Cowtrack Mountain and Glass Mountain Quadrangles, California and Nevada—Analytic Data

U.S. GEOLOGICAL SURVEY BULLETIN 1783

Cowtrack Mountain and Glass Mountain Quadrangles, California and Nevada—Analytic Data

By PAUL C. BATEMAN, KONRAD B. KRAUSKOPF, and MICHAEL F. SHERIDAN

Modal and chemical data on the granitic rocks of the Cowtrack Mountain and Glass Mountain quadrangles

U.S. GEOLOGICAL SURVEY BULLETIN 1783

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1988

For sale by the
Books and Open-File Reports Section
U.S. Geological Survey
Federal Center, Box 25425
Denver, CO 80225

Library of Congress Cataloging-in-Publication Data

Bateman, Paul Charles, 1910–
Cowtrack Mountain and Glass Mountain quadrangles, California and Nevada—analytic data.

U.S. Geological Survey Bulletin 1783
Bibliography
Supt. of Docs. No.: I 19.3:1783
1. Rocks, Igneous—California—Cowtrack Mountain region—Analysis. 2. Rocks, Igneous—California—Glass Mountain region (Mono County)—Analysis. 3. Rocks, Igneous—Nevada—Mineral County—Analysis. 4. Intrusions (Geology)—California—Cowtrack Mountain region. 5. Intrusions (Geology)—California—Glass Mountain region (Mono County). 6. Intrusions (Geology)—Nevada—Mineral County. I. Krauskopf, Konrad Bates, 1910– . II. Sheridan, Michael F. III. Title. IV. Series.
QE75.B9 No. 1783 557.3 s 87–600068
[QE461] [552'.3'0979448]

CONTENTS

FIGURES

TABLES

Cowtrack Mountain and Glass Mountain Quadrangles, California and Nevada—Analytic Data

By Paul C. Bateman, Konrad B. Krauskopf, *and* Michael F. Sheridan

Abstract

Modal and major-element chemical data on the Mesozoic plutonic rocks of the Cowtrack Mountain and Glass Mountain quadrangles are presented in tables, maps, and diagrams. These rocks crop out in about 20 percent of the two quadrangles, and the remaining area is largely covered by Cenozoic volcanic rocks. The dominant plutonic rocks are the Triassic Wheeler Crest Granodiorite and the Jurassic granite of Casa Diablo Mountain; small masses of diorite, fine-grained granite, and aplite are also present.

INTRODUCTION

The Cowtrack Mountain and Glass Mountain quadrangles lie between the Sierra Nevada on the west and the White Mountains on the east. The Cowtrack Mountain quadrangle and almost all of the Glass Mountain quadrangle are in Mono County, California, but the northeast corner of the Glass Mountain quadrangle extends into Mineral County, Nevada (fig. 1). This report provides modal and chemical data on the granitic rocks of the two quadrangles. Data on the widespread Cenozoic volcanic rocks are not included here because many reports on the volcanic rocks have already been published and others are being prepared in connection with an intensive study of the geothermal potential of the Long Valley caldera immediately to the south. This report supplements the geologic map of the Glass Mountain quadrangle (Krauskopf and Bateman, 1977), but a geologic map of the Cowtrack Mountain quadrangle has not been published.

GEOLOGIC SUMMARY

Cenozoic volcanic and sedimentary rocks cover most of the region; granitic rocks crop out in less than 20 percent of the quadrangles, chiefly in uplifted or tilted fault blocks. Extensive volcanism in the general area during the Cenozoic culminated in eruption of the Pleistocene Bishop Tuff, a rhyolitic ash-flow deposit, from the Long Valley caldera to the south and in eruption of the rhyolitic Mono and Inyo craters to the west. Glass Mountain, in the southwest corner of the Glass Mountain quadrangle, forms part of the northern rim of the Long Valley caldera and is the source of a widespread older ash-flow deposit. In addition to the rhyolitic deposits, Tertiary basalt and andesite flows and pyroclastic rocks underlie most of the north half of the Glass Mountain quadrangle and large parts of the Cowtrack Mountain quadrangle.

The region is broken by an intricate system of normal faults, and granitic rocks are exposed in uplifted blocks and along the edges of tilted blocks. In the southern part of the Cowtrack Mountain quadrangle, granitic rocks crop out in the north rim of the Long Valley caldera; farther north in the quadrangle they crop out in uplifted fault blocks. In the southeastern part of the Glass Mountain quadrangle, where fault blocks are tilted eastward, granitic rocks form long north-trending ridges.

Two principal granitic rock units are present within the quadrangles, the Triassic Wheeler Crest Granodiorite and the Jurassic granite of Casa Diablo Mountain. Small bodies of diorite, fine-grained granite, and aplite are present locally. The Wheeler Crest Granodiorite is a very large intrusion that extends northward along the eastern side of the Sierra Nevada from the type locality in Wheeler Crest and into the Glass Mountain and Cowtrack Mountain quadrangles. In earlier publications, including the geologic maps of the Glass Mountain and Casa Diablo Mountain quadrangles (Krauskopf and Bateman, 1977; Rinehart and Ross, 1957), this rock was called the granodiorite of the Benton Range. However, it is identical with the Wheeler Crest Granodiorite in the eastern escarpment of the Sierra Nevada (Bateman, 1965) and is continuous with it except for alluvial and volcanic cover. The granite of Casa Diablo Mountain appears to form several rounded plutons that intrude the Wheeler Crest Granodiorite. Both rocks are highly altered in many places. The rock in many outcrops of the granite of Casa Diablo Mountain is strongly sericitized, and the Wheeler Crest Granodiorite is locally chloritized and epidotized. The time of this alteration is uncertain, but localization of alteration in

some places along gently dipping sheeting joints, which generally formed as a consequence of release of pressure during erosion, suggests that it may have occurred during Cenozoic volcanism. However, widespread alteration of hornblende crystals in the Wheeler Crest Granodiorite to decussate aggregates of biotite probably occurred during late stages of crystallization of the granodiorite.

SAMPLING AND ANALYTICAL METHODS

Discontinuous outcrops and alteration in these two quadrangles precluded collecting samples of the granitic rocks at regular intervals, and coverage is irregular. Additionally, some samples of the granite of Casa Diablo Mountain, which appeared unaltered in the field, were found to be strongly sericitized and not suitable for either chemical or modal analysis.

Chemical analyses for major elements were made of 13 selected samples (table 1), and modes and specific gravities were determined for all of the acceptable samples (figs. 2-13 and table 2). Modes were determined by counting at least 1,000 regularly spaced points on sawed and stained slabs having areas of at least 70 cm^2 (Norman, 1974). Modal analyses commonly include percentages of hornblende and biotite, as determined in thin section and apportioned to the percentage of total mafic minerals determined on stained slabs. Here, however, this would have been meaningless because the granite of Casa Diablo Mountain contains no hornblende and the hornblende in the Wheeler Crest Granodiorite of these quadrangles is largely altered to aggregates of tiny biotite flakes.

WHEELER CREST GRANODIORITE

The Wheeler Crest Granodiorite is exposed discontinuously in both quadrangles, but it probably is more or less continuous at shallow depths between outcrops. It is a medium-gray rock that generally contains alkali-feldspar megacrysts of varied size and abundance. Unlike exposures farther south in Wheeler Crest (Bateman, 1965), the rock rarely has a discernable foliation within the two quadrangles. Modes on a Q-A-P triangular diagram (fig. 14) plot most abundantly in adjoining parts of the granite and granodiorite fields as do the modes of most other megacrystic rocks of the region. An absence of smooth fresh rock surfaces made it impossible to determine the abundance of megacrysts in the field over representative areas, so megacrysts were counted on the stained slabs together with groundmass alkali feldspar. Modes that plot distant from the alkali feldspar-plagioclase join probably reflect the uneven distribution of alkali-feldspar megacrysts on the scale of hand samples. The groundmass is medium grained in most places but is fine grained locally. The color index ranges from 2 to 23 and peaks at about 10 (fig. 14). Megacrysts show a wide range of size, shape, and abundance, unlike those at Wheeler Crest, the type locality, which are well formed and tabular (Bateman, 1965). Variations occur even within a single hand sample, and in some exposures megacrysts are absent. Some megacrysts are tabular and well formed, but others are rounded; many anastomose into the adjoining rock and have extremely irregular boundaries. Sample CT-27 from the Cowtrack Mountain quadrangle has yielded a discordant U-Pb age of 214 m.y., and a sample from Wheeler Crest, 50 km south, has yielded a concordant age of 207 m.y. (Stern and others, 1981). U-Pb ages on two size fractions of each of three other samples range from 159 to 217 m.y. (Chen and Moore, 1982).

GRANITE OF CASA DIABLO MOUNTAIN

The granite of Casa Diablo Mountain crops out in the southeast corner of the Glass Mountain quadrangle and in the northwest quarter and along the south

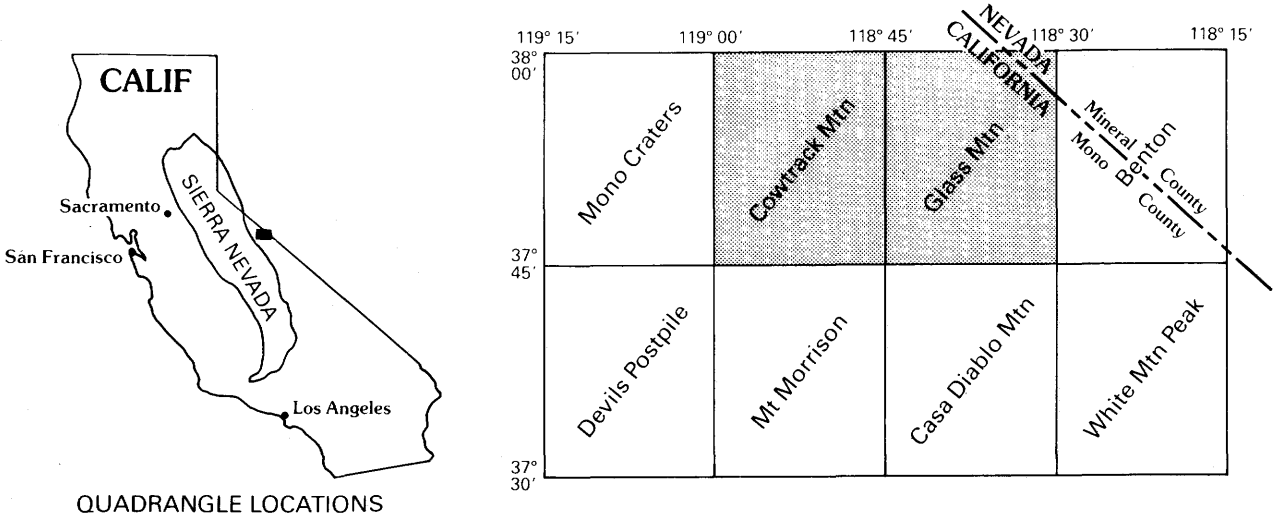

Figure 1. Index map showing location of Cowtrack Mountain and Glass Mountain quadrangles and adjacent quadrangles for which U.S. Geological Survey geologic mapping has been done.

margin of the Cowtrack Mountain quadrangle. Apparently it forms several separate plutons that intrude the Wheeler Crest Granodiorite. The rock generally is coarse grained and equigranular and shows no foliation. The color index is 1 or 2 in most samples, but it is higher in a few samples. Biotite is the only mafic silicate. Stern and others (1981) determined a concordant U-Pb age of 161 m.y. on sample GM-13 from the Glass Mountain quadrangle.

FINE-GRAINED GRANITE AND APLITE

Small bodies of fined-grained leucogranite are present in both the Cowtrack Mountain and Glass Mountain quadrangles, and dikes and small masses of aplite are scattered through the Glass Mountain quadrangle. The rocks are compositionally similar to the granite of Casa Diablo Mountain and probably are cogenetic with it.

DIORITE

The small masses of diorite are altered but appear to represent a range of compositions. They consist chiefly of hornblende and plagioclase, but clinopyroxene is present as cores in some hornblende. Opaque minerals are bordered by exsolved titanite. Quartz and biotite that appear to be primary are present in sample 1528 from a mass in the northern part of the Cowtrack Mountain quadrangle.

REFERENCES

Bateman, P.C., 1965, Geology and tungsten mineralization of the Bishop district, California: U.S. Geological Survey Professional Paper 470, 208 p.

Chen, J.H., and Moore, J.G., 1982, Uranium-lead ages from the Sierra Nevada batholith, California: Journal of Geophysical Research, v. 87, no. B6, p. 4761-4784.

Krauskopf, K.B., and Bateman, P.C., 1977, Geologic map of the Glass Mountain quadrangle, Mono County, California, and Mineral County, Nevada: U.S. Geological Survey Geologic Quadrangle Map GQ-1099, scale 1:62,500.

Norman, M.B., II, 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.

Rinehart, C.D., and Ross, D.C., 1957, Geologic map of the Casa Diablo Mountain quadrangle, California: U.S. Geological Survey Geologic Quadrangle Map GQ-99, scale 1:62,500.

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., 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.

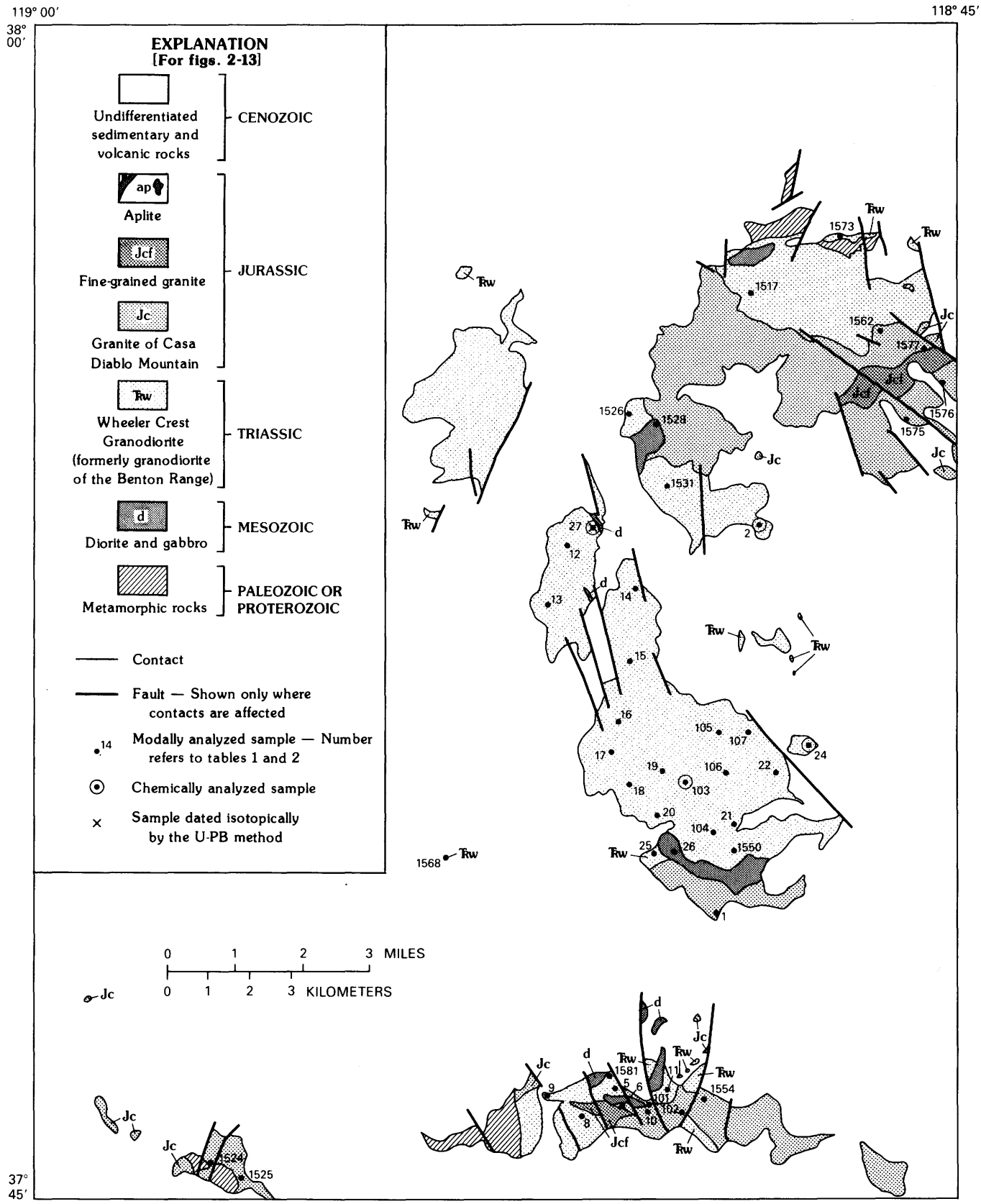

Figure 2. Cowtrack Mountain quadrangle, Calif., showing principal bedrock units and sample locations. CT- precedes all one-, two-, and three-digit sample numbers.

Figure 3. Glass Mountain quadrangle, Calif. and Nev., showing principal bedrock units and sample locations. GM- precedes all sample numbers. Explanation as in figure 2.

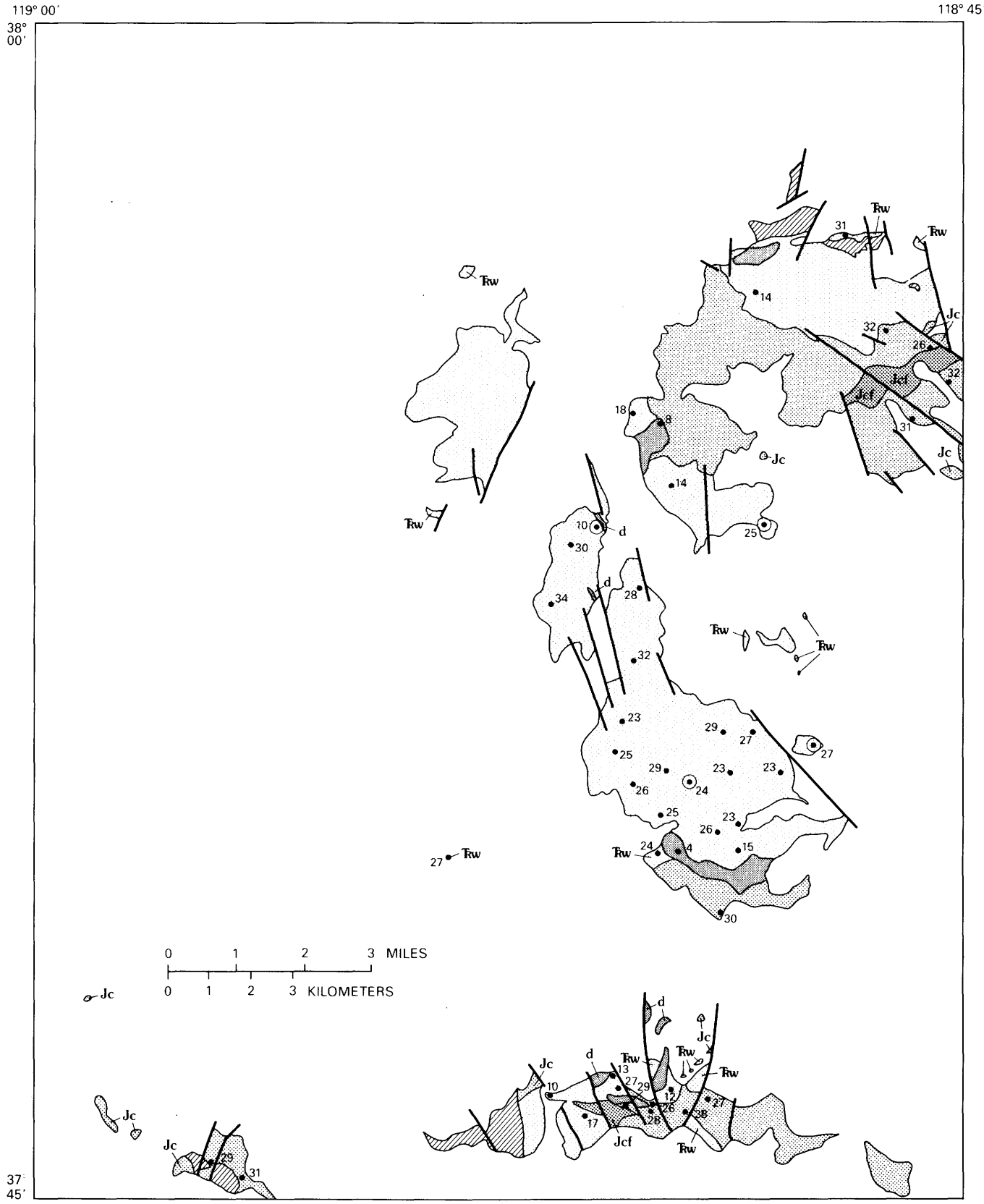

Figure 4. Volume-percent quartz, Cowtrack Mountain quadrangle. Explanation as in figure 2.

Figure 5. Volume-percent quartz, Glass Mountain quadrangle. Explanation as in figure 2.

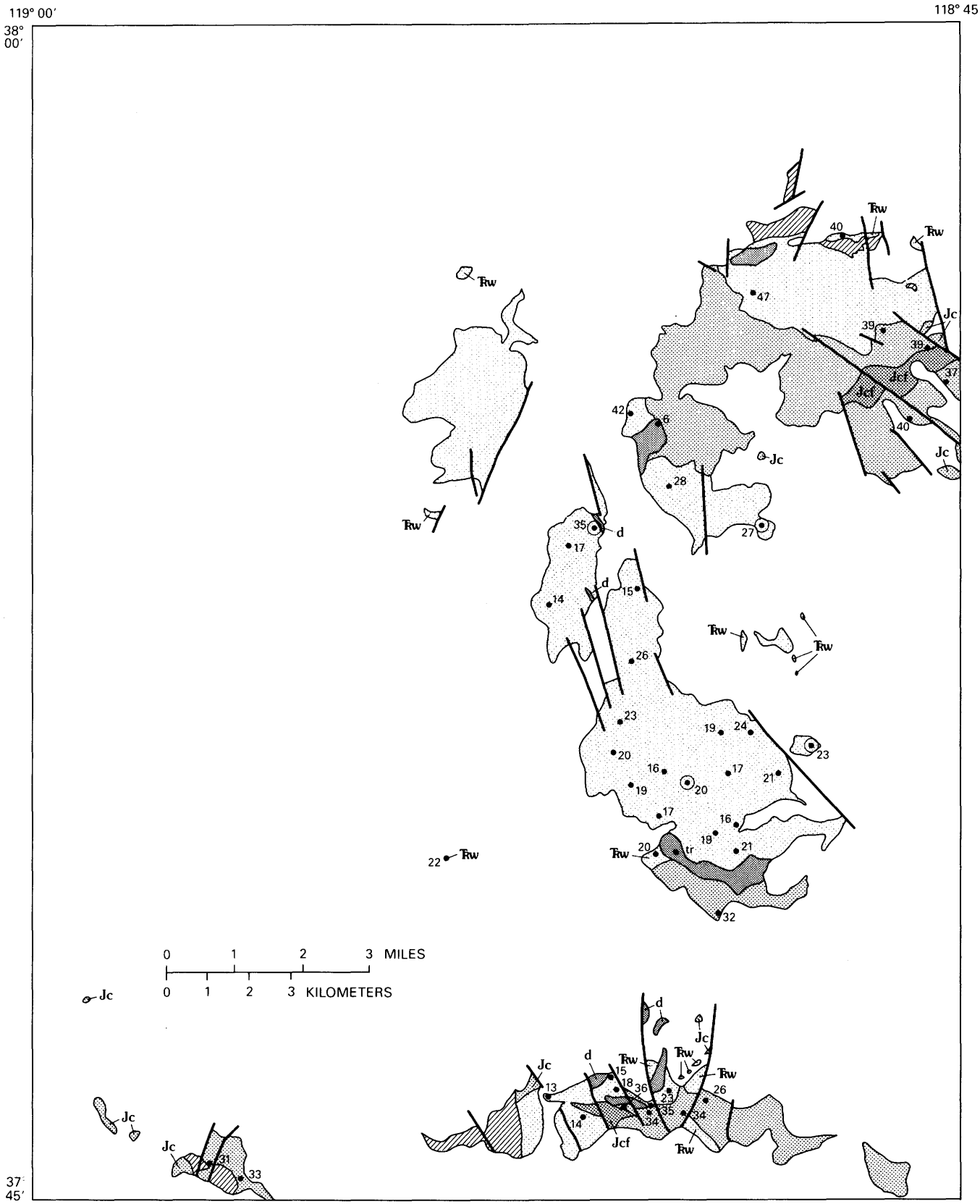

Figure 6. Volume-percent alkali feldspar, Cowtrack Mountain quadrangle. Explanation as in figure 2; tr, trace.

Figure 7. Volume-percent alkali feldspar, Glass Mountain quadrangle. Explanation as in figure 2.

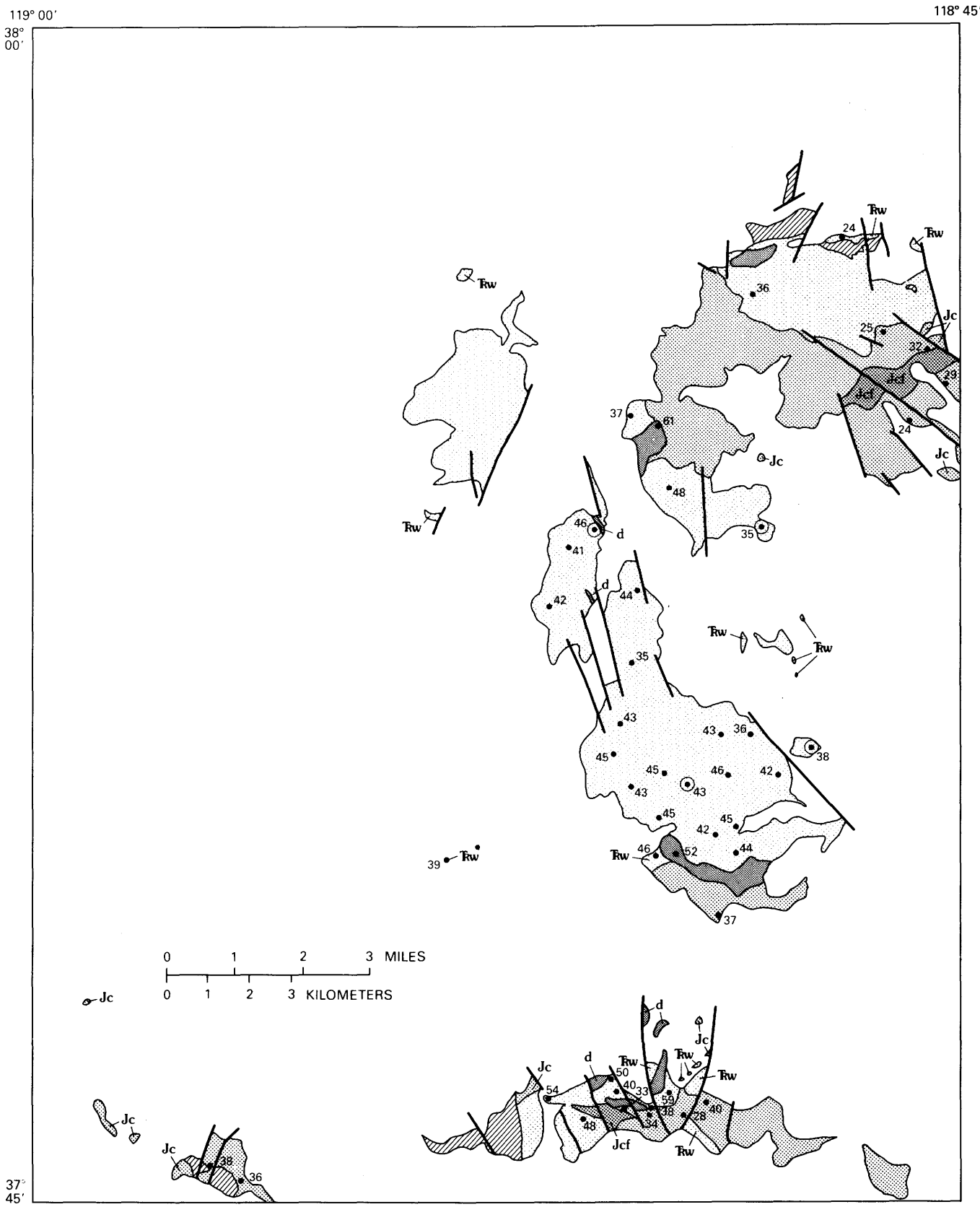

Figure 8. Volume-percent plagioclase, Cowtrack Mountain quadrangle. Explanation as in figure 2.

Figure 9. Volume-percent plagioclase, Glass Mountain quadrangle. Explanation as in figure 2.

Figure 10. Volume-percent mafic minerals, Cowtrack Mountain quadrangle. Explanation as in figure 2; tr, trace.

Figure 11. Volume-percent mafic minerals, Glass Mountain quadrangle. Explanation as in figure 2; tr, trace.

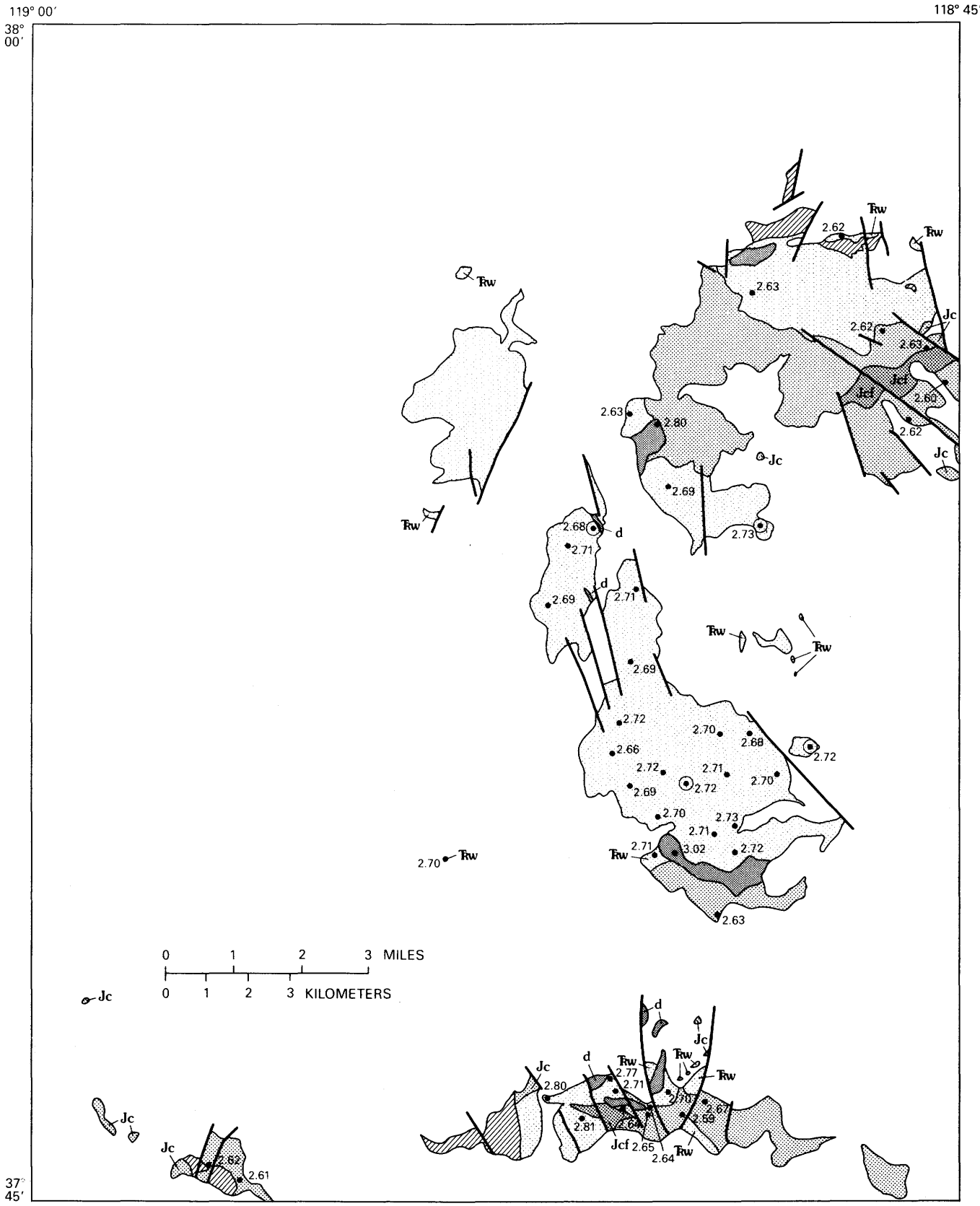

Figure 12. Bulk specific gravity, Cowtrack Mountain quadrangle. Explanation as in figure 2.

Figure 13. Bulk specific gravity, Glass Mountain quadrangle. Explanation as in figure 2.

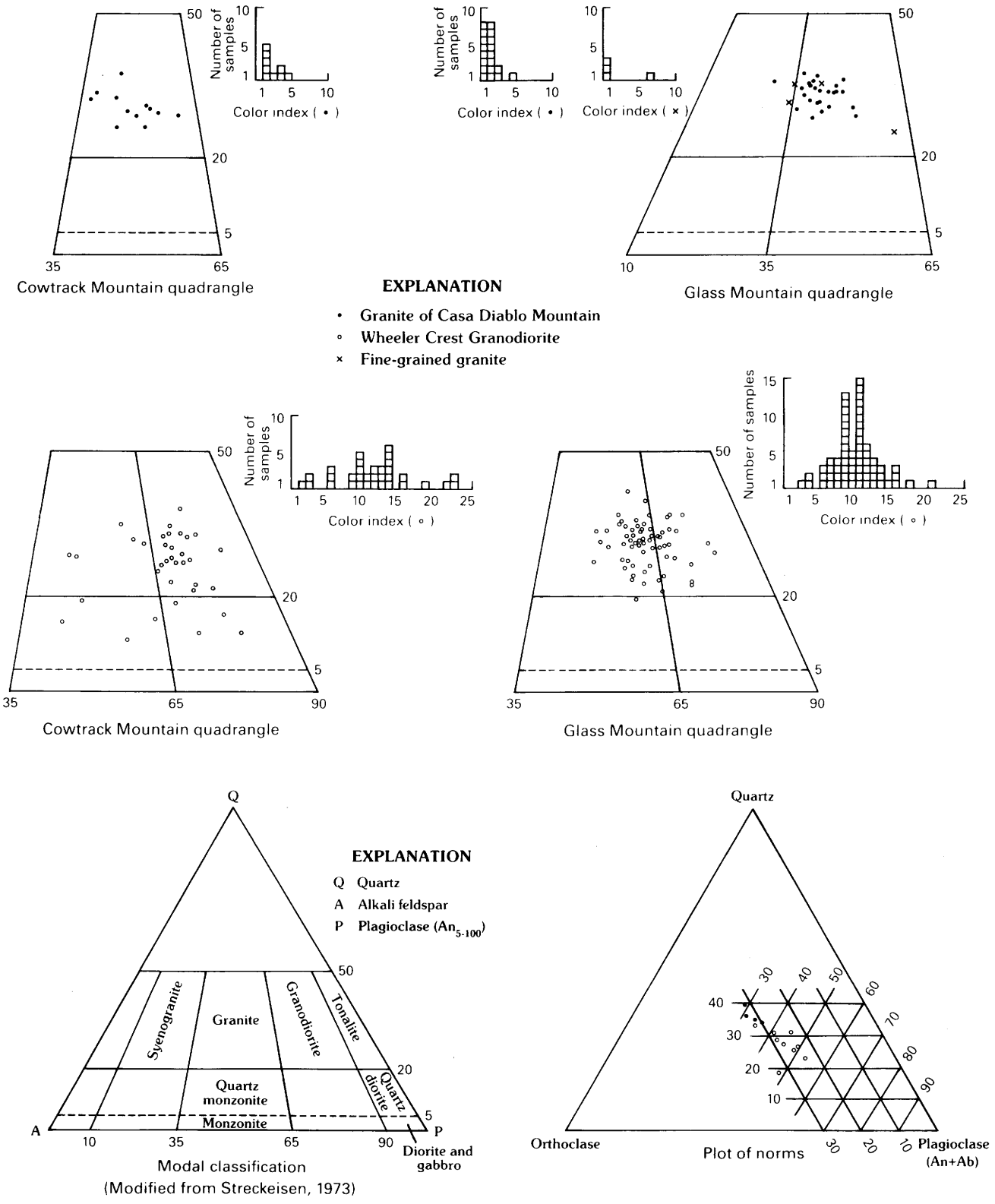

Figure 14. Plots of modes and norms of granitic rocks, Cowtrack Mountain and Glass Mountain quadrangles.

TABLE 1. Chemical analysis and norms of representative granitic rock samples, Cowtrack Mountain and Glass Mountain quadrangles, Calif. and Nev.

[--, no data. CT-27 analyzed by wet chemistry, Elaine L. Brandt, analyst; all others by the rapid rock analysis method, Leonard Shapiro, project leader.]

	Wheeler Crest Granodiorite									Granite of Casa Diablo Mountain			
Field No...	CT-2	CT-24	CT-27	CT-103	GM-4	GM-6	GM-10	GM-30	GM-123	GM-9	GM-34	GM-106	GM-134
Lab No.....	M-116095W	M-116096W	M-1161270	M-116097W	M-116086W	M-116087W	M-116089W	M-116090W	M-116093W	M-116088W	M-116091W	M-116092W	M-116094W
	Chemical analyses (weight percent)												
SiO_2.....	64.6	66.5	65.77	65.1	67.8	63.3	71.8	68.0	69.4	76.1	74.5	74.1	72.6
Al_2O_3.....	15.8	15.1	16.75	16.0	15.1	16.1	13.6	14.7	14.8	13.0	13.5	13.7	14.1
Fe_2O_3.....	2.0	1.7	2.01	1.8	1.4	2.0	1.1	1.4	1.1	.84	.80	.79	1.0
FeO.....	3.0	2.7	1.63	3.2	2.4	3.5	1.7	2.6	2.1	.26	.52	.76	1.0
MgO.....	1.8	1.6	0.83	1.7	1.4	2.0	.96	1.5	1.2	.19	.34	.45	.43
CaO.....	5.1	4.4	2.69	4.6	4.0	5.5	3.0	4.5	3.4	.56	.91	1.2	1.6
Na_2O.....	2.6	2.6	3.85	2.6	2.6	2.7	2.4	2.6	2.5	3.0	3.0	3.1	3.1
K_2O.....	3.7	4.0	4.95	3.6	4.2	3.4	5.0	3.5	4.4	5.1	5.3	5.1	4.8
H_2O^+.....	.78	.82	.44	.85	.72	.79	.77	.78	.84	.54	.60	.52	.71
H_2O^-.....	.11	.07	.09	.07	.11	.11	.10	.08	.09	.06	.13	.07	.16
TiO_2.....	.48	.45	.32	.52	.38	.56	.20	.41	.34	.14	.15	.20	.17
P_2O_5.....	.26	.24	.13	.24	.18	.31	.12	.21	.16	.02	.04	.06	.06
MnO.....	.11	.10	.11	.13	.11	.12	.08	.13	.10	.06	.07	.05	.05
CO_2.....	.01	.02	.09	.01	.02	.02	.01	.03	.03	.02	.01	.01	.01
Sum.....	100.4	100.3	99.7	100.4	100.4	100.4	100.8	100.4	100.6	99.9	99.9	100.1	99.8
	CIPW norms												
Q.....	21.7	24.3	17.5	22.9	25.6	19.7	30.8	27.5	28.4	38.0	34.6	33.4	32.3
C.....	--	--	.5	.05	--	--	--	--	0.1	1.6	1.3	1.0	1.1
or.....	22.0	23.8	29.5	21.4	24.9	20.2	29.6	20.8	26.1	30.4	31.6	30.3	28.7
ab.....	22.1	22.1	32.9	22.1	22.1	23.0	20.3	22.1	21.3	25.6	25.6	26.4	26.5
an.....	20.6	17.8	12.6	21.4	17.2	21.9	11.6	18.2	15.9	2.7	4.3	5.6	7.6
di.....	2.5	2.1	--	--	1.3	2.9	2.1	2.4	--	--	--	--	--
hy.....	6.5	6.0	3.1	8.0	5.7	7.7	3.4	5.8	5.6	.5	1.0	1.6	1.9
mt.....	2.9	2.5	2.9	2.6	2.0	2.9	1.6	2.0	1.6	.6	1.2	1.2	1.5
il.....	.9	.9	.6	1.0	.7	1.1	.4	.8	.6	.3	.3	.4	.3
ap.....	.6	.6	.3	.6	.4	.7	.3	.5	.4	<.05	.1	.1	.1
hm.....	--	--	--	--	--	--	--	--	--	.4	--	--	--
Total...	99.8	100.1	99.9	100.1	99.9	100.1	100.1	100.1	100.0	100.2	100.0	100.0	100.0

TABLE 2. Modes and specific gravities of granitic rock samples from the Cowtrack Mountain and Glass Mountain quadrangles, Calif. and Nev.

Sample number	Modes (volume percent)				Specific gravity
	Quartz	Plagioclase	Alkali feldspar	Mafic minerals	
Wheeler Crest Granodiorite, Cowtrack Mountain quadrangle					
CT-2....	25	35	27	13	2.73
CT-5....	27	40	18	14	2.71
CT-8....	17	48	14	22	2.81
CT-9....	10	54	13	23	2.80
CT-11...	12	59	23	6	2.70
CT-12...	30	41	17	12	2.71
CT-13...	34	42	14	10	2.69
CT-14...	28	44	15	14	2.71
CT-15...	32	35	26	6	2.69
CT-16...	23	43	23	12	2.72
CT-17...	25	45	20	11	2.66
CT-18...	26	43	19	11	2.69
CT-19...	29	45	16	10	2.72
CT-20...	25	45	17	13	2.70
CT-21...	23	45	16	16	2.73
CT-22...	23	42	21	14	2.70
CT-24...	27	38	23	12	2.72
CT-25...	24	46	20	9	2.71
CT-27...	10	46	35	10	2.68
CT-103..	24	43	20	14	2.72
CT-104..	26	42	19	13	2.71
CT-105..	29	43	19	9	2.70
CT-106..	23	46	17	14	2.71
CT-107..	27	36	24	14	2.68
1517....	14	36	47	3	2.63
1526....	18	37	42	3	2.63
1531....	14	48	28	10	2.69
1550....	15	44	21	19	2.72
1568....	27	39	22	12	2.70
1573....	26	30	38	6	2.64
1581....	13	50	15	23	2.77
Wheeler Crest Granodiorite, Glass Mountain quadrangle					
GM-2....	28	34	30	9	2.69
GM-3....	34	33	26	7	2.67
GM-4....	28	36	25	11	2.69
GM-5....	18	46	18	18	2.75
GM-6....	20	47	18	16	2.74
GM-10...	39	33	22	7	2.67
GM-11...	30	36	22	12	2.70
GM-15...	28	38	23	11	2.70
GM-18...	32	36	23	9	2.67
GM-21...	24	42	20	14	2.74
GM-26...	28	40	23	9	2.67
GM-28...	32	38	19	11	2.69
GM-29...	28	39	19	14	2.70
GM-30...	26	40	19	15	2.72
GM-32...	30	36	21	13	2.69
GM-33...	25	37	28	10	2.68
GM-36...	19	41	27	13	2.71
GM-46...	29	33	32	6	2.66
GM-47...	25	38	30	8	2.69
GM-51...	17	42	29	12	2.74
GM-52...	22	41	25	11	2.71
Wheeler Crest Granodiorite, Glass Mountain quadrangle (continued)					
GM-53...	21	40	29	11	2.72
GM-54...	23	46	17	13	2.74
GM-55...	23	42	19	16	2.72
GM-56...	29	39	21	11	2.70
GM-57...	28	40	22	10	2.69
GM-58...	24	42	27	7	2.66
GM-59...	29	36	26	10	2.68
GM-61...	28	38	25	9	2.68
GM-62...	28	38	24	9	2.67
GM-63...	28	38	23	11	2.71
GM-64...	21	39	28	11	2.71
GM-64A..	29	42	17	12	2.70
GM-65...	21	45	24	10	2.68
GM-67...	27	41	19	13	2.69
GM-69...	28	50	13	9	2.69
GM-72...	29	40	20	12	--
GM-73...	28	36	27	9	2.68
GM-74...	18	45	25	12	2.71
GM-75...	22	44	23	11	2.66
GM-76...	29	36	26	9	2.68
GM-77...	30	30	30	11	2.70
GM-80...	27	41	21	12	2.69
GM-83...	24	42	25	9	2.71
GM-84...	24	38	27	11	2.72
GM-104..	24	47	12	16	2.73
GM-112..	32	44	22	3	2.65
GM-114..	33	42	15	11	2.71
GM-115..	32	33	25	11	2.66
GM-117..	31	43	19	8	2.67
GM-122..	30	38	23	9	2.69
GM-123..	30	37	23	11	2.68
GM-124..	33	34	27	7	2.67
GM-125..	31	37	25	7	2.68
GM-128..	27	40	25	9	2.68
GM-129..	29	37	25	10	2.64
GM-130..	23	36	27	14	2.70
GM-131..	32	40	17	11	2.71
GM-132..	36	35	19	9	2.67
GM-135..	23	37	20	21	2.75
GM-136..	29	40	26	6	2.65
GM-137..	33	37	21	9	2.68
GM-138..	28	37	25	10	2.66
GM-139..	32	37	24	6	2.67
Granite of Casa Diablo Mountain, Cowtrack Mountain quadrangle					
CT-1....	30	37	32	2	2.63
CT-6....	29	33	29	2	2.64
CT-10...	28	34	34	4	2.65
CT-101..	26	38	35	2	2.64
CT-102..	38	28	34	0	2.59
1524....	29	38	31	2	2.62
1525....	31	36	33	tr	2.61
1554....	27	40	26	7	2.67
1562....	32	25	39	4	2.62

TABLE 2. Modes and specific gravities of granitic rock samples from the Cowtrack Mountain and Glass Mountain quadrangles, Calif. and Nev.--Continued

Sample number	Modes (volume percent)				Specific gravity
	Quartz	Plagio-clase	Alkali feldspar	Mafic minerals	
Granite of Casa Diablo Mountain, Cowtrack Mountain quadrangle (continued)					
1575....	31	24	40	5	2.62
1576....	32	29	37	2	2.60
Granite of Casa Diablo Mountain, Glass Mountain quadrangle					
GM-1....	30	31	38	2	2.59
GM-7....	30	25	44	1	2.60
GM-9....	36	25	38	2	2.61
GM-12...	34	24	41	1	2.60
GM-13...	37	25	37	2	2.61
GM-14...	37	23	39	1	2.58
GM-16...	31	35	34	tr	2.57
GM-20...	35	31	33	1	2.60
GM-23...	33	30	35	2	2.60
GM-24...	35	25	39	2	2.60
GM-25...	32	27	41	1	2.61
GM-31...	28	35	33	5	2.64
GM-34...	33	29	36	3	2.61
GM-35...	33	31	34	2	2.63
GM-71...	33	25	41	1	2.59
GM-82...	28	28	41	4	2.64
GM-105..	34	29	34	2	2.62
Granite of Casa Diablo Mountain, Glass Mountain quadrangle (continued)					
GM-106..	31	28	38	3	2.62
GM-109..	34	30	36	tr	2.61
GM-110..	34	27	38	1	2.60
GM-113..	36	18	46	tr	2.58
GM-126..	32	28	40	1	2.58
GM-134..	29	30	39	3	2.65
Fine-grained granite, Cowtrack Mountain quadrangle					
1577....	26	32	39	3	2.63
Fine-grained granite, Glass Mountain quadrangle					
GM-8....	32	23	44	1	2.61
GM-107..	34	26	38	2	2.61
Diorite and gabbro, Cowtrack Mountain quadrangle					
CT-26...	4	52	tr	44	3.02
1528....	8	61	6	26	2.80

GPO 585-045/78031