Lake Eleanor Quadrangle, Central Sierra Nevada, California--Analytical Data

U.S. GEOLOGICAL SURVEY BULLETIN 1585

U.S. DEPARTMENT OF THE INTERIOR

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By F. C. W. DODGE and L. C. CALK

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Lake Eleanor Quadrangle, Central Sierra Nevada, California--Analytical Data

By F. C. W. Dodge and L. C. Calk

ABSTRACT

A variety of granitic, gabbroic, and metasedimentary rocks, covered locally with remnants of Cenozoic lava flows and glacial deposits, underlie the Lake Eleanor 15-minute quadrangle. More than 400 rock samples were collected during geologic mapping of the quadrangle. Modes were determined on 258 plutonic rock samples and bulk specific gravities on 262. Volume percentages of quartz, potassium feldspar, plagioclase, and mafic minerals and the bulk specific gravities are plotted on a simplified geologic map, and histograms of color index and specific gravities are plotted. Ternary plots of quartz, potassium feldspar, and plagioclase show that the compositions of the granitic rocks are predominantly granodiorite and tonalite, but range from granite to quartz diorite. Chemical analyses and assorted trace-element contents are tabulated for 28 of the plutonic rocks, 5 metasedimentary rocks, and 2 volcanic rocks. Zircon U-Pb ages are tabulated for 8 granitic rock samples and range from 109 to 166 Ma.; however, younger granitic rocks crop out in the quadrangle. Biotite and hornblende K-Ar ages are tabulated for one of these samples. Chondrite-normalized rare-earth-element patterns of 10 plutonic rocks are plotted.

INTRODUCTION

The Lake Eleanor 15-minute quadrangle covers an area of about 620 km^2 on the western slope of the Sierra Nevada (fig. 1). The eastern third of the quadrangle is within Yosemite National Park. California Highway 120 crosses the southern part of the quadrangle, and branching roads provide access to much of the quadrangle. Elevations range from 610 to 2,213 m. Large tracts are heavily forested, and in much of the quadrangle, outcrops of unweathered bedrock are sparse.

The analytical data compiled herein, including chemical and modal analyses, specific gravities, and isotopic age determinations, supplement the geologic map of the Lake Eleanor quadrangle and were determined on samples collected during geologic mapping. Although some of these data have been reported elsewhere (for example, Bateman and others, 1984; Stern and others, 1981), for the sake of completeness, they are all brought together in the maps, diagrams, and tables of this report. Similar reports have been published for many of the other 15-minute quadrangles of the Mariposa 1° by 2° sheet.

GENERAL GEOLOGY

Plutonic rocks of the Sierra Nevada batholith underlie three-quarters of the quadrangle, and prebatholithic rocks underlie the remaining quarter along the south edge. Cenozoic lava flows and glacial deposits locally overlie the crystalline rocks in the northern two-thirds of the quadrangle.

Metasedimentary rocks, a part of the western metamorphic belt of the Sierra Nevada, have been assigned to two informal units. The quartzite and schist of Pilot Ridge is of early Paleozoic age. Fossils found in the phyllite and chert of Hites Cove immediately south of the Lake Eleanor quadrangle (Bateman and others, 1985) indicate an Early Triassic age.

Plutonic rocks make up 19 intrusive units that range in composition from gabbro to leucogranite. Individual units consist of small plutons covering only a few square kilometers as well as parts of much larger bodies extending many kilometers beyond the quadrangle. Tonalites on the west side of the quadrangle have been radiometrically dated at 165 Ma and are the oldest known granitic rocks within the western part of the main mass of the Sierra Nevada batholith. Granitoids to the east are generally progressively younger, some correlative with Early and Late Cretaceous rocks that crop out in Yosemite Valley.

Small patches of trachyandesite that trend southwesterly across the central part of the quadrangle are the erosional remnants of a Tertiary mudflow that originated far to the northeast. Trachyandesite samples of the same mudflow immediately northeast and southwest of the quadrangle have been dated at 9.1 and 9.2 Ma, respectively (Dalrymple, 1963, recalculated to the new decay constants recommended by Steiger and Jaeger, 1977). Younger trachyandesite covers 5 km^2 in the northeast corner of the quadrangle.

Quaternary glacial deposits cover broad areas, particularly along Eleanor and Cherry Creeks and the Tuolumne River. These deposits are not shown on the simplified geologic map (fig. 2).

ANALYTICAL DATA

A total of 420 rock samples were collected from the quadrangle during mapping. The generally poor exposure of unweathered bedrock precluded following a regularly spaced sampling pattern. Of the plutonic rock samples collected, stained slabs (Norman, 1974) of 258 were modally analyzed (figs. 3-6, 8), and powders of 28 were chemically analyzed (table 1), as were powders of 2 samples of Tertiary volcanic rocks (table 2) and 5 samples of metasedimentary rocks (table 3); assorted trace elements were determined by X-ray or emission spectrographic methods on all the chemically analyzed powders, and rare-earth elements were determined on 10 of the plutonic rock powders by neutron activation analysis (fig. 11). Whole-rock bulk specific gravities were determined on 262 plutonic rock samples (figs. 7, 10), and densities were determined on the 5 chemically analyzed metasedimentary rock powders (table 3). Zircons separated from 8 plutonic rock samples were dated by the U-Pb method (table 4), and biotite and hornblende separated from 1 of these samples were dated by the K-Ar method (table 5).

Systematic variations of modal constituents and bulk specific gravity within plutonic bodies are generally not apparent. This may in part simply reflect the lack of a regularly spaced sample pattern and the uncertainty of whether some samples are typical because of poor exposure. Isopleths were drawn on figures 3-6 where the data permitted. Concentric zoning could not be demonstrated, and areas could only be contoured consistently in the granodiorite of Sawmill Mountain, the tonalite of Poopenaut Valley, and the granodiorite of Yosemite Creek.

The percentage contents of quartz, potassium feldspar, and plagioclase in the granitic rocks recalculated to 100 are plotted on ternary diagrams (fig. 8). Ternary compositions lie within a broad band extending from the quartz diorite field across the tonalite and granodiorite fields into the granite field in the classification scheme of Streckeisen and others (1973). Histograms of color index (volume percent mafic minerals) and of specific gravity are shown in figures 9 and 10 for each of the granitic units.

Rare-earth-element (REE) abundances normalized to chondrite values (composite of 9 of Haskin and others, 1968) of 10 plutonic rocks are plotted in figure 10. Patterns of granitic rock samples are similar to others of central Sierra Nevada granites (for example, Dodge and others, 1982; Frey and others, 1978; Noyes and others, 1983; Sawka and others, 1984) with light REE abundances generally 50 to 100 times those of chondrites, heavy REE abundances about 10 times or less than those of chondrites, and no or only small negative europium anomalies. Gabbro samples (LE-96 and LE-1040) both show slight enrichment in intermediate REE's, but only minor concentration of light relative to heavy REE's.

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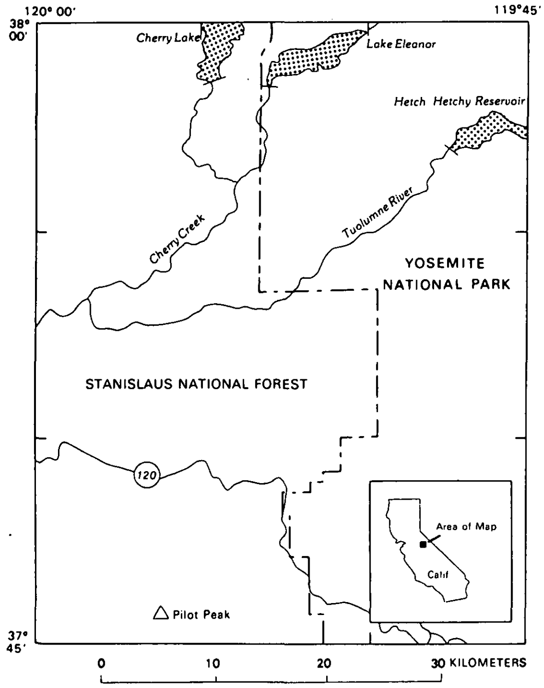

Figure 1. Index map of the Lake Eleanor quadrangle.

EXPLANATION FOR FIGURE 2

TERTIARY

- Tv — Volcanic rocks

CRETACEOUS

- Kgr — Felsic granitic rocks
- Ksg — Sentinel Granodiorite
- Kyc — Granodiorite of Yosemite Creek
- Khr — Granodiorite of Hodgdon Ranch
- Kcc — Tonalite of North Crane Creek
- Ktc — Tonalite of Tamarack Creek
- Kav — Quartz diorite of Aspen Valley
- Krm — Granite of Rancheria Mountain
- Kbm — Granite of Bald Mountain
- Ksl — Granite of Swamp Lake
- Kec — El Capitan Granite
- Ktf — Granodiorite of Tueeulala Falls
- Kcf — Granodiorite of Crane Flat
- Ksm — Granodiorite of Sawmill Mountain
- Kpv — Tonalite of Poopenaut Valley *(Porphyritic phase, stippled)*
- Khg — Granodiorite of Hazel Green Ranch *(Contact phase, stippled)*

CRETACEOUS OR JURASSIC

- KJm — Mafic intrusive rocks

JURASSIC

- Jwr — Granite of Woods Ridge
- Jgc — Tonalite of Granite Creek *(Contact phase, stippled)*

PRE-JURASSIC

- ms — Metasedimentary rocks

• LE-1040 — Chemically analyzed sample

× LE-36 — Isotopically dated sample

(Symbols may be combined)

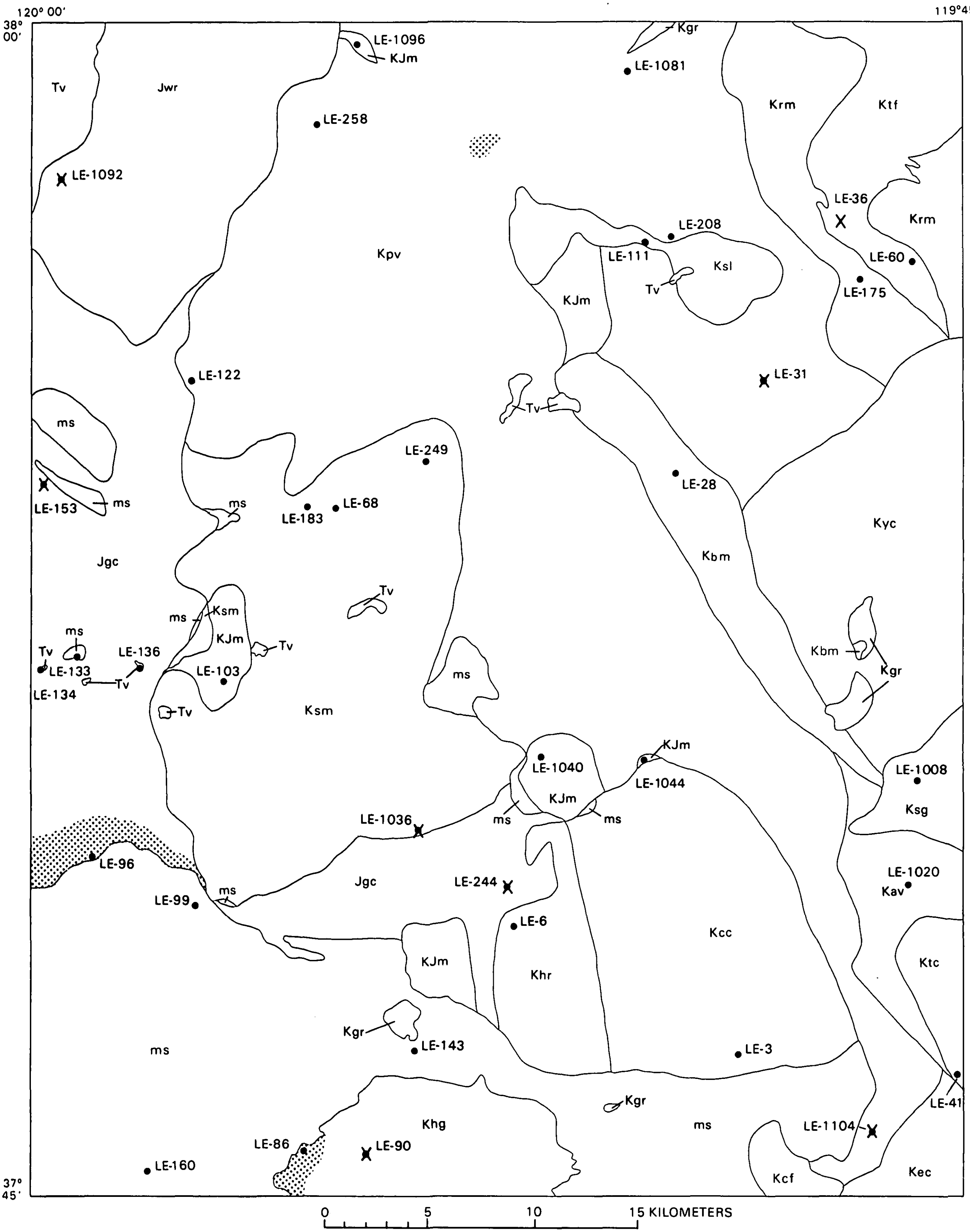

Figure 2. Locations of chemically analyzed and isotopically dated samples (see tables 1-4). Generalized geologic map of Lake Eleanor quadrangle from F.C.W. Dodge and L.C. Calk (unpub. data, 1985).

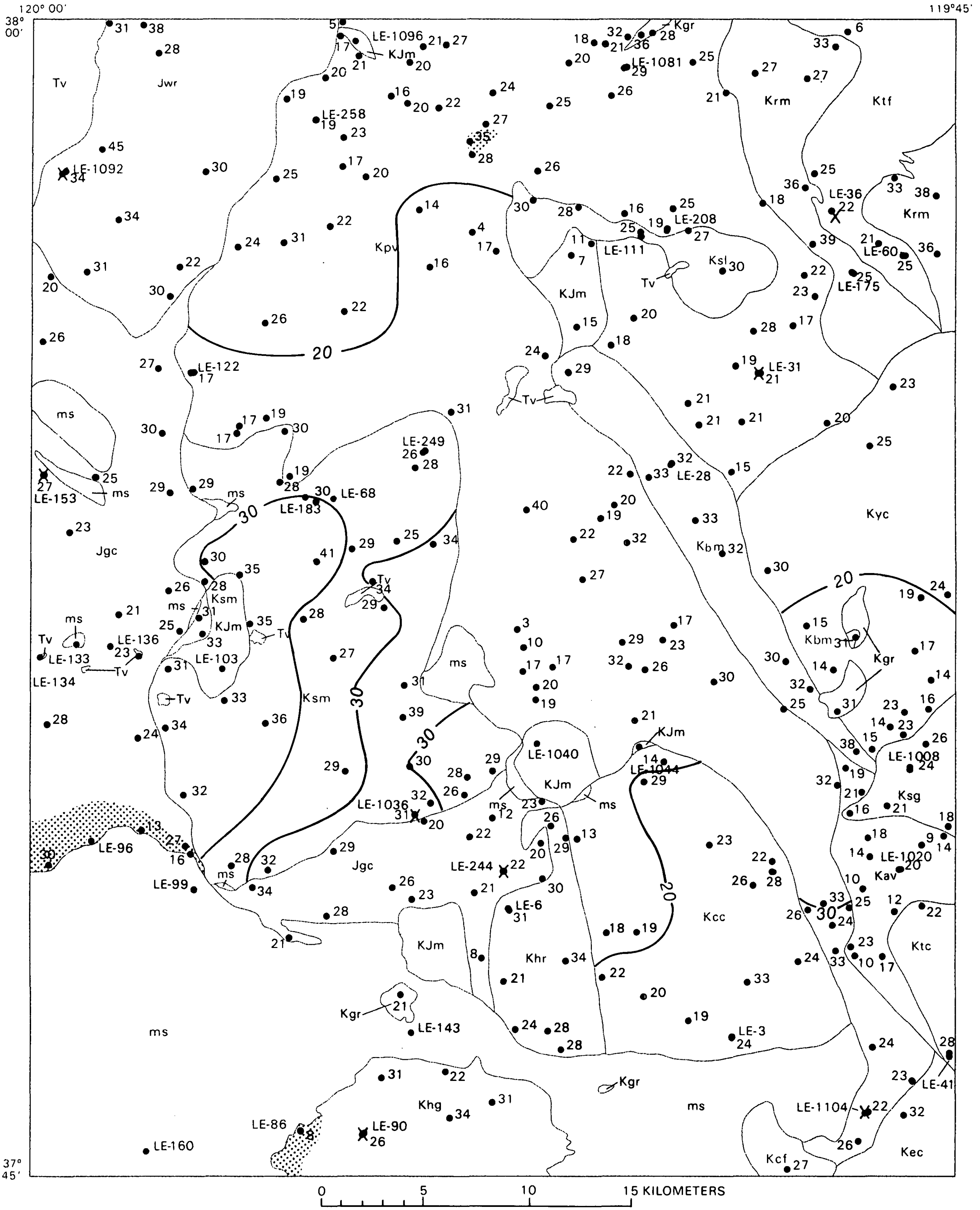

Figure 3. Volume-percent quartz in plutonic rocks indicated by isopleths. Dot indicates location of sample. See figure 2 for explanation of generalized geology.

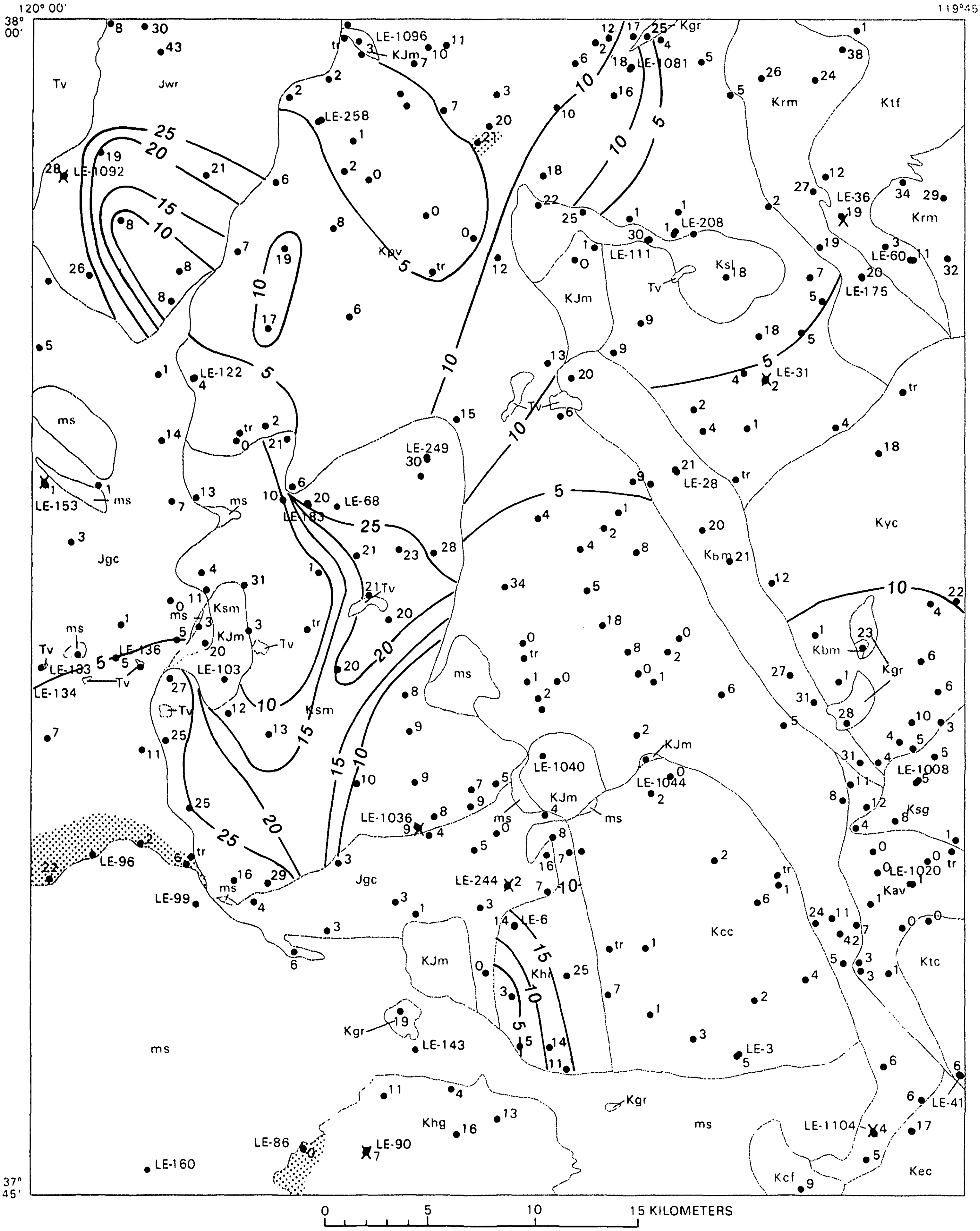

Figure 4. Volume-percent potassium feldspar in plutonic rocks indicated by isopleths. Dot indicates location of sample; tr indicates trace amount. See figure 2 for explanation of generalized geology.

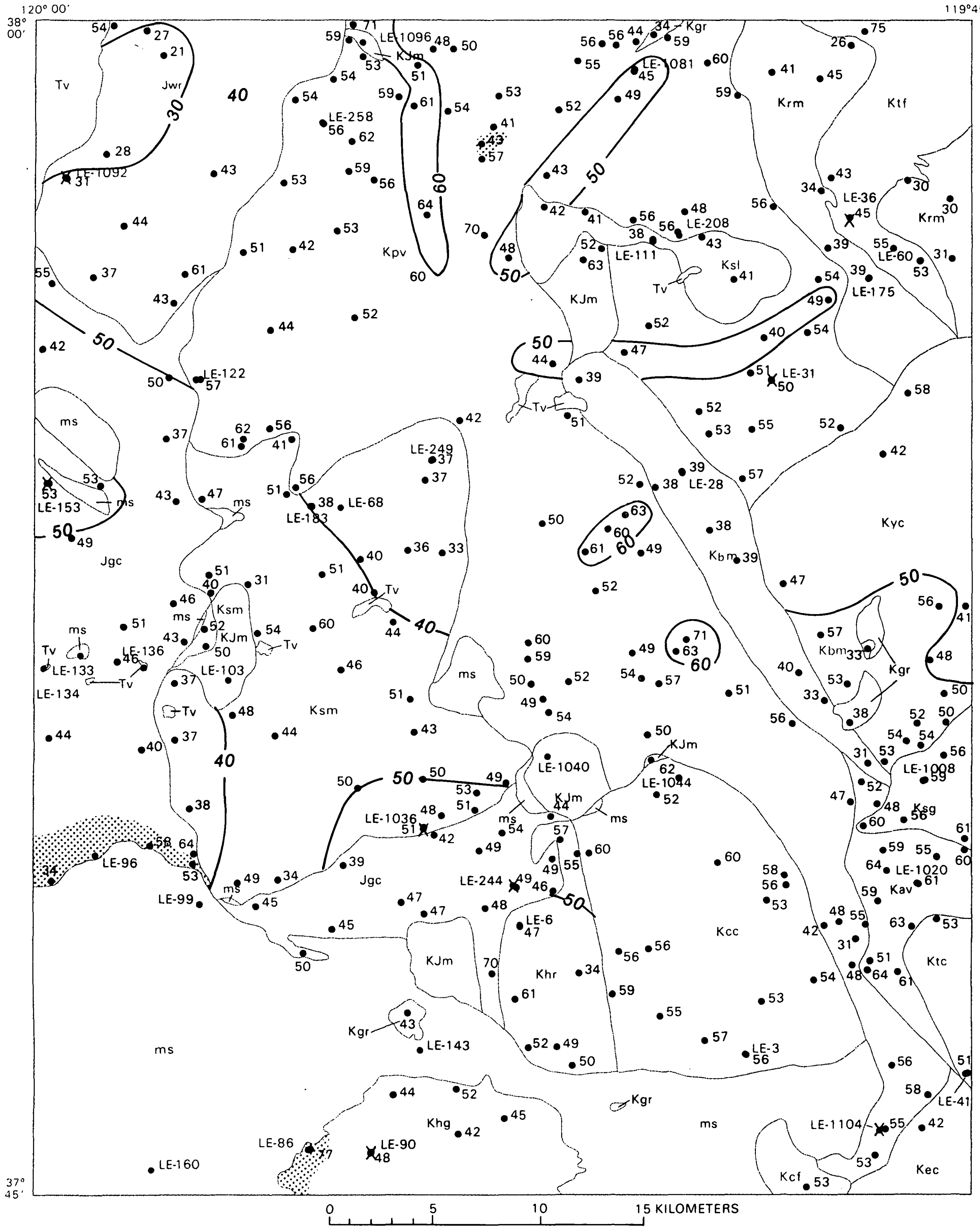

Figure 5. Volume-percent plagioclase in plutonic rocks indicated by isopleths. Dot indicates location of sample. See figure 2 for explanation of generalized geology.

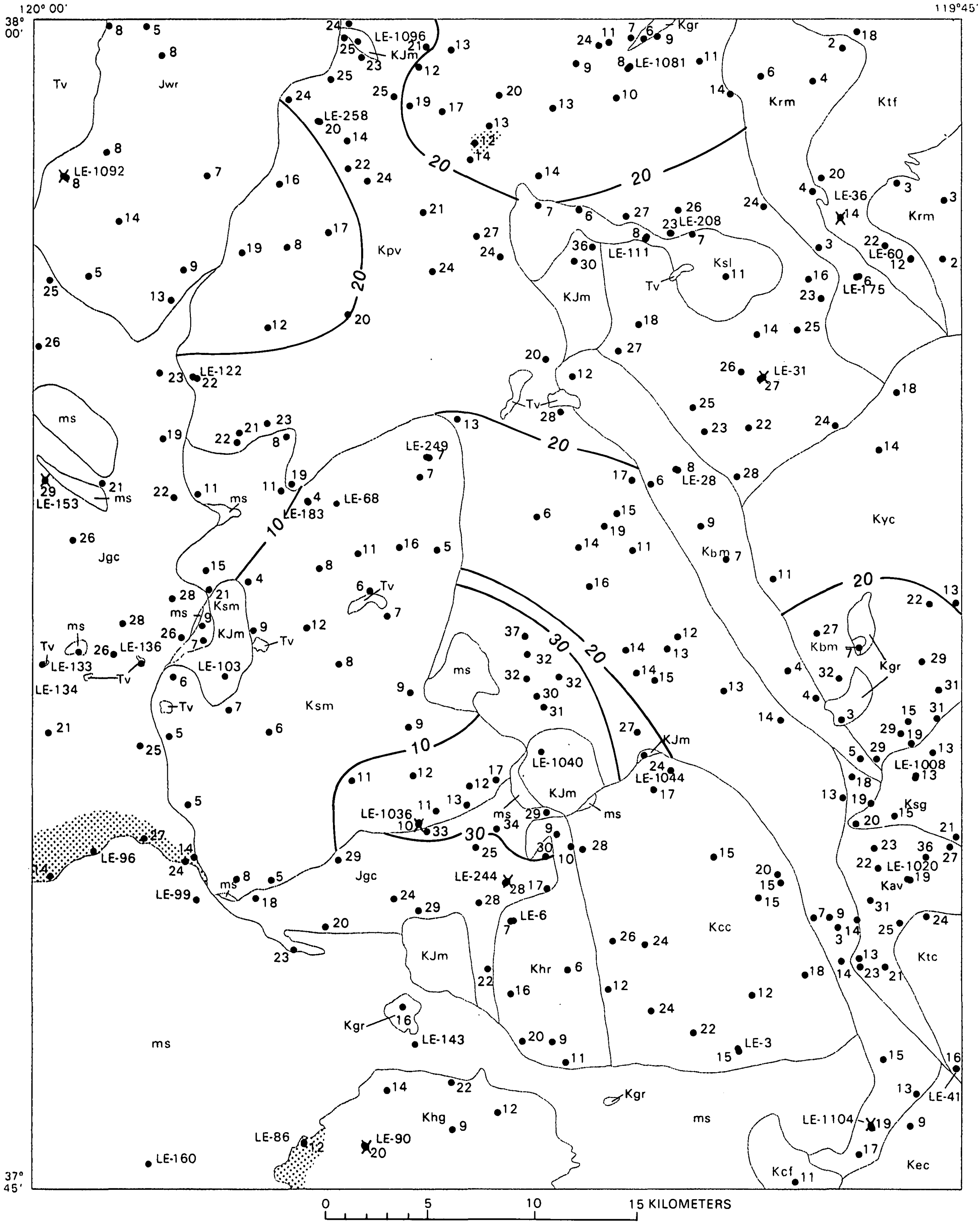

Figure 6. Volume-percent mafic minerals in plutonic rocks indicated by isopleths. Dot indicates location of sample. See figure 2 for explanation of generalized geology.

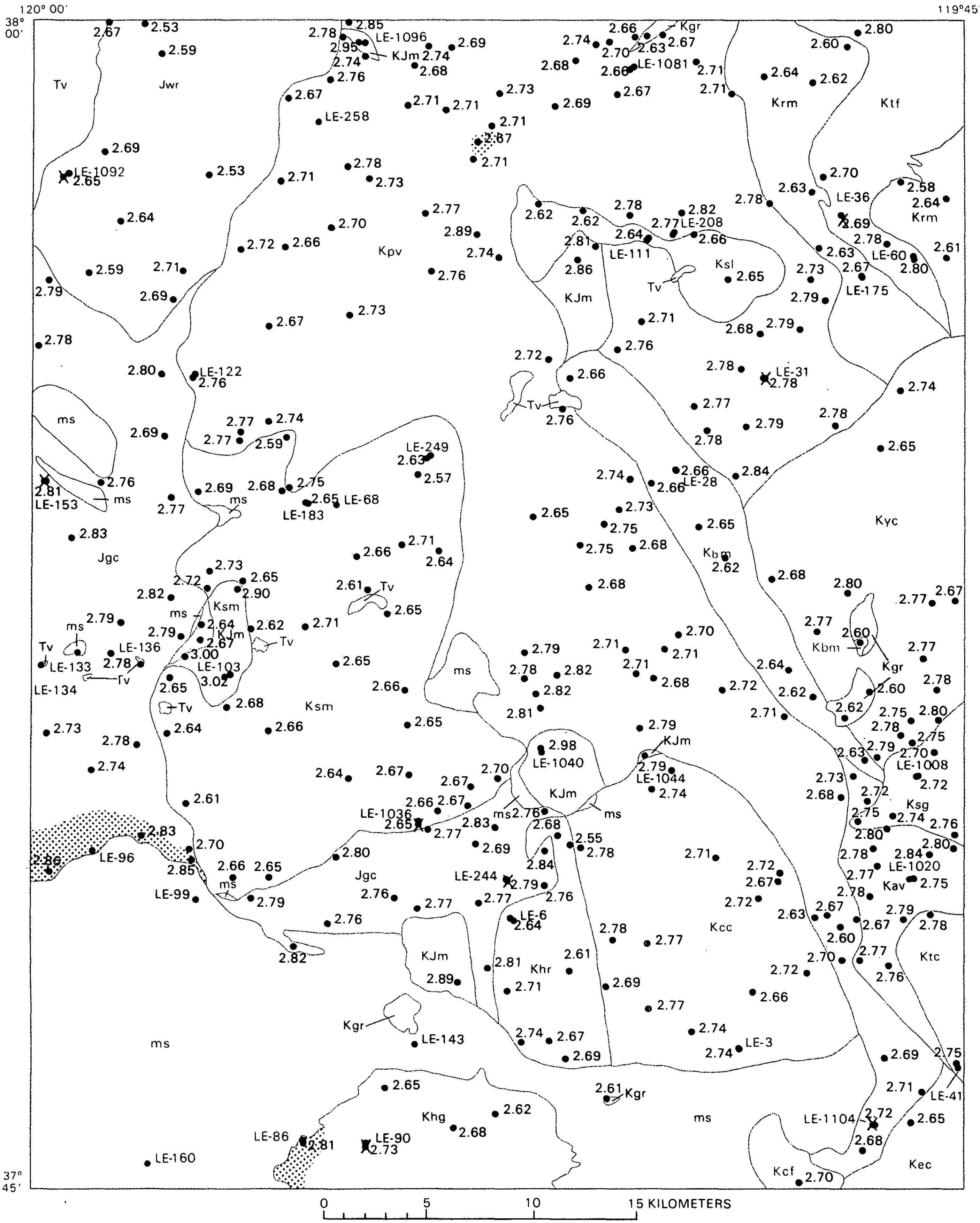

Figure 7. Bulk specific gravity of plutonic rocks. Dot indicates location of sample. See figure 2 for explanation of generalized geology.

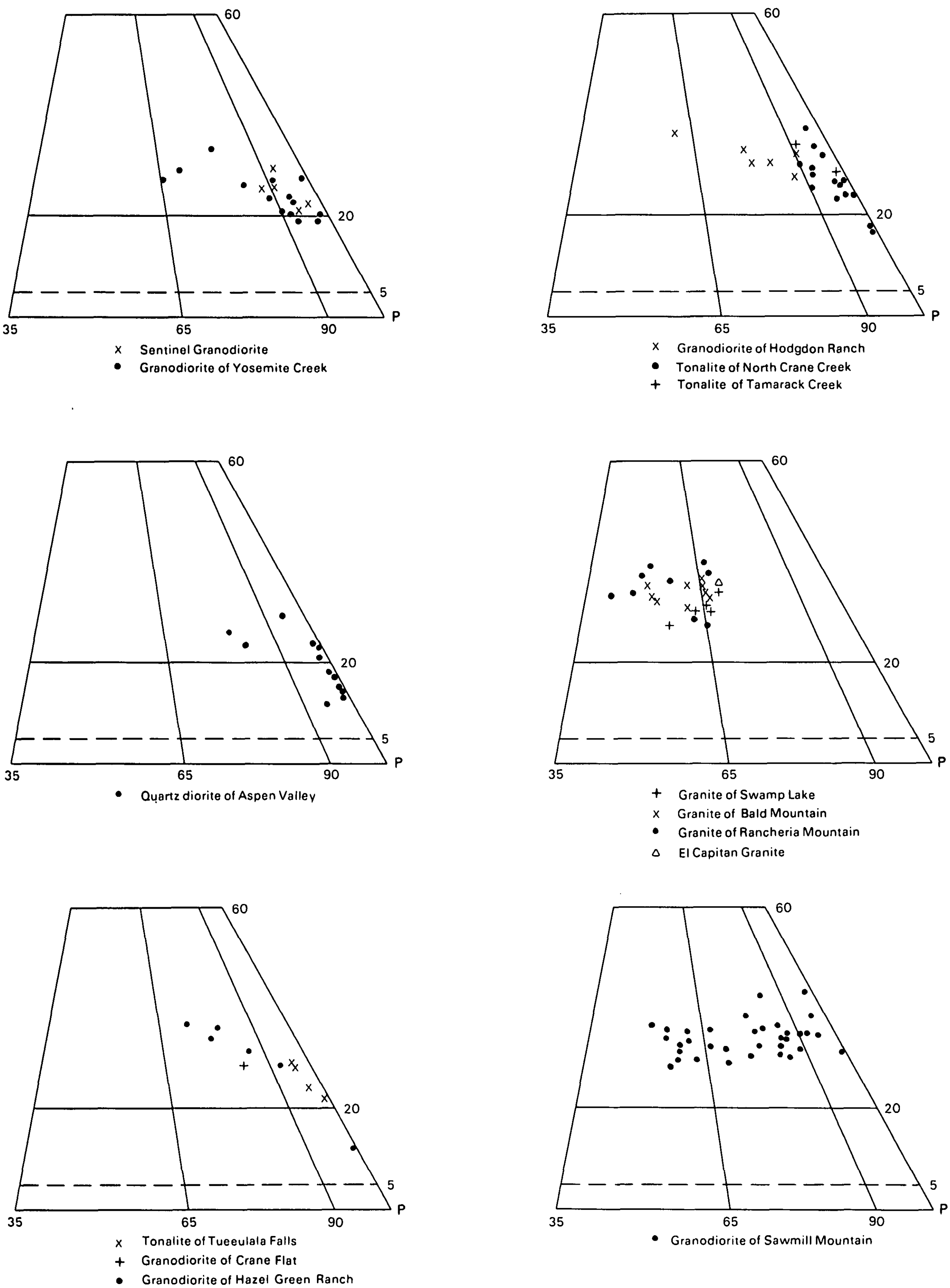

Figure 8. Modal plots of granitic rocks in the Lake Eleanor quadrangle. Explanation found on page 12.

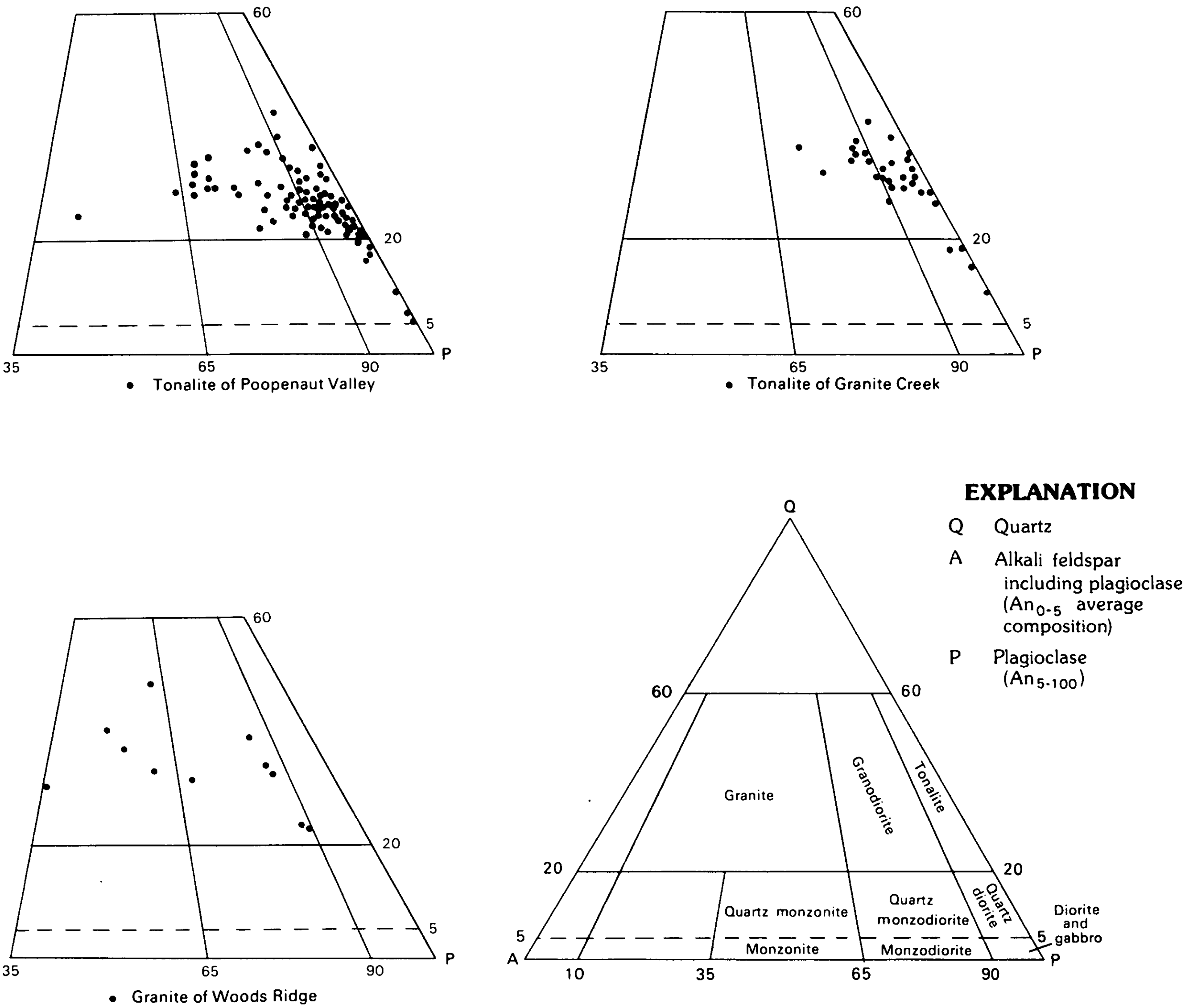

Figure 8. Continued.

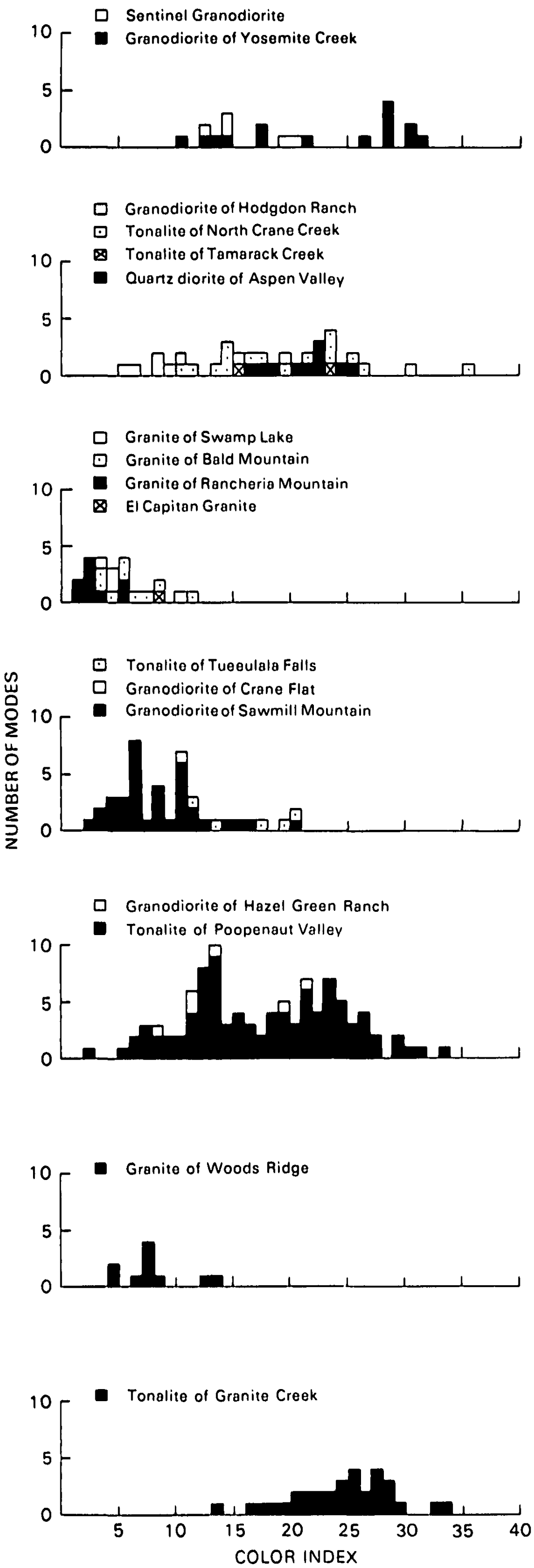

Figure 9. Histograms of color index (volume-percent mafic minerals) of granitic rocks.

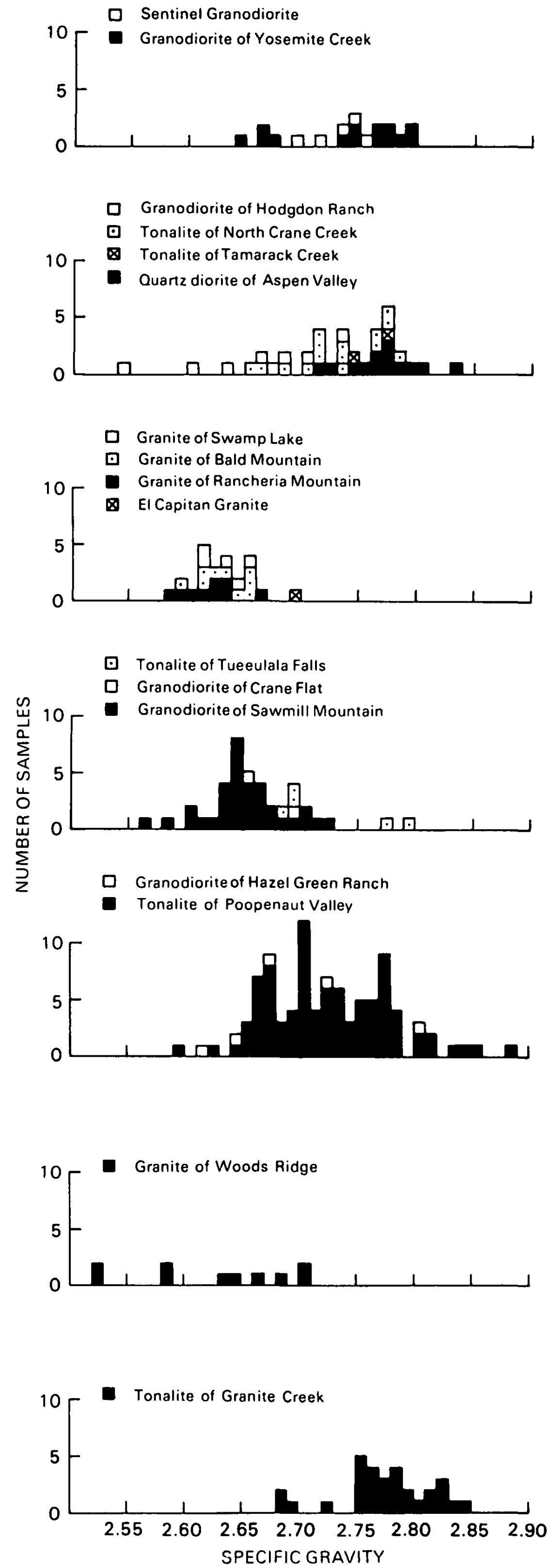

Figure 10. Histograms of bulk specific gravities of granitic rocks.

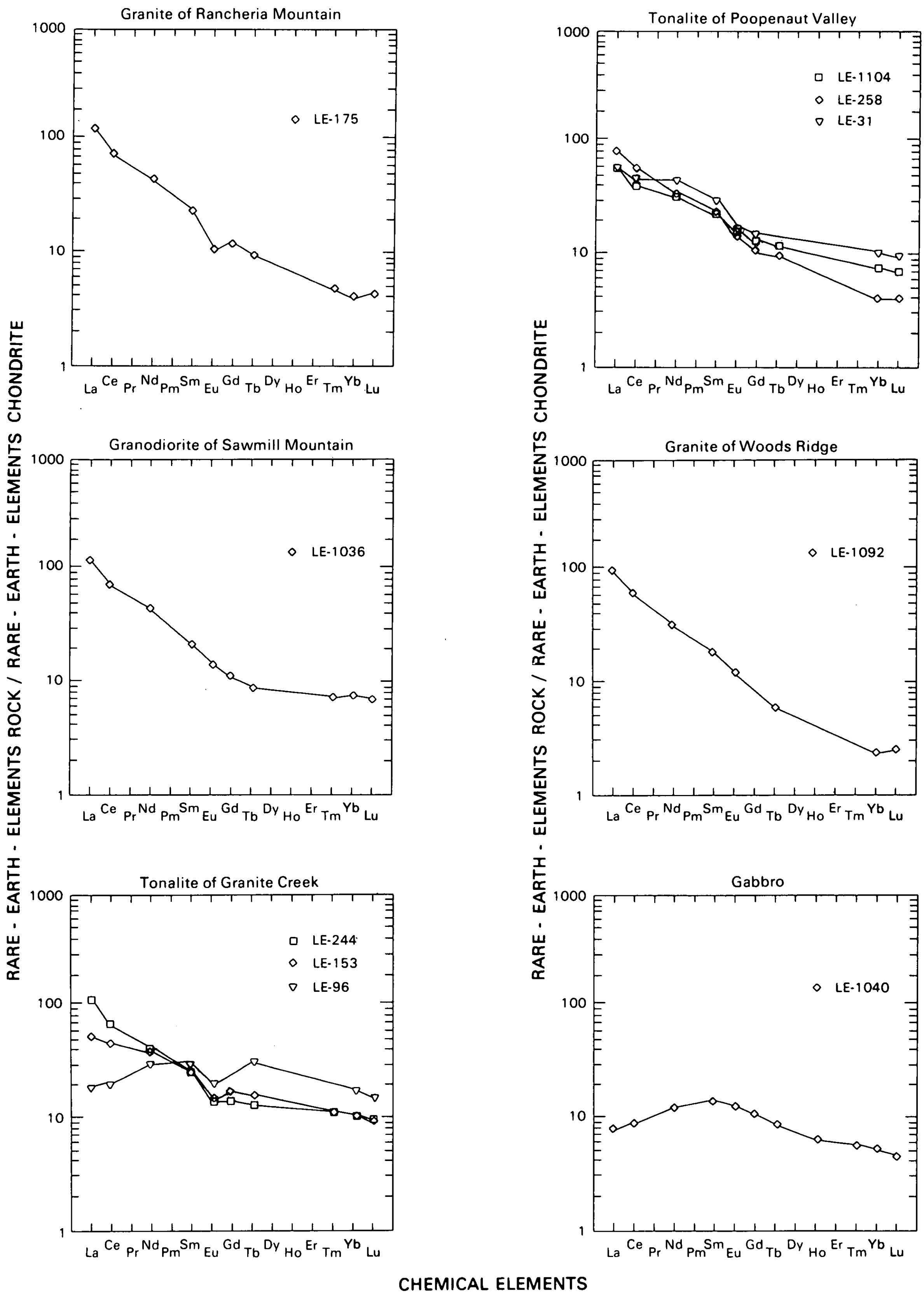

Figure 11. Chondrite-normalized rare-earth elements in plutonic rocks (see figure 2 for location of samples). Instrumental neutron activation analyses of all samples by L.J. Schwarz.

Table 1. Chemical and trace element analyses, norms, modal analyses, and specific gravities of plutonic rocks

[Chemical analyses by V.F. McDaniel and P.E. Bristow using a combination of X-ray fluorescence and chemical methods. Trace-element analyses by V.F. McDaniel using X-ray fluorescence methods. Modal analyses and specific gravities by Oleg Polovtzoff. CIPW norm (Cross and others, 1902)].

	Pyroxenite	Gabbro			Tonalite of Granite Creek: Contact facies	Tonalite of Granite Creek: Main facies		Granite of Woods Ridge
Sample------	LE-1044	LE-1040	LE-1096	LE-103	LE-96	LE-153	LE-244	LE-1092
				Chemical analyses (weight percent)				
SiO_2---------	42.60	42.54	43.07	43.50	44.40	59.21	61.69	73.76
Al_2O_3--------	9.66	20.53	19.33	16.41	12.98	16.66	15.86	14.02
Fe_2O_3--------	3.93	3.92	2.81	5.98	1.19	.82	.94	.73
FeO----------	6.16	5.88	5.52	7.67	11.30	6.00	5.23	.96
MgO----------	22.02	8.36	11.56	7.66	10.98	3.55	2.89	.57
CaO----------	7.93	13.07	12.16	13.10	10.98	6.31	6.21	2.32
Na_2O---------	.98	2.02	1.38	1.53	2.06	2.49	2.43	2.93
K_2O----------	.13	.34	.35	.36	.62	2.13	2.44	4.14
H_2O^+---------	4.89	1.79	2.89	1.70	2.06	1.51	.68	.30
H_2O^----------	.08	.15	.25	.16	.07	.09	.10	.12
TiO_2---------	.42	1.76	1.07	1.20	1.95	.75	.68	.24
P_2O_5---------	.11	.08	.11	.17	.15	.19	.17	.08
MnO----------	.149	.107	.118	.163	.188	.118	.120	.033
CO_2----------	.08	.06	.05	.05	.29	.23	.07	.15
Total------	99.14	100.61	100.67	99.65	99.09	100.06	99.51	100.35
				Trace-element analyses (parts per million)				
Ba----------	55	112	76	80	177	840	920	1550
Ni----------	470	40	94	29	49	28	21	12
Rb----------	<5	<5	5	<5	11	75	76	56
Sr----------	106	610	620	425	163	335	335	295
Y-----------	12	11	<5	7	33	13	14	<5
				CIPW norms (weight percent)				
Q-----------	-	-	-	-	-	14.77	18.71	34.98
C-----------	-	-	-	-	-	-	-	.69
or----------	.82	2.04	2.12	2.18	3.79	12.81	14.61	24.52
ab----------	8.81	9.28	10.73	13.24	14.13	21.45	20.84	24.85
an----------	22.93	46.60	46.69	37.70	25.18	28.50	25.50	11.01
ne----------	-	4.36	6.79	-	2.12	-	-	-
di----------	14.30	14.18	11.48	22.25	24.02	1.75	3.82	-
hy----------	12.48	-	-	4.20	-	17.62	13.43	2.25
ol----------	33.49	13.57	21.77	8.84	24.80	-	-	-
mt----------	6.06	5.76	4.18	8.87	1.79	1.21	1.38	1.06
il----------	.85	3.39	2.09	2.33	3.83	1.45	1.31	.46
ap----------	.28	.19	.27	.41	.37	.46	.41	.19
Total---	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.01
				Modal analyses (volume percent)				
Quartz-------	-	-	-	-	-	27	22	34
Potassium feldspar---	-	-	-	-	-	1	2	28
Plagioclase--	-	-	-	-	-	43	49	31
Mafic minerals---	-	-	-	-	-	29	28	8
Total------	-	-	-	-	-	100	101	101
				Bulk specific gravities				
	3.01	2.98	2.95	3.02	3.08	2.81	2.79	2.65

Table 1. Chemical and trace element analyses, norms, modal analyses, and specific gravities of plutonic rocks—Continued

	Tonalite of Tueeulala Falls	Grano-diorite of Bald Mountain	Grano-diorite of Swamp Lake	Grano-diorite of Rancheria Mountain	Tonalite of Aspen Valley	Tonalite of Tamarack Creek	Tonalite of N Crane Creek	Grano-diorite of Hodgdon Ranch	Sentinel Grano-diorite
Sample------	LE-60	LE-28	LE-111	LE-175	LE-1020	LE-41	LE-3	LE-6	LE-1008
				Chemical analyses (weight percent)					
SiO_2---------	68.40	71.08	72.54	72.18	62.16	62.79	64.16	67.56	64.69
Al_2O_3--------	15.62	14.93	14.86	14.61	17.42	16.77	16.46	16.07	16.86
Fe_2O_3--------	1.66	.85	.88	.78	1.99	2.11	1.81	1.58	1.92
FeO----------	2.04	1.48	1.32	1.44	3.22	3.08	2.56	1.68	2.14
MgO----------	1.32	.59	.50	.46	2.32	2.21	2.06	1.31	1.54
CaO----------	3.69	2.57	2.23	2.10	5.68	5.30	5.24	3.06	5.00
Na_2O---------	3.86	3.31	3.48	3.86	3.68	3.62	3.73	3.37	4.00
K_2O----------	2.38	3.70	3.96	3.07	1.58	2.00	1.84	2.95	2.06
H_2O^+---------	.60	.39	.35	.34	.69	.82	.72	1.02	.54
H_2O^----------	.10	.19	.05	.04	.11	.20	.14	.79	.16
TiO_2---------	.52	.33	.31	.32	.64	.70	.74	.59	.73
P_2O_5---------	.13	.10	.12	.11	.25	.21	.21	.21	.21
MnO----------	.100	.069	.054	.063	.107	.105	.077	.061	.071
CO_2----------	.05	.09	.07	.07	.06	.09	.11	.12	.06
Total------	100.47	99.68	100.72	99.44	99.91	100.01	99.86	100.32	99.98
				Trace element analyses (parts per million)					
Ba-----------	820	980	860	1050	680	820	780	940	800
Ni-----------	25	22	16	18	21	19	24	17	21
Rb-----------	86	95	111	98	43	57	37	82	54
Sr-----------	310	265	215	265	530	460	590	485	640
Y------------	8	<5	<5	5	<5	5	<5	8	<5
				CIPW norms (weight percent)					
Q------------	26.64	31.15	31.30	32.71	18.45	19.18	21.40	28.79	21.03
C------------	.30	1.06	1.08	1.40	-	-	-	2.31	-
or-----------	14.10	22.08	23.34	18.33	9.43	11.95	11.00	17.71	12.27
ab-----------	32.75	28.29	29.37	32.99	31.44	30.97	31.92	28.97	34.11
an-----------	17.51	12.22	10.25	9.80	26.60	23.87	22.99	14.03	22.14
ne-----------	-	-	-	-	-	-	-	-	-
di-----------	-	-	-	-	.16	1.08	1.54	-	1.19
hy-----------	5.00	3.10	2.52	2.76	9.20	8.03	6.60	4.25	4.58
ol-----------	-	-	-	-	-	-	-	-	-
mt-----------	2.41	1.25	1.27	1.14	2.91	3.09	2.65	2.33	2.81
il-----------	.99	.63	.59	.61	1.23	1.34	1.42	1.14	1.40
ap-----------	.31	.24	.28	.26	.60	.50	.50	.51	.50
Total----	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.01
				Modal analyses (volume percent)					
Quartz-------	25	32	25	35	20	28	24	31	22
Potassium feldspar---	11	21	30	20	1	6	5	14	5
Plagioclase--	52	39	38	39	61	51	56	47	59
Mafic-------- minerals---	12	8	8	6	19	16	15	7	13
Total-----	100	101	101	100	101	101	100	99	99
				Bulk specific gravities					
	2.70	2.66	2.64	2.67	2.75	2.75	2.74	2.64	2.72

Table 1. Chemical and trace element analyses, norms, modal analyses, and specific gravities of plutonic rocks—Continued

	Tonalite of Poopenaut Valley						Granodiorite of Hazel Green Ranch		Granodiorite of Sawmill Mountain		
							Contact facies	Main facies			
Sample------	LE-31	LE-208	LE-122	LE-258	LE-1104	LE-1081	LE-86	LE-90	LE-1036	LE-249	LE-183
					Chemical analyses (weight percent)						
SiO_2---------	60.23	61.37	62.65	63.99	65.39	71.34	48.65	63.74	69.99	71.48	72.12
Al_2O_3--------	17.16	17.74	16.84	16.81	16.60	15.05	24.97	16.29	15.18	15.10	14.26
Fe_2O_3--------	1.95	1.78	1.93	1.55	1.02	.88	.16	1.49	1.05	.85	1.04
FeO----------	4.17	3.60	3.16	2.56	3.16	1.18	3.90	3.00	1.74	1.40	1.28
MgO----------	2.84	2.28	2.39	2.03	1.50	.71	5.10	2.45	.87	.52	.39
CaO----------	6.32	5.78	5.70	5.03	4.21	2.73	14.24	5.13	2.92	2.16	1.71
Na_2O---------	3.42	3.98	3.70	3.83	3.96	3.73	1.90	3.29	4.20	2.94	3.76
K_2O----------	1.85	1.83	1.77	2.32	2.46	3.44	.35	2.26	2.34	4.14	4.19
H_2O^+---------	.77	.89	.93	.66	.58	.42	1.00	.88	.58	.75	.52
H_2O^----------	.09	.09	.11	.10	.12	.12	.10	.16	.16	.37	.10
TiO_2---------	.81	.77	.85	.67	.62	.40	.22	.60	.36	.29	.32
P_2O_5---------	.21	.22	.24	.19	.19	.12	.13	.17	.17	.13	.10
MnO----------	.112	.092	.080	.072	.084	.051	.085	.084	.082	.065	.050
CO_2----------	.05	.06	.06	.04	.05	.06	.48	.06	.06	.31	.07
Total------	99.89	100.48	100.41	99.85	99.94	100.23	101.29	99.60	99.70	100.51	99.91
					Trace-element analyses (parts per million)						
Ba-----------	670	1050	740	1100	1100	1350	245	710	960	940	920
Ni-----------	17	21	34	29	17	18	46	28	22	11	16
Rb-----------	58	62	32	50	62	69	<5	81	51	120	75
Sr-----------	480	500	680	630	375	425	760	405	335	235	165
Y------------	18	20	<5	6	<5	<5	<5	14	<5	<5	<5
					CIPW norms (weight percent)						
Q------------	14.83	14.75	18.60	19.04	20.53	29.62	-	20.82	28.99	33.12	30.01
C------------	-	-	-	-	.23	.52	-	-	.85	2.19	.68
or-----------	11.03	10.87	10.53	13.84	14.66	20.40	2.07	13.56	13.98	24.69	24.95
ab-----------	29.21	33.86	31.52	32.72	33.78	31.68	16.12	28.26	35.93	25.11	32.06
an-----------	26.25	25.28	24.28	22.03	19.80	12.81	58.74	23.36	13.52	9.96	7.89
ne-----------	-	-	-	-	-	-	-	-	-	-	-
di-----------	3.28	1.73	2.12	1.54	-	-	9.13	1.10	-	-	-
hy-----------	10.50	8.93	7.94	6.83	7.89	2.65	7.22	9.16	4.10	2.83	2.04
ol-----------	-	-	-	-	-	-	5.76	-	-	-	-
mt-----------	2.85	2.60	2.82	2.27	1.49	1.28	.23	2.19	1.54	1.24	1.52
il-----------	1.55	1.47	1.63	1.29	1.19	.76	.42	1.16	.69	.56	.61
ap-----------	.50	.52	.57	.45	.45	.29	.31	.41	.41	.31	.24
Total----	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.01
					Modal analyses (volume percent)						
Quartz-------	21	19	17	19	22	29	11	26	31	26	30
Potassium feldspar---	2	1	4	5	4	18	0	7	9	30	28
Plagioclase--	50	56	57	56	55	45	77	48	51	37	38
Mafic-------- minerals---	27	23	22	20	19	8	12	20	10	7	4
Total-----	100	99	100	100	100	100	100	101	101	100	100
					Bulk specific gravities						
	2.78	2.77	2.76	2.73	2.72	2.66	2.81	2.73	2.65	2.63	2.65

Table 2. Chemical and trace-element analyses and norms of trachyandesite

[Chemical analyses by B.W. King, L.F. Espos, and M.J. Cremer using a combination of X-ray fluorescence and chemical methods. Ba, Rb, S, Sr, Y, Zn, and Zr determined by X-ray fluorescence methods by B.W. King and L.F. Espos. Co, Cr, Cu, Sc, and V determined by quantitative spectrographic methods by Chris Heropoulos. CIPW norm (Cross and others, 1902)].

Sample------	LE-136	LE-134
Chemical analyses (weight percent)		
SiO_2---------	56.16	56.17
Al_2O_3--------	17.29	17.32
Fe_2O_3--------	2.62	3.80
FeO----------	3.96	2.78
MgO----------	3.91	4.07
CaO----------	6.59	6.61
Na_2O---------	3.37	3.41
K_2O----------	2.99	2.46
H_2O^+---------	.45	.89
H_2O^----------	.20	.52
TiO_2---------	.98	.88
P_2O_5---------	.44	.43
MnO----------	.113	.114
CO_2----------	.07	.18
Total------	99.14	99.63
Trace-element analyses (parts per million)		
Ba-----------	1,300	1,500
Co-----------	19	22
Cr-----------	56	170
Cu-----------	40	78
Rb-----------	65	48
S------------	<7	30
Sc-----------	14	13
Sr-----------	840	960
V------------	130	160
Y------------	18	18
Zn-----------	83	82
Zr-----------	220	215
CIPW norms (weight percent)		
Q------------	6.25	8.90
or-----------	17.95	14.83
ab-----------	28.97	29.43
an-----------	23.59	25.18
di-----------	5.39	4.24
hy-----------	11.06	9.10
mt-----------	3.86	5.62
il-----------	1.89	1.71
ap-----------	1.06	1.04
Total----	100.03	100.02

Table 3. Chemical and spectrographic analyses of metasedimentary rocks

[Chemical analyses by P.L.D. Elmore, Gillison Chloe, J.L. Kelsey, Hezekiah Smith, and James Glen, using rapid-rock methods. Semiquantitative spectrographic analyses by R.E. Mays. Results determined spectrographically are identified with geometric brackets whose boundries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, and so on, but are reported arbitrarily as midpoints of these brackets, that is, 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so on. The precision of a reported value is approximately plus or minus one bracket at 68 percent, or two brackets at 95 percent confidence. N = not detected. Looked for, but not detected in any samples: Ag, As, Au, Be, Bi, Cd, Ce, Co, Eu, Ge, Hf, In, Li, Mo, Nb, Pb, Pd, Pt, Re, Sb17Sn, Ta, Te, Th, Tl, U, V, W, Zn]

	Black slate	Banded hornfels	Quartz-mica schist		Quartzite
Sample------	LE-160	LE-68	LE-143	LE-99	LE-133
Chemical analyses (weight percent)					
SiO_2---------	73.7	79.1	91.1	92.5	95.0
Al_2O_3--------	14.4	6.4	3.9	3.2	2.5
Fe_2O_3--------	2.2	1.0	1.0	.00	.00
FeO----------	.36	1.6	.24	.27	.31
MgO----------	.77	1.9	.20	.46	.08
CaO----------	.06	6.4	.06	.10	.08
Na_2O---------	.15	1.1	.12	.11	.08
K_2O----------	4.0	.29	.85	1.5	.63
H_2O^+---------	2.7	.75	1.3	.72	.25
H_2O^----------	.26	.11	.09	.06	.06
TiO_2---------	.87	.31	.28	.14	.18
P_2O_5---------	.07	.57	.03	.04	.00
MnO----------	.00	.10	.00	.00	.00
CO_2----------	<.05	<.05	<.05	<.05	<.05
Total------	100	100	99	99	99
Powder density (gm/cm^3)	2.76	2.76	2.72	2.72	2.72
Semiquantitative spectrographic analyses (parts per million)					
B-----------	100	N	N	N	N
Ba----------	2000	200	150	200	500
Cr----------	70	100	15	10	3
Cu----------	20	10	7	7	N
Ga----------	15	N	N	N	N
Ni----------	N	70	N	N	N
Sc----------	15	3	N	N	N
Sr----------	30	200	N	10	N
V-----------	100	100	N	N	N
Y-----------	20	20	N	N	N
Yb----------	2	2	N	N	N
Zr----------	100	50	150	70	70

Table 4. Uranium-lead age determinations on zircon from granitic rocks

[Determinations by T.W. Stern. Constants used: $^{238}U/^{235}U$=137.88; 238λ=0.155x10^{-9} years. Analytical uncertainties ∿±3 percent]

		Tonalite of Granite Creek		Granite of Woods Ridge	Granodiorite of Sawmill Mountain	Tonalite of Poopenaut Valley		Granodiorite of Hazel Green Ranch	Tonalite of Tueeulala Falls
Sample------		LE-153	LE-244	LE-1092	LE-1036	LE-31	LE-1104	LE-90	LE-36
Parts per million	Pb	16.26	20.99	19.40	7.45	8.62	10.24	14.64	23.37
	U	635.7	841.9	811.5	408.9	435.5	533.2	511.8	1260
	Th	137.2	172.1	249.2	126.7	204.3	204.1	1161	663.3
Atomic ratios	$^{208}Pb/^{206}Pb$	.07992	.07518	.09887	.09928	.19289	.13779	.75710	.19556
	$^{207}Pb/^{206}Pb$	.05549	.05374	.05958	.05440	.06566	.05456	.05730	.05717
	$^{204}Pb/^{206}Pb$	.00033	.00029	.00067	.00059	.00125	.00038	.00069	.00060
Age (Ma)	$^{208}Pb/^{232}Th$	158.8	156.6	111.2	89.3	109.9	117.5	114.8	109.9
	$^{207}Pb/^{235}U$	169.6	163.1	152.8	110.7	111.7	120.1	112.6	109.0
	$^{206}Pb/^{238}U$	165.7	162.6	150.9	116.1	114.1	118.8	115.3	108.7

Table 5. Potassium-argon age determinations of sample LE-1104 from the tonalite of Poopenaut Valley

[Potassium measurements by P.R. Klock. Argon measurements by J.C. Von Essen. Constants used: λ_β=4.962x10^{-10}yr^{-1}; λ_ϵ=0.581x10^{-10}yr^{-1}; $^{40}K/\Sigma K$=1.167x10^{-14}]

Mineral	K_2O (weight %)	Radiogenic ^{40}Ar (mol/gm)	Radiogenic ^{40}Ar (%)	Age (Ma)
Biotite	8.48	126.3x10^{11}	65.2	100.6±0.7
Hornblende	0.905	153.7x10^{12}	84.6	114.3±0.7

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