Complete Bouguer Gravity and General Geology of the Cape San Martin, Bryson, Piedras Blancas, and San Simeon Quadrangles, California

GEOLOGICAL SURVEY PROFESSIONAL PAPER 646-A

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By STEPHEN H. BURCH

GEOPHYSICAL FIELD INVESTIGATIONS

GEOLOGICAL SURVEY PROFESSIONAL PAPER 646-A

Detailed gravity data define the extent of the Burro Mountain ultramafic body, and regional data outline major features of the Salinian and Franciscan basement blocks

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By Stephen H. Burch

ABSTRACT

Complete Bouguer gravity coverage of 390 stations and general geologic mapping were compiled for the Cape San Martin, Bryson, Piedras Blancas, and San Simeon quadrangles, California. These quadrangles constitute a 30- by 30-minute rectangle covering approximately 600 square miles of land area, most of which is in the rugged Santa Lucia Range.

Two distinct basement units underlie the map area. In the northeast part, the granitic-metamorphic Salinian block constitutes the basement. The eugeosynclinal Franciscan Formation, however, underlies most of the map area and here constitutes all but a small part of the Santa Lucia Range. The Nacimiento fault is commonly believed to separate these major basement blocks. Overlying both basement units is a sequence of Cretaceous and Tertiary marine deposits and the nonmarine Paso Robles Formation.

Detailed gravity data indicate that the unserpentinized core of the Burro Mountain ultramafic body has a subsurface volume no greater than 1 to 2 cubic kilometers and extends no deeper than 2,000 to 3,000 feet. Aeromagnetic data seem to preclude a large volume of subsurface serpentinite.

The major features defined by regional gravity data include: (1) a rather even gradient of 3 milligals per mile in the entire southern half of the area which probably reflects deep structure of the continental margin, (2) a 10-milligal high coincident with the topographic mass of the Santa Lucia Range which suggests a density of over 2.8 grams per cubic centimeter for this mass, (3) a broad gravity low associated with Lockwood Valley which suggests that the valley is underlain by as much as 7,000 feet of low density sediments, and (4) a conspicuous gravity gradient of up to 20 milligals per mile which cuts diagonally across the entire Bryson quadrangle and represents a fault which vertically displaces the basement surface 5,000 to 10,000 feet. The most significant structural feature of the map area, the contact between the Franciscan and Salinian basement blocks, shows little or no gravity expression.

INTRODUCTION

This report presents and interprets a 2-mgal (milligal) complete Bouguer gravity map of the Cape San Martin, Bryson, Piedras Blancas, and San Simeon quadrangles, California. Detailed gravity coverage was obtained for the Burro Mountain ultramafic body, and the regional coverage was collected as part of a broader survey of the San Luis Obispo 1:250,000 Army Map Service gravity sheet. The gravity map is overprinted on a generalized geologic map compiled from several sources.

The four quadrangles constituting the map area (fig. 1) form a 30- by 30-minute block covering approximately 600 square miles of land area, most of which is in the rugged Santa Lucia Range. The area extends

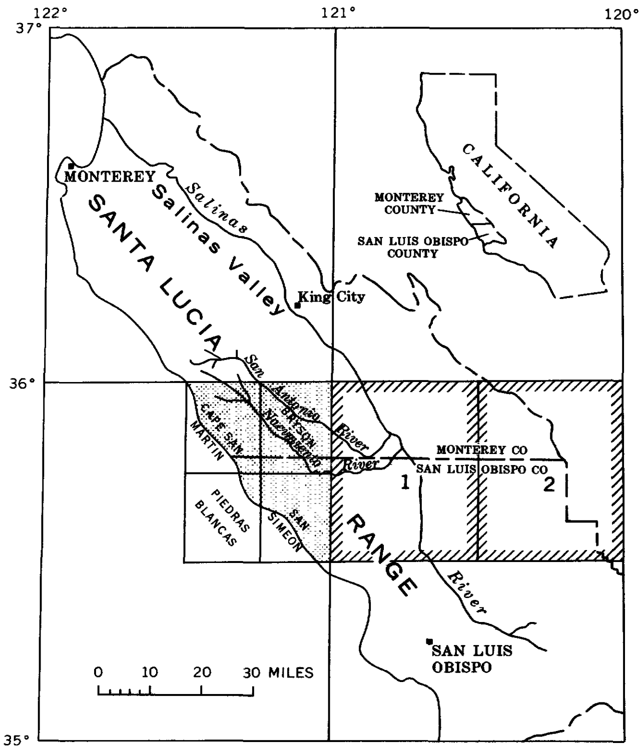

Figure 1.—Location of the Cape San Martin, Bryson, Piedras Blancas, and San Simeon quadrangles, California. 1, area described by Burch and Durham (1970); 2, area described by Hanna, Burch, and Dibblee (1971).

from Lucia and Cambria on the coast to Lake Nacimiento, Lockwood, and Jolon on the east and northeast.

The author wishes to thank D. L. Durham and B. M. Page, who gave generously of their time in discussing geologic problems and contributed their mapping to the compilation on the geologic map.

GENERAL GEOLOGY

The geologic map (pl. 1) is a compilation from several sources which are indexed by area at the bottom of the map. Rock units are lumped to provide continuity with companion maps to the east (Burch and Durham, 1970; Hanna and others, 1971).

The map area may be separated into two major basement blocks, the Franciscan block of eugeosynclinal rocks in most of the area and the Salinian block of granitic-metamorphic rocks in the northeast part. The boundary between these blocks is generally thought to be the Nacimiento fault. Such is indeed the case near the northwest corner of the map area where the basement contact is exposed. In the eastern part of the map area, however, it is doubtful whether the gently dipping contact between the Franciscan Formation and Upper Cretaceous rocks, mapped as the Nacimiento fault zone, is also the contact between the two basement blocks.

Overlying both basement blocks is a sequence of upper Mesozoic and Tertiary marine deposits and the nonmarine Paso Robles Formation.

BASEMENT ROCKS

ULTRAMAFIC ROCKS

The ultramafic rocks are emplaced only in Franciscan Formation, and most are serpentinites typical of those found throughout the Franciscan (Bailey and Everhart, 1964, p. 47). The smaller bodies are thoroughly serpentinized, and intense shearing has destroyed original textures in all but a few 2–3-inch remnant blocks. The centers of the larger bodies consist of blocky serpentinite, but invariably this grades outward to the usual sheared material. These serpentinite bodies crop out as elongate pods and lenses concordant with the regional structure. They commonly form discontinuous trains which continue many miles along zones of apparent slippage.

The Burro Mountain mass, by contrast, is a large, nearly equidimensional (1 by 1½ miles) block of massive fresh ultramafic rock, only the outer 700–1,000 feet of which is altered to serpentinite. The primary rock, before serpentinization, consisted of approximately 65 percent periodotite and 35 percent dunite (Burch, 1968). Variations among these lithologic types produce a well-defined internal structure traceable through most of the body. In the interior the primary rock was affected only by incipient serpentinization, and densities approach 3.30 g/cm^3 (grams per cubic centimeter). This fresh core, however, grades outward through massive, partially serpentinized rock to blocky and sheared serpentinite at the margins, where the density is 2.50–2.60. Fresh ultramafic rock is nowhere in contact with country rock.

FRANCISCAN FORMATION

The Franciscan Formation in the map area is part of a 10- by 100-mile tract extending from Point Sur to San Luis Obispo. It consists of moderately to highly deformed eugeosynclinal rocks deposited on an unknown basement. Palynomorphs recently collected by B. M. Page from this area are of Early and possibly Late Cretaceous age (W. R. Evitt, written commun., 1969). The rock types and their estimated percentages are: graywacke (60), siltstone and shale (25), conglomerate (1), mafic volcanic rocks (10), chert and accompanying shale (2), and glaucophane schist and related metamorphic rocks (2). Granitic rocks are lacking in this section of the Franciscan.

The structure of the Franciscan Formation reflects moderate to extreme deformation, predominantly by faulting. Even in the least deformed areas, graywacke outcrops are cut by slickensided joints and by seams of sheared and hardened mudstone, and outcrops of layered chert are highly contorted. In the more deformed areas, such as major throughgoing shear zones, the Franciscan Formation is characterized by competent tectonic blocks of all sizes and lithologic types incorporated in a sheared matrix of shale and other less competent rock. The structural complexity of the rocks everywhere makes stratigraphic work exceedingly difficult.

METAMORPHIC ROCKS

Metamorphic rocks, probably correlative with the Sur Series, constitute most of the Salinian basement exposed in the map area. Compton (1966, p. 1364), whose mapping extended into the northwestern part of the area, describes these high-grade metasedimentary rocks as "mainly medium-grained quartzites, quartzofeldspathic gneisses and granofelses (Goldsmith, 1959), calc-silicate granofelses, amphibolites, pelitic schists, marbles, and metadolomites."

GRANITIC ROCKS

Granitic rocks are seen only as two small outcrops in northeastern Cape San Martin quadrangle and as two tiny slivers in western Bryson quadrangle. Well data (table 1), however, indicate that granitic rocks constitute much of the unexposed Salinian basement. Compton (1966, p. 1365) describes the lithology to the north as chiefly "adamellite, granodiorite, and tonalite, with some potassic granite and basic-to-ultrabasic rocks."

TERTIARY INTRUSIVE ROCKS

Tertiary intrusive rocks crop out in the San Simeon quadrangle at Pine Mountain and near Cambria. These rocks are porphyritic and nonporphyritic felsic alphanites.

SUPERBASEMENT SEDIMENTARY ROCKS

PALEOCENE AND UPPER MESOZOIC DEPOSITS

The unit designated as Paleocene and upper Mesozoic deposits includes (1) rocks represented as the Knoxville Formation and as Lower Cretaceous marine on the San Luis Obispo geologic sheet (Jennings, 1958) and (2) an Upper Cretaceous unit and a Paleocene unit, both part of Taliaferro's (1943, p. 132) Asuncion Group. It crops out in a northwest-trending belt 4 to 5 miles wide immediately east of the Franciscan Formation and as small patches resting on the Franciscan. The unit appears to be absent in the subsurface northeast of the Jolon fault, since well data there indicate that Miocene strata or younger beds directly overlie basement. All the rocks lumped in this unit are lithologically similar to the marine sedimentary rocks of the Great Valley sequence; they consist predominantly of massive-bedded, poorly sorted, medium- to coarse-grained, potassium-feldspar-bearing arkosic sandstones with lesser amounts of interbedded mudstone and conglomerate. The contact between this unit and the Franciscan Formation appears to be a fault contact throughout the map area. The contact is steep in the Cape San Martin quadrangle, but in the northeast part of the San Simeon quadrangle, dips are shallow and features resembling klippes and fensters suggest that the contact may be a thrust fault (B. M. Page, oral commun., 1968).

MIDDLE AND LOWER MIOCENE DEPOSITS

The unit designated as middle and lower Miocene sedimentary deposits includes rocks of the Tierra Redonda and Vaqueros Formations. It forms a parallel belt just east of the previously described older rocks. The belt is narrow in the center but spreads out into a broad syncline to the southeast and envelops the granitic core of an anticline to the northwest. It appears to be in depositional contact with (1) the aforementioned granitic core, (2) subsurface granitic basement east of the Jolon fault, and (3) older rocks in the aforementioned syncline. It is in fault contact with older rocks along the narrow central belt. The rocks consist chiefly of sandstone, commonly fossiliferous; conglomerate and mudstone are locally abundant. Well-indurated calcareous sandstones commonly alternate with friable partly calcareous or silty sandstones (Durham, 1965a, p. 9).

TABLE 1.—*Selected exploratory wells from the Bryson quadrangle, California*

[Elevation: kb, kelly bushing; gr, ground; t, from topographic map]

Map reference (pl. 1)	Operator	Well	Location Sec.	Location T.S.	Location R.E.	Year begun	Elevation (feet)	Total depth (feet)	Reported geologic data (depths in feet)
1	Humble Oil & Refining Co	Meta E. Oberg 1	19	22	8	1957	1,206 kb	5,770	Basement top at 5,690.
2	Empire State Oil Co	Empire State-Thorup-Plaskett 1	29	22	8	1967	1,160 t	4,526	None.
3	Texaco, Inc	Martinus C. H. 1	27	22	8	1966	1,530 gr	1,799	Basement top at 1,748.
4	do	Valdez C. H. 1	26	22	8	1966	1,310 kb	653	Basement top at 607.
5	General Petroleum Corp	Hotchkiss 35-29	29	22	9	1952	1,842 gr	6,259	Bottom in Miocene rocks.
6	Time Petroleum Co	Roth 1	5	23	8	1964	975 gr	5,890	Top of Monterey Shale at 2,305; top of middle and lower Miocene deposits at 3,925; bottom in Miocene deposits.
7	do	Paulsen 1	3	23	8	1964	1,100 gr	4,907	Top of Pancho Rico Formation at 2,595; top of Monterey Shale at 2,685; basement top at 4,830.
8	Burke, Jack P	USL 67-X	6	23	9	1964	1,479 kb	850	Top of granite at 756.
9	General Petroleum Corp	Wright-Texas 25-5	5	23	9	1958	1,420 t	2,587	Bottom in granite.
10	Time Petroleum Co	Heinsen 1	10	23	8	1964	970 kb	1,656	Bottom in Pancho Rico Formation.
11	Humble Oil & Refining Co	Anna L. Pauson 1	10	23	8	1956	1,000 gr	4,003	Bottom in Miocene deposits.
12	do	Gladys Stockdale 1	13	23	8	1957	986 kb	2,388	Bottom in basement.
13	Texaco, Inc	Keans (NCT-1) 1	27	22	8	1959	1,355 kb	2,416	Do.
14	Marport Oil Co	Marport-Parlet-Block 1-1	19	23	9	1957	995 kb	1,493	Basement top at 1,470.
15	Humble Oil & Refining Co	Floyd L. Patterson 1	19	23	9	1958	910 t	1,225	Basement top at 1,123.
16	do	R. M. Diggs 1	33	23	9	1955	921 kb	1,245	Reported bottom in pre-Tertiary rocks.
17	Chamberlin, C. H	Shepard 1	24	24	8	1963	1,589 kb	1,690	Bottom in Monterey Shale.

Also lumped within this unit are three small patches shown as Miocene nonmarine by Jennings (1958). These rocks constitute the spectacular outcrops for which the Palisades were named.

VOLCANIC ROCKS

Miocene volcanic rocks are shown in the Piedras Blancas and San Simeon quadrangles by Jennings (1958). Those of the Piedras Blancas quadrangle are shown as pyroclastic rocks and those in the San Simeon quadrangle as rhyolite.

MONTEREY SHALE

The Monterey Shale is widespread on both sides of Lockwood Valley and attains a thickness of at least 2,700 feet on the south side of the valley and 6,600 feet on the north side (Durham, 1965a, p. 13). It conformably overlies the Vaqueros Formation in this area. It also conformably overlies and intertongues with the Tierra Redonda Formation. In the San Simeon quadrangle it is in depositional contact with Franciscan Formation and lower Miocene marine (Jennings, 1958) as well as Upper Cretaceous rocks (B. M. Page, unpub. data, 1966). The rocks are chiefly porcelanite, porcelaneous mudstone, and mudstone with some chert and dolomitic carbonate beds. The dominantly calcareous beds in the lower part of the Monterey Shale southwest of Lockwood Valley constitute the Sandholdt Member.

Forminifera indicative of early and middle Miocene age are found in the Sandholdt Member. The overlying siliceous rocks of the Monterey are generally lacking in fossils useful in age determination, but stratigraphic relationships with the Santa Margarita and Pancho Rico Formations indicate that these siliceous strata are probably of late Miocene age but could include beds of latest middle Miocene and early Pliocene age (Burch and Durham, 1970).

PANCHO RICO FORMATION

Small areas of the Pancho Rico Formation were mapped by Durham (1965a) in the vicinity of Lockwood Valley but were left unnamed at the time his mapping was published. The Pancho Rico conformably overlies the Monterey and contains fossils characteristic of early Pliocene age. The rocks are characteristically fine-grained thick- or massive-bedded sandstone, but pebbly sandstone and mudstone appear locally.

PASO ROBLES FORMATION

The Paso Robles Formation crops out in and along the sides of Lockwood Valley. This nonmarine unit conformably overlies the Pancho Rico and unconformably overlies the Monterey. The unit is generally considered to be Pliocene and possibly Pleistocene in age. The rocks are chiefly conglomerate, conglomeratic sandstone, and sandstone.

SURFICIAL DEPOSITS

Surficial deposits include older alluvium and alluvium. Older alluvium covers the floors of Lockwood and Stoney Valleys. Alluvium occurs along the beds of most streams. The older alluvium is mainly semiconsolidated silt, sand, and gravel, and the alluvium is similar but unindurated. The older alluvium and alluvium combined are probably no thicker than a few score feet in most places, but their thickness is uncertain, partly because of difficulty in distinguishing older alluvium from Paso Robles Formation in wells. The older alluvium is considered of Pleistocene and possibly Holocene age because it unconformably overlies the Paso Robles Formation. The alluvium is Holocene.

STRUCTURE

Structure within the Franciscan block is so characteristic of the overall Franciscan Formation that it was described earlier (p. A2) in conjunction with that unit. The character of the Nacimiento fault was noted earlier in the broad overview of geologic relationships and again in discussing the contact of the Paleocene and upper Mesozoic unit with the Franciscan Formation. Structures of interest in the Salinian block include the Jolon and Espinosa fault zones. The Jolon fault zone, although its surface expression in the mapped area is only minor and its precise location uncertain, is of major structural significance. According to Durham (1965b), it separates contemporaneous but unlike sequences of Miocene and Pliocene strata and has experienced at least 11 miles of right-lateral strike-slip movement. It extends about 20 miles beyond the map area to the southeast. The Espinosa fault zone, in the northeast corner of the map, is generally marked by a zone of crushed and contorted rock 500 or more feet wide and displaces basement sharply downward on the northeast (Durham, 1965a, p. 23). It extends beyond the map area 12 miles to the southeast where it terminates against the Jolon fault.

GRAVITY DATA

GRAVITY SURVEY

The map area includes 390 gravity stations which are tied to eight gravity bases. The principal facts for the bases are given in table 2 and those for the 390 stations in table 3. All the data are tied to base 173 (Chapman, 1966, p. 36) at the U.S. Geological Survey office in Menlo Park, Calif. The observed gravity at this base, determined by numerous ties to North American Gravity Standardization Stations at the San Francisco Airport, is taken to be 979,958.74 mgal.

TABLE 2.—*Principal facts for bases used in gravity survey*

Base	Lat N.	Long W.	Elevation (ft)	Observed gravity [1] (mgal)	Description
SLUKB	36 7.73	121 1.12	405.8	979793.04	USC&GS BM G154 at San Lucas.
BRADB	35 51.81	120 47.73	552.0	979737.30	USGS BM 553 at Bradley.
PSROB	35 37.55	120 41.28	720.0	979717.17	USC&GS BM L24 at Paso Robles.
JOLNB	35 58.47	121 10.47	979.0	979722.66	USGS BM 979 at Jolon.
175B	35 54.78	121 27.99	195.0	979823.27	USC&GS BM L260 near Pacific Valley.
SSIMB	35 38.64	121 11.26	17.0	979817.49	USGS BM 19 at San Simeon.
CAMBB	35 33.55	121 5.33	81.0	979801.24	USC&GS BM A694 at Cambria.
BUROB	35 52.31	121 17.25	1620.0	979738.24	Established on Los Burros Creek.

[1] The amount of scatter among numerous ties between these bases suggests that the relative observed gravity of each is known to ±0.02 mgal.

Table 3.—*Principal facts for gravity stations*

Station	Lat N.	Long W.	Elevation (ft)	Observed gravity (mgal)	Terrain correction (mgal)	Free-air anomaly (mgal)	Complete Bouguer anomaly (mgal)
7	35 57.97	121 5.12	1104	979717.46	1.55	−6.57	−43.12
8	35 57.98	121 5.92	1046	979718.44	1.51	−11.06	−45.65
9	35 57.98	121 6.99	1009	979720.49	1.51	−12.49	−45.81
A10	35 56.44	121 7.25	938	979724.39	1.65	−13.07	−43.80
JOLNB	35 58.47	121 10.47	979	979722.64	1.91	−13.86	−45.74
12	35 57.70	121 9.82	945	979724.22	1.59	−14.38	−45.41
13	35 57.18	121 8.93	930	979724.66	1.54	−14.61	−45.17
14	35 56.24	121 5.87	951	979727.42	1.49	−8.53	−39.87
15	35 56.21	121 3.88	986	979729.79	1.66	−2.82	−35.20
16	35 55.80	121 3.03	979	979733.88	1.53	1.19	−31.07
17	35 55.25	121 2.06	1046	979731.25	1.52	5.65	−28.94
18	35 54.49	121 1.12	944	979735.91	1.61	1.80	−29.18
19	35 54.48	121 0.05	1061	979715.60	1.61	−7.49	−42.50
37	35 50.32	121 2.20	948	979734.40	1.92	6.62	−24.19
38	35 49.33	121 3.37	1584	979699.09	2.36	32.54	−19.75
39	35 48.88	121 6.02	996	979747.18	2.01	25.97	−6.40
40	35 54.23	121 7.77	858	979730.20	2.40	−11.63	−38.85
41	35 53.10	121 9.71	1255	979734.45	2.19	31.58	−9.55
42	35 52.20	121 10.18	1055	979751.47	2.17	31.07	−3.18
A43	35 52.48	121 12.81	1083	979756.15	2.45	37.98	3.05
A45	35 47.69	121 11.07	1902	979705.12	3.79	70.81	9.00
46	35 46.98	121 10.77	1950	979701.91	4.36	73.13	10.24
A47	35 45.53	121 11.64	1265	979741.53	4.36	50.39	11.10
48	35 41.49	121 11.98	1193	979742.09	8.06	49.94	16.82
A49	35 39.00	121 11.93	74	979814.39	2.28	20.53	20.25
A50	35 39.26	121 12.98	53	979818.43	2.26	22.22	22.65
51	35 39.35	121 14.79	30	979823.84	2.25	25.34	26.55
52	35 39.92	121 15.78	67	979823.54	2.36	27.71	27.75
53	35 40.13	121 16.45	98	979822.34	2.38	29.13	28.12
54	35 40.61	121 17.06	46	979826.92	2.37	28.13	28.91
55	35 41.54	121 17.38	18	979829.32	2.56	26.57	28.51
56	35 42.08	121 18.06	35	979828.42	2.77	26.50	28.06
57	35 42.94	121 18.30	26	979825.40	3.03	21.41	23.54
58	35 44.30	121 18.73	80	979824.85	3.59	24.00	24.83
59	35 45.30	121 18.79	120	979822.80	4.60	24.29	24.75
60B	35 45.89	121 19.10	32	979826.49	6.95	18.86	24.71
61	35 47.32	121 20.06	364	979806.56	10.46	28.13	26.01
A62	35 47.84	121 20.74	531	979795.06	10.77	31.59	24.02
63	35 57.69	121 11.00	945	979729.80	1.70	−8.78	−39.71
64	35 58.75	121 13.05	992	979732.49	1.83	−3.19	−35.60
78	35 59.17	121 10.64	1024	979725.75	2.00	−7.52	−40.86
79	35 57.01	121 11.95	1282	979715.56	3.58	9.64	−31.02
80	35 55.86	121 13.52	1405	979737.31	2.94	44.60	−.94
81	35 55.50	121 14.03	1189	979751.54	2.16	39.03	.16
A82	35 55.99	121 14.60	1219	979751.79	2.62	41.41	1.95
83	35 56.50	121 15.25	1291	979749.86	2.28	45.52	3.25
A84	35 58.20	121 16.16	1358	979745.53	2.55	45.06	.75
85	35 57.72	121 16.74	1287	979754.63	2.61	48.17	6.37
86	35 57.67	121 17.24	1316	979754.24	2.58	50.58	7.74
87	35 56.93	121 17.66	1284	979756.82	3.19	51.21	10.09
A88	35 56.28	121 16.79	1204	979759.74	2.82	47.53	8.80
89	35 55.70	121 15.25	1258	979751.68	2.38	45.38	4.34
90	35 55.77	121 14.83	1232	979751.97	2.30	43.12	2.90
91	35 54.40	121 12.29	1307	979738.00	2.40	38.16	−4.54
92	25 54.46	121 11.08	1352	979728.58	2.02	32.89	−11.75
93	35 54.70	121 10.53	1248	979726.48	2.09	20.66	−20.32
94	35 55.45	121 11.74	1862	979686.92	7.46	37.78	−18.98
95	35 56.12	121 12.67	1689	979702.80	5.77	36.43	−16.06
96	35 53.04	121 14.61	1217	979753.49	3.12	47.13	8.25
97	35 55.70	121 17.08	1181	979760.65	4.23	47.11	10.57
98	35 58.18	121 18.87	1304	979756.99	3.04	51.47	9.51
99	35 57.73	121 18.79	1252	979760.33	3.22	50.56	10.58
100	35 57.19	121 18.96	1242	979761.85	4.35	51.92	13.40
101	35 58.74	121 15.09	1075	979750.51	2.36	22.65	−12.09
102	35 58.58	121 14.11	1027	979740.64	2.06	8.50	−24.89
103	35 59.14	121 13.40	1007	979730.23	1.87	−4.59	−37.48

Table 3.—*Principal facts for gravity stations*—Continued

Station	Lat N.	Long W.	Elevation (ft)	Observed gravity (mgal)	Terrain correction (mgal)	Free-air anomaly (mgal)	Complete Bouguer anomaly (mgal)
104	35 58.58	121 20.19	1315	979760.51	4.12	55.46	14.28
107	35 59.51	121 26.00	3463	979634.99	19.74	130.60	31.07
108	35 58.32	121 26.50	3431	979633.01	18.49	127.31	27.63
A109	35 58.27	121 26.99	3306	979637.72	21.33	120.34	27.79
110	35 57.88	121 25.65	3415	969636.08	15.01	129.50	26.90
111	35 57.64	121 24.78	3210	979649.64	11.87	124.13	25.42
112	35 57.90	121 24.62	3204	979651.26	11.38	124.81	25.82
113	35 58.08	121 24.08	3406	979634.39	16.19	126.68	25.56
114	35 58.09	121 22.67	3441	979630.76	17.40	126.33	25.22
115	35 57.79	121 21.89	3179	979643.18	16.42	114.54	21.45
116	35 57.59	121 21.20	2599	979682.29	8.78	99.40	18.60
117	35 56.97	121 20.31	1911	979723.67	6.75	77.06	17.87
118	35 56.86	121 19.13	1664	979737.07	4.18	67.30	14.07
119	35 52.70	121 16.38	2221	979695.91	7.47	84.46	15.35
BUROB	35 52.31	121 17.25	1620	979738.24	5.26	70.82	20.19
121	35 53.18	121 18.78	2335	979698.24	7.60	96.82	23.92
122	35 53.23	121 19.27	2408	979692.20	7.04	97.57	21.60
123	35 53.62	121 19.68	2650	979678.42	9.32	105 99	23.98
124	35 54.18	121 19.41	2322	979699.89	6.02	95.82	21.97
125	35 54.65	121 20.35	3004	979652.72	13.09	112.11	21.70
126	35 54.81	121 21.77	3122	979649.82	11.54	120.08	24.06
A127	35 55.14	121 22.08	3275	979638.60	16.01	122.77	25.97
128	35 54.52	121 21.84	3369	979630.79	18.99	124.68	27.64
A130	35 50.89	121 18.26	3373	979618.87	20.95	118.32	23.10
A131	35 50.84	121 15.80	2535	979676.80	10.89	97.53	21.04
137	35 57.97	121 9.98	958	979724.08	1.60	−13.68	−45 15
138	35 57.98	121 8.60	971	979724.28	1.53	−12.27	−44.26
139	35 57.98	121 7.88	991	979722.53	1.51	−12.14	−44.84
140	35 58.85	121 5.91	1095	979716.60	1.83	−9.53	−45.50
141	35 57.13	121 61.4	1074	979718.92	1.83	−6.73	−41.97
142	35 57.08	121 5.30	1016	979723.29	1.41	−7.74	−41.41
143	35.57.07	121 4.33	1027	979724.57	1.48	−5.41	−39.39
144	35.56.65	121 2.99	1078	979725.56	1.55	.97	−34.69
145	35 55.33	121 3.52	924	979736.31	1.39	−.88	−31.39
146	35 54.92	121 2.22	979	979735.98	1.45	4.55	−27.80
147	35 53.97	121 1.59	944	979737.58	1.50	4.21	−26.87
148	35 52.89	121 8.58	1668	979700.24	5.47	36.51	−15.56
149	35 52.62	121 8.04	1450	979716.42	2.30	32.57	−15.16
150	35 52.16	121 7.33	1887	979678.04	5.79	35.95	−23.35
151	35 51.79	121 7.39	2131	979664.28	9.25	45.66	−18.57
152	35 51.33	121 5.80	1914	979667.99	5.74	29.62	−30.65
153	35 51.01	112 5.33	1879	979671.04	6.00	29.83	−28.97
154	35 50.92	121 4.52	1693	979681.62	4.78	23.05	−30.57
155	35 49.86	121 4.17	1630	979695.98	4.26	33.00	−18.98
156	35 50.53	121 5.17	1590	979701.70	2.62	34.00	−18.24
157	35 49.64	121 5.45	1459	979712.62	4.21	33.87	−12.26
158	35 49.75	121 6.75	1189	979736.70	2.05	32.40	−6.59
159	35 49.51	121 7.26	1232	979735.38	2.19	35.47	−4.86
160	35 49.81	121 8.87	905	979758.42	5.00	27.32	1.08
161	35 50.47	121 9.48	979	979755.96	3.51	30.88	1.59
163	35 51.81	121 13.91	1730	979720.54	5.02	64.18	9.52
164	35 51.35	121 13.90	1856	979712.92	4.65	69.07	9.70
165	35 49.65	121 12.85	1914	979704.19	5.76	68.22	7.96
166	35 49.21	121 13.28	2371	979677.95	7.36	85.58	11.20
167	35 49.79	121 14.37	2744	979654.80	12.14	96.68	14.25
168	35 50.13	121 14.55	2790	979650.02	13.76	95.74	13.35
169	35 50.77	121 14.78	2208	979692.41	5.62	82.49	11.97
170	35 48.45	121 12.50	2319	979678.58	6.28	82.40	8.73
171	35 47.76	121 11.93	2527	979662.92	8.96	87.29	9.14
A172	35 58.12	121 28.94	173	979832.32	12.64	20.51	27.17
173	35 57.25	121 28.82	205	979828.27	10.08	20.71	23.71
171	35 56.20	121 28.13	101	979833.51	9.14	17.67	23.32
175B	35 54.78	121 27.99	195	979823.27	8.83	18.30	20.39
176	35 52.55	121 26.66	344	979807.01	9.82	19.24	17.17
177	35 51.52	121 24.92	39	979822.14	16.02	7.15	21.82
A178	35 50.18	121 23.41	559	979790.52	14.19	26.35	21.24
179	35 54.68	121 26.30	2455	979681.89	16.32	89.61	21.30
180	35 55.35	121 25.88	2714	979668.85	16.15	99.97	22.59
181	35 56.00	121 25.78	3178	979640.48	20.24	114.30	25.07
182	35 56.74	121 24.29	3169	979648.99	13 32	120.91	25.06
183	35 56.47	121 23.41	2929	979664.51	10.78	114.25	24.11
184	35 55.80	121 23.05	2927	979662.91	14.23	113.42	26.79
185	35 53.74	121 22.01	3490	979620.05	19.44	126.43	25.69
186	35 53.26	121 23.36	3277	979632.35	18.45	119.39	24.97
187	35 53.08	121 24.85	2672	979667.80	16.32	98.21	22.44
188	35 49.21	121 22.40	645	979787.75	11.30	33.05	22.08
D189	35 33.87	121 4.46	77	979797.74	2.24	11.46	11.04
CAMBB	35 33.75	121 5.33	81	979801.25	2.24	15.51	14.95
B191	35 34.30	121 6.67	34	979808.75	1.93	17.81	18.56
B192	35 34.87	121 7.04	26	979809.80	1.91	17.30	18.31
B193	35 35.79	121 7.50	26	979810.47	2.02	16.66	17.78
B194	35 36.41	121 8.17	64	979809.96	2.08	18.84	18.71
B195	35 37.02	121 8.87	53	979812.19	2.16	19.17	19.50
B196	35 38.08	121 9.79	46	979813.25	2.39	18.06	18.86
SSIMB	35 38.64	121 11.26	17	979817.49	2.39	18.78	20.58
C271	35 34.88	121 0.54	259	979774.45	4.00	3.85	−1.10
272	35 34.47	121 2.23	197	979783.17	2.48	7.32	3.00
B273	35 34.39	121 2.40	166	979786.01	2.33	7.36	3.95
B274	35 34.23	121 3.55	109	979792.38	2.05	8.59	6.88
275	35 33.19	121 4.30	247	979788.41	1.92	19.08	12.47
276	35 32.27	121 3.35	97	979794.33	2.35	12.20	11.20
277	35 32.44	121 0.60	236	979778.47	2.11	9.18	3.13
278	35 30.55	121 1.35	185	979785.23	1.96	13.82	9.39
279	35 31.16	121 1.97	148	979788.71	1.85	12.96	9.69
280	35 31.76	121 4.15	692	979758.74	5.71	33.30	15.12
281	35 30.46	121 2.61	715	979752.67	6.08	31.24	12.64

Table 3.—*Principal facts for gravity stations*—Continued

Station	Lat N.	Long W.	Elevation (ft)	Observed gravity (mgal)	Terrain correction (mgal)	Free-air anomaly (mgal)	Complete Bouguer anomaly (mgal)
312	35 40.24	121 12.81	96	979816.01	2.74	22.45	21.87
313	35 41.68	121 13.47	357	979802.05	3.09	30.99	21.75
314	35 41.95	121 14.41	344	979804.61	3.07	31.95	23.13
315	35 41.78	121 15.03	508	979794.19	3.06	37.19	22.71
316	35 40.52	121 14.10	434	979799.40	2.70	37.24	24.95
317	35 40.83	121 15.41	402	979802.10	2.71	36.49	25.31
318	35 41.59	121 16.03	462	979797.75	3.92	36.70	24.66
319	35 42.69	121 16.68	594	979789.70	4.82	39.50	23.80
320	35 42.02	121 17.07	362	979804.27	4.29	33.20	24.98
321	35 43.10	121 14.55	1590	979723.87	10.34	66.76	22.24
322	35 43.10	121 15.10	1523	979727.75	10.67	64.34	22.46
323	35 44.44	121 14.77	2476	979666.78	15.89	91.08	21.62
324	35 45.20	121 14.24	1090	979691.14	12.40	78.06	18.39
325	35 44.71	121 15.56	2610	979653.30	16.73	89.82	16.59
326	35 44.76	121 16.76	1966	979699.63	15.08	75.52	22.79
327	35 45.08	121 17.83	984	979766.86	8.51	49.93	24.48
328	35 39.76	121 10.37	566	979779.11	4.68	30.44	15.58
329	35 40.21	121 9.38	1349	979729.83	8.45	54.17	16.07
330	35 40.65	121 9.34	1790	979698.13	10.95	63.32	12.52
331	35 40.94	121 10.85	1243	979737.51	6.01	50.84	13.95
332	35 46.34	121 10.39	2552	979657.32	11.08	86.06	9.18
333	35 45.78	121 9.69	2410	979666.51	8.17	82.70	7.79
334	35 45.21	121 9.13	2705	979644.16	11.22	88.90	6.89
335	35 43.91	121 7.70	2535	979652.78	9.08	83.39	5.09
336	35 43.42	121 7.37	2644	979644.55	10.37	86.10	5.35
337	35 43.13	121 7.07	2465	979658.31	8.19	83.44	6.66
338	35 40.52	121 3.16	3263	979589.80	16.47	93.69	−2.24
339	35 40.18	121 2.72	3137	979594.19	17.17	86.71	−4.19
340	35 37.35	121 4.74	1209	979719.47	7.68	34.71	.67
341	35 37.44	121 5.89	938	979744.86	5.88	34.49	7.98
352	35 45.56	121 0.36	771	979749.38	2.02	11.74	−12.86
A353	35 45 19	121 0.73	773	979748.99	2.63	12.06	−12.00
354	35 45.38	121 2.03	788	979749.54	2.45	13.75	−11.00
355	35 44.55	121 2.60	787	979752.50	3.46	17.80	−5.91
356	35 44.90	121 3.11	784	979753.73	2.94	18.25	−5.88
357	35 44.27	121 3.57	779	979754.07	3.85	19.02	−4.03
358	35 44.91	121 4.18	770	979756.46	4.32	19.65	−2.62
359	35 44.03	121 0.64	773	979750.78	3.22	15.50	−7.96
383	35 59.95	121 1.59	2115	979661.88	4.83	30.10	−8.00
386	35 58.50	121 0.61	2256	979650.32	5.43	33.88	−38.48
388	35 57.10	121 0.04	2801	979604.16	11.69	40.96	−43.87
444	35 46.30	121 0.15	843	979744.47	2.28	12.54	−14.28
451	35 48.63	121 9.50	2289	979675.65	6.20	76.40	3.68
452	35 50.00	121 9.97	1410	979729.93	3.58	46.06	.98
453	35 49.02	121 10.73	2232	979681.79	5.58	76.62	5.20
454	35 57.13	121 10.08	921	979729.18	1.59	−10.86	−41.07
455	35 56.22	121 8.74	903	979728.74	1.55	−11.69	−41.32
456	35 55.57	121 9.33	890	979728.69	2.12	−12.04	−40.64
457	35 56.03	121 10.38	1114	979719.95	2.24	−.37	−36.58
458	35 54.52	121 9.00	1315	979706.09	3.64	6.83	−34.91
459	35 54.58	121 8.41	1226	979706.62	3.12	−1.09	−40.29
460	35 53.80	121 9.05	1516	979705.13	3.71	25.80	−22.79
461	35 53.30	121 10.87	1239	979739.03	2.23	34.37	−6.16
462	35 53.07	121 11.46	1433	979728.32	4.02	42.23	−3.20
463	35 54.09	121 12.82	1345	979736.96	3.33	41.14	−1.95
464	35 53.25	121 12.72	1390	979735.60	3.63	45.21	.87
465	35 54.91	121 13.17	1271	979742.69	2.42	38.74	−2.71
466	35 55.12	121 14.54	1267	979747.66	3.00	43.03	2.31
467	35 54.33	121 13.85	1291	979743.63	3.17	42.39	1.00
468	35 54.27	121 14.93	1390	979740.70	4.24	48.85	5.13
469	35 53.77	121 13.82	1315	979744.27	4.07	46.08	4.77
470	35 52.96	121 13.91	1202	979752.12	2.66	44.46	5.64
471	35 52.62	121 14.53	1271	979749.24	2.92	48.56	7.61
472	35 53.16	121 15.52	1256	979752.97	4.01	50.11	10.77
474	35 53.09	121 17.08	2325	979690.92	8.48	88.69	17.01
475	35 53.57	121 17.50	2020	979714.14	4.97	82.54	17.85
476	35 54.43	121 18.50	1722	979735.54	4.38	74.69	19.67
477	35 55.20	121 19.30	2401	979692.01	8.55	93.91	19.69
478	35 55.16	121 18.10	2303	979696.40	5.97	89.14	15.71
479	35 55.72	121 18.46	2903	979651.55	13.23	99.92	13.12
480	35 56.17	121 19.24	2617	979672.09	11.83	92.92	14.55
481	35 53.77	121 16.74	2213	979695.83	8.04	82.10	13.83
482	35 53.43	121 16.40	1834	979719.27	6.98	70.38	14.10
483	35 54.05	121 15.56	1526	979733.84	5.29	55.10	7.74
484	35 55.20	121 16.52	1673	979726.70	5.71	60.14	8.14
485	35 55.17	121 15.07	1527	979731.53	4.93	51.28	3.53
486	35 55.06	121 15.60	1583	979729.06	4.54	54.24	4.16
487	35 59.65	121 15.35	1297	979722.01	3.46	13.73	−27.57
488	35 59.06	121 16.03	1374	979739.63	3.15	39.44	−4.82
489	35 59.83	121 16.70	1710	979710.75	4.55	41.06	−13.38
490	35 59.72	121 17.64	1866	979712.22	4.97	57.36	−2.03
491	35 58.97	121 17.43	1405	979742.68	2.60	45.53	−.35
492	35 59.93	121 18.73	1783	979726.03	4.31	63.06	5.87
493	35 59.46	121 19.52	1595	979742.86	3.58	62.88	11.43
494	35 59.03	121 19.18	1534	979745.47	3.32	60.37	10.76
495	35 58.51	121 18.19	1770	979724.49	5.47	62.33	6.74
496	35 52.61	121 17.28	2006	979714.63	5.58	83.09	19.48
497	35 52.28	121 18.08	2350	979691.71	6.85	92.99	18.82
498	35 51.09	121 19.19	3496	979615.99	18.84	126.72	25.17
499	35 55.06	121 7.23	982	979718.87	1.53	−12.48	−44.85
500	35 54.56	121 6.78	1016	979717.77	1.61	−9.67	−43.13
501	35 53.97	121 5.99	1070	979713.74	2.29	−7.77	−42.42
502	35 55.07	121 5.91	1232	979704.64	2.80	−3.21	−42.93
503	35 53.76	121 3.89	941	979727.54	1.81	−5.81	−36.48
504	35 54.64	121 4.79	1270	979702.94	3.22	−.72	−41.33
505	35 54.24	121 2.97	977	979731.22	1.70	.57	−31.45

Table 3.—*Principal facts for gravity stations*—Continued

Station	Lat N.	Long W.	Elevation (ft)	Observed gravity (mgal)	Terrain correction (mgal)	Free-air anomaly (mgal)	Complete Bouguer anomaly (mgal)
506	35 53.82	121 3.22	921	979731.46	1.92	−3.85	−33.73
507	35 52.66	121 0.42	925	979738.89	1.76	5.61	−24.57
508	35 52.94	121 1.31	744	979748.19	1.42	−2.52	−26.79
509	35 53.59	121 0.51	941	979737.02	1.40	3.91	−27.17
511	35 50.52	121 0.27	1165	979715.93	1.49	8.27	−30.45
512	35 51.25	121 0.02	1075	979722.37	2.49	5.21	−29.41
513	35 51.63	121 1.06	1098	979720.17	2.09	4.63	−31.18
514	35 50.60	121 1.25	1165	979715.13	1.79	7.36	−31.06
515	35 50.14	121 18.18	2967	979647.31	12.59	109.66	20.02
516	35 49.37	121 18.54	2685	979664.21	10.78	101.14	19.38
526	35 53.02	121 2.56	776	979742.50	1.45	−5.31	−30.65
527	35 52.00	121 2.31	1090	979721.52	1.92	4.70	−31.01
528	35 51.90	121 3.47	1252	979705.23	2.93	3.79	−36.49
529	35 51.09	121 2.40	1138	979717.23	2.16	6.22	−30.90
530	35 52.73	121 4.02	1063	979717.25	2.86	−3.15	−36.99
531	35 52.83	121 6.12	1355	979698.53	3.33	5.45	−37.98
532	35 52.66	121 4.96	1111	979714.70	2.03	−1.09	−37.41
533	35 51.66	121 4.56	1445	979692.23	4.25	9.28	−36.33
534	35 51.33	121 19.36	3350	979629.96	15.12	126.62	26.36
535	35 52.20	121 19.64	2749	979668.49	10.99	107.40	23.65
536	35 52.50	121 18.98	2215	979703.02	6.69	91.29	21.60
537	35 58.77	121 28.55	1893	979726.24	17.47	75.27	27.45
538	35 52.18	121 21.34	3400	979627.63	15.61	127.78	26.29
539	35 50.87	121 21.48	3590	979604.98	22.53	124.86	23.77
540	35 50.15	121 22.22	2866	979645.62	21.61	98.46	21.31
541	35 51.51	121 20.85	3200	979639.35	13.06	121.65	24.48
542	35 50.67	121 17.64	3040	979642.17	13.78	110.62	19.67
543	35 50.09	121 16.26	2471	979677.85	9.87	93.63	18.32
544	35 51.84	121 11.92	1157	979750.12	2.30	39.83	2.19
545	35 51.00	121 10.52	1375	979731.42	4.19	42.83	−.43
546	35 50.25	121 8.02	1230	979736.38	3.31	35.22	−3.92
547	35 51.39	121 9.22	1434	979723.84	3.43	40.24	−5.81
548	35 35.76	121 2.44	690	979752.09	3.61	20.78	.56
549	35 35.70	121 3.40	723	979749.02	3.23	20.90	−.84
550	35 36.00	121 1.12	860	979737.81	4.23	22.15	−3.31
553	35 48.18	121 19.21	2414	979676.53	14.39	89.67	20.84
554	35 49.96	121 19.28	2085	979703.19	7.56	82.85	18.51
555	35 47.24	121 18.34	2390	979678.25	13.70	90.47	21.78
556	35 46.61	121 17.75	2525	979664.18	19.61	90.00	22.57
557	35 48.35	121 18.61	1532	979739.19	5.93	69.14	22.22
558	35 48.03	121 16.97	697	979785.95	6.70	37.83	20.46
559	35 41.93	121 8.83	1193	979737.57	4.82	44.79	8.43
560	35 42.62	121 9.38	1136	979741.77	5.29	42.65	8.73
561	35 43.18	121 10.84	1464	979724.79	7.01	55.72	11.21
562	35 45.73	121 13.22	1764	979711.91	7.21	67.42	13.78
563	35 46.59	121 13.44	1541	979728.76	4.98	62.07	13.88
564	35 46.52	121 15.10	1330	979744.21	5.34	57.78	17.22
565	35 46.55	121 16.18	1181	979749.77	10.07	49.28	18.59
566	35 47.10	121 9.94	2016	979695.82	4.81	73.07	8.36
567	35 47.84	121 9.96	2677	979647.69	10.25	86.05	4.03
568	35 45.48	121 6.54	1850	979697.76	4.21	61.71	2.11
569	35 45.83	121 7.34	2279	979669.40	7.22	73.20	1.84
570	35 46.62	121 7.40	2282	979670.22	5.93	73.17	.42
571	35 38.47	121 8.12	662	979765.65	4.60	27.85	9.59
572	35 39.60	121 7.64	1492	979709.99	9.05	48.65	6.22
573	35 38.78	121 6.76	1180	979729.19	7.48	30.67	6.42
A574	35 59.23	121 11.90	1423	979693.96	4.31	−1.87	−46.66
575	35 57.56	121 13.14	1222	979726.04	3.08	13.70	−25.40
576	35 56.85	121 13.78	1856	979696.22	6.43	44.52	−13.07
577	35 59.22	121 9.73	1219	979712.21	1.94	−2.79	−42.92
578	35 59.58	121 8.38	1308	979705.14	2.15	−2.00	−44.99
579	35 59.28	121 7.19	1114	979718.10	1.76	−6.86	−43.55
581	35 59.77	121 5.36	1705	979686.11	3.53	16.03	−39.25
590	35 57.93	121 1.87	1386	979706.54	2.11	9.09	−36.63
591	35 57.04	121 0.97	1764	979678.09	3.01	17.46	−40.38
949	35 58.81	121 3.87	1630	979693.50	3.16	17.74	−35.33
950	35 59.29	121 2.61	1505	979699.42	2.69	11.22	−38.02
957	35 48.67	121 2.57	1665	979692.99	2.23	35.00	−20.21
958	35 48.40	121 5.27	978	979745.21	1.97	22.99	−8.80
959	35 48.04	121 0.07	1479	979702.16	2.76	27.57	−20.70
960	35 49.02	121 1.38	1538	979698.84	3.19	28.40	−21.47
961	35 47.46	121 4.07	1413	979713.60	2.28	33.63	−12.85
962	35 47.16	121 2.89	1477	979705.55	2.79	32.03	−16.14
963	35 47.44	121 5.65	962	979746.02	2.96	23.66	−6.59
1031	35 52.53	121 17.57	1620	979739.02	5.09	71.29	20.49
1032	35 49.03	121 9.96	2410	979664.48	10.05	76.04	3.01
1038	35 58.59	121 16.10	1724	979718.59	6.70	51.99	−.78
1039	35 58.52	121 11.66	1035	979726.63	1.83	−4.67	−38.57
1040	35 59.57	121 11.30	1445	979698.84	3.58	4.59	−41.69
1041	35 59.95	121 11.61	1394	979704.23	3.20	4.65	−40.25
1042	35 58.91	121 11.23	1414	979693.25	5.09	−2.97	−46.67
2BM	35 52.61	121 13.84	1058	979760.40	3.84	39.69	7.01
3BM	35 52.89	121 14.38	1079	979760.64	3.11	41.48	7.36
4BM	35 52.55	121 14.52	1235	979752.28	2.94	48.24	8.57
7BM	35 52.63	121 15.69	1877	979715.20	6.20	71.76	12.94
8BM	35 52.66	121 16.02	1916	979714.76	5.46	74.69	14.06
9BM	35 52.79	121 16.22	1947	979714.12	5.26	76.82	14.91
10BM	35 52.46	121 14.22	1199	979753.82	2.96	46.61	8.18
11BM	35 52.26	121 14.18	1130	979757.79	3.64	44.37	9.00
15BM	35 51.64	121 12.24	1000	979759.48	3.46	34.70	3.64
17BM	35 51.29	121 11.94	983	979759.80	3.73	33.91	3.71
18BM	35 50.68	121 11.92	983	979760.17	4.70	35.20	5.95
19BM	35 51.39	121 13.04	1423	979737.67	2.94	53.06	6.89
21BM	35 51.06	121 13.93	1487	979734.92	2.81	56.75	9.67
22BM	35 52.78	121 16.41	2047	979708.34	5.82	80.43	15.65
23BM	35 52.81	121 16.66	1985	979714.07	4.80	80.23	16.59

Table 3.—*Principal facts for gravity stations*—Continued

Station	Lat N.	Long W.	Elevation (ft)	Observed gravity (mgal)	Terrain correction (mgal)	Free-air anomaly (mgal)	Complete Bouguer anomaly (mgal)
24BM	35 52.71	121 16.76	1971	979716.08	4.64	81.07	17.75
25BM	35 52.78	121 16.91	1884	979721.08	4.73	77.85	17.59
26BM	35 52.60	121 16.98	1809	979725.94	4.66	75.90	18.15
27BM	35 52.48	121 17.22	1693	979733.24	4.83	72.43	18.86
28BM	35 52.14	121 17.46	1658	979733.68	5.58	70.12	18.49
29BM	35 52.14	121 14.23	1182	979754.83	3.87	46.42	9.51
32BM	35 52.28	121 17.28	1593	979738.24	5.73	68.34	19.10
33BM	35 52.17	121 17.27	1584	979738.08	5.85	67.53	18.72
34BM	35 52.10	121 17.28	1584	979737.27	6.40	66.76	18.52
35BM	35 51.96	121 17.25	1575	979736.53	9.43	65.41	20.49
36BM	35 51.88	121 16.98	1567	979736.70	8.48	64.90	19.32
37BM	35 51.93	121 16.90	1554	979736.97	7.92	63.92	18.21
38BM	35 52.03	121 16.75	1536	979737.22	8.69	62.33	18.02
39BM	35 52.04	121 16.65	1508	979737.17	10.63	59.61	18.21
40BM	35 51.99	121 16.54	1469	979739.89	11.56	58.72	19.59
41BM	35 51.88	121 16.52	1438	979742.30	11.82	58.41	20.60
42BM	35 51.76	121 16.50	1423	979742.92	13.90	57.79	22.58
43BM	35 51.78	121 16.33	1387	979747.00	13.77	58.40	24.31
44BM	35 51.79	121 16.12	1337	979749.94	13.44	56.68	23.97
45BM	35 51.90	121 16.02	1313	979751.18	13.08	55.50	23.26
46BM	35 51.95	121 15.88	1289	979752.63	12.83	54.57	22.93
47BM	35 51.98	121 15.77	1269	979753.47	11.16	53.52	20.88
48BM	35 51.86	121 15.56	1245	979753.74	12.02	51.66	20.73
49BM	35 51.93	121 15.39	1236	979753.52	6.90	50.51	14.76
50BM	35 51.83	121 15.16	1223	979754.39	6.42	50.30	14.52
51BM	35 51.95	121 14.62	1147	979756.58	3.85	45.19	12.09
3GT	35 52.58	121 16.41	2182	979698.87	6.29	83.92	14.97
4GT	35 52.20	121 16.30	2827	979650.13	18.98	96.37	17.93
5GT	35 52.18	121 16.31	2797	979654.49	18.82	97.94	20.37
14GT	35 51.82	121 15.03	1190	979755.05	7.55	47.89	14.37
15GT	35 52.04	121 15.47	1225	979754.59	9.40	50.41	17.53
19GT	35 51.29	121 16.26	1645	979732.21	9.30	68.60	21.15
20GT	35 51.84	121 16.71	2228	979694.07	9.68	84.50	17.36
21GT	35 51.97	121 17.47	2047	979709.04	6.85	82.26	18.52
24GT	35 52.31	121 17.25	1605	979739.32	5.60	70.49	20.72
30GT	35 50.85	121 17.30	2499	979680.82	7.50	97.30	18.96

The accuracy of the gravity data undoubtedly vary from station to station. The observed gravity measurements for the 293 stations read with a LaCoste-Romberg gravity meter were probably accurate to 0.02 mgal after correcting for tidal effects. The 97 stations read with a Worden meter (scale constant about 0.5 mgal) were probably accurate to 0.1–0.2 mgal after correcting for drift. Latitude and longitude were measured to ±0.01 minute. Elevation accuracy depends critically on the type of source data. Roughly 20 percent of the stations were read at bench marks, and elevation errors for these should be less than 0.5 feet. Another 10 percent are field-checked spot elevations probably accurate to within 1 foot, and 55 percent are unchecked spot elevations accurate to within 5 feet. Nine stations were established on the shore of Lake Nacimiento with an estimated elevation accuracy of ±1 foot. Forty-one stations in the vicinity of Burro Mountain (identified by the letters "BM"—for example 32BM—on pl. 1 and in table 3) were leveled in with a Zeiss Opton Self-leveling Level and were probably accurate to ±2 feet.

All gravity data were corrected for terrain effects (at density 2.67 g/cm^3) out to a radius of 166.7 km. For the inner zones, terrain corrections were made by hand using Hayford-Bowie templates and dividing each compartment into four subcompartments where corrections were large. For the outer zones, the corrections were made by computer using a program developed by Donald Plouff. For most of the stations the boundary between inner- and outer-zone corrections was either 5.24 or 2.29 km, and 1-minute and 3-minute terrain digitization grids were employed. For about 40 stations near Burro Mountain, however, computer corrections were carried in to 0.068 km, and additional 0.05-minute and 0.25-minute terrain grids were used.

All basic measurements were reduced to anomaly values using a gravity reduction program developed by the author. The basic procedures and formulas of the reduction are as follows:

1. The gravity difference (ΔG) between the base and a given station is calculated in one of six ways depending on the reduction option selected. It is then corrected for tide and drift.
2. Observed gravity (OG) = Gravity Base Value + ΔG.
3. Theoretical gravity (THG) = $978049(1+.005228 \sin^2\theta - 0.0000059\sin^2 2\theta)$, where θ = latitude.
4. Free-air anomaly (FAA) = $OG - THG + (0.09411549 - 0.000137789\sin^2\theta)E - 0.0000000067E^2$, where E = elevation.
5. Simple Bouguer anomaly (BA) = $FFA - 0.012774\rho E$, where ρ = reduction density.
6. Curvature correction (CC) = $0.0004462 \times E - 3.28 \times 10^{-8} \times E^2 + 1.27 \times 10^{-15} \times E^3$.
7. Complete Bouguer anomaly (CBA) = $BA + TC - CC$, where TC = terrain correction.

GRAVITY INTERPRETATION

Most quantitative interpretation of gravity anomalies here relies largely on a two-dimensional two-layer basement-sediment model. Density contrasts of 0.3 and 0.5 g/cm³ are commonly used to arrive at maximum and minimum dimensions for various anomalous features. The following estimates are used for unit densities:

	g/cm³
Surficial deposits	<2.2
Paso Robles Formation	2.2
Pancho Rico Formation	2.3
Monterey Shale	2.3
Middle and lower Miocene deposits	2.4
Paleocene and upper Mesozoic deposits	2.5
Basement rocks	2.67

Using these values, the density contrasts 0.3 and 0.5 furnish good approximations to common sediment-basement combinations. A mixed sequence of Cretaceous and Tertiary rocks on basement will have a density contrast close to 0.3. Quaternary deposits on basement, however, have a density difference of close to 0.5.

Interpretation of anomalies associated with ultramafic rocks requires different assumptions, since these rocks range in density from 2.5 to 3.3 depending on degree of serpentinization.

In arriving at subsurface mass distribution, graticule and various simple mathematical calculations and interpretations using a U.S. Geological Survey modification of Bott's (1960) interpretation program were fitted to outcrop and well data.

GRAVITY ANOMALIES

DETAILED SURVEY OF THE BURRO MOUNTAIN ULTRAMAFIC BODY

The gravity high at Burro Mountain was first reported by Thompson (1963). On the basis of a preliminary survey of about 20 stations collected from an area of roughly 20 square miles in the vicinity of the Burro Mountain body, Thompson defined an 8-mgal high over the ultramafic body. This surprisingly small value led him to conclude that the depth of the fresh ultramafic rock was shallow, perhaps on the order of the topographic relief of the body, and he speculated on an abundance of concealed serpentinite at depth, perhaps essential to the emplacement of the high density mass.

In the current survey, considerable effort was spent in refining the Burro Mountain anomaly. In addition to selected stations of Thompson (designated by the letters GT—for example, 24GT—on pl. 1 and in table 3) and readings at nearly all elevations available on the topographic map, 41 stations were surveyed in with a Zeiss Opton Self-leveling Level. In order to improve the accuracy of terrain corrections, the computer program employed an extremely fine digitization grid in this vicinity. Twelve square miles were digitized on a 0.05-minute grid, and approximately 200 square miles were digitized on a 0.25-minute grid.

The results of this detailed investigation confirm the essential correctness of Thompson's preliminary conclusions. The anomaly was again determined to be about 8 mgal (pl. 1) after removing the regional gradient. The total anomalous mass was determined by Gauss' theorem to be roughly 5×10^{14} grams. Using the widest range of reasonable density contrasts, one arrives at a subsurface volume for the fresh ultramafic rock of between 1 and 2 km³. This small volume, combined with the size and shape of the anomaly and the mapped ultramafic contacts, suggests a maximum depth of 1 km for the fresh ultramafic rock. Considering the known density distribution in plan view (Burch, 1968, fig. 3), the fresh rock probably extends no deeper than 2,000 feet.

The one inference made by Thompson which was not corroborated by subsequent detailed investigation is the abundance of concealed serpentinite at depth. On an aeromagnetic profile (fig. 2) the Burro Mountain body produces an anomaly of only 30–40 gammas. This is in striking contrast to the smaller elongate body 4 miles to the southwest, which produces an anomaly of 300 gammas, and several smaller serpentinites to the southeast, which produce anomalies of 100–200 gammas.

Both gravity and aeromagnetic data thus suggest that neither the fresh nor the altered ultramafic rocks of the Burro Mountain body extend to any significant depth. This lends support to the author's earlier contention (Burch, 1968) that the body is an isolated tectonically emplaced block.

REGIONAL SURVEY

The regional gravity map consists basically of a rather even northeastward gravity gradient of roughly −3 mgal per mile except (1) in the northwestern corner where a broad gravity high is associated with the Santa Lucia Mountain mass, (2) in the northeastern corner where a broad gravity low is associated with Lockwood Valley, (3) south and east of Lockwood Valley where several basement irregularities are reflected in the gravity picture, (4) west of Lockwood Valley where a very steep gravity gradient (up to 20 mgals per mile) cuts diagonally across the entire Bryson quadrangle, and (5) at numerous places in the Franciscan Formation where small irregularities reflect small heterogeneities in this unit or possible small errors in elevation control.

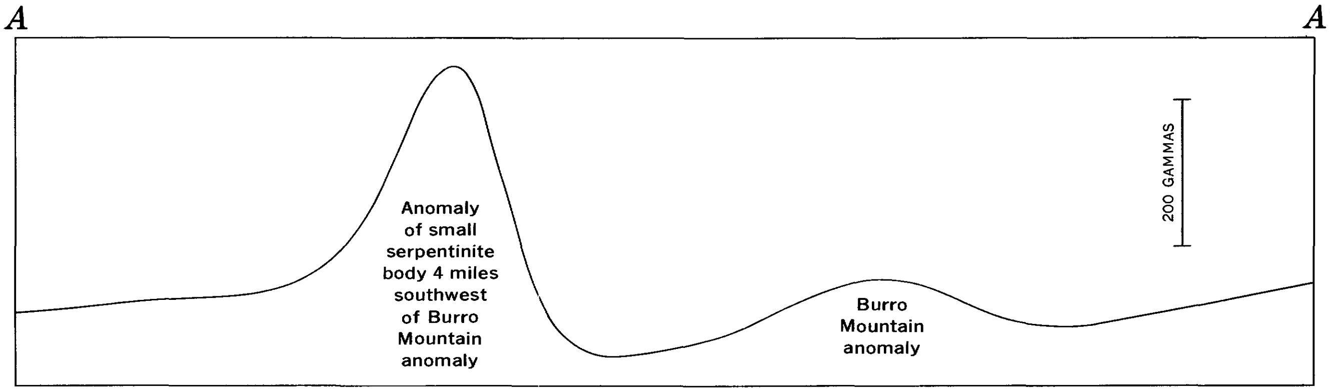

FIGURE 2.—Aeromagnetic profile (*A–A′* on pl. 1) comparing the Burro Mountain anomaly with the anomaly caused by a smaller serpentinite body 4 miles southwest.

The even gradient of roughly −3 mgal per mile obtains with only minor interruption over the entire southern half of the area. This value corresponds closely with the value shown by Thompson and Talwani (1964, fig. 4) for the continental margin. Such a broad and even gradient is most likely caused by a very deep-seated density contrast and thus probably reflects deeper structure of the continental margin. The evenness of the gradient also suggests a rather homogeneous density for the Franciscan Formation in this area and seemingly precludes large masses of anomalous density. It also requires that the overlying patches of Tertiary sedimentary rock be relatively thin.

The gravity high in the upper left-hand corner of the map area in the southeastern end of a long northwest-trending high which continues more than 40 miles beyond the edge of the map area (Bishop and Chapman, 1967). To the north the high is associated with the western metamorphic belt of the Santa Lucia Range, but in the map area it crosses the Nacimiento fault and continues with diminished amplitude for over 12 miles within the Franciscan block. The close coincidence of the gravity and topographic highs indicates that the anomaly results from the high density of the mountain mass itself rather than from some buried anomalous body. A simple calculation using the slab formula suggests that the true density of the mountain mass in the area of the anomaly is 2.80 to 2.85 g/cm^3. This density must be considered tentative, however, because it is difficult to distinguish residual and regional anomalies at the western edge of the mountain mass. Offshore data (Burch and others, 1970) indicate a gravity low about 7 miles from the coast, where complete Bouguer values may be as low as −20 to −30 mgal.

Several interesting anomalies are found in the Salinian block in the Bryson quadrangle. The broad low in Lockwood Valley indicates a relatively large thickness of low-density sedimentary rocks. Analysis using the Bott interpretation program suggest a depth to basement of 7,000 feet at the bottom of the low. At the northern end of this valley a sharp linear gravity low extends about 2 miles northwest from Jolon, along the Jolon fault. This anomaly could represent disruption of the basement along the Jolon fault, but more likely it is caused by low-density diatomite, also probably faulted in along the same fault. At the lower end of Lockwood Valley, crossing the map boundary, is a northwest-trending 8-mgal high. The Bott program, together with a graticule analysis and well data on the flank, suggests that the source is a basement ridge with approximately 2,500 feet of vertical relief which rises to within 300–400 feet of the surface. The gravity high and presumably the basement ridge continue with diminished size northward out of the map area. The steep gravity gradient east of the high reflects a large displacement of the basement surface across the Espinosa fault zone.

The existence of a northeast-trending basement fault in the northeast corner of the map area is suggested by the 1- to 2-mile right-lateral offset of several northwest-trending features in this area. The gravity contours north of the map area (therefore not shown on pl. 1) indicate the offset of the gravity ridge and the parallel low just northeast of it. The southern end of the Lockwood Valley low also appears to terminate against this fault. The significance of the possible fault is that a similar transverse fault, the Indian Valley fault, appears 19 to 20 miles southeast (Burch and Durham, 1970) on the opposite side of the Espinosa and Jolon faults. If these transverse faults once joined, approximately 16 miles of right-lateral strike-slip movement on the Espinosa fault would be required, in addition to 3 or 4 miles on the Jolon fault, in order to explain the current 19- to 20-mile offset of the transverse faults.

Probably the most conspicuous feature of the gravity map is the steep northwest-trending gravity gradient (up to 20 mgal per mile) west of Lockwood Valley. Such a gradient probably reflects a major and continuous basement fault. Use of the simple slab formula indicates a vertical displacement of the basement surface of at least 5,000 feet and possibly 10,000 feet. The fault cannot be traced at the surface since the entire tract of Monterey Shale appears to be cut by numerous small faults.

Many small anomalies, or gravitational irregularities, in the Franciscan are defined by a single station only. While some reflect small anomalous-density masses, others are probably caused by elevation uncertainties. Station 516 (4 miles southwest of Burro Mountain), for example, is a gravity low located on ultramafic rock and associated with a strong magnetic high (fig. 2). The ultramafic rock, having a low-density and high-magnetic susceptibility, is thus well serpentinized. Station 329, on the other hand, controls a small, sharp positive anomaly which could signify either a small anomalous mass or uncertainty in elevation or field data.

The most significant structural feature of the map area, the contact between the Franciscan and Salinian structural blocks, shows little or no gravity expression. It was suggested earlier that the gently dipping contact between Upper Cretaceous rocks and the Franciscan Formation in the eastern part of the map area, mapped as the Nacimiento fault zone, probably does not also mark the basement contact. If this is true, a wide area of unknown basement exists between the easternmost outcrops of Franciscan Formation and westernmost known occurrences of granitic basement. The gravity data permit little more than a speculative guess regarding the location of the basement contact in this area. Subtle reentrants of the gravity contours at stations 486 and 151 could conceivably represent Salinian basement faulted against younger, lighter rocks on the west. A fault at these locations lines up well with the fault extending southeast from the metamorphic block composing Chalk Peak and with the thrust fault in the eastern part of Bryson quadrangle. Although the relationship between the basement contact and the thrust fault is almost certainly coincidental, Burch and Durham (1970) suggest that the basement contact may continue to follow the thrust fault several miles southeast beyond the map boundary, eventually merging with the Jolon and Rinconada faults.

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