

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Principal facts for a gravity survey of the Dell, Dixon Mountain,
Caboose Canyon, and Gallagher Gulch 1:24,000 quadrangles,
Beaverhead County, Montana

by

Dolores M. Kulik, Viki Bankey, and Michael R. Brickey

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

Table of Contents

	Page
Introduction	1
Data Collection	1
Elevation Control	1
Data Reduction	1
References	2

Illustrations

Figure 1.--Map showing the location of the gravity study area.....	3
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Appendices

Appendix A: Gravity base station descriptions.....	4
B: Principal facts of gravity data.....	9

Introduction

This report presents data and principal facts collected by the U.S. Geological Survey. During the summer field seasons of 1980-1983 approximately 90 new gravity stations were established in these quadrangles. The area is located partly in the Beaverhead National Forest (fig. 1).

Data Collection

Gravity observations were made using LaCoste & Romberg gravity meter G-24 and Worden gravity meter W-177. The gravity stations were referenced to the U.S. Department of Defense (DOD) base at Grant (appendix A), which is part of the International Gravity Standardization Net (IGSN-71). Additional bases were set by the USGS and tied to this primary base, and their descriptions are found in Appendix A. Gravity survey loops were started and closed daily by making repeat observations at the primary or secondary bases. Access was by helicopter and ground traverses into the roadless areas and by vehicle along highways and secondary roads.

Elevation Control

The survey area is bounded by latitude $44^{\circ}30' - 44^{\circ}45'$ N and longitude $112^{\circ}37'30'' - 112^{\circ}52'30''$ W. The station elevations were obtained from benchmarks, spot elevations, and section corners on 1:24,000-scale USGS maps. The uncertainty of elevations based on benchmarks is assumed to be 0.5 ft (0.15 m). For spot elevations and section corners with elevations in black, on 1:24,000-scale maps with a 40-ft contour interval, the uncertainty is assumed to be 3 ft (1 m). At a reduction density of 2.67 g/cm^3 , this elevation uncertainty translates to a maximum uncertainty in the Bouguer anomaly value of 0.18 mGals.

However, errors in the estimation of terrain corrections give rise to the greatest uncertainty in Bouguer values. Computer generated terrain corrections in mountainous areas are generally accurate to within 1 mGal, but could exceed this in areas of extreme relief.

Data Reduction

Computer programs existing on the USGS Digital Equipment Corporation VAX 11-750 computer system were used to obtain principal facts and terrain corrected gravity values. A program written by M. Webring and R. Wahl (USGS, unpub. program, 1983) was used to reduce gravity meter readings to observed gravity values by calculating and correcting for earth-tide and an assumed linear meter-drift. The theoretical gravity value was calculated using the 1967 formula of the Geodetic Reference System (International Association of Geodesy, 1967). Mathematical equations are given in Cordell and others (1982).

Terrain corrections were computed using a program by R. H. Godson (USGS, unpub. program, 1978), correcting for the gravity effects of terrain from each station to a radius of 166.7 km (103.4 mi) using the method of Plouff (1977). Godson's program also calculates earth curvature corrections and complete (terrain corrected) Bouguer gravity anomaly values. These computed terrain corrections use mean elevation digital 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. A density of 2.67 g/cm^3 was used to calculate terrain corrections and for reduction giving the corrections and gravity anomaly values listed in Appendix B.

References

- Cordell, Lindrith, Keller, G. R., and Hildenbrand, T. G., 1982, Bouguer gravity map of the Rio Grande Rift, Colorado, New Mexico, and Texas: U.S. Geological Survey Geophysical Investigations Series, Map GP-949, scale 1:1,000,000.
- Defense Mapping Agency, 1974, World Relative Gravity Reference Network, North America, Part 2: Defense Mapping Agency Aerospace Center Reference Publication 25, with supplement updating gravity values to the International Gravity Standardization Net 1971, Aerospace Center, St. Louis Missouri, 1635 p.
- Hammer, Sigmund, 1939, Terrain corrections for gravimeter stations: Geophysics, v.4, p. 184-194.
- International Association of Geodesy, 1967, Geodetic Reference System, 1967: International Association of Geodesy Special Publication No. 3, 116 p.
- Plouff, Donald, 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.

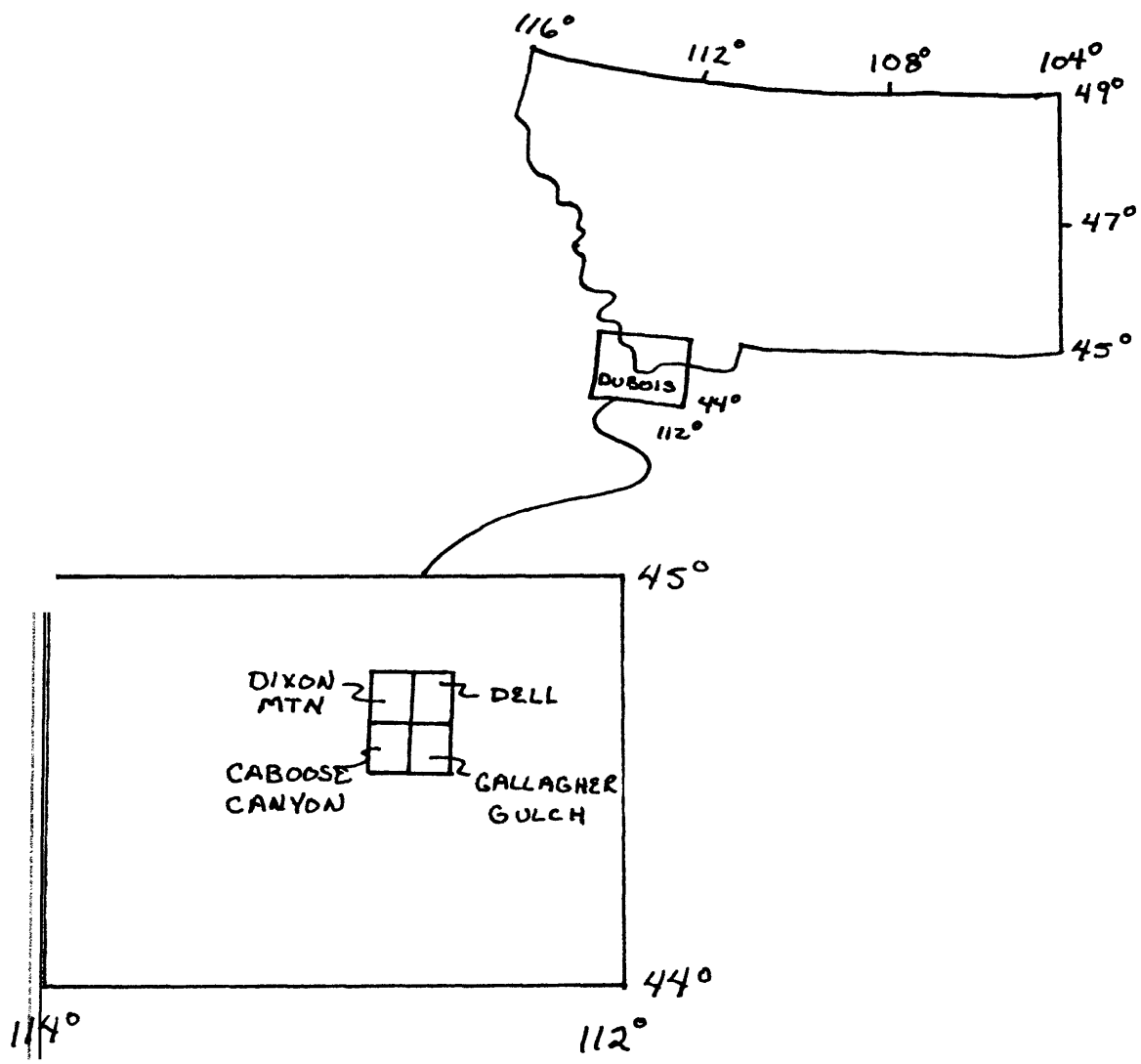


Figure 1.--Map showing the location of the gravity study area.

Appendix A: Gravity Base Station Descriptions

GRAVITY BASE STATION

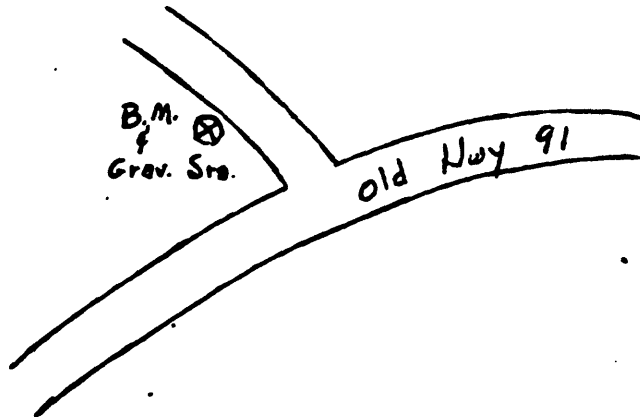
LATITUDE <div style="text-align: center;">45° 00.30'N (1)</div>	STATION DESIGNATION <div style="text-align: center;">GRANT</div>
LONGITUDE <div style="text-align: center;">113° 12.50'W (1)</div>	
ELEVATION <div style="text-align: center;">1842.2 METERS (1)</div>	COUNTRY/STATE <div style="text-align: center;">USA/Montana</div>
REFERENCE CODE NUMBERS	ADOPTED GRAVITY VALUE
ACIC 3945-1	g = 980 044.49 mgals
HUS 212	
	ESTIMATED ACCURACY
	± 0.3 mgals
	DATE
	MONTH/YEAR 10/70

DESCRIPTION AND/OR SKETCH

T 9S, R 13W, S 33

Station is located on north side of a light duty road, 0.15 of a mile northwest of a road junction, about 1.0 mile west of entrance to an airstrip. BM stamping: "R 5" BM elevation: 6044 feet.

(1)



(1)

REFERENCE SOURCE

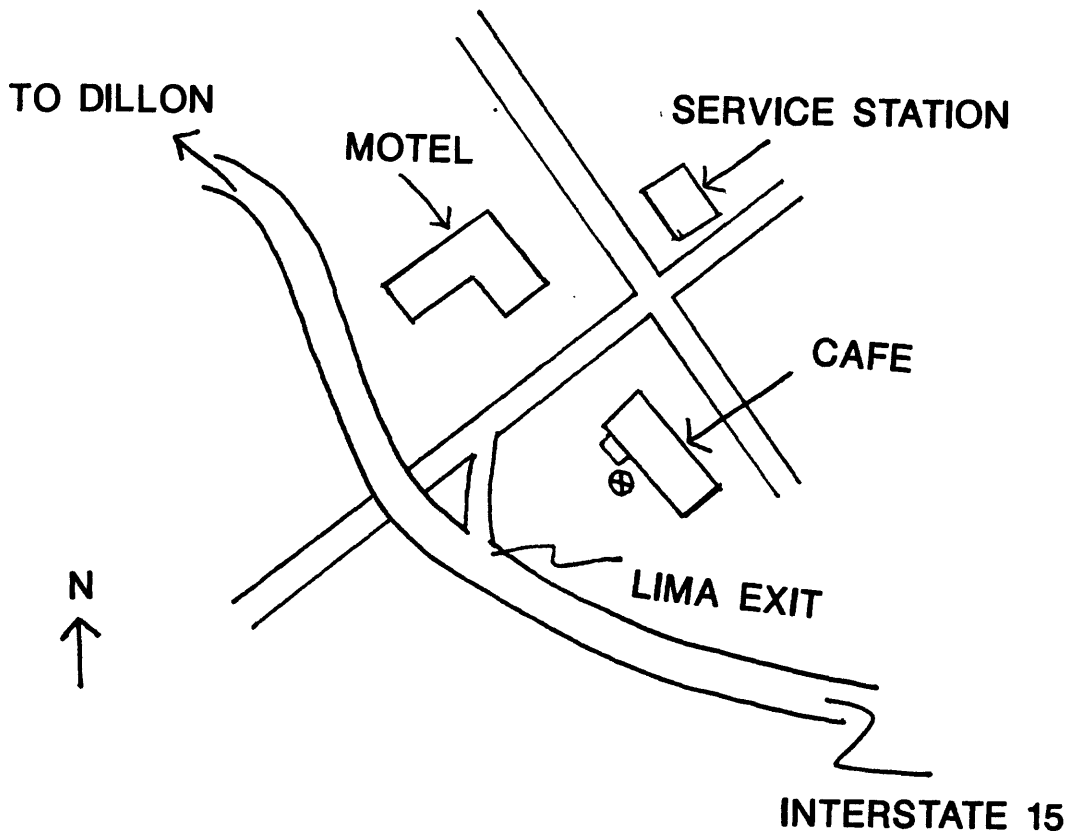
(1) 04099

**GRAVITY BASE STATION
U.S. GEOLOGICAL SURVEY**

STATE/COUNTRY Montana		STATION DESIGNATION LIMA		OBSERVED GRAVITY 980003.81	
NEAREST TOWN Lima		LONGITUDE 112°36'W		LATITUDE 47°38'N	
ELEVATION 6272 ft		TOPOGRAPHIC MAP(S) Lima, MT 1:24,000			
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE	
7/13/80	Bankey/Brickey	G-24	GRANT	980044.49	

DESCRIPTION/SKETCH

The base is located at the Kalbas Korner's Cafe. Facing east toward the cafe from the freeway side the base is at the lower right corner of the door that is not in use. The base is approximately 15 feet from the edge of the building.

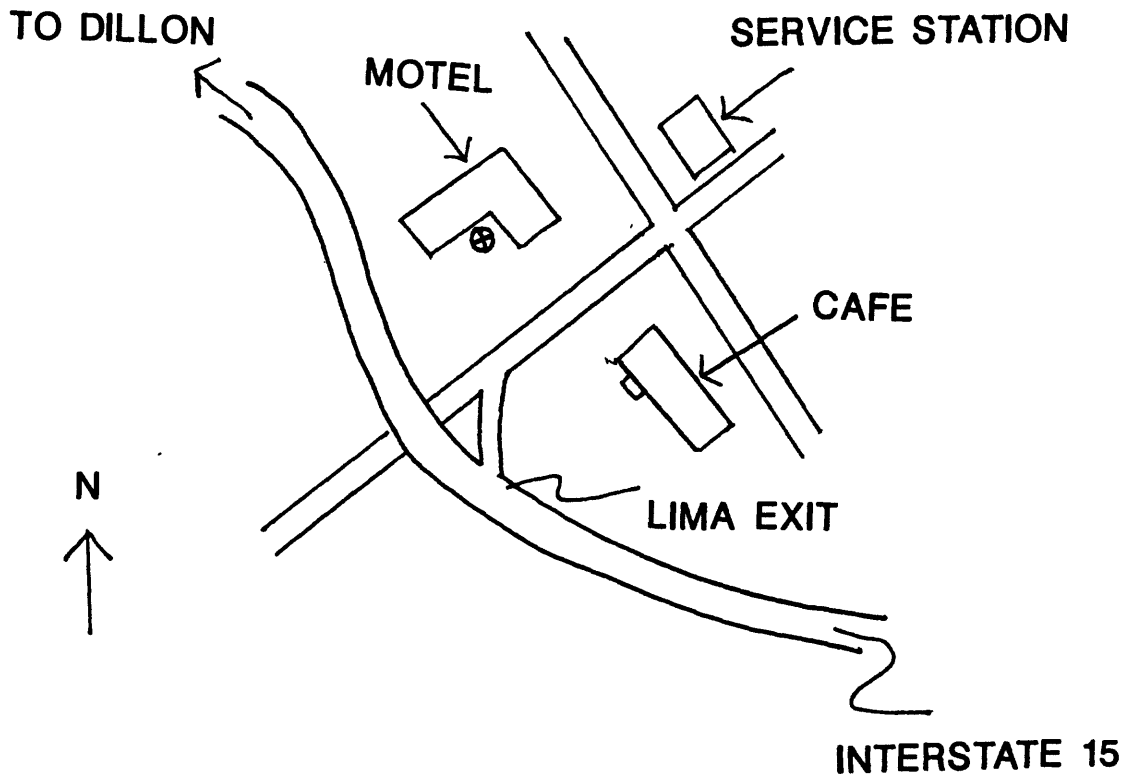


**GRAVITY BASE STATION
U.S. GEOLOGICAL SURVEY -**

STATE/COUNTRY Montana		STATION DESIGNATION KALBAS (KLBS)		OBSERVED GRAVITY 980003.81
NEAREST TOWN Lima		LONGITUDE 112° 36' W		LATITUDE 47° 38' N
ELEVATION 6272 ft		TOPOGRAPHIC MAP(S) Lima, MT 1:24,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
8/5/81	Kulik	W-177	GRANT	980044.49
9/23/83	Kulik	W-177	GRANT	980044.49

DESCRIPTION/SKETCH

The base is located at the Kalbas Holiday Motel in Lima, Montana on the sidewalk in front of unit 5.

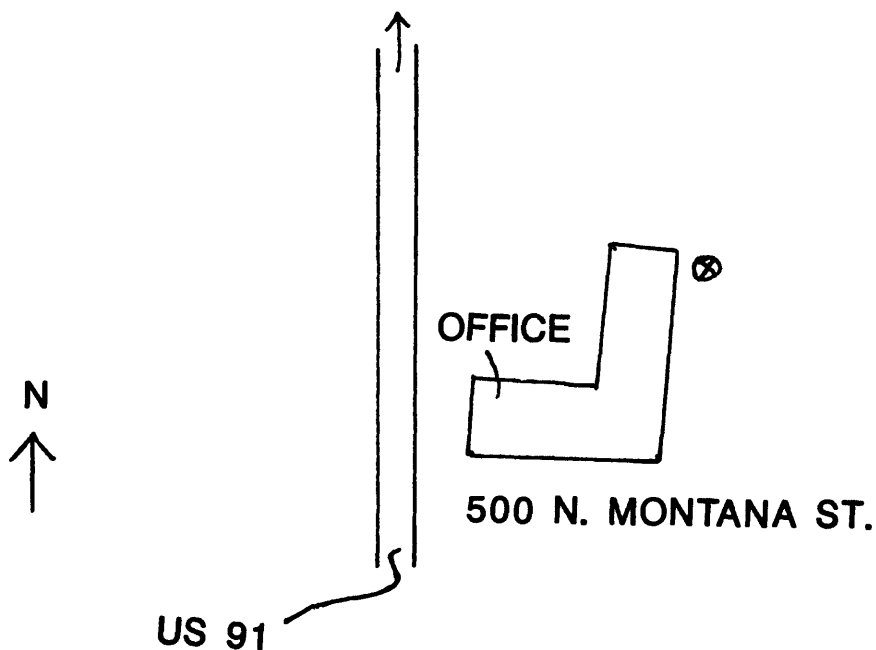


**GRAVITY BASE STATION
U.S. GEOLOGICAL SURVEY -**

STATE/COUNTRY Montana		STATION DESIGNATION DOWN		OBSERVED GRAVITY 980155.61
NEAREST TOWN Dillon		LONGITUDE 112°38'W		LATITUDE 45°14'N
ELEVATION 5090 ft		TOPOGRAPHIC MAP(S) Dillon, MT 1:24,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
9/24/83	Kulik	W-177	GRANT	980044.49
9/24/83	Kulik	W-177	KALBAS	980003.81
11/5/83	Kulik	W-177	KALBAS	980003.81

DESCRIPTION/SKETCH

The base is located at the Sundowner Motel in Dillon, Montana on the sidewalk in front of the northernmost ground floor unit of the N-S wing.



Appendix B: Principal Facts of Gravity Data

Explanation of Headings

Identification

sta-id Gravity station identification number

Location

latitude North latitude in degrees, decimal minutes.

longitude West longitude in degrees, decimal minutes.

ele Station in elevation feet.

st State where station is located.

Gravity

observed Observed gravity in milliGals.

theoretical Theoretical gravity in milliGals.

Corrections

Terrain Terrain correction, 166.7 km radius, in milliGals.

Bouguer Simple Bouguer slab 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 density d_1 .

BOUGUER GRAVITY DATA

ell gravity data
 . m. kulik
 eter used: vario

STATION IDENTIFICATION	L O C A T I O N S	G R A V I T Y	C O R R E C T I O N S	A N O M A L I E S					
proj sta-1d	LATITUDE deg min	LONGITUDE deg min	ELE (in ft)	ST OBSERVED	TERRAIN BOUGUER CURV	SPECIAL	FREE AIR	COMPLETE-BOUGUER	
					2.67 g/cc			d1=2.67 d2=2.45	
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p1b	44 36.41	-112 38.92	6484.00	mt 979995.22	980583.46	3.66 -221.15	-1.51	0.00 21.27	-197.73 -183.79
1p2a	44 35.89	-112 39.45	6544.00	mt 979990.60	980582.68	4.87 -223.20	-1.51	0.00 23.08	-196.76 -182.77
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p3a	44 25.93	-112 41.79	6932.00	mt 979945.78	980567.66	1.70 -236.43	-1.52	0.00 29.74	-206.51 -191.47
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p5a	44 26.61	-112 33.47	8827.00	mt 979829.26	980568.69	13.06 -301.06	-1.38	0.00 90.21	-199.18 -180.75
1p6a	44 27.44	-112 37.81	8580.00	mt 979840.42	980569.93	14.58 -292.64	-1.41	0.00 76.92	-202.55 -184.76
1p6a	44 28.38	-112 39.02	9511.00	mt 979778.17	980571.35	25.00 -324.39	-1.28	0.00 100.70	-199.97 -180.83
1p6a	44 28.82	-112 37.37	8876.00	mt 979826.89	980572.02	12.57 -302.73	-1.38	0.00 89.11	-202.43 -183.87
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p1a	44 37.95	-112 35.93	6322.00	mt 980003.81	980585.79	1.12 -215.63	-1.51	0.00 12.32	-203.69 -189.94
1p20a	44 25.71	-112 40.13	6555.00	mt 979963.74	980567.33	2.89 -223.57	-1.51	0.00 12.61	-209.59 -191.28
1p20a	44 33.55	-112 19.04	6800.00	mt 979966.19	980579.16	0.58 -231.93	-1.52	0.00 26.25	-206.62 -187.43
1p21a	44 33.97	-112 20.19	6765.00	mt 979967.23	980579.79	0.73 -230.73	-1.52	0.00 23.37	-208.15 -189.07
1p21a	44 34.40	-112 22.18	6694.00	mt 979972.14	980580.43	1.00 -228.31	-1.52	0.00 20.96	-207.87 -189.01
1p21a	44 34.71	-112 23.34	6660.00	mt 979973.42	980580.90	1.10 -227.15	-1.52	0.00 18.58	-208.99 -190.24
1p21a	44 35.09	-112 24.57	6700.00	mt 979971.52	980581.47	1.07 -228.52	-1.52	0.00 19.87	-209.10 -190.23
1p21a	44 36.01	-112 27.28	6580.00	mt 979979.66	980582.87	1.40 -224.42	-1.52	0.00 15.34	-209.20 -190.70
1p21a	44 36.50	-112 28.86	6540.00	mt 979983.34	980583.59	1.08 -223.06	-1.51	0.00 14.52	-208.97 -190.56
1p21a	44 36.89	-112 30.54	6451.00	mt 979988.29	980584.19	1.19 -220.03	-1.51	0.00 10.52	-209.83 -191.67
1p21a	44 37.03	-112 31.76	6413.00	mt 979991.82	980584.41	1.60 -218.73	-1.51	0.00 10.27	-208.37 -190.36
1p21a	44 37.11	-112 33.78	6500.00	mt 979993.84	980584.52	1.31 -221.70	-1.51	0.00 20.35	-201.55 -183.27
1p21a	44 37.95	-112 35.42	6275.00	mt 980004.26	980585.79	1.21 -214.02	-1.51	0.00 8.35	-205.97 -188.31
1p22a	44 39.20	-112 36.15	6190.00	mt 980012.58	980587.67	0.90 -211.12	-1.50	0.00 6.80	-204.93 -187.48
1p22a	44 40.10	-112 37.39	6135.00	mt 980022.39	980589.03	0.88 -209.25	-1.50	0.00 10.09	-199.78 -182.49
1p22a	44 40.87	-112 38.59	6089.00	mt 980028.53	980590.20	0.92 -207.68	-1.50	0.00 10.74	-197.51 -180.35
1p22a	44 41.90	-112 40.13	6043.00	mt 980033.10	980591.74	0.93 -206.11	-1.50	0.00 9.44	-197.24 -180.21
1p22a	44 42.49	-112 41.01	6018.00	mt 980034.10	980592.64	1.03 -205.26	-1.50	0.00 7.20	-198.52 -181.57
1p22a	44 43.55	-112 41.93	6006.00	mt 980037.63	980594.23	1.01 -204.85	-1.50	0.00 8.00	-197.33 -180.41
1p22a	44 40.50	-112 13.05	6729.00	mt 979978.83	980589.63	0.83 -229.51	-1.52	0.00 21.73	-208.46 -189.49
1p22a	44 41.79	-112 13.02	6827.00	mt 979975.06	980591.58	1.62 -232.85	-1.52	0.00 25.23	-207.52 -188.34

BOUGUER GRAVITY DATA

ell gravity data
 . m. kulik
 eter used: vario

STATION IDENTIFICATION proj	L O C A T I O N S		E L E (in ft)	S T OBSERVED	G R A V I T Y		C O R R E C T I O N S		T E R R A I N B O U G U E R		S P E C I A L	A N O M A L I E S	
	L A T I T U D E deg	L O N G I T U D E deg			T H E O R E T I C A L	T E R R A I N	C U R V	2.67 g/cc	F R E E A I R	C O M P L E T E - B O U G U E R d1=2.67 d2=2.45			
1p228	44 41.77	-112 11.82	6729.00	mt	979981.20	980591.55	1.54	-229.51	-1.52	0.00	22.19	-207.29	-188.38
1p229	44 41.79	-112 9.23	6760.00	mt	979985.96	980591.58	1.05	-230.56	-1.52	0.00	29.83	-201.20	-182.16
1p230	44 40.46	-112 8.77	6650.00	mt	979983.76	980589.57	0.82	-226.81	-1.52	0.00	19.30	-208.21	-189.46
1p231	44 41.78	-112 8.76	6772.00	mt	979985.68	980591.56	1.02	-230.97	-1.52	0.00	30.70	-200.78	-181.70
1p232	44 41.79	-112 9.98	6702.00	mt	979985.73	980591.58	1.34	-228.59	-1.52	0.00	24.16	-204.61	-185.76
1p233	44 41.82	-112 14.06	6868.00	mt	979972.60	980591.63	1.88	-234.25	-1.52	0.00	26.58	-207.31	-188.04
1p234	44 42.37	-112 14.95	6949.00	mt	979967.17	980592.46	2.82	-237.01	-1.52	0.00	27.93	-207.78	-188.36
1p235	44 42.94	-112 15.69	7007.00	mt	979964.97	980593.32	3.43	-238.99	-1.52	0.00	30.31	-206.76	-187.23
1p236	44 43.36	-112 16.18	7100.00	mt	979960.46	980593.95	3.39	-242.16	-1.51	0.00	33.91	-206.38	-186.58
1p237	44 43.84	-112 16.71	7250.00	mt	979952.23	980594.67	2.35	-247.28	-1.51	0.00	39.05	-207.39	-187.08
1p238	44 44.45	-112 16.76	7424.00	mt	979944.04	980595.59	1.55	-253.21	-1.50	0.00	46.28	-206.88	-186.02
1p239	44 44.64	-112 17.35	7235.00	mt	979955.53	980595.86	2.46	-246.77	-1.51	0.00	39.73	-206.08	-185.83
1p240	44 45.62	-112 18.04	7160.00	mt	979962.35	980597.35	3.99	-244.21	-1.51	0.00	38.03	-203.70	-183.78
1p241	44 46.25	-112 18.08	7141.00	mt	979966.87	980598.30	2.98	-243.56	-1.51	0.00	39.81	-202.28	-182.34
1p242	44 46.77	-112 18.30	7033.00	mt	979974.05	980599.09	5.78	-239.88	-1.52	0.00	36.06	-199.55	-180.14
1p243	44 47.81	-112 19.15	6981.00	mt	979978.27	980600.66	3.73	-238.10	-1.52	0.00	33.83	-202.06	-182.62
1p244	44 48.46	-112 19.46	6880.00	mt	979985.48	980601.64	4.82	-234.66	-1.52	0.00	30.57	-200.79	-181.72
1p245	44 49.11	-112 20.01	6830.00	mt	979993.04	980602.62	3.64	-232.95	-1.52	0.00	32.44	-198.39	-179.37
1p246	44 49.79	-112 20.11	6855.00	mt	979995.45	980603.64	1.96	-233.80	-1.52	0.00	36.18	-197.18	-177.95
1p265	44 29.83	-112 40.65	9580.00	mt	979784.26	980573.55	29.74	-326.75	-1.26	0.00	111.07	-187.19	-162.62
1p271	44 30.76	-112 40.50	8030.00	mt	979888.58	980574.95	5.36	-273.88	-1.47	0.00	68.40	-201.59	-179.34
1p272	44 29.90	-112 39.62	8880.00	mt	979838.85	980573.64	14.34	-302.87	-1.38	0.00	99.82	-190.09	-166.20
1p273	44 29.72	-112 39.68	9600.00	mt	979778.84	980573.38	31.67	-327.43	-1.26	0.00	107.71	-189.31	-164.84
1p274	44 29.80	-112 38.66	9202.00	mt	979808.72	980573.50	25.62	-313.85	-1.33	0.00	100.08	-189.48	-165.62
1p275	44 29.38	-112 35.75	9092.00	mt	979805.84	980572.87	13.75	-310.10	-1.34	0.00	87.51	-210.19	-185.66
1p276	44 29.65	-112 33.66	8520.00	mt	979856.21	980573.27	12.99	-290.59	-1.42	0.00	83.74	-195.28	-172.29
1p277	44 30.12	-112 35.79	9413.00	mt	979798.35	980573.98	15.72	-321.05	-1.29	0.00	109.05	-197.58	-172.31
1p278	44 31.16	-112 33.35	8443.00	mt	979813.12	980575.55	6.86	-287.97	-1.43	0.00	31.14	-251.40	-228.12
1p279	44 35.75	-112 38.16	7485.00	mt	979879.99	980582.47	5.11	-255.29	-1.50	0.00	1.09	-250.59	-229.85
1p280	44 34.85	-112 36.38	8364.00	mt	979818.80	980581.11	12.91	-285.27	-1.44	0.00	23.83	-249.97	-227.41
1p281	44 34.20	-112 34.17	8642.00	mt	979800.25	980580.13	10.34	-294.75	-1.41	0.00	32.37	-253.45	-229.89
1p282	44 32.92	-112 32.89	9600.00	mt	979725.37	980578.20	23.68	-327.43	-1.26	0.00	49.40	-255.61	-230.47
1p283	44 33.41	-112 37.05	8402.00	mt	979817.08	980578.94	6.99	-286.57	-1.43	0.00	27.85	-253.16	-230.01
1p284	44 31.71	-112 38.74	9245.00	mt	979806.94	980576.38	13.36	-315.32	-1.32	0.00	99.46	-203.82	-178.83
1p285	44 32.56	-112 40.07	9250.00	mt	979805.31	980577.66	13.85	-315.49	-1.32	0.00	97.02	-205.94	-180.98
1p286	44 33.42	-112 40.72	7938.00	mt	979894.25	980578.95	8.18	-270.74	-1.47	0.00	61.42	-202.62	-180.86
1p290	44 37.05	-112 41.01	8765.00	mt	979855.47	980584.43	16.90	-298.95	-1.39	0.00	94.85	-188.59	-165.24
1p291	44 36.68	-112 34.99	6875.00	mt	979966.37	980583.87	2.79	-234.49	-1.52	0.00	28.75	-204.46	-185.24
1p292	44 35.24	-112 32.04	7262.00	mt	979936.64	980581.70	3.06	-247.69	-1.51	0.00	37.56	-208.58	-188.30
1p309	44 31.23	-112 37.20	10961.00	mt	979672.74	980575.65	41.88	-373.85	-0.95	0.00	127.14	-205.78	-178.35

BOUGUER GRAVITY DATA

all gravity data
 . m. kulik
 eter used: vario

STATION IDENTIFICATION proj sta-id	L O C A T I O N S		ELE (in ft)	ST OBSERVED	G R A V I T Y		C O R R E C T I O N S		A N O M A L I E S			
	LATITUDE deg	LONGITUDE min deg			THEORETICAL	TERRAIN BOUGUER CURV 2.67 g/cc	SPECIAL	FREE AIR	COMPLETE-BOUGUER d1=2.67 d2=2.45			
1p416	44 37.64	-112 7.77	6606.00	mt 979978.85	980585.32	0.55	-225.31	-1.52	0.00	14.51	-211.76	-193.12
1p417	44 37.20	-112 7.59	6615.00	mt 979978.71	980584.66	0.53	-225.62	-1.52	0.00	15.88	-210.72	-192.05
1p418	44 36.30	-112 7.60	6641.00	mt 979982.93	980583.30	0.64	-226.51	-1.52	0.00	23.90	-203.48	-184.74
1p419	44 35.85	-112 7.69	6671.00	mt 979985.27	980582.62	0.89	-227.53	-1.52	0.00	29.74	-198.41	-179.61
1p420	44 35.94	-112 8.72	6680.00	mt 979981.54	980582.76	0.89	-227.84	-1.52	0.00	26.72	-201.74	-182.92
1p421	44 34.30	-112 8.48	7089.00	mt 979959.68	980580.29	1.19	-241.79	-1.51	0.00	45.76	-196.35	-176.40
1p422	44 33.85	-112 8.45	7135.00	mt 979956.24	980579.61	1.53	-243.35	-1.51	0.00	47.33	-196.01	-175.96
1p423	44 33.15	-112 8.67	7412.00	mt 979937.81	980578.55	2.15	-252.80	-1.50	0.00	55.98	-196.18	-175.40
1p424	44 32.79	-112 8.15	7672.00	mt 979921.24	980578.01	2.64	-261.67	-1.49	0.00	64.38	-196.15	-174.68
1p425	44 32.65	-112 7.38	7640.00	mt 979924.71	980577.80	2.23	-260.58	-1.49	0.00	65.05	-194.80	-173.38
1p426	44 32.95	-112 6.12	7586.00	mt 979930.20	980578.25	2.04	-259.74	-1.50	0.00	65.01	-193.18	-171.91
1p427	44 32.41	-112 5.12	7617.00	mt 979928.43	980577.44	2.36	-259.79	-1.50	0.00	66.97	-191.96	-170.63
1p428	44 32.05	-112 4.64	7640.00	mt 979927.74	980576.89	1.93	-260.58	-1.49	0.00	68.98	-191.16	-169.72
1p429	44 38.47	-112 33.93	6258.00	mt 980005.60	980586.58	1.05	-213.44	-1.51	0.00	7.32	-206.58	-188.96
1p430	44 38.46	-112 32.52	6387.00	mt 979998.64	980586.55	1.07	-217.84	-1.51	0.00	12.49	-205.79	-187.81
1p431	44 38.82	-112 31.50	6382.00	mt 979999.70	980587.10	1.74	-217.67	-1.51	0.00	12.54	-204.90	-186.99
1p432	44 39.00	-112 30.10	6332.00	mt 980004.25	980587.38	0.76	-215.97	-1.51	0.00	12.12	-204.60	-186.74
1p433	44 40.08	-112 29.57	6311.00	mt 980010.37	980589.00	1.41	-215.25	-1.51	0.00	14.63	-200.72	-182.97
1p434	44 40.10	-112 28.28	6351.00	mt 980009.32	980589.03	1.74	-216.61	-1.51	0.00	13.31	-203.07	-185.24
1p435	44 39.90	-112 27.58	6365.00	mt 980002.76	980588.73	1.79	-217.09	-1.51	0.00	12.37	-204.45	-186.58
1p436	44 39.71	-112 26.42	6394.00	mt 979998.45	980588.44	1.51	-218.08	-1.51	0.00	11.07	-207.01	-189.04
1p437	44 39.98	-112 25.83	6454.00	mt 979993.78	980588.84	2.57	-220.13	-1.51	0.00	11.63	-207.44	-189.39
1p438	44 39.49	-112 24.78	6458.00	mt 979992.40	980588.12	2.68	-220.26	-1.51	0.00	11.37	-207.73	-189.68
1p439	44 39.20	-112 23.52	6490.00	mt 979989.15	980587.67	2.78	-221.36	-1.51	0.00	11.56	-208.53	-190.40
1p440	44 40.56	-112 26.83	6665.00	mt 979985.24	980589.73	2.06	-227.32	-1.52	0.00	22.04	-204.74	-186.05
1p441	44 40.78	-112 27.46	6759.00	mt 979981.46	980590.06	2.14	-230.53	-1.52	0.00	26.76	-203.14	-184.20
1p442	44 41.58	-112 27.54	7580.00	mt 979934.90	980591.27	3.24	-258.53	-1.50	0.00	56.13	-200.66	-179.50
1p443	44 42.24	-112 28.43	6939.00	mt 979972.23	980592.26	1.06	-236.67	-1.52	0.00	32.25	-204.88	-185.34
1p444	44 43.07	-112 27.90	6616.00	mt 979992.51	980593.51	1.04	-225.65	-1.52	0.00	20.92	-205.21	-186.58
1p445	44 43.11	-112 28.58	6680.00	mt 979988.34	980593.57	0.80	-227.84	-1.52	0.00	22.71	-205.84	-187.01
1p446	44 43.57	-112 28.48	6590.00	mt 979995.44	980594.27	0.93	-224.77	-1.52	0.00	20.65	-204.70	-186.13
1p447	44 44.33	-112 28.71	6570.00	mt 980000.46	980595.41	1.05	-224.08	-1.52	0.00	22.65	-201.90	-183.40
1p448	44 44.73	-112 28.97	6548.00	mt 980003.79	980596.02	1.18	-223.33	-1.51	0.00	23.31	-200.36	-181.93
1p449	44 45.78	-112 30.57	6492.00	mt 980011.56	980597.60	0.85	-221.42	-1.51	0.00	24.23	-197.85	-179.55
1p450	44 46.49	-112 31.85	6394.00	mt 980024.10	980598.66	0.86	-218.08	-1.51	0.00	26.49	-192.24	-174.22
1p451	44 45.16	-112 33.32	6265.00	mt 980031.23	980596.66	1.06	-213.68	-1.51	0.00	23.51	-190.62	-172.97
1p452	44 46.24	-112 33.05	6345.00	mt 980031.77	980598.30	0.86	-216.41	-1.51	0.00	29.94	-187.12	-169.24
1p453	44 46.92	-112 32.97	6364.00	mt 980030.42	980599.32	0.91	-217.06	-1.51	0.00	29.35	-188.31	-170.38
1p454	44 47.82	-112 33.19	6392.00	mt 980028.90	980600.67	1.09	-218.01	-1.51	0.00	29.10	-189.34	-171.34
1p455	44 48.34	-112 32.62	6457.00	mt 980022.28	980601.46	0.91	-220.23	-1.51	0.00	27.80	-193.03	-174.83

BOUGUER GRAVITY DATA

all gravity data
 . m. kulik
 aster used: vario

STATION IDENTIFICATION proj sta-id	L O C A T I O N S LATITUDE deg min		L O N G I T U D E LONGITUDE min		E L E (in ft)	S T OBSERVED	G R A V I T Y THEORETICAL		C O R R E C T I O N S TERRAIN BOUGUER CURV		S P E C I A L	A N O M A L I E S FREE COMPLETE-BOUGUER AIR d1=2.67 d2=2.45		
	deg	min	deg	min			2.67 g/cc	2.67 g/cc	FREE AIR	COMPLETE-BOUGUER				
1p310	44	32.25	-112	35.84	10706.00	mt	979695.04	980577.19	38.71	-365.15	-1.02	123.95	-203.51	-176.52
1p311	44	32.70	-112	34.03	10388.00	mt	979713.90	980577.87	36.13	-354.30	-1.09	112.27	-207.00	-180.69
1p312	44	32.80	-112	30.85	7300.00	mt	979933.81	980578.02	3.69	-248.98	-1.51	41.98	-204.82	-184.48
1p313	44	30.55	-112	30.91	7712.00	mt	979908.41	980574.63	3.70	-263.03	-1.49	58.68	-202.14	-180.65
1p314	44	29.00	-112	31.20	9200.00	mt	979801.79	980572.29	22.12	-313.79	-1.33	94.17	-198.82	-174.68
1p315	44	27.76	-112	29.97	9136.00	mt	979810.99	980570.42	13.32	-311.60	-1.34	99.23	-200.39	-175.70
1p316	44	30.90	-112	27.42	7698.00	mt	979906.93	980575.16	6.05	-262.56	-1.49	55.36	-202.64	-181.38
1p317	44	32.37	-112	28.54	6925.00	mt	979959.02	980577.38	1.59	-236.19	-1.52	32.61	-203.51	-184.05
1p318	44	33.09	-112	28.27	6916.00	mt	979961.18	980578.46	1.19	-235.88	-1.52	32.83	-203.38	-183.91
1p319	44	34.00	-112	29.70	7017.00	mt	979954.07	980579.84	1.46	-239.33	-1.52	33.84	-205.55	-185.82
1p321	44	33.25	-112	25.15	7401.00	mt	979925.93	980578.70	3.23	-252.43	-1.51	42.91	-207.79	-187.14
1p320	44	34.71	-112	27.57	6733.00	mt	979972.73	980580.90	0.71	-229.64	-1.52	24.75	-205.70	-186.71
1p322	44	32.44	-112	26.51	7095.00	mt	979947.53	980577.48	1.05	-241.99	-1.51	36.98	-205.47	-185.49
1p353	44	40.96	-112	1.43	8280.00	mt	979887.26	980590.33	11.14	-282.41	-1.45	75.18	-197.53	-175.06
1p341	44	33.64	-112	41.70	6832.00	mt	979964.75	980579.29	4.35	-233.02	-1.52	27.68	-202.51	-183.54
1p338	44	37.03	-112	37.98	6379.00	mt	979999.26	980584.41	2.15	-217.57	-1.51	14.51	-202.42	-184.54
1p339	44	35.27	-112	39.95	6603.00	mt	979985.52	980581.74	4.86	-225.21	-1.52	24.48	-197.39	-179.10
1p340	44	34.91	-112	40.69	6677.00	mt	979980.71	980581.20	4.48	-227.73	-1.52	27.16	-197.61	-179.09
1p343	44	33.82	-112	39.59	6998.00	mt	979954.72	980579.56	6.07	-238.68	-1.52	32.97	-201.15	-181.86
1p344	44	49.34	-112	10.26	7450.00	mt	979951.05	980602.96	7.21	-254.10	-1.50	48.35	-200.04	-179.57
1p345	44	47.86	-112	9.18	9518.00	mt	979814.62	980600.74	19.39	-324.63	-1.27	108.41	-198.10	-172.85
1p346	44	46.82	-112	8.41	9418.00	mt	979824.77	980599.16	10.38	-321.22	-1.29	110.75	-201.39	-175.67
1p347	44	46.27	-112	8.02	9337.00	mt	979827.42	980598.34	9.80	-318.46	-1.31	106.62	-203.35	-177.81
1p348	44	45.22	-112	7.68	8661.00	mt	979872.81	980596.76	6.89	-295.40	-1.40	90.10	-199.82	-175.93
1p349	44	43.94	-112	6.86	7265.00	mt	979961.34	980594.82	2.57	-247.79	-1.51	49.42	-197.31	-176.98
1p350	44	43.93	-112	5.61	7515.00	mt	979948.26	980594.81	3.79	-256.32	-1.50	59.83	-194.19	-173.26
1p351	44	42.51	-112	4.79	6814.00	mt	979987.28	980592.66	1.60	-232.41	-1.52	35.14	-197.18	-178.04
1p352	44	41.64	-112	3.25	8222.00	mt	979894.44	980591.35	9.41	-280.43	-1.45	75.89	-196.58	-174.13
1p354	44	39.73	-112	0.73	7355.00	mt	979947.38	980588.48	2.80	-250.86	-1.51	50.26	-199.30	-178.74
1p369	44	39.41	-112	17.93	6662.00	mt	979977.01	980587.98	1.18	-227.22	-1.52	15.26	-212.29	-193.54
1p370	44	40.22	-112	16.45	6693.00	mt	979974.36	980589.21	1.91	-228.28	-1.52	14.31	-213.58	-194.80
1p371	44	40.19	-112	15.64	6682.00	mt	979973.43	980589.16	1.77	-227.90	-1.52	12.39	-215.26	-196.51
1p372	44	40.42	-112	15.19	6718.00	mt	979974.21	980589.52	2.38	-229.13	-1.52	16.20	-212.06	-193.26
1p373	44	40.52	-112	14.27	6681.00	mt	979978.82	980589.66	1.67	-227.87	-1.52	17.19	-210.53	-191.77
1p397	44	29.70	-112	37.24	8600.00	mt	979855.40	980573.34	7.71	-293.32	-1.41	90.37	-196.66	-173.01
1p411	44	40.06	-112	8.76	6642.00	mt	979981.80	980588.98	0.70	-226.54	-1.52	17.19	-210.16	-191.43
1p412	44	39.61	-112	8.76	6636.00	mt	979980.28	980588.30	0.57	-226.33	-1.52	15.79	-211.49	-192.76
1p413	44	39.16	-112	8.76	6610.00	mt	979980.52	980587.62	0.51	-225.45	-1.52	14.27	-212.18	-193.52
1p414	44	38.77	-112	8.77	6604.00	mt	979980.92	980587.02	0.51	-225.24	-1.52	14.69	-211.56	-192.91
1p415	44	38.55	-112	8.12	6587.00	mt	979980.51	980586.70	0.52	-224.66	-1.52	13.01	-212.65	-194.05

BOUGUER GRAVITY DATA

ell gravity data
 . m. kulik
 eter used: vario

STATION IDENTIFICATION proj sta-id	L O C A T I O N S LATITUDE deg min	L O C A T I O N S LONGITUDE deg min	ELE E (in ft)	ST OBSERVED	G R A V I T Y THEORETICAL	TERRAIN BOUGUER 2.67 g/cc	C O R R E C T I O N S SPECIAL	FREE AIR	A N O M A L I E S COMPLETE-BOUGUER d1=2.67 d2=2.45		
1P456	44 49.68	-112 33.14	6520.00	mt 980020.71	980603.48	1.17	-222.38	-1.51	30.13	-192.59	-174.24
1P476	44 39.45	-112 22.05	6577.00	mt 979984.21	980588.05	4.68	-224.32	-1.52	14.42	-206.74	-188.52
1P477	44 39.36	-112 21.44	6612.00	mt 979983.77	980587.91	2.77	-225.52	-1.52	0.00	-206.86	-188.38
1P478	44 39.22	-112 20.22	6673.00	mt 979978.38	980587.70	1.97	-227.60	-1.52	0.00	-209.19	-190.47
1P479	44 39.07	-112 19.79	6704.00	mt 979976.02	980587.48	1.23	-228.65	-1.52	0.00	-210.20	-191.34
1P480	44 38.98	-112 18.93	6650.00	mt 979977.94	980587.34	1.26	-226.81	-1.52	0.00	-211.36	-192.65
1P481	44 39.40	-112 17.93	6662.00	mt 979977.20	980587.98	1.17	-227.22	-1.52	0.00	-212.09	-193.34
1P482	44 39.86	-112 16.89	6681.00	mt 979975.58	980588.66	1.33	-227.87	-1.52	0.00	-213.12	-194.33
1P483	44 39.32	-112 28.28	6402.00	mt 979999.49	980587.85	0.98	-218.35	-1.51	0.00	-205.43	-187.40
1P484	44 39.28	-112 27.05	6395.00	mt 979999.04	980587.80	1.41	-218.12	-1.51	0.00	-205.81	-187.83
1P485	44 38.77	-112 29.21	6361.00	mt 980001.63	980587.02	0.93	-216.96	-1.51	0.00	-204.97	-187.04
1P502	44 29.50	-112 14.30	6550.00	mt 979984.16	980573.05	0.92	-223.40	-1.51	0.00	-197.16	-201.36
1P503	44 31.18	-112 15.31	6754.00	mt 979975.55	980575.58	0.99	-230.36	-1.52	0.00	-196.03	-200.35
1P504	44 30.00	-112 14.34	6560.00	mt 979981.04	980573.80	0.87	-223.74	-1.52	0.00	-200.48	-204.69
1P505	44 32.15	-112 16.40	6720.00	mt 979971.46	980577.04	0.56	-229.20	-1.52	0.00	-204.04	-208.35
1P506	44 32.94	-112 17.68	6764.00	mt 979966.58	980578.23	0.56	-230.70	-1.52	0.00	-207.49	-211.82
1P507	44 32.00	-112 18.60	6842.00	mt 979962.89	980576.81	1.05	-233.36	-1.52	0.00	-204.59	-208.97
1P508	44 31.31	-112 18.94	6975.00	mt 979954.23	980575.77	0.70	-237.90	-1.52	0.00	-204.61	-209.08
1P509	44 30.80	-112 19.80	7080.00	mt 979947.25	980575.00	0.82	-241.48	-1.51	0.00	-204.40	-208.94
1P510	44 30.30	-112 20.95	7215.00	mt 979938.57	980574.25	0.94	-246.08	-1.51	0.00	-204.13	-208.75
1P511	44 29.50	-112 21.03	7285.00	mt 979935.07	980573.05	1.19	-248.47	-1.51	0.00	-201.99	-206.65
1P512	44 28.16	-112 20.67	7515.00	mt 979920.76	980571.02	2.46	-256.32	-1.50	0.00	-199.23	-204.02
1P513	44 34.63	-112 18.00	7030.00	mt 979949.97	980580.78	0.91	-239.77	-1.52	0.00	-210.37	-214.87
1P514	44 35.10	-112 15.76	6886.00	mt 979973.05	980581.49	0.98	-228.04	-1.52	0.00	-208.52	-212.80
1P515	44 35.30	-112 13.91	6731.00	mt 979972.99	980581.79	0.65	-229.58	-1.52	0.00	-206.51	-210.83
1P516	44 35.81	-112 12.93	6734.00	mt 979973.33	980582.55	0.59	-229.68	-1.52	0.00	-206.83	-211.15
1P517	44 36.04	-112 11.53	6699.00	mt 979976.32	980582.91	0.99	-228.48	-1.52	0.00	-205.88	-210.16
1P518	44 35.67	-112 1.79	6650.00	mt 979988.39	980582.35	1.50	-226.81	-1.52	0.00	-195.67	-199.92
1P519	44 35.27	-112 5.25	6647.00	mt 979989.07	980581.74	1.33	-226.71	-1.52	0.00	-194.73	-198.98
1P520	44 35.20	-112 3.80	6695.00	mt 979985.14	980581.64	1.31	-228.35	-1.52	0.00	-195.71	-199.99
1P521	44 35.22	-112 1.75	6722.00	mt 979985.76	980581.67	1.41	-229.27	-1.52	0.00	-193.41	-197.70
1P522	44 35.68	-112 0.18	6757.00	mt 979981.14	980582.37	1.05	-230.46	-1.52	0.00	-196.99	-201.31
1P523	44 43.95	-112 40.84	5985.00	mt 980039.91	980594.84	1.06	-204.13	-1.50	0.00	-195.87	-200.70
1P524	44 43.66	-112 39.13	6036.00	mt 980038.78	980594.41	1.34	-205.87	-1.50	0.00	-194.22	-198.08
1P525	44 44.37	-112 37.88	6126.00	mt 980037.25	980595.47	1.18	-208.94	-1.50	0.00	-191.60	-195.52
1P526	44 44.38	-112 36.60	6170.00	mt 980037.71	980595.49	1.32	-210.44	-1.50	0.00	-188.39	-192.33
1P527	44 44.40	-112 35.00	6239.00	mt 980033.76	980595.52	1.03	-212.79	-1.51	0.00	-188.53	-192.53
1P528	44 44.89	-112 33.82	6287.00	mt 980029.82	980596.26	1.16	-214.43	-1.51	0.00	-190.21	-194.23
1P529	44 44.03	-112 33.92	6220.00	mt 980027.05	980594.95	1.36	-212.15	-1.51	0.00	-195.49	-199.47
1P530	44 43.26	-112 32.83	6472.00	mt 980008.49	980593.80	0.78	-220.74	-1.51	0.00	-198.39	-202.54

BOUGUER GRAVITY DATA

ell gravity data
 . m. kulik
 eter used: vario

STATION IDENTIFICATION	STATION	LONGITUDE	LONGITUDE	STATION	GRAVITY	TERRAIN	CORRECTION	SPECIAL	FREE	ANOMALIES		
proj	sta-id	deg	min	deg	observed	theoretical	BOUGUER	CURV	AIR	COMPLETE-BOUGUER		
		deg	min	deg	ST	THEORETICAL	BOUGUER	CURV	AIR	d1=d2		
					Observed	Theoretical	BOUGUER	CURV	AIR	d1=d2		
					(in ft)		2.67 g/cc					
1P531	44 43.07	-112 31.75	6572.00	mt	979995.26	980593.51	2.12	-224.15	-1.52	19.54	-204.01	-208.20
1P532	44 41.48	-112 31.28	6480.00	mt	979998.64	980591.11	1.35	-221.01	-1.51	16.67	-204.50	-208.65
1P533	44 41.00	-112 30.80	6441.00	mt	980000.21	980590.38	1.09	-219.68	-1.51	15.30	-204.81	-208.93
1P534	44 42.65	-112 30.14	7020.00	mt	979966.10	980592.88	0.96	-239.43	-1.52	33.10	-206.88	-211.38
1P535	44 42.88	-112 29.35	6868.00	mt	979975.66	980593.23	0.69	-234.25	-1.52	28.03	-207.05	-211.45
1P536	44 43.22	-112 28.60	6680.00	mt	979989.10	980593.73	0.78	-227.84	-1.52	23.30	-205.27	-209.55
1P537	44 43.10	-112 26.70	6680.00	mt	979992.53	980593.55	1.05	-227.84	-1.52	26.91	-201.39	-205.67
1P538	44 44.66	-112 25.33	6786.00	mt	979990.64	980595.91	3.42	-231.45	-1.52	32.63	-196.92	-201.22
1P539	44 44.20	-112 24.67	6865.00	mt	979985.00	980595.22	2.00	-234.15	-1.52	35.10	-198.56	-202.93
1P540	44 43.73	-112 23.82	6960.00	mt	979981.92	980594.50	2.43	-237.39	-1.52	41.65	-194.82	-199.25
1P541	44 43.24	-112 23.28	6950.00	mt	979975.10	980593.77	1.73	-237.04	-1.52	34.64	-202.19	-206.63
1P542	44 43.35	-112 22.00	7075.00	mt	979966.49	980593.93	2.67	-241.31	-1.51	37.61	-202.54	-207.04
1P543	44 45.03	-112 14.79	7299.00	mt	979951.58	980596.47	14.70	-248.95	-1.51	41.20	-194.56	-198.97
1P544	44 44.10	-112 19.26	7563.00	mt	979935.65	980595.06	1.31	-257.95	-1.50	51.48	-206.66	-211.50
1P606	44 44.90	-112 25.20	6977.00	mt	979975.61	980596.27	1.65	-237.97	-1.52	35.17	-202.66	-207.11
1P607	44 45.57	-112 25.07	7156.00	mt	979965.96	980597.28	2.73	-244.07	-1.51	41.33	-201.52	-206.07
1P608	44 46.70	-112 25.47	7616.00	mt	979942.40	980598.98	1.37	-259.76	-1.50	59.28	-200.60	-205.47
1P609	44 47.96	-112 26.05	7263.00	mt	979970.44	980600.88	1.80	-247.72	-1.51	52.26	-195.17	-199.80
1P610	44 48.41	-112 26.67	7171.00	mt	979978.65	980601.56	1.65	-244.38	-1.51	51.15	-193.30	-197.87
1P611	44 48.91	-112 25.77	7501.00	mt	979956.82	980602.32	1.22	-255.84	-1.50	59.57	-196.55	-201.35
1P612	44 49.93	-112 25.31	7820.00	mt	979939.11	980603.86	1.85	-266.72	-1.48	70.28	-196.07	-201.05
1P622	44 49.80	-112 28.67	6840.00	mt	980008.80	980603.66	1.68	-233.29	-1.52	48.10	-185.03	-189.40
1P623	44 48.03	-112 30.86	6553.00	mt	980017.32	980600.99	1.28	-223.50	-1.51	32.33	-191.41	-195.60