U.S. DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Uranium, potassium, and thorium contour maps derived from a helicopter gamma-ray spectrometer survey of the Getchell Trend, Humboldt County, Nevada

Survey conducted and maps

prepared by TerraSense, Inc.

With an introduction by

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U.S. Geological Survey

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Introduction

by James A. Pitkin and Patricia L. Hill

The U.S. Geological Survey (USGS) contracted with TerraSense, Inc., of Sunnyvale, Calif., for a helicopter gamma-ray spectrometer survey of the Getchell Trend, Humboldt County, Nevada (Figure 1). The survey was flown October 27-November 1, 1988, along 1/4 mi (400 m) spaced flight lines oriented N.58° W. at 400 ft (122 m) above ground level. The survey aggregated 182 square miles (466 km^2) and included two tie lines flown approximately normal to survey lines.

The survey measured terrestrial gamma-rays from the natural radioelements uranium, potassium, and thorium with 2048 cubic inches (33 liters) of sodium iodide (thallium-activated) crystals and monitored the distribution of radon in air with 512 cubic inches (8 liters) of sodium iodide crystals. The gamma-ray data were corrected for background radioactivity, spectral backscatter, and radon in air; were altitude normalized; and were converted to concentration units of parts per million for uranium and thorium and percent for potassium. The conversion of the gamma-ray data to concentration units was enabled by calibration of the helicopter system at the Department of Energy sites at Grand Junction, Colorado (Ward, 1978), and Lake Meade, Nevada (Geodata International, Inc., 1977), and by flying an altitude curve over Utah Lake near Provo, Utah. We believe the additional expense of these calibrations to be worthwhile, because they permit the reporting of survey results in the quantitative units of parts per million and percent rather than the usual counts per unit time (generally seconds). Equilibrium in the uranium and thorium decay series is assumed.

The Getchell Trend lies on the east side of the Osgood Mountains and includes five operating gold mines and other known and potential mineralized areas. The contract gamma-ray spectrometer survey is part of a U.S. Geological Survey program to investigate geophysical techniques for mineral exploration in covered terrain. The geophysical study of the Getchell Trend is discussed by Hoover and others (1988).

Fully corrected and quantitatively reduced 200-m (656 ft) grid files of uranium, potassium, and thorium were used to produce the contour maps of this report at scale 1:24,000. The survey area at scale 1:24,000 conveniently subdivides into four parts. The uranium maps are sheets 1 through 4 (see bottom right of each sheet), the potassium maps are sheets 5 through 8, and the thorium maps are sheets 9 through 12. Also included in the report is the TerraSense final report to the U.S. Geological Survey that describes the helicopter, the geophysical equipment, its calibration, and acquisition and reduction of the gamma-ray spectrometer data.

The 200 m (656 ft) digital grid files used to prepare the maps of this report are available by purchase from:

Ron Buhmann, Tape Librarian, MCG
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Mountain Administrative Support Center
325 Broadway
Boulder, CO 80303-3328
Telephone: 303/497-6128

References

Geodata International, Inc., 1977, Lake Meade dynamic test range for calibration of airborne gamma radiation measuring systems: U.S. Department of Energy Open-File Report GJBX-46(77), 83 p.

Hoover, D. B., Grauch, V. J. S., Krohn, M. D., Labson, V. F., and Pitkin, J. A., 1988, The Getchell Trend airborne geophysical demonstration project, north-central Nevada, in Schindler, K.S., (ed.), USGS research on mineral resources--1989, program and abstracts: U.S. Geological Survey Circular 1035, p. 32.

Ward, D. L., 1978, Construction of calibration pads facility, Walker Field, Grand Junction, Colorado: U.S. Department of Energy Open-File Report GJBX-37(78), 57 p.

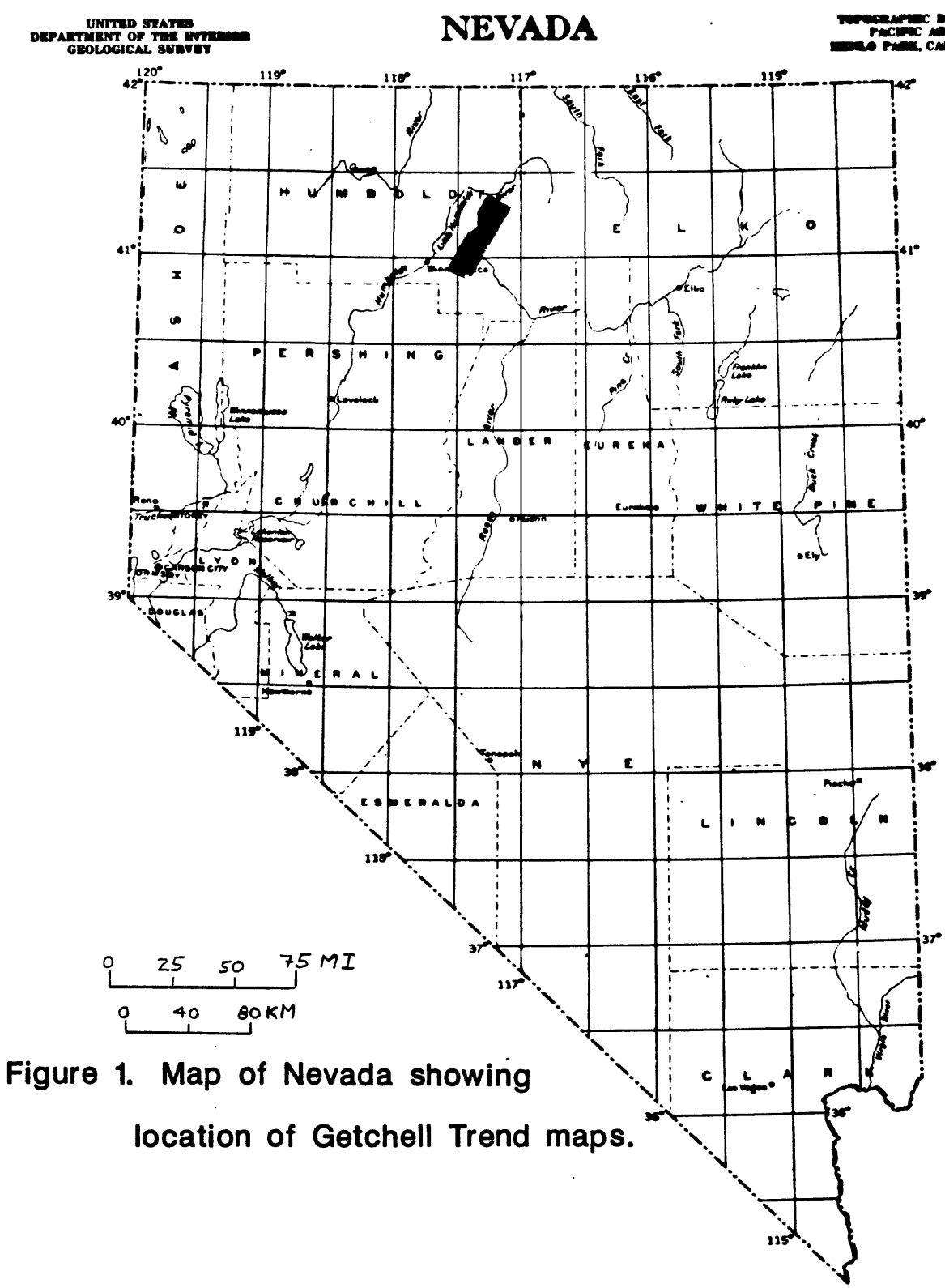

Figure 1. Map of Nevada showing location of Getchell Trend maps.

Operational Report

Helicopter Gamma-ray Spectrometer Survey

Getchell Area, Nevada

Contract # 14-08-0001-22632

by

TerraSense, Inc.

January, 1989

This report is submitted in fulfillment of contract #14-08-0001-22632 between the United States Geological Survey and TerraSense, Inc. 395 java drive, Sunnyvale, California 94089.

Summaries of the equipment used, calibration procedures, production flying, compilation, and data tape descriptions comprise this operations report.

Equipment

Helicopter - SA315B Lama, Reg # N3597D
Camera - Color video
Spectrometer system - Geometrics GR-800 & GR-900
Geometrics DET-2048/512R
(2048 in^3 down, 512 in^3 up NaI)
Digital recorder - Geometrics G-714
Analog recorder - RMS GR33
Radar altimeter - Honeywell YG7600
Barometric altimeter - Rosemount
Thermometer - Davtron M 301C

Calibration

After installing and testing all the equipment at Rocky Mountain Helicopter's facilities, a high-altitude flight for aircraft and cosmic background was completed on 22 October near Provo, Utah.

The helicopter was moved to Grand Junction, Colorado to acquire data over the Walker Field Static Test Pads. The Lama helicopter was then ferried to Boulder City, Nevada for the Dynamic Test Range flying at Lake Meade. On 26 October, 30 calibration lines were flown, 3 each at the specified altitudes of 100 to 1000 feet, 100 feet apart over the test range. In addition, two more high-altitude flights were flown.

Walker Field Test Pad Results

Window	channel 1	channel 2*
K40d	116	132
Bi214d	141	157
Tl208d	204	237
Totald	34	254
Cosmicd	255	255
K40u	372	388
Bi214u	344	357
"	396	460
Tl208u	460	493
Cosmicu	511	511

* Channel numbers range 0-511

Stripping Coefficients Sij, as defined in TSI's Technical bid (ie. the effect of the "j" window on the "i" window)

Sut	Skt	Sku	Stu	Suk	Stk	Sct(ppu)
.28866	.15366	.84434	.081393	0.0	0.0	.000065

High Altitude Results

Aircraft background

Window	cps
K40d	13.6
Bi214d	10.3
Tl208d	2.6
Totald	173.6
K40u	4.1
Bi214uw	8.7
Tl208u	1.0

Cosmic background

Window	cps(per 1000 counts cosmic)
K40d	131.3
Bi214d	101.9
Tl208d	150.8
Totald	2265.7
K40u	144.6
Bi214uw	575.5
Tl208u	159.2

Attenuation Coefficients from Lake Meade Test Range

Window	Coefficient
K40d	0.002720
Bi214d	0.001846
Tl208d	0.001827
Totald	0.001361

Field Survey

After calibration, the helicopter was ferried to Winnemucca, Nevada to begin production flying. Daily calibration procedures were performed as detailed in TSI's Technical Bid. This included flying a Test Line before and after each flight to ensure repeatability of each day's flying.

For each flight, the pilot would fly the preset flight lines as drawn on the 1:24,000 topographic maps. He maintained the nominal flight altitude of 400 feet above terrain while the operator/navigator directed the pilot by visually matching the maps to the terrain. After each day's flying, the analog

records were examined for data problems. If any were found, that portion was marked for reflights.

When the survey was finished, the helicopter and crew remained on site until the digital data were verified in Sunnyvale, California.

A total of 4 flights, beginning on 28 October and ending on 31 October, was required to finish the survey. Flight logs detailing the 128 traverses and two tie-lines are included at the end of this report.

Compilation

The digital airborne data were loaded from magnetic tape onto TSI's Sun 3/280 computer system. The GPIB spectrometer channel data were decoded into window data in counts per second and placed into TSI's database. Altimeter and temperature data were calibrated into real units - feet, degrees.

All data were checked for errors, noise, missing and duplicate data. The raw gamma-ray data were corrected for :

- aircraft background
- cosmic background
- stripping(Compton scatter)
- pulse pileup
- airborne radon - Bi214 only
- altitude variations from 400 feet mtc

Corrected window values less than zero were set to 0.0.

The color video film was used to select clearly identifiable features on the topographic maps to locate the actual position of the helicopter over the ground. These locations were marked with the corresponding fiducial from the video and digitized in UTM coordinates with a Calcomp 9100 digitizer. The digitized locations were uploaded to the Sun 3/280 and plotted to verify proper flight path recovery.

These locations were then merged with the corrected digital data using the fiducial numbers for synchronization. Then the data were interpolated using TSI's proprietary minimum curvature algorithm. The primary(interpolated) grid size was 200 meters, which was splined to 50 meters for contouring purposes.

The 3 elemental contour maps - K40, %, bi214 ppmeU, Tl208 ppmeT - were plotted on a Benson-Varian electrostatic plotter on paper and photographed onto the final mylar base.

Data Tapes

The Gridded data tape contains :

Header record - 45 characters as :

Project name	Getchell, Nev.
Contractor	TerraSense
Central meridian	-117
False easting	500000
False northing	4000000

Data record - 45 characters :	Format
Row	I5
Column	I5
UTM easting(meters)	F10.0
UTM northing(meters)	F10.0
K40 %	F5.2
ppmeU	F5.1
ppmeT	F5.1

Invalid values are represented as :

K40	-9.99
ppmeU	-99.9
ppmeT	-99.9

Tape block size = 7,200 characters; last block is less.

The Profile digital data tape contains :

Header record - 90 characters as :

Project name	Getchell Area
State	Nevada
Contractor	TerraSense, Inc.
Computer	Sun 3/280

Data record - 90 characters :	Format
Line number	I4
Line direction	A2
Fiducial	I7
Year & Julian date	I5
Time (HHMMSS)	I6
Latitude	F8.4
Longitude	F9.4
Radar altitude(feet)	F5.1
Barometric altitude(feet)	I5
Percent K40	F5.1
ppm Bi214	F5.1
ppm Tl208	F5.1
Atmospheric Bi214(cps)	F4.1
Cosmic(cps)	F5.1
Total count(cps)	I6
Air temperature(deg C)	F4.1
Air pressure(mm Hg)	F5.1

Tape block size = 9,000 characters; last block is less.