Bass Lake Quadrangle, West-Central Sierra Nevada, California—Analytic Data

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Bass Lake Quadrangle, West-Central Sierra Nevada, California—Analytic Data

By PAUL C. BATEMAN

Modal and chemical data on the
granitic rocks of the Bass Lake quadrangle

U.S. GEOLOGICAL SURVEY BULLETIN 1809

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

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Bass Lake Quadrangle, West-Central Sierra Nevada, California—Analytic Data

By Paul C. Bateman

Abstract

Plutonic rocks underlie about 80 percent of the Bass Lake quadrangle. By far the most extensive intrusion is the Bass Lake Tonalite, which underlies more than 70 percent of this quadrangle and a total area of at least 2,000 km^2 in the western Sierra Nevada between 37° and 38° north latitude. Smaller bodies of biotite granite, granodiorite, trondhjemite, and sparse diorite underlie about 10 percent of the quadrangle. More than 200 samples of these plutonic rocks were analyzed for mineral content, and 27 selected samples were also analyzed for their major elements. These data are tabulated, and the modal data and bulk specific gravity of the rocks are plotted on maps and contoured to show their spatial distribution. In addition, modal data are ploted on Q-A-P diagrams, and CIPW norms of chemical data are plotted on a quartz-orthoclase-plagioclase (albite + anorthite) triangular diagram.

INTRODUCTION

The Bass Lake quadrangle is in the western foothills of the central Sierra Nevada about 65 km north of Fresno (fig. 1). This report supplements the geologic map of the Bass Lake quadrangle (Bateman, 1989) by providing modal and chemical data on the plutonic rocks, which underlie about 80 percent of the quadrangle. These data are given in tables and plotted on maps and diagrams. The brief text provides a background for understanding and interpreting the data.

GEOLOGIC SUMMARY

The oldest rocks in the quadrangle (fig. 2) are scattered remnants of metamorphosed Paleozoic and Mesozoic sedimentary and volcanic rocks, which are correlative with strata in the western metamorphic belt of the Sierra Nevada farther to the north. The most extensive mass is the Coarsegold roof pendant, which extends northwesterly across the southern part of the quadrangle. Smaller remnants of metasedimentary and metavolcanic rocks are scattered across the northern part.

The most extensive geologic unit within the quadrangle is the Bass Lake Tonalite (Bateman, in press), which underlies more than 2,000 km^2 in the western Sierra Nevada including about 70 percent of the Bass Lake quadrangle. Except for a few small bodies of diorite and gabbro whose ages are uncertain, the Bass Lake Tonalite (formerly tonalite of Blue Canyon) is also the oldest plutonic rock, having an isotopic U-Pb age of about 114 Ma (Stern and others, 1981). The Ward Mountain Trondhjemite (Bateman, in press) (formerly plagiogranite of Ward Mountain), which extends across the southeastern corner of the quadrangle, has a U-Pb isotopic age of 115 Ma and undoubtedly is cogenetic with, and only slightly younger than, the Bass Lake Tonalite. The granites of Thornberry and Goat Mountains, near the south boundary, and the granite of Hogan Mountain, along the northern boundary, are also assumed to be related to, and only slightly younger than, the Bass Lake Tonalite but have not been dated isotopically. Samples of the granite porphyry of Star Lakes collected in the Yosemite quadrangle to the north have yielded a Rb-Sr age of 108±3.6 Ma (R.W. Kistler, written commun., 1984). The granite of Shuteye Peak, which extends into the eastern side of the quadrangle, has been dated at 102 Ma, by the U-Pb method, the same age as the El

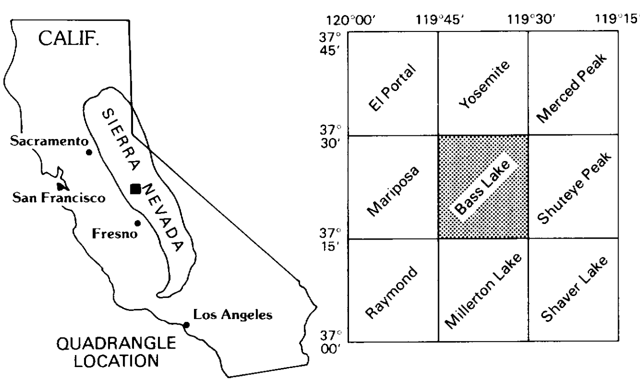

Figure 1. Location of Bass Lake quadrangle, California, and adjacent quadrangles.

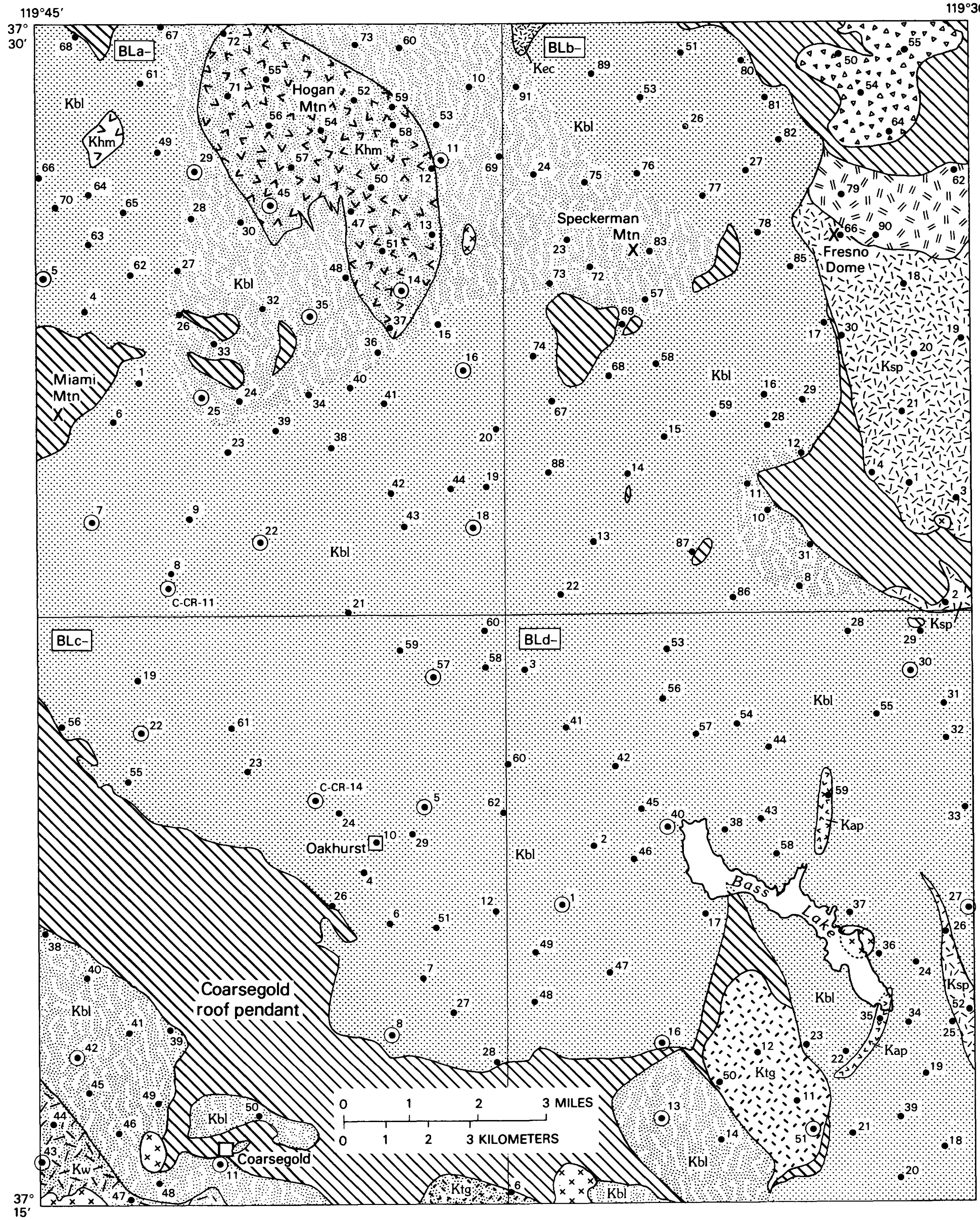

Figure 2. Bass Lake quadrangle, Calif., showing principal geologic bedrock units and locations of modally and chemically analyzed samples. Boxed letters within each quadrant prefix most sample numbers within quadrants. Numbers refer to sample numbers in tables 1 and 2. Geology from Bateman (1989).

Capitan Granite, which has yielded U-Pb ages of 102 and 103 Ma (Stern and others, 1981). The El Capitan Granite protrudes into the northern edge of the quadrangle. The granodiorite of Grizzly Creek, near the northeastern corner of the quadrangle, intrudes the granite of Shuteye Peak and is the youngest plutonic rock unit in the quadrangle but has not been dated isotopically.

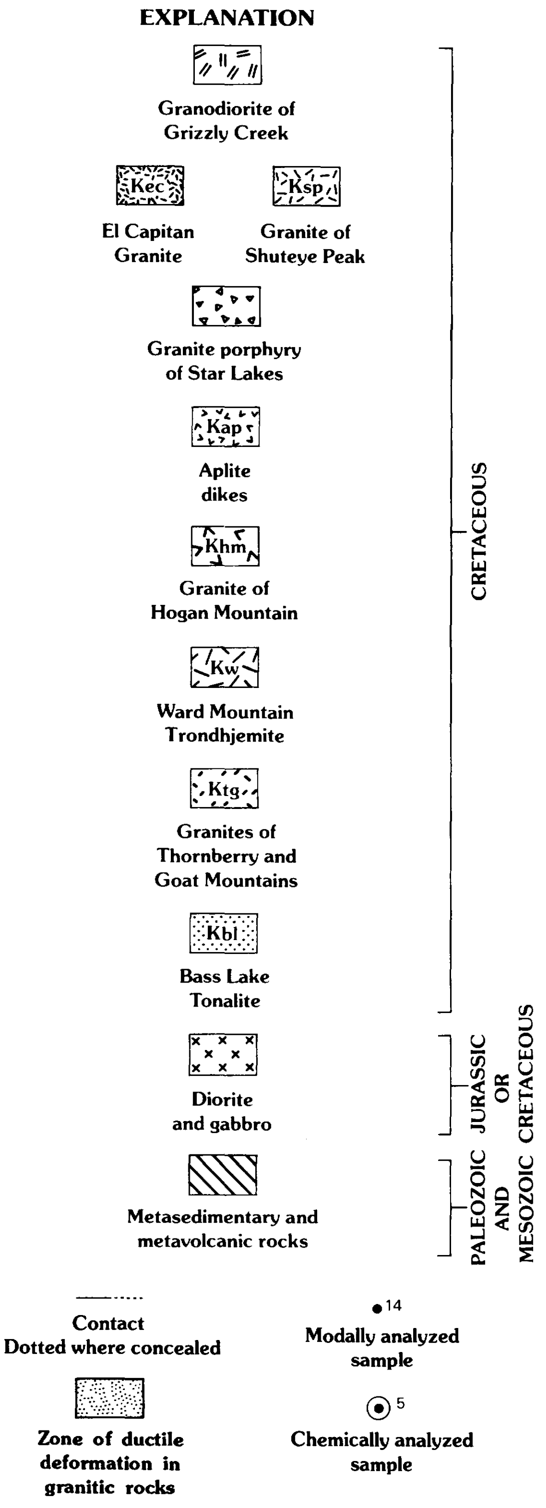

Figure 2. Continued.

SAMPLING AND ANALYTIC METHODS

Representative rock samples were collected in the course of geologic mapping. Topography, areas of deep weathering and soil cover, lush vegetation, and other conditions prevented collecting samples at fixed intervals, but I did try to collect samples of unaltered rock about 1.6 km (1 mile) apart. More than 200 samples of plutonic rocks were collected, almost all of which were analyzed modally; 27 of the freshest and most representative samples were also analyzed by X-ray spectroscopy for major oxides (tables 1 and 2). Modal analyses were made by counting 1,000 or more equally spaced points on stained slabs having minimum areas of 70 cm^2. On these slabs, alkali feldspar was stained yellow and plagioclase red (Norman, 1974). Counts on samples collected within a few meters of one another show good agreement, but, because the spacing of points was less than the distance across many grains, error limits cannot be assigned (Van der Plas and Tobi, 1965). Hornblende and biotite are not readily distinguishable on stained slabs, so their proportions were determined by counts on thin sections and were apportioned to the percentages of mafic minerals determined on stained slabs.

BASS LAKE TONALITE

The Bass Lake Tonalite (Bateman, in press) has been called the tonalite of Blue Canyon and the granodiorite of Blue Canyon in reports on adjacent quadrangles, and it has now been shown to be coextensive with the earlier named granodiorite of The Gateway (Calkins, 1930). Because neither "Blue Canyon" nor "The Gateway" is available for a formal lithologic name, Bateman (in press) chose the name Bass Lake Tonalite because the rock is well exposed over wide areas adjacent to Bass Lake. Typical undeformed Bass Lake Tonalite is a dark-gray, medium-grained, hypidiomorphic granular rock having a color index that ranges from 5 to 40 but peaks at 20 (fig. 11). Although the rock is predominantly tonalite, it ranges in composition from quartz diorite to granite (fig. 11). It has a hypidiomorphic granular texture where undeformed and generally exhibits a foliation that is shown both by the preferred orientation of platy and prismatic minerals and by lens-shaped mafic inclusions. Plagioclase, quartz, and biotite are present in all samples, and alkali feldspar and hornblende are in most, although generally in small amounts. Alkali feldspar is commonly interstitial, which indicates it was the the last mineral to crystallize, but it forms small blocky megacrysts where it is abundant. On the average, rocks that contain less than 10 percent mafic minerals contain little or no hornblende, but the average ratio of hornblende to biotite increases markedly as the total content of mafic minerals increases above 10 percent. A line drawn along the axis of the plot in figure 11 shows the relation of hornblende (H) to biotite (B), and is described by the following equation:

$$H = 2(B-10).$$

Magnetite is generally sparse, indicating low-oxygen fugacity during crystallization, but is present and even abundant in some samples where it is closely associated with anhedral titanite. Probably both minerals are secondary after ilmenite. Epidote and chlorite are common alteration products of hornblende and biotite.

The tonalite in the southwest corner of the quadrangle, southwest of the Coarsegold roof pendant, and adjacent to the granite of Hogan Mountain, in the northwest quarter of the quadrangle, has been ductilely deformed and is gneissic. Bateman and others (1983) have attributed the deformation southwest of the Coarsegold roof pendant to intrusion of the Ward Mountain Trondhjemite in an advanced state of crystalliztion. Similar deformation in the northwestern part of the quadrangle, maarginal to the granite of Hogan Mountain, presumably was caused by emplacement of the Hogan Mountain magma in a late state of crystallization.

Different minerals responded differently during ductile deformation. Quartz is the most sensitive mineral to strain, and rocks that are otherwise undeformed commonly show undulatory extinction or are composed of mosaics in which the crystal lattices of the different segments have been rotated slightly. With greater strain, quartz breaks down to microcrystalline mortar between other minerals in the rock, especially the feldspars. Biotite and hornblende are almost as responsive as quartz to strain and are readily reduced to elongate strands, shreds, and tiny isolated fragments. Plagioclase is relatively resistant; in moderately deformed rocks porphyroclasts commonly survive, although different parts may be optically discontinuous across sharp lines as the result of slight rotation. Interstitial alkali feldspar appears to fail with plagioclase and joins quartz, plagioclase, and the mafic minerals in granoblastic mosaics. In contrast, equant alkali feldspar grains and megacrysts are resistant to deformation and appear undeformed in a granoblastic groundmass, often giving the erroneous impression that they grew as porphyroblasts after deformation. The common presence of mineral grains along growth zones within megacrysts shows that the megacrysts existed before and survived deformation.

Contours of modal values and specific gravity (figs. 3–10) reflect the cooling and solidification history of the Bass Lake Tonalite and show that it is compositionally zoned. The map showing the distribution of quartz + alkali feldspar (fig. 10) is particularly informative because these minerals crystallized at the lowest temperatures and increase in abundance toward low-temperature zones where crystallization was completed last. The most extensive cooling center is the broad area extending southeast from Miami Mountain to Bass Lake, where foliations are obscure or absent. Within this zone final crystallization occurred 2 to 3 km north of the north end of Bass Lake in the area enclosed by a 50-percent contour. Other smaller crystallization centers lie southwest of Hogan Mountain and in the eastern side of Speckerman Mountain. These centers probably represent upward protrusions of magma that crystallized inward from their margins. Thus, crystallization within the largest zone probably proceeded inward from the Coarsegold roof pendant and the chain of metamorphic remnants that extend toward the east and southeast from Miami Mountain and downward from a roof that arched across the intervening area. The mafic minerals and specific gravity show inverse relations to quartz + alkali feldspar, decreasing toward the last zones to crystallize.

GRANITES OF THORNBERRY AND GOAT MOUNTAINS

The granites of Thornberry and Goat Mountains form two elliptical plutons that intrude the Bass Lake Tonalite in the southern part of the quadrangle. Grain size, texture, and composition all vary widely, in part because of incompletely digested fragments of Bass Lake Tonalite. The rock is strongly foliated, but only a sample from the margin of the granite of Thornberry Mountain shows evidence of significant ductile deformation. Although called granite, most modes plot in the granodiorite field, and one sample having a low color index and a low content of quartz and alkali feldspar plots in the quartz diorite field (fig. 11). The isotopic age of this rock has not been determined but is tentatively assumed to be only slightly younger than the Bass Lake Tonalite.

WARD MOUNTAIN TRONDHJEMITE

A tongue of the Ward Mountain Trondhjemite (Bateman, in press) extends into the southwestern corner of the quadrangle. The modes of most samples of this rock, collected in the adjacent Millerton Lake quadrangle, plot in the tonalite field, but some plot in the granodiorite field and a few plot in the granite field (Bateman and Busacca, 1983). Three samples collected from within the Bass Lake quadrangle plot in the tonalite and granodiorite fields and have color indices that range from 5 to 7 (fig. 11). In most places the rock is deformed and has a granoblastic texture. It intrudes the Bass Lake Tonalite, but a U-Pb age of 115 Ma (Stern and others, 1981) indicates the rock is closely affiliated with the Bass Lake Tonalite. Bateman (in press) has included it with the Bass Lake Tonalite in the Fine Gold Intrusive Suite.

GRANITE OF HOGAN MOUNTAIN

The granite of Hogan Mountain is a medium-grained, equigranular rock having a color index that ranges between 2 and 8 (fig. 11). All samples have granoblastic textures that indicate strong ductile deformation. Granoblastic texture in adjacent parts of the Bass Lake Tonalite, which the granite intrudes, indicates that the deformation was caused by intrusion of the Hogan Mountain magma when it was in a late stage of crystallization. Deformation of the Bass Lake Tonalite suggests that the Bass Lake may not have cooled significantly below its solidus when it was intruded by the Hogan Mountain magma and may have been emplaced only slightly earlier.

GRANITE PORPHYRY OF STAR LAKES

The granite porphyry of Star Lakes extends from the Yosemite quadrangle on the north into the northeast corner of the Bass Lake quadrangle where it is in contact only with metamorphic rocks. Within the Bass Lake quadrangle the rock is medium-grained hornblende-biotite granodiorite, but D.L. Peck (oral commun., 1984) reports that the rock is variable in composition and texture and becomes generally more leucocratic farther north.

GRANITE OF SHUTEYE PEAK

The granite of Shuteye Peak is a light-colored, medium-grained, equigranular rock that ranges in composition from granodiorite to granite. It has a hypidiomorphic granular texture and generally lacks foliation. The color index of samples collected from within the quadrangle ranges from 3 to 12 (fig. 11). The granite of Shuteye Peak intrudes the Bass Lake Tonalite, has a U-Pb age of 102 Ma, and is significantly younger than the Bass Lake Tonalite (Stern and others, 1981).

GRANODIORITE OF GRIZZLY CREEK

The granodiorite of Grizzly Creek crops out near the northeastern corner of the quadrangle, where it is closely associated with metamorphic rocks. It is a dark, medium-grained rock that ranges in composition from granodiorite to tonalite. Its most distinguishing feature is rounded quartz phenocrysts 3 to 6 mm across. Because of poor exposures and compositional and textural similarity, a contact between the granodiorite of Grizzly Creek and the Bass Lake Tonalite has not been accurately located. Nevertheless, a contact must exist because the granodiorite of Grizzly Creek intrudes the granite of Shuteye Peak, which, in turn, intrudes the Bass Lake Tonalite. Where the contact of the granodiorite of Grizzly Creek with the granite of Shuteye Peak is exposed at the eastern base of Fresno Dome, the Grizzly Creek magma heated and remobilized the granite of Shuteye Peak, and the two magmas mixed intricately.

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FIGURES 3–11; TABLES 1 and 2

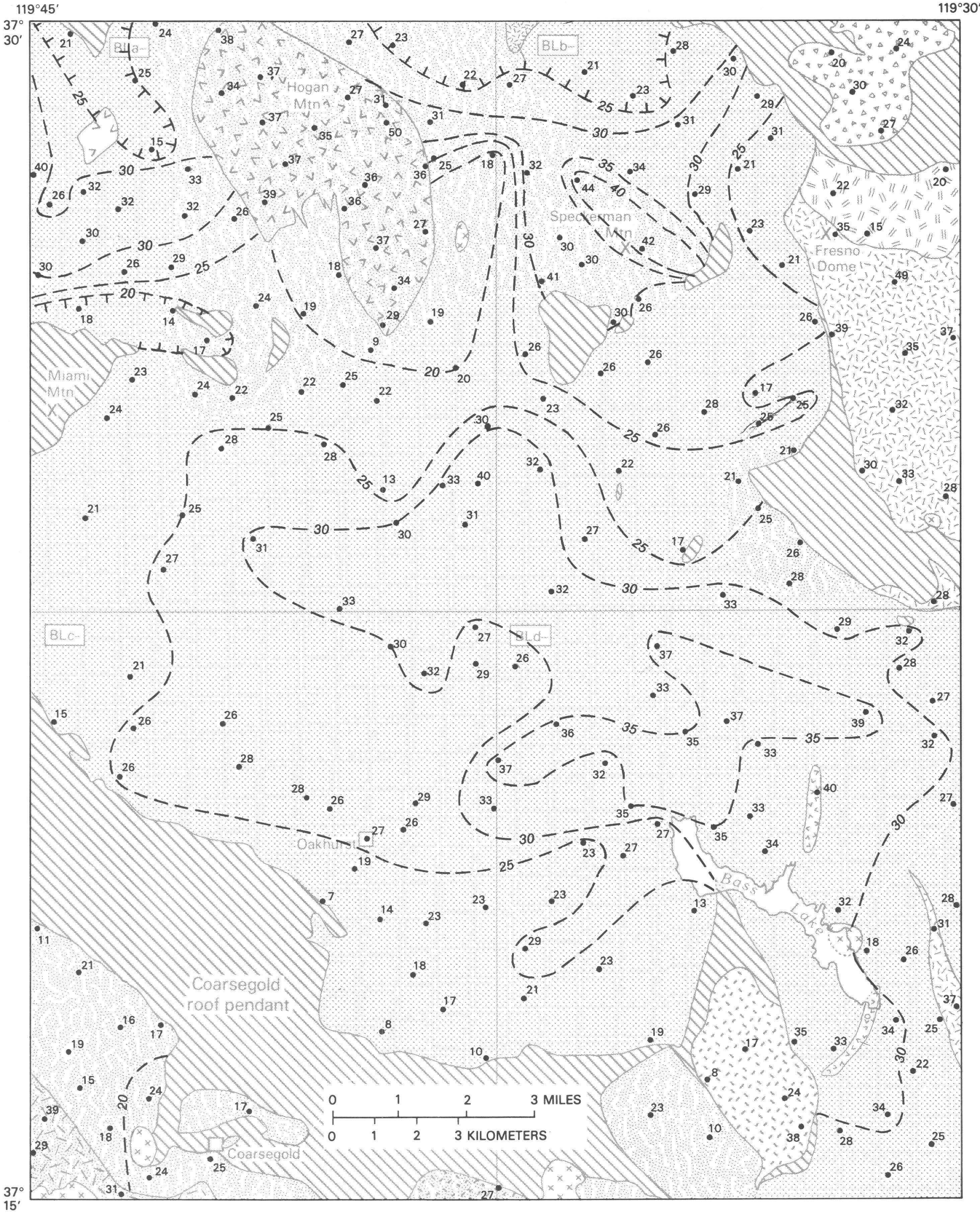

Figure 3. Bass Lake quadrangle, Calif., showing volume-percent quartz. Explanation in figure 2. Contours on Bass Lake Tonalite are at 5-percent intervals; hachures point in direction of lower percentage.

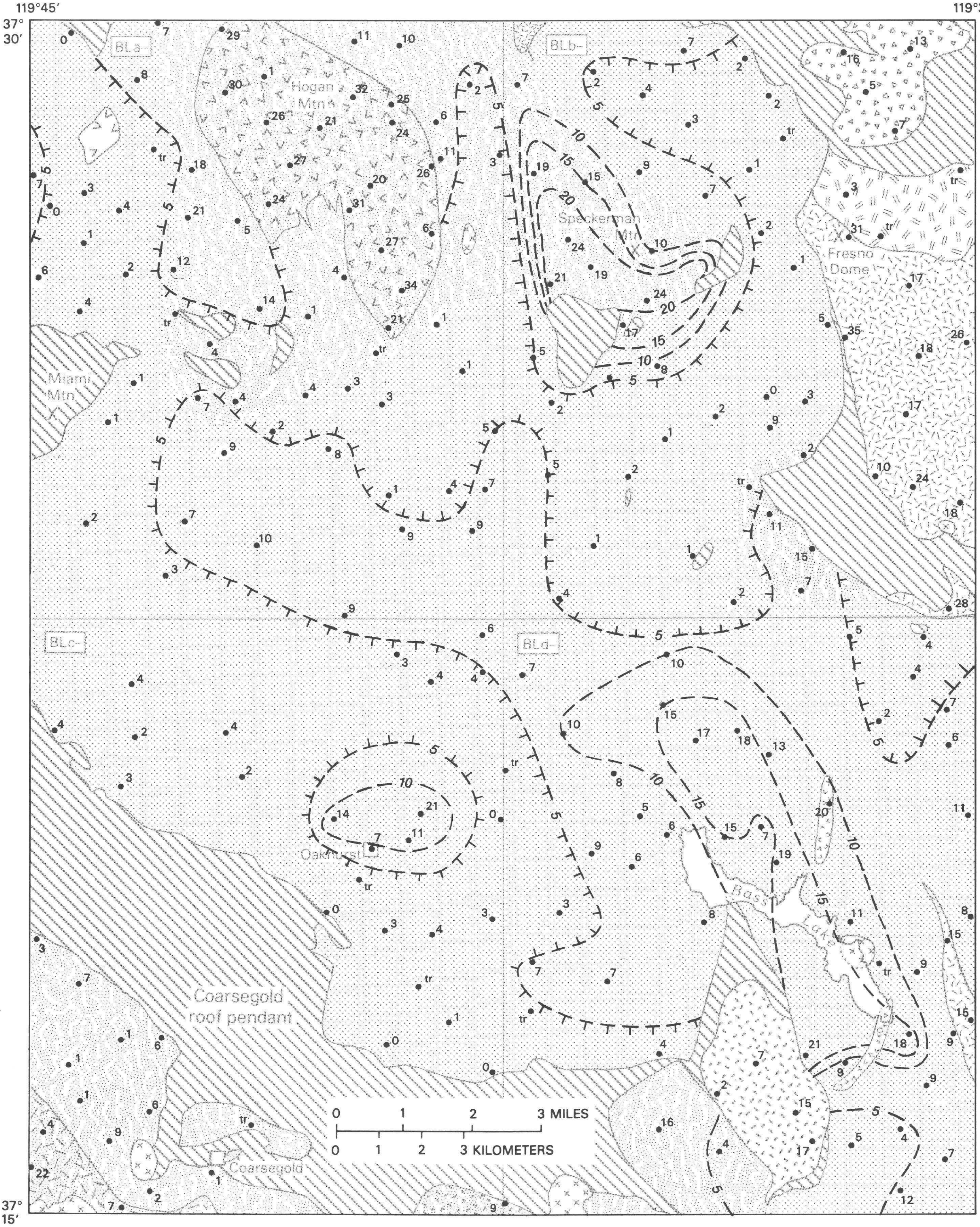

Figure 4. Bass Lake quadrangle, Calif., showing volume-percent alkali feldspar. Explanation in figure 2. Contours on Bass Lake Tonalite are at 5-percent intervals; hachures point in direction of lower percentage; tr, trace.

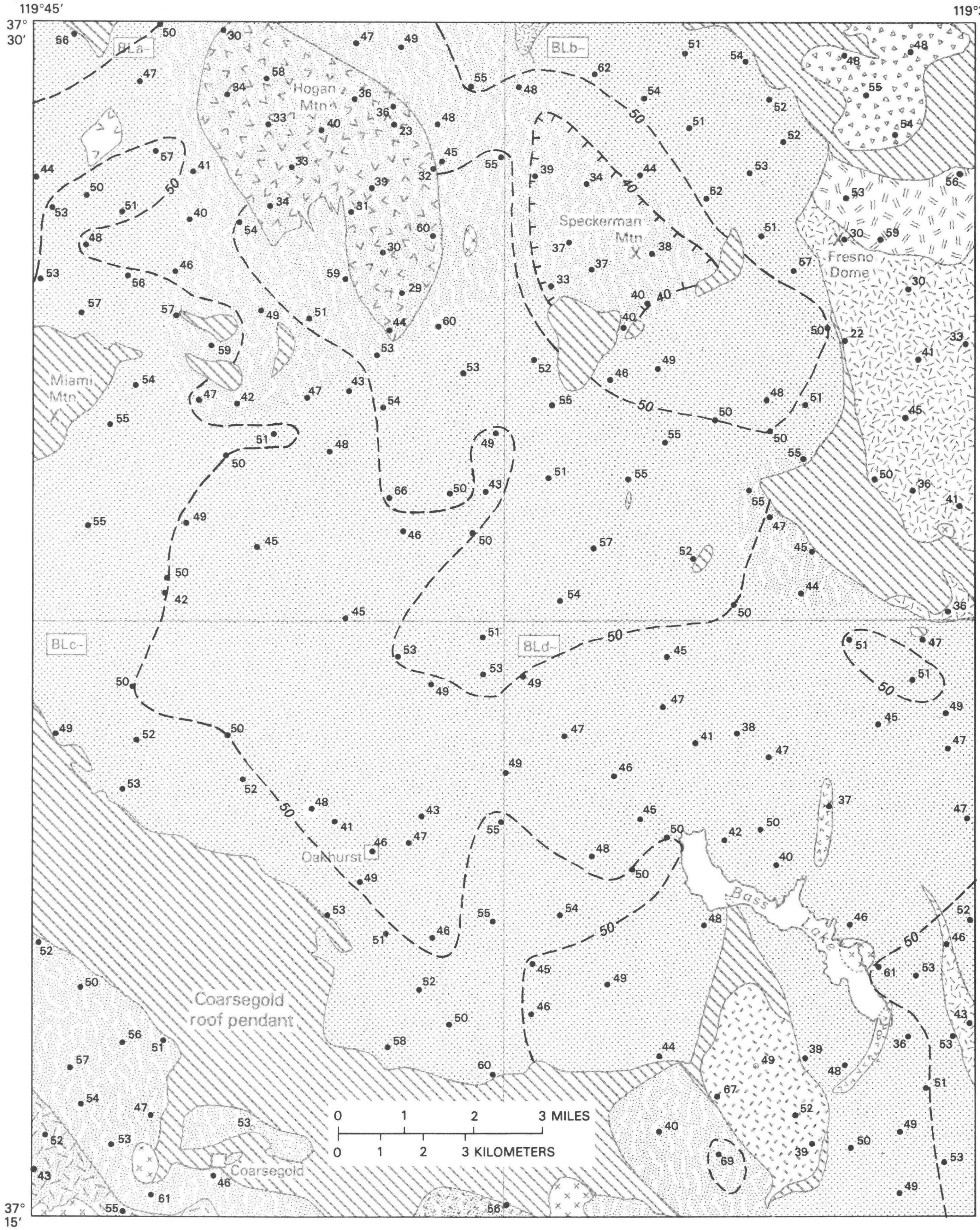

Figure 5. Bass Lake quadrangle, Calif., showing volume-percent plagioclase. Explanation in figure 2. Contours on Bass Lake Tonalite are at 5-percent intervals; hachures point in direction of lower percentage.

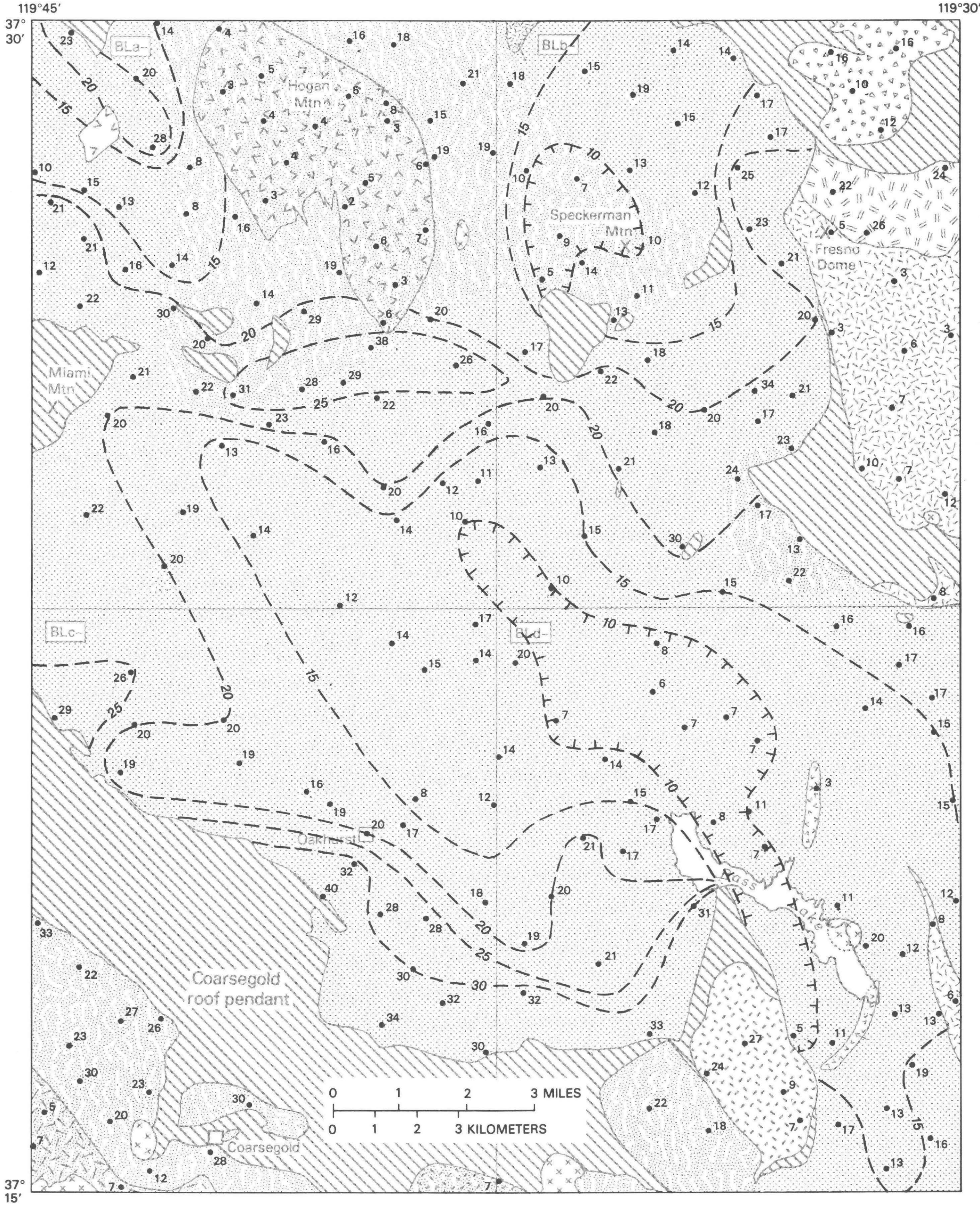

Figure 6. Bass Lake quadrangle, Calif., showing volume-percent mafic minerals. Explanation in figure 2. Contours on Bass Lake Tonalite are at 5-percent intervals; hachures point in direction of lower percentage.

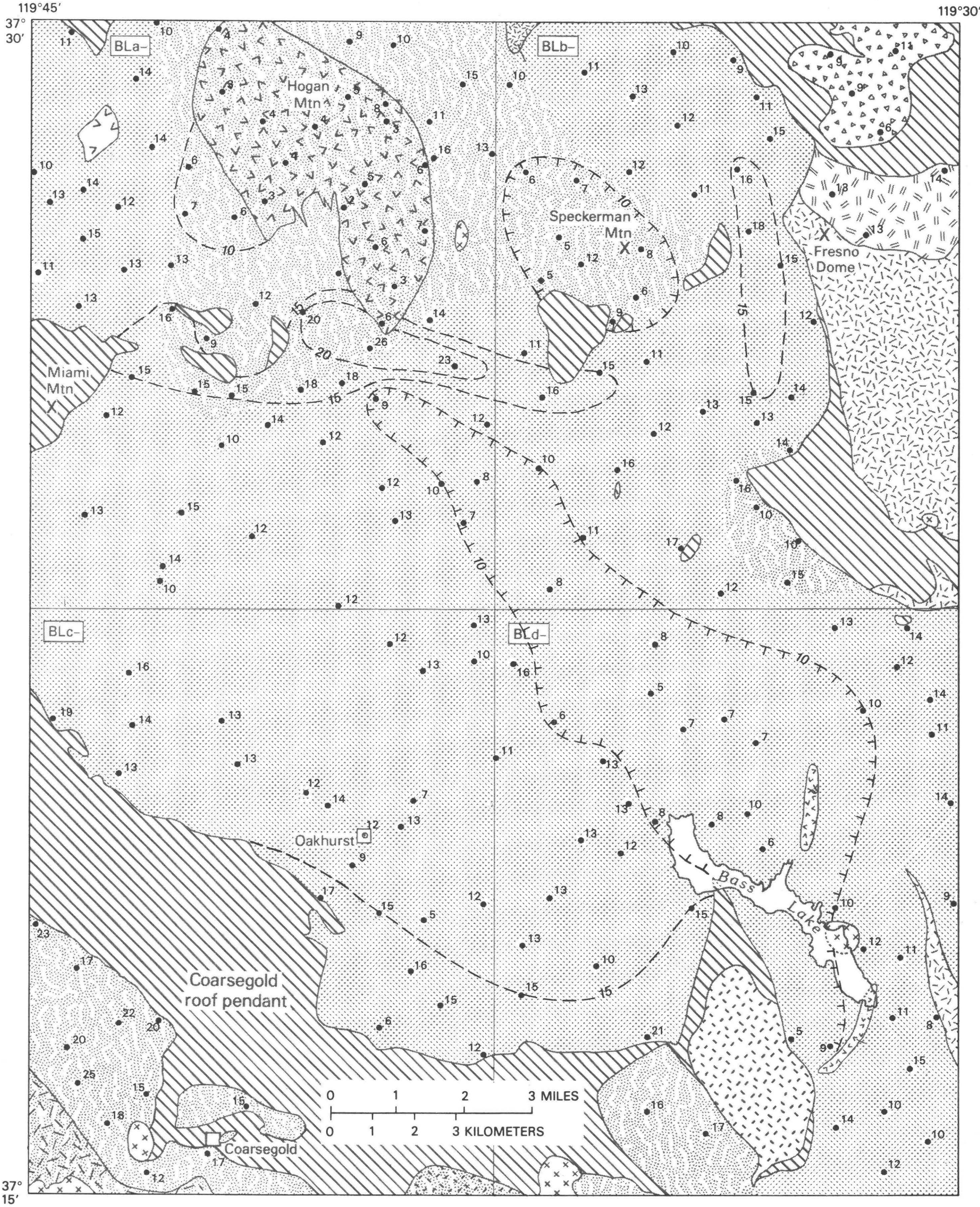

Figure 7. Bass Lake quadrangle, Calif., showing volume-percent biotite. Explanation in figure 2. Contours on Bass Lake Tonalite are at 5-percent intervals; hachures point in direction of lower percentage.

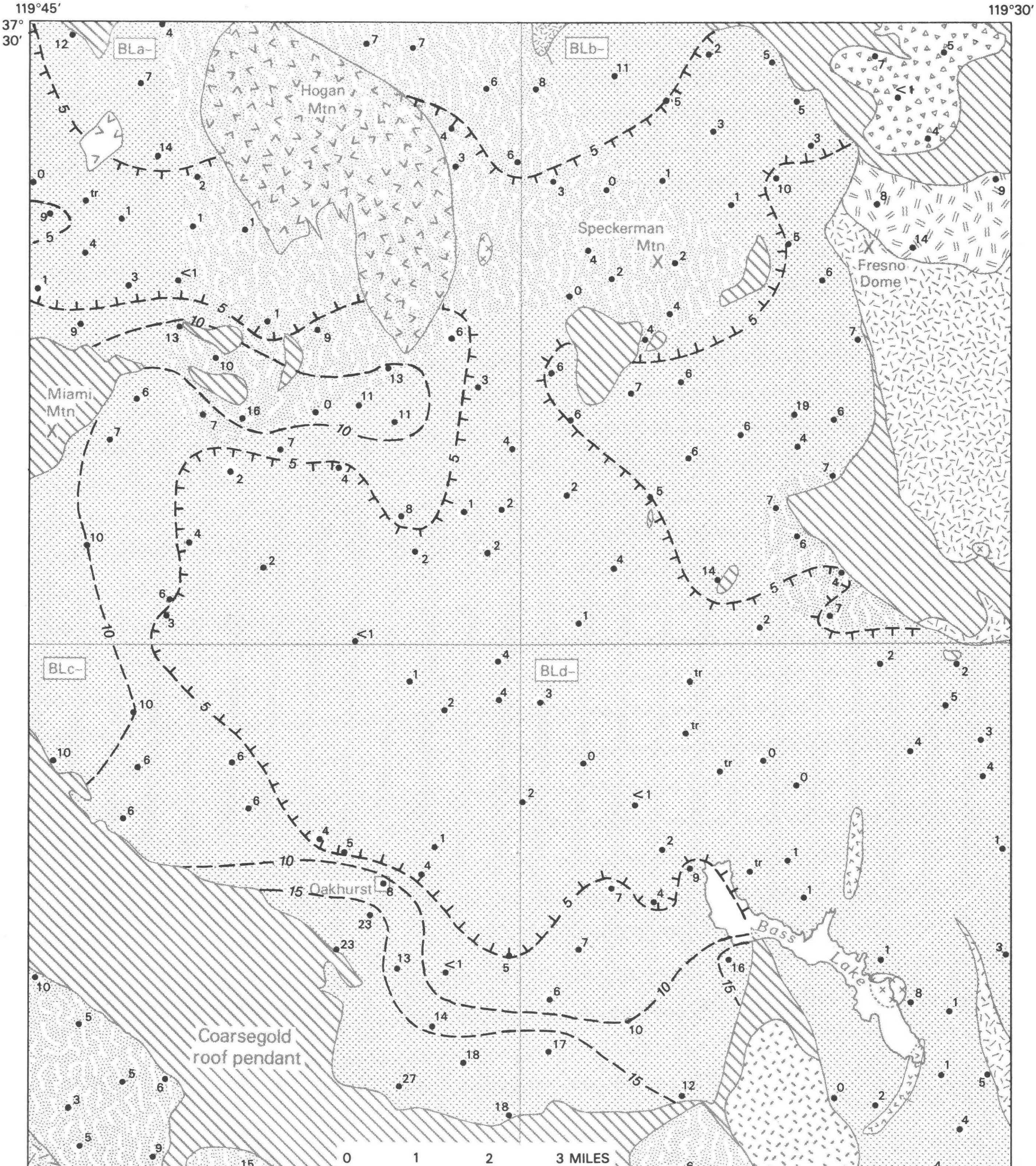

Figure 8. Bass Lake quadrangle, Calif., showing volume-percent hornblende. Explanation in figure 2. Contours on Bass Lake Tonalite are at 5-percent intervals; hachures point in direction of lower percentage.

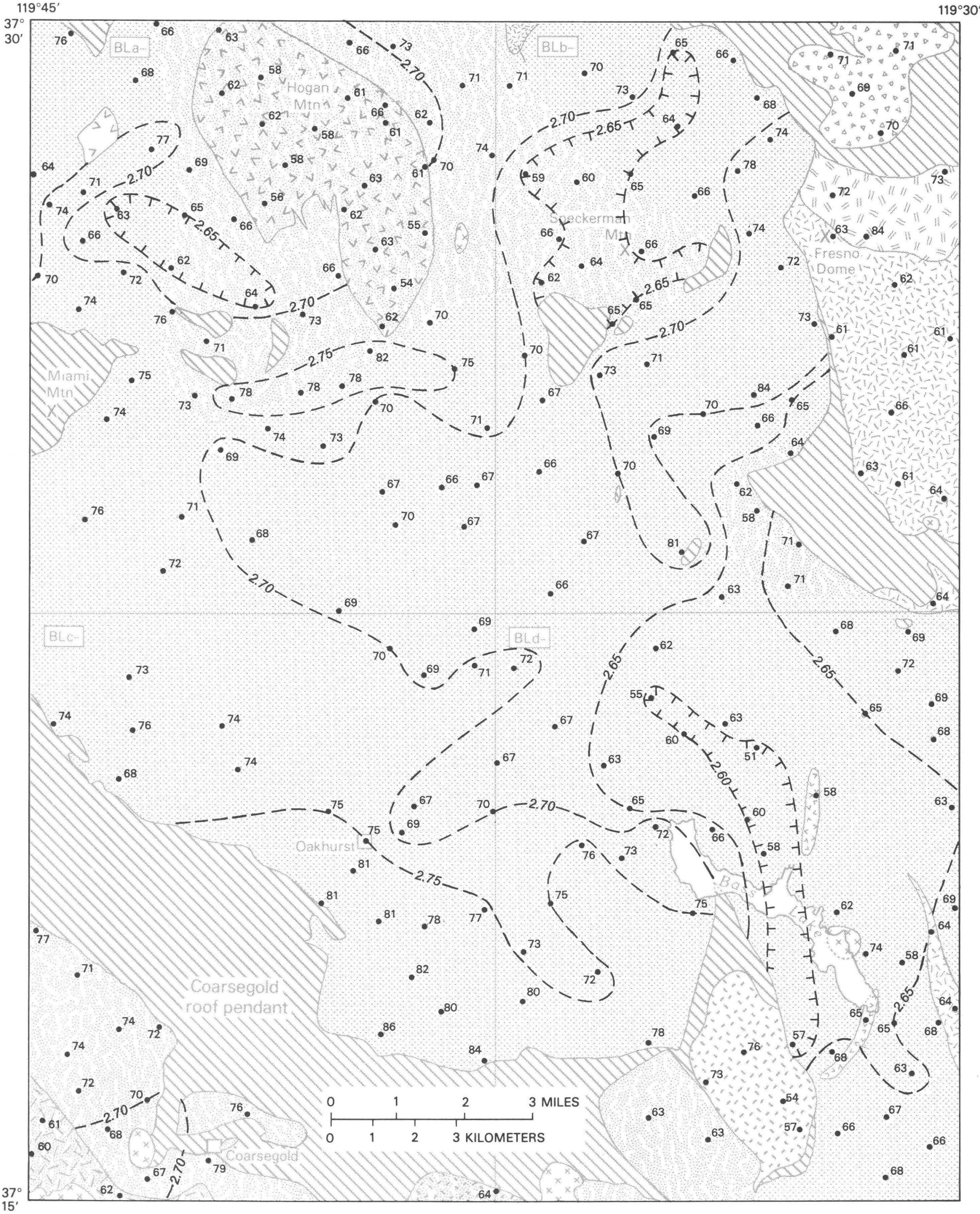

Figure 9. Bass Lake quadrangle, Calif., showing bulk specific gravity; add 2. (including decimal) for actual values. Explanation in figure 2. Contours on Bass Lake Tonalite are at 0.05 intervals; hachures point in direction of lower specific gravity.

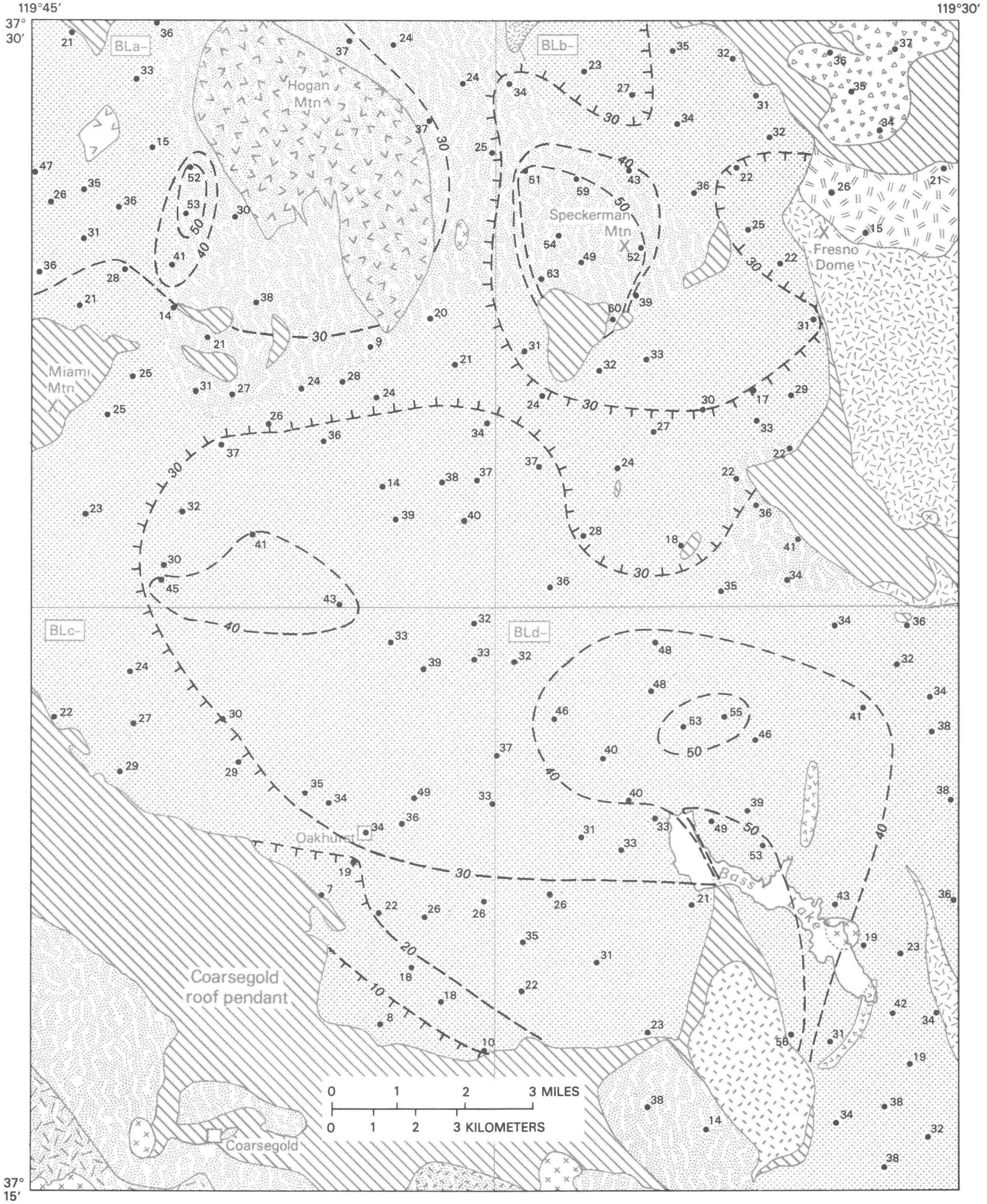

Figure 10. Bass Lake quadrangle, Calif., showing volume-percent quartz + alkali feldspar. Explanation in figure 2. Contours on Bass Lake Tonalite are at 10-percent intervals; hachures point in direction of lower percentage.

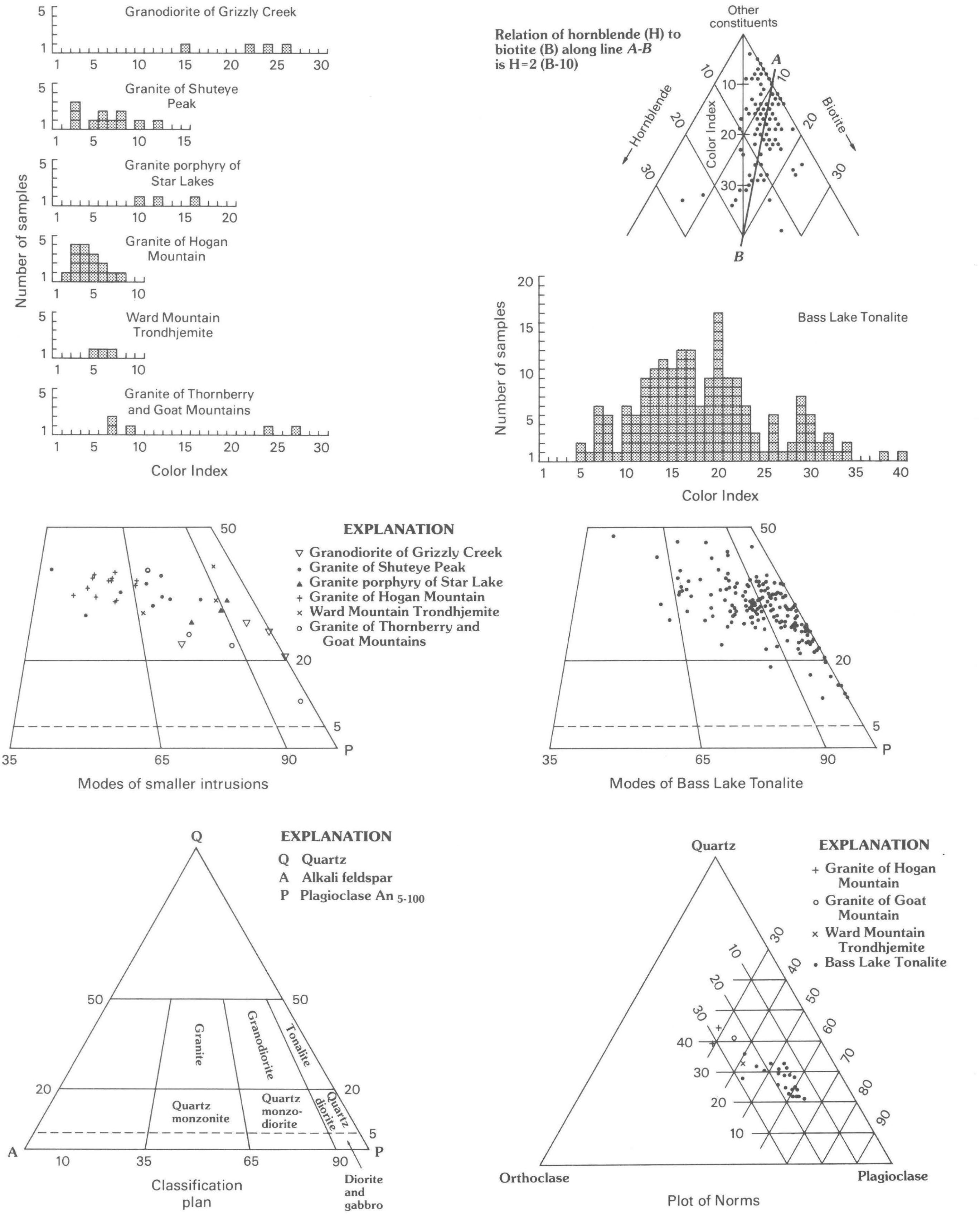

Figure 11. Plots of modes and norms of granitic rocks within Bass Lake quadrangle, Calif. Classification plan modified slightly from Streckeisen (1973).

Table 1. Chemical analyses, norms, modes, color index, and specific gravity of representative rock samples, Bass Lake quad-

[X-ray spectroscopy, J.S. Wahlberg, project leader; chemical analysis for FeO, H_2O, and CO_2, project leader, J.L. Seeley. Sample locations shown

Bass Lake Tonalite

Field No.	BLa-5	BLa-7	BLa-11	BLa-16	BLa-18	BLa-22	BLa-25	BLa-29	BLa-35	C-CR-11	C-CR-14	BLc-5	BLc-8
Lab. No.	M-145282	M-145283	M-145284	M-145286	M-145287	M-145288	M-145289	M-145290	M-145291	M-112951W	M-112952W	M-145293	M-145294
North Lat.	37°26.8'	37°23.7'	37°28.5'	37°25.6'	37°23.9'	37°23.2'	37°25.2'	37°28.3'	37°26.2'	37°22.5'	37°20.5'	37°21.8'	37°17.2'
West Long.	119°44.9'	119°44.2'	119°38.4'	119°37.1'	119°37.9'	119°41.7'	119°42.2'	119°42.6'	119°40.5'	119°43.3'	119°40.7'	119°38.6'	119°39.2'
Chemical analyses (weight percent)													
SiO_2	69.4	63.0	67.8	61.6	68.3	69.7	66.2	73.0	62.1	66.4	64.6	70.3	54.9
Al_2O_3	15.4	16.4	14.7	16.5	15.7	15.3	15.5	13.9	16.5	15.8	16.5	14.8	17.5
Fe_2O_3	1.07	1.68	1.15	1.54	1.37	1.10	.76	.71	1.46	.76	.61	.96	1.32
Fe	2.32	3.48	2.44	4.06	1.79	1.80	3.25	1.24	3.51	3.4	3.9	1.71	6.26
MgO	1.4	2.6	1.8	3.0	1.3	1.2	2.3	.85	3.2	1.8	2.0	1.1	5.32
CaO	3.86	5.36	3.74	5.34	3.78	3.69	4.47	2.26	5.34	4.3	4.7	3.14	8.75
Na_2O	3.4	3.0	3.0	3.0	3.5	3.2	3.2	3.1	3.4	3.2	3.1	3.1	2.6
K_2O	2.20	2.31	3.14	2.25	2.73	2.81	2.85	3.82	2.06	2.4	2.6	3.55	.85
H_2O^+	.65	1.02	.55	1.06	.49	.58	.68	.36	1.13	.77	1.2	.58	1.20
H_2O^-	.05	.09	.06	.20	.08	.08	.05	.06	.17	.13	.11	.04	.06
TiO_2	.39	.67	.49	.80	.49	.34	.51	.23	.66	.52	.56	.31	.85
P_2O_5	<.1	.1	<.1	.1	.1	<.1	<.1	<.1	.2	.11	.12	<.1	.1
MnO	.06	.08	.06	.09	.05	.05	.07	.04	.08	.13	.09	.05	.14
CO_2	.09	.01	.01	.01	.01	.01	.04	<.01	.01	<.05	<.05	<.01	.01
Sum	100.3	100.1	98.9	99.6	99.7	100.0	100.0	99.6	99.8	99.7	100.0	99.8	99.9
CIPW norms (weight percent)													
Q	29.7	20.4	27.1	18.1	27.3	30.0	22.3	33.9	17.4	25.0	21.5	29.7	8.0
C	.4	—	—	—	.4	.3	—	.6	—	.4	.3	.2	—
or	13.1	13.8	18.9	13.5	16.3	16.7	17.0	22.8	12.4	14.4	15.6	21.2	5.1
ab	28.9	25.7	25.8	25.8	29.9	27.3	27.3	26.5	29.2	27.4	26.6	26.5	22.3
an	19.2	24.8	17.7	25.3	18.3	18.5	19.7	11.3	24.0	20.9	22.8	15.7	34.0
di	—	1.2	1.0	.8	—	—	2.2	—	1.2	—	—	—	7.6
hy	6.4	10.1	7.0	12.3	4.7	5.0	9.4	3.5	11.9	9.6	11.0	4.7	19.1
mt	1.6	2.5	1.7	2.3	2.0	1.6	1.1	1.0	2.1	1.1	.9	1.4	1.9
il	.7	1.3	1.0	1.5	.9	.7	1.0	.4	1.3	1.0	1.1	.6	1.6
ap	—	.2	—	.2	.2	—	—	—	.5	.3	.3	—	.2
hm	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	100.0	100.1	100.2	99.8	100.1	100.1	100.0	100.0	100.0	100.1	100.1	100.0	99.8
Modes (volume percent)													
Quartz	30	21	25	20	31	31	24	33	19	31	28	29	8
K-feldspar	6	2	11	1	9	10	7	18	1	14	7	21	0
Plagioclase	53	55	45	53	50	45	47	41	51	42	48	43	58
Biotite	11	13	16	23	7	12	15	6	20	10	12	7	7
Hornblende	1	10	3	3	2	2	7	2	9	3	4	1	27
Total	101	100	100	100	100	100	100	100	100	100	99	101	100
Color index													
	12	22	19	26	10	14	22	8	29	13	16	8	34
Bulk specific gravity													
	2.70	2.76	2.70	2.75	2.67	2.68	2.73	2.66	2.73	—	—	2.67	2.86

rangle, Calif.

on fig. 2. —, not detected or measured]

Bass Lake Tonalite—*Continued*										Granite of Hogan Mountain		Granite of Goat Mountain	Ward Mountain Trondhjemite
BLc-11 M-145295 37°15.5' 119°42.1'	BLc-22 M-145296 37°21.0' 119°43.3'	BLc-42 M-145297 37°16.9' 119°44.2'	BLc-57 M-145299 37°20.1' 119°38.7'	BLd-1 M-145300 37°18.8' 119°36.6'	BLd-13 M-145301 37°16.1' 119°34.9'	BLd-16 M-145302 37°17.1' 119°35.1'	BLd-27 M-145303 37°18.9' 119°30.1'	BLd-30 M-145304W 37°21.9' 119°31.0'	BLd-40 M-145305 37°19.8' 119°34.9'	BLa-45 M-145292 37°27.6' 119°41.4'	BLa-14 M-145285 37°26.6' 119°39.0'	BLd-51 M-145306 37°15.9' 119°32.5'	BLc-43 M-145298 37°15.5' 119°45.0'
Chemical analyses (weight percent)													
62.6	63.1	64.1	67.3	63.7	65.9	61.9	69.3	66.9	67.0	74.6	75.5	73.0	73.4
15.2	16.5	16.5	15.9	16.5	14.9	16.2	15.5	15.8	16.2	12.9	13.1	14.4	15.3
.76	1.67	.60	1.78	1.47	0.09	1.01	.72	1.17	1.15	.35	.65	.36	.09
5.62	3.54	4.10	2.69	3.07	3.97	4.44	1.93	2.66	2.45	.67	.45	1.31	.69
3.5	2.5	2.6	1.5	2.1	1.9	3.4	1.2	1.8	1.6	.2	.2	.3	.30
4.95	5.45	4.79	3.99	5.11	3.90	6.23	3.88	4.45	4.72	.87	.85	1.06	1.54
2.9	3.1	3.5	3.2	3.2	2.2	2.7	3.6	3.4	3.5	2.9	2.9	3.0	3.8
2.35	2.13	2.24	2.52	2.23	4.13	2.32	2.25	2.20	2.11	4.24	5.12	3.72	4.2
1.05	.76	.73	.73	.73	.76	.86	.53	.70	.66	.64	.41	1.31	.38
.03	.04	.01	.11	.07	.03	.03	.06	.08	.04	.42	.16	1.00	.06
.84	.64	.61	.53	.56	.53	.70	.39	.55	.51	.07	.08	.11	.10
.1	.1	<.1	.1	.2	.1	.1	<.1	.1	.1	<.01	<.01	<.1	<.1
.1	.09	.08	.06	.08	.08	.09	.04	.06	.06	<.02	<.02	.04	<.02
.09	.01	<.01	<.01	.01	<.01	.01	<.01	.01	.01	.02	—	.04	<.01
100.1	99.6	99.9	100.4	99.0	98.5	100.0	99.4	99.9	100.1	98.1	99.4	99.8	100.0
CIPW norms (weight percent)													
18.0	20.4	18.6	27.4	21.8	24.0	17.5	28.9	25.6	25.3	41.4	37.6	38.7	31.4
—	—	—	.9	.05	—	—	.1	—	—	3.0	1.6	3.6	2.0
14.0	12.7	13.4	15.0	13.4	25.0	13.8	13.5	13.1	12.5	25.6	30.4	22.6	24.9
24.8	26.5	29.9	27.2	27.6	19.1	23.1	30.8	29.0	29.8	25.1	24.7	26.1	32.3
21.8	25.1	23.0	19.2	24.5	19.0	25.5	19.5	21.5	22.4	1.6	3.2	5.4	7.0
2.0	1.3	.9	—	—	.1	4.2	—	.1	.4	—	—	—	—
16.4	9.9	12.3	6.5	9.0	11.4	12.9	5.4	7.6	6.6	.5	.5	2.8	1.8
1.1	2.5	.9	2.6	2.2	.1	1.5	1.1	1.7	1.7	.5	.5	.5	.1
1.6	1.2	1.2	1.0	1.1	1.0	1.3	.8	1.1	1.0	1.2	.8	.2	.2
.2	.2	—	.2	.5	.2	.2	—	.2	.2	1.0	.4	—	.2
—	—	—	—	—	—	—	—	—	—	—	.3	—	—
99.9	99.8	100.2	100.0	100.2	99.9	100.0	100.1	99.1	99.9	99.9	100.0	99.9	99.9
Modes (volume percent)													
25	26	19	32	23	23	19	28	28	27	39	34	38	29
1	2	1	4	3	16	4	8	4	6	24	34	17	22
46	52	57	49	54	40	44	52	51	50	34	29	39	43
17	14	20	13	13	16	21	9	12	8	3	3	7	6
11	6	3	2	8	6	12	3	5	9	—	—	—	—
100	100	100	100	101	101	100	100	100	100	100	100	101	100
Color index													
28	20	23	15	21	22	33	12	17	17	3	3	7	6
Bulk specific gravity													
2.79	2.76	2.74	2.69	2.75	2.72	2.78	2.69	2.72	2.72	2.56	2.59	2.57	2.60

Table 2. Modes, color index, and specific gravity of granitic rocks, Bass Lake quadrangle, Calif.
[tr, trace; –, not measured. Location of samples shown on figs. 2–10]

Sample number	Modes (volume percent)					Color index	Specific gravity
	Quartz	Plagio-clase	Alkali feldspar	Biotite	Horn-blende		
			Bass Lake Tonalite				
BLa–l	23	54	1	15	6	21	2.75
4	18	57	4	13	9	22	2.74
5	30	53	6	11	1	12	2.70
6	24	55	1	12	7	20	2.74
7	21	55	2	13	10	22	2.76
8	27	50	3	14	6	20	2.72
9	25	49	7	15	4	19	2.71
10	22	55	2	15	6	21	2.71
11	25	45	11	16	3	16	2.70
15	19	60	1	14	6	20	2.70
16	20	53	1	23	3	26	2.75
18	31	50	9	7	2	10	2.67
19	40	43	7	8	2	11	2.69
20	30	49	5	12	4	16	2.71
21	33	45	9	12	tr	12	2.69
22	31	45	10	12	2	14	2.68
23	28	50	9	10	2	13	2.69
24	22	42	4	15	16	31	2.78
25	24	47	7	15	7	22	2.73
26	14	57	tr	16	13	29	2.76
27	29	46	12	13	1	14	2.62
28	32	40	21	7	1	8	2.65
29	33	41	18	6	2	8	2.66
30	26	54	5	6	1	8	2.66
32	24	49	14	12	1	14	2.64
33	17	59	4	9	10	20	2.71
34	22	47	4	18	10	28	2.78
35	19	51	1	20	9	29	2.73
36	9	53	tr	26	13	38	2.82
38	28	48	8	12	4	16	2.73
39	25	51	2	14	7	23	2.74
40	25	43	3	18	11	29	2.78
41	22	54	3	9	11	22	2.70
42	13	66	1	12	8	20	2.67
43	30	46	9	13	2	14	2.70
44	33	50	4	10	1	12	2.66
49	15	57	tr	14	14	28	2.77
53	31	48	6	11	4	15	2.62
60	23	49	10	10	7	18	2.73
61	25	47	8	14	7	20	2.68
62	26	56	2	13	3	16	2.72
63	30	48	1	15	4	21	2.66
64	32	50	3	14	tr	15	2.71
65	32	51	4	12	1	13	2.63
66	40	44	7	10	0	10	2.64
67	29	50	7	10	4	14	2.66
68	21	56	0	11	12	23	2.76
69	20	55	5	13	6	19	2.74
70	26	53	0	13	9	21	2.74
73	27	47	11	9	7	16	2.66
			Bass Lake Tonalite—*Continued*				
BLb–8	28	44	7	15	7	22	2.71
10	25	47	11	10	6	17	2.58
11	21	55	tr	16	7	24	2.62
12	21	55	2	14	7	23	2.64
13	27	57	1	11	3	15	2.67
14	22	55	2	16	5	21	2.70
15	26	55	1	12	6	18	2.69
16	17	48	0	15	19	34	2.84
17	26	50	5	12	7	20	2.73
22	32	54	4	8	1	10	2.66
23	30	37	24	5	4	9	2.66
24	32	39	19	6	3	10	2.59
26	31	51	3	12	3	15	2.64
27	21	53	1	16	10	25	2.78
28	25	50	9	13	4	17	2.66
29	25	51	3	14	6	21	2.65
31	26	45	15	10	4	13	2.71
51	28	51	7	10	2	14	2.65
53	23	54	4	13	5	19	2.73
57	26	40	24	6	4	11	2.65
58	26	49	8	11	6	18	2.71
59	28	50	2	13	6	20	2.70
67	23	55	2	16	5	20	2.67
68	26	46	5	15	7	22	2.73
69	30	40	17	9	4	13	2.65
72	30	37	19	12	2	14	2.64
73	41	33	21	5	0	5	2.62
74	26	52	5	11	6	17	2.70
75	44	34	15	7	0	7	2.60
76	34	44	9	12	1	13	2.65
77	29	52	7	11	1	12	2.66
78	23	51	2	18	5	23	2.74
80	30	54	2	9	5	14	2.66
81	29	52	2	11	5	17	2.68
82	31	52	tr	15	3	17	2.74
83	42	38	10	8	2	10	2.66
85	21	57	1	15	6	21	2.72
86	33	50	2	12	2	15	2.63
87	17	52	1	17	14	30	2.81
88	32	51	5	10	2	13	2.66
89	21	62	2	11	3	15	2.70
91	27	48	7	10	8	18	2.71
BLc–4	19	49	tr	9	23	32	2.81
5	29	43	21	7	1	8	2.67
6	19	51	3	15	13	28	2.81
7	18	52	tr	16	14	30	2.82
8	8	58	0	27	6	34	2.86
10	27	46	7	12	8	20	2.75
11	25	46	1	17	11	28	2.79
12	23	55	3	12	5	18	2.77

Table 2. Modes, color index, and specific gravity of granitic rocks, Bass Lake quadrangle, Calif.—*Continued*

Sample number	Modes (volume percent)					Color index	Specific gravity
	Quartz	Plagio-clase	Alkali feldspar	Biotite	Horn-blende		
Bass Lake Tonalite—*Continued*							
BLc–19	21	50	4	16	10	26	2.73
22	26	52	2	14	6	20	2.76
23	28	52	2	13	6	19	2.74
24	26	41	14	14	5	19	2.75
26	7	53	0	17	23	40	2.81
27	17	50	1	15	18	32	2.80
28	10	60	0	12	18	30	2.84
29	26	47	11	13	4	17	2.69
38	11	52	3	23	10	33	2.77
39	17	51	6	20	6	26	2.72
40	21	50	7	17	5	22	2.71
41	16	56	1	22	5	27	2.74
42	19	57	1	20	3	23	2.74
45	15	54	1	25	5	30	2.72
46	18	53	9	18	1	20	2.68
48	24	61	2	12	0	12	2.67
49	24	47	6	15	9	23	2.70
50	17	53	tr	15	15	30	2.76
51	23	46	4	23	5	28	2.78
55	26	53	3	13	6	19	2.68
56	17	49	4	19	10	29	2.74
57	32	49	4	13	2	15	2.69
58	29	53	4	10	4	14	2.71
59	30	53	3	12	1	14	2.70
60	27	51	6	13	4	17	2.69
61	26	50	4	13	6	20	2.74
62	33	55	0	—	—	12	2.70
BLd–1	23	54	3	13	7	20	2.75
2	23	48	9	13	7	21	2.76
3	26	49	7	16	3	20	2.72
13	23	40	16	16	6	22	2.72
14	10	69	4	17	1	18	2.73
16	19	44	4	21	12	33	2.78
17	13	48	8	15	16	31	2.75
18	25	53	7	10	6	16	2.66
19	22	51	9	15	4	19	2.63
20	26	49	12	12	1	13	2.68
21	28	50	5	14	2	17	2.66
22	33	48	9	9	2	11	2.68
23	35	39	21	5	0	5	2.57
24	26	53	9	11	1	12	2.58
25	25	53	9	8	5	13	2.68
27	28	52	8	9	3	12	2.69
28	29	51	5	13	2	16	2.68
29	32	47	4	14	2	16	2.69
30	28	51	4	12	5	17	2.72
31	27	49	7	14	3	17	2.69
32	32	47	6	11	4	15	2.68
33	27	47	11	14	1	15	2.63
34	34	36	18	11	1	13	2.65
36	18	61	tr	12	8	20	2.74

Sample number	Modes (volume percent)					Color index	Specific gravity
	Quartz	Plagio-clase	Alkali feldspar	Biotite	Horn-blende		
Bass Lake Tonalite—*Continued*							
BLd–37	32	46	11	10	1	11	2.62
38	35	42	15	8	tr	8	2.66
39	34	49	4	10	4	13	2.67
40	27	50	6	8	8	17	2.72
41	36	47	10	6	0	7	2.67
42	32	46	8	13	tr	14	2.63
43	33	50	7	10	1	11	2.60
44	33	47	13	7	0	7	2.51
45	35	45	5	13	2	15	2.65
46	27	50	5	13	4	17	2.73
47	23	48	7	10	10	21	2.72
48	21	46	tr	16	16	32	2.80
49	29	45	7	13	6	19	2.73
53	37	45	10	8	tr	8	2.62
54	37	38	18	7	0	7	2.63
55	39	45	2	12	2	14	2.65
56	33	47	15	5	0	6	2.55
57	35	41	17	7	0	7	2.60
58	34	40	19	6	1	7	2.58
60	37	49	tr	11	2	14	2.67
C–CR–11	31	42	14	10	3	13	—
C–CR–14	28	48	7	12	4	16	—
Granites of Thornberry and Goat Mountains							
BLd–6	27	56	9	–	–	7	2.64
11	24	52	15	–	–	9	2.54
12	17	49	7	–	–	27	2.76
50	8	67	2	–	–	24	2.73
51	38	39	17	–	–	7	2.57
Ward Mountain Trondhjemite							
BLc–43	29	43	22	–	–	6	2.60
44	39	52	4	–	–	5	2.61
47	31	55	7	–	–	7	2.62
Granite of Hogan Mountain							
BLa–12	36	32	26	–	–	6	2.61
13	27	60	6	–	–	7	2.55
14	34	29	34	–	–	3	2.59
37	29	44	21	–	–	6	2.62
45	39	34	24	–	–	3	2.56
47	36	31	31	–	–	2	2.62
50	36	39	20	–	–	5	2.63
51	37	30	27	–	–	6	2.63
52	27	36	32	–	–	5	2.61
54	35	40	21	–	–	4	2.58
55	37	58	1	–	–	5	2.58
56	37	33	26	–	–	4	2.59

Table 2. Modes, color index, and specific gravity of granitic rocks, Bass Lake quadrangle, Calif.—*Continued*

Sample number	Modes (volume percent)					Color index	Specific gravity
	Quartz	Plagio-clase	Alkali feldspar	Biotite	Horn-blende		
Granite of Hogan Mountain—*Continued*							
BLa–57	37	33	27	–	–	4	2.58
58	47	24	27	–	–	3	2.61
59	31	36	25	–	–	8	2.66
71	34	34	30	–	–	3	2.62
72	38	30	29	–	–	4	2.63
Aplite dikes							
BLd–35	–	–	–	–	–	–	2.65
59	20	39	3	–	–	–	2.58
Granite porphyry of Star Lakes							
BLb–50	20	48	16	9	7	16	2.71
54	30	55	5	9	tr	10	2.69
55	24	48	13	11	5	16	2.71
64	27	54	7	6	4	12	2.70
Granite of Shuteye Peak							
BLb–1	33	36	24	–	–	7	2.61
2	28	36	28	–	–	8	2.64
3	28	41	18	–	–	12	2.64
4	30	50	10	–	–	10	2.63
18	49	30	17	–	–	3	2.62
19	37	33	26	–	–	3	2.61
20	35	41	18	–	–	6	2.61
21	32	45	17	–	–	7	2.66
30	39	22	35	–	–	3	2.61
66	35	30	31	–	–	5	2.63
BLd–26	31	46	15	–	–	8	2.64
52	37	43	15	–	–	6	2.64
Granodiorite of Grizzly Creek							
BLb–62	20	56	tr	14	9	24	2.73
79	22	53	3	13	8	22	2.72
90	15	59	tr	13	13	26	2.84

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Geologic Quadrangle Maps are multicolor geologic maps on topographic bases in 7 1/2- or 15-minute quadrangle formats (scales mainly 1:24,000 or 1:62,500) showing bedrock, surficial, or engineering geology. Maps generally include brief texts; some maps include structure and columnar sections only.

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Miscellaneous Investigations Series Maps are on planimetric or topographic bases of regular and irregular areas at various scales; they present a wide variety of format and subject matter. The series also includes 7 1/2-minute quadrangle photogeologic maps on planimetric bases which show geology as interpreted from aerial photographs. Series also includes maps of Mars and the Moon.

Coal Investigations Maps are geologic maps on topographic or planimetric bases at various scales showing bedrock or surficial geology, stratigraphy, and structural relations in certain coal-resource areas.

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