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GRAVITY, MAGNETIC, AND PHYSICAL PROPERTY DATA OF THE DEEP CREEK RANGE AND VICINITY, EASTERN NEVADA AND WESTERN UTAH

By

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INTRODUCTION

Gravity, magnetic, and physical property data were collected in the vicinity of the Deep Creek Range, Nevada and Utah, as part of a geophysical assessment of the Goshute Indian Reservation. Together these data can be used as an aid to determine the relationship between geology, gravity anomalies, magnetic anomalies, physical properties, and to model subsurface geologic structure.

ACKNOWLEDGMENTS

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GRAVITY DATA

There are approximately 585 gravity stations in the study area and about 424 of these are new gravity stations collected in the vicinity of the Goshute Indian Reservation by the U.S. Geological Survey (fig 1.). Previous gravity data were compiled from U.S. Geological Survey, Stanford University, and the U.S. Department of Defense gravity files (Ponce and others, 1984; National Geophysical Data Center, 1988; Ponce, 1992). Pre-existing gravity coverage of the study area was poor, with about a third of the study area having no stations per 5 x 5 km (25 km^2) compartment.

Data were obtained by making gravity measurements at known elevations, usually at 'spot' elevations or bench marks shown on topographic maps. Some stations were surveyed by the gravity crew using an electronic distance measuring device using spot elevations or benchmarks for vertical and horizontal control.

Gravity data were reduced using the Geodetic Reference System of 1967 (International Union of Geodesy and Geophysics, 1971) and referenced to the International Gravity Standardization Net 1971 gravity datum (Morelli, 1974, p. 18). Observed gravity values were tied to base stations descibed by Ponce (1992) and include ELYA, at the Ely Airport, Nevada; and IBAPA, at the Ibapah School, Nevada. Gravity data were reduced to complete Bouguer anomalies for a reduction density of 2.67 g/cm^3.

Gravity stations were processed by applying standard corrections to the data and include: a field reading to gravity unit conversion, which converts readings in arbitrary units to mGal by using manufacturer determined factors and a calibration constant determined by repeated measurements over established calibration loops (Ponce and Oliver, 1981); an earth-tide correction, which removes the effect of the tidal attraction of the sun and moon; the instrument drift correction, which accounts for nonelastic changes in the instrument's spring and temperature effects; a free-air correction, which accounts for the different elevation of each station; a Bouguer correction, which accounts for the attraction of rock material between the station and sea-level; a latitude correction, which takes into account the variation of the Earth's gravity at sea-level with latitude; the curvature correction, which corrects for the Earth's curvature; a terrain correction, which removes the effect of topography; and an isostatic correction, which removes long-wavelength variations in the gravity field and is based on a model of isostatic compensation.

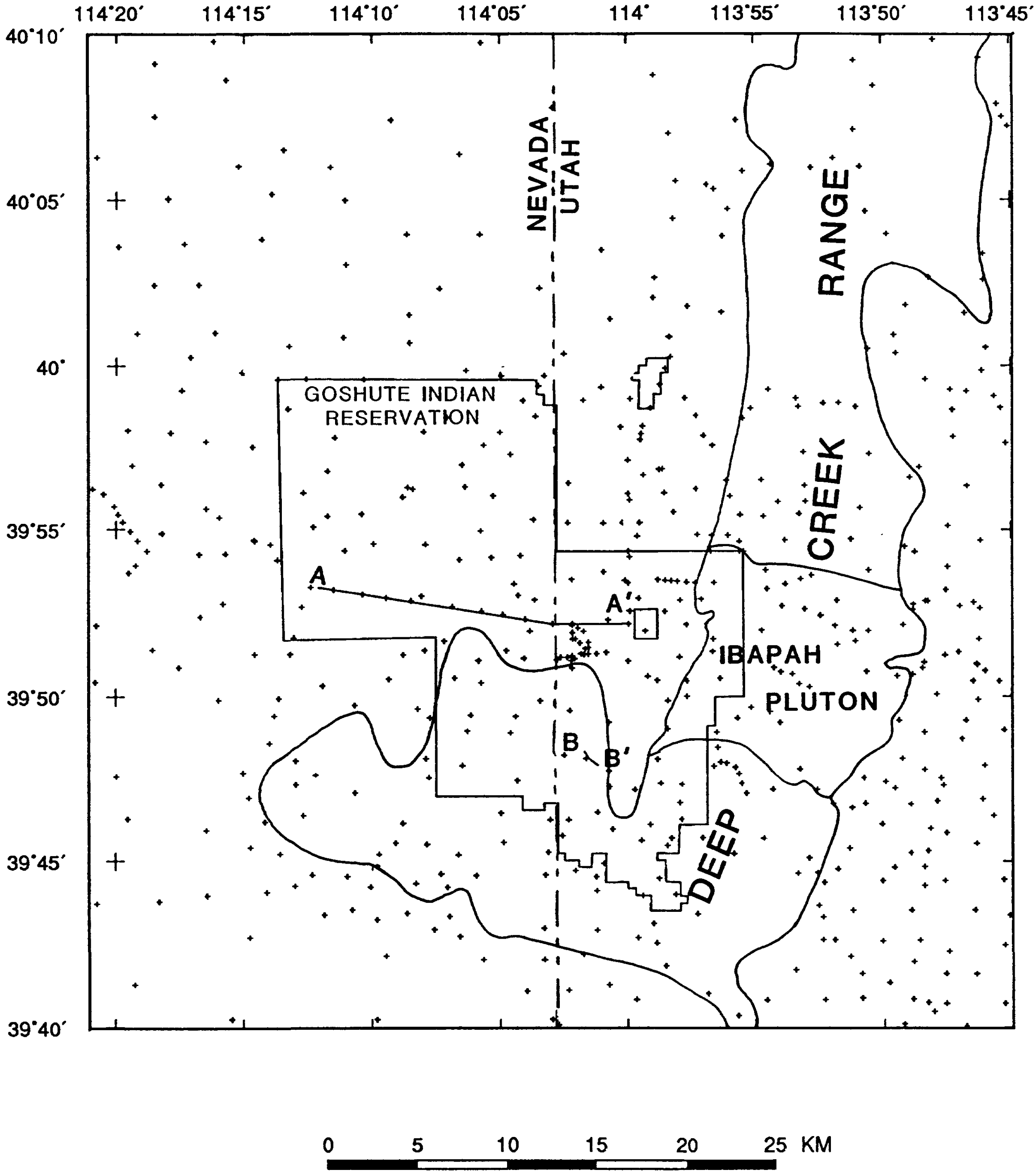

FIGURE 1.–Index map of the Deep Creek Range and vicinity showing gravity station locations and ground magnetic traverses AA' and BB'.

Terrain corrections were computed to a radial distance of 166.7 km and involved a three-part process: (1) Hayford-Bowie zones A and B (Hayford and Bowie, 1912) with an outer radius of 68 m were estimated in the field with the aid of tables and charts, or sketched and later calculated in the office; (2) Hayford-Bowie zones C and D with an outer radius of 0.59 km or in areas of mountainous terrain, zones C, D, E, and F with an outer radius of 2.29 km were calculated by averaging compartment elevations using a 1:24,000-scale topographic map and a circular template based on Hayford's system of zones (see Spielman and Ponce, 1984); and (3) terrain corrections from a distance of 0.59 km (zone D) or 2.29 km (zone F) to 166.7 km were calculated using a digital elevation model and a procedure by Plouff (1977).

Isostatic corrections were removed from the Bouguer gravity field assuming an Airy-Heiskanen model for isostatic compensation of topographic loads (Simpson and others, 1983) with an assumed sea-level crustal thickness of 25 km, a crustal density of 2.67 g/cm^3, and a density contrast across the base of the crust of 0.4 g/cm^3. A discussion of the isostatic correction and its significance is given by Simpson and others (1986).

MAGNETIC DATA

Nine aeromagnetic surveys exist in the vicinity of the the study area (Hill, 1991). Figure 2 shows the boundaries of the aeromagnetic surveys and table 1 lists these surveys in chronological order by year flown and gives the survey specifications. All of the aeromagnetic surveys, with the exception of the Mt. Moriah survey (table 1, fig. 2, area 9), are inadequate for detailed magnetic investigations but can be used for general investigations of the study area.

Two ground magnetic traverses (AA' and BB', fig. 1) were collected within the Goshute Indian Reservation to determine the magnetic signature across a pediment and to determine whether or not the Bismark Mine (near B', fig. 1) was related to possible magnetic rocks. Ground magnetic data were processed by applying a diurnal drift correction to the observed readings which removes the effect of cyclical daily fluctuations of the Earth's magnetic field. These corrections were determined by periodically reoccupying a base station during the magnetic survey.

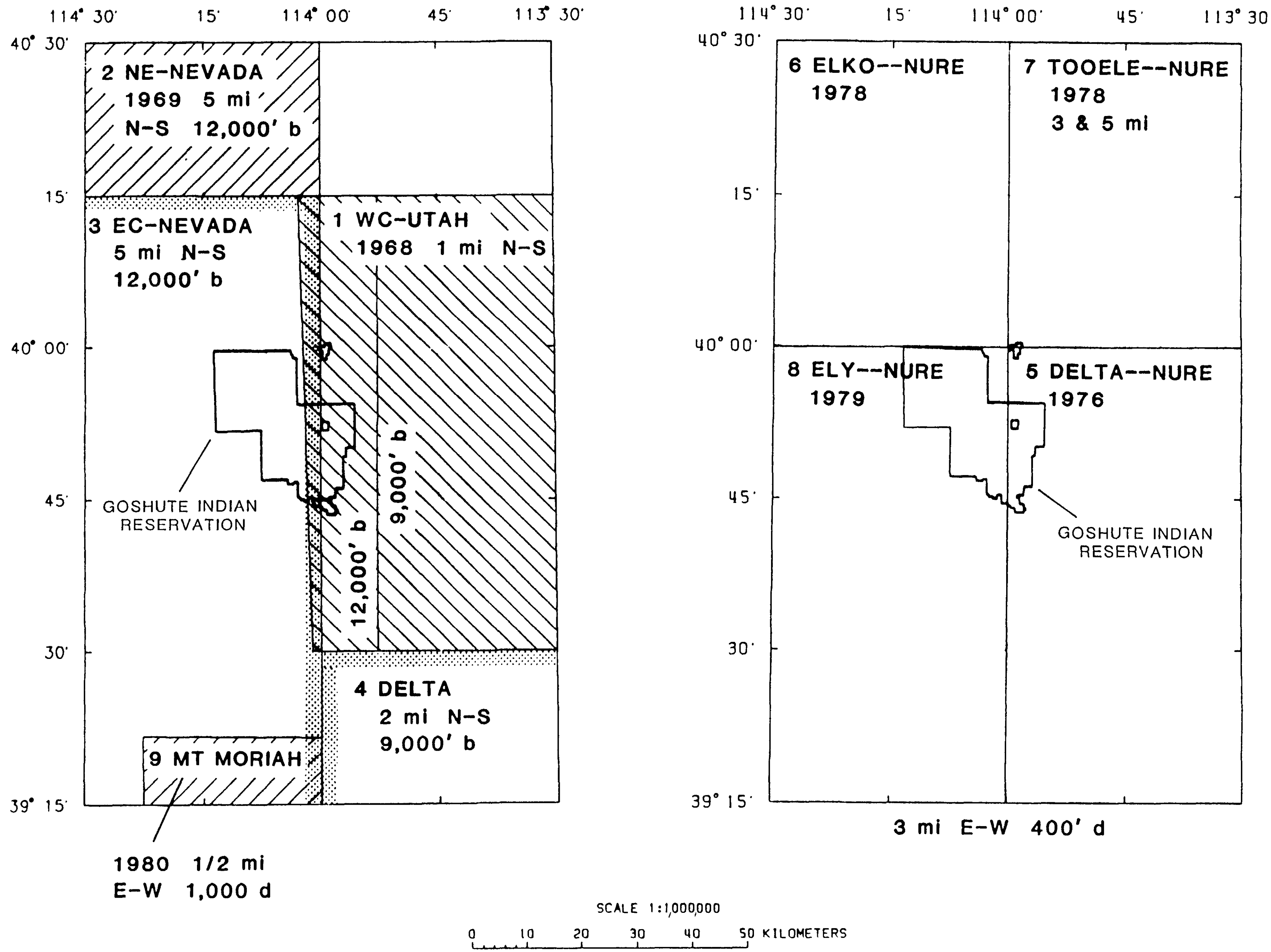

FIGURE 2.-Index of aeromagnetic surveys of the Deep Creek Range and vicinity showing survey number, name, year flown, flight-line spacing, direction, and elevation..

PHYSICAL PROPERTY DATA

DENSITY DATA

About 166 density measurements were made in the vicinity of the Deep Creek Range (fig. 3). The densities of selected rock types are listed in table 2. Densities of all rock samples were measured in the laboratory using an electronic balance and the buoyancy method. Densities of each sample were determined using the following formulas:

Grain density $= \frac{W_a}{W_a - W_w}$,

Saturated bulk density $= \frac{W_s}{W_s - W_w}$, and

Dry bulk density $= \frac{W_a}{W_s - W_w}$,

where,

W_a = weight in air,

W_w = saturated weight in water, and

W_s = saturated weight in air.

Density measurements indicate that the Ibapah pluton (fig. 3) has an average grain density of 2.62, an average saturated bulk density of 2.58, and an average dry bulk density of 2.56 g/cm^3. These values are considerably lower than the average dry bulk density of 2.66 g/cm^3 for 334 granite samples reported by Carmichael (1984). Sedimentary and metamorphic rocks of the Deep Creek Range have an average grain density of 2.69 g/cm^3 and range in grain density of about 2.60 to 2.85 g/cm^3. These data indicate that the density of the Ibapah pluton may be about 0.07 g/cm^3 lower than the surrounding rocks, a contrast sufficiently high to use in modeling subsurface structure.

MAGNETIC PROPERTY DATA

About 176 magnetic susceptibility measurements were made in the vicinity of the Deep Creek Range (fig. 3). Most magnetic susceptibility measurements were determined in the laboratory using a handheld SCINTREX susceptibility meter. In addition, some measurements were made in the field at rock outcrops and the remanent magnetization of a number of oriented rock samples of the Ibapah pluton were measured using a cryogenic magnetometer. Rock units in the study area vary from weakly to strongly magnetic based on magnetic susceptibility data and the relationship between lithology and magnetic anomalies. In general, granitic rocks are moderately to strongly magnetic with the exception of weakly magnetic felsic and 2-mica granitic rocks in the southwestern part of the study area. Volcanic rocks have a wide range in magnetic susceptibility and Paleozoic carbonate rocks are essentially nonmagnetic.

Magnetic susceptibility measurements of 87 granitic samples of the Ibapah pluton indicate that these rocks are moderately magnetic with an average susceptibility of about 0.4 x 10^{-3} cgs with a range of 0.0 x 10^{-3} to 1.9 x 10^{-3} cgs (table 2). Magnetic susceptibility measurements at outcrop-scale from 15 sites yield an average susceptibility of about 0.4 x 10^{-3} cgs with a range of 0.0 to 1.0 x 10^{-3} cgs. These values are lower than the 0.8 x 10^{-3} cgs median value determined for 33 samples reported by Nutt and others (1990, p. C26).

Magnetic property measurements on 17 oriented granitic core samples from the Ibapah pluton indicate that the natural remanent magnetization has varied directions and a wide range in magnitude suggesting that most samples have been struck by lightning (table 3). This is not surprising considering that all samples were collected in the highest parts of the range and the long geologic time these samples were exposed to possible lightning strikes. In order to remove the effect of lightning strikes the samples were demagnetized in an alternating magnetic field. An example of a stepwise alternating field demagnetization of a single core is shown in table 4. In addition, several samples were thermally demagnetized to determine the dominant magnetic mineral. An example of a stepwise thermal demagnetization of a sample is shown in table 5.

The characteristic or representative remanent magnetization for all samples that have been demagnetized indicates that granitic rocks of the Ibapah pluton have a low remanent magnetization of about 0.03 x 10^{-3} cgs (table 6). Thermal demagnetization shows that at a temperature of 530° to 587° C these samples become nonmagnetic indicating that magnetite is the dominant magnetic mineral. The pluton also has a low Koenigsberger ratio (Q), the ratio between remanent and induced magnetization, of about 0.1 (table 3 and 5). The low Q indicates that the induced magnetization is responsible for producing the observed magnetic anomaly associated with the Ibapah pluton and suggests that the pluton may extend to great depths (Ponce and Langenheim, 1992).

DESCRIPTION OF DISKETTE

The data described in this report are available on a $3\frac{1}{2}$-inch, high-density, and double-sided diskette formatted for IBM personal computers. The diskette requires the following hardware: (1) an IBM or compatible computer running PC or MS-DOS, and (2) a double-sided, high-density disk drive.

The diskette contains a total of 4 files:

readme.txt, a description of the data and format;

gir.ary, listing of gravity data;

gir.mag, listing of magnetic data;

gir.prp, listing of physical property data;

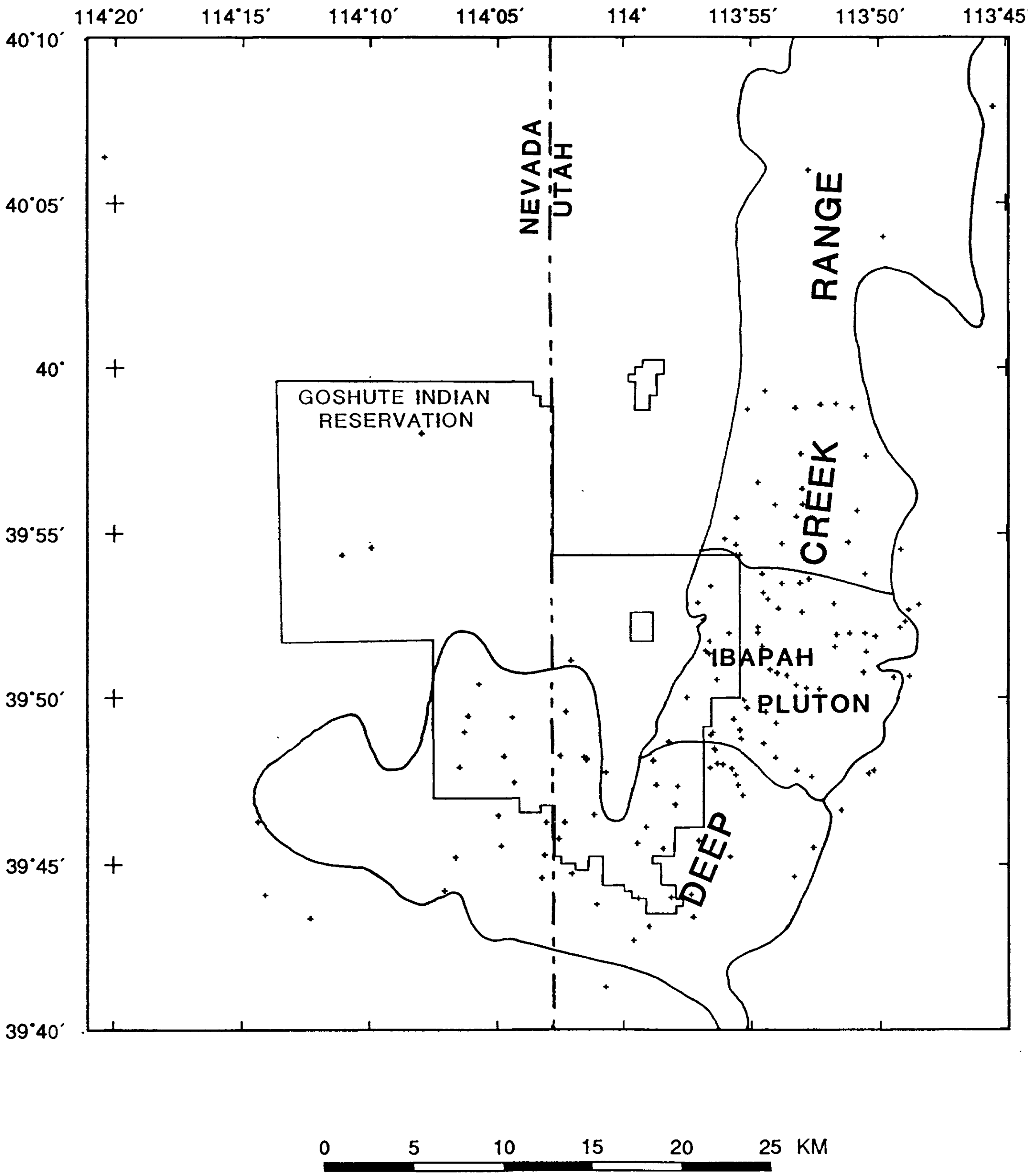

FIGURE 3.–Locations of density and magnetic susceptibility measurements.

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TABLE 1.–*Published aeromagnetic surveys in the vicinity of the Deep Creek Range*

[b, barometric; d, drape; Geodata, Geodata International, Inc.; H-QEB, High-Life Helicopters, Inc. and QEB, Inc.; IGRF, International Geomagnetic Reference Field; na, not available; ni, not indicated; NURE, National Uranium Resource Evaluation program Scintrex, Scintrex Mineral Surveys, Inc.; TI, Texas Instruments, Inc.; USGS, U.S. Geological Survey]

Area	Name	Year flown	Contractor	Elevation (1,000 ft)	Spacing (mi)	Direction	Scale	Gradient removed	Digital	Reference
1	WC-Utah	1968	USGS	9 & 12b	1	N-S	1:250,000	ni	Yes	USGS, 1971
2	NE-Nevada	1969	USGS	12b	5	N-S	1:250,000	ni	No	USGS, 1978b
3	EC-Nevada	na	USGS	12b	5	N-S E-W ENE-WSW	1:250,000	ni	No	USGS, 1978a
4	Delta	na	Scintrex	9b	2	N-S	1:250,000	Yes	No	USGS, 1972
5	Delta-NURE	1976	TI	0.4d	3	E-W	1:500,000	IGRF	Yes	TI, 1979
6	Elko-NURE	1978	Geo-Life	0.4d	3	E-W	1:500,000	IGRF	Yes	Geo-Life, 1979a
7	Tooele-NURE	1978	Geo-Life	0.4d	3 & 5	E-W	1:500,000	IGRF	Yes	Geo-Life, 1979b
8	Ely-NURE	1979	H-QEB	0.4d	3	E-W	1:500,000	IGRF	Yes	H-QEB, 1980
9	Mt Moriah	1980	Geodata	1d	0.5	E-W	1:62,500	IGRF	Yes	USGS, 1981

TABLE 2.–*Physical property measurements of selected rock types in the vicinity of the Deep Creek Range*

[susc., susceptibility]

Lithology	Number of density samples	Grain density g/cm^3	Saturated bulk density g/cm^3	Dry bulk density g/cm^3	Number of susc. samples	Average susc. 10^{-3} cgs	Range in susc. 10^{-3} cgs
Andesite	1	2.46	2.45	2.44	1	0.6	—
Aplite	3	2.61	2.59	2.58	3	0.1	0.1-0.2
Basalt	2	2.34	2.31	2.28	2	0.4	0.4-0.5
Conglomerate	1	2.66	2.64	2.62	1	0.1	—
Diorite	3	2.78	2.76	2.75	2	1.2	0.3-2.2
Granitic							
all samples	71	2.62	2.58	2.56	87	0.4	0.0-1.9
outcrop	-	—	—	—	15	0.4	0.0-1.0
Limestone	36	2.71	2.69	2.67	33	0.0	0.0-0.1
Metasediment	1	2.67	2.67	2.66	1	0.1	—
Mudstone	1	2.57	2.54	2.52	1	0.0	—
Pelite	1	2.74	2.72	2.71	1	0.1	—
Phyllite	3	2.72	2.65	2.60	3	0.0	—
Rhyolite	1	2.21	2.16	2.11	1	0.2	—
Sandstone	4	2.78	2.77	2.75	4	0.0	0.0-0.1
Schist	1	2.83	2.81	2.81	1	0.0	—
Shale	2	2.74	2.68	2.66	2	0.0	—
Siltstone	1	2.27	2.25	2.23	1	—	—
Slate	3	2.68	2.65	2.64	3	0.1	0.1-0.1
Quartzite	29	2.65	2.64	2.63	28	0.0	0.0-0.2
Paleozoic	77	2.69	2.67	2.65	73	0.0	0.0-0.2

TABLE 3.–*Magnetic property measurements of 17 oriented granitic rock samples of the Ibapah pluton*

[D, declination; I, inclination; Jr, remanent magnetization]

Sample	I deg	D deg	Jr 10^{-3} cgs	Comments
127-1	-37.2	249.4	10.0	Part of a single core from 127
127-1A	-15.3	254.7	11.1	Part of a single core from 127
152-1	41.3	67.3	0.0842	
154A-1	-3.5	308.0	0.298	
154B	-30.9	34.5	1.60	
154C-1	27.1	71.3	2.07	Separately drilled core from sample 154C
154C-2	16.4	59.0	2.07	Separately drilled core from sample 154C
154C-3	21.1	40.2	2.37	Separately drilled core from sample 154C
156-1	24.3	144.8	2.77	Separately drilled core from sample 156
156-2	29.2	133.1	2.25	Separately drilled core from sample 156
173-1	53.0	191.4	4.89	
175A	-51.9	243.6	1.21	
175B-1	-55.7	106.9	1.32	Separately drilled core from sample 175B
175B-2	-54.5	111.8	1.61	Separately drilled core from sample 175B
176-1A	82.5	167.1	7.69	Part of a single core from 176
176-1B	80.4	163.5	7.25	Part of a single core from 176
176-2	78.7	200.0	7.64	

TABLE 4.–*Alternating field demagnetization of sample 154C (154C-1)*[1]

[D, declination; I, inclination; Jr, remanent magnetization]

Step	I deg	D deg	Jr 10^{-3} cgs	Peak field oersteds
1	28.2	58.9	1.52	50
2	25.8	52.3	0.880	100
3	31.8	31.8	0.375	150
4	26.6	41.2	0.205	200
5	16.4	37.8	0.112	250
6	9.9	24.4	0.0626	300
7	3.0	26.5	0.0380	350
8	-4.2	28.9	0.0327	400
9	-15.7	27.4	0.0295	450
10	-21.1	26.6	0.0280	500
11	-31.6	26.7	0.0274	550
12	-34.9	20.6	0.0262	600
13	-32.4	21.0	0.0299	650
14	-40.0	24.0	0.0296	700

[1]Indicates that Jr is very low, 0.03 x 10^{-3} cgs.

TABLE 5.–*Thermal demagnetization of sample 154C-3*[1]

[D, declination; I, inclination; Jr, remanent magnetization]

Step	I deg	D deg	Jr 10^{-3} cgs	Temp °C
1	21.1	40.2	2.37	20
2	19.6	39.2	2.06	143
3	19.0	37.6	1.98	188
4	19.1	37.8	1.81	244
5	18.8	36.5	1.54	288
6	16.8	36.2	1.31	341
7	16.9	36.2	0.866	437
8	17.3	35.6	0.679	486
9	16.7	35.7	0.485	533
10	2.7	31.1	0.108	587

[1]Change in slope of Jr versus temperature at about 530° to 587°C indicates that magnetite is the dominant magnetic mineral.

TABLE 6.—*Characteristic remanent magnetization of oriented granitic rock samples*[1]

[Jr, maximum characteristic remanent magnetization; Q, Koenigsberger ratio, the ratio between remanent and induced magnetization; X, susceptibility from hand sample]

Sample	I deg	D deg	Jr 10^{-3} cgs	X 10^{-3} cgs	Q= Jr/.52X	Comments
127-1	-23	152	0.029	0.4	0.1	
127-1A	—	—	—	0.4	—	
152-1	49	90	0.032	0.4	0.2	
154A-1	-76	324	0.0031	0.4	0.01	
154B	—	—	—	0.4	—	
154C-1	-40	24	0.030	0.3	0.2	Poorly constrained
154C-2	—	—	—	0.3	—	
154C-3	—	—	—	0.3	—	
156-1	—	—	—	0.3	—	
156-2	25	198	0.022	0.3	0.1	
173-1	61	202	0.049	0.7	0.1	
175A	-39	246	0.10	0.4	0.5	Poorly constrained
175B-1	-10	98	0.013	0.4	0.1	
175B-2	—	—	—	0.4	—	
176-1A	78	68	0.14	0.5	0.5	Poorly constrained
176-1B	—	—	—	0.5	—	
176-2	85	94	0.43	0.5	1.6	Poorly constrained

[1]Value reported is the last value determined in the stepwise alternating field demagnetization of the sample, whether or not the sample reached a characteristic value. For samples that are poorly constrained Jr and Q may be considered a maximum value.