United States Department of the Interior

Geological Survey

Principal Facts for Gravity Stations

Ennis Geothermal Area, Montana

by

Viki Bankey, Jody Paton, and M. Dean Kleinkopf

Open-File Report 80-1084

1980

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Introduction

On August 16-17, 1979, 112 gravity stations were established north of the town of Ennis, Montana. The survey area lies in the valley west of the Madison River, centering around the Ennis Geothermal Area. The data were obtained as part of the U.S. Geological Survey's program to evaluate geothermal resource areas. The data collected complement an earlier gravity survey (Senterfit, 1980) as well as an audio-magnetotelluric survey (Long and Senterfit, 1979). This report presents the principal facts for this data, and includes a complete Bouguer Anomaly Map (Appendix C) of the data incorporating Senterfit's survey.

Data Collection

Gravity observations were made using the LaCoste-Romberg[1] gravity meter, G-235. The gravity values were referenced to the Department of Defense (DOD) bases at Three Forks, Montana, and the USGS base in Helena, Montana, which are part of the International Gravity Standardization Net (IGSN), 1971, established by the Defense Mapping Agency Aerospace Center (1974). The DOD base station description for Three Forks has been modified for this base station and is included in this report (Appendix A). It includes the ISGN-71 value of 980290.09 mgals which was used for this survey. A secondary base was established in the study area at U.S. Coast and Geodetic Survey Bench Mark Y145, which was tied to the USGS base in Helena (1978) and DOD base at Three Forks (1979). Gravity loops were started and closed daily by observations at this secondary base.

1/ Use of brand names is for descriptive purposes and does not constitute endorsement by the U.S.G.S.

Elevation Control

The U.S. Geological Survey topographic map of Ennis, Montana at a scale of 1:62,500, shows the location of the Ennis Geothermal Area. Station elevations were surveyed using a Hewlett-Packard Distance Meter surveying instrument. The elevations were computed from ties to survey point E-45, with a known elevation of 1500.5 m (R. T. Leonard, oral commun., 1979).

An individual elevation obtained with this instrument is estimated to have a precision of 0.15 m for distances from instrument to station of less than 2.1 km. This translates to uncertainties in Bouguer values of .03 mgal. Horizontal distance at this range is also accurate to within 0.15 m.

Data Reduction

Computer programs existing on the USGS Honeywell Multics computer system were used to obtain principle facts and terrain corrected gravity values. An unpublished program by D. A. Dansereau and R. R. Wahl of the U.S. Geological Survey was used to calculate Earth tide and linear meter-drift and corrections. The theoretical gravity value was calculated using the 1967 formula of the Geodetic Reference System (International Association of Geodesy, 1967).

Terrain corrections were computed from each station out to 166.7 km using an unpublished program by R. H. Godson (USGS, 1978) and the method of Plouff (1977). The program uses mean elevation data on a 15 second grid for corrections from 0 to 5 km; 1 minute terrain data for corrections from 5 to 21 km, and 3 minute terrain data for corrections from 21 to 166.7 km. An assumed density of 2.67 g/cm^3 was used for terrain corrections. This program also calculates earth curvature corrections and complete (terrain corrected) Bouguer anomaly values. Corrections for terrain ranged from 1.35 mgal to 1.60 mgal. Two complete Bouguer anomaly values per station were obtained assuming average rock densities of 2.67 g/cm^3 and 2.50 g/cm^3. The corrections and anomaly values are listed in Appendix B, and the contoured Bouguer gravity map is included as Appendix C.

References

Defense Mapping Agency Aerospace Center, 1974, World Relative Gravity Reference Network, North America, Part 2: DMAAC Reference Publication 25, with supplement updating gravity values to the International Gravity Standardization Net 1971, 1635 p.

International Association of Geodesy, 1967, Geodetic Reference System, 1967, International Association of Geodesy Special Publication 3, 74 p.

Long, C. L., and Senterfit, R. M., 1979, Audio-magnetotelluric data log and station-location map for the Ennis Hot Springs area, Montana: USGS Open-File Report 79-1308.

Plouff, D., 1977, Preliminary documentation for a FORTRAN program to compute gravity terrain corrections based on topography digitized on a geographic grid: U.S. Geological Survey Open-File Report 77-535.

Senterfit, R. M., 1980, Principal facts for a gravity survey of the Ennis, Montana Geothermal area: U.S. Geological Survey Open-File Report 80-98.

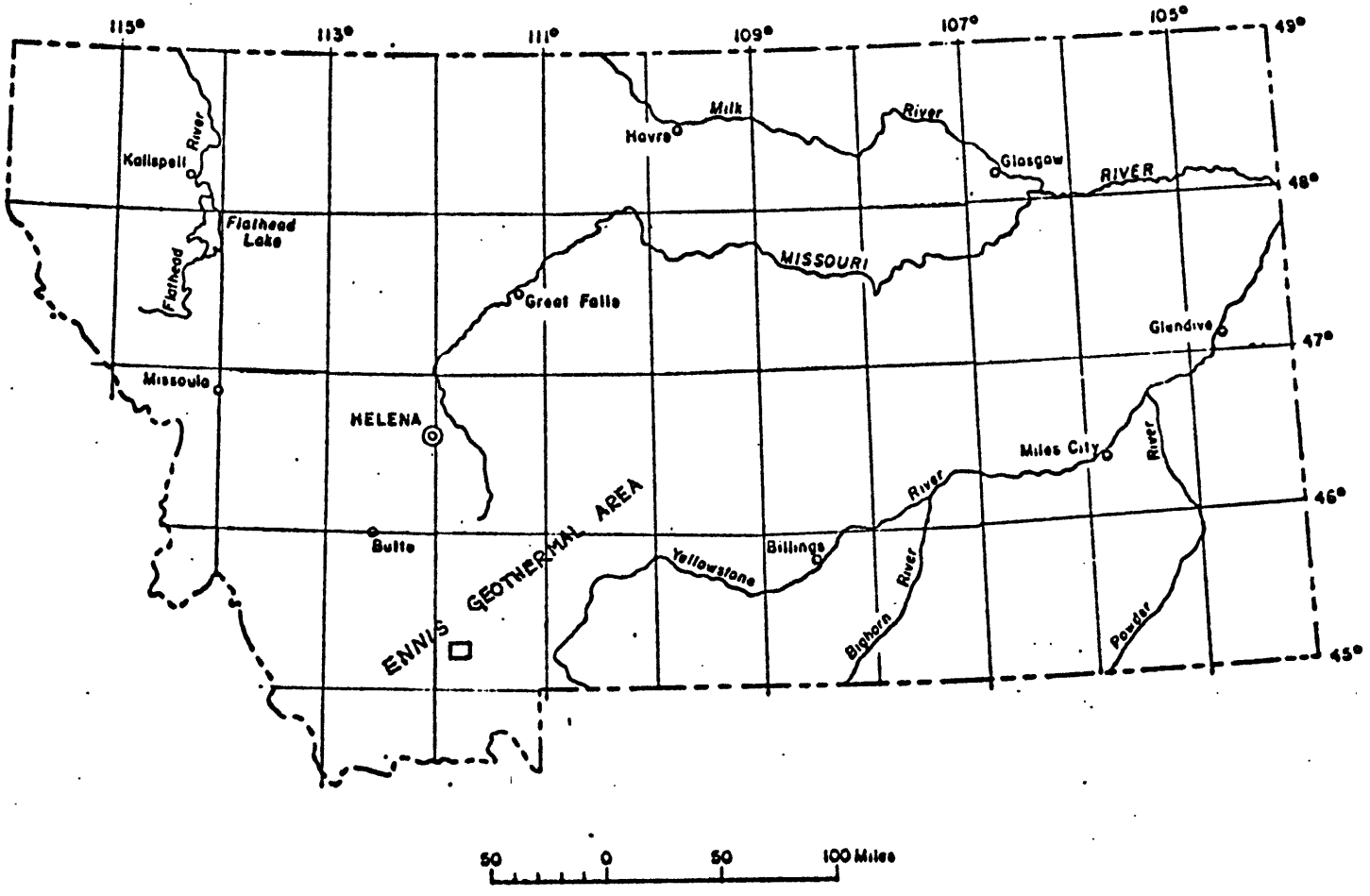


FIGURE 1: Location map of the Ennis Geothermal Area, Montana

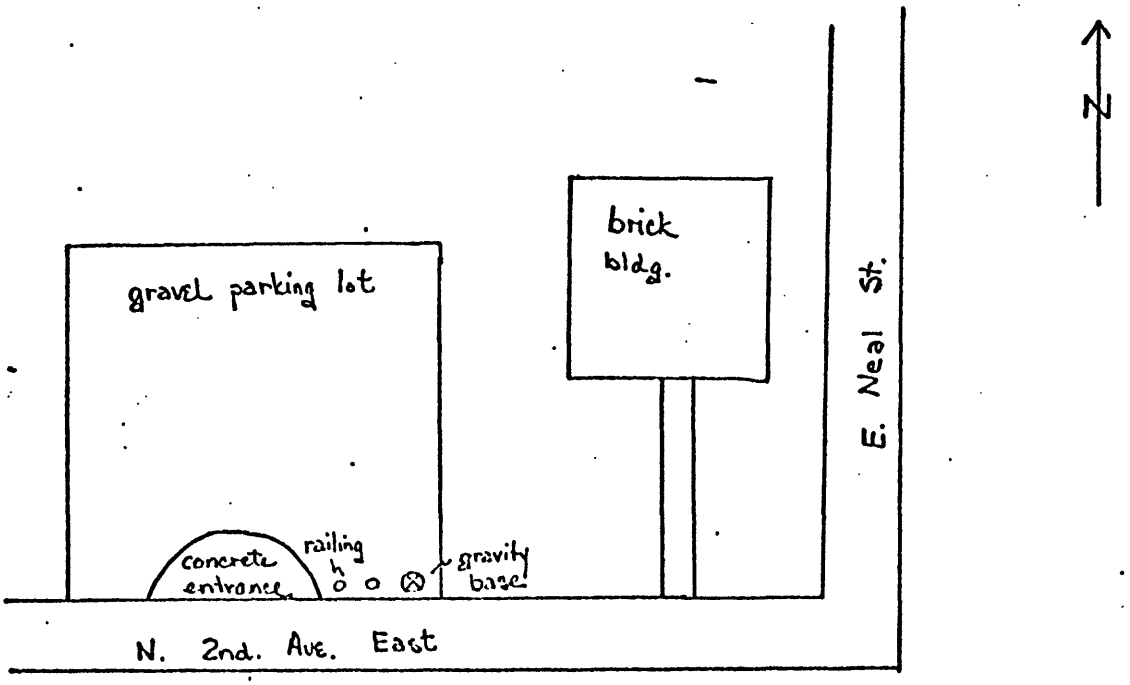
Appendix A
Descriptions of Gravity Base Stations
U.S. GEOLOGICAL SURVEY
GRAVITY BASE STATION

STATE/COUNTRY	STATION DESIGNATION	OBSERVED GRAVITY
MONTANA	THREE FORKS DOD	980290.09 mgal
NEAREST TOWN	**LONGITUDE**	**LATITUDE**
THREE FORKS	111°33.25'	45°53.75'
ELEVATION	**TOPOGRAPHIC MAP(S)**	
4080 ft. (1243.8 m)	Bozeman 2°	

DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
			ACIC 1231-0	
			IGC 15651-J	

DESCRIPTION/SKETCH

Station is located in front of the remains of the Three Forks consolidated school in Three Forks, MT, at the northwest corner of North 2nd Ave. East and East Neal St. Base is 0.6 m east of the iron railing posts at the concrete entrance.



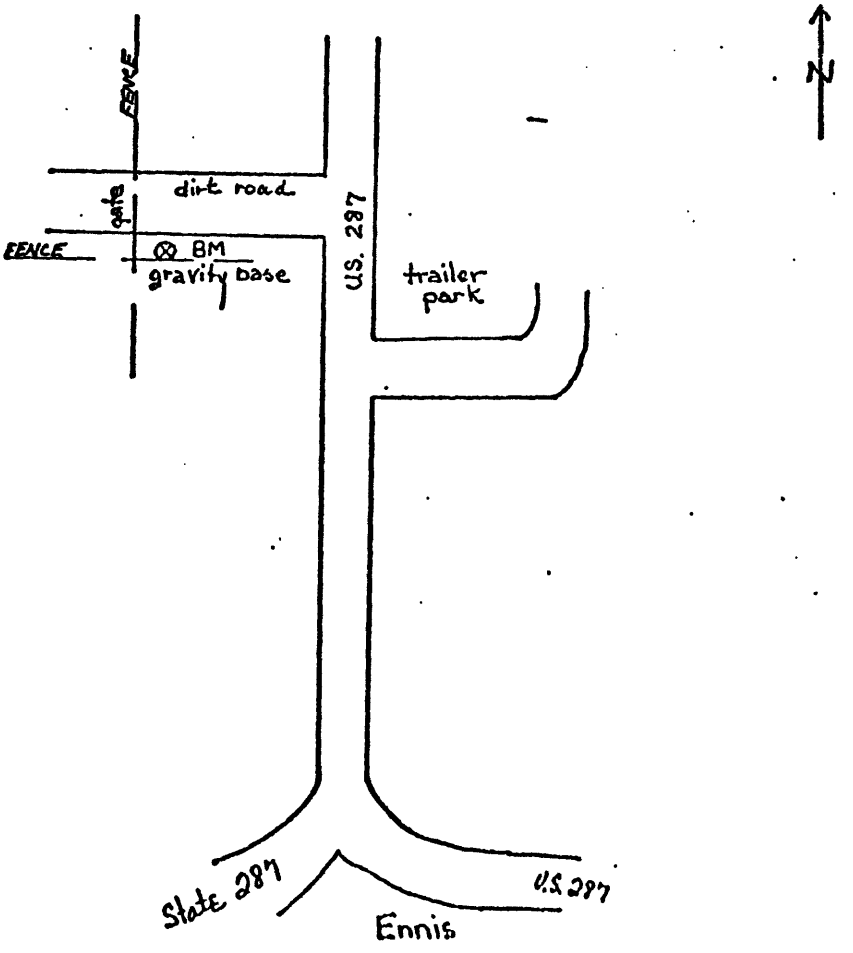
U.S. GEOLOGICAL SURVEY
GRAVITY BASE STATION

STATE/COUNTRY	STATION DESIGNATION	OBSERVED GRAVITY
MONTANA	ENNIS	980173.87 mgal
NEAREST TOWN	LONGITUDE	LATITUDE
ENNIS	111°43'89	45°23'20
ELEVATION	TOPOGRAPHIC MAP(S)	
4895 ft (1492 m.)	Ennis 15', Bozeman 2°	

DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
10/2/79	McBride	G-235	Three Forks DOD	980290.08 mgal

DESCRIPTION/SKETCH

Base is 3.2 km north of junction of state & U.S. 287 in Ennis, then west on farm road. Base is east of gate and south of road, 1 meter from fence.



MDK 12/

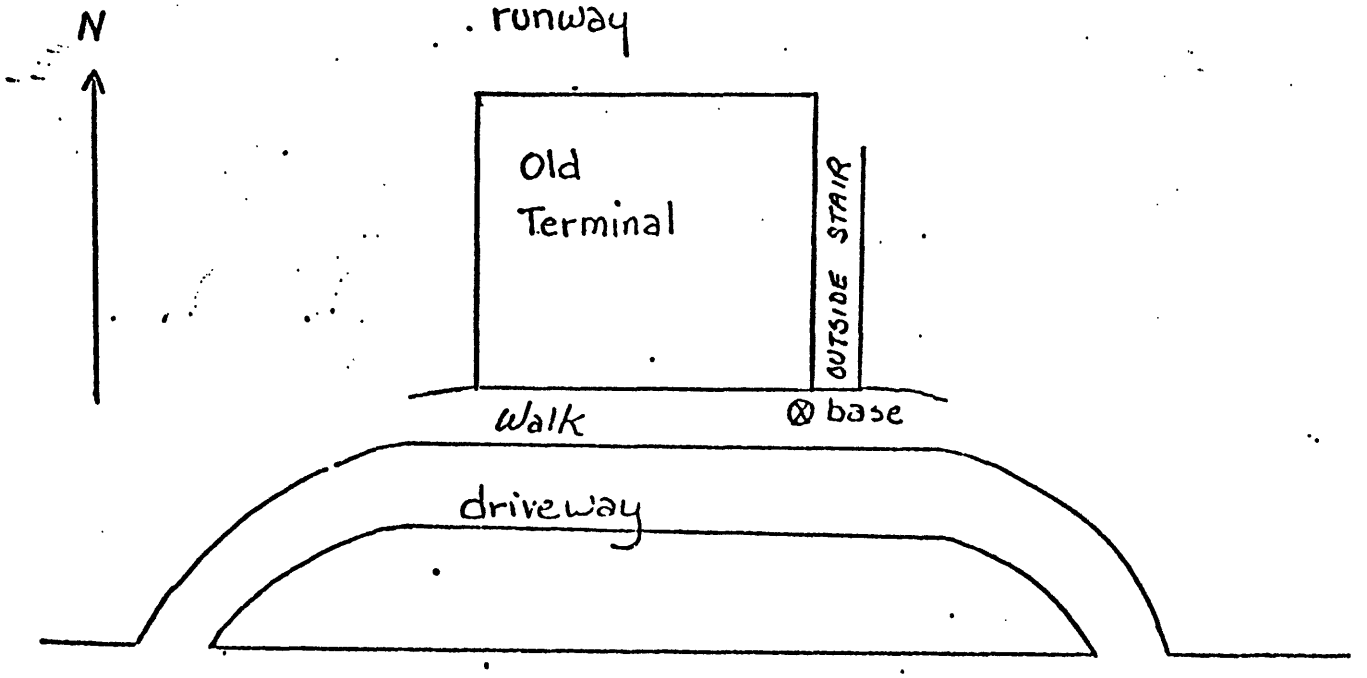
U.S. GEOLOGICAL SURVEY
GRAVITY BASE STATION

STATE/COUNTRY	STATION DESIGNATION	OBSERVED GRAVITY
Montana	Helena Airport	980363.26 mgals
NEAREST TOWN	LONGITUDE	LATITUDE
Helena	111° 59.50'	46° 36.50'
ELEVATION	TOPOGRAPHIC MAP(S)	
1180.3 m (3872')	White Sulphur Springs 1/250,000	

DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/2/77	Kleinkopf	Worden E-134	Helena airport DOD	980363.50 mgals

DESCRIPTION/SKETCH

Base is on concrete walk at southeast corner of the airport terminal building, to west side of outside stairway - "employee entrance". Note the DOD location is on north side of the terminal in the security area.



Appendix B: Principal Facts of Gravity Data

Explanation of headings

identification	
proj	Project name.
sta-id	Gravity station identification.
location	
latitude	North latitude in degrees, minutes, and hundredths of minutes.
longitude	West longitude in degrees, minutes and hundredths of minutes.
elev, f	Station elevation in feet.
st	State where location is located.
observed gravity	Observed gravity in milligals.
theoretical gravity	Theoretical gravity.
corrections	
terrain	Terrain correction out to 166.7 km in milligals.
Bouguer	Elevation correction in milligals.
curv	Curvature correction in milligals.
special	Not used.
anomalies	
free air	Free-air anomaly in milligals.
complete-Bouguer	Complete Bouguer anomaly in milligals for designated densities.
spec fields	Not used.

BOUGUER GRAVITY DATA

Ennis Geothermal Area
V. Bankey 3-18-80
Meter ID: g-235 Date: 04/03/80

STATION IDENTIFICATION proj	sta-id	LOCATIONS LATITUDE deg	min	LONGITUDE deg	min	ELE (in ft)	ST	GRAVITY OBSERVED	THEORETICAL	CORRECTIONS TERRAIN	BOUGUER	CURV	SPECIAL	ANOMALIES FREE AIR	COMPLETE-BOUGUER d1=2.67	d2=2.50	SPEC FIELDS
North :	ennis	45	22.70	-111	43.85	4885.0	mt	980173.87	980653.29	1.60	-166.95	-1.40	0.00	-19.20	-185.95	-169.42	
North :	tx2	45	22.03	-111	43.78	4918.3	mt	980173.79	980652.28	1.42	-167.75	-1.40	0.00	-16.11	-183.84	-175.16	
North :	e3	45	21.97	-111	43.78	4921.0	mt	980173.71	980652.19	1.42	-167.84	-1.40	0.00	-15.84	-183.67	-172.98	
North :	e4	45	21.97	-111	43.70	4919.5	mt	980173.28	980652.19	1.41	-167.79	-1.40	0.00	-16.41	-184.20	-173.51	
North :	e5	45	21.97	-111	43.61	4920.6	mt	980173.26	980652.19	1.40	-167.83	-1.40	0.00	-16.33	-184.16	-173.48	
North :	e6	45	21.86	-111	43.77	4916.7	mt	980173.02	980652.02	1.47	-167.69	-1.40	0.00	-16.77	-184.39	-173.72	
North :	e7	45	21.85	-111	43.81	4916.1	mt	980173.14	980652.01	1.47	-167.67	-1.40	0.00	-16.69	-184.30	-173.63	
North :	e8	45	21.77	-111	43.79	4917.7	mt	980172.86	980651.89	1.45	-167.73	-1.40	0.00	-16.71	-184.38	-173.71	
North :	e9	45	21.76	-111	43.73	4902.1	mt	980173.83	980651.88	1.51	-167.20	-1.40	0.00	-17.19	-184.27	-173.63	
North :	e10	45	21.80	-111	43.69	4900.7	mt	980173.71	980651.93	1.52	-167.15	-1.40	0.00	-17.50	-184.52	-173.89	
North :	e11	45	21.85	-111	43.69	4899.3	mt	980174.07	980652.01	1.55	-167.10	-1.40	0.00	-17.34	-184.29	-173.66	
North :	e12	45	21.85	-111	43.64	4897.9	mt	980174.11	980652.01	1.57	-167.05	-1.40	0.00	-17.43	-184.32	-173.69	
North :	e13	45	21.85	-111	43.62	4897.9	mt	980173.94	980652.01	1.57	-167.05	-1.40	0.00	-17.61	-184.49	-173.86	
North :	e14	45	21.85	-111	43.58	4898.7	mt	980173.65	980652.01	1.53	-167.08	-1.40	0.00	-17.82	-184.77	-174.14	
North :	e15	45	21.81	-111	43.52	4899.8	mt	980172.95	980651.95	1.47	-167.12	-1.40	0.00	-18.35	-185.40	-174.76	
North :	e16	45	21.75	-111	43.57	4901.5	mt	980172.46	980651.86	1.47	-167.18	-1.40	0.00	-18.59	-185.70	-175.06	
North :	e17	45	21.73	-111	43.47	4901.3	mt	980171.71	980651.83	1.45	-167.17	-1.40	0.00	-19.33	-186.45	-175.81	
North :	e18	45	21.74	-111	43.39	4900.6	mt	980171.26	980651.84	1.48	-167.15	-1.40	0.00	-19.87	-186.93	-176.29	
North :	e19	45	21.85	-111	43.40	4897.4	mt	980172.47	980652.01	1.49	-167.04	-1.40	0.00	-19.12	-186.07	-175.44	
North :	e20	45	21.84	-111	43.48	4898.6	mt	980173.19	980651.99	1.49	-167.08	-1.40	0.00	-18.28	-185.26	-174.63	
North :	e21	45	21.90	-111	43.43	4896.3	mt	980173.18	980652.09	1.49	-167.00	-1.40	0.00	-18.59	-185.50	-174.87	
North :	e22	45	21.97	-111	43.45	4893.8	mt	980173.88	980652.19	1.48	-166.91	-1.40	0.00	-18.23	-185.06	-174.44	
North :	e23	45	21.99	-111	43.46	4893.6	mt	980173.92	980652.22	1.47	-166.91	-1.40	0.00	-18.24	-185.07	-174.45	
North :	e24	45	21.99	-111	43.43	4892.6	mt	980173.66	980652.22	1.48	-166.87	-1.40	0.00	-18.59	-185.38	-174.76	
North :	e25	45	21.99	-111	43.36	4890.8	mt	980172.89	980652.22	1.50	-166.81	-1.40	0.00	-19.53	-186.24	-175.63	
North :	e26	45	22.04	-111	43.36	4889.8	mt	980173.05	980652.30	1.51	-166.78	-1.40	0.00	-19.55	-186.21	-175.60	
North :	e27	45	22.10	-111	43.36	4888.2	mt	980173.26	980652.38	1.53	-166.72	-1.40	0.00	-19.58	-186.17	-175.56	
North :	e28	45	22.05	-111	43.41	4890.4	mt	980173.56	980652.31	1.51	-166.80	-1.40	0.00	-18.99	-185.67	-175.06	
North :	e29	45	21.74	-111	43.78	4916.5	mt	980172.65	980651.84	1.45	-167.69	-1.40	0.00	-16.98	-184.62	-173.95	
North :	e30	45	21.70	-111	43.66	4904.6	mt	980172.74	980651.78	1.50	-167.28	-1.40	0.00	-17.95	-185.13	-174.48	
North :	e31	45	21.92	-111	43.70	4920.0	mt	980173.12	980652.12	1.41	-167.81	-1.40	0.00	-16.45	-184.25	-173.57	
North :	e32	45	21.93	-111	43.57	4895.3	mt	980174.60	980652.13	1.53	-166.96	-1.40	0.00	-17.31	-184.14	-173.52	
North :	e33	45	23.59	-111	43.57	4919.4	mt	980172.84	980654.63	1.35	-167.79	-1.40	0.00	-19.31	-187.14	-176.46	
North :	e34	45	22.06	-111	43.52	4914.0	mt	980172.96	980652.33	1.38	-167.60	-1.40	0.00	-17.39	-185.01	-174.34	
North :	e35	45	22.07	-111	43.58	4917.0	mt	980173.31	980652.34	1.39	-167.70	-1.40	0.00	-16.77	-184.48	-173.81	
North :	e36	45	22.08	-111	43.64	4917.9	mt	980173.44	980652.35	1.40	-167.74	-1.40	0.00	-16.57	-184.31	-173.63	
North :	e37	45	22.08	-111	43.71	4919.3	mt	980173.56	980652.35	1.41	-167.78	-1.40	0.00	-16.32	-184.09	-173.41	
North :	e38	45	22.08	-111	43.79	4916.1	mt	980174.04	980652.35	1.45	-167.67	-1.40	0.00	-16.14	-183.77	-173.09	
North :	e39	45	22.04	-111	43.79	4918.6	mt	980173.84	980652.30	1.43	-167.76	-1.40	0.00	-16.04	-183.77	-173.09	

BOUGUER GRAVITY DATA

Ennis Geothermal Area
V. Bankey 3-18-80
Meter ID: g-235 Date: 04/03/80

STATION IDENTIFICATION proj	sta-id	LOCATIONS LATITUDE deg	min	LONGITUDE deg	min	ELE (in ft)	ST	GRAVITY OBSERVED	THEORETICAL	CORRECTIONS TERRAIN	BOUGUER	CURV	SPECIAL	ANOMALIES FREE AIR	COMPLETE-BOUGUER d1=2.67	d2=2.50	SPEC FIELDS
North :	e40	45	22.04	-111	43.72	4920.6	mt	980173.55	980652.30	1.40	-167.83	-1.40	0.00	-16.15	-183.98	-173.29	
North :	e41	45	22.01	-111	43.70	4920.4	mt	980173.51	980652.25	1.40	-167.82	-1.40	0.00	-16.16	-183.98	-173.30	
North :	e42	45	22.02	-111	43.66	4920.3	mt	980173.53	980652.27	1.39	-167.82	-1.40	0.00	-16.16	-183.99	-173.31	
North :	e43	45	22.03	-111	43.61	4919.2	mt	980173.40	980652.28	1.39	-167.78	-1.40	0.00	-16.42	-184.21	-173.52	
North :	e44	45	22.03	-111	43.57	4917.6	mt	980173.35	980652.28	1.39	-167.72	-1.40	0.00	-16.61	-184.35	-173.67	
North :	e45	45	21.97	-111	43.58	4921.6	mt	980173.29	980652.19	1.38	-167.86	-1.40	0.00	-16.21	-184.09	-173.40	
North :	e47	45	22.13	-111	43.77	4920.5	mt	980174.36	980652.43	1.43	-167.82	-1.40	0.00	-15.46	-183.28	-172.60	
North :	e48	45	22.19	-111	43.78	4918.9	mt	980174.25	980652.52	1.42	-167.77	-1.40	0.00	-15.53	-183.58	-172.90	
North :	e49	45	22.26	-111	43.79	4917.3	mt	980173.84	980652.63	1.43	-167.71	-1.40	0.00	-16.50	-184.18	-173.51	
North :	e50	45	22.32	-111	43.79	4912.7	mt	980173.45	980652.72	1.45	-167.56	-1.40	0.00	-17.41	-184.92	-174.25	
North :	e51	45	22.40	-111	43.79	4909.7	mt	980173.12	980652.84	1.47	-167.46	-1.40	0.00	-18.15	-185.53	-174.88	
North :	e52	45	22.44	-111	43.70	4908.9	mt	980172.47	980652.90	1.44	-167.43	-1.40	0.00	-18.93	-186.32	-175.66	
North :	e53	45	22.40	-111	43.70	4908.3	mt	980172.77	980652.84	1.45	-167.41	-1.40	0.00	-18.62	-185.98	-175.33	
North :	e54	45	22.34	-111	43.70	4911.7	mt	980173.13	980652.75	1.44	-167.52	-1.40	0.00	-17.85	-185.34	-174.67	
North :	e55	45	22.26	-111	43.69	4915.6	mt	980173.59	980652.63	1.41	-167.66	-1.40	0.00	-16.91	-184.55	-173.88	
North :	e56	45	22.30	-111	43.63	4917.5	mt	980173.98	980652.69	1.40	-167.72	-1.40	0.00	-16.40	-184.12	-173.44	
North :	e57	45	22.13	-111	43.67	4914.7	mt	980173.96	980652.43	1.43	-167.63	-1.40	0.00	-16.43	-184.02	-173.35	
North :	e58	45	22.12	-111	43.58	4922.1	mt	980173.70	980652.41	1.37	-167.88	-1.40	0.00	-15.97	-183.68	-173.19	
North :	e59	45	22.12	-111	43.50	4921.1	mt	980173.18	980652.41	1.36	-167.84	-1.40	0.00	-16.59	-184.48	-173.79	
North :	e60	45	22.14	-111	43.53	4919.0	mt	980173.31	980652.45	1.37	-167.77	-1.40	0.00	-16.69	-184.49	-173.81	
North :	e61	45	22.16	-111	43.51	4918.4	mt	980173.22	980652.48	1.37	-167.75	-1.40	0.00	-16.87	-184.65	-173.97	
North :	e62	45	22.19	-111	43.54	4919.7	mt	980173.25	980652.52	1.36	-167.80	-1.40	0.00	-16.76	-184.60	-173.91	
North :	e63	45	22.22	-111	43.60	4918.1	mt	980173.30	980652.57	1.39	-167.74	-1.40	0.00	-16.91	-184.66	-173.98	
North :	e64	45	22.26	-111	43.60	4916.7	mt	980173.08	980652.63	1.39	-167.69	-1.40	0.00	-17.32	-185.02	-174.34	
North :	e65	45	22.29	-111	43.55	4913.9	mt	980172.47	980652.67	1.38	-167.60	-1.40	0.00	-18.24	-185.85	-175.18	
North :	e66	45	22.33	-111	43.60	4915.1	mt	980172.45	980652.73	1.40	-167.64	-1.40	0.00	-18.20	-185.84	-175.17	
North :	e67	45	22.33	-111	43.56	4912.1	mt	980172.53	980652.73	1.40	-167.54	-1.40	0.00	-18.40	-185.94	-175.27	
North :	e68	45	22.27	-111	43.52	4890.3	mt	980173.24	980652.64	1.48	-166.79	-1.40	0.00	-19.65	-186.36	-175.75	
North :	e69	45	22.21	-111	43.47	4892.0	mt	980173.32	980652.55	1.47	-166.85	-1.40	0.00	-19.32	-186.10	-175.48	
North :	e70	45	22.21	-111	43.38	4890.3	mt	980174.14	980652.55	1.50	-166.79	-1.40	0.00	-18.66	-185.35	-174.74	
North :	e71	45	22.30	-111	43.38	4888.2	mt	980173.64	980652.69	1.50	-166.72	-1.40	0.00	-19.50	-186.11	-175.51	
North :	e72	45	22.31	-111	43.44	4887.0	mt	980173.88	980652.70	1.49	-166.68	-1.40	0.00	-19.38	-185.97	-175.36	
North :	e73	45	22.21	-111	43.32	4889.3	mt	980173.67	980652.55	1.48	-166.76	-1.40	0.00	-19.22	-185.90	-175.29	
North :	e74	45	22.15	-111	43.35	4891.7	mt	980173.96	980652.46	1.49	-166.84	-1.40	0.00	-18.62	-185.37	-174.75	
North :	e75	45	22.08	-111	43.37	4894.3	mt	980173.79	980652.35	1.48	-166.93	-1.40	0.00	-18.44	-185.29	-174.67	
North :	e76	45	22.12	-111	43.43	4893.4	mt	980174.51	980652.41	1.49	-166.90	-1.40	0.00	-17.87	-184.67	-174.05	
North :	e77	45	22.16	-111	43.45	4893.0	mt	980174.45	980652.48	1.48	-166.89	-1.40	0.00	-18.02	-184.82	-174.20	
North :	e78	45	22.14	-111	43.47	4894.0	mt	980174.58	980652.45	1.49	-166.92	-1.40	0.00	-17.77	-184.60	-173.98	
North :	e79	45	22.15	-111	43.50	4919.9	mt	980172.90	980652.46	1.37	-167.80	-1.40	0.00	-17.03	-184.67	-174.18	

BOUGUER GRAVITY DATA

Ennis Geothermal Area
V. Bankey 3-18-80
Meter ID: g-235 Date: 04/03/80

STATION IDENTIFICATION proj	sta-id	LOCATIONS LATITUDE deg	min	LONGITUDE deg	min	ELE (in ft)	ST	GRAVITY OBSERVED	THEORETICAL	CORRECTIONS TERRAIN	BOUGUER	CURV	SPECIAL	ANOMALIES FREE AIR	COMPLETE-BOUGUER d1=2.67	d2=2.50	SPEC FIELDS
North :	e46	45	22.20	-111	43.51	4912.8	mt	980172.78	980652.54	1.38	-167.56	-1.40	0.00	-17.89	-183.47	-174.80	
North :	e63	45	22.22	-111	43.60	4918.1	mt	980173.20	980652.57	1.39	-167.74	-1.40	0.00	-17.00	-184.75	-174.07	
North :	e80	45	22.02	-111	43.85	4920.5	mt	980174.33	980652.27	1.46	-167.82	-1.40	0.00	-15.35	-183.11	-172.43	
North :	e81	45	21.78	-111	44.18	4927.0	mt	980177.51	980651.91	1.55	-168.05	-1.40	0.00	-11.20	-179.09	-168.40	
North :	e82	45	21.73	-111	44.18	4930.4	mt	980176.94	980651.83	1.53	-168.16	-1.40	0.00	-11.37	-179.41	-168.71	
North :	e83	45	21.70	-111	44.11	4930.8	mt	980176.30	980651.78	1.53	-168.18	-1.40	0.00	-11.93	-179.98	-169.28	
North :	e84	45	21.69	-111	44.04	4930.6	mt	980175.23	980651.77	1.47	-168.17	-1.40	0.00	-12.99	-181.10	-170.39	
North :	e85	45	21.67	-111	43.94	4929.8	mt	980173.72	980651.73	1.46	-168.14	-1.40	0.00	-14.56	-182.64	-171.94	
North :	e86	45	21.74	-111	43.91	4929.6	mt	980173.60	980651.84	1.44	-168.13	-1.40	0.00	-14.80	-182.89	-172.19	
North :	e87	45	21.77	-111	44.00	4930.0	mt	980175.16	980651.89	1.44	-168.15	-1.40	0.00	-13.24	-181.35	-170.65	
North :	e88	45	21.78	-111	44.08	4927.7	mt	980176.26	980651.91	1.52	-168.07	-1.40	0.00	-12.38	-180.33	-169.64	
North :	e89	45	21.83	-111	43.99	4926.7	mt	980175.14	980651.98	1.47	-168.04	-1.40	0.00	-13.67	-181.03	-170.94	
North :	e90	45	21.81	-111	43.85	4926.5	mt	980173.58	980651.95	1.44	-168.03	-1.40	0.00	-15.22	-183.21	-172.51	
North :	e91	45	21.88	-111	43.85	4925.3	mt	980173.65	980652.05	1.45	-167.99	-1.40	0.00	-15.37	-183.31	-172.61	
North :	e92	45	21.90	-111	43.92	4921.8	mt	980174.57	980652.09	1.48	-167.87	-1.40	0.00	-14.80	-182.59	-171.91	
North :	e93	45	21.92	-111	44.02	4923.1	mt	980175.43	980652.12	1.49	-167.91	-1.40	0.00	-13.85	-181.68	-170.99	
North :	e94	45	21.93	-111	44.14	4920.5	mt	980176.61	980652.13	1.60	-167.82	-1.40	0.00	-12.93	-180.56	-169.88	
North :	e95	45	22.00	-111	44.12	4916.2	mt	980176.35	980652.23	1.56	-167.68	-1.40	0.00	-13.70	-181.22	-170.55	
North :	e96	45	22.01	-111	44.01	4919.8	mt	980175.29	980652.25	1.48	-167.80	-1.40	0.00	-14.44	-182.16	-171.48	
North :	e97	45	22.01	-111	43.92	4919.1	mt	980174.64	980652.25	1.47	-167.78	-1.40	0.00	-15.15	-182.86	-172.18	
North :	e98	45	22.09	-111	43.84	4917.1	mt	980174.58	980652.37	1.47	-167.71	-1.40	0.00	-15.52	-183.16	-172.49	
North :	e99	45	22.10	-111	43.95	4916.2	mt	980175.40	980652.38	1.50	-167.68	-1.40	0.00	-14.80	-182.38	-171.71	
North :	e100	45	22.11	-111	44.03	4914.5	mt	980176.03	980652.40	1.55	-167.62	-1.40	0.00	-14.35	-181.82	-171.15	
North :	e101	45	22.14	-111	44.21	4914.8	mt	980176.95	980652.45	1.66	-167.63	-1.40	0.00	-13.44	-180.81	-170.15	
North :	e102	45	22.21	-111	44.12	4910.8	mt	980176.68	980652.55	1.66	-167.49	-1.40	0.00	-14.20	-181.43	-170.78	
North :	e103	45	22.19	-111	44.01	4912.6	mt	980176.14	980652.52	1.52	-167.55	-1.40	0.00	-14.54	-181.97	-171.31	
North :	e104	45	22.22	-111	43.87	4909.2	mt	980175.25	980652.57	1.54	-167.44	-1.40	0.00	-15.79	-183.09	-172.44	
North :	e105	45	22.24	-111	43.82	4910.0	mt	980174.47	980652.59	1.49	-167.47	-1.40	0.00	-16.53	-183.90	-173.25	
North :	e106	45	22.32	-111	43.86	4908.2	mt	980173.90	980652.72	1.54	-167.40	-1.40	0.00	-17.39	-184.65	-174.00	
North :	e107	45	22.32	-111	43.92	4906.4	mt	980174.69	980652.72	1.55	-167.34	-1.40	0.00	-16.77	-183.96	-173.31	
North :	e108	45	22.34	-111	43.99	4904.4	mt	980175.26	980652.75	1.61	-167.27	-1.40	0.00	-16.42	-183.48	-172.84	
North :	e109	45	22.40	-111	43.85	4904.2	mt	980173.69	980652.84	1.55	-167.27	-1.40	0.00	-18.10	-185.21	-174.57	
North :	e111	45	22.38	-111	44.12	4903.6	mt	980174.87	980652.80	1.74	-167.25	-1.40	0.00	-16.94	-183.05	-173.22	