U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-2362 (SHEET 2 OF 3)

Table 1.—Comparison of SiO_2 content, phenocryst mineralogy,[1] inclusions,[1] age, magnetic polarity, and volume of volcanic map units in the Clear Lake volcanic area, California

[Data or map unit symbol queried where uncertain. Empty spaces, absent or no information.]

Map unit	Geographic area and name of map unit[2]	SiO_2[3]	PHENOCRYSTS: Quartz[4]	PHENOCRYSTS: Feldspar: K-feldspar	PHENOCRYSTS: Feldspar: Plagioclase	PHENOCRYSTS: Biotite	PHENOCRYSTS: Hornblende	PHENOCRYSTS: Pyroxene: Orthopyroxene	PHENOCRYSTS: Pyroxene: Clinopyroxene	PHENOCRYSTS: Olivine (or other)[5]	PHENOCRYSTS: Clots of phenocrysts[6]	INCLUSIONS: Diabasic-textured mafic[7]	INCLUSIONS: Other types[8]	INCLUSIONS: Xenocrysts[9]	Age[10]	Mag. polarity[11]	Vol.[12]
			mm %	mm %	mm %	mm %	mm %	mm %	mm %	mm %	mm %	mm %	mm %	mm %			
	WESTERN AREA																
kk	Kelsey Tuff Member of Kilgore Formation[13]	57.9–59.8	1–2 <1		1–2 2				1 <1	1–2 2			2–5 1		C ~36,000 yr		0.15
dkc	Rhyodacite of Kelsey Creek	72.2	2–5 10–15	2–5 7–10	2–5 3–5	1–2 1–2									≤ 0.58–≥ 0.02	N	0.47
dch	Rhyodacite of Camels Hump	69.8–71.6	2–7 5	2–7 5	2–7 5	1–2 0.5	1 0.5					10–100 1–2			≤ 0.69–≥ 0.02	N	0.29
ms	Basaltic andesite of Mills Creek	74.1	2–5 10	2–5 10	2–5 10	0.25–2 3–5						10–100 0.5–2			≤ 0.65–≥ 0.02		0.27
bdb	Basaltic andesite of Bottle Rock Ridge	57.9							0.5–1.5 2–3	0.5–1.5 1					≤ 0.68–≥ 0.02		0.008
dlv	Dacite of Tule Valley	64.8	1–5 1	1–5 1.5	1–5 1.5	0.5–1 0.25									≤ 0.69–≥ 0.02	N	0.0029
bs	Olivine basalt north of Sweetwater Creek									1–25 15–30			a 5–20		≤ 0.82–≥ 0.02		0.0052
	CENTRAL AREA AND MOUNT KONOCTI																
rd	Young pyroclastic deposits	56.9–62.9						p		p							0.080
ha	Basaltic andesite of Anderson Island	56.8			0.5–1.5 1					0.25–2 2–3							0.00001
bbf, bbl	Basaltic andesite of Buckingham Peak	56.2–57.7								0.5–1 5					1–2 kf,pl 0.5		0.012
hh	Basaltic andesite of Horsedrink Bend	57.6			1.5 5					1–2 2					1–2 q 5		0.029
dwp	Rhyodacite of Wright Peak	66.5	1–5 5	1–10 5–10	1–10 5–8	0.5–2 1–2		0.5–2 0.5	0.5–2 0.5						≤ 0.26–≥ 0.02		0.26
bshf, bshp	Basaltic andesite of Howard Peak	57.2						0.25–1 2–3	0.25–2 3–5				2–40 d,v 0.5–1	1–5 q 0.5			0.019
bsh	Basaltic andesite of Howard Peak	56.8						0.25–2 <0.25	0.25–1 <0.25				2–300 d,v 0.5–1	1–2 q			0.016
dmk	Dacite of Mount Konocti	65.4	1–6 2	0.5–6 5	0.5–6 10	0.5–1 tr		0.5–1 1	0.5–1 0.25			0.5–3 pl,px tr					0.077
dbr	Dacite of Benson Ridge	66.4–68.6	0.5–6 5–8	0.5–10 5	0.5–10 5–10	0.5–3 0.5–1		0.5–2 0.5	0.5–2 0.5			10–12,000 1–2					2.77
dbh	Dacite of Buddingham Bluffs	66.4	1–3 1	0.5–10 <1	0.5–10 5–10											N	1.6
dhg	Dacite of Henderson	67.5	0.5–5 2	1–10 1	1–6 5–10	0.5–2 0.5		0.5–2 1	0.5–2 1			5–20 1–2				N	0.70
dsh	Rhyodacite of Soda Bay	68.0–70.2	1–5 5–8	2–50 3	1–10 10–15	0.5–2 0.5–1				0.5–2 0.5–2		1–10 1–2			≤ 0.43–≥ 0.05	N	0.17
dh	Rhyodacite of Horseshoe Bay	70.5	1–5 3	3–10 5	3–10 10	0.5–2 2		0.5–2 0.5	0.5–2 0.5			5–500 1–25	50–250 tf	tr	≤ 0.43–≥ 0.05 ≤ 0.25–≥ 0.04 ≤ 0.25–≥ 0.02 ≤ 0.35–≥ 0.02	N	1.557
df	Dacite of Fraser Point	64.6	0.5–1 5	0.5–5 2	part data 0.5–1 tr			0.5–1 tr	0.5–2 2	0.5–2 2							3.77
dbm	Dacite of Bell Mine	64.9	1–3 1–2	2–8 5	2–8 5	0.5–1 tr	0.5 tr	1–2 1	1–2 1								0.26
dbb	Dacite north of Elu Flat	67.9	1–10 2	1–10 5	1–10 5	0.5–1 tr	0.25–1 0.2	0.5–2 0.5	0.5–2 0.5								0.41
dkb	Dacite of Konocti Bay	64.7	1–5 5	1–5 5	1–6 5	1–2 tr		1–3 1.5	1–3 1.5							N	1.5
dbc	Dacite of Shaul Valley	66.4	1–5 2	1–5 5	1–10 5	0.5–1 <0.5	0.5–4 1	0.5–2 0.5	0.5–3 0.5								0.31
ea	Basaltic andesite	63.1–64.3			0.25–2 10–15			0.25–3 3–6	0.25–1.5 1	(0.15–0.3 ca. <1)		3–15 2	1 1		≤ 1.09–≥ 0.02 ≤ 1.09–≥ 0.02 ≤ 1.15–≥ 0.02 ≤ 1.11–≥ 0.02	R	0.93
rsmq, rsmp	Rhyolite north of Sugarloaf	72.9	2–8 5	2–15 5	2–15 5	0.5–1 1		0.25–0.5 tr		3–10 5					≤ 1.11–≥ 0.02 ≤ 1.11–≥ 0.02	R	0.018
rbr	Pacific pyroclastic deposit north of Sugarloaf												0.1?		≤ 1.71–0.21		0.0078
rsvl, rsvp	Rhyolite west of Sugarloaf	74.1	1–5 10	2–6 5–7	2–8 5–7	0.5–1.5 2–3				400 tr	5–700 b,d, f,pl,v,mu,qtz	<1		1–2 q tr	≤ 0.54–≥ 0.02		0.707
bwf, bwp	Basaltic andesite of Lower Lake Road	57.6								1 tr	0.5–1 1–2				≤ 0.44–≥ 0.08	N	0.026
bwf, bwp	Basaltic andesite of Shaul Valley	57.0								1–2 1	1 3–6			3–5 q 1			0.041
bws	Basaltic andesite of Sugarloaf Mound	54.0			0.5–2 10					0.5 tr	1 5		b–300 d tr				0.0008
aws	Andesite west of Shaul Valley	59.7			<0.5 tr					0.5–1 0.5–1			inc				0.0002
ry	Rhyolite of Cole Canyon	75.0	2–5 10	2–5 10	2–5 10	0.5–2 1						5–100 1–2			≤ 0.54–≥ 0.02	bnd	0.027
rm	Rhyolite northeast of Mount Olive	74.3	1–5 10–15	2–6 5–7	2–8 5–7	0.5–1 <0.5	0.5–4 1						d,pf,f				0.013
rmg	Pacific pyroclastic deposit west of Sulphur Mound	74.7	tr		tr								b–200 d,dem,dd, mu,sand,f,px,tf				0.0083
rsm	Rhyolite south of Mcinnis Creek	75.9			1–2 1					1 1			low wi				0.0006
bmp	Rhyolite of Red Hill Road	74.4		1–7 0.5–2	1–7 0.5–2	1–2 0.5–1				1 tr		10–60 0–2			≤ 0.50–≥ 0.02		0.068
rrf, rrc, rrp	Pyroclastic flow	74.3			1–2 1	1–2 0.5–1				1 tr			10m wi				0.27
rtc	Rhyolite of Thurston Creek	75.1–75.7			1–2 1	0.5–1 tr				1 tr			10m wi		≤ 0.47–≥ 0.01 ≤ 0.51–≥ 0.01	N	
dkl	Rhyodacite of Sugarloaf	70.8	1–5 5	1–10 5–10	1–10 10–15	0.5–1 0.5	0.25–1 0.5	0.5–2 0.5	0.5–2 2			5–50 5–10			≤ 0.61–≥ 0.02 ≤ 0.64–≥ 0.03		0.317
dsm	Dacite north of Mount Sugarloaf	70.8	2–5 5	2–5 3–5	2–5 2–5	1 1									≤ 0.80–≥ 0.02 ≤ 0.67–≥ 0.01		0.787
dsp	Rhyodacite of Mount Olive	70.8–71.1	2–10 5–10	2–10 5–8	2–10 5–7	1 0.5	0.5 0.25–1	0.5							≤ 0.53–≥ 0.02		0.58
	CLEARLAKE HIGHLANDS–THURSTON LAKE AREA																
rlv	Rhyolite of Borax Lake	76.1										0.2 cpx-opx-xl dryk, bar	0.5 tr		≤ 0.91–≥ 0.01	N	0.067
dcpk	Dacite of Clearlake Park	66.8–64.8			0.5–2 0.25								tex?	1–2 q tr			0.027
bar	Basaltic andesite of Arrowhead Road	54.7			0.5–2 tr					0.5–1.5 0.5				0.5–2 q tr			0.0047
bcp, bcl	Basaltic andesite of Roundtop Mountain	53.2–55.2			0.5 tr					0.5 5				1–5 q tr		N	0.10
dcc	Dacite of Cache Creek	67.5	1–4 2	2–20 1	2–20 4	0.5–2 tr		1 0.5	0.5 0.5	0.5–2 tr		5 tr			≤ 0.40–≥ 0.04	N	0.12
dw	Dacite of Wheeler Ridge	64.0	1–5 2–5		1–10 5–8			0.5–1 tr	0.25–1 tr	0.25–1 1							0.35
dcf	Dacite south of Cache Creek	64.7	1–3 4	1–3 2	1–3 2				0.5–1 1	0.5–1 1					≤ 0.44–≥ 0.03		0.10
ddf	Dacite of Plum Flat	67.3	1–5 2–3	2–10 7–10	2–10 7–10	1–2 2–3	0.25–1 <<0.5	1–4 0.5–1	1–2 0.5–1	1 1							1.05
dtr	Dacite of Thurston Lake	66.2 5	3–5		5–15 7–15			0.5–1 tr	0.5–1 tr	1–15 0.25		>10 2–3					1.7
dpl	Dacite of Pinkeye	66.7	2–5 5	2–5 2–3	2–5 2–3				part data 0.25–0.5 0.5	0.25–0.5 0.5	2 spx 3				≤ 0.46–≥ 0.03		0.19
dhl	Dacite of Clearlake Highlands	65.6	1–4 3		1–4 3	0.5–3 tr			2 4	0.5–3 tr		0 tr			≤ 0.52–≥ 0.06		0.12
dsp	Rhyodacite of Spruce Grove	68.1	2–5 1	2–5 <1	1–10 5–10	0.25–1 0.5–5	0.5–5 <1								≤ 1.2–≥ 0.3	R	0.0277
dnh	Rhyodacite north of Bald Mountain	69.3				0.25–1 1	0.5–4 2									R	0.0012
	NORTHEAST AREA																
bmg, bmp	Basaltic andesite of Mount Gaddis	57.4–58.8			0.5–3 10					0.5–1 1	0.5–2 3			1.5 q 1			0.33
bcg, bcp	Younger basaltic andesite of Cobb Creek	57.6			0.5–3 5					0.2 1	0.2 1						0.032
bsvp	Older basaltic andesite of Cobb Creek	56.7			0.5–1 2					0.5–1.5 0.5	0.5–1.5 0.5						0.0093
bdg, bdm	Basaltic andesite of Rattlesnake Mountain	57.6			1.5 5					0.5–1 1							0.021
sdd, sdf	Andesite of Sulphur Creek	57.7–59.3			0.5–1 0.5–2					1 tr					≤ ~44,000 y; 900 yr		0.092
sdf	Andesite of old cinder cone				1							tr					0.00397
bc	Inclusions of basaltic andesite	55.7			0.5–1 4					tr 1			2–20 f 1–10			N	0.021
dcm, dsmt, dsmc	Rhyodacite of Cobb Mountain	65.7			0.5–2 3		1 tr	0.5–2 10		0.25–1 0–5	0.25–1 2–10					N	0.0095
bsg, bsd	Basaltic andesite rocks	56.8–58.0			1–2 6–35									1–10 q tr	t ~1.85–0.10; t ~1.22–0.53; t ~1.34–0.29; t ~1.49–0.38; t ~1.65–0.08; t ~1.96–0.06; t ~2.31–0.2	most R, few N or I	0.2
	MOUNT HANNAH AREA																
dlv	Rhyodacite of Siegler Mountain	68.5–69.1	1–5 5	1–10 5	1–10 5	1 1–2	1–3 0.25–1	0.5 0.25–1	0.25						≤ 0.61–≥ 0.02	N	0.47
dvc	Dacite of Mount Harriett	68.7–69.4	1–3 1		0.5–5 5–10				1–2 1			5–30 ~0.5			≤ 0.33–≥ 0.16	I	0.083
dch	Older dacite of Mount Harriett	65.8–68.2	1–3 3–5		1–10 5–10	0.5–1 tr			1–2 5			5–150 1–10				I	0.607
dhh	Dacite of Harrington Peak	66.9–69.0	1–2 1		1–6 5–10				1–2 2–3			5–10 tr				I	0.29
adp	Basalt of Poison Spring	49.9									1–6 ope-opx 15–30						
dl	Rhyodacite of Lookout	69.2	1–3 3–5		1–10 10–15	0.5–1 tr		0.25–1 1	0.25–1 1			5–150 1–10				I	0.58
aw	Andesite of Split Top Ridge	62.7–63.5			1–6 0.5–1			1–4 2	1–4 2	1–4 ope-opx 1					≤ 0.36–≥ 0.06 ≤ 0.36–≥ 0.06	I	0.16
dh	Rhyodacite of Dinner Grove	66.6–69.7	1–5 2–3		2–4 tr				1–3 1–2				3–10 px,tf tr		≤ 0.61–≥ 0.02		
dbs	Dacite of Boggs Lake	67.3	1–5 5		1–6 tr				1–2 1						≤ 0.52–≥ 0.03	bnd	0.47
sg	Andesite of Sugarloaf	60.3			1–2 29–30 part data				1–2 part data						≤ 0.99–≥ 0.08	R	0.038
asf	Andesite of Sanhedrin Flat	62.6			0.5–2 20				0.5–3 15–20	0.25–0.5 tra 0.25					≤ 1.00–≥ 0.05	R	0.477
rbg, rbf	Rhyolite of Bonanza Springs	74.3–77.5			0.5 0.25			0.5 0.25	0.25 0.25				>px,f 1–2		≤ 1.02–≥ 0.04	R	0.35
																R	1.67

[1]Modal (volume) percent of phenocrysts and inclusions mainly estimated from hand specimen; a few estimated from outcrop or thin section. Horizontal bracket indicates combined data for two or more map units listed. Abbreviations: mm, length in millimeters; %, modal percent; p, present; tr, trace.

[2]Units named primarily on the basis of SiO_2 content: basalt less than 53, basaltic andesite 53–59, andesite 59–63, dacite 63.5–68, rhyodacite 68–72, and rhyolite more than 72 percent SiO_2. A few units that have a range of SiO_2 content are named for the dominant SiO_2 type. Units belonging to petrographic criteria that suggest affinity to rocks of the same petrologic group.

[3]SiO_2 content determined by U.S. Geological Survey rapid-rock methods (Shapiro, 1975) and recalculated to a 100-percent total, volatile-free, and a ratio of ferrous to ferric iron adjusted to 0.85. Accuracy for SiO_2 by the rapid-rock method is generally ±1 percent. The chemical variation of samples from three volcanic units near Borax Lake (dacite of Borax Lake (dlv), dacite of Clearlake Park (dcpk), basaltic andesite of Arrowhead Road (bar)) suggests that SiO_2 accuracy is better than ±0.5 percent in that series.

[4]Quartz in rhyolite, rhyodacite, and dacite is phenocrystic; quartz in basalt, basaltic andesite, and andesite is probably xenocrystic.

[5]Olivine phenocrysts commonly altered to iddingsite+iron-titanium oxides; cs, ?-magnetite, ihs, ilmenite +hematite+quartz; opx, orthopyroxene; cpx, clinopyroxene; px, combined cpx and opx; pl, plagioclase; ol, olivine.

[6]Diabasic-textured mafic inclusions are andesitic in composition (SiO_2 58.9–62.4 percent) and are mainly composed of elongate plagioclase and clinopyroxene or amphibole. Inclusions of basaltic andesite and basalt are rare and are not listed in this column. Clots of rocks that are similar to inclusions that have been interpreted as chilled inclusions of basaltic or andesitic melt in felsic volcanic rocks elsewhere (Eichelberger, 1980; Bacon and Metz, 1984; Sliman and others, 1991).

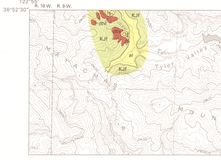
[7]Abbreviations: f, Fraxinian assemblage; gr, Green Valley sequence; sp, serpentinite; c, rhyolite; d, dacite; a, andesite; ba, basaltic andesite; b, basalt; package map unit symbol is given for inclusions known to be from other units of the Clear Lake Volcanics.

[8]Abbreviations: q, quartz; pl, plagioclase; KF, K-feldspar; coml, cordierite.

[9]Age in potassium-argon (K/Ar) age in millions of years (Ma) from Donnelly-Nolan and others (1981) unless specified as C, for carbon-14 age, in thousands of years (yr). Analytical data for ages are listed in Donnelly-Nolan and others (1981). Multiple ages are listed for a whole rock; a, sanidine; hr, biotite. Parentheses enclose age that does not fit stratigraphic sequence, magnetic polarity, or other ages on the same unit.

[10]Magnetic polarity from Mankinen and others (1978), Mankinen and others (1981), or determined in the field by B.C. Hearn, Jr., using a portable Brunger magnetometer. Abbreviations: N, normal; R, reversed; I, intermediate; bnd, boundary.

[11]Volume calculated from estimates of average thickness, existing area of exposure, and estimated area concealed beneath younger deposits. Volume for the early basalts rocks (bsv, bsg, bsw) includes their maximum area of exposure south of the map area. Volume queried where average thickness and (or) concealed extent uncertain.


Base from U.S. Geological Survey Lucerne, Clearlake Oaks, Clearlake Highlands, and Lower Lake, 1958, photorevised 1973; Kelseyville, 1958, photorevised 1973; Cobb Mountain, 1958, photorevised 1973; Aetna Springs, 1958, photorevised 1978; Geysers, 1959; Whispering Pines, 1958, photoinspected 1975; Mount St. Helena, 1959, photoinspected 1973
CLEAR LAKE
Kelseyville
Lower Lake
Cobb Mountain
Clearlake Highlands
Clearlake Oaks
Lucerne
Kjf
Kjd
Kjv
Kjbr
Kjbc
Kjbl
Kjbs
Kjbt
Kjbb
Kjbm
Kjbw
Kjbd
Kjbh
Kjbp
Kjbf
Kjbg
Kjbn
Kjbv
Kjbe
Kjbk
Kjbi
Kjbj
Kjbx
Kjbz
Kjby
Kjbu
Kjbq
Kjbo