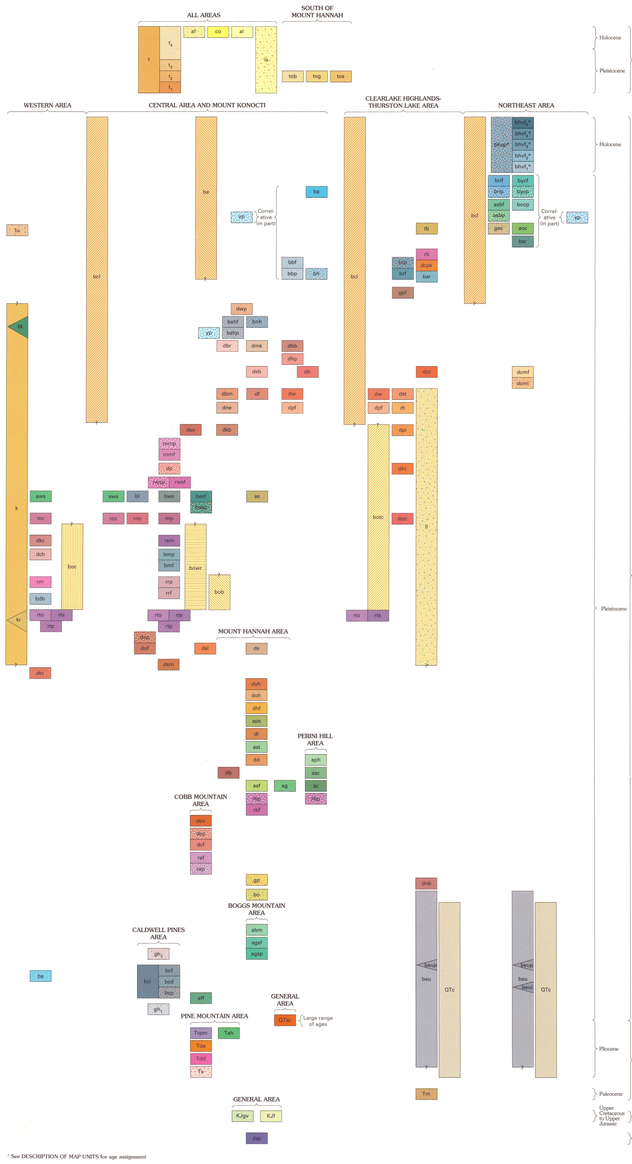
CORRELATION OF MAP UNITS



* See DESCRIPTION OF MAP UNITS for age assignment

DESCRIPTION OF MAP UNITS

[This map supersedes I.I.S. Geological Survey Open-File Report 76–751 (Hearn and others, 1976). Descriptions of map units are grouped by geographic areas 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 areas underlain by the Sonoma Volcanics, Franciscan assemblage, and Great Valley sequence (Kgv) 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-grained unless the 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 Marvinmen and others (1978, 1981) or were determined in the field by R.C. Hearn, Jr., using a portable fluxgate magnetometer. Maximum thickness of units is unknown unless specified. Thicknesses 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 (lbo)

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 dacite 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 Kelsey Creek—Pebble to small boulder-size gravel. Contains clasts of the andesite of Boggs Mountain (atm), rhyodacite of Diener Drive (dd), obsidian from the rhyolite of Bonanza Springs (rbp), andesite of Split Top Ridge (atr), rhyodacite of Lumley Ridge (ald), 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 the rhyolite of Cobb Mountain (dot, dcp), dacite of Cobb Valley (dcv), and rhyolite of Alder Creek (raf, rap) that locally are up to 3 m diameter. Source to east and southeast; deposited in an ancestral Kelsey Creek drainage. Maximum thickness 20 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 greywacke clasts of the Franciscan assemblage (Kfr), as well as pebbles reworked from Franciscan assemblage conglomerates. 15 percent clasts of the rhyodacite of Cobb Mountain (dot, dcp), and 5 percent clasts of the rhyolite of Alder Creek (raf, rap). Locally contains 2–3 m thick beds of sand and silt derived from tuff of lacustrine diatomite. Similar gravels occur in sec. 5, T. 11 N., R. 8 W. Source to south and southwest; deposited in an ancestral Alder Creek drainage. Maximum thickness 25 m

WESTERN AREA

Basin deposits of Clear Lake (Holocene and Pleistocene)—See description under central area and Mount Konocti. Shown only in cross section

t_{sf} — **Upland terrace deposits (named by Soil Mechanics and Foundation Engineers, Inc., 1965) west of Alder Creek (Holocene to Pleistocene)**—Poorly stratified sand, gravel, gravelly clay, and clayey sand. Occurs in Big Valley in a small fault-block bounded on the south by the Wight Way fault and on the north by an unnamed fault; fault boundaries to the south form Soil Mechanics and Foundation Engineers, Inc. (1967). Extent and age poorly known; apparently overlies the Kelseyville Formation (k) and is older than high terrace deposits (t_4). Thickness 34 to 44 m (Rymer, 1978, p. 85)

k — **Kelseyville Formation, undivided (named by Rymer, 1981; includes pyroclastic and lake deposits)**—Well-bedded, lacustrine, deltaic, and fluvial deposits consisting of pebble-cobble gravel, sandy gravel, sand, silt, diatomaceous siltstone, claystone, punriceous sandstone, and tuff. Clasts in conglomerates are 80–95 percent Franciscan assemblage rocks (chert, greenstone, greywacke of Kfr) and serpentinite (Jap), and 5–20 percent volcanic rocks from the dacite of Cobb Valley(?) (dcv), rhyolite of Alder Creek (raf, rap), andesite of Boggs Mountain (atm), and obsidian (rbo) from the rhyolite of Thurston Creek. Clasts are derived from terrain to the south, southeast, or southwest. The formation was deposited in an ancestral Clear Lake basin. The Kelseyville Formation is probably co-extensive with similar deposits concealed at depth in Big Valley and beneath Clear Lake. Wood (sample number W-3420, U.S. Geological Survey Radiocarbon Laboratory, Reston, Va.) and a conifer cone (dated by Yokohama laminates, M.J. Rymer, oral commun., 1979) found 45 and 3 m below the base of the Kelsey Tuff Member in sec. 26 and sec. 27, T. 13 N., R. 9 W., respectively, are both older than 38,000 yr by the carbon-14 method. Age of the exposed base of the Kelseyville Formation is approximately 0.60 Ma, based on the average age of the rhyolite of Thurston Creek (Donnelly-Nolan and others, 1981); age of exposed top of the Kelseyville Formation is estimated to be 0.13 Ma by Rymer (1981), but is more likely 0.35 to 0.45 Ma based on ages of probable sources of the Kelsey Tuff Member on or south of Mount Konocti. Upper part of the Kelseyville Formation is eroded and lower part is unexposed; thickness in map area about 390 m; minimum total thickness about 500 m (Rymer, 1981)

ks — Kelsey Tuff Member (named by Rymer, 1981; formerly augite ash of Hearn and others, 1976)—Upper part consists of 40–170 cm of poorly bedded, unsorted, grey to light-tan ash, lapilli, lapilli tuff, and tuff of crystal-poor, slightly vesicular basaltic andesite; lower part consists of 10–40 cm of interbedded tuff, claystone, and siltstone. Upper part is composed of 20–30 percent basaltic andesite fragments, and 5 percent lithic fragments (dacite, greenstone, chert, greywacke, and, rarely, diabasic-textured rhyolite fragments); average basaltic andesite fragment 0.5 cm diameter, maximum generally 6 cm. Basaltic andesite fragments contain about 1 percent small Franciscan assemblage inclusions. Lower part typically contains sparse to rare pumice lapilli and thin Howard Peak and Buckingham Peak. Probably overlain by the rhyodacite of Homestead Bay (dhb). Exposed thickness 250 cm

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 Cache Creek of Hearn and others, 1976) (Pleistocene)**—Flow of moderately porphyritic hornblende dacite. Possible source vent concealed 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

dch — **Dacite of Konocti Bay (Pleistocene)**—Flows and domes of moderately porphyritic dacite; contains clasts of basaltic andesite of Ely Flat. In sec. 21, T. 13 N., R. 8 W. Exposed thickness about 200 m

dcv — **Dacite of Shad Valley (Pleistocene)**—Dornal flows of sparsely porphyritic hornblende-biotite dacite. Probably overlain by the dacite of Cobb Valley(?) and by the Wight Way fault and on the north by an unnamed fault; fault boundaries to the north by Soil Mechanics and Foundation Engineers, Inc. (1967). Extent and age poorly known; apparently overlies the Kelseyville Formation (k) and is older than high terrace deposits (t_4). Thickness about 130 m

dbr — **Rhyodacite of Bonnie Brae (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 (rmv), and is overlain by the rhyodacite of Cobb Valley (dcv) and Kelseyville Formation (k). Biotite-hornblende dacite of normal magnetic polarity in S1/2 sec. 26, T. 13 N., R. 9 W. Maximum exposed thickness about 90 m

dwp — **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 lithic fragments in a pilotaxitic groundmass. Surfaces of flows on east slope of Wright Peak show arcuate flow ridges, which are known locally as "lava rings" (Mauldin, 1960). Overlies the basaltic andesites south of Howard Peak (bxhf, bxhp) and north of Howard Peak (bxh). Younger dacite unit on Buckingham Peak: Maximum thickness 150 m

dbr — **Dacite of Benson Ridge (Pleistocene)**—Flows of coarsely porphyritic biotite dacite. Contains 10–20 percent of 1–25-mm-diameter subrounded fragments of vesicular olivine-rich basalt that, in part, have cores of olivine phenocrysts, and 0–20 percent of separate olivine crystals and fragments of vesicular or solid, phenocryst-poor andesite of unknown derivation that become more abundant at top of exposure. Overlies the basalt of Lake Pillsbury Formation (k). Possibly similar in age to the olivine basalt of Caldwell Pines (bxf, bxt, bxp, bxp) based on relative abundance of olivine. Exposed thickness 10 m

CENTRAL AREA AND MOUNT KONOCTI

Younger basin deposits (Holocene to Pleistocene)

bcf — Basin deposits of Clear Lake—Shown only in cross section. Deltaic, lacustrine, marsh, and marginal fluvial deposits composed of gravel, sand, silt, clay, mud, peat, and diatomite. Upper part (Rymer, 1981). Age ranges from present to greater than 0.175 Ma based on paleomagnetic and preliminary potassium-argon data (Donnelly-Nolan, unpub. rept; Perkins, 1981). Lower part may overlie or grade into the Kelseyville (k) and Lower Lake (ll) Formations. Maximum thickness 20 m

be — 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 Cache Creek. Age ranges from present to probably less than 0.5 Ma. Exposed thickness about 25 m; drilled thickness about 120 m

yf — **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, greywacke, and shale from the Franciscan assemblage (Kfr) and Great Valley sequence (Kgv). Unit consists dominantly of airfall deposits (rarely reworked by water or by slumping) and contains lesser amounts of mass deposits from underwater or subaerial eruptions (based on presence of mud-armored lapilli and distinct bomb sags) and base-surge deposits. Sources are: (1) inferred vents suggested by alignment of hydrothermally altered Clear Lake shoreline, by lake-bottom topography, and by localized pyroclastic deposits along the lake shore; (2) Sulphur Mound Mine (bwm); (3) inferred vent north-northwest of the Bell Mine; and (4) cinder cones east of Clearlake Oaks. Map unit probably correlates in part with ash beds in sediments beneath Clear Lake; youngest ash bed beneath Clear Lake is in core 7 taken from Harwell Water Power Point and Pirates Cove and is about 11,000 years old (Sims, Adam, and Rymer, 1981); oldest part is near Bell Mine, is apparently overlain by the basaltic andesite south of Howard Peak (bxhf, bxhp), and is about 0.35 Ma. Maximum exposed thickness about 60 m

bxhf — Basaltic andesite of Howard Peak—Flow(?) of blocky aa 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 Shad Valley (dsv); possibly contemporaneous with the basaltic andesite of Lower Lake Road (bl). Exposed thickness about 50 m

bxhp — Flows

Pyroclastic deposits—Bomb, block, and lapilli tephra

bxwh — **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 (rbs) of the rhyolite of Thurston Creek and rhyodacite of Sulphur Mound Mine (dsm), overlain by the rhyolite west of Sugarloaf (rwsp) and dacitic pyroclastic deposit north of McIntire Creek (dp). Maximum thickness about 10 m

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

bxh — **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 subrounded, partly fused, 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 (bxhf, bxhp); overlain by the rhyodacite of Wright Peak (dwp) and probably by the basaltic andesite of Buckingham Peak (bbt, bap). Maximum exposed thickness about 10 m

dmk — **Dacite of Mount Konocti (Pleistocene)**—Flows of medium-grained, moderately porphyritic dacite, commonly hydrothermally bleached. Sparse plagioclase and quartz phenocrysts are 1–3 mm in size, in contrast with the larger phenocrysts in other dacite and rhyodacite units. Age high on Mount Konocti: Potassium-argon is 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 great vertical extent (Mauldin, 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 and domes of coarsely porphyritic biotite dacite. Contains 10–20 percent of 1–25-mm-diameter subrounded fragments of basaltic-andesite-to-dacite composition, and 5 percent of 1–10-cm-diameter, subangular fragments of chert, blocks of biotite rhyolite absent. Overlies the rhyolite of Thurston Creek; clasts in breccia at base probably are from the rhyolite of Thurston Creek. Cuts flow (bmf) of the basaltic andesite of McIntire Creek. Maximum thickness about 200 m

dsb — **Rhyodacite of Soda Bay (Pleistocene)**—Flows and domes of coarsely and abundantly porphyritic biotite rhyodacite. Contains 1–5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

dsb — **Dacite of Buckingham Bluffs (Pleistocene)**—Flow of moderately porphyritic dacite. Contains 0.5–2 percent, 1–5-mm-diameter gneissose-plagioclase mafic inclusions. Source vent concealed 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 10–20 percent of 1–25-mm-diameter, subangular fragments of the dacite of Benson Ridge (dbr), 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. Contains 1–5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

dmh — **Dacite south of McIntire Creek (formerly rhyolite of Hildebrand Springs of Hearn and others, 1976) (Pleistocene)**—Vent breccia of pumice lapilli, pumice blocks, fused-pumice breccia, and obsidian composed of sparsely porphyritic rhyolite. Fused pumice breccia contains part of border of vent. Obsidian closely resembles obsidian (rbs) of the rhyolite of Thurston Creek. Cuts flow (bmf) of the basaltic andesite of McIntire Creek. Exposed thickness 20 m

bmf — **Basaltic andesite of McIntire Creek (Pleistocene)**—Sparsely porphyritic basaltic andesite. Maximum thickness about 80 m in eastern part of unit, about 30 m in western part of unit

bmp — Pyroclastic deposits—Bomb, block, and lapilli tephra forming subdued, eroded cinder cone; basaltic andesite in cinder cone is slightly more olivine rich than in flows

bmv — Flows

rhyolite of Red Hill Road (Pleistocene)—Porphyritic biotite-feldspar rhyolite. Age of 0.50±0.02 Ma on sanidine

rmp — Pyroclastic deposits—Coarse bomb and block tephra composed of pumice and perlitic blocks as much as 1.5 m diameter and diabasic-textured andesite inclusions as much as 30 cm diameter. Lapilli tephra and ash absent. Unit contains more abundant phenocrysts than flow and is slightly younger(?) than flow (rmv)

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

rmp — 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 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 (sla) or Mount Olive (dot, dop), diabasic-textured mafic inclusions up to 40 cm diameter, fragments of basaltic andesite, and rare fragments and blocks up to 15 cm diameter of fine- to black glassy rhyolite 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 greywacke averaging 6 mm diameter, and abundant clear quartz grains of 1–3 mm diameter

bsf — **Basaltic andesite of Lower Lake Road (Pleistocene)**—Flows, coarse blocks and bombs, and pyroclastic breccia of sparsely porphyritic basaltic andesite. Overlies and contains partially melted inclusions of the rhyodacite of Mount Olive (dop, dof) and rhyolite northeast of Mount Olive (rne). Maximum exposed thickness 50 m

bsa — **Basaltic andesite east of Shad Valley (Pleistocene)**—Basaltic andesite. Contains vesicular, 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 Shad Valley (dsv); possibly contemporaneous with the basaltic andesite of Lower Lake Road (bl). Exposed thickness about 50 m

bsaf — Flows

Pyroclastic deposits—Bomb, block, and lapilli tephra

bwsh — **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 (rbs) of the rhyolite of Thurston Creek and rhyodacite of Sulphur Mound Mine (dsm), overlain by the rhyolite west of Sugarloaf (rwsp) and dacitic pyroclastic deposit north of McIntire Creek (dp). Maximum thickness about 10 m

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

bpdk — **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 subrounded, partly fused, 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 (bxhf, bxhp); overlain by the rhyodacite of Wright Peak (dwp) and probably by the basaltic andesite of Buckingham Peak (bbt, bap). Maximum exposed thickness about 10 m

dmk — **Dacite of Mount Konocti (Pleistocene)**—Flows of medium-grained, moderately porphyritic dacite, commonly hydrothermally bleached. Sparse plagioclase and quartz phenocrysts are 1–3 mm in size, in contrast with the larger phenocrysts in other dacite and rhyodacite units high (1) on Mount Konocti: Potassium-argon is 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 great vertical extent (Mauldin, 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 biotite dacite. Contains 10–20 percent of 1–25-mm-diameter subrounded fragments of basaltic-andesite-to-dacite composition, and 5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

dsb — **Rhyodacite of Soda Bay (Pleistocene)**—Flows and domes of coarsely and abundantly porphyritic biotite rhyodacite. Contains 1–5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

dsb — Pyroclastic deposits—Bomb, block, and lapilli tephra

dsm — **Rhyodacite of Sulphur Mound Mine (Pleistocene)**—Flow or dome of moderately porphyritic biotite rhyodacite. Contains 1–5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

rne — **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(?) depart 1–3 m thick, composed of 90–95 percent biotite rhyolite fragments up to 30 cm diameter and 5–10 percent dacite and andesite gravel west of Shad Valley (ava). Biotite rhyolite occurs in drill holes beneath Cache Flat and at 125 ft depth in NE1/4 sec. 15, T. 13 N., R. 9 W. in Big Valley. Apparently overlies the rhyodacite of Mount Olive (dot, dop); overlain by the Kelseyville Formation (k) and dacite of Benson Ridge (dbr); cut by dikes of the andesite west of Shad Valley (ava). Age of 0.54±0.02 Ma on sanidine. Maximum exposed thickness 80 m

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

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

bpdk — **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 subrounded, partly fused, 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 (bxhf, bxhp); overlain by the rhyodacite of Wright Peak (dwp) and probably by the basaltic andesite of Buckingham Peak (bbt, bap). Maximum exposed thickness about 10 m

dmk — **Dacite of Mount Konocti (Pleistocene)**—Flows of medium-grained, moderately porphyritic dacite, commonly hydrothermally bleached. Sparse plagioclase and quartz phenocrysts are 1–3 mm in size, in contrast with the larger phenocrysts in other dacite and rhyodacite units high (1) on Mount Konocti: Potassium-argon is 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 great vertical extent (Mauldin, 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 biotite dacite. Contains 10–20 percent of 1–25-mm-diameter subrounded fragments of basaltic-andesite-to-dacite composition, and 5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

dsb — **Rhyodacite of Soda Bay (Pleistocene)**—Flows and domes of coarsely and abundantly porphyritic biotite rhyodacite. Contains 1–5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

dsb — Pyroclastic deposits—Bomb, block, and lapilli tephra

dsm — **Rhyodacite of Sulphur Mound Mine (Pleistocene)**—Flow or dome of moderately porphyritic biotite rhyodacite. Contains 1–5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

rhyolite of Cole Creek (Pleistocene)—Flow or flows, coarse blocks and bombs, coarse pyroclastic breccia, and lapilli tephra, and pyroclastic surge deposits of 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 dacite and andesite gravel west of Shad Valley (ava). Biotite rhyolite occurs in drill holes beneath Cache Flat and at 125 ft depth in NE1/4 sec. 15, T. 13 N., R. 9 W. in Big Valley. Apparently overlies the rhyodacite of Mount Olive (dot, dop); overlain by the Kelseyville Formation (k) and dacite of Benson Ridge (dbr); cut by dikes of the andesite west of Shad Valley (ava). Age of 0.54±0.02 Ma on sanidine. Maximum exposed thickness 80 m

dsb — **Rhyodacite of Soda Bay (Pleistocene)**—Flows and domes of coarsely and abundantly porphyritic biotite-hornblende rhyodacite. Contains 1–5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

dsb — Pyroclastic deposits—Bomb, block, and lapilli tephra

dsm — **Rhyodacite of Sulphur Mound Mine (Pleistocene)**—Flow or dome of moderately porphyritic biotite rhyodacite. Contains 1–5 percent of 1–10-cm-diameter, subangular fragments of chert, siltstone, sandstone, and chert from the Franciscan assemblage (Kfr) and the Great Valley sequence (Kgv). Erupted either from the vent for the rhyolite south of McIntire Creek (rmv) or from a separate, unidentified vent on Benson Ridge

Older basin deposits (Pleistocene)

boc — Basin deposits southeast of Camel Back Ridge—Poorly exposed lacustrine, alluvial, and minor pyroclastic deposits in small local basin. Consists of silty claystone, diatomaceous siltstone, and lapilli tuff of rhyolitic pumice. Unit contains fragments of pumice and perlitic rhyolite like that of Milky Creek; also contains 1–3-cm-diameter pebbles of vesicular gray dacite, abundant 1–3-mm-diameter quartz, and sparse 1-mm-diameter biotite flakes. Lapilli tuff of crystal-rich biotite rhyolite pumice is locally cemented by siliceous sinter. Probably overlies obsidian (rbc) of the rhyolite of Thurston Creek and steeply tilted beds of the Kelseyville Formation (k) on the north side of basin. Exposed thickness about 2 m; maximum thickness probably about 20 m

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

bobb — Basin deposits of lower Thurston Creek—Well-bedded lacustrine and deltaic deposits composed of clay, silt, diatomaceous siltstone, punriceous 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, greywacke, shale, and the glassy rhyodacite of Diener Drive (dd). North of Manning Flat, basal part contains locally derived boulder conglomerate of obsidian (rbs) 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

bob — 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 (rbs) of the rhyolite of Thurston Creek; may be contemporaneous with the basin deposits of lower Thurston Creek (bobt) 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 (rwsp) of the rhyolite west of Sugarloaf, obsidian (rbo) of the rhyolite of Thurston Creek, and rhyolite northeast of Mount Olive (rne). Maximum thickness about 200 m

rhyolite of Thurston Creek (Pleistocene)—Coarse bomb and block tephra and lapilli tuff. Contain sparse obsidian fragments and, close to source vent, contain blocks of vesicular biotite rhyolite up to 1.5 m in diameter

mwsf — Flows—Small lateral extent

dcp — **Dacitic pyroclastic deposit north of McIntire Creek (Pleistocene)**—Lithic pumiceous breccia. Contains blocks of bi