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U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

PRINCIPAL FACTS FOR ABOUT 2,800 GRAVITY STATIONS ON THE ELY 1° by 2° QUADRANGLE, NEVADA AND UTAH

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INTRODUCTION

The principal facts, base stations, and accuracies of about 2,800 stations on the Ely quadrangle are described. The Ely quadrangle is located between lat 39° and 40° N. and long 114° and 116° W., and includes parts of Nevada and Utah (fig. 1). While compiling data sets, redundant gravity stations and stations having doubtful locations or values were excluded. An accuracy code has been assigned to some gravity data sets so that their horizontal and vertical control and observed gravity accuracy can be evaluated. This data base was used in preparing complete Bouguer and isostatic gravity maps of the Ely quadrangle (Ponce, 1991; 1992).

Gravity data were compiled from 3 primary sources: U.S. Geological Survey (USGS); Stanford University; and the U.S. Department of Defense, Defense Mapping Agency (DMA). Data obtained from the DMA contain a number of sources including USGS data collected by D.R. Mabey in about 1963 and D.L. Healey in about 1977 and data collected by the DMA Topographic Command/Geodetic Survey Squadron from about 1971 to 1981. This gravity data set is available on a diskette formatted for IBM PC's using DOS 2.0 or higher versions.

ACKNOWLEDGMENTS

A number of persons at the U.S. Geological Survey assisted in data collection and reduction including T.V. Bare, E.T. Dixon, R.N. Harris, K.S. Kirchoff-Stein, N.E. Kitchen, V.E. Langenheim, M.E. Milling, R.W. Saltus, and especially S.B. Kohrn, J.B. Spielman, and J.M. Glen. H.R. Blank of the USGS provided data collected in the Snake Range as part of the Mt. Moriah Wilderness area. Stanford University provided data collected by J.D Garing and R. Ward, and H.L. Scheirer and Kathy Velasco.

PREVIOUS WORK

A number of previous reports describe gravity data either collected or interpreted on the Ely quadrangle. Some of these published reports are listed in chronological order in table 1. D.R. Mabey collected gravity data in the Ely, Nevada area in about 1960 and prepared a complete Bouguer gravity anomaly map (Carlson and Mabey, 1963). Mabey (1964) also compiled and described major features of a complete Bouguer gravity anomaly map of Eureka County and vicinity that includes the southwestern part of the Ely quadrangle. Gibbs and others (1968) collected gravity data from 1964-66 and described gravity anomalies in the Ruby Mountains adjacent to the northern border of the Ely quadrangle. A complete Bouguer gravity anomaly map was compiled for the eastern half of the Ely quadrangle by J.D. Garing and R. Ward of Stanford University in 1982 as part of a study of the Snake Range decollement by Miller and others (1983). Whitebread and others (1983) briefly mention gravity data in the Wheeler Peak area of the Snake Range. Ponce (1984) released preliminary principal facts of the Ely quadrangle, Ponce and Kirchoff-Stein (1987) released data in the eastern part of the Ely quadrangle, and Berger and others (1990) published principal facts of gravity data collected in the northern part of Steptoe Valley. Nutt and others (1990) briefly mention gravity data in the Deep Creek Range adjacent to the eastern border of the Ely quadrangle. Ponce (1991) compiled Bouguer and isostatic gravity maps, at a scale of 1:1,000,000 and summarized their relationship to exposed and buried granitic plutons. Nutt and others (1991, 1992) compiled gravity data and described gravity anomalies of the Goshute Indian Reservation and vicinity that includes the northeastern part of the Ely quadrangle. Finally, Ponce (1992) collected and compiled gravity data for a complete Bouguer gravity map of the Ely quadrangle at a scale of 1:250,000.

OBSERVED GRAVITY DATUM AND BASE STATIONS

Observed gravity values are referenced to the International Gravity Standardization Net 1971 (IGSN 71) gravity datum described by Morelli (1974). Two primary IGSN 71 gravity base stations are located in the Ely quadrangle: (1) ELYA, at the Ely Airport; and (2) BAKER, at the Silver Jack Motel (formerly the Terry Motel, formerly the Baker Store) in Baker, Nev. (Jablonsky, 1974). Recently compiled USGS gravity data and secondary base stations are referenced to ELYA. Multiple gravity meter ties between ELYA and BAKER, assumming a value at ELYA of 979,480.08 mGal (Jablonsky, 1974) yield an observed gravity value at BAKER of 979,343.35 mGal. A minor discrepancy of 0.05 mGal results when compared to the value reported at BAKER by Jablonsky (1974) of 979,343.30 mGal.

A number of secondary base stations were established by the author throughout the Ely quadrangle as part of the gravity collection effort. These stations are ultimately referenced to ELYA and were established at benchmarks or other reoccupiable locations. Primary and secondary base stations are listed in table 2, locations are shown in figure 2, and detailed descriptions are in the appendix.

GRAVITY METHODS

GENERAL

Gravity anomalies were calculated using standard corrections including: (a) the Earth-tide correction, which corrects for tidal effects of the moon and sun; (b) instrument drift correction, which compensates for drift in the instrument's spring; (c) the latitude correction, which incorporates the variation of the Earth's gravity with latitude; (d) the free-air correction, which accounts for the difference in elevation between each station and sea level; (e) the Bouguer correction, which corrects for the attraction of material between the station and sea-level; (f) the curvature correction, which corrects the Bouguer correction for the effect of the Earth's curvature to 166.7 km; (g) the terrain correction, which removes the effect of topography to a radial distance of 166.7 km; and (h) the isostatic correction, which removes long-wavelength variations in the gravity field inversely related to topography.

Observed gravity values were obtained from gravity meter scale-readings using factory calibration tables for LaCoste and Romberg meters and a single constant factor for Worden gravity meters. Observed gravity values at each station are calculated using a time-dependent linear drift correction between the first and last base station reading of each day or if applicable, multiple days. For observed gravity values determined by the USGS using LaCoste and Romberg meters, calibration table values were modified by a secondary calibration factor (table 3) based on repeated measurements over mountain calibration loops including Mount Hamilton, Calif. (Barnes and others, 1965) and Charleston Peak, Nev. (Ponce and Oliver, 1981).

Theoretical gravity on the ellipsoid was calculated using the Geodetic Reference System 1967 formula (International Union of Geodesy and Geophysics, 1971, p. 60) and free-air gravity anomalies were calculated using Swick's formula (1942, p. 65) for the free-air correction. Bouguer, curvature, and terrain corrections were added to the free-air correction to determine the complete Bouguer anomaly at a standard reduction density of 2.67 g/cm^3. Finally, a regional gravity field was 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).

STATION LOCATIONS–VERTICAL AND HORIZONTAL CONTROL

Gravity stations can be essentially located anywhere, provided sufficiently accurate vertical and horizontal control can be established. Because elevation accuracy critically affects gravity anomaly accuracy, the errors associated with the elevation control must be considered when collecting gravity data.

In general, bench marks and surveyed points are considerered accurate to less than about 0.3 m (1 ft) relative to a reference elevation. Photogrammetric *spot* elevations are generally accurate to half the topographic map contour interval or about 3 m (10 ft) on a 7-m (20-ft) contour interval topographic map. Because spot elevations are the most common type of elevation control on topographic maps, most gravity stations are collected at these locations. A 3-m (10 ft) elevation error results in a gravity error of about 0.6 mGal.

Horizontal control is not as critical as elevation control because the theoretical variation of gravity with latitude, described by the following approximation of the GRS 67 formula:

$$g = (978.03185)(1 + 0.005278895 sin^2\phi + 0.000023462 sin^2\phi) \text{ Gal},$$

where

ϕ is the latitude,

amounts to only about 0.01 mGal per 12 m (40 ft) of north-south error at a latitude of 45°.

For regional gravity work, gravity stations with a 3-m (10-ft) accuracy in elevation and a 120-m (400-ft) accuracy in north-south positioning is acceptable. However, for detailed, local, or high-precision surveys an elevation accuracy of 0.03 m (0.1 ft) and a positioning accuracy of about 12 m (40 ft), each of which produces a gravity effect of 0.01 mGal, is desirable.

TERRAIN CORRECTIONS

Terrain corrections, which account for the gravity effect of topography near a gravity station may be calculated manually, digitally, or by a combination of both methods. Manual terrain correction systems involve dividing the terrain surrounding a gravity station into a series of zones and compartments. The average elevation of each compartment is manually estimated from a topographic map and used to derive the gravity effect of the terrain. Generally, two manual terrain correction systems are currently in use. Hayford and Bowie (1912) devised a system dividing the terrain surrounding a gravity station into zones and equal area compartments. A system of subcompartments was devised based on Bowie's (1917, p. 9-18) subdivided zones to make the Hayford-Bowie system more accurate in areas of steep terrain. The second system, devised by Hammer (1939), was modeled after the Hayford-Bowie system of 1912 but relates the outer and inner radii of zones to the width of the compartments to obtain equidimensional compartments and minimizes the total number of compartments while maintaining accuracy.

A number of systems exist for calculating terrain corrections using digital elevation data (Plouff, 1966; Krohn, 1976; Plouff, 1977). Digital terrain correction systems use topography digitized on a geographic grid to form a digital elevation model (DEM). The terrain correction is calculated by computing the gravity effect of each grid cell within a specified radius of the gravity station. The DEM used for the Ely quadrangle was derived from digitial elevations determined from topographic map contour plates at a scale of 1:250,000. The later is available from the Department of Interior, U.S. Geological Survey, National Cartographic Information Center, 507 National Center, Reston, VA 22092.

GRAVITY DATA

Gravity data, organized by source, are described in the following sections. Station locations of all gravity data are shown in figure 3. Locations of gravity stations by source are shown in figures 4-7.

USGS GRAVITY DATA

Data were collected by the author (USGS) as part of a cooperative program with the Nevada Bureau of Mines and Geology (NBMG). In addition, data were collected in the northeast corner of the Ely quadrangle as part of a study of the Goshute Indian Reservation. About 13 gravity stations, with a station name prefix of *mcb* were collected by H.R. Blank (USGS, written commun., 1989) as part of a mineral resource study of the Mt. Moriah area in the Snake Range. A plot of USGS data is shown in figure 4.

Observed gravity values were ultimately referenced to the IGSN 71 datum base station at the Ely Airport (ELYA, Jablonsky, 1974). A number of LaCoste and Romberg gravity meters were used including G-17, G161, G177, and G614. These meters and their calibration factors are listed in table 3.

Vertical and horizontal control were primarily obtained using photogrammetric spot elevations shown on USGS topographic maps. In addition, station locations and elevations were controlled by bench marks, surveyed points, contour interpolation, and stream-gradient interpolation. A code that describes the location and observed gravity accuracies was assigned to these data (table 4). A summary of the number of stations with a particluar accuracy code (table 5) indicates that about 75% of USGS data are located at spot elevations while about 16% are on or near bench marks.

Terrain corrections were calculated using a three part process: the innermost terrain correction was estimated in the field to the outer radius of Hayford-Bowie zone B (68 m) using a system of tables and charts or sketched and later estimated in the office, the inner-zone or manual terrain correction was estimated for Hayford-Bowie zones C and D with an outer radius of 0.59 km using a computer procedure by Spielman and Ponce (1984), and finally, the outer-zone terrain correction was calculated from the outer radius of zone D to 167 km using a DEM and a computer procedure by Plouff (1977).

USGS WATER RESOURCES DIVISION GRAVITY DATA

About 244 gravity stations within the Ely and Elko quadrangles were obtained from a principal facts report by Berger and others (1990). Most of these stations are located in the northern part of Steptoe Valley (fig. 5). Observed gravity values were referenced to the IGSN 71 datum using a base station near the Ely Airport terminal building (Department of Defense, Defense Mapping Agency ACIC No. 0390-0). Data were collected using a thermostatically controlled Worden gravity meter. Vertical and horizontal control were obtained from spot elevations, bench marks, or contour interpolation using USGS topographic maps. Station elevations were reported to the nearest 3 m (10 ft). Terrain corrections were computed from 1.42 mi (2.29 km) to 103 mi (167 km) using a computer procedure by Plouff (1977). (See Berger and others, 1990).

Most of the 244 gravity stations are redundant with existing gravity data and only 94 were retained. Of these 94, only 43 stations are within the boundaries of the Ely quadrangle and listed in this report. A comparison of 67 stations that are redundant with USGS data resulted in an observed gravity datum shift of +1.43 mGal. In addition, locations were redigitized and elevations were recovered as listed on USGS topographic maps (usually to the nearest foot or meter). Terrain corrections were recomputed from the station to a radial distance of 167 km in two parts, an inner part from 0.0 to 0.59 km and an outer part from 0.59 to 167 km using a computer procedure by Plouff (1977). An accuracy code assigned to these data indicate that 70% of the data are located at spot elevations.

STANFORD UNIVERSITY GRAVITY DATA

About 230 gravity stations were obtained from Stanford University, most of which are located in the Snake Range and Spring Valley (fig. 6). The following discussion applies to data with a station name prefix of *KV* collected by H.L. Scheirer and Kathy Velasco (H.L. Scheirer, written commun., 1984).

Observed gravity values were ultimately referenced to the IGSN 71 datum base station at the Ely Airport (ELYA; Jablonsky, 1974). Gravity data were collected with LaCoste and Romberg gravity meter G102. Linear drift corrections were made based on repeated measurements during the day as well as base station readings at the beginning and close of each day. A precision of about 0.1 mGal was reported.

Vertical control was obtained by using two American Paulin System Model M-2 precision altimeters. The elevation accuracy was reported to be about 20 ft. Horizontal control was obtained using the Ely 1 by 2 degrees quadrangle USGS topographic map. Latitude and longitude were reported to have an accuracy of about 0.1 minute.

Terrain corrections were estimated in the field for Hammer zones B, C, and D and computer terrain corrections were calculated to a radius of 167 km by the USGS. Terrain correction errors were estimated to be about 0.1 to 0.2 mGal.

Subsequently, larger-scale USGS topographic maps became available and vertical and horizontal control were re-examined by the author. Elevations were revised when discrepancies between map and altimetric elevations were greater than about 20 ft (7 m). Horizontal locations were revised using a combination of USGS topographic maps and a detailed road log of the original gravity survey (H.L. Scheirer, written commun., 1984). Terrain corrections were recomputed all the way into the station, but separated into two parts: inner-zone from 0.0-0.39 km (Hammer zone E) and outer zone from 0.39 to 167 km. In addition, about 15 stations with the largest inner-zone terrain corrections were manually re-estimated to Hammer zone E.

A comparison of the observed gravity of two KV-stations, that are redundant with USGS data agree to 0.03 and 0.07 mGal. The close agreement indicates that this survey is on the same gravity datum as the USGS survey, which is not surprising because they both are referenced to the same base station (ELYA).

DEFENSE MAPPING AGENCY GRAVITY DATA

These data are available from the National Geophysical Data Center, National Oceanic and Atmospheric Administration, Mail Code E/GCX2, 325 Broadway, Boulder, Colorado 80303, USA. In general, vertical and horizontal control were obtained from USGS topographic maps. Data collected by the DMA Topographic Command/Geodetic Survey Squadron made use of an inertial navigation system for vertical and horizontal control. DMA four-digit source codes were converted to an alphabetic code (table 6).

Terrain corrections were computer calculated from the station to a radial distance of 167 km, separated into two parts: an inner-zone from 0.0 to 0.59 km and an outer-zone from 0.59 to 167 km. Some inner-zone computer corrections were replaced with more accurate manually estimated corrections in areas of steep terrain.

Data used to prepare a complete Bouguer gravity map of the Ely area (Carlson and Mabey, 1963) were collected in 1960, using a Worden gravity meter, and referenced to the base station at ELYA (Jablonsky, 1974). Vertical and horizontal control for most stations were obtained from bench marks and spot elevations shown on USGS topographic maps, control for some stations were obtained by plane-table surveys.

Data collected in Eureka County and vicinity (Mabey, 1964) that includes the northwestern parts of the Ely quadrangle were referenced to an airport base network described by Woollard (1958). Vertical and horizontal control was otained from USGS topographic maps; some control was obtained by plane-table methods and altimetry.

In addition to the DMA data set, a few miscellaneous data of unknown source are included at the end of the DMA data. These data have prefixes of *DOD* and *HW* and amount to 19 stations.

DESCRIPTION OF DISKETTE

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

The diskette contains a total of 6 files: *readme.txt*, a description of the contents and format of the gravity data; *ely.ary*, all data organized by source; *usgs.ary*, USGS data; *wrd.ary*, USGS Water Resources Division data; *stanford.ary*, Stanford University data; *dma.ary*, data available from the Defense Mapping Agency plus some miscellaneous data of unknown source. A description of the gravity data format is shown in table 7 and the first ten lines of the first gravity file is shown in table 8.

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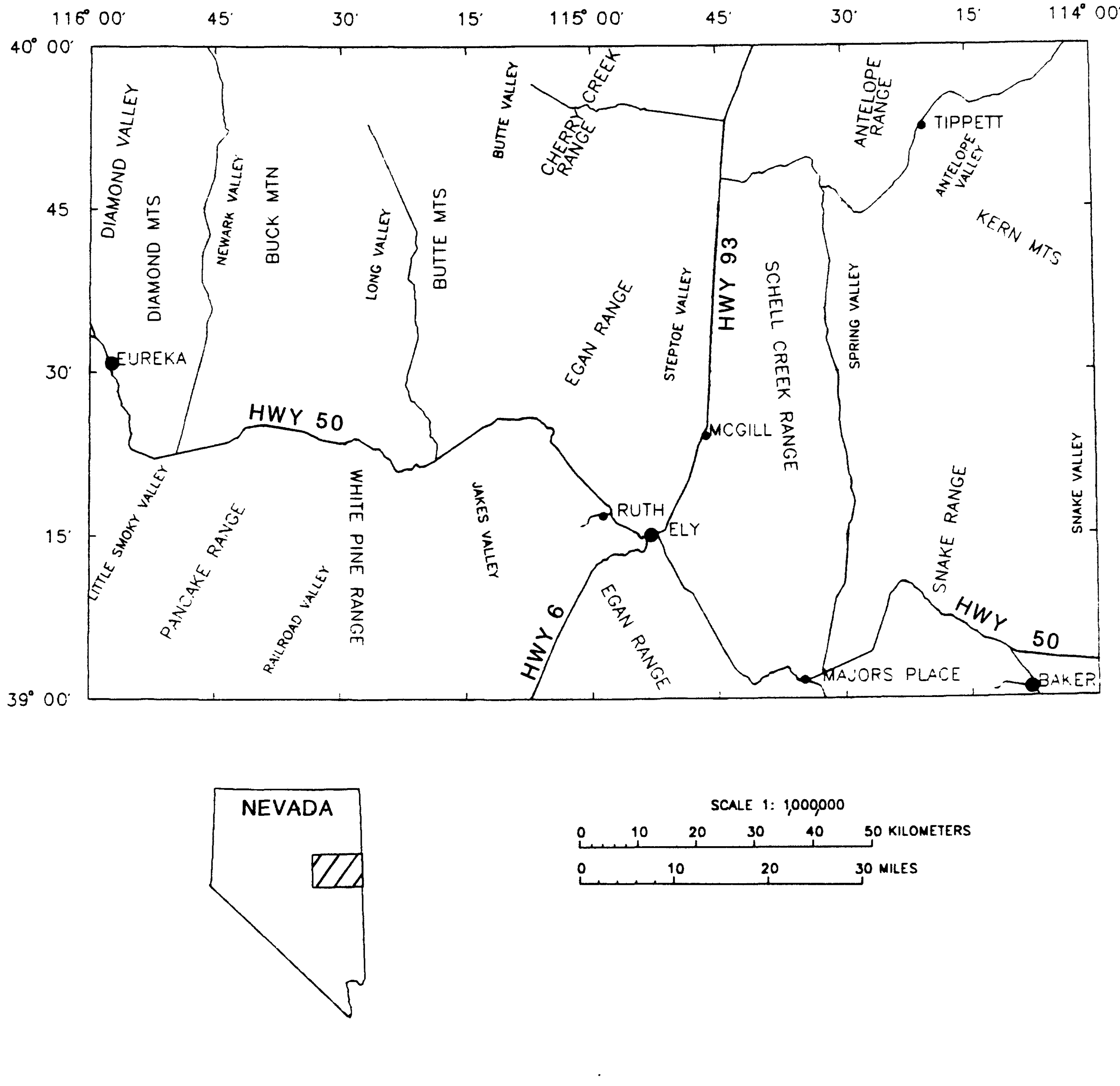


Figure 1. Index map of the Ely quadrangle.

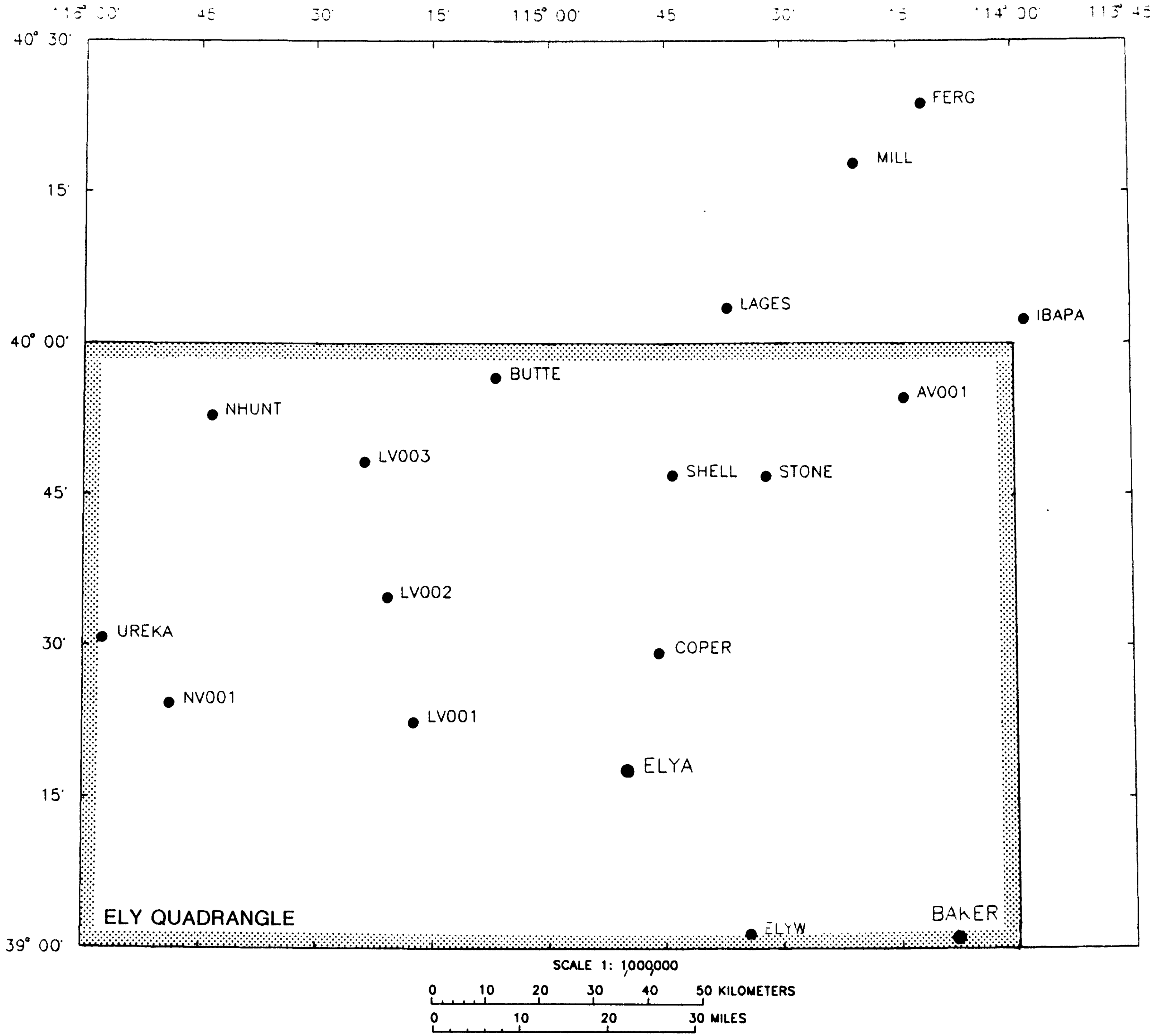


Figure 2. Gravity base station locations.

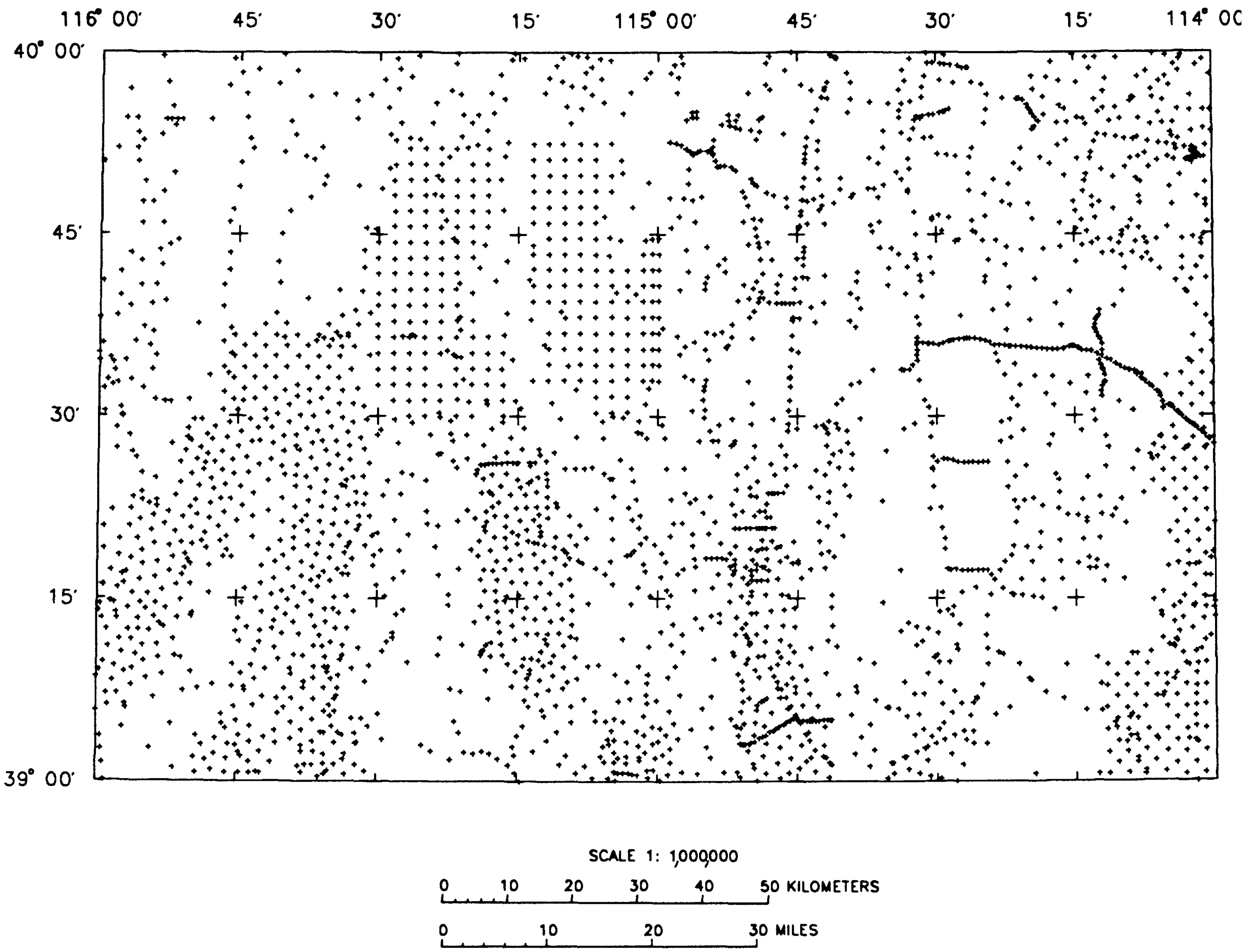


FIGURE 3. Gravity station locations.

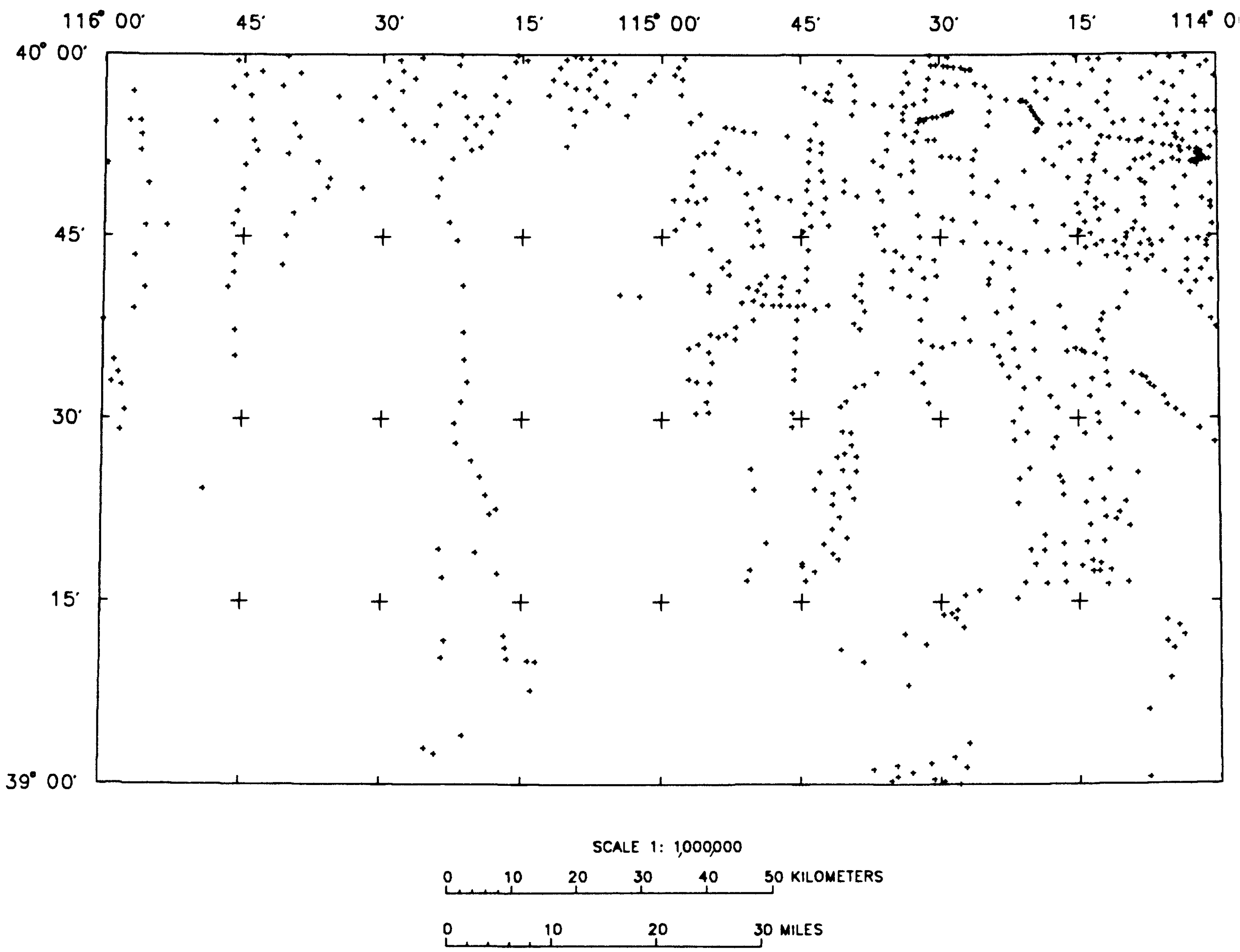


FIGURE 4. USGS gravity stations.

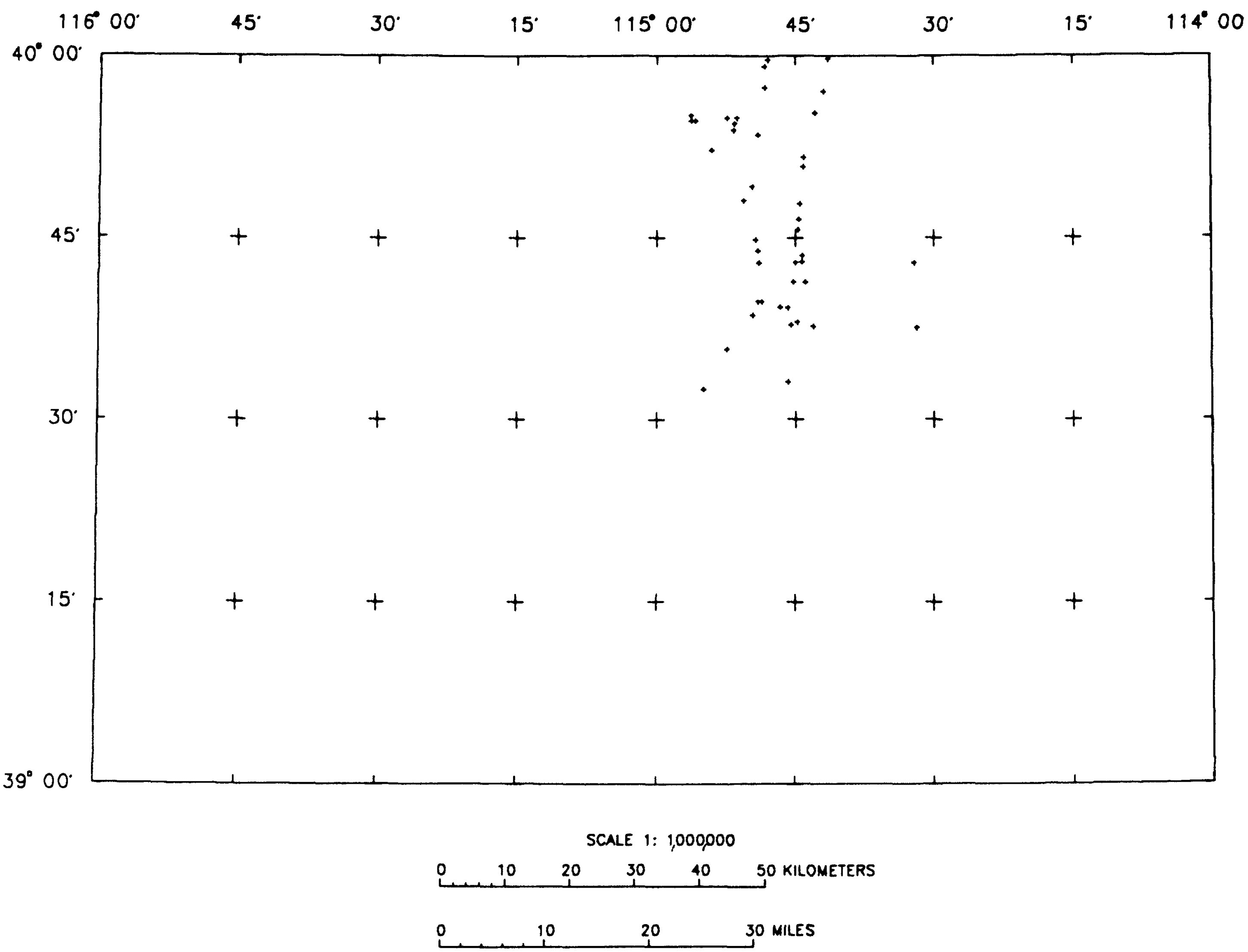


FIGURE 5. USGS WRD gravity stations.

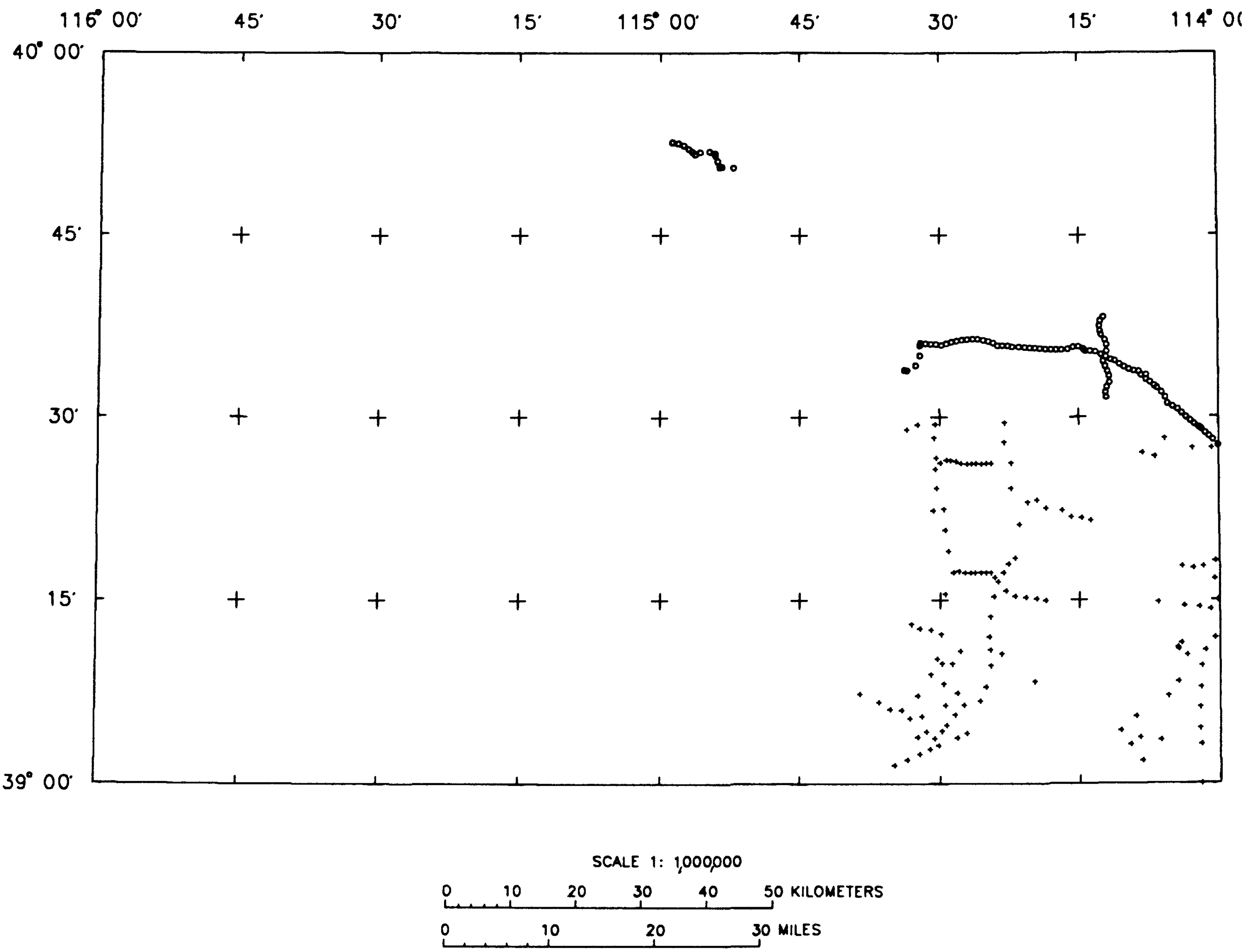


FIGURE 6. Stanford University gravity stations. Circle, data with KV prefix.

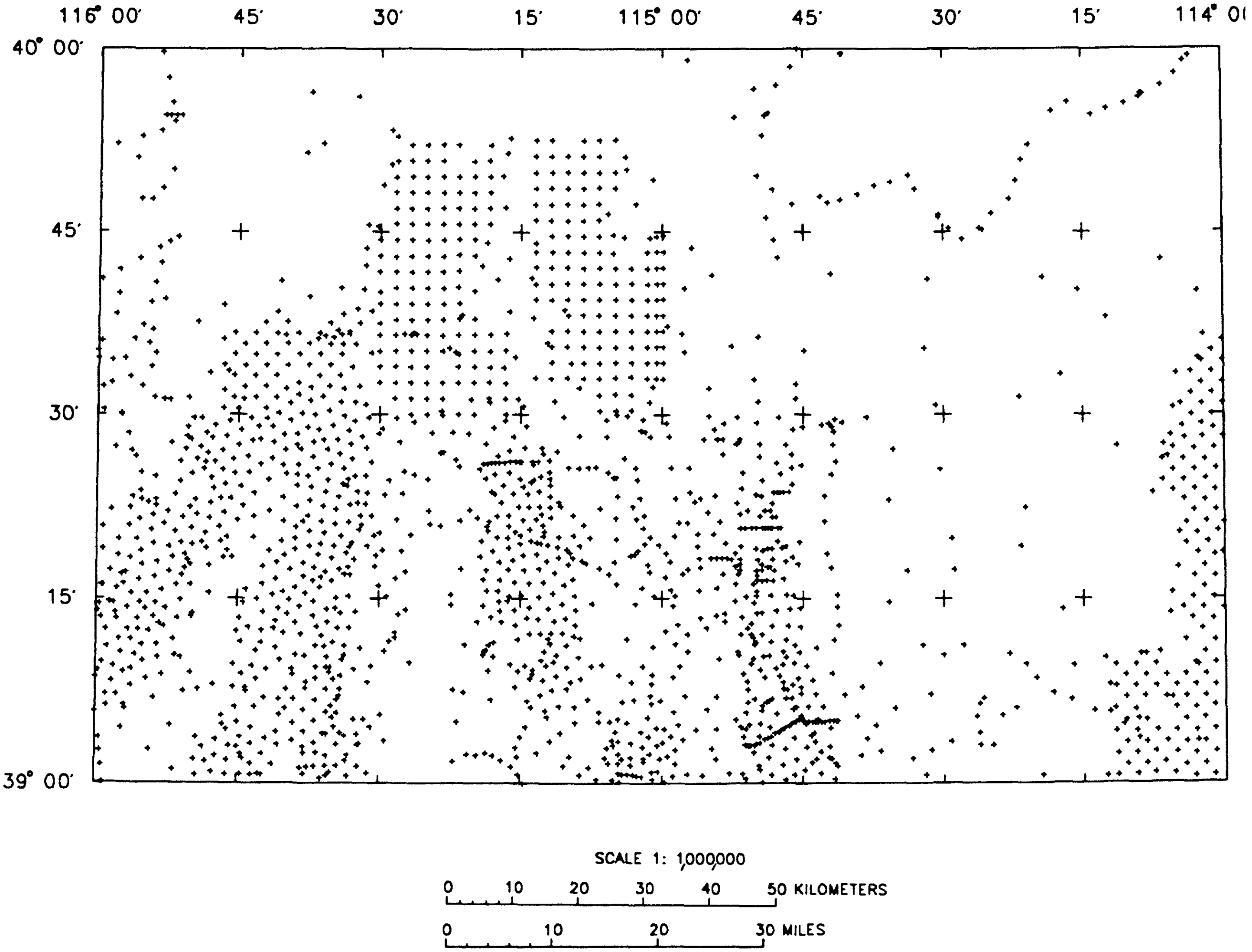


FIGURE 7. DMA gravity stations.

TABLE 1.–*Published gravity reports on or adjacent to the Ely quadrangle*

Area	Comments	Reference
Ely area	Gravity and magnetics	Carlson and Mabey (1963)
Eureka County	Gravity	Mabey (1964)
Ruby Mts	Gravity	Gibbs and others (1968)
Snake Range	Gravity	Miller and others (1983)
Wheeler Peak	Gravity	Whitebread and others (1983)
Ely quadrangle	Principal facts of gravity data	Ponce and others (1984)
E. Ely quadrangle	Principal facts of gravity data	Ponce and Kirchoff-Stein (1987)
Steptoe Valley	Principal facts of gravity data	Berger and others (1990)
Deep Creek Range	Gravity and magnetics	Nutt and others (1990)
Ely quadrangle	Gravity and magnetics	Ponce (1990)
NE. Ely quadrangle	Gravity and magnetics	Nutt and others (1991)
NE. Ely quadrangle	Gravity and magnetics	Nutt and others (1992)
Ely quadrangle	Complete Bouguer gravity map	Ponce (1992)

TABLE 2.–*Base stations on or adjacent to the Ely quadrangle*

Station	Latitude (deg min)	Longitude (deg min)	Elevation (m)	Observed Gravity[1] (mGal)	Comments
AV001	39 54.67	114 14.57	1,736	979,601.45	Secondary base
BAKER	39 0.60	114 7.50	1,631	979,343.35	Jablonsky (1974)
BUTTE	39 56.56	115 7.11	1,911	979,565.87	Secondary base
COPER	39 29.37	114 45.94	1,920	979,510.96	Do.
ELYA	39 17.59	114 50.52	1,906	979,480.08	Jablonsky (1974)
ELYW	39 1.55	114 34.71	1,970	979,462.96	Secondary base
FERG	40 23.79	114 12.19	1,796	979,676.09	Do.
IBAPA	40 2.19	113 59.09	1,609	979,654.33	Do.
LAGES	40 3.48	114 37.42	1,825	979,607.17	Do.
LV001	39 22.56	115 17.69	1,962	979,498.81	Do.
LV002	39 34.86	115 21.15	1,908	979,544.46	Do.
LV003	39 48.34	115 24.05	1,862	979,563.65	Do.
MILL	40 17.92	114 20.86	1,708	979,653.66	Do.
NHUNT	39 52.92	115 43.88	1,900	979,576.08	Do.
NV001	39 24.24	115 49.08	1,811	979,547.72	Do.
SHELL	39 46.88	114 44.45	1,856	979,549.86	Do.
STONE	39 46.83	114 32.37	1,914	979,553.01	Do.
UREKA	39 30.72	115 57.58	1,975	979,527.66	Do.

[1]IGSN 71 datum.

TABLE 3.–*Gravity meter calibration factors*

Meter	Factor	Organization	Remarks
LaCoste and Romberg Meters			
G-17	1.00252	USGS	Factor based on multiple runs over Mt. Hamilton calibration loop.
G161	1.000573	USGS	Factor based on multiple runs over Mt. Hamilton calibration loop.
G177	1.0003[2]	USGS	Factor based on 3 runs over Mt. Hamilton calibration loop in 1980.
G614	1.00038	USGS	Factor based on multiple runs over Mt. Hamilton and Charleston Peak calibration loops.

[1]Secondary calibration factor in addition to factory calibration tables for LaCoste and Romberg meters.

[2]Ponce and Oliver (1981, p. 9 and 10.)

TABLE 4.–*Explanation of accuracy codes*

[NGS, National Geodetic Survey; NMD, National Mapping Division; USGS, U. S. Geological Survey]

Code	Explanation	Code	Explanation
	General elevation and location code–1st digit		
A	Altimetry, good control	P	On or near surveyed mark
B	On USGS or NGS level-line bench mark	Q	River gradient interpolation
C	Contour line interpolation	R	Lake or reservoir elevation by leveling
D	Destroyed or not found reference mark	S	Sea level elevation
E	Near level-line bench mark other than USGS or NGS	T	Photogrammetry by USGS NMD
F	Map elevation, black or field checked	U	Unknown elevation source
G	Map elevation, brown or not field checked	V	On vertical angle bench mark
H	Near vertical angle bench mark	W	Map elevation, blue
I	Other special source	X	On or near boundary marker
K	Photogrammetry by other than USGS NMD	Y	Altimetry, poor control
N	Near USGS or NGS level-line bench mark	Z	Special source (e.g. mobile elevation recorder)
M	On level-line bench mark other than USGS or NGS		

Code	Elevation code–2nd digit	Elevation accuracy (ft)	Approximate gravity effect (mGal)
1	On bench mark	0.2	0.01
2	Near bench mark	0.3	0.02
3	Transit or good alidade survey	1.0	0.06
4	Vertical angle bench mark or black map elevation	2.0	0.12
5	Black map elevation on old map or good photogrammetry	4.0	0.24
6	Brown map elevation or good photogrammetry on 20 ft contour interval map	10	0.6
7	Brown map elevation on 80 ft contour interval map or good altimetry	20	1.2
8	Contour interpolation on 80 ft contour interval map	40	2.4
9	Contour interpolation on 200 ft contour interval map or poor altimetry	80	4.8

Code	Latitude code–3rd digit (based at lat 37°)	Latitude accuracy (min)	Distance accuracy (ft)	Approximate gravity effect (mGal)
1	Triangulation or special survey data	0.007	42	0.01
2	Location known to 0.04 in on 1:24,000 map (special care)	0.014	84	0.02
3	0.10 in on 1:24,000 map or 0.04 in on 1:62,500 map	0.035	210	0.05
4	0.21 in on 1:24,000 map or 0.08 in on 1:62,500 map	0.07	420	0.1
5	0.42 in on 1:24,000 map or 0.16 in on 1:62,500 map	0.14	840	0.2
6	0.40 in on 1:62,500 map or 0.1 in on 1:250,000 map	0.35	2,100	0.5
7	0.80 in on 1:62,500 map or 0.2 in on 1:250,000 map	0.7	4,200	1.0
8	1.60 in on 1:62,500 map or 0.4 in on 1:250,000 map	1.4	8,400	2.0
9	4.00 in on 1:62,500 map or 1.0 in on 1:250,000 map	3.5	21,000	5.0

Code	Observed gravity code–4th digit	Approximate gravity effect (mGal)
1	Local survey with special gravity meter	0.01
2	Multiple observations with LaCoste and Romberg gravity meter	0.02
3	Average LaCoste and Romberg or multiple observations with Worden gravity meter	0.05
4	LaCoste and Romberg observation with small vibrations or average Worden gravity meter	0.1
5	Data from loop with closure error this large	0.2
6	Data from loop with closure error this large	0.5
7	Data from loop with closure error this large	1
8	Data from loop with closure error this large	2
9	Data from loop with closure error this large	4

TABLE 5.–*Number of stations with a particular accuracy code*

Accuracy Code	Number of occurences			
Location Code	USGS	WRD	Stanford	DMA
B	33	—	—	—
C	6	10	75	—
D	3	—	—	—
G	546	30	8	—
H	5	—	—	—
N	73	3	—	—
P	49	—	—	—
Q	1	—	—	—
V	1	—	—	—
X	13	—	—	—
Y	—	—	17	—
blank	—	—	130	1,816
Elevation Code				
1	34	—	—	—
2	85	3	4	—
3	49	—	—	—
4	2	—	—	—
6	547	30	8	—
7	1	10	—	—
8	12	—	88	—
blank	—	—	130	1,816
Latitude Code				
1	—	—	—	—
2	5	—	—	—
3	723	43	12	—
4	2	—	88	—
blank	—	—	130	1,816
Observed Gravity Code				
2	14	—	—	—
3	716	—	100	—
4	—	43	—	—
blank	—	—	130	1,816
Observed Gravity Code				
Total	730	43	230	1,816

TABLE 6.–*DMA source codes*

[NOAA, National Oceanic and Atmospheric Administration; DMATC/GSSQ, Defense Mapping Topographic Command/Geodetic Survey Squadron]

Code	DMA source code	Source	Year	Number of stations
A	1083	NOAA	—	14
C	2149	USGS, Eureka-Fallon profile, Nevada	1963	13
D	2179	USGS, Mabey, D., Basin and Range	—	476
J	4936	USGS, Healey, D.L., and Currey, F.E.	1977	107
L	5144	DMATC/GSSQ, State of Nevada	1971	31
M	5163	DMATC/GSSQ, Regional survey of Nevada	1972	37
N	5786	DMATC/GSSQ, Valeys in Nevada and Utah	1980	260
O	5829	DMATC/GSSQ, Regional surveys of Nevada	1980	137
P	5845	DMATC/GSSQ, Railroad Valley	1981	60
R	5871	DMATC/GSSQ, Little Smokey and Antelope Valleys	1981	70
S	5893	DMATC/GSSQ, Spring, Long, and Butte Valleys	1981	592
—	—	Unknown	—	19
Total				1,816

TABLE 7.–*Format of gravity data on diskette*

Columns	Input format	Item
1-8	A8	Station name
10-11	F2.0	Latitude, degrees
12-15	F4.2	Latitude, minutes to 0.01 min
17-19	F3.0	Longitude, degrees
20-23	F4.2	Longitude, minutes to 0.01 min
24-29	F6.1	Elevation to 0.1 ft
30-36	F7.2	Observed gravity to 0.01 mGal with leading 9 removed
37-40	A4	Four character accuracy code
41-46	F6.2	Free-air anomaly to 0.01 mGal
47-52	A6	Date station was occupied, month, day, year
53-57	F5.2	Inner-zone terrain correction to 0.01 mGal
58-62	F5.2	Total terrain correction to 0.01 mGal
63	A1	Terrain correction code denoting extent of inner-zone terrain correction and system, upper case denotes Hayford-Bowie system (Hayford and Bowie, 1912), lower case denotes Hammer system (Hammer, 1939). Z, computer calculated from 0.0 to 0.59 km. z, computer calculated from 0.0 to 0.39 km
64-69	F6.2	Complete Bouguer anomaly to 0.01 mGal
70-75	F6.2	Isostatic anomaly to 0.01 mGal

TABLE 8.–*The first ten lines of the gravity file*

Contents

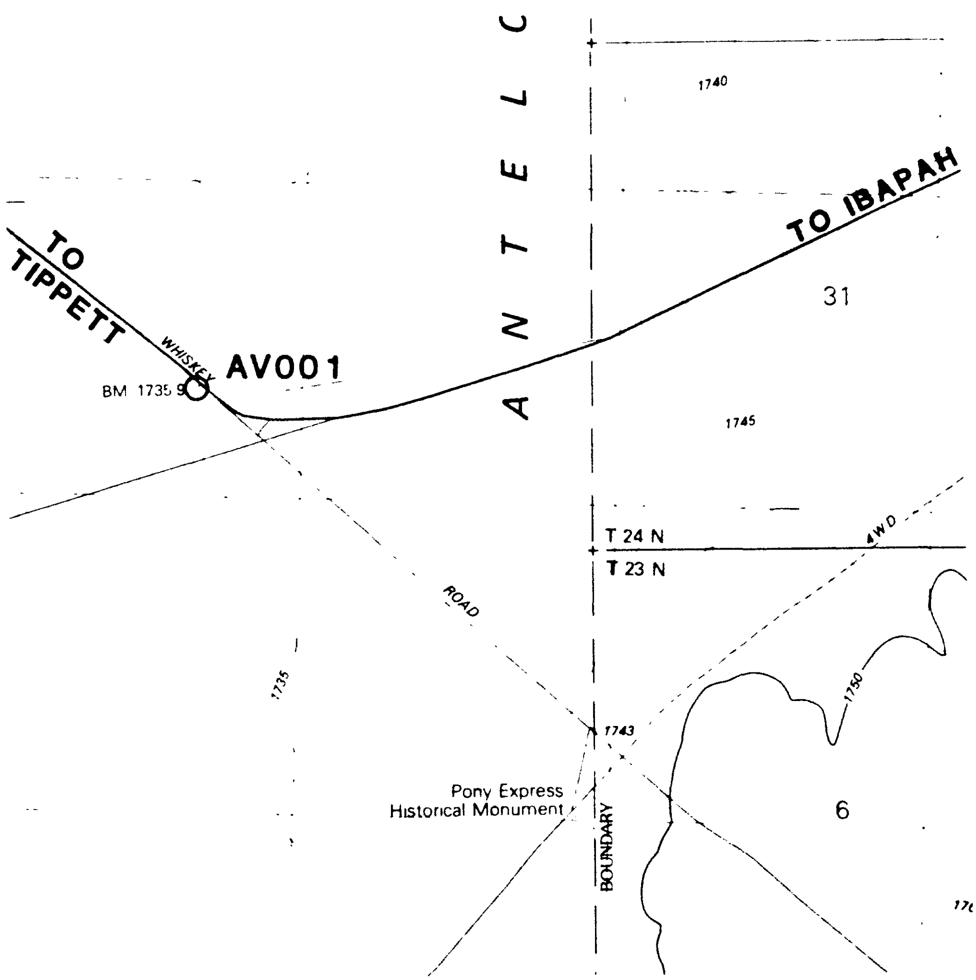
```
  ELYA 391759 1145052 625307948008B132 -3819-25146    1  131D-25165 -3900AIRY
  ELYW 39 155 1143471 646437946296B132 -1177-23225    9  173D-23203 -2236AIRY
 AR001 394662 1142970 678507951865G633   741-22401    9  127D-22425 -1843AIRY
 AR002 394640 1142859 692007951314G633  1491-22111   27  196D-22066 -1511AIRY
 AR003 394460 1142750 625607955513G633  -283-21620   21  137D-21634 -1067AIRY
 AR004 394618 1142609 609007956313G633 -1277-22049   12  166D-22033 -1534AIRY
 AR005 394835 1142469 637207955938G633   677-21056    9  154D-21053  -643AIRY
 AR006 394864 1142639 682907953229G633  2219-21073   55  349D-20875  -426AIRY
 AR007 394961 1142371 613407957604G633   -81-21002    5  188D-20964  -610AIRY
 AR008 395006 1142642 707607952240G633  3340-20794  130  469D-20477   -60AIRY
```

APPENDIX–BASE STATION DESCRIPTIONS

GRAVITY BASE STATION # AV001	
NAME AV001	**STATE** Nevada
LATITUDE 39°54.67′	**LONGITUDE** 114°14.57′
ELEVATION 5,695 ft (1,736 m)	**QUADRANGLE** Spring Creek Flat, 1:24,000
OBSERVED GRAVITY 979,601.45 mGal	**SBA** -218.38 mGal

LOCATION DESCRIPTION:

The station is 7.7 mi NE. of Tippett along an unpaved road leading to Ibapah, Utah. The station is at a U.S. Coast & Geodetic Survey benchmark stamped "G61 1954" that is adjacent to a small rock cairn. Place the meter adjacent to and on the north side of the benchmark Read the meter facing north.

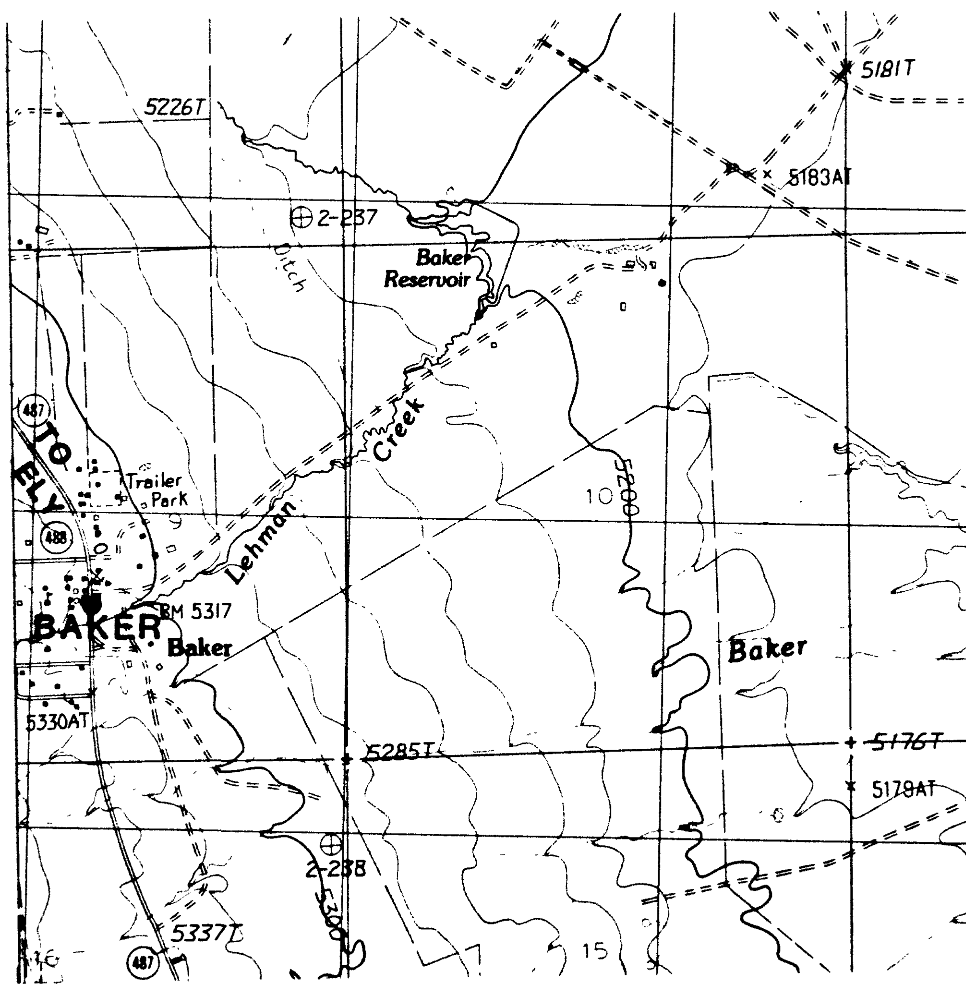


SPRING CREEK FLAT NW QUADRANGLE
NEVADA-WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # ACIC 2360-1 (Jablonsky, 1974)	
NAME BAKER	**STATE** Nevada
LATITUDE 39°00.60'	**LONGITUDE** 114°07.50'
ELEVATION 5,351 ft (1,631 m)	**QUADRANGLE** Baker, NV 1:24,000
OBSERVED GRAVITY 979,343.35 mGal	**SBA** -217.09 mGal

LOCATION DESCRIPTION:

The station is in Baker, Nev. about 62 mi SE of the junction of U.S. Hwy 50 and 93 in Ely, Nev., at the entrance to the Silver Jack Motel (formerly the Terry Motel, formerly the Baker Store) on the west side of Nevada State Hwy 487 and across from the 'Outlaw' cafe-bar. The station is at a U.S. Air Force Gravity Station disc 0.5 ft S. of the front steps. Place the meter over the disc. Read the meter facing north.



BAKER QUADRANGLE
NEVADA - UTAH
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # BUTTE

NAME BUTTE	**STATE** Nevada
LATITUDE 39°56.56′	**LONGITUDE** 115°07.11′
ELEVATION 6,269 ft (1,911 m)	**QUADRANGLE** Ninemile Well, 1:24,000
OBSERVED GRAVITY 979,565.87 mGal	**SBA** -222.42 mGal

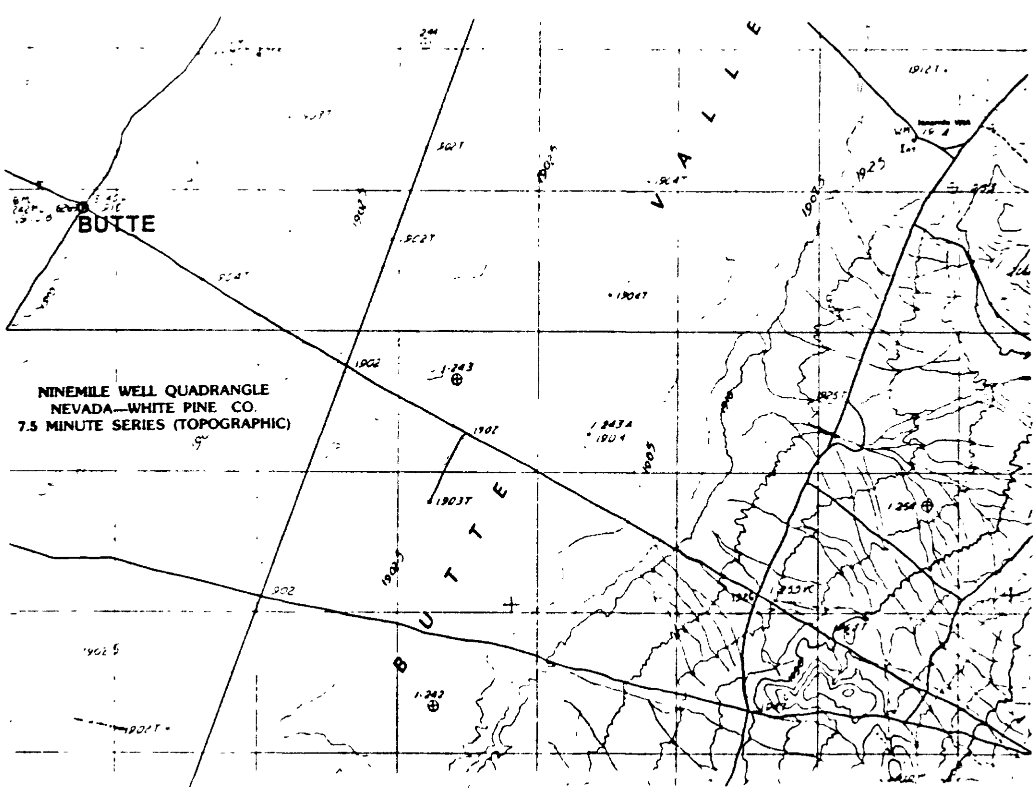
LOCATION DESCRIPTION:

The station is at the intersection of 2 unpaved roads in northern Butte Valley - on the west side of the valley at the base of alluvial fans originating from the northern Butte Mts. From Nine Mile Well the station is 0.2 mi SE. to a main road along the western edge of Cherry Creek range, then 2.1 mi SW. to another road heading NW., then 3.45 mi NW. along this road to a road intersection.

The station is at a USGS benchmark stamped "242MDC 1975 6269 ft" that is encased in PVC pipe, adjacent to a 5-ft high green metal stake and a rock cairn. Place the meter adjacent to and on the south side of the benchmark. Read the meter facing north.

Sign at intersection reads:

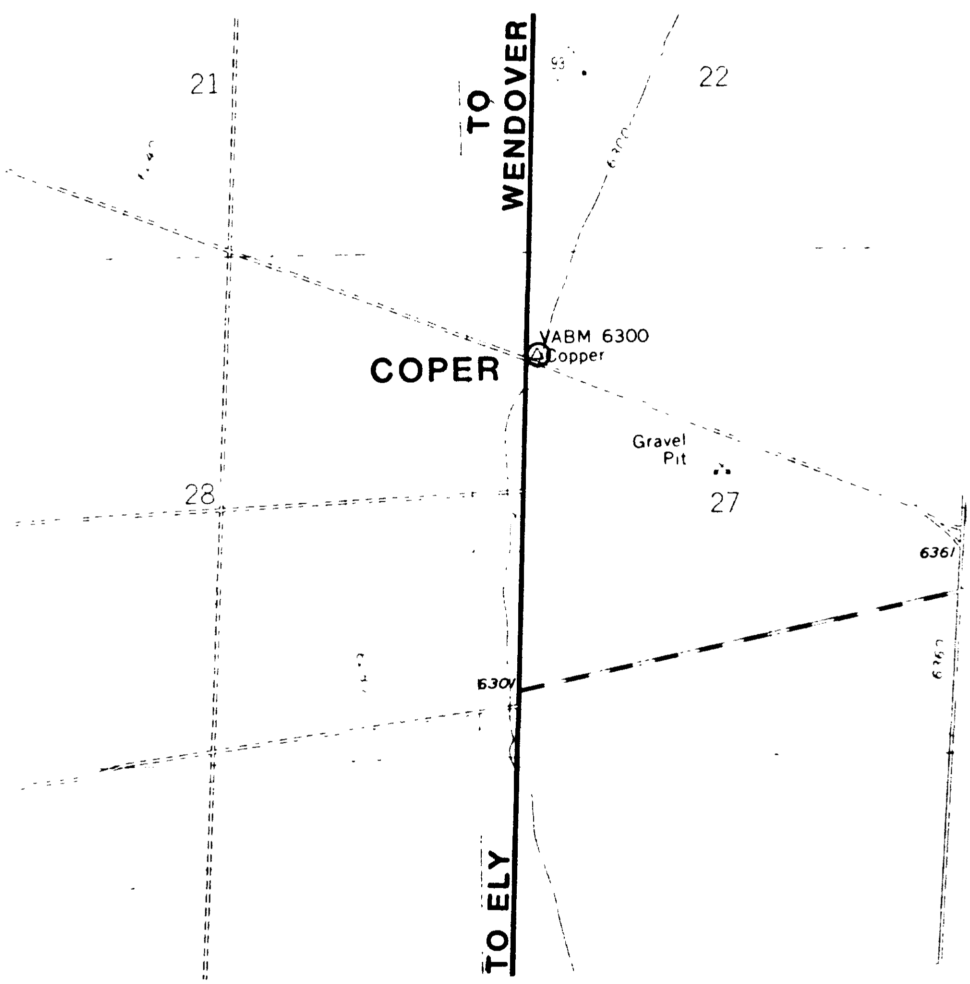
Facing south		Facing north	
West Butte Valley		Straton Ranch	17
Long Valley	1	Long Valley	10
Egan Canyon	15	Ruby Lake	29
Ruby Lake	29	Egan Canyon	15



GRAVITY BASE STATION # COPER	
NAME COPER	**STATE** Nevada
LATITUDE 39°29.37′	**LONGITUDE** 114°45.94′
ELEVATION 6,300 ft (1,920 m)	**QUADRANGLE** McGill, 1:24,000
OBSERVED GRAVITY 979,510.96	**SBA** -235.18 mGal

LOCATION DESCRIPTION:

The station is 17.5 mi N. of the Ely Airport along U.S. Hwy 50 at the intersection with an unpaved road about 0.65 mi S. of a road to Duck Creek (Humbolt National Forest). The station is at a U.S. Coast & Geodetic Survey vertical angle benchmark stamped "COPER 1954" and is adjacent to a witness post. Place the meter over the benchmark. Read the meter facing north.

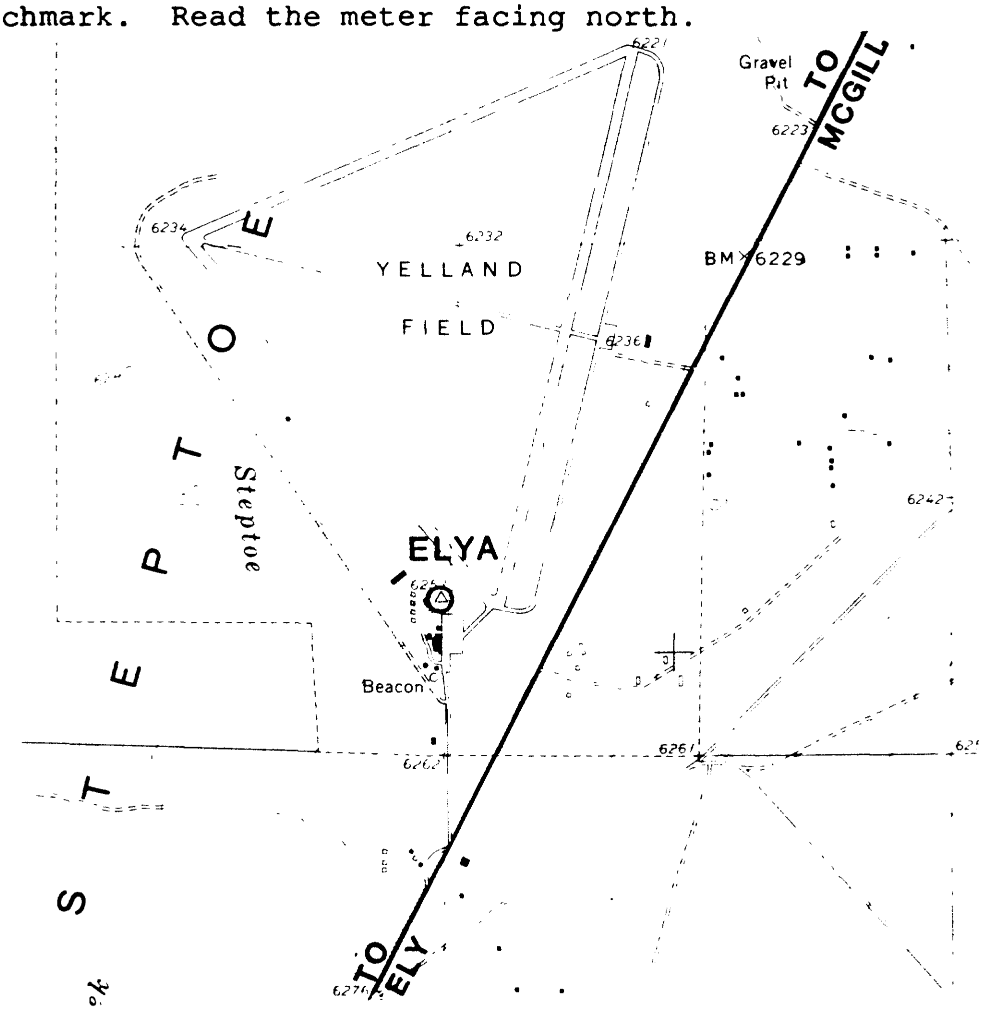


MC GILL QUADRANGLE
NEVADA–WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # ACIC 0390-2 (Jablonsky, 1974)	
NAME ELYA	**STATE** Nevada
LATITUDE 39°17.59'	**LONGITUDE** 114°50.52'
ELEVATION 6,253 ft (1,905.9 m)	**QUADRANGLE** East Ely, 1:24,000
OBSERVED GRAVITY 979,480.08	**SBA** -251.46 mGal

LOCATION DESCRIPTION:

The station is located near the FAA Building at the Ely Airport. From the intersections of U.S. Hwy 50 and U.S. Hwy 93, in Ely, the station is 3.3 mi N. along U.S. Hwy 93, then 0.4 mi W. along an airport access road marked with a 'Nevada Department of Wildlife' sign on Hwy 93 leading to a hangar, office building, and the FAA Building. The station is at a U.S. Coast and Geodetic Survey vertical angle bench mark stamped 'ELY AIRPORT 1954' about 120 ft north of the east corner of the FAA Building. Place the meter over the benchmark. Read the meter facing north.

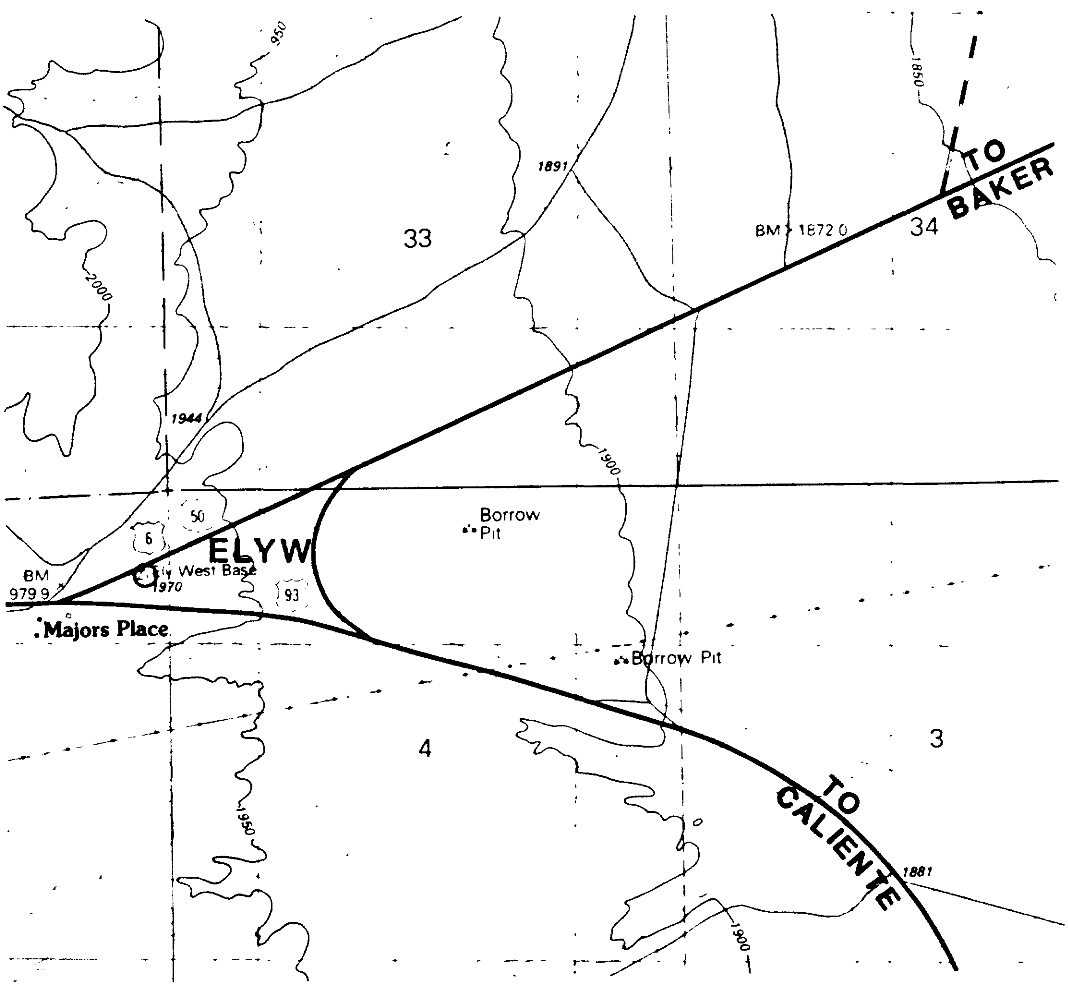


EAST ELY QUADRANGLE
NEVADA–WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # ELYW	
NAME ELYW	**STATE** Nevada
LATITUDE 39°01.55'	**LONGITUDE** 114°34.71'
ELEVATION 6,464 ft (1,970 m)	**QUADRANGLE** Majors Place, 1:24,000
OBSERVED GRAVITY 979,462.96	**SBA** -232.25 mGal

LOCATION DESCRIPTION:

The station is located along U.S. Hwy 50 about 26.9 mi SE. of the Hwy 6, 50, and 93 junction in Ely, and about 0.2 mi E. of the Hwy 6, 50, and 93 junction at Majors Place, or about 1.7 mi W. of Hwy 50 and 893 junction. Nevada State Hwy 893 leads to North Spring Valley. The station is at a U.S. Coast & Geodetic Survey vertical angle benchmark stamped 'ELY WEST BASE 1944' and adjacent to an orange witness post. Place the meter over the benchmark. Read the meter facing north.

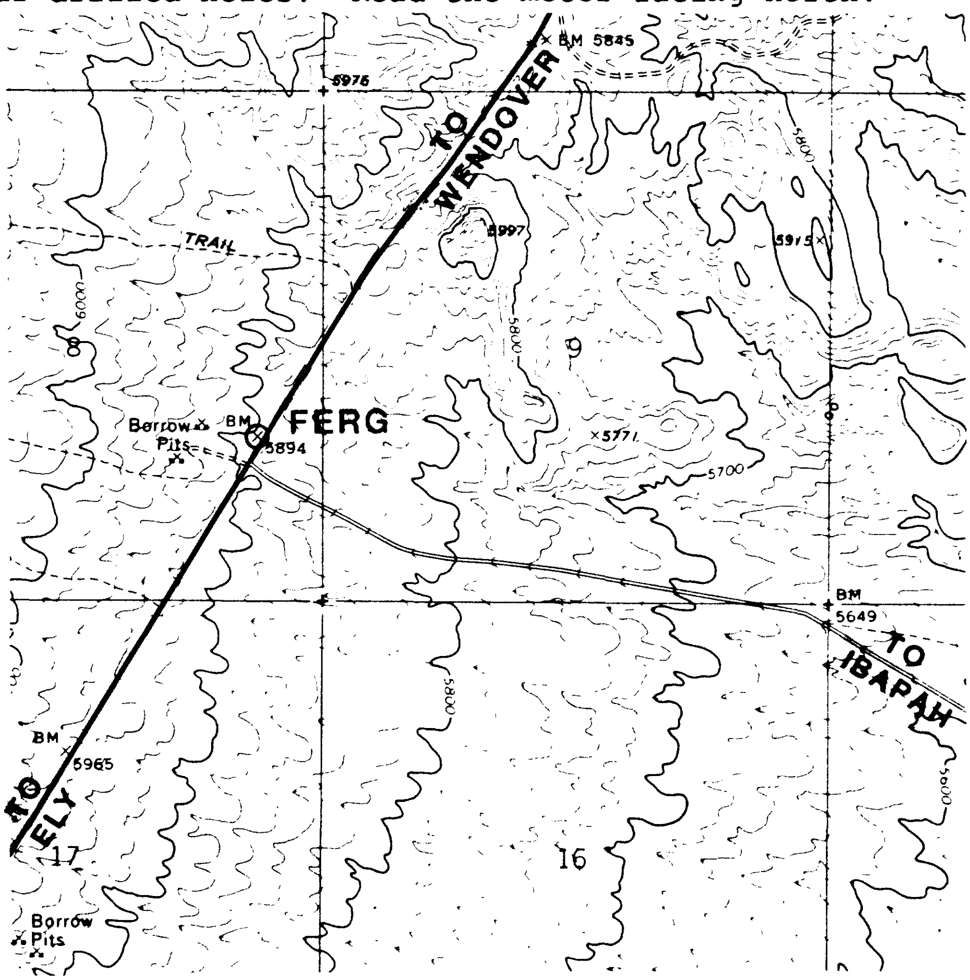


MAJORS PLACE QUADRANGLE
NEVADA-WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION #	FERG		
NAME	FERG	**STATE**	Nevada
LATITUDE	40°23.79'	**LONGITUDE**	114°12.19'
ELEVATION	5,894 ft (1,796 m)	**QUADRANGLE**	Ferguson Mtn. 1:24,000
OBSERVED GRAVITY	979,676.09 mGal	**SBA**	-175.12 mGal

LOCATION DESCRIPTION:

The station is along U.S. Hwy 93A about 25.5 mi s. of the junction of U.S. Hwy 93 and 40 in Wendover, Nevada, 93.7 mi N. of the Hwy 6/50/93 junction in Ely, Nevada, or 33.6 mi N. of the 93/93A junction about 200 ft N. and 50 ft W. of the intersection of 93A and road heading SE. to Ibapah, Utah. Station is at a U.S. Coast and Geodetic Survey benchmark stamped "P191 1958" set in a rock boulder adjacent to a 4-ft high green and white metal stake. Place the meter west of and adjacent to the benchmark and align the base-plate in the star-drilled holes. Read the meter facing north.

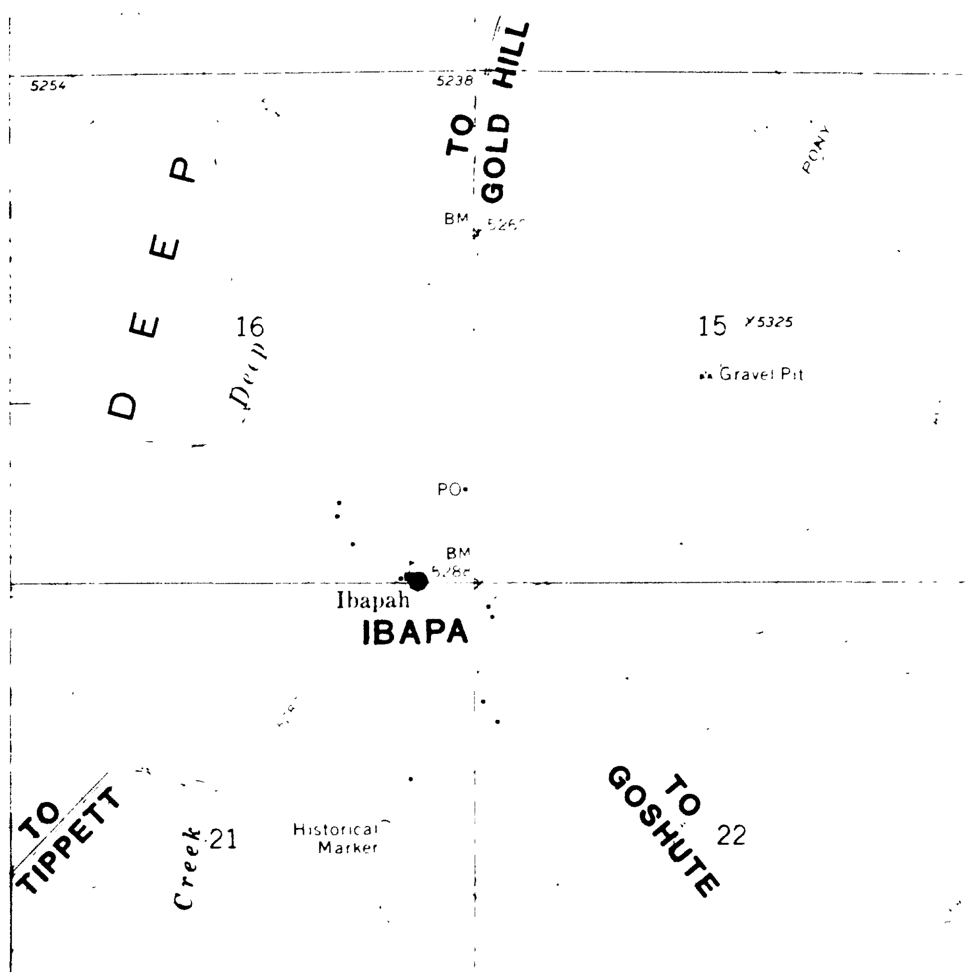


FERGUSON MTN. QUADRANGLE
NEVADA–ELKO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION #	IBAPA		
NAME	IBAPA	**STATE**	Utah
LATITUDE	40°02.19'	**LONGITUDE**	113°59.09'
ELEVATION	5,278 ft (1,609 m)	**QUADRANGLE**	Ibapah, 1:24,000
OBSERVED GRAVITY	979,654.33	**SBA**	-201.65 mGal

LOCATION DESCRIPTION:

The station is near the main entrance to the Ibapah School, Ibapah, Nev. The station is in the corner adjacent to a side entrance to the school building about 10 ft W. of a flag pole. Place the base plate in the star-drilled holes. Read the meter facing north.



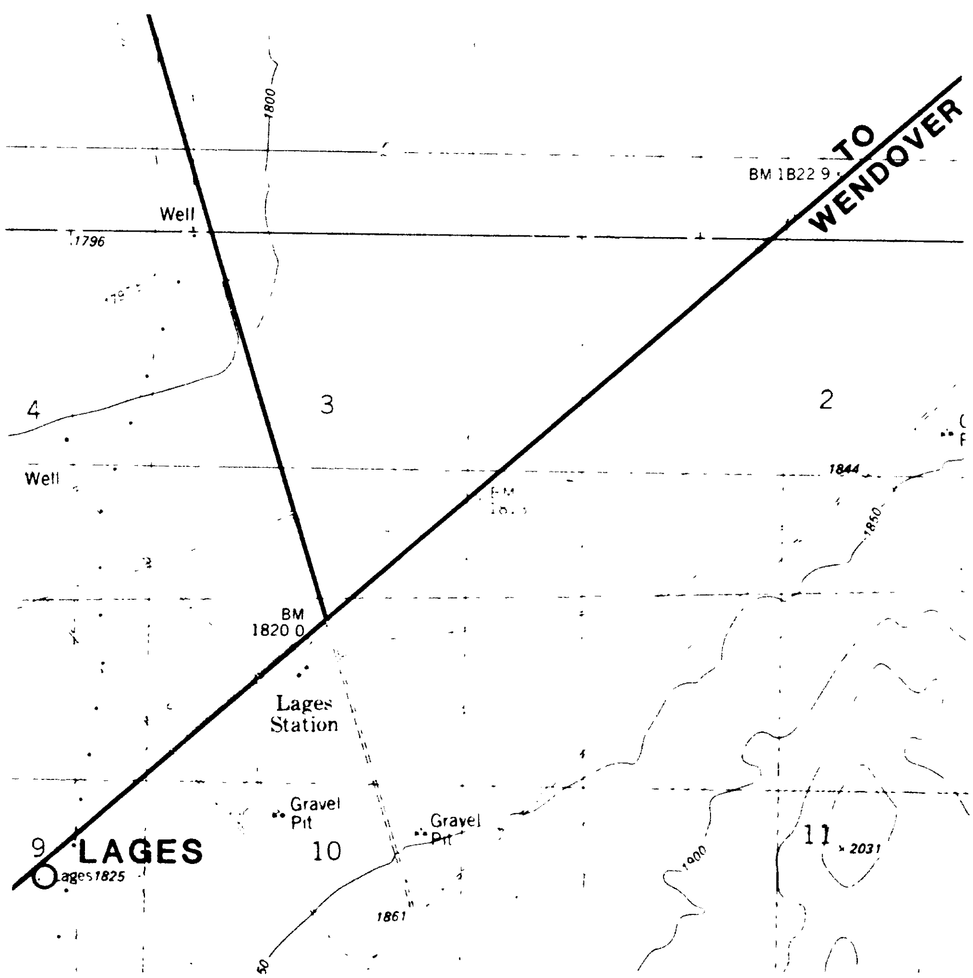
IBAPAH QUADRANGLE
UTAH–TOOELE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # LAGES

NAME	LAGES	**STATE**	Nevada
LATITUDE	40°03.48'	**LONGITUDE**	114°37.42'
ELEVATION	5,988 ft (1,825 m)	**QUADRANGLE**	Lages Station 1:24,000
OBSERVED GRAVITY	979,607.17	**SBA**	-208.21 mGal

LOCATION DESCRIPTION:

The station is along U.S. Rte 93 about 56 mi N. of the Ely Airport and 0.7 mi S. of the U.S. Rte 93/93A intersection on the east side of the road. Station is at a U.S. Coast & Geodetic Survey vertical angle benchmark stamped 'LAGES 1965' and adjacent to a wooden witness post. Place the meter over the benchmark. Read the meter facing north.

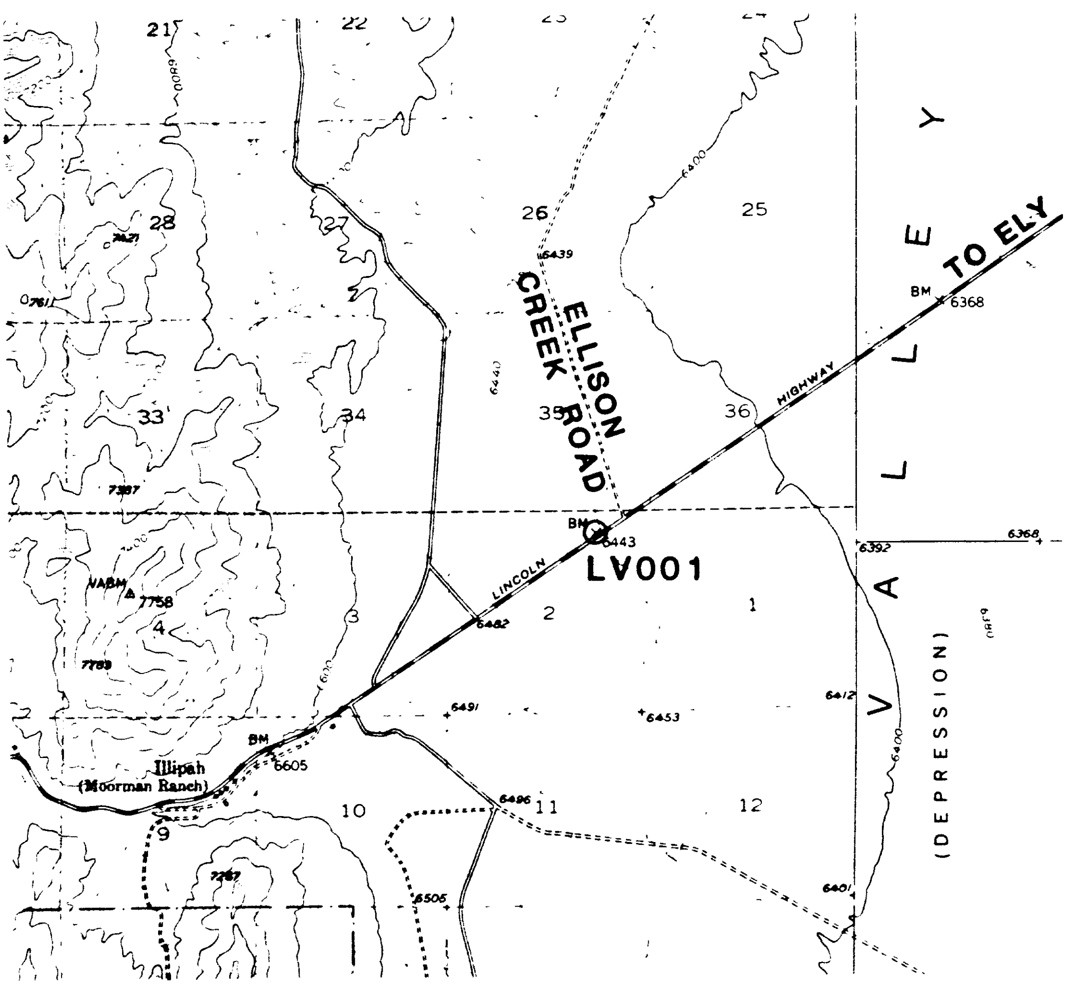


LAGES STATION QUADRANGLE
NEVADA
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # LV001			
NAME	LV001	**STATE**	Nevada
LATITUDE	39°22.56′	**LONGITUDE**	115°17.69′
ELEVATION	6,436.2 ft (1,961.75 m)	**QUADRANGLE**	Illipah, 1:24,000
OBSERVED GRAVITY	979,498.81 mGal	**SBA**	-229.10 mGal

LOCATION DESCRIPTION:

The station is along U.S. Hwy 50 about 30.8 mi W. of the Hwy 50 and 93 intersection in Ely, Nev. and 1.55 mi E. of Ellison Creek Rd. The station is located on the north side of the highway, 132 ft from the centerline of the road, 10 ft E. of a culvert and 35 ft S. of a fence. The station is at a USGS benchmark stamped 'A44RC1 1975 6436 ft" set in a white PVC casing, and adjacent to a rock cairn and green 3-ft high metal stake. Place the meter adjacent to and north of the benchmark. Read the meter facing north.

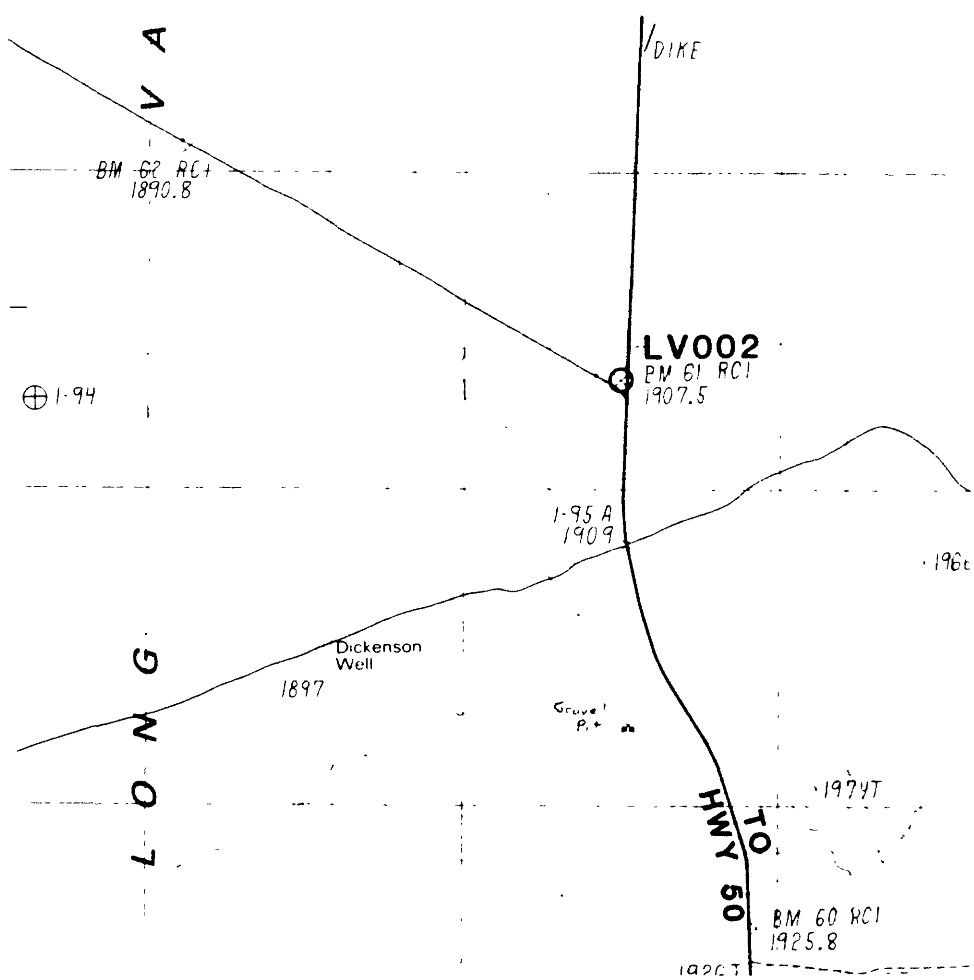


ILLIPAH QUADRANGLE
NEVADA-WHITE PINE CO.
15 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # LV002	
NAME LV002	**STATE** Nevada
LATITUDE 39°34.86′	**LONGITUDE** 115°21.15′
ELEVATION 6,258.3 ft (1,907.53 m)	**QUADRANGLE** Dickenson Well, 1:24,000
OBSERVED GRAVITY 979,544.46 mGal	**SBA** -212.30 mGal

LOCATION DESCRIPTION:

The station is 16.5 mi N. of U.S. Hwy 50 along a road heading north to Long Valley. The station is at a USGS benchmark stamped 'G1RC1 1975 6258 FT' and encased in white PVC pipe and adjacent to a small rock cairn. Place meter adjacent to and on the north side of benchmark. Read the meter facing north.

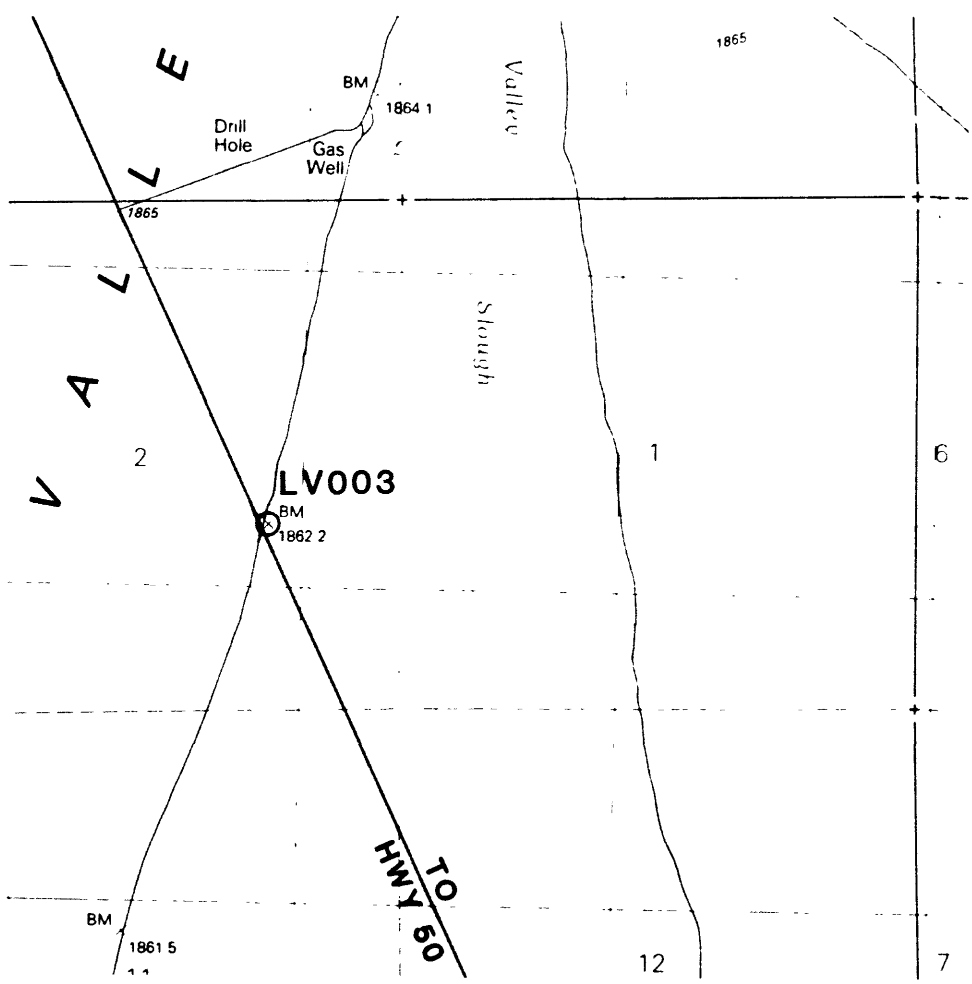


DICKENSON WELL QUADRANGLE
NEVADA—WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # LV003	
NAME LV003	**STATE** Nevada
LATITUDE 39°48.34′	**LONGITUDE** 115°24.05
ELEVATION 6,109.5 ft (1,862.18 m)	**QUADRANGLE** Long Valley Slough, 1:24,000
OBSERVED GRAVITY 979,563.65 mGal	**SBA** -221.99 mGal

LOCATION DESCRIPTION:

The station is about 50.4 mi N. along Long Valley Road from the intersection of Long Valley road and a secondary road heading NNE. Station is 16.6 mi N. of LV002 along Long Valley Road. The station is at a USGS benchmark stamped '82RC1 1975 6110 ft' encased in a white PVC casing and adjacent to a small rock cairn. Place the meter adjacent to the benchmark. Read the meter facing north.



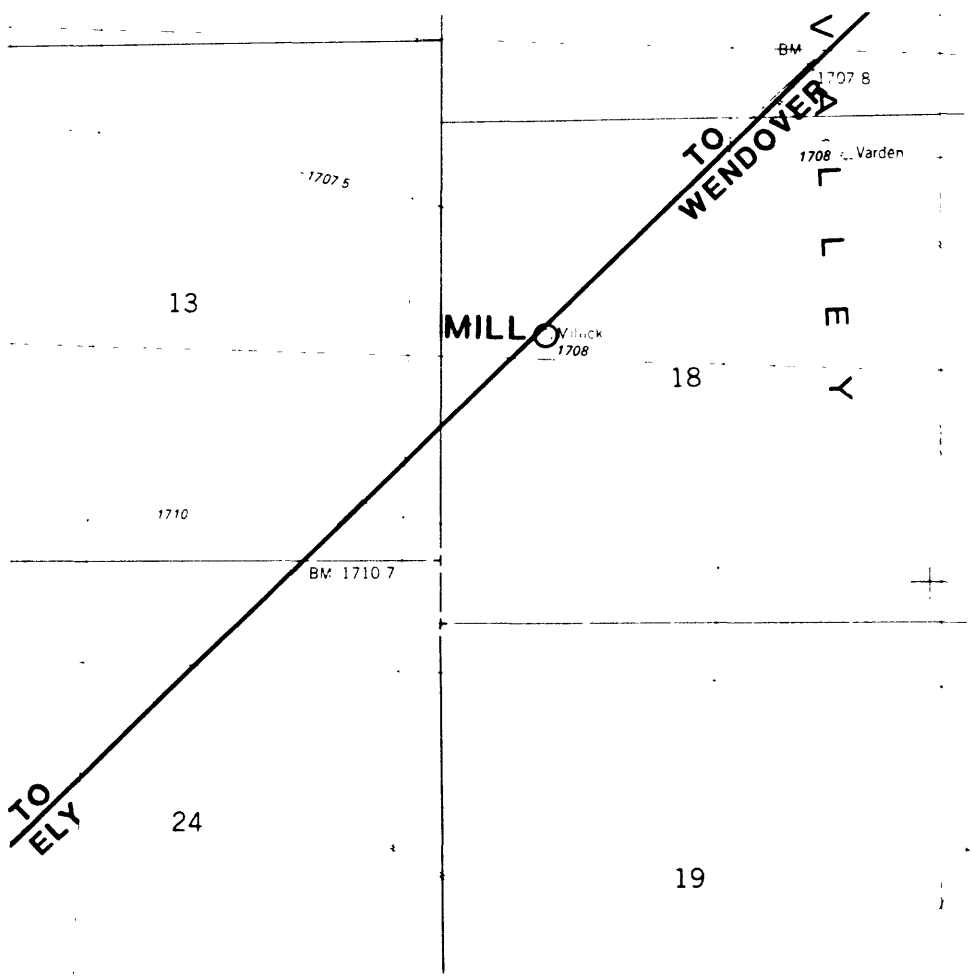
LONG VALLEY SLOUGH QUADRANGLE
NEVADA-WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # MILL

NAME MILL	**STATE** Nevada
LATITUDE 40°17.92'	**LONGITUDE** 114°20.86'
ELEVATION 5,604 ft (1,708 m)	**QUADRANGLE** White Horse Mountain, 1:24,000
OBSERVED GRAVITY 979,653.66 mGal	**SBA** -206.18 mGal

LOCATION DESCRIPTION:

The station is 2.0 mi E. of Dolly Varden Ranch Road and on the south side of the road. The station is at a U.S. Coast and Geodetic Survey benchmark stamped "MILLICK 1965" with a witness post about 90 ft from road. Place the meter over the benchmark. Read the meter facing north.

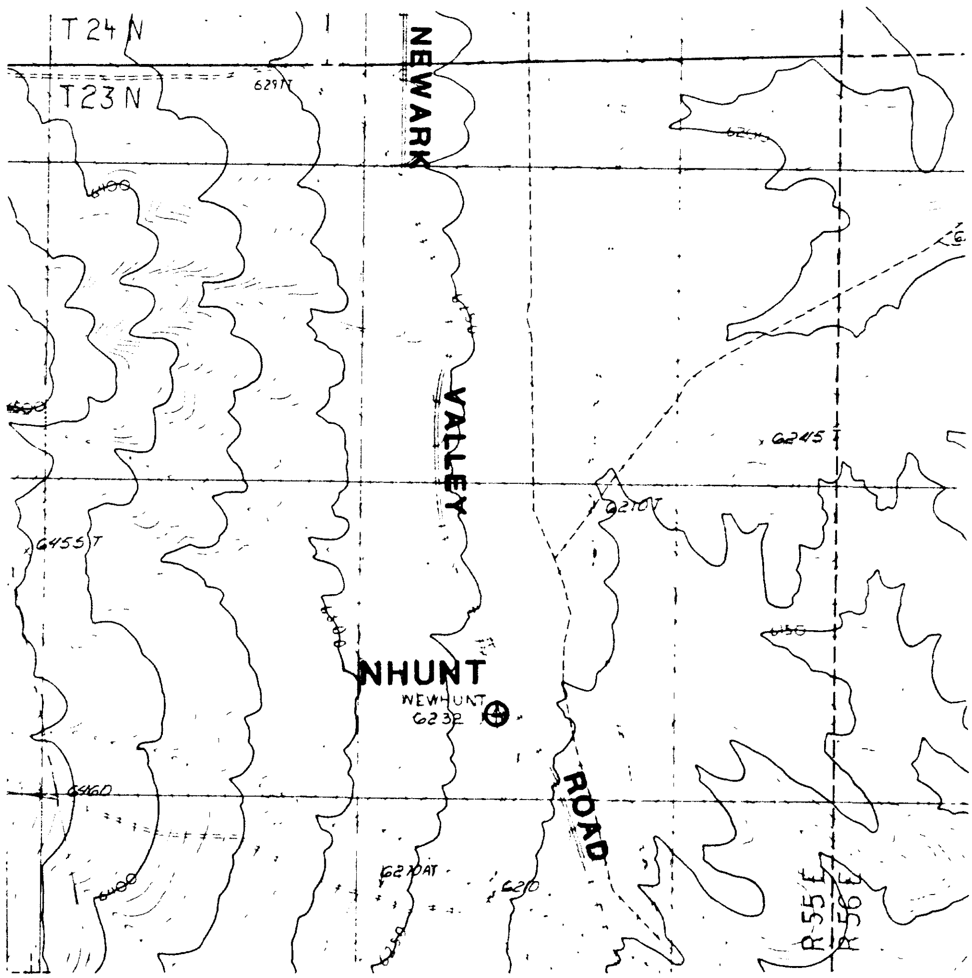


WHITE HORSE MOUNTAIN QUADRANGLE
NEVADA-ELKO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # NHUNT	
NAME NHUNT	**STATE** Nevada
LATITUDE 39°52.92′	**LONGITUDE** 115°43.88′
ELEAVATION 6,232.3 ft (1,899.61 m)	**QUADRANGLE** Cold Creek Ranch, 1:62,500
OBSERVED GRAVITY 979,576.08 mGal	**SBA** -209.00 mGal

LOCATION DESCRIPTION:

Station is 14.9 mi E. of Eureka (or 66.7 mi W. of the Ely Airport/Rte 93 junction) along U.S. Hwy 50, 37.0 mi N. along Newark Valley Rd., at intersection with a jeep trail heading west. Station is about 230 ft SW. of Newark Valley Rd, about 60 ft W. of secondary road. The station is at a U.S. Coast & Geodetic Survey vertical angle benchmark stamped 'NEWHUNT 1947' and adjacent to two wooden stakes about 3-ft high. Place the meter over the benchmark. Read the meter facing north.



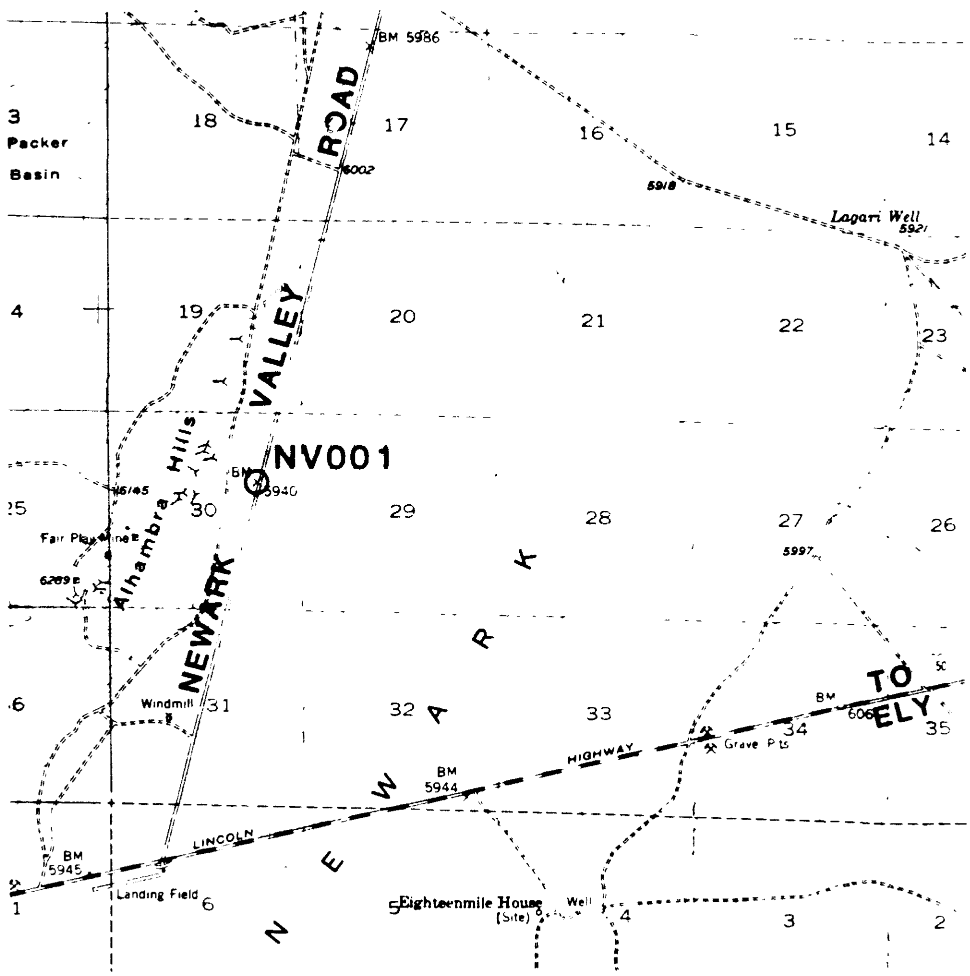
COLD CREEK RANCH NW QUADRANGLE
NEVADA–WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # NV001	
NAME NV001	**STATE** Nevada
LATITUDE 39°24.24′	**LONGITUDE** 115°49.08′
ELEVATION 5,940.3 ft (1,810.60 m)	**QUADRANGLE** Pinto Summit, 1:62,250
OBSERVED GRAVITY 979,547.72 mGal	**SBA** -212.37 mGal

LOCATION DESCRIPTION:

The station is located 14.9 mi E. of Eureka along Hwy 50 then 2.0 mi N. along Newark Valley Rd. The station is 36 ft W. of the centerline of the road, 86 ft S. of a culvert, 31 ft S. of a paddleboard (SR892WP2), and about 0.2 mi S. of a dirt road leading east to a well.

The station is at a USGS benchmark stamped '13AA 1951 5940 ft' and set in a concrete slab. Place the meter adjacent to and south of the benchmark. Read the meter facing north.

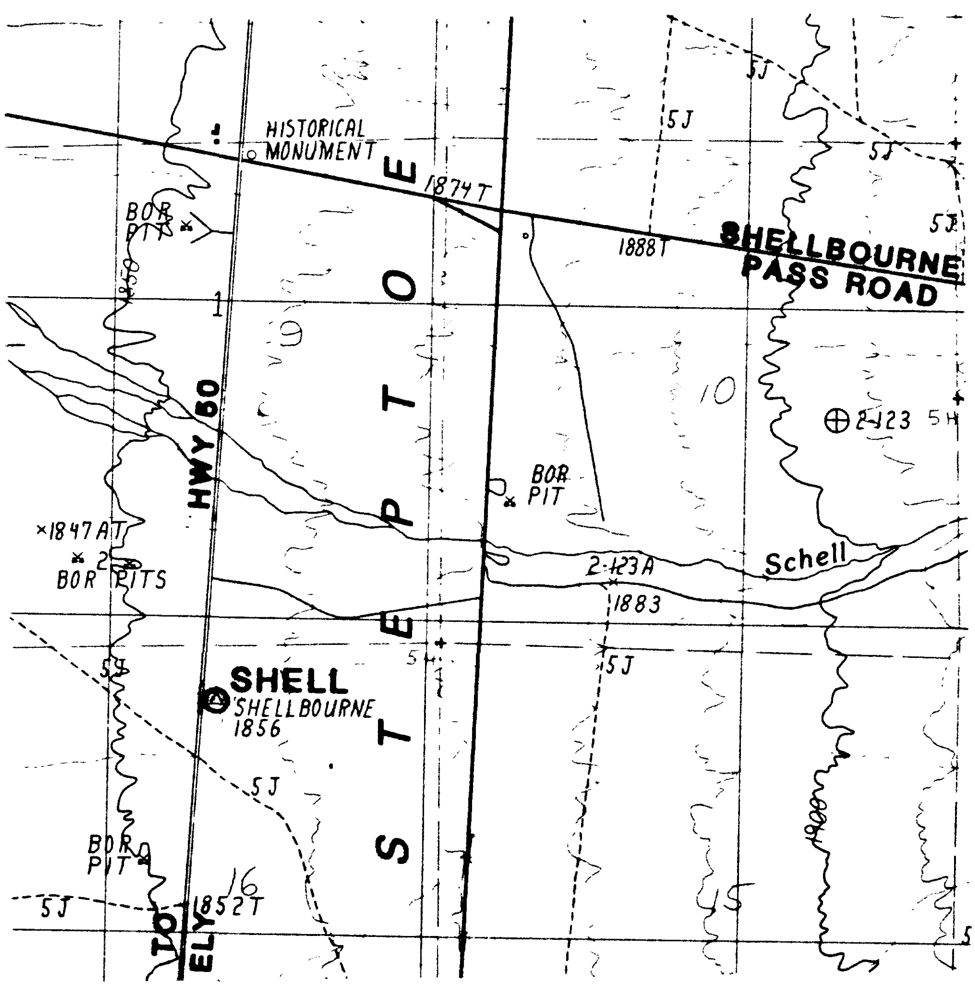


PINTO SUMMIT QUADRANGLE
NEVADA
15 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # SHELL	
NAME SHELL	**STATE** Nevada
LATITUDE 39°46.88′	**LONGITUDE** 114°44.45′
ELEVATION 6,090.0 ft (1,856.23 m)	**QUADRANGLE** Shellbourne, 1:24,000
OBSERVED GRAVITY 979,549.86 mGal	**SBA** -234.79 mGal

LOCATION DESCRIPTION:

The station is along U.S. Hwy 50 about 35.1 mi N. of the Ely Airport Road and Hwy 50 intersection. The station is about 165 ft S. of sign on east side of road that reads: "The Pony Express Historic Site 1 mile (1.6 kilometer)". The station is at a U.S. Coast & Geodetic Survey vertical angle benchmark stamped 'SHELLBOURNE 1967' and adjacent to a witness post. Place the meter over the benchmark. Read the meter facing north.



SCHELLBOURNE QUADRANGLE
NEVADA—WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # STONE	
NAME STONE	**STATE** Nevada
LATITUDE 39°46.83′	**LONGITUDE** 114°32.37′
ELEVATION 6,280.9 ft (1,914.42 m)	**QUADRANGLE** Stonehouse, 1:24,000
OBSERVED GRAVITY 979,553.01 mGal	**SBA** -220.13 mGal

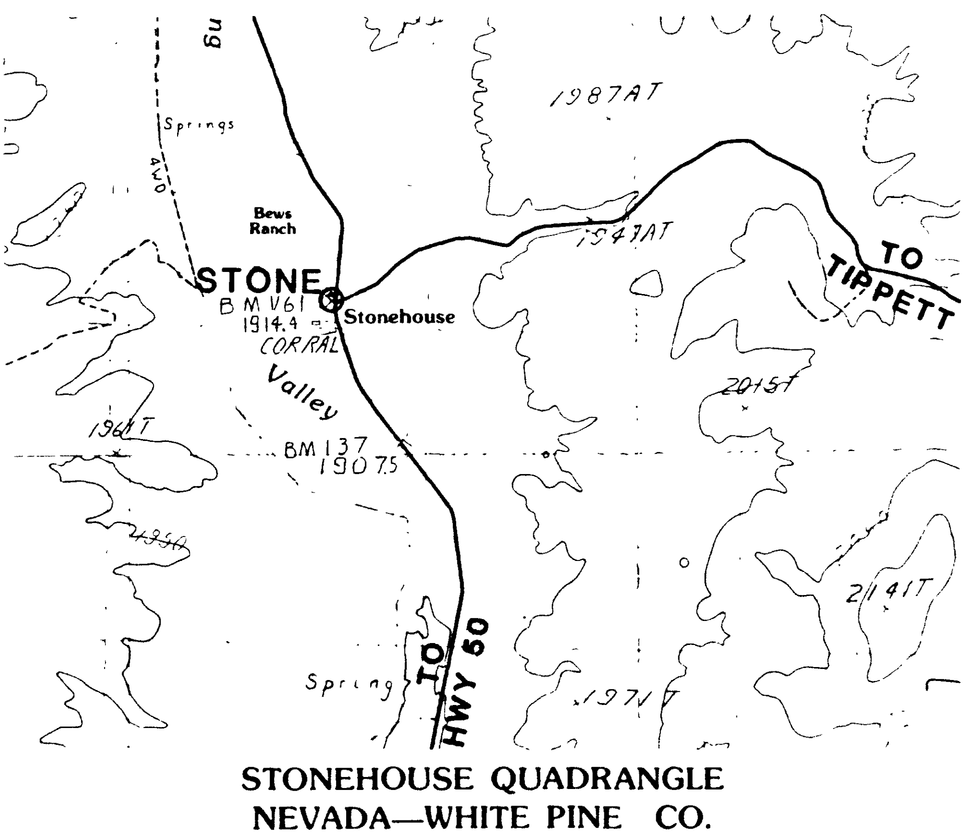
LOCATION DESCRIPTION:

The station is 14.7 mi E. of the junction of U.S. Hwy 50 and Shellbourne Pass Road along Shellbourne Pass Road. The station is located at the intersection between Shellbourne Pass Road and a road that heads east to Tippett and Ibapah and is adjacent to a stone house with wood roof.

Sign at intersection reads:

↑	Spring Valley	U.S. 50
←	Tippett	15
←	Ibapah Utah	42

Station is at a U.S. Coast & Geodetic Survey benchmark stamped 'V61 1934' adjacent to a witness post, obscured by bushes. Place the meter adjacent to and on the north side of the benchmark. Read the meter facing north.



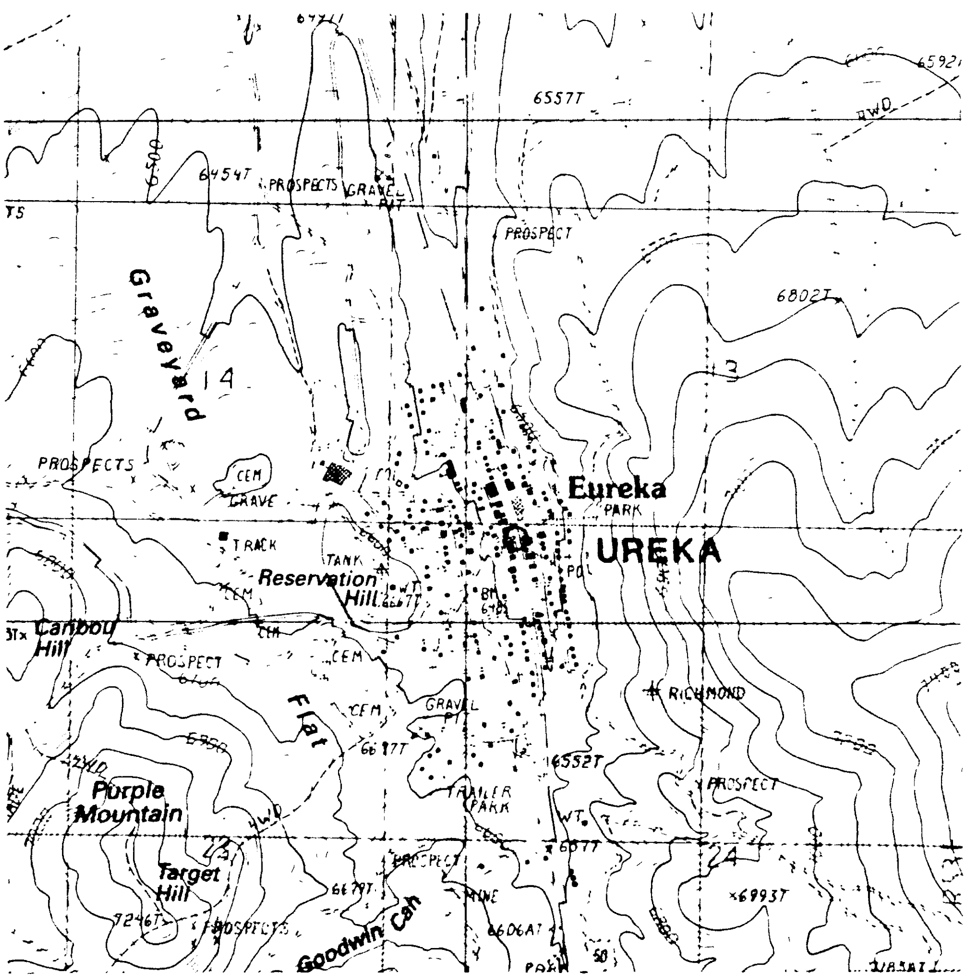
STONEHOUSE QUADRANGLE
NEVADA—WHITE PINE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

GRAVITY BASE STATION # UREKA	
NAME UREKA	**STATE** Nevada
LATITUDE 39°30.72′	**LONGITUDE** 115°57.58′
ELEVATION 6,480.7 ft (1,975.32 m)	**QUADRANGLE** Eureka, 1:62,500
OBSERVED GRAVITY 979527.66 mGal	**SBA** -209.54 mGal

LOCATION DESCRIPTION:

The station is in Ureka at the Eureka County Courthouse, 5 ft N. of main entrance. The courthouse is a large, 2-story red brick building with white trim along U.S. Hwy 50.

The station is located 2 ft below a USGS benchmark stamped 'R30 1931 Reset 1972' that is set in a stone ledge around the base of the building. Place the base plate directly below the benchmark and touching the building. Read the meter facing the building or west.



EUREKA QUADRANGLE
NEVADA–EUREKA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)