 3333 2 22222              2   2    11   222   1 11  11  .
.-01  223 79    5    111  22 11      2            33 2   22      2  111111111111111       22222     1   111  22   3    222222                      1111            1111     11  .
.00     2 3 6 764211111            22       3   22222222       111                  111    222          2        222     222222222   1111        11      11111111  222211  .
.0    1 23 4 4321   111      222222   333333 222             1111      0000   00 11       1111 2     222222   22          2222 111111   111         1111    112   2 1  .
.0    1 2222    21      111  22       2222 3       33 2   111111111 0----000000  1        11 1   33 22    22   2 1       2222 1      1     11    00 1    1 0 1          0-.
.00  1 22     222 11     11  2   3    222       ++ 33 2 111 1111 1 0-----00        11          11 1 233 222222222 111 222 1   1111   111         1111      1 222 11  .
. 0 1 22             1111 11 2   3          33         3   2 11                   0----00         11              111 2     222222222 11    22    111          111       111111111    22222  .
.  11                111111 2   33333333     33    22  11         000000000  111    2222222                                  222222    111 222 2222               1     1   1111 11    222    .
.             111111111  2  3   4 44            3 222222   1 0000-----0 1       22         3    2        1111111   2 2222 1 1 22222222         222               11       1 22223 5.
.     22   111111     222    3 4 5  433 44                  22 1 ---------01 2   22   333333       111 111 22     22                    222     2         222   22         .
. 3   22  111111     22    33 4 5     33 443               2     0--   ---  --    2                                                                                  .
+..............................................................................................................................+
```

X1= 500000.0
Y1= 6760000.0

X2= 662560.0
Y2= 6760000.0

FIGURE 10

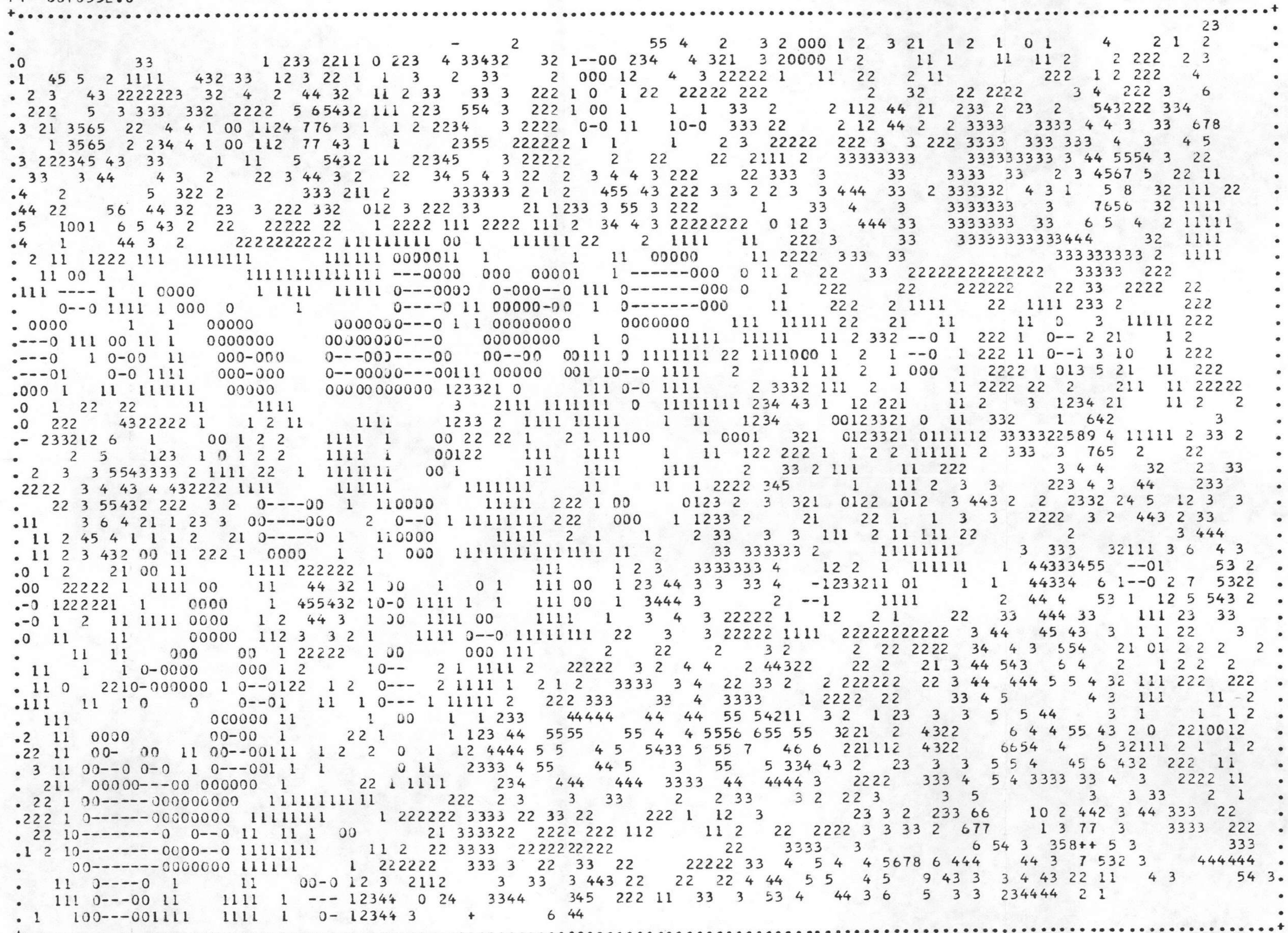
LEGEND TO URN POT RATIO MAP

CONTOUR VALUE	LOWER LIMIT	UPPER LIMIT
-		1.0
0	1.0	1.5
1	1.5	2.0
2	2.0	2.4
3	2.4	2.9
4	2.9	3.3
5	3.3	3.8
6	3.8	4.3
7	4.3	4.7
8	4.7	5.2
9	5.2	5.6
+	5.6	

ALASKA- SLEETMUTE URN POT RATIO GRID FILE PRINT

X4= 500000.0
Y4= 6878552.0

X3= 662560.0
Y3= 6878552.0



X1= 500000.0
Y1= 6760000.0

X2= 662560.0
Y2= 6760000.0

FIGURE 11

LEGEND TO URN THOR RATIO MAP

CONTOUR VALUE	LOWER LIMIT	UPPER LIMIT
-		0.1
0	0.1	0.1
1	0.1	0.2
2	0.2	0.2
3	0.2	0.3
4	0.3	0.3
5	0.3	0.4
6	0.4	0.4
7	0.4	0.5
8	0.5	0.5
9	0.5	0.6
+	0.6	

ALASKA- SLEETMUTE URN THOR RATIO GRID FILE PRINT

```
X4=  500000.0                                                                                                                                      X3=  662560.0
Y4= 6878552.0                                                                                                                                      Y3= 6878552.0
+.............................................................................................................................................................+
.                                                                                                                                                   0112  .
.                                                    0                          54        2 4    1111 2      2 112  22      22 345    3 32           .
. 1 4 4                          2 33 22   1112 34        4  44     21     34444 5 43 3   4 2     22       2    222222  222        3333  222       .
. 2   443333332 11234    333 2 333 22    2 333   3 444     33 22    23     444 3333   2222222         22222222222222   2      3333333333        .
.22 3          333    333 222       3333   2222  33333 4444   333   2222  33   3333333      3           3333  2  333 2222            333           .
.  33 45 5   3333   3   2222       33 4 3   2   33 45 6 5 44 3333 222 333333      33       33333     3    32 2       2    3 2    543333     44   .
.  3335   75   23 554   1112    2    5543222 3    3    65   32 3   21   3333 32   2 44 3      3 3 2234 4 21     4    22      3  4           4   .
.3322235665  2 344                  44433 2  3 4      5   33  333 2 3     33 22 3333       3333333     3      3333      333 22 3         3333    .
. 3             3333  3  222       33  33       33      6 654 3333333333     3333 33333   11233           3333     3333333333 45 5 444   333333  .
.3333   3  44   33333            33333333          333 4      54   33  3333          333333 3333    333   44   33333   3333333     3  455       33 .
.  33 2223 444      33   3333333333      22    33333 4     4   3      3   3 4444 33        43      3333    55433  3     33    33 44 32222       43  2 .
.444 2   1 455   4   3223433 3 33333   1123        3 4  433 4     234 34555 4 3      44443   2   3      44       333333          44 4 5788 5     3 .
.  42 11 23 44      3   33   333333        222   3333  2     3333      3333   4   33      33   332   2 3 444      333333            4444444   4 33 .
.  4 22   2   2 1 2 3333333333            22            2      33333      33333333              3          33 44             3333             44 444 33 .
. 4    22 2222       2   3333333333    222222222 3              33         3333    2222 22            22223       4           3333333333        333333 .
.  3 2 1 2   2      2 3333333    333 222222 2   2             2233 223333 2   122222    22         333      44444     33             333333 4444    3    2 .
.3332100 2        2   3    333 4   3   2222233     12 2 233 2     22233        1     22222222 2 2    3   444    4 33   222222           33 444    3    2      3 .
.   2       2 2222 3 3333333333      22222222     2            222 222    3     22  22222222              33 444     4 3   2             2222     444    3     22   33 .
. 22222             333333              22222222222222         2222222      33            22             22      23    44 5  43    2 1111          234 44 33 2222 33 .
.    22 333    2 33333          22        2222  22222    2222  111      2222233333  33           3    222222 3 44        32  321  0111111       12      4    3  2   22  33 .
.111    33      22 2 33      222 2222222        22       22      111    1 22                   4322    3  3 2222    234 445         321     1      11111  2  3   333  2222      3 .
.     1   44 32    2 33      2  21              222      22 2       22   22 22223 3345               333                3    4444 33       2       2222          2    333        22222 .
. 1    2 3    3 2 22      222          22                       2222 3    33 2222222        3 44 3                 3 4 4  333             3      222             22222            2222222 .
. 1    2 33333    333     22          222                       2222 34       3 22222                  333       22222 34 5 43    33          3 2222    33333      1 2         2222222 .
. 1    2    3    3              2         2          3333            22222   4 33    222               222  222222           234    4  222 3    4    2          2      3           113      2222222 1 1 .
. 1       22    5421 34          11123       344 3  33 2      1     33           2               2222    1 2    2  111  2      43      223 444   21111  2  3333332  467 53                  222 .
. 1 2 2           223           11 1 2  33 3    33  33 2222   2  22222222          222          22222         222222222    3333 2      22     333333    6 554 33333 .
.       22    34 44444  3 22           22                33  3  3       2222        222222              222222222222222222222222     333          3         333333       4444444     333      3333 .
.         2 33       3     5543 2222222222                                22222  222222                 2222                        2223 4432    22  33      2 34       3333333333            44 4          344 4 .
.         2 3 4          22 33            22              222            33   222222      222      3333  2222 33  22 33 22 333          134      2 2 444 4 33    3 22          3     5 3 1       55443 .
.1            45          332     2 3 33         1111        2     2 344322         2            223444     22 2    3   23 3  2             22 3     32 23            333333333 3 4444443      3 4444 .
. 2      45      2 2222               22            22     33           33 2223333  222      3333     22     33333    3    3 45543  22     3  22       3                 33333        3   33333333 .
. 22    44  3222222222222222222     3333333               222                 22       3                  333             33333333                    2222222222222                3333     3 22           3333 .
.    23        33      2222222222            3 4      4 3   22        22    1 2           33      2222     33             3333     4 5                 22222222222  1    4          4              11  22 3 3 .
. 2 3     333         222222222      3 4      7    4     2     222222  12 3  2 33  22222      3 44 3      33 4 5 3          3 321          333 222 2      44334  6  3   -01  22333      33 .
. 2344     33 2     3332 11 2 3333        +97  321     2    23 3              2 332    2        2    44 3 3333       3 2112 33              2                    33          3 44          11     2    333  33 .
. 2 3 333      222        22222       3 4 67               2       2222  2 2              33 222222  33 33333333     2          2          222222      333333333333        3 32     22 333     33 .
. 22 33           2        2222             3 4  5      5 4      222            2 1 2      3333                  333333333               2          222222222        33              3           3455     1  2 3 .
. 22                2      2       22       3333 3     44444  3 222 3       32          2 3333333       3       3       3    222      22         2222222222     3        4444 3          33 45  32 112  44 4 .
. 2                      22222222  3 4  3223 44  3333      1        45         333333       3      3 3              432  33  2  1       4 444322222  22222         4444                   22 3333       3            4554      3 3 .
.12333 23            2 22     1            65      1  4    2      33                           3 24     4 12333 444 33 33 222 3 3                         2222222      33 444444 3333 444 3 22           44                3 .
. 22                    2222222 344  322 3 3        3      2 11 2 3              3 44 3     33      4444   333333333 32 1 2        22222     3333      44 444                      3     22      333          3 .
. 22                    222                   33     333  33333333      22  222  222 3      444                        4444                              44 3222           222 2 3       333 4            444444     33 2         2        2 22 .
. 22 333      2222        33 333          33            3333 3 2      222 2     444 4          4      44           4              4444 5          8753222 1  2 44 3       4       55 444          4 3 21  123321     1 .
. 223443 12           3 3      3 443  22333333443211      22 45 4 34 6     433 5                   334 44  676  57          2     1112       4 33          55        4444  55 432             2        2          2 .
.2 2    554  1 2          33                    3          333333        32      2  22 33          3456 654          4       44              44 4                3 3 3  222 2 3           3      4              44           4            3       22                222 .
.           3    3 2   2        2222 3333                        3333      222222 2      2 3 45 5 4          4          33      33                  3333          2222      3333        44 444                  222 333                        2 .
.2     3333     22      4  3     2          3                     33          222          2             3    4  4                  332       2 3333 33                                  2222       3444 44 333        3 22 333          2 333 2 .
.2 3 33      2       2 333 222                     3                          3       3      3     3            3333        3 2       2      22            2 2222 33 22           45 4 43 2       4 32                       2 33332 .
. 3      43        211 113          21     333          333 22          3 3                 3        2     3             222 3 333          223         3 2     2             3333          2 4         6544       3 455          3 33333 3333333 .
.23 4 3       2         1 3 43       2                        22            3                                     33                333333          3              3333333333                     4 6 5 4444          7 7 4 33333333 .
. 3           33 2222     4 43 2                     22222  333     22          3      3333333333                  3333333333333 4 554      33     45       654            444       44 6 6       33        33     44444 .
.              33333      44     3                222222     22 33     32       2             3                             3        3333          333               4 44 3      44 7 7      3 4       4          4              234 3 3           4        4 .
.                33          44      3     222       222222        2 3    43           3455                  543 44432 3333       4432       443      4 3       33456 7       4       4 234             4       43 .
. 4      4322            44 32      2     22 2332      1234 5 4           6                          5     56                                                                                                                                                                     .
+.............................................................................................................................................................+
X1=  500000.0                                                                                                                                      X2=  662560.0
Y1= 6760000.0                                                                                                                                      Y2= 6760000.0
```

FIGURE 12

LEGEND TO THOR POT RATIO MAP

CONTOUR VALUE	LOWER LIMIT	UPPER LIMIT
-		1.7
0	1.7	2.3
1	2.3	2.9
2	2.9	3.5
3	3.5	4.1
4	4.1	4.6
5	4.6	5.2
6	5.2	5.8
7	5.8	6.4
8	6.4	6.9
9	6.9	7.5
+	7.5	

ALASKA- SLEETMUTE THOR POT RATIO GRID FILE PRINT

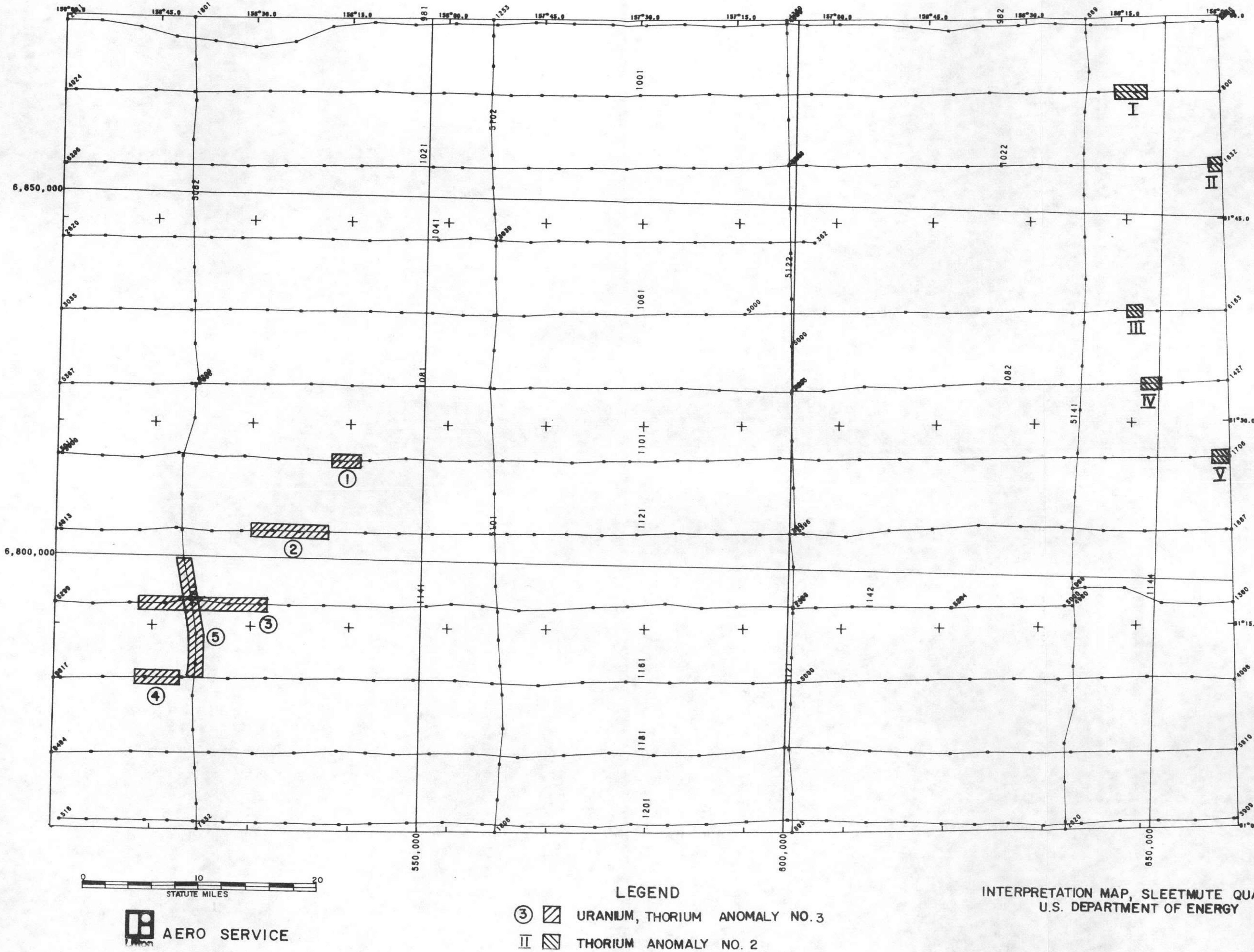
```
X4=  500000.0                                                                                                                       X3=  662560.0
Y4= 6878552.0                                                                                                                       Y3= 6878552.0
+..........................................................................................................................................+
.                                                                                                                      8          9 7         .
.                                                               7 76     65555555    7    8     77666 66 555678 7    555      8              .
.77  8 99                        777  777 7 77     7    5  555      455  7    677 655 555    6 77       777     666      77 6      5 6          .
.777 78 985445   7   7 7 8     6  77777     7777 6666 55555555 4 4 5 6  666    65    55  666  77    77          777 6 5       6 77          .
.     7 88765      7       68 +97 6  77   666 66666 55         55555 44 44    5   55 66 5 4   55 666   6 7   7 6   6 7   88   76 5    6   66 7  .
. 666666   5   77   777        6   6  77 6 55   55    666 6         5 4   33   44 33345666 5       5 6 6 5   7 88 5 567 88   8  777   6    6  8  .
.66    66 5 56   66           44 566777 655 44 5   5 5   6 5 66   4 3333 44   22      666665   5     6 5  7 88      56 8   8 8 888 7   666677777 .
.76    66 5 56 666          444 566 777   54 44 5555   6655          4     444 33345 66   5555   666   6 7   7 6     7 88888   888 7          6  .
. 666666        7     776 5    55 6  7    5 444 55555            55  44   555     55             66666     77777        777  77 66 788 77 6  55 .
.                      666  5555   6       6 55555555          55555      66   66666     555 6     6666 7777   77   77   66   7    6 7  9 8  6 5 .
.     77       777 6666              66 777 6 5      5    5    5555         6 77 666 6 55555 6      6  67              7      6   667    9 9    6 .
.6    77   8  78 76   6 55  6      6 777     5566 5     5   5     555  666      666 6 55 555 66   6 5     87    7777   66 666666 6 78   87  55555 .
.45   77        8876   5555555555   6     6 555555 444 55         555      66666 6   55    5555 666    67   7  6        66   666666666 7777 6 55555 .
.4 5 6  77   9 + 7 5              555           5   444444444444     44   555     55 444           56    6     6      66                66666 7  6 55 .
.444   555 6 7   7654 33333   44          4444 3     3   4   333 333 4     5     43    3 44      7          555       55           555    666666 66 55 .
.    4444444 5   5 3              3   4 44      4 32 2 333 3       2 33 4          2 12 44 334   5 4 4   4444      33333     4   5 566       6   5     4444 .
.33    333333 4432222222222      444  3333 4 3 22333    22222   3   444444 21123 4 33 455 44      33        222222 33 44 568    8   5   444       .
.333333333          3222222222    3     333333   3      3444             33    4     3222 3        4 55 4     33 222      11111 2 3    4 567765 4444     333 .
.3333333333 455 43 22222     333        3333333     345    54  3333333333     3333      444 5       4 333 2      11      00 1 2 3       4 5 4333      33    3 .
.333    3     3 4 4          22    3333 222  3333333        356      444       333    2    2    4      44     5   5433    3 2   11      0---     2 3333 333 2 233    3 223 .
.33    4 3      3  43 2      2  33 4 2         3333333    2       5 4   4        33    11 3       5 4    555554 3       3 32    1111 ---      2 3 33       2   233    33 33 .
.       444       33 44 3 333 33      4          3333333   2       55       44 4     3   01 45555 5555        543333    3   22        1 1 2 3     33      3 2 33            4 .
.444     4          5554              44444 3222 3333333333 56 6 555   4444 3   1   455 55555          5 4      4444 3333              4444444 44     333 4 55        .
.55   55        55555    555           5 43          33          4444       77       55555          4444 5    66666 55555 44     5 5 4 4 5    6      5555 44444           44   66 666 .
. 6776 5        66 5   5 66 77 7           22 3    4           55 6    66                   55 6666 666         66 5      55        6   5444    77     7         6     4 54           5   7 7 6 .
.5 8   5 66 6    65     6     7 8887          22 3  4    55555556 766 666 66 56 776666       777 6 5 4    6 44567       4 67         77   666          7 5     44 5 6         66 .
.57    7 6        7 65 66    7 8  87           22     4     55          56 77 66666           6    6666    777    65 4 5 55 5666 5 56 7         77    66          66 5 444444 55 .
. 7887            77    666    77               43    3     4             44 5 6      666             66         66          77 6 55 555555555 6 777          65          5    44 3       34 5 .
.7       7    77777      6            66 5 44         4       4           4 5    66666      55      4444             5 6 7777            5              55    45      777     7    6666 5 44 432 2       5 .
.8     7      7     7                 6 5 4             4 5     5        23     5 6666         5     444              444    5677777    6 555     44 5     4 4      777      77 66      55 44      4322     455 .
. 8  7    6 88     666        7    5      33     3 4456 6 1 13444      6           55 444        33 44 4567777 66        555 44 5       3      6                       566 5                4 333 4 5 .
.   76 4 6           55 66666 544 444 33 45     5 2 2        44 5       555  444               4444 5 6             55      555       555 4 4       66                          6 5 5555 .
.    6          65    345           5 44 44    33 4            2    3 4                         4444           55          5 666             6               55555555 66         66            66 6666666 55 .
.5    55     555        345555          4444        333         44                  4      4       4444444      5666665   444 5      6 77 6 6     7 6     5655 5      6    6665       6 66  66677      556 .
.   55            444 555                44          44 3 33 444                                 33      4444 44            7          334 55                    6      76          544 5        677666       6666 66 77       55 .
.     5 444444 5 55 44     4  33 4       2 3 44         4433    43    3 4 44        5    77776       45             5555    6 7  76 55                66                     6666666666 555 5 .
.4    5 444444     5        4444     33              3     3     4                  4 3333      444        56 77776 555                 5      66 77 6 55        5     6    777777        7 6        555            55 .
.            4444           44444        333           333                              33333        44        55     666        77777                   6666            6 5            5 6    7          7                  6 55 4            4 .
.55                   44          3 222 3            4444             44          33333     4    555     6 55 6      8 88          7      666     6 77 65             5 6 77     87          7                     4 3                56 .
. 55       555 4             44      2 1 23        4444 44          444    33                 4 5      5 6 65 56        99 8888             45 677       6 4           56 777       877              766 6     3         4      55 .
.6     44 5 5 4 3334           11  12344444      5543334444333 4     456 6666 6        7      9      888               56      7 76 55 5556      77 88    88                      6 54      4 5555 .
.6 5 4            4     4     4    3          11 23 4444           4          4444            4444           6                      6666 7 8        88 765      5 6 7777 6         55     6 77                              77    66 5555       6 66 .
.6       44         4444444      3              2 3 44                          44     44                 4        666 77 77                 7 8888 7 6       44           77          7      6          5        6             77777        77            666             6 77 6 .
.    6543      3 4 4 33     3     11                                                 55 44                     7 7           788 7                7 8 88 7 65 44 67            8 7       6      5        6              7 777 7     77         66 6 678 7 .
.7 654         2 4 4 3     4      100 3 55           55        4 5                   445 88            667 987              6               3 8     655 5            9 8887                   6                7                      888 77                6       7 77 .
.6665 2112344 32 34         100 3    55      55      4 5 6      444          788 8              5 8 7 6666      888     7 666           7 8       88      77 66          6 777           7       99       7777        666        6 .
.6 5 32      2 3 2       2 33         1 234 5                             5       5 55                          55 6 666666 7777777777 888 7        88888            77              66666                8       89           88 87655 6 .
. 5     3 2    22 1   1 2           3 4           4444444 55 66666666 777 6 5555             555 6              6 7                    777          888            8    77 6 5         5    88            8      9 6    56 .
.5 43 2              1     1     2 33 44         4     33         4 56             7777          88764 4 5 5           5 6      6 6788 7   7           8     8    9    7          65444                                 7    +++8655 5 4 .
.6 3 2 111      22 111 233       445554 333                456777       8876     9              45      5444             66     67     77777777             9             877 6           4445 8     8           8         98             555 .
. 4    2 111      2     111      3     44    5 4               44     677          8 7      788     5     5     5 44 55           6 77777      777          8 999 8 77 6      55        5678 8             88        8 7  6       5 .
.   3 2 1111      1111 2 3     44              444444      5 6 7            7          77766    666     5          5     66   7777 7 888                     777 8 766                     6 777777 888 7         6 .
. 3333       1       1  2    3      44        5    4444 5555     78     876           6666        66          6      44 5     6 7              7      8      777 6     88 5             6665      5 77          78 8 7 67       5 .
. 33333     1000       3 4                   555 44 45         5     7 999    6          66               6 77                     5      6     887777     8888777 7 6     6 55 5 66665        678 .
.2 333 2 1000              55     4 555 44 45           66             +                     66 7                                                                                                                             .
+..........................................................................................................................................+
X1=   500000.0                                                                                                                      X2=   662560.0
Y1= 6760000.0                                                                                                                       Y2= 6760000.0
```

FIGURE 13

strike and it suggests that the Cretaceous graywackes and shales are far more heavily intruded by the felsic igneous rocks than is indicated by the geologic map. This zone is coincident with a zone of abrupt magnetic excursion, further suggesting severe igneous intrusion. The most definitive concentrations of gamma radiation in the uranium and thorium spectral windows are present on Traverse 1100 (fiducials 2490-2590), Traverse 1120 (fiducials 2230-2500), Traverse 1140 (fiducials 5530-5930), Traverse 1160 (fiducials 4200-4320), and Tie line 5080 (fiducials 8350-8700).

A zone of increased gamma radiation, particularly high in the thorium spectral window, is observed in the southwest on Traverse 1180 (fiducials 6240-6580) and Traverse 1200 (fiducials 1100-1680). The zone lies between the Boss Creek and Holitna faults in a region of Kuskokwim graywacke and shale (Kk) exposure. However, the region in question corresponds closely to an upland area of the Kuskokwim Mountains and the altimeter record suggests that the apparent increased level of radiation in this area is attributable to signal amplification due to normalizing less than perfect data over a large altitude variance.

Erratic high zones of gamma radiation in the thorium spectral window and to a lesser extent in the uranium window are present in the Holokuk basalt (Th) and the Kuskokwim hornfels (Kkh) adjacent to the Tertiary quartz monzonite stock in the Horn Mountains, observed on Traverse 1040 (fiducials 860-1100) and in the basalts and sediments adjacent to the Kiokluk Mountain stock observed on Traverse 1140 (fiducials 6440-6520). Both of these igneous complexes are manifested by significant magnetic deviation and the altimeter record suggests that the apparent anomalous radioactivity recorded over both zones is attributable to signal amplification due to normalizing less than perfect data over a large altitude variance.



LEGEND

③ URANIUM, THORIUM ANOMALY NO. 3

II THORIUM ANOMALY NO. 2

FIGURE 14

INTERPRETATION MAP, SLEETMUTE QUADRANGLE
U.S. DEPARTMENT OF ENERGY

In the northeastern part of the Sleetmute quadrangle, unusually strong gamma radiation is observed over the Quaternary alluvium (Qal) deposits along two rivers, the Stony River and the Swift River, both tributaries of the Kuskokwim River. The higher gamma radiation level is mainly confined to the throium spectral window, suggesting that the source may be sedimentary monazite deposition. The possible thorium enriched zones are observed on Traverse 1000 (fiducials 3770-3850), Traverse 1020 (fiducials 9620-9657), Traverse 1060 (fiducials 5930-5970), Traverse 1080 (fiducials 8150-8200), and Traverse 1100 (fiducials 4970-5011).

The areas of anomalous radioactivity that warrant further investigation include the persistent belt of uranium and thorium radiation in the west and southwest corrsponsding to an area of Kuskokwim graywackes and shales (Kk) believed to be extensively intruded by Eocene felsic igneous rocks, and the alluvial deposits along the Stony River and Swift River in the northeast. The former may be a zone of irregularly distributed uranium mineralization and the latter may include monazite-enriched sands.

Other areas on the Sleetmute quadrangle displaying apparent anomalous radioactivity are probably attributable to signal amplification due to normalizing less than perfect data over a large altitude or radon variance.

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APPENDIX A

Geologic Legend

G E O L O G I C   L E G E N D

Aero Symbol	Map Symbol	
QA	Qal	: Quaternary alluvial deposits
QC	Qc	: Quaternary colluvial deposits
QCW		: Quaternary colluvial deposits (moist phase)
QG	Qg	: Pleistocene glacial deposits
QGW		: Pleistocene glacial deposits (moist phase)
KK	Kk	: Kuskokwim group graywacke and shale
KH	Kkh	: Kuskokwim group hornfels
KT	KTRPCg	: Gemuk group
DS	DSOh	: Holitna group
TH	Th	: Holokuk basalt
TT	Tgl/Tgt	: Getmuna rhyolite group
KI	Ki	: Iditarod basalt
TM	Tqm	: Quartz monzonite
TR	Tr	: Albite rhyolite
W		: Water

APPENDIX B

List of Geologic Units by Anomaly

List of Geologic Units by Anomaly

ANOMALY	FORMATIONS	LOCATION	FIDUCIAL INTERVAL	BRIEF DESCRIPTION
		Uranium, Thorium Anomalies		
1.	Kk/Tr	t-1100	2490-2590	General increase in total count, particularly in U and T spectral windows.
2.	Kk/Tr	t-1120	2230-2500	
3.	Kk/Tr	t-1140	5530-5930	
4.	Kk/Tr	t-1160	4200-4320	
5.	Kk/Tr	tl-5080	8350-8700	
		Thorium Anomalies		
I.	Qal	t-1000	3770-3850	Increase in T window count, supported by U/T and T/K ratios
II.	Qal	t-1020	9620-9657	
III.	Qal	t-1060	5930-5970	
IV.	Qal	t-1080	8150-8200	
V.	Qal	t-1100	4970-5011	

APPENDIX C

List of Anomalies by Geologic Unit

List of Anomalies by Geologic Unit

Formation	No. of Samples	No. of U, Th Anomalies	No. of Th Anomalies
Kk/Tr	21,817/238	5	
Qal	4478		5

A P P E N D I X D

Mean Radiometric Values by Geologic Unit

MEAN VALUE BY GEOLOGIC MAP UNIT

SLEETMUTE QUAD

LINE 1200

UNIT	E THOR	E URN	POT PCT	U/TH	U/K	TH/K
KK	3.01	1.16	0.75	0.424	1.797	4.414
QA	2.21	1.05	0.54	0.511	2.181	4.374
KT	2.57	0.96	0.76	0.412	1.382	3.533
QC	2.27	1.10	0.41	0.501	2.930	5.770

UNIT	E THOR	E URN	POT PCT	U/TH	U/K	TH/K
QCW	0.42	0.38	0.05	0.778	6.983	9.104
QG	3.03	1.30	0.61	0.442	2.200	5.117
DS	2.49	1.16	0.46	0.498	2.778	5.540
TM	4.29	2.41	0.96	0.582	2.706	4.603

LINE 1180

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QC	2.09	0.86	0.35	0.384	2.305	6.068
KK	2.96	1.18	0.78	0.426	1.647	3.873
KT	2.25	0.81	0.78	0.355	1.015	2.946

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QCW	1.01	0.50	0.18	0.305	1.741	5.169
QA	2.04	0.82	0.44	0.414	1.784	4.475
DS	2.23	1.05	0.38	0.498	3.165	5.741

LINE 1160

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QC	2.18	1.04	0.37	0.485	2.878	5.940
KK	3.21	1.19	0.84	0.402	1.552	4.120
KT	1.64	0.58	0.36	0.358	1.579	4.613

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QCW	0.89	0.57	0.12	0.569	4.388	7.056
DS	2.76	1.23	0.48	0.461	2.700	5.929
QA	2.21	1.48	0.42	0.700	3.744	5.389

LINE 1140

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QC	1.91	0.85	0.35	0.416	2.353	5.446
KK	3.46	1.40	0.92	0.438	1.621	4.078
QA	1.92	0.93	0.42	0.513	2.247	4.604
KT	1.45	0.49	0.40	0.331	1.286	3.710
QCW	1.00	0.47	0.13	0.273	3.207	5.215

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
TH	3.03	1.09	0.80	0.308	1.241	3.815
QG	3.41	1.66	0.82	0.480	1.978	4.200
KH	2.59	0.84	0.64	0.372	1.341	4.016
DS	2.05	0.80	0.35	0.441	2.351	5.809

LINE 1120

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
KK	2.55	1.05	0.61	0.423	1.867	4.362
TR	3.35	1.41	0.85	0.427	1.638	3.789
QG	2.56	0.89	0.63	0.384	1.488	4.084
QA	1.84	0.62	0.37	0.387	1.692	4.752
QCW	0.80	0.87	0.11	0.458	2.494	4.835

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
TM	1.50	0.34	0.48	0.188	0.574	3.181
TH	1.16	0.42	0.31	0.322	1.695	3.750
KH	2.86	1.08	0.78	0.374	1.328	3.743
QC	1.86	0.83	0.34	0.418	2.373	5.255

LINE 1100

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
KK	2.40	0.92	0.58	0.386	1.795	4.740
QA	2.14	0.99	0.44	0.428	2.210	4.805
TH	4.04	1.15	0.94	0.288	1.331	4.640
W	0.0	0.0	0.06	0.0	0.0	0.0

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
TR	2.71	1.57	2.02	0.590	0.782	1.342
QC	1.91	0.88	0.36	0.454	2.438	5.067
QCW	1.22	0.55	0.21	0.442	2.533	5.375

MEAN VALUE BY GEOLOGIC MAP UNIT

SLEETMUTE QUAD

LINE 1080

UNIT	E THOR	E URN	POT PCT	U/TH	U/K	TH/K
QA	1.86	0.93	0.40	0.477	2.652	5.024
W	1.22	0.70	0.26	0.466	2.116	4.852
QCW	1.06	0.42	0.19	0.333	1.734	4.952
KH	3.50	1.02	0.70	0.268	1.305	5.409

UNIT	E THOR	E URN	POT PCT	U/TH	U/K	TH/K
QC	2.31	0.76	0.41	0.324	1.805	5.722
KK	2.53	0.93	0.55	0.368	1.728	5.010
TR	2.43	0.59	0.62	0.255	0.984	4.197

LINE 1060

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
KK	2.23	0.76	0.62	0.353	1.256	3.702
QA	2.18	0.91	0.58	0.395	1.418	3.820
KH	1.62	0.96	0.37	0.494	1.883	3.531
TH	1.71	0.35	0.45	0.206	0.819	3.821

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QC	2.10	0.98	0.53	0.456	1.859	3.988
W	1.01	0.49	0.33	0.411	1.552	3.222
TR	1.62	1.27	1.00	0.693	1.353	1.798
QCW	1.08	0.44	0.21	0.390	1.490	3.074

LINE 1040

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
KK	2.04	0.76	0.56	0.378	1.397	3.643
QA	2.01	0.78	0.53	0.390	1.441	3.714
QG	3.27	1.42	1.14	0.368	1.083	2.800
TH	5.98	2.51	1.90	0.424	1.330	3.132
QC	2.53	0.92	0.61	0.370	1.569	4.215

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
TM	6.64	2.59	2.15	0.398	1.212	3.080
KH	4.47	2.65	1.60	0.603	1.711	2.810
W	1.91	0.47	0.48	0.202	0.620	3.050
TR	4.44	1.42	1.95	0.315	0.738	2.380

LINE 1020

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
KK	2.79	1.19	0.53	0.444	2.333	5.351
KI	1.56	0.80	0.27	0.479	2.997	5.630
QA	3.20	1.32	0.63	0.421	2.291	5.108
QGW	0.98	0.50	0.16	0.478	3.427	6.374
QCW	1.66	0.67	0.23	0.440	2.929	6.546

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QG	2.37	1.11	0.51	0.495	2.343	4.735
TH	2.59	1.15	0.52	0.464	2.222	5.114
W	2.18	0.64	0.47	0.305	1.412	4.629
QC	2.54	0.98	0.46	0.388	2.104	5.499

LINE 1000

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
KK	2.57	1.08	0.53	0.442	2.253	5.102
QA	1.69	0.96	0.32	0.495	2.960	5.456
KI	1.75	0.64	0.34	0.384	1.886	5.337
TR	2.67	0.30	0.71	0.119	0.469	3.814

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
TH	3.10	1.18	0.66	0.393	1.853	4.784
TT	3.69	1.15	0.89	0.322	1.329	4.147
QC	3.49	1.42	0.68	0.432	2.239	5.132
QCW	1.15	0.64	0.15	0.473	3.890	6.353

LINE 980

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
KK	2.56	0.94	0.48	0.385	2.110	5.527
QA	2.30	0.90	0.46	0.416	2.160	5.293
KI	1.57	0.70	0.28	0.438	2.610	5.934

UNIT	THOR	URN	POT	U/TH	U/K	TH/K
W	2.36	0.52	0.48	0.219	1.070	5.039
QC	2.16	0.66	0.35	0.307	1.841	6.186
QCW	0.98	0.38	0.13	0.302	1.651	4.181

D2

MEAN VALUE BY GEOLOGIC MAP UNIT

SLEETMUTE QUAD

LINE 5080

UNIT	E THOR	E URN	POT PCT	U/TH	U/K	TH/K	UNIT	E THOR	E URN	POT PCT	U/TH	U/K	TH/K
QA	2.12	0.87	0.43	0.406	1.976	5.286	QG	3.37	1.36	0.84	0.379	1.432	4.428
KT	1.74	0.89	0.69	0.521	1.408	2.611	QC	1.41	0.66	0.24	0.480	2.712	5.829
KK	3.30	1.17	0.79	0.367	1.700	4.628	QGW	1.04	0.49	0.16	0.436	3.379	6.630

LINE 5100

UNIT	THOR	URN	POT	U/TH	U/K	TH/K	UNIT	THOR	URN	POT	U/TH	U/K	TH/K
KK	2.34	0.92	0.50	0.420	1.979	4.829	KH	4.37	1.15	1.13	0.260	0.978	3.832
QCW	0.99	0.53	0.17	0.454	2.457	5.273	TM	5.02	1.09	1.58	0.221	0.690	3.192
QC	1.83	0.76	0.36	0.435	2.302	5.345	TH	1.49	0.59	0.33	0.401	1.920	4.531
QG	2.99	0.96	0.79	0.352	1.442	3.932	QA	2.36	0.95	0.42	0.408	2.282	5.680
W	1.20	1.14	0.29	0.897	4.401	3.405							

LINE 5120

UNIT	THOR	URN	POT	U/TH	U/K	TH/K	UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QC	2.36	1.06	0.41	0.479	2.656	5.828	QA	1.96	0.75	0.38	0.394	2.043	5.020
DS	2.43	0.97	0.41	0.429	2.617	6.068	W	2.42	0.50	0.48	0.181	1.078	5.037
QCW	1.07	0.45	0.13	0.458	2.659	5.032	KK	2.43	1.02	0.51	0.451	2.132	4.836

LINE 5140

UNIT	THOR	URN	POT	U/TH	U/K	TH/K	UNIT	THOR	URN	POT	U/TH	U/K	TH/K
QC	2.09	1.27	0.38	0.567	3.196	5.653	QCW	1.03	0.85	0.15	0.819	4.732	4.978
QA	2.98	1.71	0.62	0.621	3.107	5.021	W	1.01	0.0	0.07	0.0	0.0	7.600
DS	1.51	0.80	0.20	0.518	4.074	7.690	KK	2.81	1.34	0.49	0.512	2.831	5.820

D3

APPENDIX E

Standard Deviation Table

SLEETMUTE QUAD

FORMATION QA

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	4286	1.98	NORMAL	-0.66	0.22	1.10	2.86	3.74	4.62
E URANIUM	3716	0.65	LOGNORMAL	0.16	0.25	0.41	1.04	1.66	2.65
POTASSIUM	4351	0.43	NORMAL	-0.16	0.04	0.23	0.62	0.82	1.01
EU/K	3664	1.56	LOGNORMAL	0.28	0.50	0.88	2.76	4.87	8.59
EU/ETH	3504	0.42	NORMAL	-0.17	0.03	0.22	0.62	0.81	1.01
ETH/K	4197	4.67	NORMAL	1.07	2.27	3.47	5.87	7.07	8.27

FORMATION GC

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	8917	1.96	NORMAL	-0.81	0.12	1.04	2.89	3.81	4.74
E URANIUM	7649	0.88	NORMAL	-0.54	-0.07	0.40	1.35	1.82	2.29
POTASSIUM	9076	0.36	NORMAL	-0.17	0.01	0.18	0.54	0.71	0.89
EU/K	7409	1.89	LOGNORMAL	0.34	0.60	1.07	3.34	5.91	10.44
EU/ETH	7068	0.42	NORMAL	-0.17	0.03	0.22	0.62	0.81	1.01
ETH/K	8579	5.41	NORMAL	1.42	2.75	4.08	6.74	8.07	9.40

FORMATION GCW

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	1571	0.42	LOGNORMAL	0.05	0.10	0.21	0.87	1.79	3.68
E URANIUM	1382	0.48	NORMAL	-0.41	-0.11	0.18	0.77	1.07	1.36
POTASSIUM	2278	0.06	LOGNORMAL	0.00	0.01	0.03	0.15	0.34	0.82
EU/K	769	1.04	LOGNORMAL	0.09	0.20	0.46	2.34	5.28	11.90
EU/ETH	568	0.34	LOGNORMAL	0.07	0.12	0.20	0.56	0.94	1.58
ETH/K	1209	4.02	LOGNORMAL	1.44	2.03	2.86	5.66	7.97	11.22

FORMATION GG

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	1044	2.79	NORMAL	-0.31	0.72	1.76	3.83	4.86	5.90
E URANIUM	966	1.13	NORMAL	-0.25	0.21	0.67	1.59	2.05	2.51
POTASSIUM	1044	0.48	LOGNORMAL	0.11	0.18	0.29	0.78	1.29	2.13
EU/K	966	1.72	NORMAL	-0.78	0.05	0.89	2.56	3.39	4.23
EU/ETH	959	0.40	NORMAL	-0.14	0.04	0.22	0.58	0.76	0.93
ETH/K	1044	4.24	NORMAL	1.41	2.35	3.30	5.18	6.13	7.07

SLEETMUTE QUAD

FORMATION QGW

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	299	0.85	NORMAL	-0.22	0.13	0.49	1.21	1.57	1.93
E URANIUM	195	0.39	NORMAL	-0.09	0.07	0.23	0.56	0.72	0.88
POTASSIUM	307	0.13	NORMAL	-0.02	0.03	0.08	0.18	0.23	0.28
EU/K	187	3.26	NORMAL	-0.87	0.51	1.89	4.64	6.02	7.39
EU/ETH	125	0.43	NORMAL	-0.18	0.02	0.23	0.64	0.84	1.04
ETH/K	295	6.36	NORMAL	0.26	2.29	4.33	8.39	10.43	12.46

FORMATION KK

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	21716	2.49	NORMAL	0.13	0.91	1.70	3.27	4.06	4.85
E URANIUM	19178	0.94	NORMAL	-0.47	-0.00	0.47	1.41	1.88	2.35
POTASSIUM	21776	0.49	LOGNORMAL	0.10	0.16	0.29	0.85	1.48	2.56
EU/K	19136	1.43	LOGNORMAL	0.31	0.51	0.85	2.39	3.99	6.67
EU/ETH	18894	0.38	NORMAL	-0.14	0.03	0.21	0.55	0.73	0.90
ETH/K	21659	4.54	NORMAL	0.58	1.90	3.22	5.85	7.17	8.49

E2

FORMATION KH

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	409	2.89	NORMAL	-0.35	0.73	1.81	3.97	5.05	6.13
E URANIUM	369	1.02	NORMAL	-0.50	0.01	0.52	1.53	2.04	2.54
POTASSIUM	421	0.63	LOGNORMAL	0.20	0.30	0.43	0.92	1.34	1.96
EU/K	369	1.22	NORMAL	-0.49	0.08	0.65	1.79	2.37	2.94
EU/ETH	369	0.23	LOGNORMAL	0.05	0.08	0.14	0.39	0.67	1.14
ETH/K	409	3.79	NORMAL	1.55	2.30	3.04	4.54	5.28	6.03

FORMATION KT

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	1088	2.01	NORMAL	-0.63	0.25	1.13	2.89	3.77	4.65
E URANIUM	913	0.77	NORMAL	-0.34	0.03	0.40	1.14	1.51	1.88
POTASSIUM	1093	0.70	NORMAL	-0.03	0.21	0.45	0.94	1.18	1.42
EU/K	913	1.15	NORMAL	-0.58	-0.00	0.57	1.72	2.30	2.87
EU/ETH	874	0.39	NORMAL	-0.15	0.03	0.21	0.57	0.75	0.93
ETH/K	1088	2.98	NORMAL	-0.20	0.86	1.92	4.04	5.10	6.15

SLEETMUTE QUAD

FORMATION DS

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	1370	2.25	NORMAL	-0.22	0.60	1.43	3.07	3.90	4.72
E URANIUM	1335	0.99	NORMAL	-0.31	0.12	0.56	1.42	1.85	2.29
POTASSIUM	1373	0.40	NORMAL	-0.01	0.13	0.26	0.53	0.67	0.81
EU/K	1326	2.03	LOGNORMAL	0.37	0.66	1.15	3.56	6.26	11.00
EU/ETH	1291	0.45	NORMAL	-0.18	0.05	0.24	0.66	0.87	1.08
ETH/K	1361	5.60	NORMAL	1.84	3.09	4.35	6.86	8.11	9.37

FORMATION TH

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	855	2.68	NORMAL	-3.22	-1.18	0.85	4.92	6.95	8.98
E URANIUM	664	0.35	LOGNORMAL	0.03	0.07	0.16	0.79	1.77	3.96
POTASSIUM	856	0.42	LOGNORMAL	0.08	0.13	0.24	0.75	1.32	2.35
EU/K	664	1.44	NORMAL	-0.81	-0.06	0.69	2.19	2.94	3.69
EU/ETH	626	0.34	NORMAL	-0.12	0.03	0.19	0.50	0.65	0.81
ETH/K	855	4.06	NORMAL	0.51	1.69	2.87	5.24	6.42	7.61

E3

FORMATION IT

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	75	3.38	LOGNORMAL	2.31	2.62	2.97	3.83	4.35	4.94
E URANIUM	75	1.05	NORMAL	0.17	0.46	0.76	1.35	1.64	1.94
POTASSIUM	75	0.66	NORMAL	0.61	0.69	0.78	0.95	1.04	1.12
EU/K	75	1.16	NORMAL	-0.05	0.36	0.77	1.59	2.00	2.41
EU/ETH	75	0.29	NORMAL	-0.04	0.07	0.18	0.41	0.52	0.63
ETH/K	75	3.99	NORMAL	2.83	3.21	3.60	4.38	4.76	5.15

FORMATION KI

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	249	1.46	NORMAL	-0.35	0.25	0.86	2.07	2.68	3.28
E URANIUM	215	0.61	NORMAL	-0.27	0.02	0.32	0.91	1.20	1.49
POTASSIUM	254	0.27	NORMAL	-0.09	0.03	0.15	0.39	0.51	0.63
EU/K	207	1.85	LOGNORMAL	0.53	0.80	1.22	2.81	4.26	6.48
EU/ETH	185	0.40	NORMAL	-0.06	0.10	0.25	0.56	0.71	0.86
ETH/K	241	5.52	NORMAL	0.62	2.25	3.89	7.16	8.79	10.42

SLEETMUTE QUAD

FORMATION TM

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	254	5.23	NORMAL	0.67	2.19	3.71	6.76	8.28	9.80
E URANIUM	238	2.01	NORMAL	-0.79	0.15	1.08	2.94	3.87	4.81
POTASSIUM	254	1.63	NORMAL	-0.36	0.30	0.97	2.29	2.96	3.62
EU/K	238	0.83	LOGNORMAL	0.16	0.26	0.48	1.44	2.51	4.36
EU/ETH	238	0.36	NORMAL	-0.16	0.01	0.18	0.53	0.70	0.87
ETH/K	254	2.85	LOGNORMAL	1.19	1.60	2.13	3.80	5.08	6.79

FORMATION TR

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	238	2.98	NORMAL	-2.49	-0.66	1.16	4.80	6.63	8.45
E URANIUM	209	1.11	NORMAL	-1.11	-0.37	0.37	1.84	2.58	3.32
POTASSIUM	238	1.30	NORMAL	-1.33	-0.45	0.43	2.18	3.06	3.93
EU/K	209	0.68	LOGNORMAL	0.12	0.21	0.38	1.20	2.13	3.79
EU/ETH	208	0.35	NORMAL	-0.25	-0.05	0.15	0.55	0.75	0.95
ETH/K	238	2.07	LOGNORMAL	0.63	0.94	1.39	3.07	4.57	6.79

E4

FORMATION

DATA	SAMPLES	MEAN		-3	-2	-1	+1	+2	+3
E THORIUM	136	1.46	NORMAL	-1.49	-0.51	0.47	2.44	3.42	4.40
E URANIUM	107	0.34	LOGNORMAL	0.06	0.10	0.19	0.63	1.15	2.09
POTASSIUM	165	0.26	LOGNORMAL	0.06	0.10	0.16	0.43	0.69	1.12
EU/K	105	0.80	LOGNORMAL	0.08	0.17	0.37	1.74	3.79	8.23
EU/ETH	87	0.18	LOGNORMAL	0.03	0.05	0.10	0.34	0.62	1.15
ETH/K	132	3.95	NORMAL	0.34	1.54	2.75	5.16	6.36	7.57

APPENDIX F

Single Record Data Listing

REC NO.	LAT	LONG	RESID MAG GAMMA	TERR CL FEET	FLG	GEOL UNIT	COSM CPS	ATM U CPS	TOTAL COUNT CPS	FLG	ETH PPM	FLG	EU PPM	FLG	K PCT	FLG	EU/ETH	EU/K	ETH/K	TEMP CELCIUS	BARO PRES MMHG
5079	64.0086	160.9199	55305	763	MAR	W	31	1	-12	NAD	-1.1	NAD	-0.5	NAD	0.0	NAD	0.0	0.0	0.0	12.7	746.8
5080	64.0087	160.9189	55305	751	MAR	W	28	1	36	MAR	0.0	NAD	0.1	NAD	0.1	NAD	0.0	0.0	0.0	12.7	747.1
5081	64.0087	160.9176	55305	741	MAR	W	26	1	4	NAD	0.2	NAD	0.1	NAD	-0.1	NAD	0.0	0.0	0.0	12.7	747.4
5082	64.0088	160.9166	55305	730	MAR	W	35	1	-60	NAD	0.0	NAD	0.3	NAD	-0.1	NAD	0.0	0.0	0.0	12.7	747.7
5083	64.0088	160.9154	55305	722	MAR	W	26	1	-4	NAD	-2.7	NAD	2.3		-0.4	NAD	0.0	0.0	0.0	12.7	748.0
5084	64.0089	160.9144	55305	712	MAR	W	28	1	-12	NAD	0.5	NAD	-1.7	NAD	0.0	NAD	0.0	0.0	0.0	12.7	748.1
5085	64.0089	160.9131	55305	702	MAR	W	23	1	37	MAR	0.0	NAD	0.4	NAD	-0.3	NAD	0.0	0.0	0.0	12.7	748.5
5086	64.0090	160.9121	55305	691		W	22	1	50		0.3	NAD	-0.1	NAD	0.0	NAD	0.0	0.0	0.0	12.7	748.8
5087	64.0091	160.9109	55305	680		W	23	1	46		0.3	NAD	0.0	NAD	-0.0	NAD	0.0	0.0	0.0	12.7	749.1
5088	64.0092	160.9099	55305	673		W	17	1	72		0.6	MAR	0.3	NAD	-0.3	NAD	0.0	0.0	0.0	12.8	749.3
5089	64.0092	160.9087	55305	668		W	20	1	156		-1.6	NAD	0.7	MAR	-0.0	NAD	0.0	0.0	0.0	12.8	749.4
5090	64.0093	160.9075	55304	666		W	32	1	113		0.0	NAD	0.6	MAR	0.0	NAD	0.0	0.0	0.0	12.8	749.4
5091	64.0093	160.9064	55304	667		W	30	1	247		-0.2	NAD	0.6	MAR	0.1	NAD	0.0	0.0	0.0	12.8	749.3
5092	64.0094	160.9052	55304	671		W	29	1	343		0.2	NAD	1.1		0.3		0.0	4.0	0.0	12.8	749.2
5093	64.0094	160.9042	55304	679		W	23	1	659		2.9		-0.8	NAD	0.8		0.0	0.0	3.5	12.8	748.9
5094	64.0095	160.9030	55304	663		W	34	0	965		3.2		1.4		0.8		0.5	1.9	4.1	12.9	748.5
5095	64.0096	160.9017	55305	647		KS	24	0	1208		8.6		0.0	NAD	0.5		0.0	0.0	18.3	12.9	748.1
5096	64.0096	160.9007	55305	463		KS	12	0	945		2.5		1.7		0.5		0.7	3.5	5.2	12.9	747.8
5097	64.0098	160.8995	55305	455		KS	20	0	831		3.0		1.5		0.6		0.5	2.8	5.5	12.9	747.6
5098	64.0098	160.8985	55305	457		KS	22	0	759		2.2		1.4		0.3		0.6	5.1	8.1	12.9	747.1
5099	64.0099	160.8973	55305	465		KS	29	0	699		1.7		2.0		0.5		1.1	4.4	4.1	12.9	746.5
5100	64.0100	160.8962	55305	479		KS	28	0	610		0.5	NAD	1.3		0.4		0.0	3.7	0.0	12.9	746.1
5101	64.0100	160.8950	55305	497		KS	26	0	581		2.2		0.5	MAR	0.3		0.2	1.6	7.0	12.9	746.0
5102	64.0101	160.8940	55304	518		KS	35	0	512		1.3		-0.2	NAD	0.3		0.0	0.0	4.2	12.9	745.7
5103	64.0101	160.8928	55303	540		KS	20	0	677		2.1		1.0		0.2		0.5	5.6	11.2	12.8	745.5
5104	64.0102	160.8918	55303	569		KS	26	0	579		1.7		1.2		0.1	MAR	0.7	12.6	17.6	12.8	745.5
5105	64.0103	160.8905	55304	608		KS	21	-1	611		3.2		3.1		0.0	NAD	1.0	0.0	0.0	12.8	745.6
5106	64.0103	160.8895	55303	514		KS	16	-1	551		3.7		0.2	NAD	0.3		0.0	0.0	11.1	12.8	745.5
5107	64.0104	160.8883	55304	595		KS	37	-1	488		1.6		2.4		0.1	MAR	1.5	18.6	12.5	12.8	745.4
5108	64.0105	160.8873	55302	575		KS	22	-1	510		0.2	NAD	1.3		0.3		0.0	5.1	0.0	12.8	745.3
5109	64.0106	160.8860	55304	552		KS	28	-1	437		0.0	NAD	1.0		0.1	MAR	0.0	9.0	0.0	12.8	745.2
5110	64.0107	160.8848	55305	532		KS	25	-1	405		0.5	NAD	1.1		0.3		0.0	4.0	0.0	12.8	745.1
5111	64.0107	160.8838	55305	514		KS	25	-1	379		1.0	MAR	-0.1	NAD	0.3		0.0	0.0	3.0	12.8	744.7
5112	64.0108	160.8826	55305	501		KS	35	-1	325		0.5	MAR	1.4		0.1	MAR	2.5	13.6	5.5	12.8	744.5
5113	64.0108	160.8816	55305	490		KS	20	-1	411		0.0	NAD	1.1		0.0	NAD	0.0	0.0	0.0	12.8	744.3
5114	64.0109	160.8803	55305	481		KS	22	-1	417		1.0		1.0		0.1	MAR	1.0	12.7	12.9	12.8	744.3
5115	64.0110	160.8791	55305	477		KS	28	-1	517		0.8	MAR	1.1		0.3		1.3	4.0	3.1	12.8	744.1
5116	64.0110	160.8781	55304	479		KS	17	0	616		1.4		0.7		0.5		0.5	1.4	2.8	12.8	744.0
5117	64.0111	160.8769	55304	486		KS	23	0	623		4.3		0.8		0.6		0.2	1.4	7.0	12.8	743.9
5118	64.0111	160.8759	55303	473		KS	22	0	607		2.5		1.5		0.1		0.6	10.2	17.5	12.8	744.0
5119	64.0112	160.8746	55303	500		KS	21	0	693		3.5		0.5	MAR	0.5		0.2	1.1	7.4	12.8	744.2
5120	64.0113	160.8734	55303	509		KS	22	-1	633		2.2		2.6		0.3		1.2	8.6	7.2	12.8	744.2
5121	64.0113	160.8724	55302	516		KS	30	-1	636		3.7		0.2	NAD	0.3		0.0	0.0	10.9	12.8	744.5
5122	64.0113	160.8712	55302	519		KS	25	-2	777		5.1		1.5		0.3		0.3	5.9	20.2	12.8	744.9
5123	64.0113	160.8701	55302	518		KS	26	-2	658		3.8		0.9		0.4		0.2	2.2	9.0	12.8	745.1
5124	64.0113	160.8689	55302	517		KS	32	-2	718		0.8	MAR	1.9		0.7		2.1	2.8	1.3	12.8	745.6
5125	64.0113	160.8677	55302	523		KS	32	-2	763		2.7		2.2		0.2		0.8	13.0	16.0	12.8	746.1
5126	64.0114	160.8667	55302	541		KS	25	-1	781		3.2		1.3		0.6		0.4	2.4	5.9	12.8	746.4
5127	64.0114	160.8654	55301	559		KS	26	-1	736		1.1	MAR	2.6		0.3		2.2	8.2	3.8	12.9	746.8
5128	64.0114	160.8644	55300	574		KS	23	-1	668		3.2		0.2	NAD	0.4		0.0	0.0	7.4	12.9	747.1
5129	64.0114	160.8632	55300	592		KS	21	0	640		2.4		3.5		-0.0	NAD	1.4	0.0	0.0	12.9	747.3
5130	64.0113	160.8620	55300	606		KS	14	0	696		1.9		1.9		0.3		1.0	7.1	6.9	12.9	747.3
5131	64.0113	160.8609	55302	517		KS	27	0	595		1.4		0.7	MAR	0.3		0.5	2.4	4.4	13.0	747.7

APPENDIX G

Average Record Data Listing

RECORD NUMBER	LATITUDE	LONGITUDE	RESID TOTAL FIELD GAMMA	GEOL UNIT	COSM CPS	ATM. URAN CPS	TOTAL COUNT CPS	ETH PPM	FLG	STD DEV	EU PPM	FLG	STD DEV	POT PCT	FLG	STD DEV	EU ETH RATIO	STD DEV	EU POTA RATIO	STD DEV	ETH POTA RATIO	STD DEV
5185	64.0087	-160.8023	55293	KS	29	0	912	3.5		0	1.6		0	0.6		0	0.5	1	2.8	0	6.0	0
5186	64.0086	-160.8012	55292	KS	23	0	986	3.3		0	1.6		0	0.6		0	0.5	1	2.6	0	5.6	0
5187	64.0085	-160.8002	55291	KS	39	0	947	3.8		0	1.5		0	0.6		0	0.4	0	2.4	0	6.1	0
5188	64.0085	-160.7992	55290	KS	32	0	1017	3.5		0	1.6		0	0.6		0	0.4	0	2.5	0	5.6	0
5189	64.0084	-160.7982	55291	KS	32	0	956	3.3		0	1.6		0	0.6		0	0.5	1	2.6	0	5.1	0
5190	64.0085	-160.7971	55291	W	21	0	974	3.5		1	1.4		1	0.6		1	0.4	0	2.2	0	5.3	0
5191	64.0085	-160.7961	55291	KS	27	0	918	3.2		0	1.3		0	0.6		0	0.4	0	2.1	0	4.9	0
5192	64.0085	-160.7949	55290	KS	29	-1	886	3.3		0	1.3		0	0.6		0	0.4	0	2.3	0	5.7	0
5193	64.0085	-160.7939	55290	KS	32	-1	804	3.0		0	1.3		0	0.6		0	0.4	0	2.4	0	5.3	0
5194	64.0084	-160.7928	55290	KS	29	-1	789	3.0		0	1.2		0	0.6		0	0.4	0	2.2	0	5.5	0
5195	64.0084	-160.7918	55289	KS	31	-2	757	3.0		0	1.3		0	0.5		0	0.4	0	2.5	0	5.7	0
5196	64.0084	-160.7908	55289	KS	20	-2	809	2.7		-1	1.2		0	0.5		-1	0.4	0	2.4	0	5.6	0
5197	64.0085	-160.7896	55292	KS	24	-3	771	2.7		-1	1.3		0	0.5		-1	0.5	1	2.9	1	6.0	0
5198	64.0085	-160.7885	55292	KS	20	-3	813	2.9		-1	1.3		0	0.4		-1	0.5	1	3.1	1	6.4	0
5199	64.0085	-160.7875	55292	KS	21	-3	772	2.5		-1	1.4		0	0.4		-1	0.5	1	3.3	1	6.1	0
5200	64.0085	-160.7865	55292	KS	28	-3	764	2.7		-1	1.4		0	0.4		-1	0.5	1	3.4	1	6.7	0
5201	64.0085	-160.7855	55291	KS	29	-3	814	2.4		-1	1.5		0	0.4		-1	0.6	2	3.9	2	6.1	0
5202	64.0086	-160.7843	55291	KS	27	-3	789	2.4		-1	1.4		0	0.4		-1	0.6	2	3.8	2	6.2	0
5203	64.0086	-160.7832	55290	KS	27	-3	770	2.1		-1	1.5		0	0.4		-1	0.7	3	4.0	2	5.7	0
5204	64.0086	-160.7822	55292	KS	18	-4	695	1.9		-1	1.4		0	0.4		-1	0.7	3	4.0	2	5.5	0
5205	64.0087	-160.7812	55292	KS	33	-4	633	1.7		-1	1.5		0	0.3		-1	0.9	3	4.5	3	5.3	0
5206	64.0087	-160.7802	55291	KS	33	-5	618	2.1		-1	1.4		0	0.3		-1	0.7	3	4.1	2	5.9	0
5207	64.0088	-160.7789	55290	KS	32	-5	595	2.1		-1	1.1		0	0.3		-1	0.6	2	3.5	1	6.1	0
5208	64.0088	-160.7779	55290	KS	24	-6	605	2.1		-1	1.0		-1	0.3		-1	0.5	1	3.2	1	6.3	0
5209	64.0088	-160.7769	55291	KS	20	-6	525	1.9		-1	1.0		-1	0.3		-1	0.5	1	3.4	1	6.4	0
5210	64.0088	-160.7759	55291	KS	29	-6	645	1.9		-1	0.8		-1	0.3		-1	0.4	0	2.6	0	6.0	0
5211	64.0089	-160.7747	55291	KS	29	-7	547	2.1		-1	1.0		-1	0.3		-1	0.5	1	3.3	1	6.7	0
5212	64.0089	-160.7736	55290	KS	35	-7	530	2.1		-1	1.0		-1	0.3		-1	0.5	1	3.8	2	7.3	0
5213	64.0089	-160.7726	55289	KS	36	-8	502	1.9		-1	0.9		-1	0.3		-1	0.5	1	3.4	1	6.9	0
5214	64.0090	-160.7714	55289	KS	33	-8	551	2.2		-1	1.0		-1	0.3		-1	0.5	1	3.4	1	7.4	0
5215	64.0090	-160.7704	55289	KS	25	-7	593	2.1		-1	1.0		-1	0.3		-1	0.5	1	3.1	1	6.5	0
5216	64.0091	-160.7693	55289	KS	23	-7	669	2.1		-1	1.1		0	0.3		-1	0.5	1	3.4	1	6.3	0
5217	64.0091	-160.7683	55290	KS	23	-7	617	2.2		-1	1.1		0	0.4		-1	0.5	1	3.0	1	6.1	0
5218	64.0092	-160.7671	55299	KS	20	-7	684	2.5		-1	1.0		-1	0.4		-1	0.4	0	2.5	0	6.3	0
5219	64.0092	-160.7661	55289	KS	30	-7	608	2.7		-1	1.1		0	0.5		-1	0.4	0	2.4	0	6.1	0
5220	64.0092	-160.7651	55288	KS	29	-8	637	3.0		0	1.0		-1	0.5		-1	0.3	0	2.0	0	5.8	0
5221	64.0092	-160.7638	55287	KS	33	-8	852	3.0		0	1.0		-1	0.6		0	0.3	0	1.7	0	5.1	0
5222	64.0093	-160.7628	55287	KS	31	-9	817	3.0		0	1.3		0	0.6		0	0.4	0	2.2	0	5.2	0
5223	64.0093	-160.7618	55287	KS	26	-9	908	3.0		0	1.2		0	0.6		0	0.4	0	1.9	0	4.8	0
5224	64.0094	-160.7606	55288	KS	35	-9	991	3.5		0	1.3		0	0.7		0	0.4	0	1.9	0	5.2	0
5225	64.0094	-160.7596	55288	KS	38	-9	972	3.7		0	1.2		0	0.7		0	0.3	0	1.7	0	5.1	0
5226	64.0094	-160.7585	55288	KS	25	-9	1046	3.7		0	1.4		0	0.7		0	0.4	0	2.0	0	5.0	0
5227	64.0095	-160.7575	55287	KS	24	-8	1050	3.3		0	1.4		0	0.7		0	0.4	0	2.0	0	4.7	0
5228	64.0095	-160.7563	55287	KS	24	-8	1016	3.5		0	1.3		0	0.7		0	0.4	0	1.8	0	4.9	0
5229	64.0095	-160.7553	55288	KS	35	-8	1066	3.8		0	1.2		0	0.8		0	0.3	0	1.6	0	4.9	0
5230	64.0095	-160.7542	55287	KS	27	-7	1065	4.0		0	1.1		0	0.8		0	0.3	0	1.5	-1	5.1	0
5231	64.0095	-160.7530	55287	KS	41	-7	984	4.1		0	0.9		-1	0.8		0	0.2	-1	1.1	-1	5.1	0
5232	64.0096	-160.7520	55286	KS	30	-6	1114	4.3		0	0.9		-1	0.8		0	0.2	-1	1.1	-1	5.2	0
5233	64.0096	-160.7510	55285	KS	34	-6	1082	4.1		0	1.0		-1	0.8		0	0.2	-1	1.2	-1	5.3	0
5234	64.0097	-160.7497	55285	KS	32	-6	1041	4.1		0	1.2		0	0.8		0	0.3	0	1.5	-1	5.2	0
5235	64.0097	-160.7487	[illegible]	KS	30	-6	1071	3.8		0	1.2		0	0.8		0	0.3	0	1.6	0	5.0	0
5236	64.0097	-160.7477	55287	KS	40	-6	996	4.0		0	1.4		0	0.7		0	0.4	0	1.9	0	5.3	0
5237	64.0098	-160.7467	55287	KS	26	-6	1029	3.8		0	1.7		0	0.7		0	0.4	0	2.3	0	5.3	0

A P P E N D I X   H

DOE Single Record Reduced Data Tape

DOE SINGLE RECORD REDUCED DATA TAPE

```
  Line                         Character Number
Number     12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012

   1       02 0978   (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)
   2
   3       SINGLE RECORD REDUCED DATA TAPE
   4
   5       FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)
   6
   7       ITEM      FORMAT     DESCRIPTION
   8       1         A40        QUADRANGLE NAME AS PROJECT IDENTIFICATION
   9       2         A20        NAME OF SUBCONTRACTOR
  10       3         I4         APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
  11       4         I1         NUMBER OF AERIAL SYSTEMS USED TO COLLECT DATA FOR
  12                            THIS QUADRANGLE
  13       4         I1         AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
  14       6         A20        AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR
  15                            FIRST SYSTEM
  16       7         F6.1       NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
  17                            TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE
  18                            IN CPS PER PERCENT K FOR FIRST SYSTEM
  19       8         F6.1       NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
  20                            TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE
  21                            IN CPS PER PPM EQUIVALENT U
  22       9         F6.1       NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
  23                            TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE
  24                            IN CPS PER PPM EQUIVALENT TH
  25       10        I6         BLANK FIELD (999999)
  26       11        F6.3       4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
  27                            PLACES IN SECONDS FOR FIRST SYSTEM
  28       12        F6.3       2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
  29                            PLACES IN SECONDS FOR FIRST SYSTEM
  30       13        I3         NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST
  31                            AERIAL SYSTEM
  32       14        I3         NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST
  33                            AERIAL SYSTEM
  34       15-24     (SAME)     REPEAT OF ITEMS 5-14 FOR SECOND AERIAL SYSTEM
  35        *         *                           *
  36        *         *                           *
  37        *         *                           *
  38       85-94     (SAME)     REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
  39       95        I3         NUMBER OF FLIGHT LINES ON THIS TAPE
  40       96        I4         FIRST FLIGHT LINE NUMBER ON THIS TAPE
  41       97        I6         FIRST RECORD NUMBER OF FIRST FLIGHT LINE
  42       98        I3         JULIAN DATE (DAY OF YEAR) FIRST FLIGHT-LINE DATA WAS
  43                            COLLECTED
  44       99-101    I4,I6,I3   REPEAT OF ITEMS 96-98 FOR SECOND FLIGHT LINE ON THIS
  45                            TAPE
  46        *         *                           *
  47        *         *                           *
  48        *         *                           *
  49       390-392   I4,I6,I3   REPEAT OF ITEMS 96-98 FOR 99TH FLIGHT LINE ON THIS
  50                            TAPE
  51
```

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            Character Number
            12345678901234567890123456789012345678901234567890123456789012345678901

FORMAT FOR SINGLE RECORD REDUCED DATA RECORD (THIRD THRU LAST BLOCK)

ITEM     FORMAT     DESCRIPTION
1        I1         AERIAL SYSTEM IDENTIFICATION CODE
2        I4         FLIGHT LINE NUMBER
3        I6         RECORD IDENTIFICATION NUMBER
4        I6         GMT TIME OF DAY  (HHMMSS)
5        F8.4       LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
6        F8.4       LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
7        F6.1       TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
8        F7.1       RESIDUAL  (IGRF REMOVED) MAGNETIC FIELD INTENSITY
                    TO ONE DECIMAL PLACE IN GAMMAS
9        A8         SURFACE GEOLOGIC MAP UNIT CODE
10       I4         QUALITY FLAG CODES
11       F6.1       APPARENT CONCENTRATION OF TERRESTRIAL POTASSIUM
                    (K-40) TO ONE DECIMAL PLACE IN PERCENT K
12       F4.1       UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL
                    PLACE IN PERCENT K
13       F6.1       APPARENT CONCENTRATION OF TERRESTRIAL URANIUM
                    (BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
14       F4.1       UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL
                    PLACE IN PPM EQUIVALENT U
15       F6.1       APPARENT CONCENTRATION OF TERRESTRIAL THORIUM
                    (TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
16       F4.1       UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL
                    PLACE IN PPM EQUIVALENT TH
17       F6.1       URANIUM-TO-THORIUM RATIO TO ONE DECIMAL PLACE IN
                    PPM EQUIVALENT U PER PPM EQUIVALENT TH
18       F6.1       URANIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN
                    PPM EQUIVALENT U PER PERCENT K
19       F6.1       THORIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN
                    PPM EQUIVALENT TH PER PERCENT K
20       F8.1       GROSS GAMMA (0.4-3.0 MEV) COUNT RATE TO ONE DECIMAL
                    PLACE IN COUNTS PER SECOND
21       F6.1       UNCERTAINTY IN GROSS GAMMA COUNT RATE TO ONE DECIMAL
                    PLACE IN COUNTS PER SECOND
22       F5.1       ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL
                    PLACE IN PPM EQUIVALENT U
23       F4.1       UNCERTAINTY IN ATMOSPHERIC BI-214 4PI CORRECTION
                    TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
24       F4.1       OUTSIDE AIR TEMPERATURE TO ONE DECIMAL PLACE IN
                    DEGREES CELSIUS
25       F5.1       OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
```

APPENDIX I

DOE Raw Spectral Data Tape

DOE RAW SPECTRAL DATA TAPE

```
                        Character Number
12345678901234567890123456789012345678901234567890123456789012

01 0978  (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)

RAW SPECTRAL DATA TAPE

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK ON TAPE)

ITEM      FORMAT     DESCRIPTION
1         A40        QUADRANGLE NAME AS PROJECT IDENTIFICATION
2         A20        NAME OF SUBCONTRACTOR
3         I4         APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
4         I1         AERIAL SYSTEM IDENTIFICATION CODE
5         A20        AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER
6         I3         BFEC CALIBRATION REPORT NUMBER
7         F6.3       4PI SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
                     PLACES IN SECONDS
8         F6.3       2PI SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
                     PLACES IN SECONDS
9         I3         NUMBER OF CHANNELS (0-3 MEV) FOR 4PI SYSTEM
10        I3         NUMBER OF CHANNELS (0-3 MEV) FOR 2PI SYSTEM
11        I3         NUMBER OF FLIGHT LINES ON THIS TAPE
12        I4         FIRST FLIGHT LINE NUMBER ON THIS TAPE
13        I6         FIRST RECORD NUMBER OF FIRST FLIGHT LINE
14        I3         JULIAN DATA (DAY OF YEAR) FIRST FLIGHT LINE WAS
                     COLLECTED
15-17     I4,I6,I3   REPEAT OF ITEMS 12-14 FOR SECOND FLIGHT LINE ON THIS
                     TAPE
 *         *                         *
 *         *                         *
 *         *                         *
306-308   I4,I6,I3   REPEAT OF ITEMS 12-14 FOR 99TH FLIGHT LINE ON THIS
                     TAPE

FORMAT FOR RAW SPECTRAL DATA RECORD (THIRD THRU LAST BLOCK ON TAPE)

ITEM      FORMAT     DESCRIPTION
1         I1         AERIAL SYSTEM IDENTIFICATION CODE
2         I4         FLIGHT LINE NUMBER
3         I6         RECORD IDENTIFICATION NUMBER
4         I6         GMT TIME OF DAY (HHMMSS)
5         F8.4       LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
6         F8.4       LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
7         F6.1       TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
8         F7.1       TOTAL MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE
                     IN GAMMAS
9         A8         SURFACE GEOLOGIC MAP UNIT CODE
10        I4         QUALITY FLAG CODES
11        F4.1       OUTSIDE AIR TEMPERATURE TO ONE DECIMAL PLACE IN
                     DEGREES CELSIUS
12        F5.1       OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
13        F5.3       LIVE TIME COUNTING PERIOD TO THREE DECIMAL PLACES IN
                     SECONDS
14        I4         SUMMED RAW OUTPUT FROM COSMIC CHANNELS (3-6 MEV) IN
                     COUNTS
```

Line Number	Character Number 123456789012345678901234567890123456789012345678901234567890123456789012		
54	15	I4	RAW OUTPUT FROM CHANNEL 1 IN COUNTS
55	16	I4	RAW OUTPUT FROM CHANNEL 2 IN COUNTS
56	*	*	*
57	*	*	*
58	*	*	*
59	270	I4	RAW OUTPUT FROM CHANNEL 256 IN COUNTS

A P P E N D I X K

DOE Statistical Analysis Data Tape

DOE STATISTICAL ANALYSIS DATA TAPE

```
Line              Character Number
Number   1234567890123456789012345678901234567890123456789012345678901234567890123456789012

         03 0978  (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)

         STATISTICAL ANALYSIS DATA TAPE

         FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

         ITEM       FORMAT     DESCRIPTION
         1          A40        QUADRANGLE NAME AS PROJECT IDENTIFICATION
         2          A20        NAME OF SUBCONTRACTOR
         3          I4         APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
         4          I1         NUMBER OF AERIAL SYSTEMS USED TO COLLECT DATA FOR
                               THIS QUADRANGLE
         5          I1         AERIAL SYSTEM IDENTIFICATION CODE FOR FIRST SYSTEM
         6          A20        AIRCRAFT IDENTIFICATION BY TYPE AND FAA NUMBER FOR
                               FIRST SYSTEM
         7          F6.1       NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
                               TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE
                               IN CPS PER PERCENT K
         8          F6.1       NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
                               TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE
                               IN CPS PER PPM EQUIVALENT U
         9          F6.1       NOMINAL ALTITUDE SYSTEM SENSITIVITY RELATIVE TO
                               TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE
                               IN CPS PER PPM EQUIVALENT TH
         10         I6         BLANK FIELD (999999)
         11         F6.3       4PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
                               PLACES IN SECONDS FOR FIRST SYSTEM
         12         F6.3       2PI-SYSTEM DATA COLLECTION INTERVAL TO THREE DECIMAL
                               PLACES IN SECONDS FOR FIRST SYSTEM
         13         I3         NUMBER OF CHANNELS (0-3 MEV) IN 4PI SYSTEM FOR FIRST
                               AERIAL SYSTEM
         14         I3         NUMBER OF CHANNELS (0-3 MEV) IN 2PI SYSTEM FOR FIRST
                               AERIAL SYSTEM
         15-24      (SAME)     REPEAT OF ITEMS 5-14 FOR AERIAL SYSTEM
          *          *                             *
          *          *                             *
          *          *                             *
         85-94      (SAME)     REPEAT OF ITEMS 5-14 FOR NINTH AERIAL SYSTEM
         95         I3         NUMBER OF FLIGHT LINES ON THIS TAPE
         96         I4         FIRST FLIGHT LINE NUMBER ON THIS TAPE
         97         I6         FIRST RECORD NUMBER OF FIRST FLIGHT LINE
         98         I3         JULIAN DATE (DAY OF YEAR) FIRST FLIGHT LINE DATA WAS
                               COLLECTED
         99-101     I4,I6,I3   REPEAT OF ITEMS 96-98  FOR SECOND FLIGHT LINE ON THIS
                               TAPE
          *          *                             *
          *          *                             *
          *          *                             *
         390-392    I4,I6,I3   REPEAT OF ITEMS 96-98 FOR 99TH FLIGHT LINE ON THIS
                               TAPE
```

Character Number

12345678901234567890123456789013456789012345678901234567890123456789012

FORMAT FOR STATISTICAL ANALYSIS DATA RECORD (THIRD THRU LAST BLOCK)

ITEM	FORMAT	DESCRIPTION
1	I1	AERIAL SYSTEM IDENTIFICATION CODE
2	I4	FLIGHT LINE NUMBER
3	I6	RECORD IDENTIFICATION NUMBER
4	I6	GMT TIME OF DAY (HHMMSS)
5	F8.4	LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
6	F8.4	LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
7	F6.1	TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
8	F7.1	RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE IN GAMMAS
9	A8	SURFACE GEOLOGIC MAP UNIT CODE
10	I5	QUALITY FLAG CODES
11	F6.1	AVERAGED CONCENTRATION OF TERRESTRIAL POTASSIUM (K-40) TO ONE DECIMAL PLACE IN PERCENT K
12	F4.1	UNCERTAINTY IN TERRESTRIAL POTASSIUM TO ONE DECIMAL PLACE IN PERCENT K
13	F5.1	POTASSIUM STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
14	F6.1	AVERAGED CONCENTRATION OF TERRESTRIAL URANIUM (BI-214) TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
15	F4.1	UNCERTAINTY IN TERRESTRIAL URANIUM TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
16	F5.1	URANIUM STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
17	F6.1	AVERAGED CONCENTRATION OF TERRESTRIAL THORIUM (TL-208) TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
18	F4.1	UNCERTAINTY IN TERRESTRIAL THORIUM TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
19	F5.1	THORIUM STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
20	F8.1	GROSS GAMMA (0.4-3.0 MEV) COUNT RATE TO ONE DECIMAL PLACE IN COUNTS PER SECOND
21	F6.1	UNCERTAINTY IN GROSS GAMMA COUNT RATE TO ONE DECIMAL PLACE IN COUNTS PER SECOND
22	F5.1	ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
23	F4.1	UNCERTAINTY IN ATMOSPHERIC BI-214 4PI CORRECTION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
24	F6.1	AVERAGED URANIUM-TO-THORIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
25	F5.1	URANIUM-TO-THORIUM RATIO STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
26	F6.1	AVERAGED URANIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
27	F5.1	URANIUM-TO-POTASSIUM RATIO STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED
28	F6.1	AVERAGED THORIUM-TO-POTASSIUM RATIO TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
29	F5.1	THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION FROM THE MEAN TO ONE DECIMAL PLACE AND ALGEBRAICALLY SIGNED

APPENDIX L

DOE Statistical Analysis Summary Data Tape

DOE STATISTICAL ANALYSIS SUMMARY DATA TAPE

Character Number
1234567890123456789012345678901234567890123456789012345678901234567890123456789012

05 0978 (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODE)

STATISTICAL ANALYSIS SUMMARY TAPE (OR FILE)

FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

ITEM	FORMAT	DESCRIPTION
1	A40	QUADRANGLE NAME AS PROJECT IDENTIFICATION
2	A20	NAME OF SUBCONTRACTOR
3	I4	APPROXIMATE DATE OF SURVEY (MONTH, YEAR)
4	I6	NUMBER OF GEOLOGIC MAP UNITS USED FOR THIS QUADRANGLE

FORMAT FOR STATISTICAL ANALYSIS SUMMARY DAT RECORD (THIRD THRU LAST BLOCK)

ITEM	FORMAT	DESCRIPTION
1	A8	SURFACE GEOLOGIC MAP UNIT IDENTIFYING CODE
2	I6	TOTAL RECORDS FOR GEOLOGIC MAP UNIT
3	I6	NUMBER OF POTASSIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
4	F6.1	POTASSIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN PERCENT K
5	F6.1	POTASSIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PERCENT K
6	A3	POTASSIUM CONCENTRATION DISTRIBUTION CODE
7	I6	NUMBER OF URANIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
8	F6.1	URANIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
9	F6.1	URANIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U
10	A3	URANIUM CONCENTRATION DISTRIBUTION CODE
11	I6	NUMBER OF THORIUM RECORDS COMPUTED FOR GEOLOGIC UNIT
12	F6.1	THORIUM CONCENTRATION MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
13	F6.1	THORIUM CONCENTRATION STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT TH
14	A3	THORIUM CONCENTRATION DISTRIBUTION CODE
15	I6	NUMBER OF URANIUM-TO-THORIUM RATIO RECORDS COMPUTED FOR GEOLOGIC UNIT
16	F6.1	URANIUM-TO-THORIUM RATIO MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
17	F6.1	URANIUM-TO-THORIUM RATIO STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PPM EQUIVALENT TH
18	A3	URANIUM-TO-THORIUM RATIO DISTRIBUTION CODE
19	I6	NUMBER OF URANIUM-TO-POTASSIUM RATIO RECORDS COMPUTED FOR GEOLOGIC UNIT
20	F6.1	URANIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
21	F6.1	URANIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE DECIMAL PLACE IN PPM EQUIVALENT U PER PERCENT K
22	A3	URANIUM-TO-POTASSIUM RATIO DISTRIBUTION CODE

Line Number	Character Number 1234567890123456789012345678901234567890123456789012345678901234567890123456789012		
54	23	I6	NUMBER OF THORIUM-TO-POTASSIUM RATIO RECORDS
55			COMPUTED FOR GEOLOGIC UNIT
56	24	F6.1	THORIUM-TO-POTASSIUM RATIO MEAN TO ONE DECIMAL PLACE
57			IN PPM EQUIVALENT TH PER PERCENT K
58	25	F6.1	THORIUM-TO-POTASSIUM RATIO STANDARD DEVIATION TO ONE
59			DECIMAL PLACE IN PPM EQUIVALENT TH PER PERCENT K
60	26	A3	THORIUM-TO-POTASSIUM RATIO DISTRIBUTION CODE

A P P E N D I X   M

DOE Magnetic Data Tape

DOE MAGNETIC DATA TAPE FORMAT

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                                 Character Number
            1234567890123456789012345678901234567890123456789012345678901234567890123456789012

            04 0978   (DATA TAPE TYPE AND FORMAT SPECIFICATION DATE CODES)

            MAGNETIC DATA TAPE

            FORMAT FOR TAPE IDENTIFICATION BLOCK (SECOND BLOCK)

            ITEM      FORMAT     DESCRIPTION
            1         A40        QUADRANGLE NAME AS PROJECT IDENTIFICATION
            2         A20        NAME OF SUBCONTRACTOR
            3         I4         APPROXIMATE DATA OF SURVEY (MONTH, YEAR)
            4         I3         NUMBER OF FLIGHT LINES ON THIS TAPE
            5         I4         FIRST FLIGHT LINE ON THIS TAPE
            6         I6         FIRST RECORD NUMBER OF FIRST FLIGHT LINE
            7         I3         JULIAN DATA (DAY OF YEAR) FIRST FLIGHT LINE DATA WAS
                                 COLLECTED
            8         F8.4       LATITUDE OF GROUND BASE STATION TO FOUR DECIMAL
                                 PLACES IN DEGREES FOR FIRST FLIGHT LINE
            9         F8.4       LONGITUDE OF GROUND BASE STATION TO FOUR DECIMAL
                                 PLACES IN DEGREES FOR FIRST FLIGHT LINE
            10-14     (SAME)     REPEAT OF ITEMS 5-9 FOR SECOND FLIGHT LINE ON THIS
                                 TAPE
             *         *                        *
             *         *                        *
             *         *                        *
            495-499   (SAME)     REPEAT OF ITEMS 5-9 FOR 99TH FLIGHT LINE ON THIS
                                 TAPE

            FORMAT FOR MAGNETIC DATA RECORD (THIRD THRU LAST BLOCK)

            ITEM      FORMAT     DESCRIPTION
            1         I1         AERIAL SYSTEM IDENTIFICATION CODE
            2         I4         FLIGHT LINE NUMBER
            3         I6         RECORD IDENTIFICATION NUMBER
            4         I6         GMT TIME OF DAY (HHMMSS)
            5         F8.4       LATITUDE TO FOUR DECIMAL PLACES IN DEGREES
            6         F8.4       LONGITUDE TO FOUR DECIMAL PLACES IN DEGREES
            7         F6.1       TERRAIN CLEARANCE TO ONE DECIMAL PLACE IN METERS
            8         F5.1       OUTSIDE AIR PRESSURE TO ONE DECIMAL PLACE IN MMHG
            9         A8         SURFACE GEOLOGIC MAP UNIT CODE
            10        F7.1       TOTAL MAGNETIC FIELD INTENSITY TO ONE DECIMAL PLACE
                                 IN GAMMAS
            11        F7.1       RESIDUAL (IGRF REMOVED) MAGNETIC FIELD INTENSITY
                                 TO ONE DECIMAL PLACE IN GAMMAS
            12        F7.1       DIURNAL MAGNETIC INTENSITY VARIATION TO ONE DECIMAL
                                 PLACE IN GAMMAS
            13        F7.1       MAGNETIC DEPTH-TO-BASEMENT TO ONE DECIMAL PLACE
                                 IN METERS (IF REQUIRED)
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APPENDIX N

Reduced Calibration and Test Line Data

REDUCED CALIBRATION AND TEST LINE DATA

DATE	FLIGHT	RES. THOR. .583	RES. THOR. 2615	LOW PRE ALT.	LOW PRE T.C.	LOW PRE 2π	LOW POST ALT.	LOW POST T.C.	LOW POST 2π
09/08/79	62	9.9	5.6				380	1350	27
09/08/79	63	9.9	5.6				380	1350	27
09/08/79	64	9.9	5.6				380	1350	27
09/09/79	67	10.3	5.9	380	2000	35	340	2100	35
09/11/79	68	9.4	5.8	350	2400	25	440	2200	35
09/11/79	69	9.4	5.8	350	2400	25	440	2200	35
09/11/79	70	9.4	5.8	350	2400	25	440	2200	35
09/11/79	71	9.4	5.8	350	2400	25	440	2200	35
09/12/79	72	10.0	5.7	380	2500	30	400	2500	35
09/12/79	73	10.0	5.7	380	2500	30	400	2500	35