

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Principal Facts for Gravity Stations in the Vicinity of
Creede, Mineral County, Colorado

by

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DATA COLLECTION

A gravity survey was made in the vicinity of Creede, Colorado (fig. 1) in September, 1985. Gravity observations were made using LaCoste and Romberg gravity meters G-24 and G-551. The gravity stations were referenced to the U.S. Department of Defense (Defense Mapping Agency, 1974) base at Alamosa, Colorado (Appendix A). Gravity loops were started and closed daily by making repeat observations at a secondary base in Creede (Appendix B). Access to the survey area was by secondary roads, jeep trails and helicopter.

ELEVATION CONTROL

The survey area is bounded by latitudes $37^{\circ}40'00''$ - $38^{\circ}05'00''$ N and longitudes $106^{\circ}45'00''$ - $107^{\circ}10'00''$ W. One hundred twenty stations were obtained from spot elevations and benchmarks. The greatest elevation uncertainty occurs at spot elevations, where the uncertainty is one-half the contour interval; thus on a map with 40-ft contour intervals, the maximum Bouguer and free-air correction error would be 1.2 mgals.

DATA REDUCTION

Computer programs existing on the USGS Branch of Geophysics Digital Equipment Corporation VAX 11 750 computer system were used to obtain principal facts and terrain-corrected gravity values. A program written by M. W. Webring (USGS, 1984, unpub. program) was used to reduce gravimeter readings to observed gravity values by calculating and correcting for sun and moon-tides and linear meter drift. The theoretical gravity value was calculated using the 1967 formula of the Geodetic Reference System (International Association of Geodesy, 1971). Terrain corrections were computed using a program by R. H. Godson (USGS, 1978, unpub. program) correcting for the gravity effects of terrain from each station to a radius of 166.7 km using the method of Plouff (1977). Godson's program also calculates earth curvature corrections and complete (terrain corrected) Bouguer gravity anomaly values. For a complete description of gravity reduction equations and approximations used by the Branch of Geophysics see Cordell and others (1982). These computed terrain corrections use mean elevation digital data on a 15-second grid for corrections from 0.59 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. Terrain located less than 0.59 km from a station may not be corrected for by the above procedure due to the coarseness of the terrain model. Stations with a prefix of "CR" were corrected for terrain using topographic maps digitized along contour lines supplemented with field measurements (M. W. Webring, USGS unpub. prog.). The method uses 2000 sloping topped cylindrical segments as the terrain model starting at the station and extending to .895 km (Hammer zone F), accuracy is about .2 mGal. A density of 2.67 g/cm^3 was used to calculate terrain corrections, giving one complete Bouguer gravity anomaly value per station. The second complete Bouguer gravity anomaly value was calculated by using a reduction density of 2.45 g/cm^3 . The corrections and gravity anomaly values are listed in table 1.

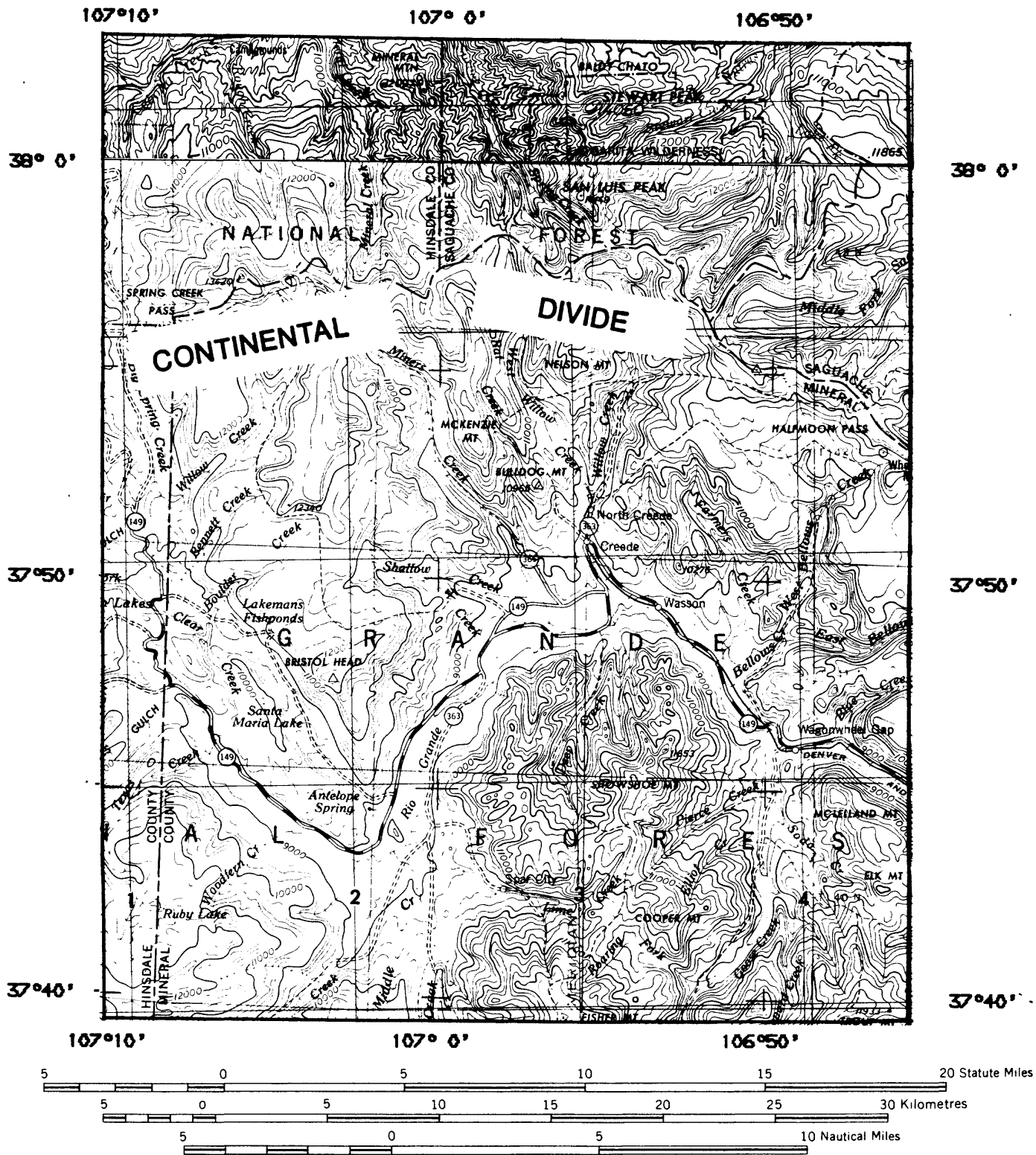


Figure 1.
 Location Map. Extracted from Durango, Colorado
 • 2° topographic map, scale 1:250,000.

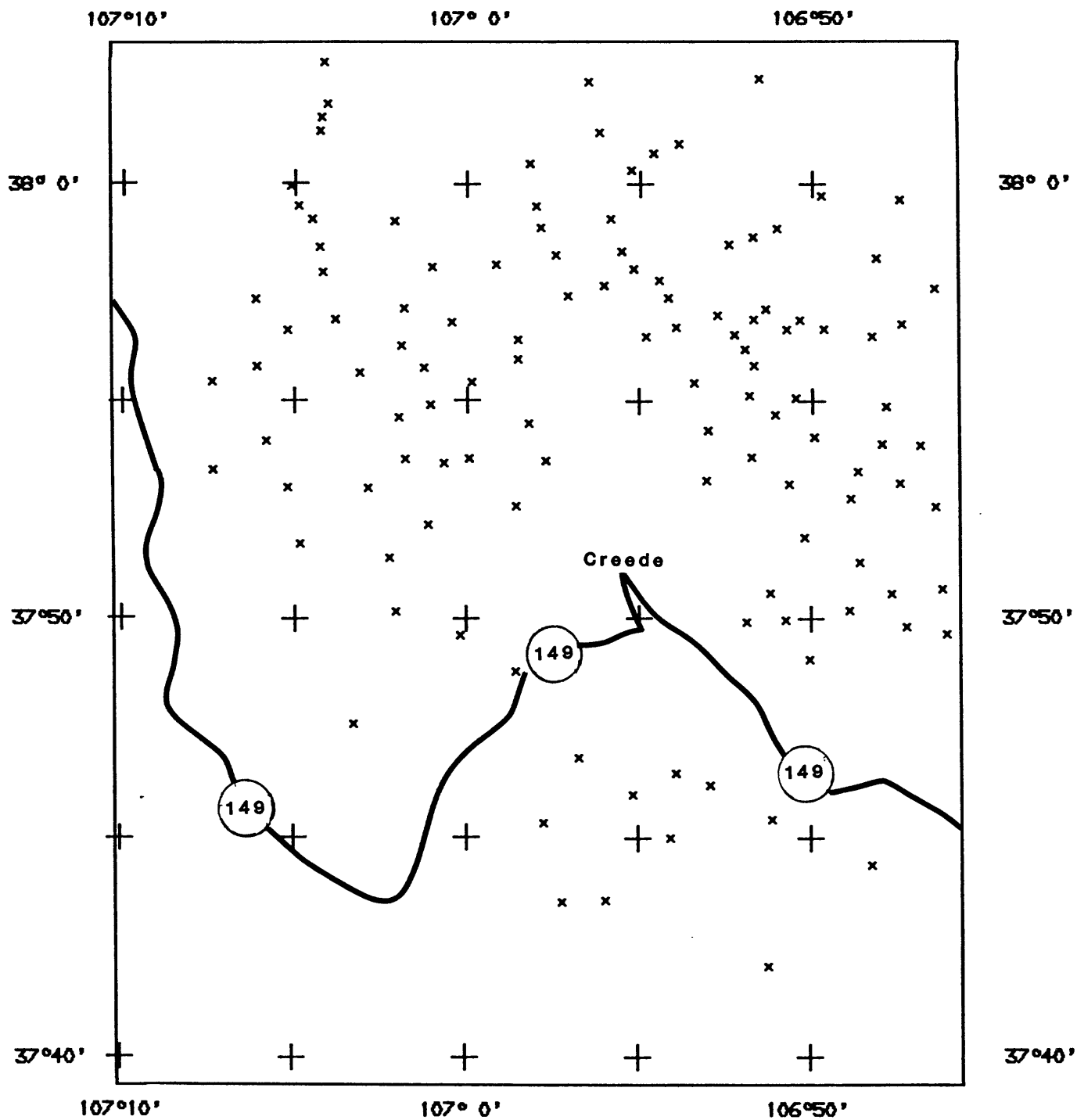


Figure 2. Location of Gravity Stations. Refer to Figure 1.

Table 1: Principal Facts of Gravity Data

Explanation of headings

Identification

proj	Not used
sta-id	Gravity station identification number

Locations

latitude	North latitude in degrees, decimal minutes
longitude	West longitude in degrees, decimal minutes
ele	Station elevation in meters
st	Not used

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 densities d1 and d2
spec fields	Not used

BOUGUER GRAVITY DATA

creede, colorado
gravity 2

STATION IDENTIFICATION proj sta-id	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		SPEC FIELDS
	LATITUDE deg	LONGITUDE deg min	ELE (in mt)	ST	OBSERVED	THEORETICAL	TERRAIN BOUGUER CURV (d1=2.67)	SPECIAL	FREE AIR	COMPLETE-BOUGUER d1=2.67 d2=2.45	
:5078	37 49.67	106 46.07	3451.56		978982.03	979977.01	7.41 -386.23 -0.85	0.00	69.33	-310.33 -279.05	
:5077	37 50.67	106 46.21	3449.73		978986.55	979978.47	4.27 -386.02 -0.85	0.00	71.82	-310.78 -279.25	
:5017	37 52.58	106 46.40	3710.33		978926.99	979981.26	13.33 -415.19 -0.57	0.00	89.77	-312.66 -279.50	
:cr13d	37 57.60	106 46.45	3135.48		979065.74	979988.59	11.86 -350.86 -1.12	0.00	44.06	-296.06 -268.03	
:5016	37 53.97	106 46.83	3878.58		978897.59	979983.29	15.85 -434.01 -0.37	0.00	110.17	-308.36 -273.88	
:5079	37 49.82	106 47.23	3515.87		978959.69	979977.23	20.67 -393.43 -0.78	0.00	66.58	-306.95 -276.18	
:cr12	37 56.76	106 47.39	3218.99		979043.87	979987.36	21.10 -360.20 -1.05	0.00	49.15	-291.00 -262.98	
:5081	37 53.11	106 47.45	3496.97		978980.25	979982.03	4.94 -391.31 -0.80	0.00	76.52	-310.65 -278.75	
:5024	37 59.62	106 47.46	3414.37		979014.16	979991.55	6.95 -382.07 -0.88	0.00	75.46	-300.54 -269.56	
:5030	37 50.58	106 47.70	3549.40		978954.14	979978.34	16.59 -397.18 -0.75	0.00	70.26	-311.08 -279.66	
:5018	37 54.85	106 47.86	3923.08		978893.09	979984.57	17.27 -438.99 -0.31	0.00	118.09	-303.94 -269.16	
:5015	37 54.02	106 47.97	3623.77		978954.32	979983.36	6.25 -405.50 -0.67	0.00	92.33	-307.59 -274.64	
:5023	37 58.28	106 48.16	3763.37		978932.99	979989.59	12.31 -421.12 -0.51	0.00	103.78	-305.54 -271.82	
:5083	37 44.40	106 48.23	3195.83		979025.03	979969.32	16.69 -357.61 -1.07	0.00	41.23	-300.77 -272.59	
:cr11	37 56.47	106 48.28	3309.21		979026.41	979986.94	11.29 -370.30 -0.98	0.00	59.91	-300.07 -270.41	
:5076	37 51.27	106 48.60	2897.12		979084.53	979979.34	13.79 -324.19 -1.28	0.00	-1.35	-313.03 -287.35	
:5013	37 53.39	106 48.68	3384.19		979003.76	979982.44	3.70 -378.69 -0.91	0.00	64.87	-311.03 -280.06	
:5075	37 50.19	106 48.87	2749.91		979112.61	979977.77	11.91 -307.71 -1.36	0.00	-17.07	-314.23 -289.74	
:5080	37 52.77	106 48.89	3388.16		979000.48	979981.53	3.97 -379.14 -0.91	0.00	63.72	-312.35 -281.37	
:cr10	37 56.62	106 49.66	3565.86		978974.17	979987.16	5.51 -399.02 -0.73	0.00	86.54	-307.70 -275.22	
:cr20	37 59.74	106 49.72	3197.66		979048.91	979991.72	9.22 -357.82 -1.07	0.00	43.26	-306.41 -277.60	
:5010	37 54.17	106 49.92	3590.54		978976.39	979983.58	5.37 -401.78 -0.70	0.00	99.94	-297.18 -264.46	
:5025	37 49.08	106 50.03	2966.62		979072.92	979976.15	9.85 -331.96 -1.23	0.00	11.65	-311.70 -285.05	
:5026	37 51.85	106 50.21	3471.67		978975.44	979980.19	7.04 -388.48 -0.83	0.00	65.75	-316.51 -285.01	
:cr09	37 56.85	106 50.35	3697.22		978945.51	979987.49	8.05 -413.72 -0.59	0.00	98.01	-308.25 -274.77	
:5009	37 55.06	106 50.44	4181.55		978826.18	979984.88	34.53 -467.92 0.05	0.00	130.48	-302.85 -267.15	
:5012	37 53.09	106 50.67	3488.13		978980.65	979982.00	4.20 -390.32 -0.81	0.00	74.22	-312.71 -280.83	
:cr08	37 56.64	106 50.73	3640.23		978958.87	979987.19	6.48 -407.34 -0.65	0.00	94.11	-307.40 -274.31	
:5029	37 49.97	106 50.75	2830.68		979103.81	979977.45	6.10 -316.75 -1.31	0.00	-0.65	-312.62 -286.91	
:cr19	37 59.00	106 51.02	3261.36		979032.32	979990.64	7.27 -364.95 -1.02	0.00	47.38	-311.31 -281.76	
:5031	37 54.66	106 51.04	3719.17		978935.35	979984.30	6.83 -416.18 -0.56	0.00	97.81	-312.10 -278.32	
:5058	37 45.43	106 51.13	2846.83		979102.29	979970.82	4.46 -318.56 -1.31	0.00	9.43	-305.97 -279.99	
:5027	37 50.58	106 51.19	2788.01		979110.06	979978.34	8.48 -311.98 -1.34	0.00	-8.44	-313.28 -288.16	
:5056	37 42.08	106 51.21	3255.57		979005.22	979965.93	14.47 -364.30 -1.02	0.00	43.21	-307.64 -278.73	
:cr07	37 57.12	106 51.33	4023.66		978868.94	979987.89	26.14 -450.25 -0.17	0.00	121.60	-302.68 -267.72	
:cr26	38 2.40	106 51.54	3408.27		979010.92	979995.61	3.10 -381.39 -0.89	0.00	66.28	-312.89 -281.65	
:5008	37 55.81	106 51.69	4140.10		978841.55	979985.98	32.19 -463.28 -0.01	0.00	131.99	-299.11 -263.59	
:cr06	37 56.85	106 51.70	3968.50		978883.53	979987.49	19.48 -444.08 -0.25	0.00	119.60	-305.25 -270.24	
:cr18	37 58.78	106 51.71	3325.98		979017.87	979990.31	7.52 -372.18 -0.96	0.00	53.17	-312.45 -282.33	
:5011	37 53.69	106 51.76	3538.42		978969.05	979982.88	4.56 -395.95 -0.76	0.00	77.24	-314.91 -282.60	

BOUGUER GRAVITY DATA

STATION IDENTIFICATION proj sta-ld	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	
	LATITUDE deg min	LONGITUDE deg min	ST OBSERVED	THEORETICAL	TERRAIN BOUGUER CURV (dl=2.67)	SPECIAL	FREE AIR	COMPLETE-BOUGUER SPEC dl=2.67 dl=2.45 FIELDS
:5032	37 55.11	106 51.82	3760.62	978924.39	979984.95	0.00	98.96	-311.82 -277.98
:5033	37 49.91	106 51.95	2741.07	979123.66	979977.36	0.00	-8.34	-311.64 -286.65
:5038	37 56.17	106 51.94	4235.20	978815.11	979986.50	0.00	134.32	-295.08 -259.70
:cr05	37 56.50	106 52.27	4153.81	978836.03	979986.98	0.00	129.69	-299.92 -264.53
:cr17	37 58.62	106 52.40	3384.19	979006.81	979990.08	0.00	60.28	-310.91 -280.32
:5022	37 56.97	106 52.74	4112.06	978843.98	979987.67	0.00	124.08	-306.64 -271.15
:5041	37 46.20	106 52.92	3463.75	978975.62	979971.95	0.00	71.74	-304.77 -273.75
:5006	37 54.31	106 53.02	3563.11	978959.62	979983.78	0.00	74.51	-317.41 -285.12
:5005	37 53.19	106 53.03	3569.82	978954.53	979982.15	0.00	73.13	-318.81 -286.52
:5004	37 55.39	106 53.41	3460.39	978985.03	979985.36	0.00	66.70	-315.06 -283.60
:cr25	38 0.91	106 53.88	3868.22	978905.40	979993.43	0.00	104.64	-314.54 -280.00
:5042	37 46.49	106 53.92	3361.33	978998.40	979972.37	0.00	62.54	-303.05 -272.93
:5034	37 56.66	106 53.94	3297.94	979015.78	979987.22	0.00	45.54	-313.27 -283.71
:5037	37 44.98	106 54.04	3659.73	978936.16	979970.16	0.00	94.89	-301.55 -268.88
:5014	37 57.35	106 54.19	3785.31	978917.27	979988.23	0.00	96.18	-312.48 -278.81
:5020	37 57.78	106 54.43	3963.31	978876.35	979988.85	0.00	109.46	-310.91 -276.27
:cr24	38 0.68	106 54.60	4018.18	978869.57	979993.09	0.00	115.34	-319.38 -283.56
:5001	37 56.46	106 54.80	3725.88	978927.67	979986.92	0.00	89.57	-320.04 -286.29
:5059	37 45.98	106 55.17	3252.22	979026.20	979971.63	0.00	57.47	-300.81 -271.29
:5021	37 58.03	106 55.17	4008.12	978867.87	979989.22	0.00	114.41	-314.18 -278.87
:cr14	37 58.05	106 55.18	4009.64	978862.95	979989.25	0.00	109.93	-318.87 -283.54
:cr23	38 0.32	106 55.26	4175.15	978829.90	979992.57	0.00	124.54	-321.89 -285.10
:cr15	37 58.45	106 55.52	3893.82	978898.96	979989.84	0.00	109.68	-312.97 -278.14
:cr16a	37 59.19	106 55.86	4271.47	978804.29	979990.91	0.00	130.25	-313.61 -277.03
:5038	37 43.59	106 55.96	3432.96	978988.03	979968.13	0.00	78.48	-301.77 -270.44
:5002	37 57.64	106 56.04	3942.59	978882.07	979988.65	0.00	109.00	-322.46 -286.91
:cr22	38 1.14	106 56.17	4204.72	978821.88	979993.77	0.00	124.43	-319.71 -283.11
:cr21	38 2.32	106 56.49	4084.62	978851.54	979995.49	0.00	115.37	-319.11 -283.31
:5036	37 46.82	106 56.72	3261.06	979023.96	979972.84	0.00	56.73	-297.59 -269.40
:5003	37 57.42	106 57.06	4005.38	978862.63	979988.33	0.00	109.22	-323.20 -287.57
:5039	37 43.51	106 57.18	3519.53	978968.18	979968.02	0.00	85.42	-300.26 -268.48
:cr01	37 58.37	106 57.44	3837.74	978905.13	979989.72	0.00	98.69	-317.16 -282.89
:5035	37 53.61	106 57.70	3552.44	978947.05	979982.76	0.00	59.68	-326.31 -294.51
:5040	37 45.33	106 57.73	3433.88	978987.09	979970.67	0.00	75.29	-300.98 -269.98
:cr02	37 59.03	106 57.88	3833.16	978903.71	979990.68	0.00	94.90	-312.57 -279.00
:cr03	37 59.48	106 58.00	3693.57	978936.94	979991.34	0.00	84.47	-317.72 -284.58
:5067	37 54.49	106 58.19	3620.72	978938.39	979984.05	0.00	70.77	-326.83 -294.07
:cr04	38 0.47	106 58.22	3097.68	979057.05	979992.79	0.00	19.52	-310.99 -283.75
:5068	37 55.96	106 58.51	3738.07	978919.82	979986.20	0.00	86.20	-320.92 -287.37
:5069	37 56.41	106 58.55	3820.36	978902.89	979986.85	0.00	93.97	-319.37 -285.31

BOUGUER GRAVITY DATA

creede, Colorado
gravity 2

STATION IDENTIFICATION proj sta-id	L O C LATITUDE deg min	A T I O N S LONGITUDE deg min	G R A V I T Y ST OBSERVED THEORETICAL	TERRAIN BOUGUER CURV (d1=2.67)	C O R R E C T I O N S SPECIAL	F R E E A I R	A N O M A L I E S COMPLETE-BOUGUER SPEC d1=2.67 d2=2.45 FIELDS
:ant19000	37 48.82	106 58.57	2650.54	979138.31	979975.77	6.24 -296.60 -1.40	0.00
:5072	37 52.58	106 58.59	3422.29	978978.29	979981.26	12.95 -382.95 -0.87	0.00
:5070	37 58.16	106 59.18	3996.23	978870.27	979989.41	20.99 -447.18 -0.21	0.00
:5052	37 55.41	106 59.85	3803.29	978896.06	979985.39	16.50 -425.59 -0.46	0.00
:5071	37 53.68	106 59.92	3294.89	979010.56	979982.87	6.41 -368.70 -0.99	0.00
:5073	37 49.63	107 0.19	3072.69	979058.35	979976.95	7.40 -343.83 -1.16	0.00
:5051	37 56.80	107 0.47	3972.76	978865.41	979987.42	15.91 -444.55 -0.24	0.00
:5055	37 53.57	107 0.68	3193.39	979033.39	979982.70	5.74 -357.34 -1.07	0.00
:5066	37 58.10	107 1.05	3556.41	978969.67	979989.32	4.80 -397.96 -0.74	0.00
:5054	37 54.90	107 1.09	3222.65	979025.83	979984.65	7.88 -360.61 -1.05	0.00
:5047	37 52.15	107 1.14	3645.71	978932.85	979980.63	14.68 -407.95 -0.64	0.00
:5090	37 55.77	107 1.26	3441.19	978979.44	979985.91	6.55 -385.07 -0.86	0.00
:5091	37 53.67	107 1.80	3631.08	978939.97	979982.85	8.59 -406.32 -0.66	0.00
:5053	37 57.14	107 1.83	3947.77	978872.18	979987.92	15.71 -441.76 -0.28	0.00
:5050	37 56.26	107 1.90	3817.32	978899.09	979986.63	15.68 -427.16 -0.44	0.00
:5049	37 54.63	107 1.96	3741.42	978912.19	979984.25	17.08 -418.66 -0.53	0.00
:5044	37 50.15	107 2.06	3265.63	979012.34	979977.71	7.48 -365.42 -1.01	0.00
:5065	37 59.15	107 2.12	3158.64	979048.66	979990.86	11.68 -353.45 -1.10	0.00
:5045	37 51.37	107 2.24	3471.06	978975.81	979979.49	4.43 -388.41 -0.83	0.00
:5060	37 53.00	107 2.85	3667.05	978936.13	979981.87	6.20 -410.34 -0.62	0.00
:5089	37 55.62	107 3.11	3738.37	978918.74	979985.70	7.33 -418.32 -0.54	0.00
:5043	37 47.60	107 3.26	3872.79	978859.28	979973.98	33.67 -433.37 -0.37	0.00
:5064	37 56.86	107 3.84	3628.64	978944.27	979987.51	7.85 -406.04 -0.66	0.00
:cr35	38 1.80	107 4.08	3159.25	979046.05	979994.73	4.24 -353.52 -1.10	0.00
:cr36	38 2.76	107 4.17	3088.54	979060.26	979996.13	7.99 -345.61 -1.15	0.00
:cr27	37 57.98	107 4.20	4117.85	978828.92	979989.15	24.21 -460.79 -0.04	0.00
:cr34	38 1.49	107 4.24	3165.04	979043.86	979994.28	4.32 -354.17 -1.10	0.00
:cr33	38 1.19	107 4.28	3422.90	978989.10	979993.84	12.26 -383.02 -0.87	0.00
:cr28	37 58.55	107 4.29	4073.04	978840.90	979989.98	24.48 -455.77 -0.10	0.00
:cr30	37 59.18	107 4.53	3809.09	978915.14	979990.90	11.42 -426.24 -0.45	0.00
:5048	37 51.70	107 4.83	3751.78	978900.87	979979.97	11.90 -419.82 -0.52	0.00
:cr31	37 59.50	107 4.91	3662.17	978934.62	979991.37	9.67 -409.80 -0.63	0.00
:cr32	37 59.93	107 5.13	3616.15	978947.38	979992.00	11.06 -404.65 -0.68	0.00
:5088	37 56.62	107 5.20	3849.93	978895.34	979987.16	8.13 -430.81 -0.40	0.00
:5084	37 53.00	107 5.21	3499.71	978963.81	979981.87	4.96 -391.62 -0.80	0.00
:5061	37 54.06	107 5.85	3698.75	978919.11	979983.42	8.28 -413.89 -0.58	0.00
:5063	37 55.79	107 6.13	3715.51	978925.12	979985.95	4.41 -415.77 -0.56	0.00
:5087	37 57.34	107 6.14	4079.14	978840.86	979988.21	18.72 -456.46 -0.10	0.00
:5085	37 53.39	107 7.40	3696.00	978912.19	979982.44	11.70 -413.58 -0.59	0.00
:5086	37 55.41	107 7.42	3644.49	978936.64	979985.39	5.25 -407.82 -0.65	0.00

REFERENCES CITED

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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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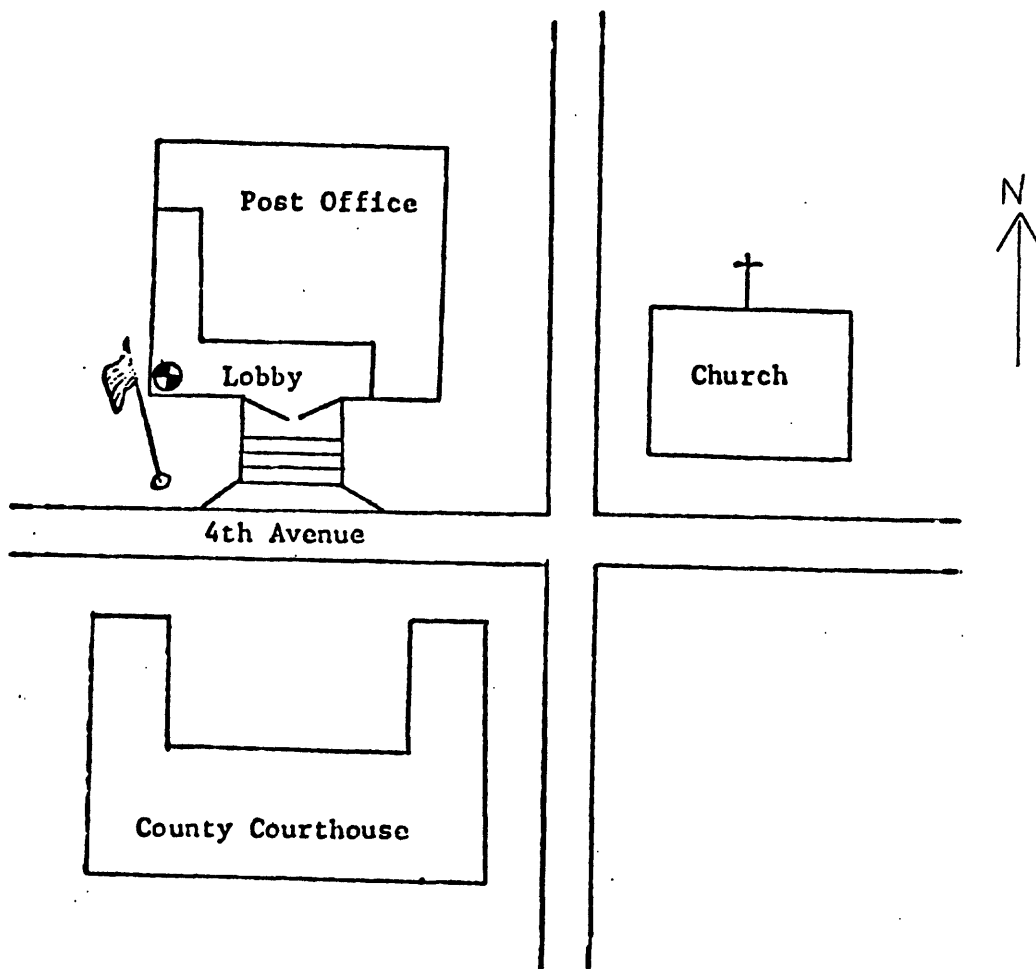
APPENDIX A

GRAVITY BASE STATION

LATITUDE		37° 28.21'N (1)		STATION DESIGNATION	
LONGITUDE		105° 52.16'W (1)		ALAMOSA	
ELEVATION		2300.9 METERS (1)		COUNTRY/STATE	
				USA/Colorado	
REFERENCE CODE NUMBERS				ADOPTED GRAVITY VALUE	
ACIC 4016-1				g = 979 234.98 mgals	
IGB 11975B					
				ESTIMATED ACCURACY	
				DATE	
				MONTH/YEAR	
				1971	

DESCRIPTION AND/OR SKETCH

The station is located at the Post Office in Alamosa, on the corner of San Juan Avenue and 4th Avenue, in the southwest corner of the Post Office lobby. It is marked with a USAF Gravity disc. (1)



(1)

REFERENCE SOURCE

9

(1) 03405

APPENDIX B

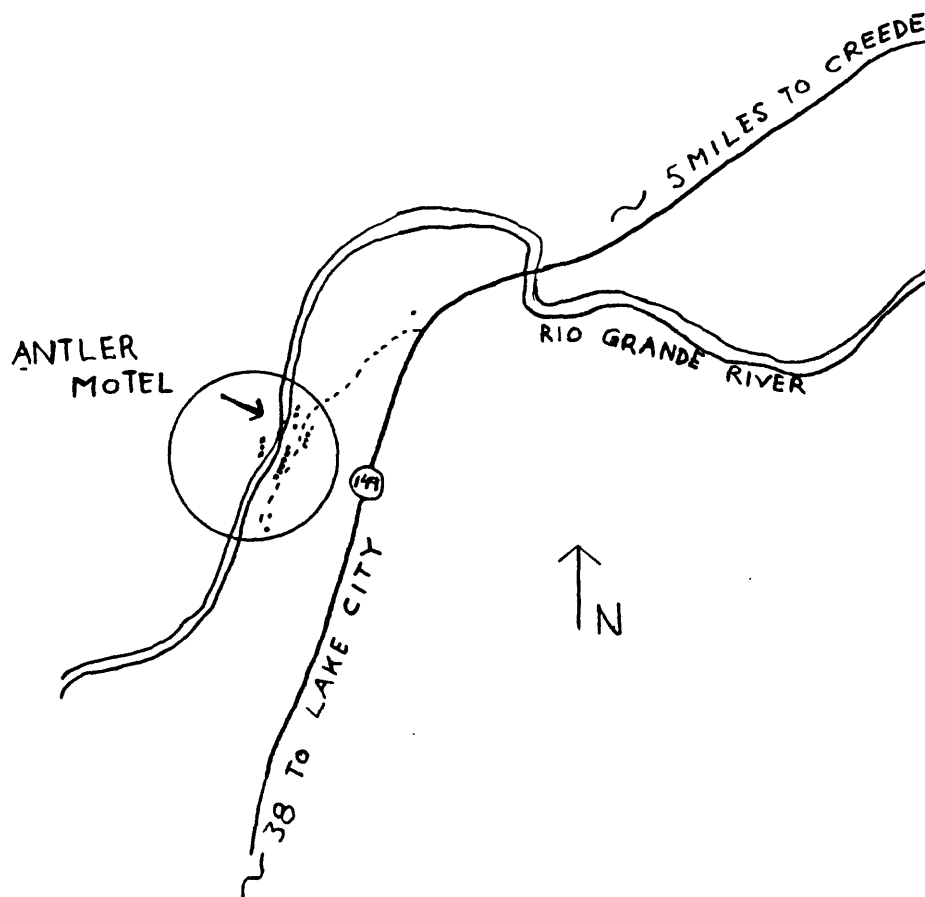
SECONDARY GRAVITY BASE STATION

LATITUDE		37°48.80'N	(1)	STATION DESIGNATION	
LONGITUDE		106°58.57'W	(1)	ANTLER MOTEL, Creede	
ELEVATION		2650.41	METERS (1)	COUNTRY/STATE	
				USA/Colorado	
REFERENCE CODE NUMBERS				ADOPTED GRAVITY VALUE	
				g = 979 138.31 mgals	
				ESTIMATED ACCURACY	
				DATE	
				MONTH/YEAR	
				9/85	
				± 0.1 mgals	

DESCRIPTION AND/OR SKETCH

The station is located on the northeast side of the suspension bridge cable at the Antler Motel.

(1)



REFERENCE SOURCE

10

(1)