Mariposa Quadrangle, Mariposa and Madera Counties, California—Analytic Data

U.S. GEOLOGICAL SURVEY BULLETIN 1613

Mariposa Quadrangle, Mariposa and Madera Counties, California—Analytic Data

By KONRAD B. KRAUSKOPF

Modal and chemical data on plutonic rocks of the Mariposa quadrangle

U.S. GEOLOGICAL SURVEY BULLETIN 1613

DEPARTMENT OF THE INTERIOR
WILLIAM P. CLARK, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

UNITED STATES GOVERNMENT PRINTING OFFICE : 1984

For sale by the
Distribution Branch, Text Products Section
U.S. Geological Survey
604 South Pickett St.
Alexandria, VA 22304

Library of Congress Cataloging in Publication Data

Krauskopf, Konrad Bates, 1910–
Mariposa quadrangle, Mariposa and Madera Counties, California—analytic data

(U.S. Geological Survey Bulletin 1613)
Bibliography: p. 2.
Supt. of Docs. no.: I 19.3:1613)
1. Rocks, igneous. 2. Petrology—California—Mariposa County. 3.Petrology—California—Madera County. I. Title. II. Series: United States. Geological Survey. Bulletin 1613.

QE75.B9 no. 1613 557.3s 84–600059
[QE461] [552'.3'0979446]

CONTENTS

FIGURES

TABLES

Mariposa Quadrangle, Mariposa and Madera Counties, California—Analytic Data

By Konrad B. Krauskopf

Abstract

About 220 samples of the plutonic rocks of the Mariposa quadrangle were collected during geologic mapping. All the samples were analyzed modally, and 11 were analyzed chemically. The tonalite of Blue Canyon, which forms the principal plutonic body in the quadrangle, ranges in composition from granite to diorite, and transitions between varieties are gradational. The distribution of different varieties shows no regular zoning but apparently is somewhat influenced by the composition of adjacent metamorphic rocks. The presence of subhedral to euhedral hornblende and biotite crystals in large parts of the tonalite of Blue Canyon is interpreted to indicate abundant water in the melt phase of the magma during crystallization, and the paucity of magnetite suggests a low oxygen fugacity.

Radiometric ages of the plutonic rocks, based chiefly on values for samples collected from the same plutons in adjacent quadrangles, are approximately 114 m.y. for the tonalite of Blue Canyon and the leucotonalite of Ward Mountain, about 111 m.y. for the leucotonalite north of Eastman Lake, and about 105 m.y. for the tonalite of Oakhurst.

INTRODUCTION

The Mariposa quadrangle is in the western foothills of the Sierra Nevada, about 50 km southwest of Yosemite Valley. State Highway 140, the main access road to Yosemite from the west, crosses the northwest corner of the quadrangle. State Highway 49, the Mother Lode highway, runs east-west across the northern part of the quadrangle. Both of these highways and a network of county roads provide access to all parts of the quadrangle. The town of Mariposa in the northwest corner and the nearby village of Bootjack are the only organized communities.

This report supplements the geologic map of the quadrangle (Krauskopf, 1984) by providing modal and chemical data on the plutonic rocks. The data are presented below in maps, diagrams, and table (figs. 1-7; table 1), and the brief text is intended as a guide to understanding and interpreting the data. A nontechnical summary of the general geology of the quadrangle accompanies the geologic map.

GENERAL GEOLOGY

The entire Mariposa quadrangle is underlain by plutonic and metamorphic rocks. The metamorphic rocks occupy two principal areas—a wide strip along the west side and a large area in the east-central part of the quadrangle. The first area is part of the foothill metamorphic belt that extends north-south continuously for 300 km along the Sierra foothills, and the second area is part of the Coarsegold septum.

The largest granitic body in the quadrangle is the tonalite of Blue Canyon, which occupies the central part of the quadrangle and extends into adjacent quadrangles on all four sides. The granitic rocks vary in texture and composition, and boundaries between the different varieties are gradational. A nearly identical rock unit, the tonalite of Oakhurst, forms a large pluton in the adjacent quadrangle (Bass Lake) to the east, and the edge of this pluton extends into the Mariposa quadrangle on the east margin.

Two bodies of leucotonalite extend into the southwestern and southeastern parts of the quadrangle. The southwestern body is designated the "leucotonalite north of Eastman Lake" on the Raymond quadrangle map and is correlated with the granodiorite of Knowles (Bateman and others, 1981); the southeastern body is herein mapped as part of the leucotonalite of Ward Mountain. Diorite and gabbro crop out in small areas in many parts of the quadrangle. Serpentinized ultramafic rocks accompany the prong of metamorphic rocks near Mariposa and appear in small bodies elsewhere.

SAMPLING AND ANALYTICAL METHODS

Figure 1 shows the locations of 223 samples of typical plutonic rocks in the Mariposa quadrangle that were collected at an average spacing of 1.6 km, using care to obtain fresh and representative samples of the rocks at each locality. All the samples were analyzed modally, and 11 were analyzed chemically (samples MA8-MC49, table 1). Analyses of three other specimens from the tonalite of Blue Canyon are also listed in table 1 (samples C-CR5 to C-CR19). These specimens are from drill cores obtained in an earlier investigation (Saucier and Crisp, 1969); because they are located only by section number, they are not included on the maps or diagrams. Of the modal analyses, 216 were made by combining the point counts of selectively stained slabs (Norman, 1974) with those of thin sections, and 7 modes were estimated from thin sections only. At least 1,000 regularly spaced points were counted on slabs with areas of 70 cm^2 or more to determine the volume percentages of quartz, K-feldspar, plagioclase, and total mafic minerals. Relative amounts of biotite and hornblende were then determined on thin sections and apportioned to the total content of mafic minerals. Isopleths were drawn on figures 2 through 6 to bring out systematic patterns, but contouring was not attempted in areas where differences in the values are unsystematic or slight.

TONALITE OF BLUE CANYON

The tonalite of Blue Canyon is a medium-grained rock, with dimensions of its principal minerals commonly in the range 1-3 mm. On a large scale, the texture and composition are remarkably uniform, but locally the composition ranges from quartz diorite and diorite on the one hand to granodiorite and granite on the other. The rock is nowhere conspicuously porphyritic, but locally both hornblende and K-feldspar form crystals as much as 20 mm long. Mafic minerals generally make up more than 15 percent of the rock. Hornblende and biotite are both commonly present, with biotite in excess, but hornblende predominates locally and is completely absent in some varieties. The proportion of hornblende, calculated as 100hornblende/(hornblende+biotite), increases with the total content of mafic minerals, from 0 at less than 10 percent mafic minerals to 50 percent at about 40 percent mafic minerals (fig. 7). Plagioclase, generally the dominant mineral, has compositions mostly in the range 35-50 percent anorthite. Normal zoning is common over a range of about 5 percent anorthite, but many specimens have a wider range, and some show conspicuous oscillatory zoning. Quartz in some specimens forms large crystals but more commonly appears as aggregates of small anhedral grains. K-feldspar locally forms numerous small subhedral phenocrysts, especially in the northern part of the quadrangle, but generally is limited to small stringers between other crystals, and in many specimens is absent altogether.

Compositional patterns are not clearly defined, but as a broad generalization the more felsic rocks (lower density, higher quartz, lower total mafic minerals, and higher biotite/hornblende ratios) appear in the south-central part and northeast corner of the quadrangle. More mafic varieties form one ill-defined belt from northwest to southeast and another from the southwest corner into the central part of the quadrangle. This distribution shows enough relation to the composition of adjacent metamorphic rocks and to areas of gabbro and diorite to suggest that the composition of the tonalite was to some extent influenced by the rocks which it intruded.

As noted by Bateman and Sawka (1981) for this tonalite in the adjacent Raymond quadrangle to the south, the scarcity of magnetite as an accessory mineral despite a general abundance of mafic constituents suggests low f_{O_2} in the magma, and the common presence of subhedral to euhedral biotite and hornblende crystals indicates a relatively high content of water.

OTHER GRANITIC ROCKS

Rocks in the small segment of the Oakhurst pluton at the east border of the Mariposa quadrangle could be described in the same terms as the tonalite of Blue Canyon, except that in such a small area the variety of rocks displayed is more limited.

The leucotonalite in the southwest corner of the quadrangle is a fine-grained light-colored rock containing biotite and muscovite in small amounts, but no hornblende. Locally, K-feldspar forms small (max 6 mm), inconspicuous phenocrysts poikilitically enclosing other minerals.

The leucotonalite of Ward Mountain in the southeast corner of the quadrangle is also a light-colored rock containing biotite and muscovite, but is coarser grained and shows conspicuous cataclastic structure. In much of the rock, biotite is concentrated in curious crescent-shaped aggregates of tiny anhedral flakes; the crescents are as much as several centimeters long.

AGES

Radiometric ages have been determined for one sample from the Mariposa quadrangle, the tonalite of Blue Canyon, collected from the west side of Ben Hur Road, 1.5 km south of Mormon Bar (UTM Zone II coordinates $^{41}48^{900}$ N., $^{2}39^{700}$ E.). Ages determined by the U-Pb method on zircon from this sample for the three ratios $^{206}Pb/^{238}U$, $^{207}Pb/^{235}U$, $^{208}Pb/^{232}Th$ are, respectively, 118.5, 113.5, and 106.2 m.y. (field No. MA-1; Stern and others, 1981, p. 4). The K-Ar mineral age for this same sample was determined as 114 m.y. on biotite and 118 m.y. on hornblende (R. W. Kistler, written commun., 1976). Combining the U-Pb values for this specimen with those for samples from adjacent quadrangles gives an approximate age of 114 m.y. for the tonalite of Blue Canyon. From adjacent quadrangles, samples of the leucotonalite of Ward Mountain give an approximate U-Pb age of 114 m.y., and samples of the tonalite of Oakhurst give an age of 105 m.y. (Stern and others, 1981). The leucotonalite north of Eastman Lake, if it can be correlated with the granodiorite of Knowles in the Raymond quadrangle to the south, has a U-Pb age of 111.5 m.y. (Bateman and Sawka, 1981).

REFERENCES CITED

Bateman, P. C., Busacca, A. J., Marchand, D. E., and Sawka, W. N., 1981, Geologic map of the Raymond quadrangle, Madera and Mariposa Counties, California: U.S. Geological Survey Geologic Quadrangle Map GQ-1555, scale 1:62,500.

Bateman, P. C. and Sawka, W. N., 1981, Raymond quadrangle, Madera and Mariposa Counties, California—analytic data: U.S. Geological Survey Professional Paper 1214, 16 p.

Krauskopf, K. B., 1984, Geologic map of the Mariposa quadrangle, Mariposa and Madera Counties, California: U.S. Geological Survey Geologic Quadrangle Map GQ-1586, scale 1:62,500.

Norman, M. B., 1974, Improved techniques for selective staining of feldspar and other minerals using amaranth: U.S. Geological Survey Journal of Research, v. 2, no. 1, p. 73-79.

Saucier, K. L. and Crisp, R. W., 1969, Tests of rock cores: Castle study area. California: U.S. Army Corps of Engineers Miscellaneous Paper C-69-16, 128 p.

Stern, T. W., Bateman, P. C., Morgan, B. A., Newell, M. F., and Peck, D. L., 1981, Isotopic U-Pb ages of zircon from the granitoids of the central Sierra Nevada, California: U.S. Geological Survey Professional Paper 1185, 17 p.

Streckeisen, A. L., chairman, 1973, Plutonic rocks: Classification and nomenclature recommended by the IUGS Subcommission on the Systematics of Igneous Rocks: Geotimes, v. 18, no. 10, p. 26-30.

FIGURES 1-7; TABLE 1

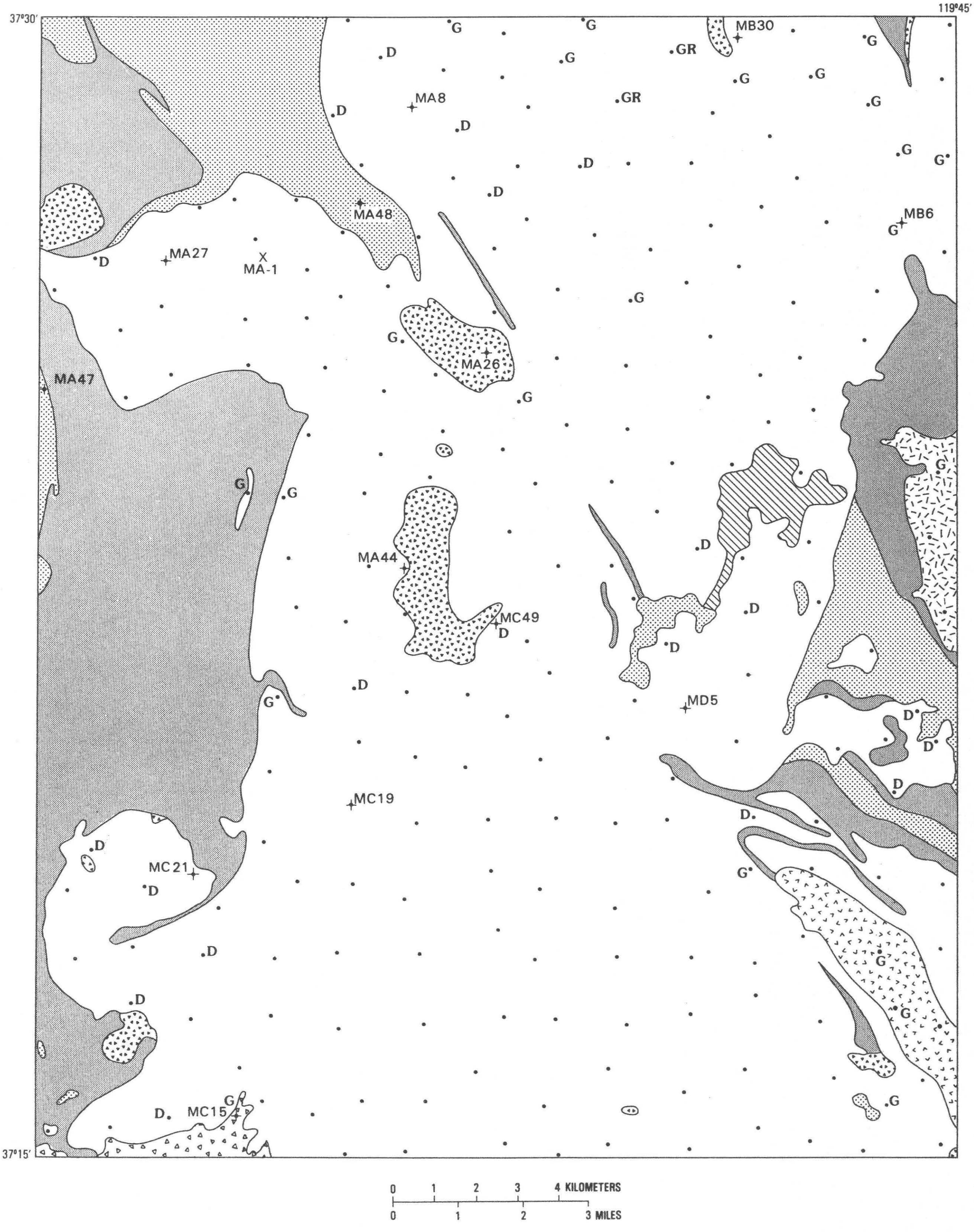

Figure 1. Mariposa quadrangle, showing principal bedrock units, locations of modally analyzed and chemically analyzed samples, and locations of samples of major granitoid types.

EXPLANATION

Leucotonalite north of Eastman Lake (Cretaceous)

Leucotonalite of Ward Mountain (Cretaceous)

Tonalite of Oakhurst (Cretaceous)

Tonalite of Blue Canyon (Cretaceous)

Diorite and gabbro (Cretaceous or Jurassic)

Metasedimentary rocks (Mesozoic and Paleozoic)—Chiefly metasedimentary rocks, minor metavolcanic rocks

Metasedimentary rocks with abundant metalimestone (Mesozoic and Paleozoic)

Metavolcanic and ultramafic rocks (Mesozoic and Paleozoic)

Contact

• Modally analyzed sample

+ MA44 Chemically analyzed sample—D, quartz diorite; G, granodiorite; GR, granite; all others, tonalite

X MA-1 Sample dated by U–Pb method

— 30 — Isopleth—Showing volume percent. See figs. 2-6

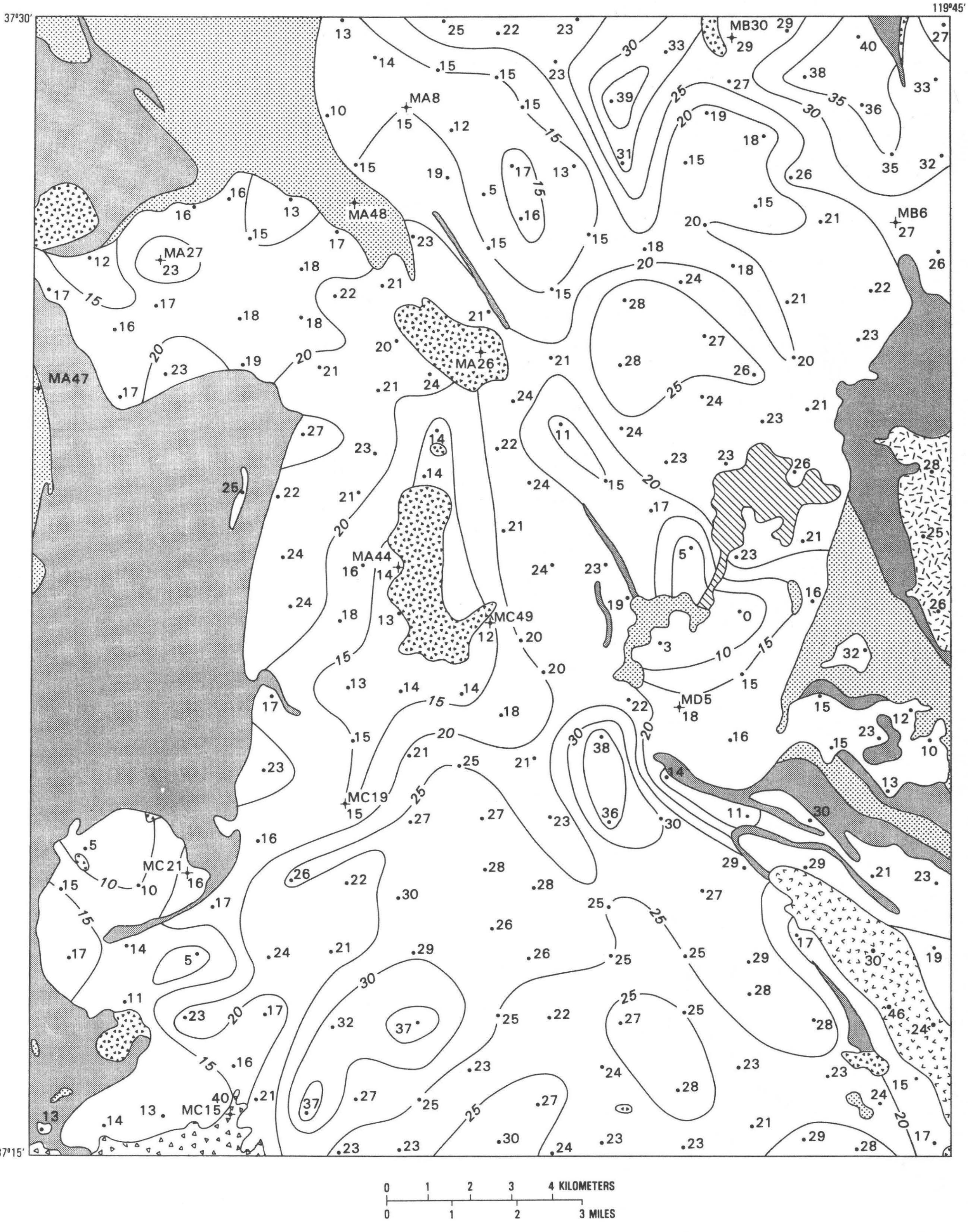

Figure 2. Mariposa quadrangle, showing volume percentages of quartz. Isopleth interval, 5 volume percent. See figure 1 for explanation.

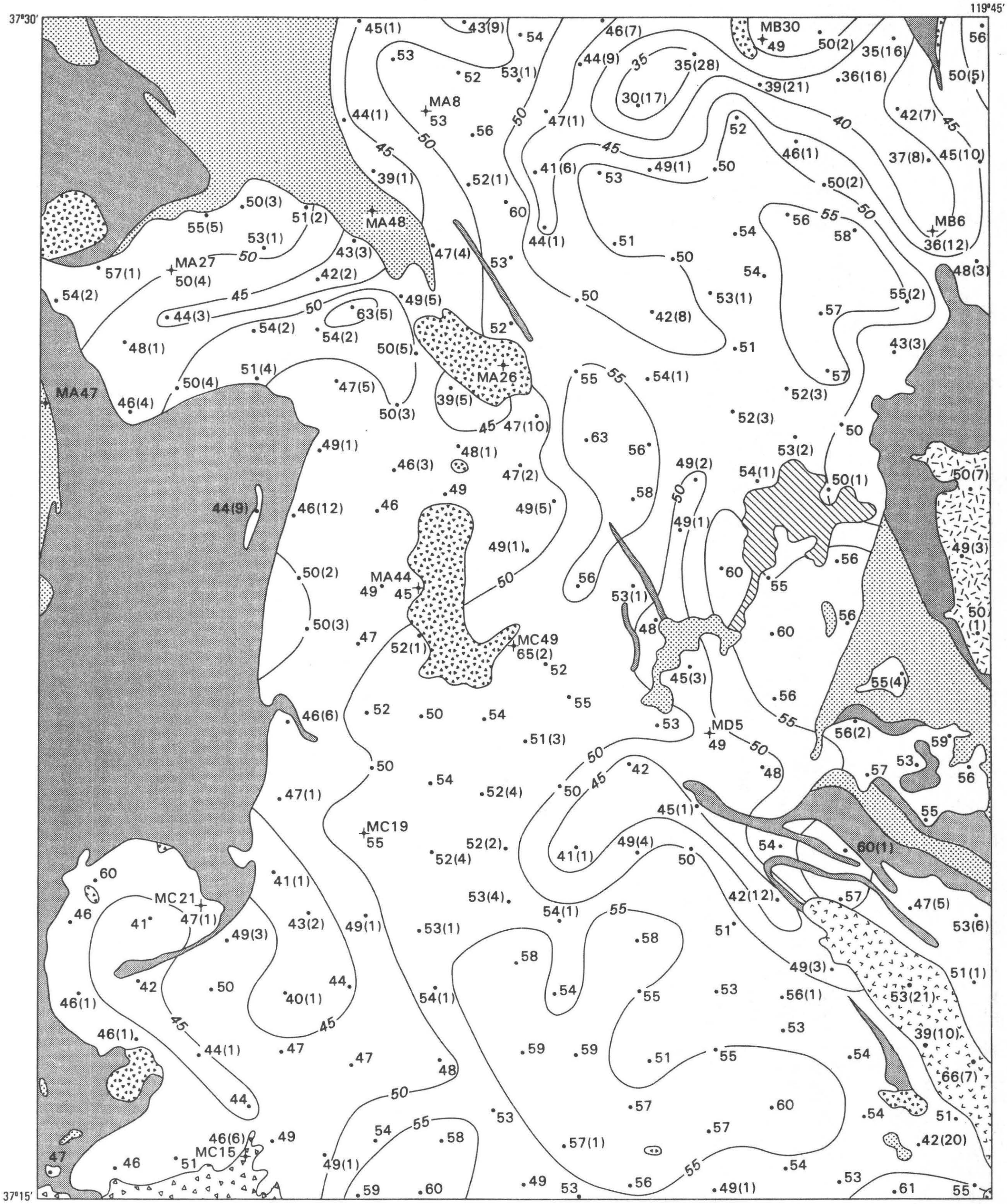

Figure 3. Mariposa quadrangle, showing volume percentages of feldspar. Numbers without parentheses are volume percentages of plagioclase (An_{5-100}), rounded to the nearest whole number. Numbers within parentheses are volume percentages of alkali feldspar, omitted where less than 0.5 volume percent. Thus, "54(3)" indicates a sample containing 54 volume percent plagioclase and 3 volume percent alkali feldspar; and "43" indicates a sample containing 43 volume percent plagioclase and less than 0.5 volume percent alkali feldspar. Isopleths show volume percentage of plagioclase; interval, 5 volume percent. See figure 1 for explanation.

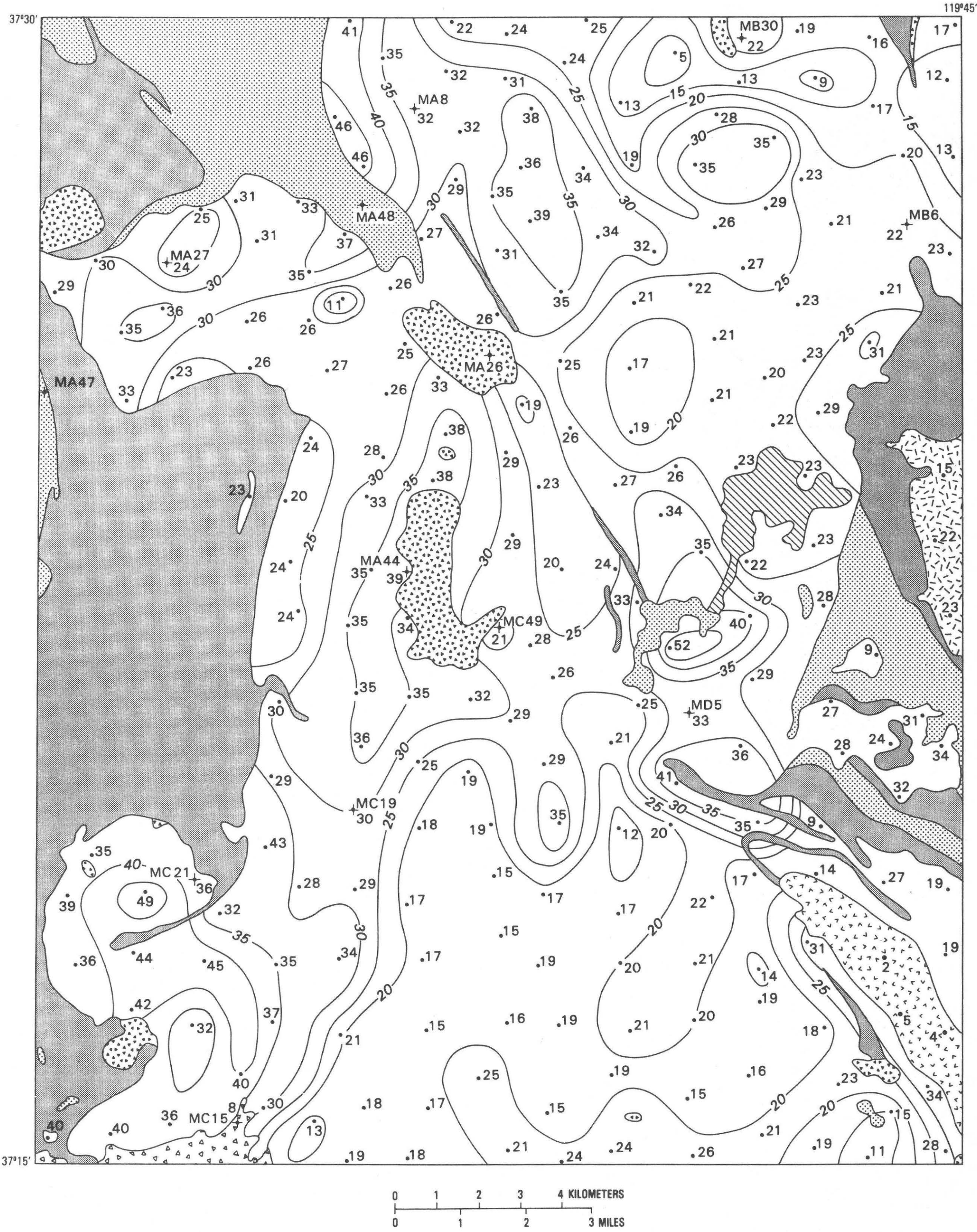

Figure 4. Mariposa quadrangle, showing volume percentages of mafic minerals. Isopleth interval, 5 volume percent. See figure 1 for explanation.

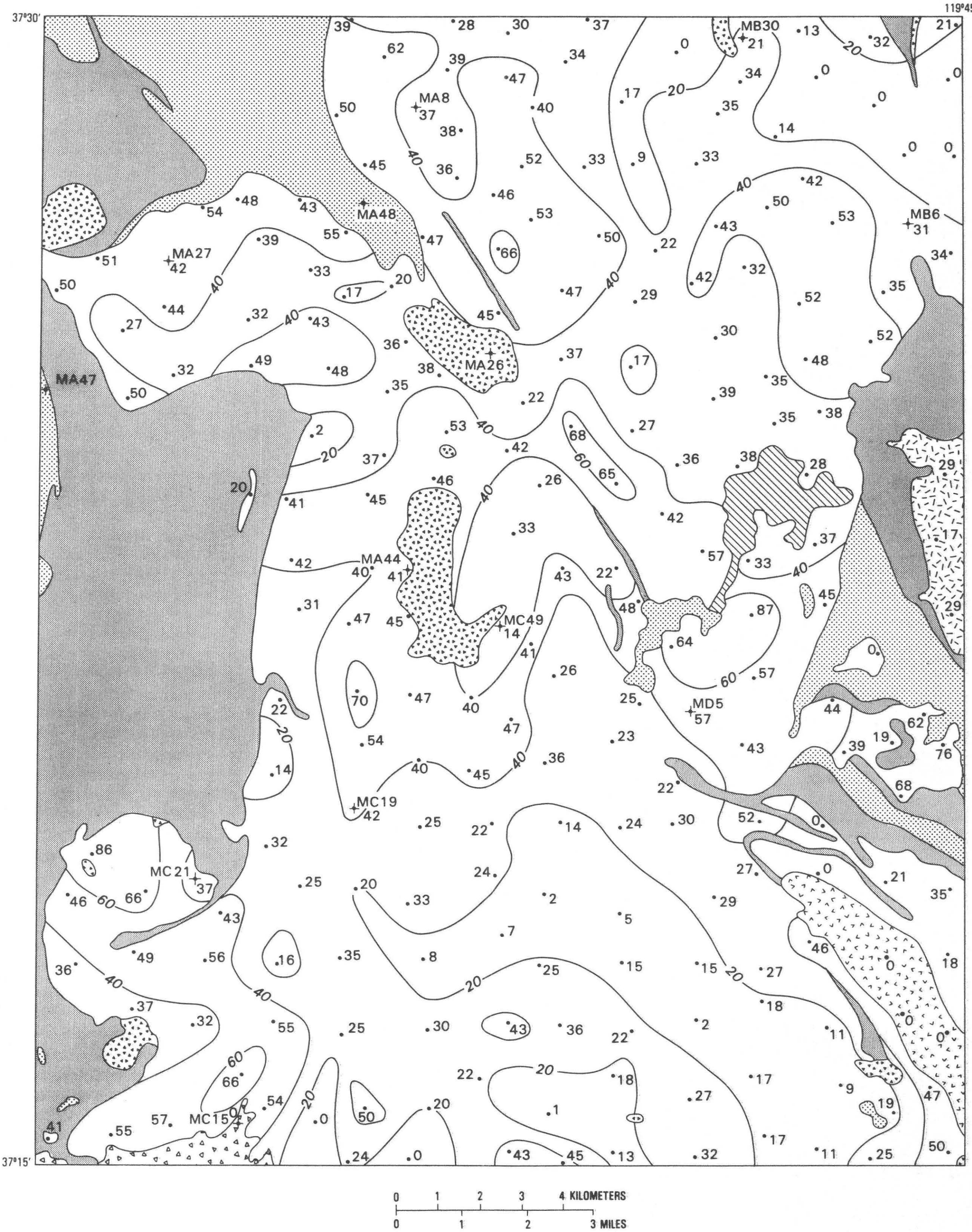

Figure 5. Mariposa quadrangle, showing values of 100hornblende/(biotite+hornblende). Isopleth interval, 20. See figure 1 for explanation.

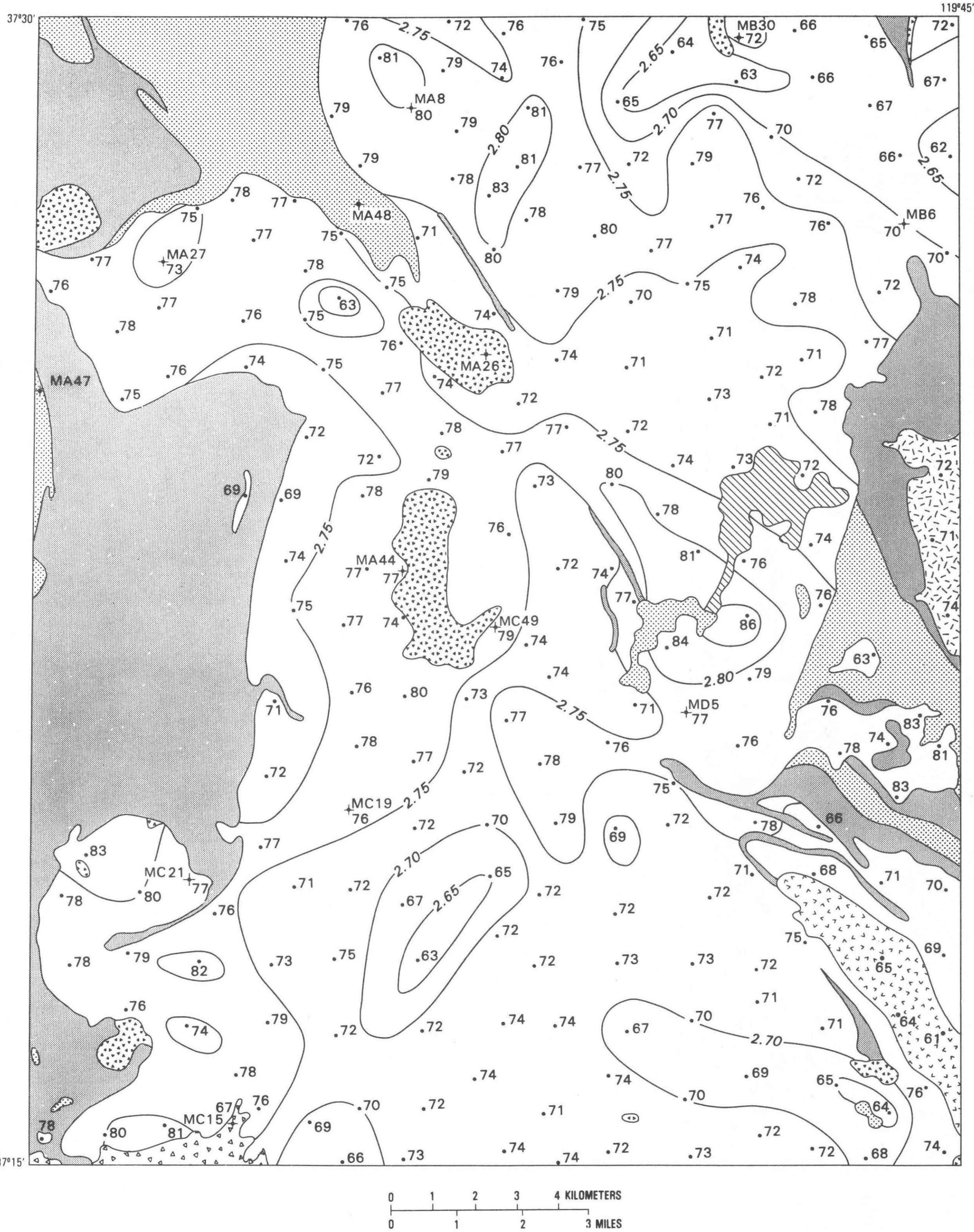

Figure 6. Mariposa quadrangle, showing bulk densities (in grams per cubic centimeter). Numbers are decimals that follow "2"; thus, "75" indicates a bulk density of 2.75 g/cm^3. Isopleth interval, 0.05 g/cm^3. See figure 1 for explanation.

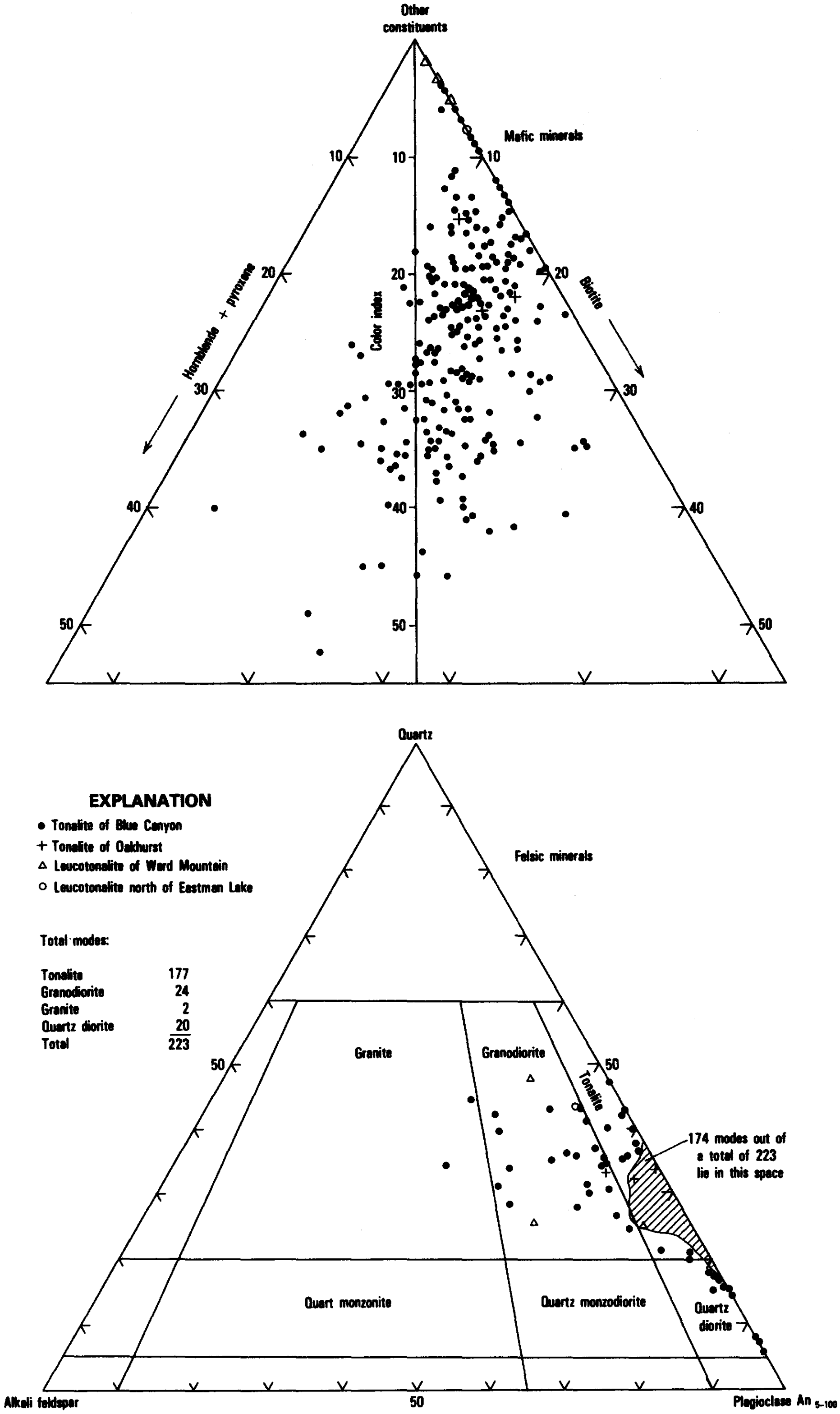

Figure 7. Modes of granitic rocks. Classification scheme by Streckeisen (1973).

Table 1. Chemical analyses, modes, and norms of samples from the Mariposa quadrangle.

[Chemical analyses for samples MA8 to MC49 and MC15 to MA48 by X-ray spectroscopy; analysts: J. S. Wahlberg, J. Taggart, J. Baker, and D. Shepard; supervisors: J. S. Wahlberg and J. M. Baldwin. Modal analyses of felsic minerals and total mafic minerals determined by counting 1,000 to 2,000 points on selectively stained slabs of at least 70-cm^2 area; analyst, Oleg Polovtsoff. Hornblende and biotite determined by apportioning counts on thin sections to total mafic minerals. Chemical analyses for samples C-CR5 to C-CR19 by rapid rock method; analysts: J. Elmore, H. Smith, G. Chloe, J. Glenn, J. Kelsey; supervisor: L. Shapiro. Modal analyses by counting on thin sections; analyst, P. C. Bateman]

Sample no.--	MA8	MA27	MA44	MB6	MB30	MC19	MC21	MD5	MC49	C-CR5	C-CR10	C-CR19	MC15	MA26	MA47	MA48
Rock name---	Tonalite of Blue Canyon												Others			
Rock type---	Tonalite	Tonalite	Tonalite	Granodiorite	Tonalite	Tonalite	Tonalite	Tonalite	Quartz diorite	Tonalite	Quartz diorite	Tonalite	Granodiorite	Hypersthene diorite	Metadacite	Serpentine
Location----	See figure 1									T.5 S. R.19 E. sec. 28	T.6 S. R.19 E. sec. 34	T.7 S. R.20 E. sec. 28	South of Green Mountain	Valley of Humbug Creek	West edge of quadrangle	3 km East of Mariposa near Highway 49
Chemical analyses (weight percent)																
SiO_2--------	59.4	64.4	61.3	67.7	66.2	61.8	61.9	60.4	67.1	60.1	54.2	66.4	73.4	56.6	79.4	44.1
Al_2O_3-------	17.6	16.4	16.6	15.2	16.2	17.1	15.9	17.7	17.0	17.1	18.7	16.4	15.2	18.9	10.2	1.45
Fe_2O_3-------	1.15	.82	1.38	.85	1.26	1.06	.86	.82	.66	.70	.00	.14	.18	1.64	.28	3.66
FeO---------	4.65	3.49	4.38	2.65	2.55	4.35	4.43	4.48	2.67	5.0	7.2	3.6	.94	5.28	.96	4.65
MgO---------	3.47	2.30	3.24	1.80	1.85	3.13	3.94	3.36	1.66	3.3	4.3	1.8	.48	4.30	1.52	39.42
CaO---------	6.84	4.67	5.91	3.53	4.46	6.07	5.17	6.55	4.46	6.1	6.9	4.5	2.26	7.96	2.01	.1
Na_2O--------	3.17	3.24	3.11	2.86	3.44	3.41	3.36	3.36	3.99	3.2	3.4	3.5	3.98	3.37	2.28	<.15
K_2O---------	1.43	2.45	1.84	3.77	2.05	1.46	2.37	1.32	1.31	1.7	2.4	1.9	2.40	.49	1.84	<.02
H_2O^+--------	.92	.96	.95	.63	.88	1.00	1.13	1.15	.80	1.1	1.2	.77	.33	.46	.67	5.29
H_2O^---------	.14	.17	.11	.11	.21	.12	.16	.12	.10	.14	.11	.13	.04	.14	.06	.51
TiO_2--------	.79	.55	.77	.50	.48	.68	.77	.69	.51	.88	.93	.50	.13	.88	.44	<.02
P_2O_5--------	.18	.14	.18	.1	.15	.13	.19	.17	.15	.18	.26	.11	.07	.19	.09	<.05
MnO---------	.1	.07	.1	.05	.07	.09	.08	.09	.05	.13	.15	.07	<.02	.12	.02	.13
CO_2---------	.18	.19	.32	.07	.16	.09	.12	.16	.19	<.05	<.05	<.05	.08	.14	.28	.22
Total----	100.1	99.9	100.2	99.8	100.0	100.5	100.4	100.4	100.65	100.0	100.0	100.0	99.5	100.5	100.1	< 99.8
Modes (volume percent)																
Quartz------	15	23	13	27	29	15	16	18	12	25	15	34	40	2 *	†	††
K-feldspar--	0	4	1	16	0	0	1	0	2	0	0	1	6	0		
Plagioclase-	53	50	45	35	49	55	47	49	65	51	60	50	46	70		
Mafic minerals										24	25	15				
Biotite---	20	13	24	15	17	17	23	14	18				8	3		
Hornblende	12	10	17	7	5	13	13	19	3				0	7		
Hypersthene	--	--	--	--	--	--	--	--	--				0	18		
Total---	100	100	100	100	100	100	100	100	100	100	100	100	100	100		
Bulk density (g/cm^3)	2.80	2.73	2.78	2.70	2.72	2.76	2.77	2.77	2.74	--	--	--	2.67	2.85	--	--
CIPW Norms (weight percent)																
Q-----------	14.08	21.19	17.22	25.35	25.42	16.87	14.82	14.84	25.74	14.76	.16	24.37	35.39	9.36	52.89	.00
C-----------	.00	.27	.00	.24	.58	.00	.00	.00	1.27	.00	.00	.67	2.13	.00	1.03	1.36
or----------	8.56	14.70	11.01	22.51	12.28	8.69	14.15	7.89	7.78	10.21	14.41	11.35	14.32	2.90	10.98	.00
ab----------	27.15	27.82	26.63	24.44	29.49	29.06	28.73	28.74	33.91	27.52	29.23	29.94	34.00	28.54	19.48	.00
an----------	29.94	22.59	26.21	17.03	21.42	27.24	21.52	29.63	21.24	27.72	29.13	21.84	10.86	35.02	9.48	.53
di----------	2.65	.00	1.86	.00	.00	1.84	2.56	1.72	.00	1.52	3.26	.00	.00	2.65	.00	.00
hy----------	14.00	10.84	13.14	7.99	7.69	13.15	15.03	14.26	7.78	15.12	21.41	10.40	2.62	17.04	4.67	47.84
mt----------	1.69	1.21	2.03	1.25	1.85	1.55	1.26	1.20	.96	1.03	.00	.21	.26	2.38	.41	5.68
il----------	1.52	1.06	1.48	.96	.92	1.30	1.48	1.33	.97	1.70	1.79	.96	.25	1.67	.84	.00
ap----------	.43	.34	.43	.24	.36	.31	.46	1.41	.36	.43	.63	.26	.17	.45	.22	.00
ol----------	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	44.60
Total----	100.02	100.02	100.01	100.01	100.01	100.01	100.01	101.02	100.01	100.01	100.02	100.00	100.00	100.01	100.00	100.01

* Estimate from thin section, not point counted.
† Sample MA47 consists of quartz, plagioclase, actinolite, and biotite. Sample was not point counted.
†† Sample MA48 consists of olivine, anthophyllite, and antigorite. Sample was not point counted.

GPO 787-042/10004