UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Principal facts for 29 gravity stations in the Boulder and Jefferson City quadrangles, Montana

by

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Introduction

In June, 1984, 29 gravity stations were established on the southeastern portion of the Butte 1° x 2° topographic quadrangle, Montana, in the Boulder and Jefferson City 15-minute quadrangles (figure 1). These stations were read to supplement data previously published by Hassemer (1984) as part of the Conterminous United States Mineral Appraisal Program (CUSMAP).

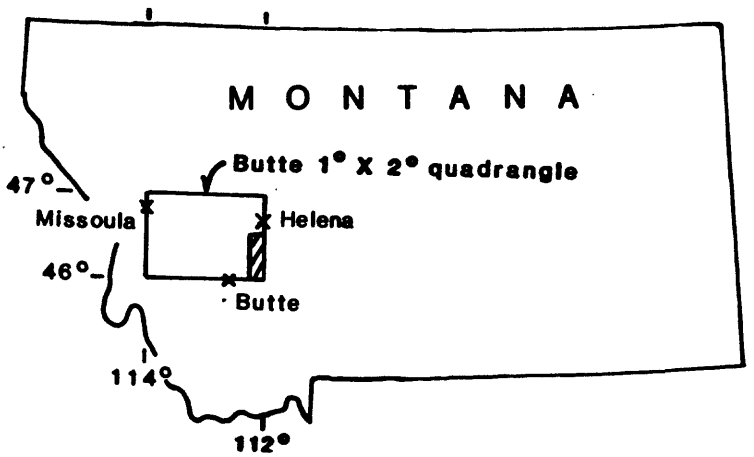

Figure 1. -- Hachured rectangle shows area of gravity data listed in this report and the location of the Butte 1° x 2° quadrangle.

Data Collection and Reduction

LaCoste and Romberg gravimeter G-2 was used to establish the observed gravity value for the stations being reported here. A temporary base station, station B0426 of Hassemer (1984), was used to reference gravity values to the International Gravity Standardization Net 1971 (Morelli and others, 1974) and is described in the appendix.

Horizontal and vertical control for station locations were obtained from U.S. Geological Survey topographic maps at a scale of 1:62,000 with a contour interval of 40 feet. More than half of the stations were located at points where the elevation was determined by interpolation between contour lines aided with the use of an altimeter. Table 1 lists a code and explanation for the elevation source and the possible error in the Bouguer gravity correction due to the elevation error. This code letter is listed in the rightmost column of the principal facts in Table 2.

Table 1.--Elevation Codes

Elevation Code	Explanation
B	Station elevation known to one foot or less. Readings were taken at bench marks or section corners with known elevations. Gravity effect due to elevation error should be less than 0.06 mGal.

F — Black spot elevations that should be accurate to four feet or less. Gravity effect due to an elevation error of four feet is 0.24 mGal.

C — Elevations determined from interpolating between 40-foot interval contour lines on 15-minute topographic maps. Elevation errors for these stations could be about 20 feet with a gravity effect of 1.20 mGal.

Data reduction was accomplished using computer programs on a Digital Equipment Corp. VAX-11/750 computer. Observed gravity values were calculated from gravimeter readings using a program by M. W. Webring, D. A. Dansereau, and R. R. Wahl (U.S. Geological Survey, unpublished) that corrects for earth tide and meter drift. Terrain, Bouguer, and earth curvature corrections and free air and Bouguer gravity anomalies were computed using a program written by R. H. Godson (U.S. Geological Survey, 1978, unpublished) which uses the 1967 formula of the Geodetic Reference System (International Association of Geodesy, 1971) to calculate theoretical gravity values. The equations and related expansions used are given by Cordell and others (1982). Terrain corrections were computed from each station to a radial distance of 166.7 kilometers using a modification of the method of Plouff (1977) in conjunction with digital terrain data for the conterminous United States obtained from the U.S. Department of Defense. In addition, corrections for Hammer zones A through C (Hammer, 1939) were estimated in the field for each station and added to the correction from the digital data.

The principal facts for the gravity stations are listed in Table 2. An explanation of the column headings follows:

IDENTIFICATION — proj - project identification
sta-id - gravity survey station number

LATITUDE — north latitude in degrees, minutes, and hundredths of minutes

LONGITUDE — west longitude in degrees, minutes, and hundredths of minutes

ELEV — elevation in feet above sea level

ST — state

OBSERVED GRAVITY — observed gravity in milliGals

THEORETICAL GRAVITY — theoretical gravity computed using the Geodetic Reference System 1967 (International Association of Geodesy, 1971)

CORRECTIONS

TERRAIN — Corrections due to effects of topography at a density of 2.67 g/cm^3 in milliGals. Column a-g lists the computer correction for Hammer zones a-g plus estimated corrections for Hammer zones a-c. Column h-x lists the computer correction from Hammer zone g to a radial distance of 166.7 km from the station.

BOUGUER	Bouguer slab correction in milliGals
CURV	corrections in milliGals due to curvature of the earth
ANOMALIES	
FREE AIR	free-air anomaly in milliGals
COMPLETE-BOUGUER	complete Bouguer anomaly in milliGals for densities of 2.67 and 2.45 g/cm^3
ELEV CODE	elevation code, see table 1

Figure 2 is a plot of station locations with station identification.

References

Cordell, L. E., 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: 1,000,000.

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International Association of Geodesy, 1971, Geodetic reference system 1967: International Association of Geodesy Special Publication No. 3, 116 p.

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Morelli, C., Gantar, C., Honkasalo, T., McConnel, R. K., Tanner, J. G., B., Uotila, U. A., and Whalen, C. T., 1974, The International Gravity Standardization Net 1971: Special Publication 4, International Association of Geodesy, International Union of Geodesy and Geophysics, 194 p.

Plouff, Donald, 1977, Preliminary documentation for a FORTRAN program to compute gravity terrain correction based on topography digitized on a geographic grid: U.S. Geological Survey Open-File Report 77-535, 43 p.

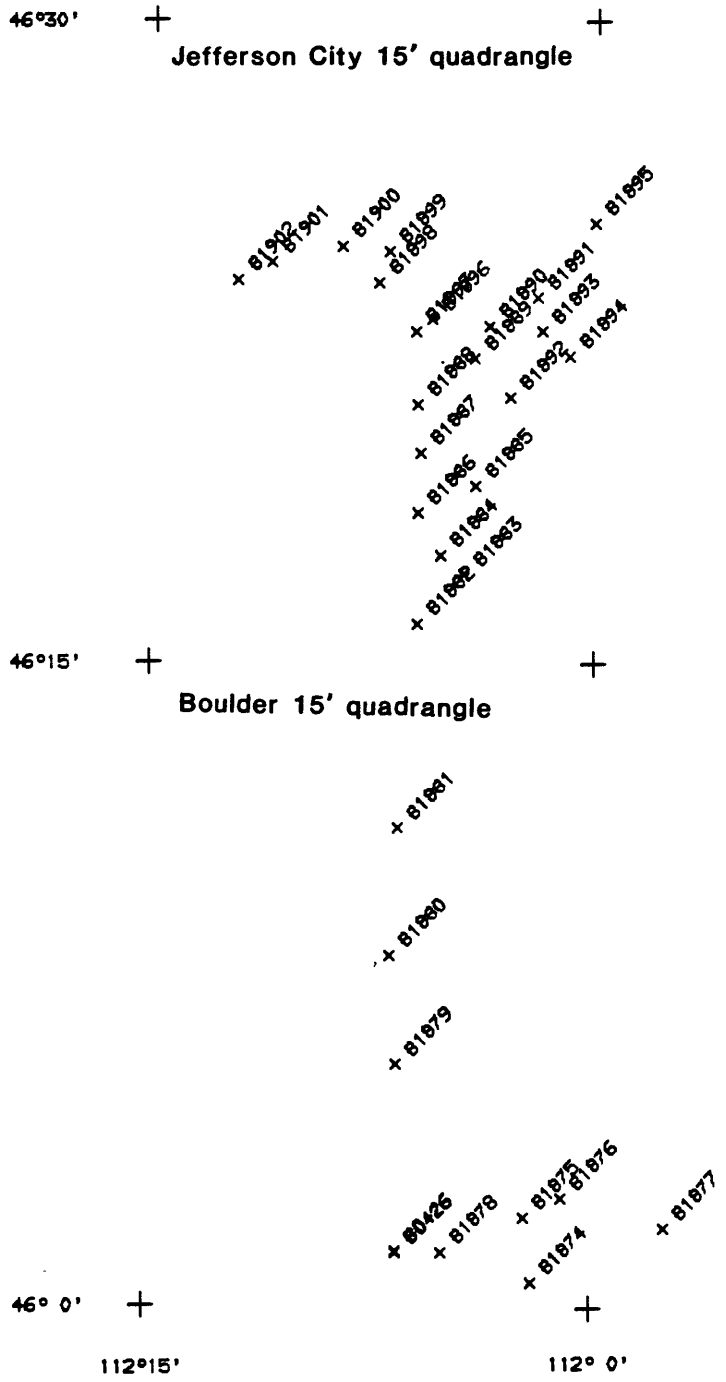


Figure 2.--Location of gravity data listed in Table 2.

Table 2.--Principal facts of gravity stations in the Boulder and Jefferson City quadrangles, Montana.

BOUGUER GRAVITY DATA

Gravity data for the SE corner of the Butte 1 x 2 quad

Meter ID: g-2

STATION IDENTIFICATION		LOCATIONS						GRAVITY		CORRECTIONS				ANOMALIES			
		LATITUDE		LONGITUDE		ELEV	ST	OBSERVED	THEORETICAL	TERRAIN		BOUGUER	CURV	FREE	COMPLETE-BOUGUER		ELEV
proj	sta-id	deg	min	deg	min	(in ft)				a-g	h-x			AIR	d1=2.67	d2=2.45	CODE
butte	:B0426	46	1.29	-112	6.50	4794.0	MT	980245.72	980711.49	0.04	2.29	-163.51	-1.38	-15.08	-177.65	-164.25	B
butte	: B1874	46	0.60	-112	1.97	7184.0	MT	980114.28	980710.45	1.23	5.29	-245.03	-1.51	79.09	-160.93	-141.15	F
butte	: B1875	46	2.11	-112	2.24	7606.0	MT	980087.25	980712.73	1.77	8.13	-259.42	-1.50	89.43	-161.58	-140.90	F
butte	: B1876	46	2.55	-112	0.95	7060.0	MT	980123.68	980713.39	0.35	4.39	-240.80	-1.51	73.90	-163.67	-144.09	C
butte	: B1877	46	1.86	-111	57.52	5280.0	MT	980220.35	980712.35	0.58	1.95	-180.09	-1.44	4.36	-174.63	-159.88	C
butte	:B0426	46	1.27	-112	6.50	4794.0	MT	980245.72	980711.46	0.27	2.59	-163.51	-1.38	-15.05	-177.09	-163.73	B
butte	: B1878	46	1.28	-112	4.98	5080.0	MT	980229.07	980711.48	0.37	3.05	-173.26	-1.42	-4.84	-176.10	-161.99	C
butte	: B1879	46	5.65	-112	6.55	5230.0	MT	980220.72	980718.06	0.70	3.19	-178.38	-1.44	-5.68	-181.61	-167.11	C
butte	: B1880	46	8.19	-112	6.81	5519.0	MT	980202.10	980721.90	0.22	2.05	-188.24	-1.46	-0.98	-188.41	-172.96	B
butte	: B1881	46	11.13	-112	6.54	5149.0	MT	980224.21	980726.33	0.61	1.58	-175.62	-1.43	-18.07	-192.92	-178.51	B
butte	: B1882	46	15.90	-112	5.95	4891.0	MT	980240.60	980733.52	0.29	1.57	-166.82	-1.40	-33.11	-199.46	-185.76	F
butte	: B1883	46	17.05	-112	4.40	4950.0	MT	980239.79	980735.25	0.20	1.83	-168.83	-1.40	-30.11	-198.32	-184.46	C
butte	: B1884	46	17.50	-112	5.21	4990.0	MT	980237.37	980735.93	0.06	1.65	-170.19	-1.41	-29.45	-199.35	-185.35	C
butte	: B1885	46	19.12	-112	4.07	5840.0	MT	980189.55	980738.37	0.68	1.32	-199.19	-1.49	0.16	-198.51	-182.14	C
butte	: B1886	46	18.49	-112	5.97	5212.0	MT	980223.71	980737.42	0.12	1.68	-177.77	-1.43	-23.74	-201.14	-186.52	B
butte	: B1887	46	19.89	-112	5.90	6060.0	MT	980175.18	980739.53	1.00	1.68	-206.69	-1.50	5.30	-200.21	-183.27	C
butte	: B1888	46	21.04	-112	6.02	5165.0	MT	980228.11	980741.27	0.52	2.07	-176.16	-1.43	-27.60	-202.61	-188.19	B
butte	: B1889	46	22.12	-112	4.11	4860.0	MT	980246.21	980742.89	1.30	2.09	-165.76	-1.39	-39.79	-203.55	-190.06	C
butte	: B1890	46	22.85	-112	3.63	4769.0	MT	980255.39	980743.99	0.46	2.08	-162.66	-1.38	-40.26	-201.76	-188.46	B
butte	: B1891	46	23.52	-112	1.98	4714.0	MT	980261.53	980745.00	0.19	1.74	-160.78	-1.37	-40.30	-200.52	-187.32	B
butte	: B1892	46	21.20	-112	2.88	4891.0	MT	980244.99	980741.51	1.22	2.54	-166.82	-1.40	-36.71	-201.17	-187.62	F
butte	: B1893	46	22.75	-112	1.83	4596.0	MT	980265.58	980743.84	0.50	2.52	-156.76	-1.36	-46.19	-201.28	-188.50	F
butte	: B1894	46	22.18	-112	0.90	4757.0	MT	980255.82	980742.98	0.52	2.80	-162.25	-1.38	-39.95	-200.26	-187.05	B
butte	: B1895	46	25.27	-112	0.03	4430.0	MT	980284.53	980747.64	0.28	2.06	-151.09	-1.33	-46.63	-196.72	-184.35	C
butte	: B1896	46	23.01	-112	5.54	5310.0	MT	980223.55	980744.23	1.37	1.36	-181.11	-1.44	-21.51	-201.33	-186.51	C
butte	: B1897	46	22.75	-112	6.12	5730.0	MT	980196.25	980743.84	0.94	1.33	-195.43	-1.48	-8.95	-203.59	-187.55	C
butte	: B1898	46	23.87	-112	7.37	5444.0	MT	980215.17	980745.53	0.90	1.89	-185.68	-1.46	-18.59	-202.93	-187.75	B
butte	: B1899	46	24.57	-112	7.03	5070.0	MT	980239.71	980746.59	1.16	2.64	-172.92	-1.42	-30.25	-200.79	-186.74	C
butte	: B1900	46	24.69	-112	8.62	5690.0	MT	980205.16	980746.77	1.21	2.18	-194.07	-1.48	-6.72	-198.88	-183.05	C
butte	: B1901	46	24.34	-112	10.97	6470.0	MT	980155.97	980746.23	2.14	2.37	-220.67	-1.51	17.91	-199.77	-181.83	C
butte	: B1902	46	23.90	-112	12.11	7220.0	MT	980111.96	980745.58	0.31	2.71	-246.25	-1.51	45.02	-199.72	-179.56	C
butte	:B0426	46	1.29	-112	6.50	4794.0	MT	980245.72	980711.49	0.04	2.29	-163.51	-1.38	-15.08	-177.65	-164.25	B

Appendix

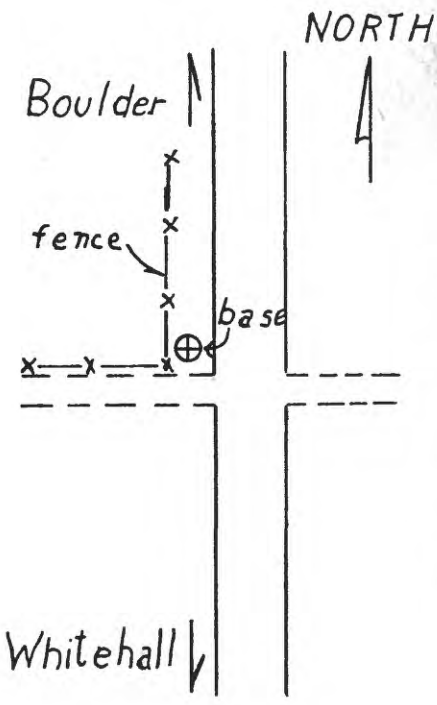
U.S. GEOLOGICAL SURVEY
GRAVITY BASE STATION

STATE/COUNTRY	STATION DESIGNATION	OBSERVED GRAVITY
Montana	B0426	980,245.71 mGals
NEAREST TOWN	LONGITUDE	LATITUDE
Whitehall	112° 6.50'	46° 1.29'
ELEVATION	TOPOGRAPHIC MAP(S)	
1461.2 m 4794 ft	Boulder 15 minute quadrangle	

DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
June 1980	J. Hassemer	G-2	Butte (ACIC code no. 0443-0)	980,159.88 mGals
June 1981	J. Hassemer	G-2	Fair (Hassemer, 1984)	980,189.30 mGals
1981	H. Kaufmann (as station BDQ02)	G-159	DQ0B7 (Kaufmann and others, 1983)	980,153.15 mGals

DESCRIPTION/SKETCH

Meter is read with a 9 inch diameter base plate on the concrete post for U.S Geological Survey bench mark 6WMM, on west side of road between Whitehall and Boulder, 10.2 miles north of I-90 at Whitehall.



Looking north