UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Principal Facts for Gravity Stations in the Stillwater Complex, Montana

by

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Introduction

The Archean Stillwater Complex is a classic example of a stratified basic intrusion, and is located in southern Montana about 50 km north of Yellowstone National Park. In August, 1979, 17 new gravity stations were established to augment the data gathered during three previous gravity surveys by Don Peterson (written commun.) collected in 1972-1974. This report includes the principal facts for both the 1979 survey and the previously unpublished 1974 survey.

Data Collection

Gravity observations were made using a LaCoste-Romberg gravity meter (G-235) for the 1979 survey, and a Worden meter (E-393) for the 1974 survey. The stations were referenced to the Department of Defense base in Three Forks, Montana, which is part of the International Gravity Standardization Net (IGSN), 1971, established by the Defense Mapping Aerospace Center, 1974. A secondary base was established in Fishtail, Montana, and tied to the DOD base in Three Forks. Complete base descriptions are included at the end of this report. Gravity loops were started and closed for daily drift corrections at these bases.

Elevation Control

The survey area is bounded by latitudes 45° 0′ to 45° 40′ north and longitudes 110° 10′ to 110° 50′ west and is located on the Bozeman and Billings U.S. Geological Survey topographic 1° X 2° quadrangles. Most of the station elevations were obtained from benchmarks, spot elevations, or section corners found on 1:24,000 and 1:62,500 scale USGS topographic maps. Station elevations marked in Appendix C with a single dot preceding the station identification were estimated from maps having 40 ft contour intervals. Station elevations with double dots were estimated from maps having 50 ft contour intervals.

For elevations based on bench marks, the uncertainty is assumed to be .15 m; for spot elevations and section corners with map elevations, the uncertainty is assumed to be one-third of the contour interval. At a contour interval of 50 ft. (15 m) this gives an uncertainty of 16.6 ft (5 m). For elevations based on topographic map contours, the uncertainty is assumed to be one-half of the contour interval. Stations with a single dot have an elevation uncertainty of 20 ft (6.1 m). Stations with double dots have an elevation uncertainty of 25 ft (7.5 m). At a density of 2.67 g/cm^3, the elevation uncertainties translate to uncertainties in Bouguer values as .2 mgal/m. The maximum uncertainty in the survey for stations estimated from 50 ft. contours is 1.5 mgal. Specific elevation uncertainties for each station are included in Appendix D.

Data Reduction

Computer programs existing on the USGS Honeywell Multics computer system were used to obtain principal facts and terrain-corrected gravity values. A program written by D. Dansereau and R. Wahl (unpub. data) was used to reduce gravity meter readings to observed gravity values by calculating and correcting for earth-tide and linear meter-drift. The theoretical gravity value was calculated using the 1967 formula of the Geodetic Reference System (International Association of Geodesy, 1967)

Hand terrain corrections were calculated from each station out to a radius of .895 km (Hammer zones A through F). Complete terrain corections were then computed using program Bouguer by R. H. Godson (unpub. data), correcting for the terrain from .895 km to a radius of 166.7 km from each station, using the method of Plouff (1977). These computed terrain corrections are based on mean elevation data digitized on a 30-second grid for corrections from .895 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 to calculate terrain corrections. This program also calculates earth curvature corrections and complete (terrain-corrected) Bouguer anomaly values. Two complete Bouguer anomaly values per station were obtained using average rock densities of 2.67 g/cm^3 and 2.50 g/cm^3. The corrections and anomaly values are listed in Appendix C.

References cited

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.

Hammer, S., 1939, Terrain corrections for gravimeter stations: Geophysics v.4, pp. 184-194.

International Association of Geodesy, 1967, Geodetic reference system, 1967, International Association of Geodesy Special Publication 3, 74 p.

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.

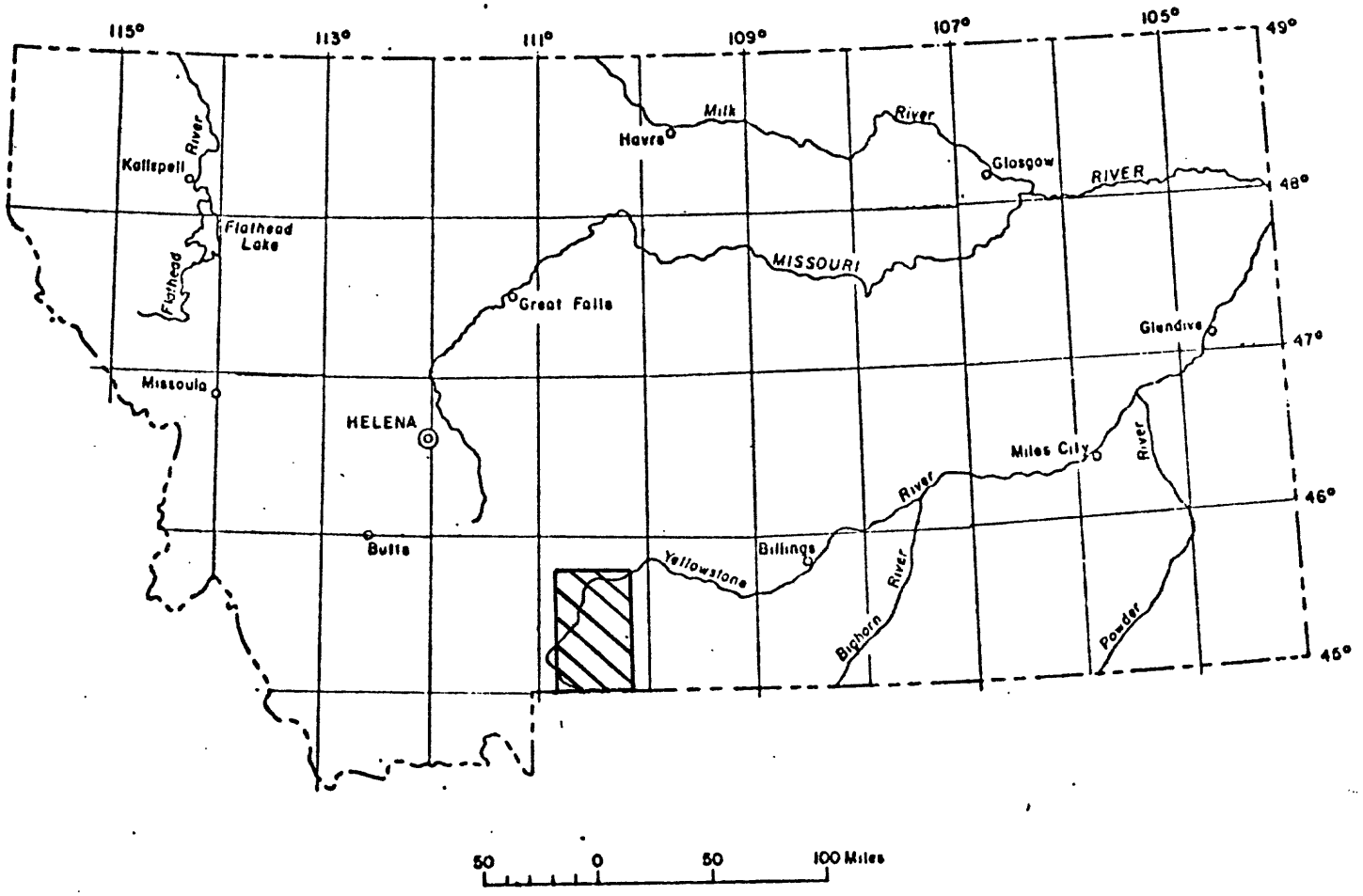


Figure 1: Location map of Stillwater Complex, Montana, area of gravity survey.

Appendix A

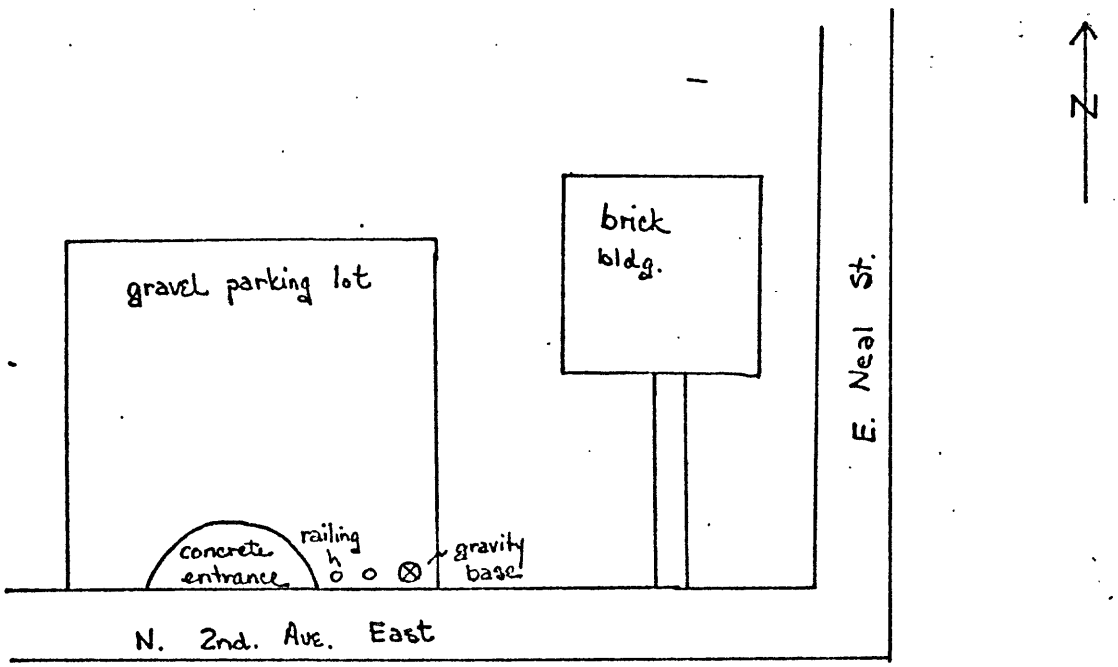
U.S. GEOLOGICAL SURVEY
GRAVITY BASE STATION

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.



Appendix B

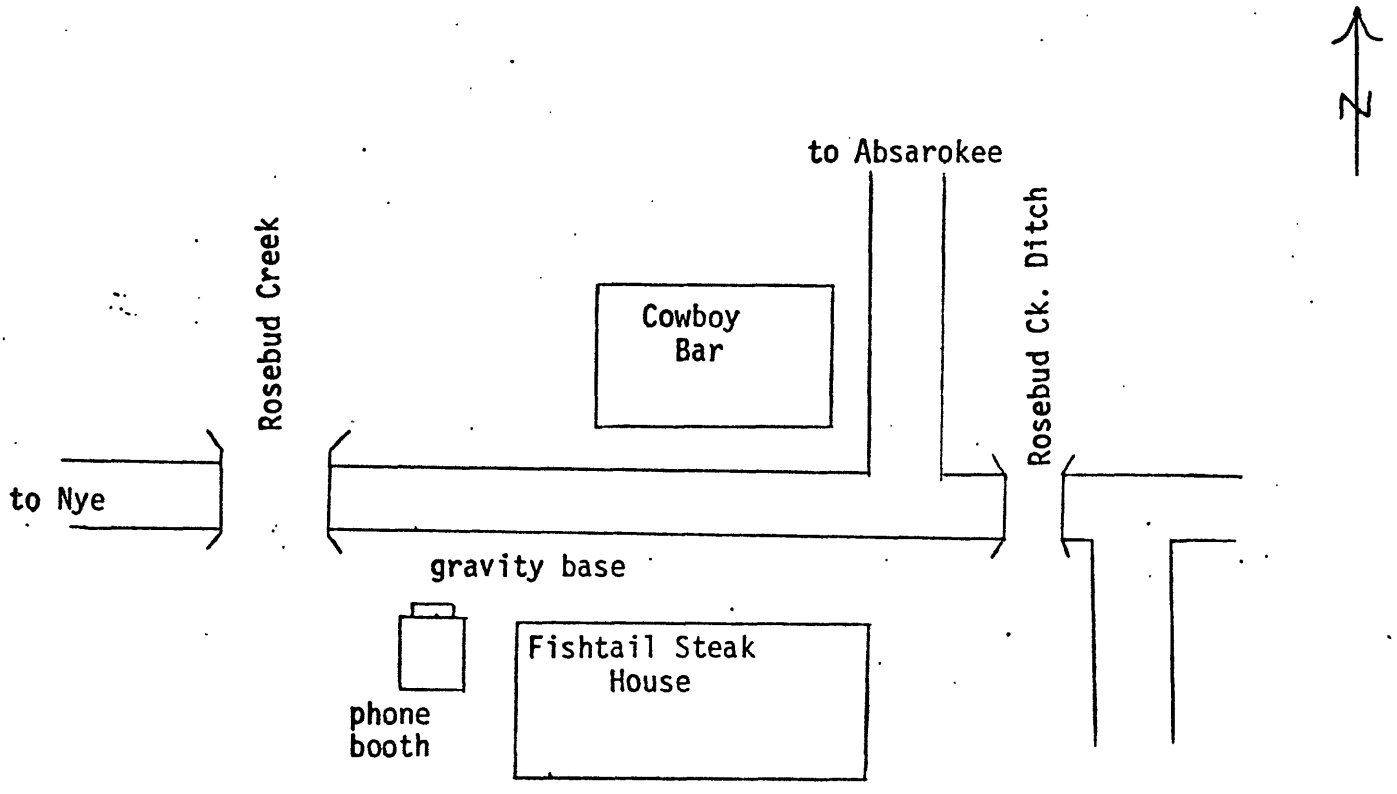
U.S. GEOLOGICAL SURVEY
GRAVITY BASE STATION

STATE/COUNTRY	STATION DESIGNATION	OBSERVED GRAVITY
Montana	Fishtail	980247.29 mgal.
NEAREST TOWN	LONGITUDE	LATITUDE
Fishtail	109° 30.50'	45° 27.50'
ELEVATION	TOPOGRAPHIC MAP(S)	
1337 m (4455') est.	Bozeman 1° x 2° ; Fishtail 7 1/2'	

DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
9/2/79	McBride	g-235	Columbus DOD	980316.58 mgal

DESCRIPTION/SKETCH

The gravity base is located on the concrete floor of a public telephone booth on the west side of the Fishtail Steak House. The base is in the northeast corner of the booth (inside).



Appendix 6: Principal Facts of Gravity Data

Explanation of headings

Identification

proj	Project name.
sta id	Gravity identification.

Location

latitude	North latitude in degrees, minutes, and hundredths of minutes.
longitude	West longitude in degrees, minutes, and hundredths of minutes.
ele	Station elevation in feet.
st	State where station is located.

Gravity

observed	Observed gravity in milligals.
theoretical	Theoretical gravity.

Corrections

terrain	Terrain correction out to 166.7km 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.

stillwater complex gravity
1979 data, and 1974 Peterson data
Meter ID: G-235 Date: 11/24/81

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=2.77	SPEC FIELDS
:	f1	45	25.20	-110	5.19	8737.0	mt	979979.44	980657.06	4.02	-297.99	-1.39	0.00	143.54	-151.83	-162.89	
:	f2	45	26.89	-110	3.30	9047.0	mt	979933.62	980659.61	8.38	-329.03	-1.25	0.00	180.64	-141.27	-153.32	
:	f3	45	28.08	-110	2.74	8968.0	mt	979977.34	980661.41	9.67	-305.87	-1.36	0.00	158.80	-138.77	-149.91	
:	f4	45	30.72	-110	1.49	9295.0	mt	979934.71	980665.39	15.46	-317.03	-1.31	0.00	142.89	-159.99	-171.33	
:	f5	45	26.56	-109	48.41	8805.0	mt	980216.86	980659.11	3.53	-165.25	-1.39	0.00	13.24	-149.87	-155.98	
:	f6	45	25.46	-109	50.65	8898.0	mt	980205.47	980657.45	5.18	-167.06	-1.40	0.00	[illegible]	-154.79	-160.9	
:	f7	45	23.31	-109	52.39	8931.0	mt	980191.37	980654.21	8.38	-168.18	-1.40	0.00	0.73	-160.47	-166.5	
:	f8	45	21.62	-109	53.66	5354.0	mt	980141.72	980651.66	8.83	-182.61	-1.45	0.00	-6.62	-181.84	-188.41	
:	f9	45	29.66	-110	2.02	6861.0	mt	980099.54	980663.79	3.05	-234.01	-1.52	0.00	80.68	-151.80	-160.51	
:	f10	45	32.29	-110	1.06	8472.0	mt	979990.54	980667.76	12.13	-288.96	-1.43	0.00	119.05	-159.20	-169.62	
:	f11	45	31.82	-110	1.23	8700.0	mt	979974.03	980667.05	13.32	-296.73	-1.40	0.00	124.67	-160.14	-170.81	
:	f12	45	37.50	-110	8.11	4916.0	mt	980212.21	980675.62	1.97	-167.67	-1.40	0.00	-1.24	-168.34	-174.60	
:	f13	45	34.52	-110	11.90	4931.0	mt	980208.93	980671.12	3.09	-168.18	-1.40	0.00	1.38	-165.11	-171.35	
:	f14	45	31.90	-110	12.82	5170.0	mt	980192.11	980667.17	5.67	-176.33	-1.43	0.00	10.98	-161.12	-167.56	
:	f15	45	28.88	-110	12.64	5270.0	mt	980174.42	980662.61	8.74	-179.74	-1.44	0.00	7.24	-165.20	-171.66	
:	f16	45	20.49	-110	13.89	6142.0	mt	980069.87	980649.95	7.15	-209.49	-1.50	0.00	-2.72	-206.55	-214.19	
:	f17	45	17.26	-110	14.52	6439.0	mt	980047.48	980645.09	6.42	-219.62	-1.51	0.00	7.68	-207.03	-215.07	
:livingst		45	39.75	-110	33.75	6000.0	mt	980231.11	980679.01	1.15	-204.64	-1.50	0.00	116.13	-88.86	-96.54	
:	159	45	37.11	-110	23.98	5803.0	mt	980157.59	980675.02	2.18	-197.92	-1.48	0.00	28.08	-169.15	-176.53	
:	161	45	36.92	-110	21.52	5358.0	mt	980181.55	980674.74	3.57	-182.75	-1.45	0.00	10.51	-170.12	-176.88	
:	162	45	36.24	-110	20.01	5335.0	mt	980170.47	980673.71	3.26	-181.96	-1.45	0.00	-1.71	-181.86	-188.60	
:	163	45	36.38	-110	18.35	6142.0	mt	980138.99	980673.92	1.80	-209.49	-1.50	0.00	42.44	-166.75	-174.59	
:	164	45	36.39	-110	17.37	5940.0	mt	980151.27	980673.94	1.64	-202.60	-1.49	0.00	35.72	-166.73	-174.31	
:	165	45	36.41	-110	16.21	5771.0	mt	980162.97	980673.97	1.80	-196.83	-1.48	0.00	31.51	-165.01	-172.37	
:	166	45	36.63	-110	14.11	5379.0	mt	980187.24	980674.30	1.39	-183.46	-1.45	0.00	18.61	-164.91	-171.78	
:	163	45	36.38	-110	18.35	6142.0	mt	980138.83	980673.92	1.80	-209.49	-1.50	0.00	42.27	-166.92	-174.75	
:	167	45	35.27	-110	15.30	5452.0	mt	980178.82	980672.25	2.53	-185.95	-1.46	0.00	19.10	-165.78	-172.79	
:	168	45	34.39	-110	16.40	5472.0	mt	980174.07	980670.92	2.85	-186.63	-1.46	0.00	17.56	-167.68	-174.62	
:	169	45	33.68	-110	17.40	5524.0	mt	980166.96	980669.85	3.42	-188.41	-1.46	0.00	16.41	-170.04	-177.13	
:	170	45	32.86	-110	18.37	5539.0	mt	980163.39	980668.62	4.21	-188.92	-1.46	0.00	15.48	-170.69	-177.66	
:livingst		45	39.75	-110	33.75	6000.0	mt	980231.11	980679.01	1.15	-204.64	-1.50	0.00	116.13	-88.86	-96.54	
:livingst		45	39.75	-110	33.75	6000.0	mt	980231.11	980679.01	1.15	-204.64	-1.50	0.00	116.13	-88.86	-96.54	
:	171	45	35.67	-110	27.32	8300.0	mt	980001.67	980672.85	10.14	-283.09	-1.44	0.00	108.93	-165.47	-175.74	
:	172	45	27.64	-110	19.25	10385.0	mt	979849.89	980660.74	15.65	-354.20	-1.10	0.00	165.08	-174.56	-187.28	
:	173	45	21.60	-110	18.61	10697.0	mt	979792.97	980651.63	19.23	-364.84	-1.02	0.00	146.58	-200.06	-213.04	
:	174	45	21.70	-110	16.42	10404.0	mt	979814.87	980651.78	16.33	-354.85	-1.09	0.00	140.81	-198.80	-211.52	
:	175	45	18.44	-110	16.21	9214.0	mt	979889.73	980646.87	5.15	-314.26	-1.33	0.00	108.84	-201.60	-213.23	
:	176	45	18.59	-110	11.65	10036.0	mt	979833.94	980647.08	13.26	-342.30	-1.17	0.00	130.03	-200.19	-212.55	
:	177	45	15.84	-110	12.13	9525.0	mt	979863.87	980642.95	4.78	-324.87	-1.27	0.00	116.10	-205.26	-217.30	
:	178	45	17.18	-110	18.74	9928.0	mt	979836.10	980644.96	9.71	-338.61	-1.20	0.00	124.16	-205.94	-218.30	

8-a

stillwater complex gravity
1979 data, and 1974 Peterson data
Meter ID: G-235 Date: 11/24/81

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=2.77	SPEC FIELDS
:	181	45	26.91	-110	26.78	10125.0	mt	979866.74	980659.64	17.63	-345.33	-1.15	0.00	158.62	-170.24	-182.55	
:	182	45	28.10	-110	21.98	6238.0	mt	980103.18	980661.57	6.51	-212.76	-1.51	0.00	28.00	-179.76	-187.54	
:livingst		45	39.75	-110	33.75	6000.0	mt	980231.11	980679.01	1.15	-204.64	-1.50	0.00	116.13	-88.86	-96.54	

BOUGUER GRAVITY DATA

stillwater complex gravity
bankey & mcbride
Meter ID: g-235 Date: 06/02/80

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
	f1	45	25.20	-110	5.19	8737.0	mt	979979.44	980657.06	4.02	-297.99	-1.39	0.00	143.54	-151.83	-135.02
	f2	45	26.89	-110	3.30	9647.0	mt	979933.62	980659.61	6.38	-329.03	-1.25	0.00	180.64	-141.27	-120.77
	f3	45	28.08	-110	2.74	8968.0	mt	979977.34	980661.41	9.67	-305.67	-1.36	0.00	158.80	-138.77	-119.82
	f4	45	30.72	-110	1.49	9295.0	mt	979934.71	980665.39	15.46	-317.03	-1.31	0.00	142.89	-159.99	-140.70
	f5	45	26.56	-109	48.41	4645.0	mt	980216.86	980659.11	3.53	-165.25	-1.39	0.00	13.24	-149.87	-139.49
	f6	45	25.46	-109	50.65	4898.0	mt	980205.47	980657.45	5.18	-167.06	-1.40	0.00	8.49	-154.79	-144.39
	f7	45	23.31	-109	52.39	4931.0	mt	980191.37	980654.21	8.38	-168.18	-1.40	0.00	0.75	-160.47	-150.21
	f8	45	21.62	-109	53.66	5354.0	mt	980141.72	980651.66	8.83	-182.61	-1.45	0.00	-6.62	-181.64	-170.09
	f9	45	29.66	-110	2.02	6861.0	mt	980099.54	980665.79	3.05	-234.01	-1.52	0.00	60.66	-151.80	-137.00
	f10	45	32.29	-110	1.06	8472.0	mt	979990.54	980667.76	12.13	-288.96	-1.43	0.00	119.05	-159.20	-141.48
•	f11	45	31.82	-110	1.23	8700.0	mt	979974.03	980667.05	13.32	-296.73	-1.40	0.00	124.67	-160.14	-142.91
	f12	45	37.50	-110	8.11	4916.0	mt	980212.21	980675.62	1.97	-167.67	-1.40	0.00	-1.24	-168.34	-157.70
	f13	45	34.52	-110	11.90	4931.0	mt	980208.93	980671.12	3.09	-168.18	-1.40	0.00	1.36	-165.11	-154.51
	f14	45	31.90	-110	12.82	5170.0	mt	980192.11	980667.17	5.67	-176.53	-1.43	0.00	10.98	-161.12	-150.16
	f15	45	28.88	-110	12.64	5270.0	mt	980174.42	980662.61	6.74	-179.74	-1.44	0.00	7.24	-165.20	-154.22
	f16	45	20.49	-110	13.89	6142.0	mt	980069.87	980649.95	7.15	-209.49	-1.50	0.00	-2.72	-206.55	-193.58
	f17	45	17.26	-110	14.52	6439.0	mt	980047.46	980645.09	6.42	-219.62	-1.51	0.00	7.68	-207.03	-193.36
	L59	45	37.11	-110	23.98	5803.0	mt	980171.29	980675.02	2.18	-197.92	-1.48	0.00	41.78	-155.45	-142.69
	L61	45	36.92	-110	21.52	5558.0	mt	980195.25	980674.74	3.57	-182.75	-1.45	0.00	24.21	-156.41	-144.91
	L62	45	36.24	-110	20.01	5335.0	mt	980184.17	980673.71	3.26	-181.96	-1.45	0.00	12.00	-168.15	-156.68
	L63	45	36.38	-110	18.35	6142.0	mt	980152.69	980673.92	1.80	-209.49	-1.50	0.00	56.13	-153.06	-139.74
	L64	45	36.39	-110	17.37	5940.0	mt	980164.97	980673.94	1.64	-202.60	-1.49	0.00	49.42	-153.03	-140.14
	L65	45	36.41	-110	16.21	5771.0	mt	980176.67	980673.97	1.80	-196.83	-1.48	0.00	45.21	-151.50	-138.79
	L66	45	36.63	-110	14.11	5379.0	mt	980200.94	980674.30	1.39	-183.46	-1.45	0.00	32.31	-151.21	-139.53
	L63	45	36.38	-110	18.35	6142.0	mt	980152.53	980673.92	1.80	-209.49	-1.50	0.00	55.98	-153.21	-139.89
	L67	45	35.27	-110	15.30	5452.0	mt	980192.52	980672.25	2.53	-185.95	-1.46	0.00	52.81	-152.07	-140.30
	L68	45	34.39	-110	16.40	5472.0	mt	980187.77	980670.92	2.85	-186.63	-1.46	0.00	51.26	-153.98	-142.19
	L69	45	33.68	-110	17.40	5524.0	mt	980180.66	980669.85	3.42	-188.41	-1.46	0.00	50.11	-156.34	-144.47
•	L71	45	35.67	-110	27.32	8300.0	mt	980015.37	980672.85	10.14	-283.09	-1.44	0.00	122.62	-151.77	-134.30
	L72	45	27.64	-110	19.25	10385.0	mt	979863.59	980660.74	15.65	-354.20	-1.10	0.00	178.79	-160.36	-139.24
	L73	45	21.60	-110	18.61	10697.0	mt	979806.67	980651.63	19.23	-364.84	-1.02	0.00	180.26	-185.36	-164.28
	L74	45	21.70	-110	16.42	10404.0	mt	979828.57	980651.78	16.33	-354.85	-1.09	0.00	154.51	-185.10	-165.48
	L75	45	18.44	-110	16.21	9214.0	mt	979903.43	980646.87	5.15	-314.26	-1.33	0.00	122.53	-187.91	-166.14
	L76	45	16.58	-110	11.65	10036.0	mt	979847.64	980647.08	13.26	-342.30	-1.17	0.00	143.73	-186.48	-165.46
••	L77	45	15.84	-110	12.13	9525.0	mt	979877.57	980642.95	4.78	-324.87	-1.27	0.00	129.80	-191.56	-171.10
	L78	45	17.18	-110	16.74	9928.0	mt	979849.80	980644.96	9.71	-338.01	-1.20	0.00	157.86	-192.25	-171.23
••	L81	45	26.91	-110	26.78	10125.0	mt	979880.44	980659.64	17.63	-345.33	-1.15	0.00	172.32	-156.54	-135.60
	L82	45	26.19	-110	21.98	6238.0	mt	980116.88	980661.57	6.51	-212.76	-1.51	0.00	41.70	-160.05	-152.83

BOUGUER GRAVITY DATA

beartooth absaroka wilderness
d. peterson

STATION IDENTIFICATION		LOCATIONS					GRAVITY		CORRECTIONS				ANOMALIES		
proj	sta-id	LATITUDE deg	min	LONGITUDE deg	min	ELE (in ft) ST	OBSERVED	THEORETICAL	TERRAIN	BOUGUER	CURV	SPECIAL	FREE AIR	COMPLETE-BOUGUER d1=2.67	d2=2.50	SPEC FIELDS
north	b72	45	16.64	-109	58.98	10147.0 mt	979843.55	980644.15	12.14	-346.09	-1.15	0.00	152.99	-182.11	-160.77	
north	b73	45	19.61	-109	59.89	10583.0 mt	979830.54	980648.63	12.55	-360.96	-1.05	0.00	176.44	-173.01	-150.76	
north	b74	45	19.89	-110	5.00	10130.0 mt	979851.66	980649.05	11.41	-345.50	-1.15	0.00	154.60	-180.64	-159.30	
north	b75	45	19.55	-110	7.26	10936.0 mt	979794.84	980648.54	14.24	-373.00	-0.96	0.00	173.96	-185.73	-162.82	
north	b76	45	21.60	-110	8.92	9399.0 mt	979910.95	980651.63	4.53	-320.57	-1.30	0.00	142.66	-174.68	-154.47	
north	b77	45	17.09	-110	7.97	9638.0 mt	979882.86	980644.83	4.67	-326.72	-1.25	0.00	143.82	-181.29	-160.59	
north	b84	45	16.12	-109	45.89	9580.0 mt	979889.60	980643.57	7.59	-326.75	-1.26	0.00	146.56	-173.84	-153.44	
north	b85	45	16.48	-109	53.24	10082.0 mt	979860.12	980646.92	13.26	-343.87	-1.16	0.00	160.68	-171.10	-149.97	
north	b86	45	19.42	-109	51.00	10251.0 mt	979851.16	980648.34	11.46	-349.63	-1.13	0.00	166.18	-173.12	-151.52	
north	b120	45	16.28	-109	55.08	10187.0 mt	979843.87	980645.61	13.52	-347.45	-1.14	0.00	157.61	-177.46	-156.13	
north	b121	45	17.99	-109	49.69	11356.0 mt	979778.76	980646.19	16.49	-387.32	-0.84	0.00	199.71	-171.95	-146.29	
north	b122	45	16.94	-110	4.28	9270.0 mt	979910.54	980644.60	7.51	-316.17	-1.32	0.00	137.16	-173.02	-153.27	
north	L01	45	35.67	-110	27.32	8300.0 mt	980017.87	980672.85	10.14	-283.09	-1.44	0.00	125.12	-149.27	-131.80	
north	L02	45	34.12	-110	26.32	9180.0 mt	979956.52	980670.52	15.45	-313.10	-1.33	0.00	148.77	-152.21	-133.05	
north	L03	45	33.21	-110	24.39	9180.0 mt	979954.77	980669.14	12.21	-313.10	-1.33	0.00	148.40	-155.63	-134.59	
north	L04	45	33.06	-110	22.80	9300.0 mt	979936.04	980669.82	16.74	-317.20	-1.31	0.00	140.25	-161.51	-142.30	
north	L05	45	32.65	-110	19.71	6755.0 mt	980105.87	980666.60	5.79	-230.39	-1.52	0.00	72.25	-153.89	-139.49	
north	L06	45	30.82	-110	20.17	5761.0 mt	980148.83	980665.54	7.61	-196.49	-1.48	0.00	24.86	-165.50	-153.38	
north	L07	45	30.38	-110	16.24	8526.0 mt	980006.36	980664.88	6.95	-290.80	-1.42	0.00	142.82	-142.44	-124.28	
north	L08	45	28.32	-110	17.68	10170.0 mt	979880.30	980661.77	12.23	-346.67	-1.14	0.00	174.28	-161.51	-140.13	
north	L09	45	25.75	-110	18.01	9456.0 mt	979919.99	980657.89	10.56	-322.52	-1.29	0.00	150.79	-162.45	-142.50	
north	L10	45	31.18	-110	18.91	6280.0 mt	980130.15	980666.08	3.91	-214.19	-1.51	0.00	54.39	-157.40	-145.92	
north	L42	45	30.49	-110	26.92	9112.0 mt	979958.16	980665.04	9.62	-310.78	-1.34	0.00	149.51	-153.00	-133.74	
north	••L43	45	29.89	-110	23.73	9125.0 mt	979949.94	980664.13	8.05	-311.23	-1.34	0.00	143.40	-161.11	-141.72	
north	L44	45	29.22	-110	28.01	8932.0 mt	979963.09	980663.13	8.45	-304.64	-1.37	0.00	139.44	-158.12	-139.17	
north	••L45	45	25.56	-110	29.00	9030.0 mt	979935.33	980657.60	10.01	-307.99	-1.35	0.00	126.40	-172.33	-153.31	
north	L46	45	24.39	-110	28.25	9122.0 mt	979933.16	980655.84	9.75	-311.13	-1.34	0.00	134.65	-166.07	-146.79	
north	••L47	45	21.90	-110	24.82	9975.0 mt	979870.25	980652.09	9.24	-340.22	-1.19	0.00	155.59	-170.58	-155.43	
north	L48	45	23.14	-110	21.68	8947.0 mt	979937.73	980653.95	6.52	-305.16	-1.37	0.00	124.67	-175.33	-156.23	
north	••L49	45	20.52	-110	21.60	9525.0 mt	979913.36	980650.00	5.21	-318.05	-1.31	0.00	139.75	-174.40	-154.40	

Appendix D

station	accurate within (meters)
F1	0.15
F2	1.5
F3	1.5
F4	1.2
F5	1.5
F6	1.5
F7	1.5
F8	1.5
F9	0.15
F10	1.2
F11	6.0
F12	0.15
F13	1.5
F14	0.15
F15	1.5
F16	0.15
F17	0.15
B72	1.5
B73	1.5
B74	7.5
B75	1.5
B76	1.5
B77	1.5
B84	1.5*
B85	1.5*
B86	1.5
B120	1.5
B121	1.5
B122	1.5*
L1	6.0
L2	6.0
L3	1.2
L4	6.0
L5	0.6
L6	0.6
L7	0.6
L8	1.5
L9	1.5*
L10	3.0
L42	0.15
L43	7.5
L44	7.5
L45	7.5
L46	1.5*
L47	7.5
L48	1.5*
L49	7.5
L59	1.2
L61	0.6
L62	0.6
L63	0.15
L64	0.6
L65	0.15
L66	0.15
L67	0.15
L68	0.6
L69	0.6

station	accurate within (meters)
L71	6.0
L72	1.5
L73	1.5
L74	0.15
L75	1.5
L76	1.5
L77	7.5
L78	1.5
L81	7.5
L82	0.15

*: indicates station elevation at lake level