Mount Whitney Quadrangle, Inyo and Tulare Counties, California—Analytic Data

U.S. GEOLOGICAL SURVEY BULLETIN 1760

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By JAMES G. MOORE

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Mount Whitney Quadrangle, Inyo and Tulare Counties, California—Analytic Data

By James G. Moore

Abstract

The Mount Whitney quadrangle includes 620 km^2 of the highest part of the crest of the Sierra Nevada, which is here underlain largely by Cretaceous granitic rocks. Seventy percent of the granitic rocks of the quadrangle belong to the Mount Whitney Intrusive Suite (80 km long and 20 km wide), which was emplaced in the Late Cretaceous during the final culmination of Sierra Nevada plutonism.

About 170 samples of plutonic rocks were collected in the quadrangle; 110 were analyzed modally for their major mineral content and 15 were further analyzed chemically for their major elements. Ten samples collected within and adjacent to the quadrangle were dated by radiometric methods. The average plutonic rock in the quadrangle is estimated to contain 70.47 percent SiO_2 and 3.98 percent K_2O. This report supplements the geologic quadrangle map of the quadrangle by documenting these analyses as well as the location of the analyzed samples.

INTRODUCTION

The Mount Whitney quadrangle includes about 620 km^2 of the highest part of the Sierra Nevada. All of the quadrangle west of the Sierra Nevada crest is within Kings Canyon and Sequoia National Parks, and that part east of the crest includes the steep east escarpment of the range and a small part of the west side of the Owens Valley. Mount Whitney, the highest point in the conterminous United States at an elevation of 4,418 m, is on the main range crest in the southeastern part of the quadrangle. A second north-trending major drainage divide, the Great Western Divide, lies in the western part of the quadrangle separated from the main crest to the east by the Kern River canyon.

This report supplements the geologic map of the Mount Whitney quadrangle (Moore, 1981) by documenting modal and chemical analyses.

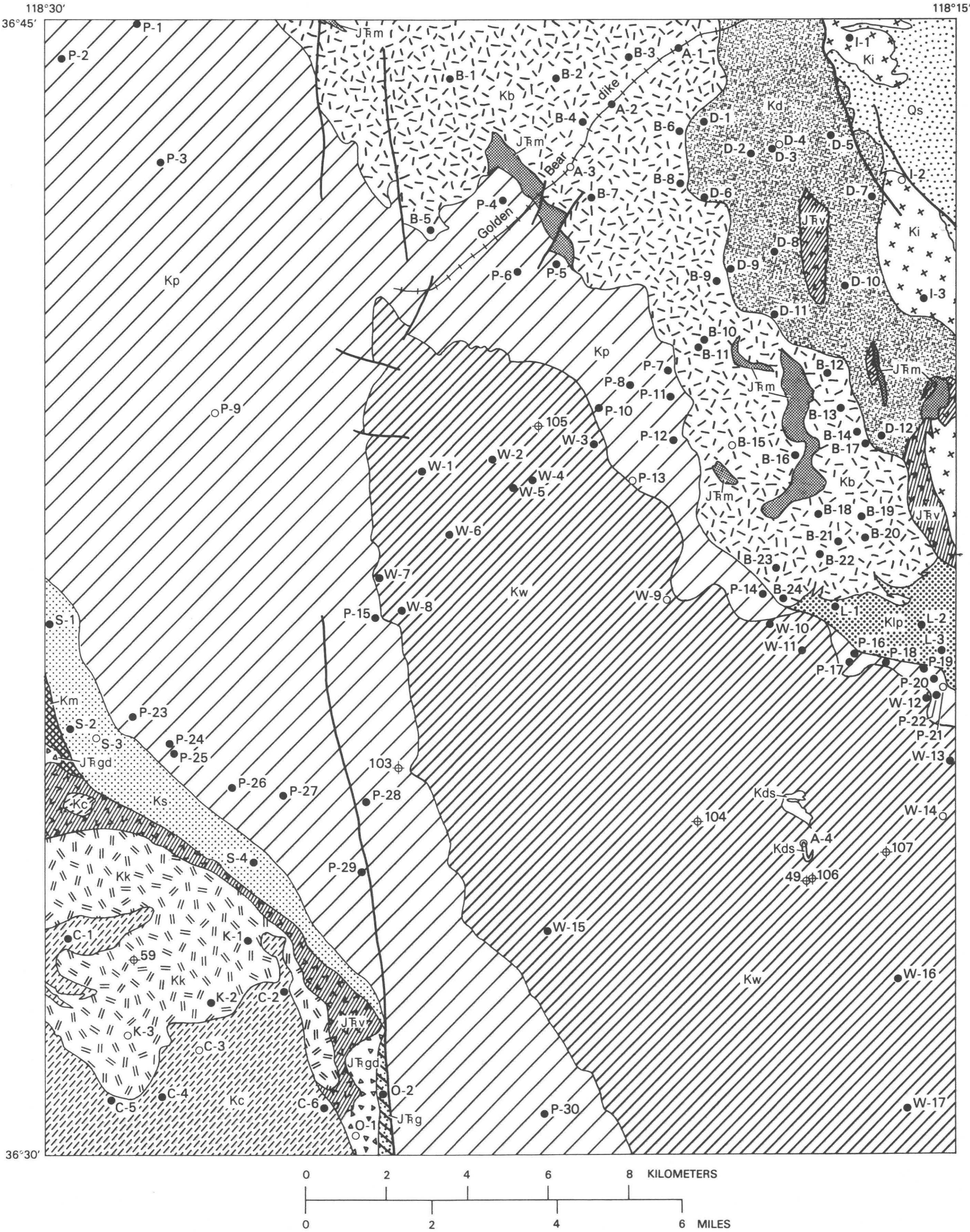
GENERAL GEOLOGY

The oldest rocks of the quadrangle are small masses of metavolcanic rocks preserved both as screens between and as inclusions within granitic plutons. These metamorphic rocks are closely associated with masses of sheared granitic rocks cut by mafic dikes tentatively assigned to the Late Jurassic Independence dike swarm.

Cretaceous granitic rocks greatly predominate among the bedrock units of the quadrangle (fig. 1). Of the 620 km^2 in the quadrangle, about 600 km^2 (98 percent) are underlain by granitoids; the remainder is either covered by sediments deposited in the Owens Valley or underlain by small masses of pregranitic metamorphosed volcanic rocks. Seventy percent of the granitic rocks are part of the Mount Whitney Intrusive Suite (Moore and Sisson, 1987), which is more than 80 km long and 20 km wide and is one of the largest cogenetic intrusive complexes in the Sierra Nevada batholith. This group of four related granitic intrusions as well as cogenetic dikes and sills was emplaced in the Late Cretaceous during the final culmination of Sierra Nevada plutonism.

SAMPLING AND ANALYTIC METHODS

About 170 samples of typical plutonic rocks weighing about one kilogram each were collected in the quadrangle, but sampling density was uneven due to the inaccessibility of the terrain in some areas. Fourteen samples were analyzed chemically for their major elements (tables 1, 2), and 110 samples were modally analyzed (tables 3-13). The locations of samples for both types of analyses are shown in figure 1, and plots showing the modal proportions of quartz, K-feldspar, and plagioclase in the granitic rocks appear in figures 2 and 3. The modal analyses were made by point counting selectively stained slabs (Norman, 1974) to determine volume percentages of quartz, K-feldspar, plagioclase, and mafic minerals. At least 1,000 regularly spaced points were counted on



118°30′
118°15′
36°45′
36°30′
Kp
Kb
Kd
Ki
Qs
Kw
Klp
Km
Ks
Kc
Kk
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JTrm
JTrv
JTrgd
JTrg
Golden Bear dike
0 2 4 6 8 KILOMETERS
0 2 4 6 MILES

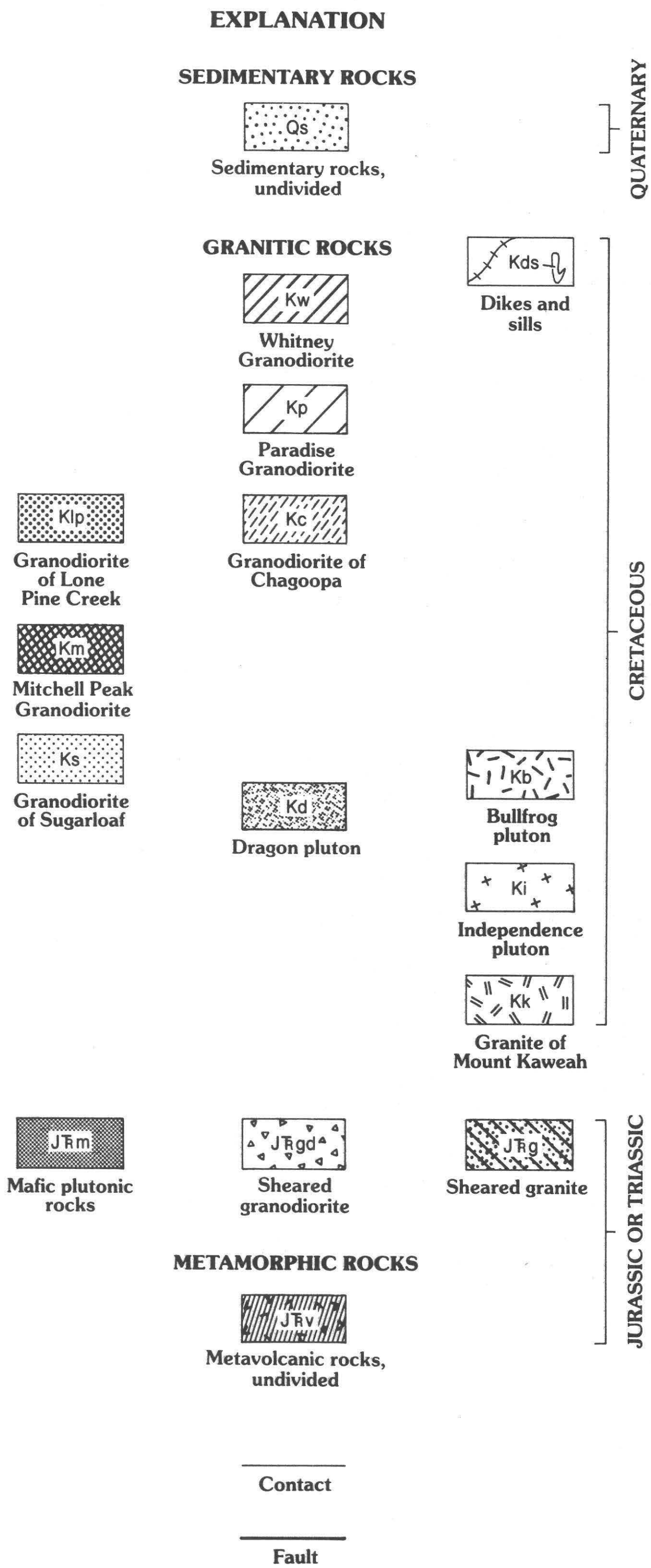

Figure 1. Generalized geologic map (from Moore, 1981) and locations of analyzed samples in Mount Whitney quadrangle. Circles, chemically analyzed (tables 1, 2); dots, modally analyzed (tables 3-13); circles with crosses, geochronologically analyzed (table 16).

slabs of about 70 cm^2. The modal classification scheme for granitic rocks employed is that of Streckeisen and others (1973).

The specific gravity of fist-sized samples was determined on a beam balance by measuring the difference between the length of the lever arm during balance of the sample in air and the length of the arm during balance while submerged in water.

MOUNT WHITNEY INTRUSIVE SUITE

The Mount Whitney Intrusive Suite is one of the largest and youngest composite granitic intrusions in the Sierra Nevada and dominates the granitoids of the Mount Whitney quadrangle. Radiometric ages for rocks in the suite fall in the range 80.4-87 Ma (see table 16). The major unit in the suite is the Paradise Granodiorite, which rings the slightly younger and more silicic Whitney Granodiorite. Marginal to the Paradise Granodiorite are the granodiorites of Sugarloaf on the west and Lone Pine Creek on the east. Silicic dikes and sills intrude various units of the suite.

The Whitney Granodiorite is extremely porphyritic, containing large (4-8 cm) nearly white K-feldspar phenocrysts. The average modal composition of the Whitney Granodiorite is close to the boundary between the granite and granodiorite fields of Streckeisen and others (1973) (fig. 2A). Mafic inclusions are small and rare (averaging less than $0.2/m^2$), and consequently very little structure can be discerned in the rock because the elongated phenocrysts are generally randomly oriented. The Paradise Granodiorite is slightly richer in plagioclase and mafic minerals (fig. 2B, table 4), and the K-feldspar phenocrysts are smaller (1-3 cm) and contain zonally arranged mafic minerals that give them a darker aspect. Mafic inclusions are not abundant (average about $0.2/m^2$), but they are abundant enough to commonly define a mappable foliation.

The granodiorite of Sugarloaf is dark and nonporphyritic, and contains abundant mafic inclusions (average about $6/m^2$). Its apparent counterpart on the opposite side of the Mount Whitney Intrusive Suite, the granodiorite of Lone Pine Creek, is similar in appearance, although somewhat more mafic (fig. 2C, table 6).

Several dikes and sills of granite porphyry containing phenocrysts of quartz and K-feldspar intrude the Whitney Granodiorite, particularly near Mount Whitney. These rocks appear to be compositionally related to the Mount Whitney Intrusive Suite and may represent a silicic residue delivered from the magma chamber before complete consolidation. The Golden Bear dike, formerly assigned to the Mount Whitney Intrusive Suite (Moore, 1981), is compositionally distinct, and hence it is probably unrelated to the suite. Modal analyses indicate that it is much poorer in quartz (fig. 2D, table 7), and chemical analyses indicate that it is poorer in SiO_2 and higher in Na_2O (table 1), than comparable rocks of the suite. The Golden Bear dike rock most resembles the quartz monzonite of the Dragon pluton;

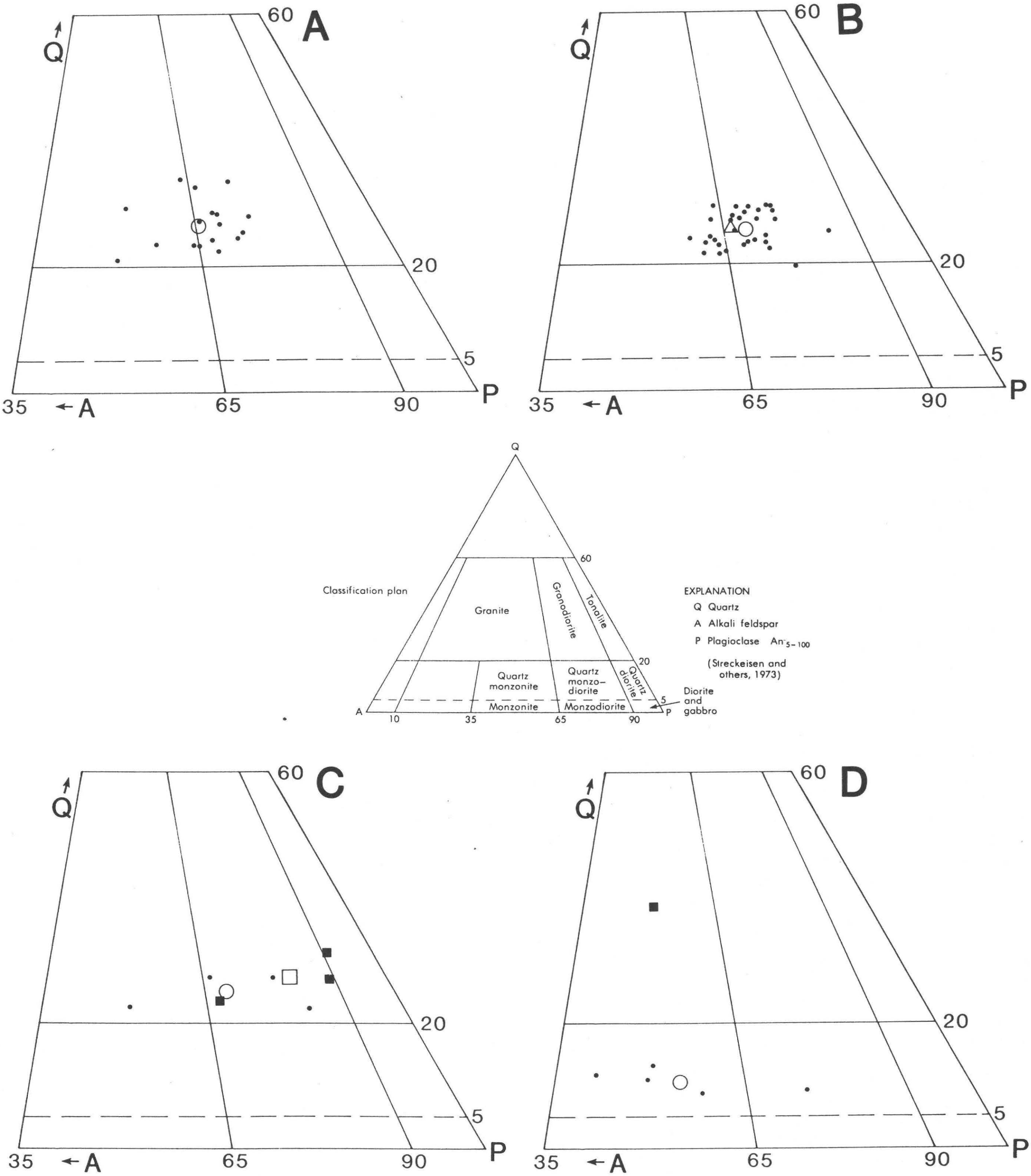

Figure 2. Plots of modes of the Mount Whitney Instrusive Suite. Classification scheme for granitic rocks from Streckeisen and others (1973). A, Whitney Granodiorite: samples (dots) and average (circle) in Mount Whitney quadrangle. B, Paradise Granodiorite: samples (dots) and average (circle) in Mount Whitney quadrangle. Triangle is average of modes within Mount Pinchot quadrangle to the north. C, Granodiorite of Sugarloaf: samples (dots) and average (circle) in Mount Whitney quadrangle. Granodiorite of Lone Pine Creek: samples (solid squares) and average (open square) in Mount Whitney quadrangle. D, Golden Bear dike: samples (dots) and average (circle) in Mount Whitney quadrangle. Sill south of Mount Whitney shown by solid square.

however, unlike the Dragon pluton, it is younger than the Paradise Granodiorite and is probably the youngest intrusive rock in the quadrangle.

OTHER GRANITIC ROCKS

The granodiorite of Chagoopa is of variable composition, ranging from quartz diorite to granite (fig. 3A, table 11), and contains an inner prophyritic facies. A darker, fine-grained facies of the granodiorite forms a thick sill in the granite of Mount Kaweah on Kaweah Peaks Ridge.

The Bullfrog pluton occupies 77 km^2 in the Mount Whitney quadrangle and an additional 59 km^2 in the Mount Pinchot quadrangle to the north. This intrusive mass is mostly composed of light-colored, silicic granite and quartz monzonite (fig. 3B, table 10) that averages only 2.5 percent mafic minerals and contains rare mafic inclusions (average 1×10^{-6} /m^2) except near contacts.

Silicic, light-colored granite similar to that of the Bullfrog pluton makes up the Independence pluton. The granite averages 2.7 percent mafic minerals (fig. 3A, table 9).

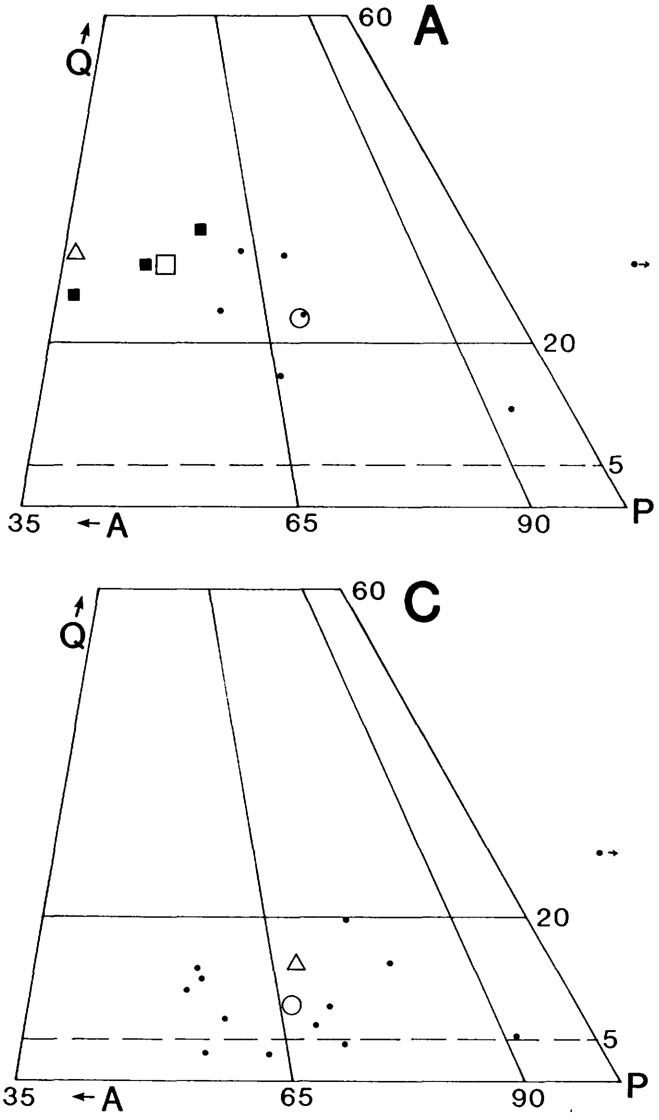

Figure 3. Plots of modes of granitic rocks other than those of the Mount Whitney Intrusive Suite. See figure 2 for classification scheme. A, Granodiorite of Chagoopa: samples (dots) and average (circle) in Mount Whitney quadrangle. Independence pluton: samples (solid squares) and average (open square) in Mount Whitney quadrangle. Average of Independence pluton in Mount Pinchot quadrangle to the north shown by triangle. B, Bullfrog pluton: samples (dots) and average (circle) in Mount Whitney quadrangle. Average in Mount Pinchot quadrangle shown by triangle. C, Dragon pluton: samples (dots) and average (circle) in Mount Whitney quadrangle. Average in Mount Pinchot quadrangle shown by triangle. D, Granite of Mount Kaweah (dots), older sheared granodiorite (triangle), and older sheared granite (square).

The granite of Mount Kaweah (in the southwest part of the quadrangle) is variable in composition (fig. 3D, table 12). Oxidation of disseminated pyrite within the unit commonly produces a faint red staining.

The rock of the Dragon pluton differs markedly in general composition from other granitoids of the quadrangle because of its low quartz content (average 8.3 percent) and its alkalic character (tables 2, 8). The rock averages about 3 mafic inclusions per square meter. Most samples plot in the quartz monzodiorite and quartz monzonite fields of Streckeisen and others (fig. 3C).

AVERAGE GRANITIC ROCK COMPOSITION

The average chemical composition of the granitic rocks within the quadrangle has been estimated. This average is based on assignment of compositions to each of the intrusive masses and then weighting these compositions on the basis of the areal proportion of each mass that is exposed within the quadrangle (table 14). The assignment of compositions to the intrusive masses was done according to the following scheme: the Whitney Granodiorite is the average of two analyses (table 1); the Paradise Granodiorite is represented by the average of three analyses (table 1); the granodiorite of Sugarloaf and the chemically similar granodiorite of Lone Pine Creek are each given by the Sugarloaf unit analysis listed in table 1; the Bullfrog pluton, Independence pluton, older sheared granodiorite, granodiorite of Chagoopa, granite of Mount Kaweah, and Dragon pluton are each represented by a single analysis (table 2); the Mitchell Peak Granodiorite is represented by the analysis of the similar granodiorite of Sugarloaf (table 1), and older sheared granite by the analysis of the similar Independence pluton (table 2); mafic plutonic rocks were represented by an unpublished analysis of similar rocks from the neighboring Triple Divide Peak quadrangle, which contains 58.69 percent SiO_2 and 2.32 percent K_2O. These last three unanalyzed masses are small and contribute little to the overall averages; they compose a total area of 4.9 km^2, or 0.8 percent of the area of granitic rocks of the quadrangle.

The average granitic rock has been calculated separately for each of the four quadrants (7.5-minute quadrangles) of the 15-minute quadrangle, and the results show that the compositions are quite uniform among the quadrants (table 15). The average granitoid of the quadrangle is silicic, containing 70.5 percent SiO_2, and would lie on about the granodiorite-granite boundary. The average SiO_2 content of granitic rocks, exclusive of mafic plutonic rocks, in the Mount Pinchot quadrangle (bordering the Mount Whitney quadrangle to the north) has been estimated at 68.2 percent (Moore, 1963); the estimated average composition of Mesozoic plutonic rocks of the Sierra Nevada is 68.4 percent (Dodge, 1972).

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TABLES 1—16

Table 1. Chemical analyses, norms, and modes of granitic rocks from the Mount Whitney Intrusive Suite

[Chemistry (in weight percent) by X-ray spectroscopy; analyst: J. Carr (supervisor, V. G. Mossotti) except for FeO and H_2O, analyst: M. Taylor (supervisor, P. J. Lamothe). CIPW norms in weight percent. Modes, in volume percent, determined by counting 1,000 - 2,000 points on selectively stained slabs at least 70 cm^2 in area; analyst: Oleg Polovtzoff]

	Whitney Granodiorite		Paradise Granodiorite			Granodiorite of Sugarloaf	Dikes, sills	
Locality No.---------	W-9	W-14	P-9	P-13	P-21	S-3	A-4	A-3
Field No.---------	200-2	7-311	7-53	7-301	6-259	7-27	7-37	75 M47
				Chemical analyses				
SiO_2----------------	72.19	69.75	70.38	69.80	68.58	66.14	76.84	67.97
Al_2O_3---------------	14.39	15.81	14.86	15.15	15.25	15.40	13.03	15.92
Fe_2O_3---------------	1.48	1.25	1.42	1.50	1.72	2.22	.49	1.21
FeO-----------------	1.00	.94	1.32	1.26	1.46	2.35	.41	1.53
MgO-----------------	.58	.65	1.09	.92	1.10	2.04	.20	.83
CaO-----------------	2.52	2.46	3.05	3.02	3.54	4.26	1.08	2.72
Na_2O----------------	3.69	3.87	3.59	3.60	4.09	3.50	3.08	4.17
K_2O-----------------	3.81	4.72	3.86	3.51	3.08	3.28	5.15	4.10
H_2O+ ---------------	.33	.36	.36	.53	.41	.56	.26	.32
H_2O- ---------------	.16	.04	.05	.18	.04	.06	.08	.12
TiO_2----------------	.37	.40	.41	.49	.51	.60	.13	.45
P_2O_5----------------	.16	.16	.17	.17	.18	.21	.04	.17
MnO-----------------	.05	.05	.07	.05	.05	.08	.01	.11
CO_2-----------------	.06	.09	.06	.06	.12	.20	.09	.42
Total---------	100.80	100.55	100.70	100.26	100.15	100.93	100.91	100.04
				CIPW norms				
Q------------------	30.29	23.33	26.94	27.90	24.54	21.58	36.65	20.86
C------------------	--	0.24	--	0.34	--	--	0.52	--
or-----------------	22.51	27.89	22.81	20.74	18.20	19.38	30.43	24.23
ab-----------------	31.22	32.74	30.38	30.46	34.61	29.61	26.06	35.28
an-----------------	11.45	11.17	13.03	13.88	14.16	16.62	5.10	12.39
di-----------------	0.07	--	0.42	--	0.94	1.32	--	--
hy-----------------	1.54	1.74	3.42	2.65	3.25	6.72	.65	3.34
mt-----------------	2.15	1.81	2.06	2.17	2.49	3.22	.71	1.75
il-----------------	.70	0.76	0.78	0.93	0.97	1.14	.25	.85
ap-----------------	.38	0.38	0.40	0.40	0.43	0.50	.09	.40
Total---------	100.31	100.06	100.24	99.47	99.59	100.09	100.46	99.10
				Modes				
Quartz--------------	30.4	26.3	25.1	19.5	20.8	23.2	38.1	11.1
Potassium feldspar--	22.7	20.9	21.9	26.2	20.2	13.3	29.8	46.5
Plagioclase---------	39.9	45.4	44.3	45.3	47.3	48.2	30.7	38.8
Mafic minerals------	7.0	7.4	8.7	9.0	11.7	15.3	1.4	3.7
Total---------	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.1
Bulk specific gravity	2.660	2.645	2.665	2.645	2.670	2.710	2.610	2.623

Table 2. Chemical analyses, norms, and modes of granitic rocks other than from the Mount Whitney Intrusive Suite

[Chemistry (in weight percent) by X-ray spectroscopy, analyst; J. Carr (supervisor, V. G. Mossotti) except for FeO and H_2O, analyst: M. Taylor (supervisor, P. J. Lamothe). CIPW norms in weight percent. Modes, in volume percent, determined by counting 1,000-2,000 points on selectively stained slabs at least 70 cm^2 in area; analyst, Oleg Polovtzoff]

	Bullfrog pluton	Independence pluton	Older sheared granodiorite	Granodiorite of Chagoopa	Granite of Mount Kaweah	Dragon pluton
Locality Number	B-15	I-2	O-1	C-3	K-3	D-4
Field "	6-67	6-159	7-44	7-261	7-257	6-21
Chemical analyses						
SiO_2	75.16	73.67	73.38	71.03	70.47	63.24
Al_2O_3	13.09	13.81	13.53	14.83	14.97	17.80
Fe_2O_3	.79	1.36	1.47	1.32	1.51	1.92
FeO	.50	.62	1.03	1.04	1.35	1.89
MgO	.27	.39	.73	.77	1.04	1.17
CaO	1.14	1.48	2.11	2.31	3.09	2.29
Na_2O	3.75	4.05	3.90	3.51	3.73	4.91
K_2O	4.64	4.05	3.06	4.43	3.69	4.33
H_2O+	.25	.39	.40	.36	.39	.79
H_2O-	.08	.12	.03	.06	.06	.08
TiO_2	.22	.29	.31	.42	.49	.73
P_2O_5	.06	.11	.12	.13	.16	.23
MnO	.04	.07	.03	.04	.05	.10
CO_2	.08	.17	.06	.10	.06	.06
Total	100.08	100.58	100.18	100.37	101.09	99.57
CIPW norms						
Q	32.93	31.17	33.61	27.84	26.93	11.71
C	—	0.33	0.25	0.37	—	1.42
or	27.42	23.93	18.08	26.18	21.80	25.59
ab	31.73	34.27	33.00	29.70	31.56	41.54
an	5.18	6.63	9.69	10.62	13.21	9.87
di	0.04	—	—	—	0.45	—
hy	0.67	0.97	2.04	2.12	3.11	3.78
mt	1.10	1.39	2.13	1.91	2.19	2.78
il	0.42	0.55	0.59	0.80	0.93	1.39
ap	0.14	0.26	0.28	0.31	0.38	0.54
Total	99.63	99.50	99.67	99.85	100.56	98.62
Modes						
Quartz	27.8	32.4	28.9	29.2	—	8.4
Potassium feldspar	32.9	27.5	19.2	24.0	—	24.4
Plagioclase	36.7	36.0	43.8	40.4	—	58.8
Mafic minerals	2.6	4.1	8.1	6.4	—	8.4
Total	100.0	100.0	100.1	100.0	—	100.0
Bulk specific gravity	2.625	2.590	2.655	2.630	—	2.635

Table 3. Modes of the Whitney Granodiorite, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
W-1	7-74	22.4	26.4	46.9	4.3	2.645
W-2	8-29	27.9	32.8	34.7	4.6	2.635
W-3	8-31	22.3	25.8	47.9	4.0	2.595
W-4	8-30	31.4	16.8	45.6	6.2	2.640
W-5	75 M44	25.1	21.4	47.9	5.6	2.665
W-6	8-28	30.6	21.0	41.8	6.6	2.640
W-7	7-238	22.8	19.4	50.9	6.9	2.655
W-8	8-27	24.9	15.7	48.2	11.2	2.660
W-9	200-2	30.4	22.7	39.9	7.0	2.660
W-10	6-90	22.5	31.1	41.4	5.0	2.650
W-11	6-77	22.6	23.1	47.7	6.6	2.655
W-12	6-254	25.1	23.3	44.4	7.2	2.640
W-13	7-307	19.9	22.3	47.6	10.2	2.655
W-14	7-311	26.3	20.9	45.4	7.4	2.645
W-15	77-4	25.4	20.0	45.0	9.6	2.625
W-16	7-54	23.4	18.4	50.6	7.6	2.650
W-17	7-212	20.3	37.8	37.8	4.1	2.622
Average--------------		24.9	23.5	44.9	6.7	2.643
Standard deviation---		3.4	5.7	4.3	2.0	0.017

Table 4. Modes of the Paradise Granodiorite, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
P-1	75 M20	21.3	19.3	49.8	9.6	2.680
P-2	75 M19	20.5	26.0	47.3	6.2	2.665
P-3	75 M21	21.5	27.2	43.0	8.3	2.675
P-4	75 M42	21.2	25.3	42.9	10.6	2.675
P-5	75 M40	25.7	20.3	42.8	11.2	2.625
P-6	75 M45	26.7	23.6	41.6	8.1	2.670
P-7	6-315	21.1	18.0	47.2	13.7	2.668
P-8	8-33	25.6	18.5	44.2	11.7	2.685
P-9	7-53	25.1	21.9	44.3	8.7	2.665
P-10	8-32	21.5	10.0	54.0	14.5	2.710
P-11	8-34	23.8	21.7	43.0	11.5	2.680
P-12	6-64	21.1	21.4	47.4	10.1	2.670
P-13	7-301	19.5	26.2	45.3	9.0	2.645
P-14	6-294	20.3	28.8	44.4	6.5	2.645
P-15	8-26	24.4	24.5	41.4	9.7	2.660
P-16	6-310	22.6	26.4	43.5	7.5	2.665
P-17	6-312	25.4	17.1	51.3	6.2	2.660
P-18	6-314	25.3	21.5	46.4	6.8	2.640
P-19	6-53	16.5	16.1	51.8	15.6	2.695
P-20	6-257	21.1	22.3	47.9	8.7	2.660
P-21	6-259	20.8	20.2	47.3	11.7	2.670
P-22	6-256	21.2	25.5	44.9	8.4	2.690
P-23	8-20	25.1	19.6	44.8	10.5	2.690
P-24	7-28	19.8	18.3	48.9	13.0	2.690
P-25	8-21	24.0	18.6	46.4	11.0	2.705
P-26	8-22	25.8	17.8	46.8	9.6	2.670
P-27	8-23	26.3	16.9	47.0	9.8	2.673
P-28	8-24	22.9	22.3	44.6	10.2	2.703
P-29	7-26	26.0	16.4	49.2	8.4	2.660
P-30	7-211	26.2	16.0	47.5	10.3	2.680
Average--------------		23.0	20.9	46.2	9.9	2.672
Standard deviation---		2.4	4.1	3.0	2.3	.019

Table 5. Modes of the granodiorite of Sugarloaf, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
S-1	8-17	24.5	21.7	43.0	10.8	2.675
S-2	8-10	18.0	10.4	51.5	20.1	2.720
S-3	7-27	23.2	13.3	48.2	15.3	2.710
S-4	6-336	20.7	34.5	35.6	9.3	2.670
Average--------------		21.6	20.0	44.6	13.9	2.694
Standard deviation---		2.5	9.4	6.0	4.2	.022

Table 6. Modes of the granodiorite of Lone Pine Creek, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
L-1	6-79	24.6	5.3	48.9	21.2	2.730
L-2	6-50	20.9	6.3	50.2	22.6	2.745
L-3	6-52	19.3	20.4	41.9	18.4	2.710
Average--------------		21.6	10.7	47.0	20.7	2.728
Standard deviation---		2.2	6.9	3.6	1.7	.014

Table 7. Modes of dikes and sills of the Mount Whitney Intrusive Suite, in volume percent

[Samples A-1 to A-3, Golden Bear dike; sample A-4, sill south of Mount Whitney]

Locality* number	Field number	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
A-1	6-288b	12.8	42.2	40.9	4.1	2.615
A-1	6-288c	8.3	36.4	50.3	5.0	2.595
A-2	75 M46b	9.4	23.1	66.4	1.1	2.630
A-3	75 M47c	11.5	50.4	35.6	2.5	2.605
A-3	75 M47d	10.5	42.5	42.0	5.0	2.650
Average--------------		10.5	38.9	47.0	3.5	2.619
Standard deviation---		1.6	9.1	10.8	1.5	.019
A-4	8-37	38.1	29.8	30.7	1.4	2.610

Table 8. Modes of the Dragon pluton, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
D-1	6-230	12.7	36.0	44.6	6.7	2.650
D-2	6-207	6.3	26.7	58.3	8.7	2.680
D-3	6-17	4.1	24.8	62.0	9.1	2.685
D-4	6-21	8.4	24.4	58.8	8.4	2.635
D-5	6-15	4.8	7.4	76.6	11.2	2.730
D-6	6-73	11.4	34.9	44.0	9.7	2.645
D-7	6-161	11.5	13.8	53.9	20.8	2.705
D-8	6-271	6.9	36.2	50.1	6.8	2.640
D-9	6-268	10.3	38.5	44.9	6.3	2.630
D-10	7-61	17.2	17.0	52.4	13.4	2.720
D-11	6-59	3.1	41.9	52.3	2.7	2.640
D-12	6-246	3.1	34.5	58.1	4.3	2.660
Average		8.3	28.0	54.6	9.0	2.668
Standard deviation		4.2	10.4	8.7	4.5	.033

Table 9. Modes of the Independence pluton, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
I-1	6-72	25.3	45.4	27.4	1.9	2.615
I-2	6-159	32.4	27.5	36.0	4.1	2.590
I-3	6-27	29.1	33.9	35.0	2.0	2.620
Average		28.9	35.6	32.8	2.7	2.608
Standard deviation		2.9	7.4	3.8	1.0	.013

Table 10. Modes of the Bullfrog pluton, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
B-1	75 M49	24.3	42.5	32.1	1.1	2.600
B-2	75 M37	37.5	40.2	21.6	.7	2.610
B-3	6-292	28.2	39.8	31.0	1.0	2.615
B-4	75 M50	28.4	44.9	25.7	1.0	2.612
B-5	7-52	31.6	47.9	18.0	2.5	2.630
B-6	6-235	19.7	48.6	28.5	3.2	2.570
B-7	75 M36	29.7	44.4	24.7	1.2	2.615
B-8	6-76	26.0	39.8	32.6	1.6	2.600
B-9	6-277	10.4	20.8	66.5	2.3	2.610
B-10	6-317	16.8	47.7	33.2	2.3	2.628
B-11	6-316c	16.9	27.8	43.6	11.7	2.685
B-12	6-35	12.3	56.2	27.8	3.7	2.625
B-13	6-28	30.1	55.9	13.9	.1	2.600
B-14	6-253	32.7	31.2	33.0	3.1	2.623
B-15	6-67	27.8	32.9	36.7	2.6	2.625
B-16	7-62	26.9	45.3	26.6	1.2	2.605
B-17	6-243	31.6	28.3	38.3	1.8	2.625
B-18	6-47	20.2	41.9	35.0	2.9	2.630
B-19	6-43	24.3	33.8	39.2	2.7	2.615
B-20	6-41	28.6	32.8	36.6	2.0	2.600
B-21	6-39	16.8	36.2	46.3	1.7	2.615
B-22	6-38	28.3	32.3	35.8	3.6	2.625
B-23	6-295	22.6	33.8	40.5	3.1	2.620
B-24	6-293	27.2	45.7	24.1	3.0	2.625
Average		24.9	39.6	33.0	2.5	2.617
Standard deviation		6.7	8.7	10.4	2.1	.019

Table 11. Modes of the granodiorite of Chagoopa, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
C-1	6-123	14.9	27.0	51.2	6.9	2.670
C-2	7-42	28.8	20.1	45.0	6.1	2.640
C-3	7-261	29.2	24.0	40.4	6.4	2.630
C-4	7-259	22.6	29.9	42.1	5.4	2.655
C-5	7-258	10.1	5.3	68.4	16.2	2.705
C-6	7-43	21.5	20.8	48.6	9.1	2.660
Average---------------		21.2	21.2	49.3	8.4	2.660
Standard deviation---		6.9	7.9	9.3	3.7	.024

Table 12. Modes of the granite of Mount Kaweah, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
K-1	6-125	17.4	30.0	46.2	6.2	—
K-2	7-262	27.1	44.3	26.8	2.1	2.601
K-3	7-257	27.2	58.6	11.3	2.9	2.600
Average---------------		23.9	44.3	28.1	3.7	2.601
Standard deviation---		4.6	11.7	14.3	1.8	.0005

Table 13. Modes of older sheared granitic rock, in volume percent

Locality No.	Field No.	Quartz	K-feldspar	Plagioclase	Mafic minerals	Specific gravity
O-1	7-44	28.9	19.2	43.8	8.1	2.655
O-2	7-30	38.4	33.1	24.4	4.1	2.612

O-1 Sheared granodiorite
O-2 Sheared granite

Table 14. Area, in square kilometers, of rock units in the Mount Whitney quadrangle

Pluton or mass	Quadrant NW.	NE.	SW.	SE.	Total quadrangle
Whitney Granodiorite	20.2	17.9	16.6	138.0	192.7
Paradise Granodiorite	115.5	19.8	70.7	11.9	217.9
Granodiorite of Sugarloaf	--	--	11.8	--	11.8
Granodiorite of Lone Pine Creek	--	.8	--	4.8	5.6
Bullfrog pluton	19.0	57.7	--	.3	77.0
Dragon pluton	--	34.5	--	--	34.5
Independence pluton	--	8.1	--	--	8.1
Granite of Mount Kaweah	--	--	23.8	--	23.8
Granodiorite of Chagoopa	--	--	22.8	--	22.8
Older sheared granodiorite	--	--	1.9	--	1.9
Older sheared granite	--	--	.8	--	.8
Granodiorite of Mitchell Peak	--	--	.4	--	.4
Mafic plutonic rocks	.3	3.4	--	--	3.7
Total (granitic rocks)	155.0	142.2	148.8	155.0	601.0
Sedimentary rocks	--	9.0	--	--	9.0
Metavolcanic rocks	--	3.8	6.2	--	10.0
Total	155.0	155.0	155.0	155.0	620.0

Table 15. Average chemical composition, in weight percent, of granitic rocks in the Mount Whitney quadrangle

	Quandrant NW.	NE.	SW.	SE.	Total quadrangle
SiO_2	70.58	70.77	69.90	70.64	70.47
Al_2O_3	14.88	15.00	15.03	15.09	15.00
Fe_2O_3	1.44	1.35	1.54	1.41	1.43
FeO	1.20	1.13	1.33	1.04	1.18
MgO	.90	.73	1.03	.69	.84
CaO	2.87	2.04	3.03	2.59	2.63
Na_2O	3.77	4.07	3.70	3.77	3.82
K_2O	3.73	4.28	3.73	4.17	3.98
TiO_2	.43	.43	.46	.39	.43
P_2O_5	.16	.14	.16	.16	.16
MnO	.06	.06	.13	.05	.08
Specific Gravity	2.662	2.646	2.656	2.648	2.653

Table 16. Radiometric ages of granitic rock units in the Mount Whitney quadrangle and vicinity

Locality[1] No.	Field-lab No.	Granitic unit	Elevation (feet)	Dating method	Mineral[2]	Age[3] (Ma)
49	OW 40	Whitney Granodiorite	13,480	U-Pb	Z	83
(50)	OW 41	Granodiorite of Lone Pine Creek	7,700	U-Pb	Z	87
59	6-124	Granite of Mount Kaweah	11,300	U-Pb	Z	(>95)
(100)	1584	Whitney Granodiorite	8,480	K-Ar	B	81.1
	1584-HBD	do.	8,480	K-Ar	H	82.0
103	1587	Paradise Granodiorite	9,280	K-Ar	B	80.4
	1587-R	do.	9,280	K-Ar	B	80.4
	1587-HBD	do.	9,280	K-Ar	H	86.1
104	1588	Whitney Granodiorite	11,530	K-Ar	B	83.9
105	1589	do.	11,500	K-Ar	B	81.6
106	1590	do.	13,777	K-Ar	B	84.0
	1590R	do.	13,777	K-Ar	B	83.6
107	1591	do.	11,600	K-Ar	B	81.3
(108)	1592	Granodiorite of Lone Pine Creek	7,680	K-Ar	B	82.1
	1592-HBD	do.	7,680	K-Ar	H	83.6

1 Samples in parentheses are slightly east of quadrangle in Lone Pine quadrangle, see figure 2 for location of others.

2 Z, zircon; B, biotite; H, hornblende. Zircon ages (Chen and Moore, 1982); other ages (Evernden and Kistler, 1970).

3 Ages in parentheses are discordant. All K-Ar ages are recalculated using the decay and abundance constants defined in Steiger and Jager, 1977.