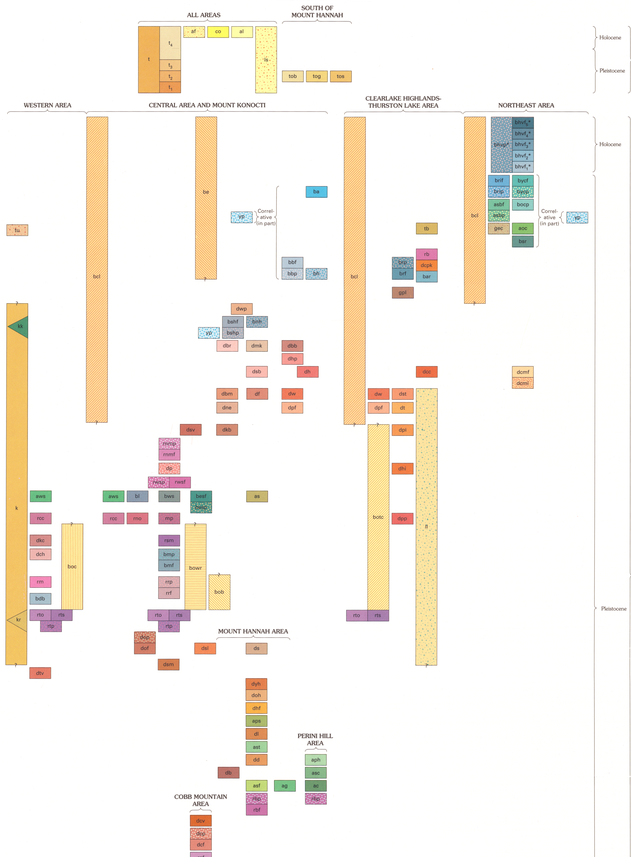
CORRELATION OF MAP UNITS



* See DESCRIPTION OF MAP UNITS for age assignment

DESCRIPTION OF MAP UNITS

[This map supersedes U.S. Geological Survey Open-File Report 76–751 (Hearn and others, 1976). Descriptions of map units are grouped by geographic area in approximate increasing age. Summaries of the evolution, chemistry, structure, and tectonic setting of the Clear Lake Volcanics are given in Hearn and others (1981) and Donnelly-Nolan and others (1981). The geology of parts of the area underlain by the Cache Formation is based on mapping by Rymer (1981); the geology of parts of the Sonoma Volcanics, the Sonoma Volcanics, Franciscan assemblage, and Great Valley sequence is based on mapping by McLaughlin (1978). Units are named primarily on the basis of SiO_2 content: basalt less than 53; basaltic andesite 53–59; andesite 59–63.5; dacite 63.5–68; rhyodacite 68–72; and rhyolite greater than 72 percent SiO_2. A few units that have a range of SiO_2 content are named for the dominant SiO_2 value, or are named according to petrographic criteria that suggest affinity to other units of the same petrologic group. Percentages of minerals are for phenocrysts and are estimated mainly from hand specimens. Size of minerals is medium throughout. Size of clasts in sedimentary and pyroclastic deposits is maximum dimension. Where vent locations for volcanic units are not shown on the map or discussed, the vent area is assumed to be within or near present outcrops. Known or inferred sequence of units is shown in the correlation chart, in the cross sections, or can be determined from the map. For some key units, position in the sequence is given in the description. Most ages are potassium-argon (K-Ar) ages determined for whole-rock samples by Donnelly-Nolan and others (1981), unless otherwise noted. A few ages are carbon-14 ages or were estimated from geologic relationships. Magnetic polarities are from Marvinken and others (1978, 1981) or were determined in the field by B.C. Hearn, Jr., using a portable fluxgate magnetometer. Maximum thickness of units is unknown unless specified. Thickness for most units is estimated from topographic relief except where drill-hole data was available]

GENERAL AREA

Surficial Deposits

al — **Alluvium (Holocene)**—Flood-plain, channel, and lake deposits of clay, silt, sand, and gravel. Locally may include youngest part of the basin deposits of Clear Lake (boc)

oo — **Colluvium (Holocene)**—Slope deposits of silt, sand, and coarser angular clasts. Mapped only where extensive or where covers critical contact of bedrock units

af — **Alluvial-fan deposits (Holocene)**—Coarse deposits of sand and generally angular pebbles and boulders derived from nearby upslope source

ls — **Landslide deposits (Holocene and Pleistocene)**—Unsorted angular blocks and soil. Largest landslide deposit is on the west side of Mount Konocti; consists of the debris of Benson Ridge (dbr) and rhyodacite of Soda Bay (dsb) and has an inferred maximum thickness of at least 250 m. Contact between adjacent landslide deposits on map separates landslides of different age or direction of movement

t — **Terrace deposits, undivided (Holocene and Pleistocene)**—Dominantly pebble to boulder gravel and minor sand. Four terrace levels mapped in the lower parts of the Kelsey Creek, Sweetwater Creek, Cole Creek, McIntire Creek, and North Fork Cache Creek drainages; terrace levels probably are correlative between adjacent drainages. In the Cole and McIntire Creek drainages, gravel is a mixture of clasts of volcanic rock and resistant components of gravel recycled from the Kelseyville Formation. Maximum thickness about 5 m. Terrace levels differentiated from youngest (lowest) to oldest (highest):

- t_4 — Unit 4 (Holocene and Pleistocene)
- t_3 — Unit 3 (Pleistocene)
- t_2 — Unit 2 (Pleistocene)
- t_1 — Unit 1 (Pleistocene)

SOUTH OF MOUNT HANNAH

Older terrace deposits of upper Kelsey Creek area (Pleistocene)

tos — Terrace deposits of Scotts Creek—Pebble to small boulder-size gravel, terrace deposits of the cordate of Bogge Mountain (boc), rhyodacite of Diener Drive (dd), obsidian from the rhyolite of Bonanza Springs (rbp), andesite of Split Top Ridge (ast), rhyodacite of Loch Lomond (dl), and abundant clasts of sandstone and shale of the Great Valley sequence (Kgv). Source local and to east; deposited by an ancestral west-flowing Sulphur Creek whose drainage basin extended farther east than at present. Maximum thickness 1 m

tob — Terrace deposits of Bottle Rock Road—Interbedded fluvial sand and pebble-boulder gravel. Contains abundant clasts derived from the Franciscan assemblage (Kfr), and obsidian clasts of older Clear Lake Volcanics, and fragments of chert, serpentine, greenstone, graywacke, and shale from the Franciscan assemblage and Great Valley sequence (Kdgv). Unit consists dominantly of airfall deposits (rarely reworked by water or mass wasting) and contains lesser amounts of mass deposits from underwater or pyroclastic eruptions (based on presence of mud-armored lapilli and distinct bomb sags) and base-surge deposits. Sources are: (1) inferred vents suggested by concentration of dikes in Bloody Glen Lake shoreline, by lake-bottom topography, and by localized, banded pyroclastic deposits along the lake shore; (2) Bottle Rock fault zone; (3) inferred vent north-northwest of the Bell Mine; and (4) cinder cones east of Clearlake Oaks. Wide range in thickness probably correlates in part with ash beds in sediments beneath Clear Lake; youngest ash bed beneath Clear Lake is in core 7 taken from Seventy Fraser Point and Pirates Cove and is about 11,000 years old (Sims, Adam, and Rymer, 1981); oldest part is near Bell Mine, is deposited on surface of Andersen Mesa, and probably is about 0.35 Ma. Maximum exposed thickness about 60 m

tog — Terrace deposits of Glenbrook—Fluvial sand, silt, and gravel of pebble-size to rare small boulder-size clasts. Gravel forms up to 40 percent of some outcrops; gravel consists of 80 percent chert and greenstone and 20 percent of the Franciscan assemblage (Kfr), as well as pebbles reworked from Franciscan assemblage conglomerates. 15 percent clasts of the rhyodacite of Cobb Mountain (dcb, dcp), and 5 percent clasts of the rhyolite of Alder Creek (ral, ras). Locally contains 2–3 m thick beds of sand and silt derived from the lacustrine diatomite. Similar gravels occur in sec. 5, T. 11 N., R. 8 W. and are inferred to be fluvial by B.C. Hearn, Jr., using a portable fluxgate magnetometer. Maximum thickness of units is unknown unless specified. Thickness for most units is estimated from topographic relief except where drill-hole data was available]

Basin deposits of Clear Lake—Pebble to small boulder-size gravel, sand, silt, clay, mud, peat, and diatomite. Shown only in cross section. Deltaic, lacustrine, marsh, and marginal fluvial deposits composed of gravel, sand, silt, clay, mud, peat, and diatomite. Maximum thickness 300 m (Rymer, 1981). Age ranges from present to greater than 0.175 Ma based on paleomagnetic and preliminary pollen analysis of core from the Environmental Research and Perkins, 1981). Lower part may overlie or grade into the Kelseyville (k) and Lower Lake (ll) Formations; may be as much as 1,000 m thick. Sulphur Creek whose drainage basin extended farther east than at present. Maximum thickness 1 m

Basin deposits of Ely Flat—Lacustrine, fluvial, and coarse alluvial deposits composed of clay, silt, sand, and gravel in subsidence basin surrounding Sugarloaf. Contains fragments of the dacite of Plum Flat (dpf) and various dacites from the Mount Konocti volcanic edifice. Deposits derived from surrounding slopes and ancestral upper drainage basin of Seigler Canyon. Age ranges from present to probably less than 0.5 Ma. Exposed thickness about 25 m; drilled thickness about 120 m

Young pyroclastic deposits (Holocene and Pleistocene)—Well-bedded coarse ash and tuff, lapilli tephra, and lapilli tuff; blocks and bombs are locally abundant; commonly weathered to dark-orange soil. Typically exhibits alternating coarse-grained (0.5–15 cm) and fine-grained (<2 mm) layers that are 1–15 cm thick and show graded bedding or, rarely, reverse-graded bedding. Dominant fragments are white, yellow, and brown hydrothermally altered scoria, or gray to black fresh scoria ranging of andesite and basaltic andesite and, rarely, of dacite. Unit contains 1–20 percent of 1–100-cm-diameter fragments of older rocks of the Clear Lake Volcanics, and fragments of chert, serpentine, greenstone, graywacke, and shale from the Franciscan assemblage and Great Valley sequence (Kdgv). Unit consists dominantly of airfall deposits (rarely reworked by water or mass wasting) and contains lesser amounts of mass deposits from underwater or pyroclastic eruptions (based on presence of mud-armored lapilli and distinct bomb sags) and base-surge deposits. Sources are: (1) inferred vents suggested by concentration of dikes in Bloody Glen Lake shoreline, by lake-bottom topography, and by localized, banded pyroclastic deposits along the lake shore; (2) Bottle Rock fault zone; (3) inferred vent north-northwest of the Bell Mine; and (4) cinder cones east of Clearlake Oaks. Wide range in thickness probably correlates in part with ash beds in sediments beneath Clear Lake; youngest ash bed beneath Clear Lake is in core 7 taken from Seventy Fraser Point and Pirates Cove and is about 11,000 years old (Sims, Adam, and Rymer, 1981); oldest part is near Bell Mine, is deposited on surface of Andersen Mesa, and probably is about 0.35 Ma. Maximum exposed thickness about 60 m

Basaltic andesite of Buckingham Peak (Pleistocene)—Olivine basaltic andesite. Unit is partly removed by landslide that may be related to eruptions which produced the mass at Little Borax Lake; fragments of this unit are common in young pyroclastic deposits (upv) northwest, north, and east of Buckingham Peak

bbf — Flow—Maximum thickness 10 m

bbp — Pyroclastic deposits—Eroded cinder cone composed of bomb, block, and lapilli tephra. Maximum thickness 50 m

Basaltic andesite of Horsehoe Bend (Pleistocene)—Blocky flow, bombs, and scoria of porphyritic olivine basaltic andesite. Deposited on flank of its cinder cone source that was constructed on the south rim of the explosive eruption that shaped Horseshoe Bay. Maximum thickness of flow 5 m and of pyroclastic deposits about 80 m

Rhyodacite of Wright Peak (Pleistocene)—Flows and dome of coarsely and abundantly porphyritic biotite rhyodacite. Contains 1–5 percent of 3–10-mm pyroxene-plagioclase inclusions; has a granular texture. Surfaces of flows on east slope of Wright Peak show arcuate flow fronts, and dikes of sparsely porphyritic dacite (Howard Peak, 1960). Overlies the basaltic andesites south of Howard Peak (bwt, bwp) and north of Howard Peak (bwh). Source dike is in the north rim of the small crater on Mount Konocti; age of 0.35±0.02 Ma on sanidine. Maximum thickness 150 m

Basaltic andesite south of Howard Peak (Pleistocene)—Olivine-clinopyroxene basaltic andesite. Contains 0–0.25 percent of inclusions of 1–5-mm-diameter porphyritic plagioclase, plagioclase, and quartz and 0–1 percent of 2–40-mm-diameter inclusions of solid, or frothy, partially melted dacite and biotite rhyolite. Forms a gradational pyroclastic blanket on high south slope of Mount Konocti. Overlies the dacites of Benson Ridge (dbr) and 30-cm diameter bed 5–10 cm above base of grade into the young pyroclastic deposits (yp) 1 km west of Bell Mine. Maximum exposed thickness about 50 m

bwp — Flow—Subordinate part of unit; forms ledge. Maximum thickness 5 m

bphp — Pyroclastic deposits—Dominant part of unit; bomb, block, and lapilli tephra

Basaltic andesite north of Howard Peak (Pleistocene)—Phenocryst-poor basaltic andesite. Coarse bomb, block, and lapilli tephra, and thin vesicular flow covering a 50x20 m area. Contains inclusions of 1–2-mm-diameter plagioclase, potassium feldspar, and quartz and 0.5–1 percent of 2-mm- to 30-cm-diameter solid, frothy, partially melted inclusions of dacite and biotite rhyolite. Forms pair of eroded ridges that are subdued remnants of low cinder cone. Probably contemporaneous with the basaltic andesite south of Howard Peak (bwh, bwp); overlain by the rhyodacite of Wright Peak (rwp) and probably by the basaltic andesite of Buckingham Peak (sbt, bsp). Maximum exposed thickness about 100 m

dmtk — **Dacite of Mount Konocti (Pleistocene)**—Flows of medium-grained, moderately porphyritic dacite, containing hornblende, augite, and (rarely) quartz phenocrysts are 1–3 mm in size, in contrast with the larger phenocrysts in other dacite and rhyodacite units high on Mount Konocti. Probable source is a 0.2 km west-northwest of Wright Peak, at or close to the vent symbol, vent is a partially caved, near-vertical passage reported to be of good vertical extent (Maudlin, 1960, p. 53–55) and is surrounded by blocks of oxidized dacite and welded dacite spatter. Maximum thickness less than 60 m

dbr — **Dacite of Benson Ridge (Pleistocene)**—Flows of coarsely porphyritic dacite and abundantly porphyritic biotite dacite. Contains 5–10 percent of textured pyroxene-plagioclase mafic inclusions as much as 1.2 m diameter. Main source on South Peak and probable second source on Benson Ridge and east of Shaul Valley. Maximum exposed thickness 300 m

dcb — **Dacite of Buckingham Bluffs (Pleistocene)**—Flow of moderately porphyritic dacite. Contains 5–10 percent of pyroxene-plagioclase mafic inclusions. Source unconcealed near present summit of Buckingham Peak. Youngest dacite unit on Buckingham Peak. Maximum thickness 150 m

dhp — **Dacite of Henderson Point (Pleistocene)**—Flows of coarsely porphyritic biotite dacite. Contains 5–10 percent of inclusions of the dacite of Big Valley (dab), but dacite of Henderson Point contains fewer large sanidine phenocrysts. Probable vent area just north of present summit of Buckingham Peak. Maximum exposed thickness 200 m

dsb — **Rhyodacite of Soda Bay (Pleistocene)**—Flows and domes of coarsely and abundantly porphyritic biotite rhyodacite. Source unconcealed beneath Big Valley and Clear Lake. Unit may represent more than one eruption; source vents lie beneath Wright Peak and possibly 0.8 km north-northwest of Howard Peak. Major flow moved west and north forming Clark Rock and Dark Rock; another flow poured northeast around flow ridges, known locally as lower "lava rings" (Maudlin, 1960) on the east slope of Wright Peak. Average of 3 is 0.42 Ma; probably younger than the dacite north of Ely Flat (dne) and older than the rhyodacite of Wright Peak (rwp), which is dated at 0.35 Ma. Maximum thickness about 400 m

dh — **Rhyodacite of Horsehoe Bay (Pleistocene)**—Flow of coarsely porphyritic rhyodacite; petrographically similar to rhyodacite of Soda Bay, probably caused from flowing into water. On Anderson Island, this rhyodacite was formed by the biotite dacite of Clear Lake (dcl) and others (1976). Contains abundant diabasic-textured mafic inclusions, up to 0.5 m diameter, that make up as much as 25 percent of flow on Anderson Island; contains sparse 5–25-cm-diameter inclusions of the dacite of Fraser Point (dff). Source unconcealed 3,300 ft west-northwest of Buckingham Peak. Age of 0.35±0.02 Ma on sanidine. Maximum exposed thickness 230 m

dff — **Dacite of Fraser Point (Pleistocene)**—Flows of sparsely porphyritic dacite. Source vent located near western limit of unit's outcrop area, at about 3,300 ft elevation on east side of ridge that forms Howard Peak and Buckingham Peak. Probably overlain by the rhyodacite of Horsehoe Bay (dh). Exposed thickness 200 m

dbm — **Dacite of Bell Mine (Pleistocene)**—Flow of moderately porphyritic dacite; altered to white opalized dacite at Bell Mine. Source vent now mostly buried at about 3,300-ft elevation southeast of South Peak. Maximum exposed thickness 120 m

dne — **Dacite north of Ely Flat (formerly dacite northeast of Clear Lake, Hearn and others, 1976) (Pleistocene)**—Flows and dome of moderately porphyritic hornblende dacite. Probable source unconcealed near 3,000-ft elevation on Mount Konocti in NE1/4 sec. 20, T. 13 N., R. 8 W. Maximum exposed thickness about 300 m

dkb — **Dacite of Konocti Bay (Pleistocene)**—Flows and domes of moderately porphyritic dacite. Source unconcealed; probably 0.4 km south of Ely Flat, in sec. 21, T. 13 N., R. 8 W. Exposed thickness about 200 m

dsv — **Dacite of Shaul Valley (Pleistocene)**—Domal flows of sparsely porphyritic hornblende-biotite dacite. Probably the source of Shaul Valley (swf, swp); overlies the dacite of Benson Ridge (dbr). Maximum thickness at least 130 m

dd — **Rhyodacite of Keeley Creek (Pleistocene)**—Flows and minor pyroclastic deposits of biotite rhyodacite. Thickness of flows 30 m

dch — **Rhyodacite of Camels Hump (Pleistocene)**—Flows, domes, and shallow intrusions of moderately porphyritic biotite-hornblende rhyodacite. Intrudes the rhyolite of Thurston Creek, intrudes and overlies the basaltic andesite dateme breccia (bxth) and the rhyolite of Milky Creek (rm), and is overlain by the rhyodacite of Keleey Creek (dke) and Kelseyville Formation (k). Biotite-hornblende dacite of normal magnetic polarity in S1/2 sec. 28, T. 13 N., R. 9 W. Maximum exposed thickness about 200 m; at 0.59±0.02 Ma on sanidine. Maximum exposed thickness 80 m

rm — **Rhyolite of Milky Creek (Pleistocene)**—Flow or flows, coarse blocks and bombs, coarse pumiceous lapilli tephra and lapilli tuff, and lapilli pyroclastic breccia, minor lapilli tuff, and minor mudflow deposits of commonly perlitic, crystal-rich biotite rhyolite; locally, massive pyroclastic breccia consists of matrix of biotite-free crystal-rich pumice; locally pyroclastic breccia is rich in brown scoria derived from the basaltic andesite dateme breccia (bxth), fragments of glassy dacite, fragments of chert, greenstone, and graywacke derived from the Franciscan assemblage (Kfr), and fragments of serpentinite (ysp). Intrudes and contains inclusions of the basaltic andesite of Buckingham Peak (bsb); contains inclusions of, and probably overlies, the rhyolite of Thurston Creek; intruded by, and overlain by, the rhyodacite of Camels Hump (dch). Closely resembles the rhyolite of Cole Creek (rsc), but the rhyolite of Milky Creek is apparently older based on a K/Ar age of 0.60±0.02 Ma on sanidine. Maximum exposed thickness 60 m

Basalt of Sugarloaf (Pleistocene)—Flows and flow(?) of abundantly and coarsely porphyritic biotite-hornblende rhyodacite. Probable source vent is faulted dome at Sugarloaf. Maximum exposed thickness 100 m

Rhyodacite of Sulphur Mound Mine (Pleistocene)—Flow or dome of moderately porphyritic biotite rhyodacite, mostly altered to opalized white dacite. Oldest unit in Sulphur Mound Mine area; ages of 0.60±0.02 Ma on sanidine from altered rhyodacite. Source at 0.67±0.02 Ma on sanidine from fresh rock sample. Minimum thickness 100 m

Rhyodacite of Mount Olive (Pleistocene)—Abundantly porphyritic biotite-hornblende rhyodacite. Overlain by obsidian (ms) and stony rhyolite (rs) of the rhyolite of Thurston Creek, Kelseyville Formation (k), basaltic andesite of Lower Lake Road (bl), pyroclastic deposits (rwap) of the rhyolite west of Sugarloaf, and rhyolite northwest of Mount Olive (rmo); probably overlain by the rhyolite of Cole Creek (rsc) and dacite of Benson Ridge (dbr), and by dacite of the southeast vent of Shaul Valley (swe). Age of 0.53±0.02 Ma on sanidine is too young; true age must be older than the overlying rhyolite of Thurston Creek dated at about 0.60 Ma. Maximum exposed thickness 180 m

Pyroclastic deposits—Block tephra, lapilli tephra, and pyroclastic breccia

Flows and domes

Basin deposits of Wildcat Road—Poorly exposed claystone, siltstone, diatomaceous siltstone, pumiceous sandstone, and conglomerate. Conglomerate contains pebbles of obsidian, andesite or dacite, and chert. Overlies obsidian (ms) of the rhyolite of Thurston Creek, andesites of Split Top Ridge (ast) and Glenview (ag), rhyodacite of Diener Drive (dd), and older dacite of Mount Hannah (dsh). Exposed thickness about 15 m

Basin deposits of lower Thurston Creek—Well-bedded lacustrine and deltaic deposits composed of clay, silt, diatomaceous siltstone, pumiceous sandstone, and pyroclastic tuff and lapilli tuff. Rarely contains gastropod molds, and some beds are rich in silicified plant debris, or are locally rich in iron oxide, causing them to weather orange or red. Locally contains pebbles of chert, greenstone, graywacke, shale, and the glassy rhyodacite of Diener Drive (dd). North of Manning Flat, basal part contains locally derived boulder conglomerate of obsidian (ms) and pumice (rp) from the rhyolite of Thurston Creek in tuffaceous matrix; boulder conglomerate is overlain by 30–60 cm of evenly bedded, light-gray dacite(?) pumice of 0.25–1.5 cm diameter. Exposed thickness about 30 m

Basin deposits of Bonfield Flat (formerly basin deposits of Konocti Conservation Camp of Hearn and others, 1976)—Poorly exposed, white, rhythmically layered beds of diatomaceous claystone and siltstone, fine-grained tuffaceous sandstone, and a few beds of tuffaceous sandstone containing pebbles and cobbles of obsidian and dacite. Overlies the rhyodacite of Diener Drive (dd) and obsidian (ms) of the rhyolite of Thurston Creek, may be contemporaneous with the basin deposits of lower Thurston Creek (bots) and upper part of the Lower Lake Formation (ll). Thickness at least 40 m

Rhyolite north of Mcintire Creek (formerly dacite of Cleft Hill of Hearn and others, 1976) (Pleistocene)—Moderately crystal-rich, locally perlitic, biotite rhyolite. Youngest unit in complex sequence east of Mount Olive; overlies flows (rem) of the basaltic andesite of McIntire Creek, pyroclastic deposits (rwap) of the rhyolite west of Sugarloaf, obsidian (rtm) of the rhyolite of Thurston Creek, and rhyolite northeast of Mount Olive (rmo). Maximum thickness about 25–40 m

Pyroclastic deposits—Coarse bomb and block tephra and lapilli tuff. Contain sparse obsidian fragments and, close to source vent, contain blocks of older Cobb Mountain rhyolite (rcb)

Flows—Small lateral extent

Dacitic pyroclastic deposit north of McIntire Creek (Pleistocene)—Lithic pyroclastic breccia. Contains blocks of biotite dacite and biotite-hornblende dacite up to 60 cm diameter, sparsely porphyritic obsidian fragments up to 5 cm diameter derived from the rhyolite of Thurston Creek (rm) or the rhyolite north of McIntire Creek (rmm), and rare small fragments of chert; blocks of biotite rhyolite absent. Overlies the rhyolite west of Sugarloaf (rwap), basaltic andesite west of Sulphur Mound Mine (bws), mixed pyroclastic deposit west of Sulphur Mound Mine (mp), and obsidian (rtm) of the rhyolite of Thurston Creek. Maximum thickness about 20 m

Rhyolite west of Sugarloaf (formerly biotite rhyolite pyroclastic deposits west of Sugarloaf of Hearn and others, 1976) (Pleistocene)—Crystal-rich biotite rhyolite. Exposed area is 1 km^2, but concealed extent may exceed 3 km^2; present in both Magma 1 Watson and in Getty 1 Kettenhofen drill holes. Source probably near present outcrops northwest or west of Sugarloaf. Scattered fragments of this rhyolite occur on top of the obsidian (rts) of the rhyolite of Thurston Creek as much as 3 km east-southeast of Ely Flat. Overlain by the dacites of Konocti Bay (dkb) and north of Ely Flat (dne). Age of 0.54±0.02 Ma on sanidine. Maximum exposed thickness 65 m

Flow—Perlitic glassy crystal-rich biotite rhyolite. West of Ely Flat

Pyroclastic deposits—Pyroclastic breccia and lapilli tuff, mostly nonbedded to poorly bedded, only locally well bedded. Biotite rhyolite pumice lapilli and blocks of pumice and lithic biotite rhyolite, both up to 1 m diameter, make up 90–95 percent of deposit. Also contains lithic fragments and blocks up to 70 cm diameter of biotite-hornblende dacite resembling the rhyodacites of Sugarloaf (dsf) or Mount Olive (dmt, dsp), diabasic-textured mafic inclusions up to 40 cm diameter, fragments of basaltic andesite, and rare fragments and blocks up to 15 cm diameter of the biotite glassy rhyodacite of Diener Drive (dd); obsidian fragments absent. Mainly airfall deposits, locally reworked by water; local well-bedded airfall layers 1–15 cm thick contain pumice fragments up to 12 cm diameter, fragments of chert and greenstone as large as 6 mm diameter, and abundant clear quartz grains of 1–3 mm diameter

Basaltic andesite of Lower Lake Road (Pleistocene)—Flows, coarse blocks and bombs, and pyroclastic breccia of sparsely porphyritic basaltic andesite south of Howard Peak (bwf, bwh), and is about 0.35 Ma. Maximum exposed thickness about 60 m

Basaltic andesite of Anderson Island (Pleistocene)—Flow(?) of blocks up to 1.7 m diameter of slightly vesicular olivine basaltic andesite; contains 1–2 percent black, rounded, partially melted blocks of crystal-rich dacite that lack visible biotite or hornblende. Source near main exposure. Overlain by the lavas of Benson Ridge (dbr) and Shaul Valley (dsv); possibly contemporaneous with the basaltic andesite of Buckingham Peak

Flows

Pyroclastic deposits—Bomb, block, and lapilli tephra

Basaltic andesite west of Sulphur Mound Mine (Pleistocene)—Porphyritic plagioclase-olivine basaltic andesite. Small flow, vent plug(?), and pyroclastic deposits of bomb, block, and lapilli tephra containing coarse scoriaceous bombs and blocks up to 3 m diameter. Contains partially fused inclusions of the rhyodacite of Sulphur Mound Mine (dsm) up to 30 cm diameter. Small area of oxidized basalt and massive fresh basalt in SW1/4SE1/4 sec. 32, T. 13 N., R. 8 W. may be a small flow and vent plug. Overlies the mixed pyroclastic deposit west of Sulphur Mound Mine (mp), apparently overlies obsidian (rts) of the rhyolite of Thurston Creek and rhyodacite of Sulphur Mound Mine (dsm); overlain by the rhyolite west of Sugarloaf (rwap) and dacitic pyroclastic deposit north of McIntire Creek (dpc). Maximum thickness about 10 m

Andesite west of Shaul Valley (formerly basalt west of Shaul Valley of Hearn and others, 1976) (Pleistocene)—Bomb and block tephra, small flow(?), and dikes of sparsely porphyritic andesite. Vents and flows dikes that cut the rhyolite of Cole Creek (rsc) and rhyodacite of Mount Olive (dst, dsp). Also vesicular flows in andesite up to 30 cm diameter (containing partially melted inclusions of the biotite rhyolite of Cole Creek (rsc)) are 5–10 percent of a mudflow(?) deposit of mixed biotite rhyolite and andesite that overlies the rhyolite of Cole Creek (rsc) in center N1/2 sec. 26, T. 13 N., R. 9 W. Maximum thickness about 5 m

Rhyolite of Cole Creek (Pleistocene)—Lapilli tuff, pumice breccia, and flows of predominantly perlitic, crystal-rich biotite rhyolite. Area of unit in center of N1/2 sec. 26, T. 13 N., R. 9 W. includes an overlying mudflow(?) deposit 1–3 m thick, composed of 90–95 percent biotite rhyolite fragments up to 30 cm diameter and 5–10 percent of mixed biotite rhyolite and basaltic andesite. Overlies the rhyolite of Thurston Creek (rm) and dacite of Shaul Valley (dsv). Biotite rhyolite occurs in drill holes beneath Cavern Flat and at 1,225 ft depth in NE1/4 sec. 13, T. 13 N., R. 9 W. in Big Valley. Apparently overlies the rhyodacite of Mount Olive (dst, dsp); overlain by the Kelseyville Formation (k) and dacite of Benson Ridge (dbr); cut by dikes of the andesite west of Shaul Valley (ase). Age of 0.64±0.02 Ma on sanidine. Maximum exposed thickness 80 m

Andesite of Seigler Canyon (Pleistocene)—Dome and surrounding flow of sparsely porphyritic basaltic andesite. Contains 0.5–2 percent of 1–5-mm-diameter inclusions of solid, or frothy, partially melted dacite and biotite rhyolite. Forms pair of eroded ridges that are subdued remnants of low cinder cone. Probably contemporaneous with the basaltic andesite south of Howard Peak (bwh, bwp); overlain by the rhyodacite of Wright Peak (rwp) and probably by the basaltic andesite of Buckingham Peak (sbt, bsp). Maximum exposed thickness about 100 m

Dacite of Mount Konocti (Pleistocene)—Flows of medium-grained, moderately porphyritic dacite, containing hornblende, augite, and (rarely) quartz phenocrysts are 1–3 mm in size, in contrast with the larger phenocrysts in other dacite and rhyodacite units high on Mount Konocti. Probable source is a 0.2 km west-northwest of Wright Peak, at or close to the vent symbol, vent is a partially caved, near-vertical passage reported to be of good vertical extent (Maudlin, 1960, p. 53–55) and is surrounded by blocks of oxidized dacite and welded dacite spatter. Maximum thickness less than 60 m

Rhyodacite of Loch Lomond (Pleistocene)—Flows and domes of moderately porphyritic rhyodacite containing coarse feldspar phenocrysts. Probable source vent at west end of Loch Lomond; other vents are concealed beneath Mount Hannah. Age is 0.90±0.03 Ma. Intermediate magnetic polarity. Maximum thickness 150 m

Andesite of Split Top Ridge (Pleistocene)—Flows of andesite that has a distinctive texture of coarse lava (15–mm-long) phenocrysts and abundant small (0.25–1 mm-long) phenocrysts of plagioclase. Widespread unit that has been correlated by texture and mineralogy. Ages of 0.88±0.06 Ma at Split Top Ridge, 0.88±0.02 Ma 0.3 km south of Loch Lomond, and 0.86±0.03 Ma on northwest side of Bogge Lake are all slightly too young. Age from stratigraphic position and intermediate magnetic polarities is about 0.90 Ma. Small differences in polarity may imply small age difference between exposures east and west of Mount Hannah. Maximum exposed thickness at Split Top Ridge 80 m; maximum thickness at Split Top Ridge about 150 m

Rhyodacite of Diener Drive (Pleistocene)—Extensive flow or flows of sparsely porphyritic pyroxene rhyodacite that is locally perlitic. Groundmass rich in subparallel 0.2-mm-long plagioclase and pyroxene. Similar to the dacite of Bogge Lake (db) but less porphyritic. Age is 0.92±0.03 Ma. Minimum thickness on Split Top Ridge 50 m

Dacite of Boggs Lake (Pleistocene)—Flows of sparsely porphyritic dacite. Groundmass rich in subparallel 0.2-mm-long plagioclase and pyroxene. Age is 0.98±0.09 Ma. Reversed magnetic polarity. Maximum exposed thickness 25 m

Andesite of Glenview (Pleistocene)—Flow and scoriaceous bombs of andesite that has a distinctive speckled appearance due to presence of 25–30 percent of 1–2-mm-long single crystals and 1–2-mm-diameter clots of plagioclase. Partly covered by older (dab) and younger (dyh) dacites of Mount Hannah. Age is 1.00±0.05 Ma. Reversed magnetic polarity. Maximum exposed thickness about 200 m

Andesite of Salmina Flat (Pleistocene)—Flows of ilmenite-bearing andesite. Contains 0.25 percent of conspicuous 0.25–0.5-mm-diameter steel-gray ilmenite in a vaguely to aphanitic groundmass. Reversed magnetic polarity. Maximum thickness about 250 m

Rhyolite of Bonanza Springs (Pleistocene)—Very sparsely porphyritic rhyolite. Age is 1.02±0.04 Ma. Reversed magnetic polarity in drill-core sample of flow. Maximum exposed thickness 70 m near Seigler Springs; thickness 1–2 m near Bonanza Springs. Drilled thickness 110 m in Republic 77–1 Bogs northwest of Mount Hannah

Pyroclastic deposits—White pumiceous tuff, lapilli tuff, and lavalike, crystal-poor rhyolite pumice breccia. Source 3–4 m in road cut on State Route 175 in W1/2 sec. 26, T. 12 N., R. 8 W. is reworked and contains boulders of the andesite of Salmina Flat (asf). Shows rhythmic layering of coarse and fine layers of widely varying thickness. Mainly deposited by airfall, locally into ponds of water and in places, reworked by water. Contains rhyolitic pyroclastic breccia near a concealed vent northeast of Seigler Springs; another probable vent is concealed northwest of Mount Hannah

Flows—Not exposed, shown only in cross section A-A'. Three phyolitic obsidian flows, which are 29, 17, and 15 m thick, are present in the drill hole northeast of Seigler Springs in Republic 77–1 Bogs

Gravel deposit east of Pinkeye Lake (Pleistocene)—Stream gravel composed of pebbles and small cobbles in coarse sandy matrix. Contains clasts of obsidian (rts) from the rhyolite of Thurston Creek, dacite from nearby dacite units, and chert from the Franciscan assemblage (Kcf). Derived from Manning Flat area and deposited in a former eastward drainage through Pinkeye Lake. Maximum thickness 2–3 m

Dacite of Cache Creek (Pleistocene)—Dome and rubbly flows of sparsely porphyritic dacite. Overlies the Lower Lake Formation (ll) and dacite of Clearlake Highlands (dhi). Age of 0.40±0.04 Ma. Maximum exposed thickness 60 m

Basalt of Wheeler Point (Pleistocene)—Domes and flows of moderately porphyritic, quartz-rich dacite. Contains 3–5 percent of 1–5-mm-diameter quartz that is commonly rimmed by clinopyroxene. Shows steep flow fronts along shore of Clear Lake. Flows north of Thurston Lake probably fed by vents or fissures aligned west-northwest in present outcrop area; source sources at south end of Konocti Bay. Probably overlies the dacite of Konocti Bay (dkb). Maximum exposed thickness 200 m

Dacite south of Thurston Lake (formerly dacite of Vulture Rock of Hearn and others, 1976) (Pleistocene)—Flows and domes of moderately porphyritic dacite. Age of 0.44±0.03 Ma. Maximum thickness about 150 m

Dacite of Plum Flat (Pleistocene)—Flows and domes of abundantly porphyritic, hornblende-biotite dacite. Maximum exposed thickness 130 m

Dacite of Thurston Lake (Pleistocene)—Two or possibly three coalesced flows, domes, and minor pyroclastic deposits of moderately porphyritic dacite. Most specimens contain one or more 1-cm-diameter or larger fragments and blocks up to 15 cm diameter of diabasic-textured mafic inclusions. Exposed thickness about 250 m

Dacite of Pinkeye Lake (Pleistocene)—Flows and domes of moderately porphyritic dacite. Base not exposed; thickness at least 200 m; probably is younger than the dacite of Plum Flat (dpf). Age of 0.48±0.03 Ma. Maximum thickness about 200 m

Dacite of Clearlake Highlands (Pleistocene)—Flows of moderately porphyritic dacite; lacks diabase-textured mafic inclusions. Interbedded with and overlain by the Lower Lake Formation (ll). Age of 0.52±0.06 Ma. Maximum exposed thickness 50 m

Rhyodacite of Peacock Point (Pleistocene)—Flow or domes of moderately porphyritic rhyodacite. Probably older than the dacite of Clearlake Highlands (dhi). Exposed thickness about 20 m

Older basin deposits (Pleistocene)

Basin deposits of lower Thurston Creek—See description under central area and Mount Konocti

Obsidian

Lower Lake Formation (named by Rymer, 1981; includes basin deposits of Wildcat Canyon of Hearn and others, 1976) (Pleistocene)—Lacustrine, marsh, fluvial, pyroclastic, and volcaniclastic deposits in an ancestral Clear Lake basin. West of and at Lower Lake, composed of dominantly sandstone and siltstone and lesser amounts of claystone, diatomaceous siltstone, conglomerate, and tuff; conglomerate contains pebbles and cobbles of chert, andesite, dacite, and Great Valley sequence (Kdgv). Northeast of Lower Lake, unit contains beds of pebbly lisaalliferous limestone up to 1 m thick and numerous beds of tuff and lapilli tuff of mafic to silicic composition up to 1.3 m thick (Rymer, 1981). North of Lower Lake, unit contains siliceous siltstone and mudstone, which commonly have root casts and diatom and gastropod fossils, and also contains 0.3–3-m-thick beds of orange limonitic mudstone that are espec