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PRINCIPAL FACTS FOR GRAVITY STATIONS SM001-SM119
LOCATED IN AND AROUND THE SOUTHERN SACRAMENTO
MOUNTAINS NEAR NEEDLES, CALIFORNIA

By
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Open-File Report 96-0005

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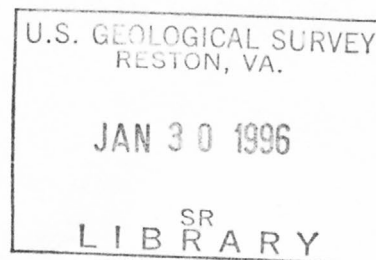


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PRINCIPAL FACTS FOR GRAVITY STATIONS SM001-SM119 LOCATED IN AND AROUND THE SOUTHERN SACRAMENTO MOUNTAINS NEAR NEEDLES, CALIFORNIA

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ABSTRACT

Contained in this report are the principal facts for 119 gravity stations in the southern end of the Sacramento Mountains near Needles in southeastern California. Gravity surveys were conducted during November of 1993 and March of 1994, as part of the author's doctoral dissertation. This report describes the base stations, gravity meter, and data collection procedure, as well as the reduction techniques and results.

INTRODUCTION

The gravity stations are located on the following 7.5 min. quadrangles: Monumental Pass, Needles SW, Stepladder Mtns. NE, and Whale Mountain. The locations are compiled in Figure 1. Interpretations of anomalies in this area can be found in Campbell and John (1994a,b).

DATA COLLECTION

The base station used in these surveys was station PB1203, latitude $34^{\circ} 51.52'$, longitude $114^{\circ} 52.15'$, on the north side of Interstate Highway 40 east of South Pass (Roberts and Jachens, 1986). The three base stations established in Needles were destroyed or inaccessible. One secondary base was established in the Sacramento Mountains near Lobeck's Pass and tied to the base station. Base station readings were taken at the beginning and end of each day and at noon if possible.

Most of the gravity stations were located at black spot elevations on U.S.G.S. topographic maps. Where benchmarks or survey markers were available, stations were located on or beside the markers. Where no elevations were available, two altimeters were used to estimate the elevation. Table 1 lists the elevation accuracy and effect on the gravity measurement for each station.

LaCoste and Romberg gravity meter G17C was used for all measurements.

DATA REDUCTION

The base station reading was adjusted according to the calibration factor of meter G17C. Calibration of the of the gravity meter is based on the calibration constant established by LaCoste and Romberg and the secondary calibration factor determined by the U.S.G.S. The base datum is the International Gravity Standardization Network of 1971 (Morelli, 1974). Tide corrections were also made to base station readings.

The gravity data were reduced to free-air gravity anomalies using standard formulas given in Telford and others (1976). Terrain corrections were made according to the Hayford-Bowie method. Inner zone (A and B) terrain corrections were estimated in the field; terrain corrections out to a radius of 0.6 km from the station were estimated using templates over 1:24,000 scale topographic maps. From 0.6 km out to a radial

distance of 166.7 km, terrain corrections for each station were calculated using digitized elevations and a program by D. Plouff (1977).

Bouguer anomalies were calculated using the 1967 Geodetic Reference System formula for theoretical gravity at sea level (International Association of Geodesy, 1971) with a standard reduction density of 2.67 g/cm^3 .

The Airy isostatic anomaly was computed using a program written by Robert Simpson and others (1983) with a sea level crustal thickness of 25 km, a surface load density of 2.67 g/cm^3 , and a density contrast at depth of 0.4 g/cm^3 .

All data reduction was performed at the U.S.G.S. Geophysics Branch in Menlo Park, California.

DATA ACCURACY

Assuming that operator and mechanical error is negligible, systematic error in observed gravity measurements relative to IGSN 71 is estimated to be at most $\pm 1 \text{ mGal}$; the largest amount of meter drift was 0.06 mGal . Imprecision due to inaccuracy in elevation (see tables 1 and 3) causes from $\pm 0.2 \text{ mGals}$ (stations beside bench marks) to $\pm 1.2 \text{ mGal}$ (altimetry). Forty-one percent of station elevations were determined with altimeters. All stations were located in the field on 1:24,000 maps to within at least 0.10 inches and later digitized; the latitudinal accuracy for location of that quality is $\pm 0.05 \text{ mGal}$. Terrain correction accuracy is within 30% for inner zone (A and B) corrections, and within 10% for outer zone corrections. The overall precision of the complete Bouguer anomalies is $\pm 2 \text{ mGal}$, though areas with high inner zone terrain corrections may have errors as large as $\pm 5 \text{ mGal}$.

ACKNOWLEDGEMENTS

This research was supported by the U.S.G.S. Volunteer Program and a graduate research grant from the Geological Society of America. The Branch of Geophysics, U.S.G.S. (Menlo Park) provided the use of their gravity meter and computers. Instruction in use of equipment and reduction of gravity data was provided by Victoria Langenheim and Robert Jachens, and is much appreciated. I also wish to thank Paul R. Stone for his capable field support.

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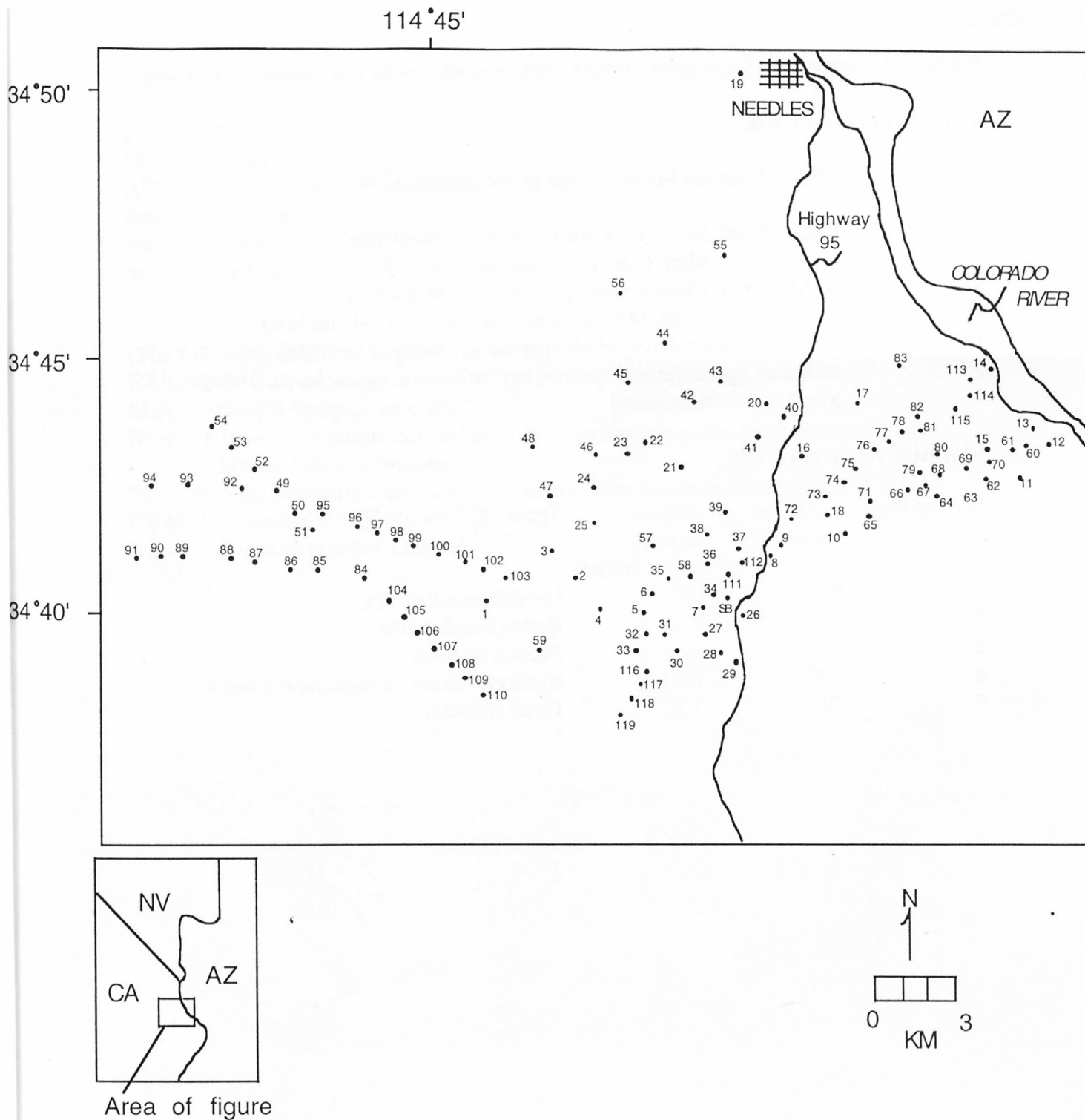


Figure 1. Location map for gravity stations SM001-SM119 (listed by number only). Base station PB1203 lies off the map. SB = secondary base station.

Table 1. Location Accuracy Codes Used in Table 3.

General Location Code

First Digit	Station Location Methods used in this survey
A	USGS Bench Mark (base plate directly on bench mark)
B	USGS Bench Mark (base plate near bench mark)
C	BLM Section Corners (base plate on or near marker)
D	USGS Topographic Map black spot elevations (field checked)
E	USGS Provisional Map black spot elevations (field checked)
F	Altimeter (good vertical control, two altimeters, closed loop), Topographic Map (horizontal control)

Elevation Accuracy Code

Second Digit	Elevation Accuracy (ft.)	Approx. Gravity Effect (mGal)	Types of Elevation Data
1	0.2	0.01	Leveled bench marks
2	0.3	0.02	Beside bench marks
3	1	0.06	Section markers
4	4	0.24	Black elevations on topographic maps
5	20	1.20	Good altimetry

Table 2. Explanation of Column Abbreviations Used in Table 3.

Elev. = Elevation
Obs. = Observed
ACC = Location and elevation accuracy code
deg. = degrees
min. = minutes
mGal = milligal

(The following columns list gravity in mGals)

FA = Free air anomaly
SBA = Simple Bouguer anomaly
Near = Inner zone terrain correction, field estimation plus calculated correction from Hayford-Bowie templates
TC = Near plus terrain correction out to 166.7 km computed from digitized data
CBA = Complete Bouguer anomaly
Iso = Isostatic residual anomaly

Table 3. 119 gravity stations in the southern Sacramento Mountains

Base datum IGSN-71

GRS 1967 formula for theoretical gravity

Bouguer reduction density of 2.67 g/cm³

Station	Latitude deg. min.	Longitude deg. min.	Elev. feet	Obs. mGal	ACC	FA	SBA	Near	TC	CBA	Iso
SM001	34 40.18	114 43.88	1984.0	979519.67	D4	1.38	-66.29	0.07	0.91	-66.14	0.96
SM002	34 40.62	114 41.69	2055.0	979528.94	C3	16.71	-53.38	0.43	0.81	-53.35	13.44
SM003	34 41.16	114 42.25	2265.0	979512.94	D4	19.70	-57.55	1.31	2.28	-56.12	11.05
SM004	34 40.00	114 41.12	2016.0	979530.42	D4	15.40	-53.36	1.04	1.35	-52.78	13.64
SM005	34 39.91	114 40.10	1980.0	979535.22	D4	16.93	-50.60	0.22	0.54	-50.81	15.41
SM006	34 40.31	114 39.80	1956.0	979539.50	D4	18.40	-48.32	0.48	0.85	-48.21	18.13
SM007	34 40.00	114 38.58	1827.0	979549.40	D4	16.60	-45.71	2.11	2.42	-44.00	22.01
SM008	34 41.18	114 36.88	1414.0	979583.29	A2	9.99	-38.24	0.05	0.59	-38.22	28.12
SM009	34 41.35	114 36.80	1380.0	979585.72	D4	8.98	-38.09	0.16	0.66	-37.99	28.41
SM010	34 41.47	114 35.09	1213.0	979592.75	D4	0.13	-41.24	0.13	0.84	-40.89	25.46
SM011	34 42.59	114 30.93	768.0	979609.70	D4	-26.35	-52.55	0.19	1.22	-51.65	15.47
SM012	34 43.23	114 30.17	554.0	979618.08	C3	-39.00	-57.90	0.16	0.71	-57.43	10.12
SM013	34 43.54	114 30.58	497.0	979622.02	D4	-42.55	-58.89	0.14	0.74	-58.36	9.27
SM014	34 44.65	114 31.59	488.0	979622.63	D4	-42.66	-59.31	0.04	0.37	-59.15	8.84
SM015	34 43.14	114 31.61	670.0	979613.41	D4	-32.64	-55.49	0.46	1.06	-54.71	12.56
SM016	34 43.06	114 36.13	1100.0	979602.15	D4	-3.33	-40.85	0.10	0.38	-40.92	26.10
SM017	34 44.05	114 34.79	915.0	979608.05	D4	-16.23	-47.44	0.95	1.22	-46.60	20.83
SM018	34 41.81	114 35.76	1238.0	979592.73	D4	1.98	-40.24	0.09	0.52	-40.22	26.28
SM019	34 50.43	114 37.67	629.0	979605.85	D4	-54.34	-75.80	0.03	0.29	-75.77	-5.21
SM020	34 44.06	114 36.99	1129.0	979593.67	D4	-10.50	-49.01	0.72	1.00	-48.47	19.06
SM021	34 42.79	114 39.04	1560.0	979569.09	D4	7.24	-45.96	0.76	1.27	-45.31	21.95
SM022	34 43.32	114 39.97	1604.0	979564.62	D4	6.17	-48.54	0.70	1.22	-47.95	19.71
SM023	34 43.10	114 40.37	1684.0	979558.35	D4	7.73	-49.71	0.96	1.48	-48.89	18.76
SM024	34 42.41	114 41.29	1904.0	979540.08	D4	11.13	-53.81	1.29	1.83	-52.72	14.82
SM025	34 41.75	114 41.23	2040.0	979532.48	D4	17.24	-52.33	0.88	1.47	-51.64	15.59
SM026	34 39.83	114 37.66	1661.0	979560.42	A2	12.24	-44.41	0.03	0.45	-44.61	21.23
SM027	34 39.42	114 38.55	1861.0	979546.98	D4	18.19	-45.28	0.47	0.79	-45.21	20.55
SM028	34 39.14	114 38.17	1955.0	979537.45	D4	17.90	-48.78	0.84	1.27	-48.26	17.35
SM029	34 38.97	114 37.84	1884.0	979542.64	D4	16.66	-47.60	0.30	0.66	-47.67	17.83
SM030	34 39.12	114 39.31	1976.0	979532.62	D4	15.08	-52.32	0.82	1.15	-51.92	13.80
SM031	34 39.49	114 39.57	2022.0	979531.13	D4	17.39	-51.57	0.77	1.19	-51.15	14.78
SM032	34 39.50	114 40.08	1973.0	979533.08	D4	14.72	-52.58	0.20	0.49	-52.84	13.18
SM033	34 39.11	114 40.22	2064.0	979523.69	D4	14.43	-55.97	0.84	1.26	-55.49	10.38
SM034	34 40.18	114 38.31	1693.0	979560.35	A2	14.69	-43.05	0.15	0.48	-43.23	22.83
SM035	34 40.58	114 39.44	1940.0	979543.56	D4	20.57	-45.60	0.31	0.75	-45.59	20.79
SM036	34 40.90	114 38.47	1750.0	979558.94	D4	17.63	-42.06	0.84	1.24	-41.50	24.89
SM037	34 41.27	114 37.70	1641.0	979567.64	D4	15.56	-40.41	0.73	1.15	-39.90	26.57
SM038	34 41.48	114 38.52	1577.0	979571.64	C3	13.24	-40.54	0.02	0.43	-40.73	25.92
SM039	34 41.89	114 38.07	1530.0	979574.66	D4	11.26	-40.92	0.31	0.70	-40.82	25.94
SM040	34 43.85	114 36.59	1091.0	979599.08	D4	-8.37	-45.58	0.35	0.61	-45.42	21.98
SM041	34 43.40	114 37.27	1137.0	979598.44	D4	-4.05	-42.83	0.13	0.42	-42.87	24.43
SM042	34 44.11	114 38.71	1255.0	979584.36	D4	-8.03	-50.84	0.06	0.36	-50.98	16.79
SM043	34 44.53	114 38.07	1148.0	979589.33	D4	-13.72	-52.87	0.10	0.37	-52.97	14.89
SM044	34 45.31	114 39.48	1208.0	979580.15	C3	-18.36	-59.56	0.13	0.47	-59.58	8.85
SM045	34 44.57	114 40.37	1363.0	979574.90	D4	-7.98	-54.47	0.28	0.83	-54.19	14.10

Table 3. (continued) 119 gravity stations in the southern Sacramento Mountains

Base datum IGSN-71

GRS 1967 formula for theoretical gravity

Bouguer reduction density of 2.67 g/cm³

Station	Latitude deg. min.	Longitude deg. min.	Elev. feet	Obs. mGal	ACC	FA	SBA	Near	TC	CBA	Iso
SM046	34 43.05	114 41.10	1780.0	979550.43	D4	8.91	-51.80	1.01	1.53	-50.96	16.81
SM047	34 42.28	114 42.26	1989.0	979532.89	D4	12.11	-55.73	1.30	1.77	-54.72	12.96
SM048	34 43.23	114 42.75	1778.0	979548.21	C3	6.25	-54.39	0.04	0.65	-54.43	13.81
SM049	34 42.48	114 48.91	2238.0	979501.60	A2	3.95	-72.38	0.06	0.38	-72.83	-3.15
SM050	34 42.01	114 48.41	2138.0	979508.58	D4	2.19	-70.73	0.02	0.31	-71.22	-1.95
SM051	34 41.70	114 48.01	2108.0	979510.56	A2	1.79	-70.11	0.02	0.29	-70.61	-1.63
SM052	34 42.93	114 49.48	2164.0	979504.53	D4	-0.71	-74.52	0.01	0.28	-75.05	-4.94
SM053	34 43.33	114 49.93	2137.0	979504.59	A2	-3.75	-76.64	0.02	0.26	-77.18	-6.70
SM054	34 43.99	114 50.68	2081.0	979508.83	A2	-5.71	-76.68	0.03	0.22	-77.25	-6.15
SM055	34 47.07	114 38.03	922.0	979596.09	D4	-31.79	-63.24	0.10	0.34	-63.28	5.67
SM056	34 46.31	114 40.55	1264.0	979579.07	D4	-15.58	-58.69	0.29	0.72	-58.48	10.59
SM057	34 41.26	114 39.82	2072.0	979538.05	D4	26.52	-44.15	1.58	2.49	-42.44	24.31
SM058	34 40.65	114 38.87	2020.0	979538.58	D4	23.02	-45.88	1.31	2.22	-44.42	21.89
SM059	34 39.21	114 42.65	2031.0	979514.67	D4	2.17	-67.10	1.74	2.13	-65.75	0.64
SM060	34 43.20	114 30.67	534.0	979620.80	F5	-38.13	-56.34	0.39	1.11	-55.46	11.97
SM061	34 43.12	114 31.09	660.0	979613.97	F5	-32.99	-55.50	0.20	0.78	-55.00	12.32
SM062	34 42.52	114 31.65	793.0	979608.62	F5	-24.98	-52.03	0.29	1.43	-50.93	16.04
SM063	34 42.36	114 32.31	893.0	979604.79	F5	-19.18	-49.64	0.14	1.25	-48.76	18.06
SM064	34 42.24	114 32.84	934.0	979603.87	F5	-16.07	-47.93	0.10	1.18	-47.14	19.56
SM065	34 41.78	114 34.58	1099.0	979598.04	F5	-5.73	-43.22	0.19	0.92	-42.75	23.73
SM066	34 42.38	114 33.61	921.0	979604.84	F5	-16.53	-47.94	0.03	0.75	-47.57	19.18
SM067	34 42.48	114 33.09	851.0	979606.85	F5	-21.24	-50.27	0.26	1.10	-49.52	17.28
SM068	34 42.58	114 32.71	787.0	979609.35	F5	-24.90	-51.74	0.23	1.16	-50.92	15.95
SM069	34 42.81	114 32.17	753.0	979608.98	F5	-28.79	-54.47	0.26	1.02	-53.77	13.27
SM070	34 42.87	114 31.56	738.0	979608.68	F5	-30.59	-55.76	0.11	0.83	-55.24	11.92
SM071	34 42.19	114 34.42	1005.0	979602.10	F5	-11.09	-45.37	0.06	0.67	-45.12	21.51
SM072	34 41.77	114 36.39	1297.0	979590.02	F5	4.89	-39.35	0.07	0.47	-39.41	27.11
SM073	34 42.27	114 35.52	1133.0	979600.05	F5	-1.22	-39.86	0.06	0.44	-39.89	26.82
SM074	34 42.54	114 35.07	1065.0	979603.50	F5	-4.54	-40.87	0.07	0.44	-40.86	25.93
SM075	34 42.83	114 34.86	1021.0	979605.30	F5	-7.29	-42.12	0.06	0.40	-42.14	24.77
SM076	34 43.20	114 34.36	947.0	979608.54	F5	-11.54	-43.84	0.22	0.54	-43.69	23.38
SM077	34 43.34	114 34.02	888.0	979609.95	F5	-15.87	-46.16	0.03	0.35	-46.18	20.96
SM078	34 43.51	114 33.67	828.0	979611.75	F5	-19.96	-48.20	0.02	0.34	-48.21	19.00
SM079	34 42.66	114 33.31	876.0	979607.82	F5	-18.17	-48.05	0.03	0.62	-47.80	19.07
SM080	34 43.09	114 32.88	827.0	979609.10	F5	-22.11	-50.32	0.05	0.50	-50.16	16.90
SM081	34 43.56	114 33.25	786.0	979611.75	F5	-23.98	-50.79	0.09	0.43	-50.69	16.54
SM082	34 43.84	114 33.36	764.0	979613.58	F5	-24.61	-50.67	0.03	0.33	-50.66	16.70
SM083	34 44.80	114 33.81	671.0	979620.11	F5	-28.18	-51.06	0.05	0.30	-51.05	16.73
SM084	34 40.67	114 46.84	2009.0	979512.56	A2	-4.07	-72.59	0.00	0.21	-73.14	-5.02
SM085	34 40.89	114 47.95	2113.0	979509.38	D4	2.22	-69.85	0.12	0.40	-70.24	-1.73
SM086	34 40.88	114 48.53	2196.0	979501.77	F5	2.43	-72.47	0.31	0.66	-72.63	-3.95
SM087	34 41.04	114 49.44	2279.0	979493.01	F5	1.25	-76.48	0.25	0.71	-76.62	-7.57
SM088	34 41.11	114 49.97	2378.0	979485.87	F5	3.33	-77.78	0.24	0.79	-77.87	-8.64
SM089	34 41.17	114 51.11	2300.0	979489.28	D4	-0.68	-79.13	0.01	0.40	-79.58	-9.98
SM090	34 41.16	114 51.72	2220.0	979492.36	F5	-5.11	-80.83	0.05	0.38	-81.28	-11.48

Table 3. (continued) 119 gravity stations in the southern Sacramento Mountains

Base datum IGSN-71

GRS 1967 formula for theoretical gravity

Bouguer reduction density of 2.67 g/cm^3

Station	Latitude deg. min.	Longitude deg. min.	Elev. feet	Obs. mGal	ACC	FA	SBA	Near	TC	CBA	Iso
SM091	34 41.15	114 52.29	2180.0	979494.40	F5	-6.83	-81.18	0.06	0.36	-81.64	-11.67
SM092	34 42.45	114 49.74	2211.0	979502.81	D4	2.67	-72.74	0.02	0.36	-73.21	-3.29
SM093	34 42.66	114 51.02	2142.0	979504.43	D4	-2.49	-75.55	0.02	0.29	-76.07	-5.64
SM094	34 42.53	114 51.88	2129.0	979502.61	D4	-5.36	-77.97	0.02	0.26	-78.51	-7.84
SM095	34 42.02	114 47.80	2139.0	979510.08	D4	3.77	-69.18	0.16	0.43	-69.56	-0.47
SM096	34 41.74	114 46.94	2080.0	979513.85	D4	2.39	-68.55	0.19	0.43	-68.91	-0.20
SM097	34 41.60	114 46.50	2064.0	979514.47	D4	1.70	-68.69	0.01	0.24	-69.23	-0.71
SM098	34 41.47	114 46.07	2022.0	979513.27	F5	-3.26	-72.22	0.02	0.22	-72.77	-4.45
SM099	34 41.33	114 45.63	2000.0	979514.58	F5	-3.82	-72.04	0.01	0.20	-72.60	-4.47
SM100	34 41.17	114 45.07	1971.0	979519.00	F5	-1.90	-69.13	0.02	0.21	-69.67	-1.77
SM101	34 40.96	114 44.40	1964.0	979524.74	F5	3.48	-63.51	0.01	0.22	-64.04	3.58
SM102	34 40.82	114 43.96	1958.0	979526.32	F5	4.69	-62.10	0.02	0.24	-62.60	4.83
SM103	34 40.65	114 43.38	1965.0	979527.40	F5	6.67	-60.35	0.02	0.24	-60.86	6.36
SM104	34 40.20	114 46.29	1956.0	979513.11	F5	-7.84	-74.55	0.01	0.19	-75.11	-7.39
SM105	34 39.88	114 45.91	1921.0	979513.47	F5	-10.32	-75.84	0.00	0.17	-76.40	-8.92
SM106	34 39.55	114 45.54	1881.0	979514.34	F5	-12.75	-76.90	0.00	0.15	-77.47	-10.24
SM107	34 39.23	114 45.16	1847.0	979515.37	F5	-14.46	-77.46	0.01	0.14	-78.03	-11.08
SM108	34 38.89	114 44.78	1816.0	979515.79	F5	-16.48	-78.42	0.00	0.12	-79.00	-12.30
SM109	34 38.57	114 44.41	1787.0	979515.74	F5	-18.80	-79.75	0.01	0.12	-80.33	-13.87
SM110	34 38.24	114 44.02	1758.0	979515.79	F5	-21.02	-80.98	0.00	0.10	-81.56	-15.33
SM111	34 40.71	114 37.94	1569.0	979571.00	F5	12.94	-40.58	0.55	0.98	-40.22	26.04
SM112	34 40.97	114 37.57	1602.0	979571.25	F5	15.92	-38.71	0.38	0.74	-38.61	27.71
SM113	34 44.52	114 32.03	527.0	979621.97	F5	-39.47	-57.45	0.07	0.39	-57.28	10.56
SM114	34 44.23	114 32.05	567.0	979619.41	F5	-37.86	-57.20	0.42	0.75	-56.70	11.00
SM115	34 43.93	114 32.42	626.0	979617.17	F5	-34.13	-55.48	0.19	0.55	-55.19	12.31
SM116	34 38.70	114 40.02	1975.0	979528.07	D4	11.02	-56.34	0.53	0.79	-56.31	9.34
SM117	34 38.47	114 40.12	1896.0	979533.52	F5	9.37	-55.30	0.05	0.27	-55.76	9.82
SM118	34 38.19	114 40.31	1936.0	979527.88	D4	7.88	-58.15	0.64	0.87	-58.02	7.47
SM119	34 37.87	114 40.61	1817.0	979532.16	F5	1.42	-60.55	0.04	0.22	-61.03	4.34

