U.S. DEPARTMENT OF THE INTERIOR
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Geologic Map of the Lockwood Valley Quadrangle, Ventura County, California
Version 1.0

by

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards or with the North American Stratigraphic Code

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DESCRIPTION OF MAP UNITS

Qa **Alluvium (Holocene)--**Silt- to boulder-size, moderately rounded to well-rounded, moderately sorted to well-sorted sediments forming channel and overbank deposits in modern floodplains. Maximum thickness greater than 5 m

Qc **Colluvium (Holocene)**—Poorly sorted angular boulders, cobbles and pebbles in light-brown clay, silt, and sand matrix. Derived from downslope movement of weathered bedrock. Includes minor alluvium in small channels and sheetwash on steeper hillsides. Maximum thickness less than 10 m

Qac **Alluvium, loess, and colluvium, undifferentiated (Holocene)--**Mapped where modern alluvium in small channels and sheetwash alluvium on gentle slopes are intimately intermixed with, or difficult to differentiate from, colluvium and loess. Deposits are poorly bedded, non-indurated to slightly indurated, dark brown to light-gray-brown clay, silt, sand, pebbles, and cobbles that mantle gently to moderately sloping surfaces and are intermixed by downslope movement. Colluvium derived from downslope movement of weathered bedrock. Loess is composed of very fine-grained air-transported sand, silt, and minor clay. Deposits commonly capped by poorly to moderately developed soil profile. Many smaller deposits not mapped. Maximum thickness probably less than 10 m

Qls **Landslide deposit (Holocene**)--Ranges from chaotically arranged debris to almost intact slumped blocks of bedrock. Younger deposits maintain hummocky topography; older deposits are dissected and rounded. About 10 m to greater than 50 m thick

Qt **Talus (Holocene)**--Angular and subangular cobbles and boulders at base of cliffs or steep hillsides. Contains boulders as large as 2 m. Maximum thickness greater than 10 m

Qdf **Debris-flow deposit (Holocene and upper Pleistocene)**—Unsorted to poorly sorted, unconsolidated bouldery, matrix-supported deposit of local origin formed by sediment-dominated flow. Holocene deposits in Mutau and Piru Creeks have preserved levees and boulder-rich surface. Inferred upper Pleistocene debris-flow deposit in and adjacent to Sec. 6, T. 7 N., R. 20 W. is highly dissected and composed of angular to subangular gneiss clasts. Thickness as much as about 30 m

Qlo **Older landslide deposit (upper? Pleistocene)**--Chaotic mixture of reddish-brown Lockwood Clay and green clay, sandstone, and minor sandy clay of uppermost Caliente Formation. Forms a mottled reddish-brown and green deposit. Mostly dissected. Lobate deposit mapped along western boundary of quadrangle, where it has a maximum thickness of about 30 m

Qoa **Older alluvium (upper? Pleistocene)**--Alluvial gravel in abandoned and dissected stream channel of ancestral San Guillermo Creek; course altered by stream capture and now is as much as 85 m below elevation of older alluvium deposits. Deposits mostly covered by fine-grained colluvial material and loess and locally capped by well-developed soil profile. Thickness difficult to assess, but probably as great as about 25 m

Qbd **Boulder diamicton (Pleistocene)**—Unsorted to poorly sorted, massive to poorly stratified, unconsolidated deposit containing subangular to subrounded clasts of local origin--mostly granite of Lockwood Peak (Kgl) and, subordinately, Frazier Mountain augen gneiss (aag) Clasts are as long as 3 m, although most are considerably smaller. Matrix is pale-tan grus (decomposed granitic material). Forms hilly topography. Mapped by Dibblee (1979) in most places as boulder gravel member of Miocene Caliente Formation, but in places overlies Quatal Formations of Pliocene age. Inferred to correlate with "terrace deposits" of Carman (1964). Debris inferred to have been shed from crystalline thrust sheets during south-directed thrusting of Frazier Mountain and South Frazier Mountain thrusts, which were active as recently as the early Pleistocene (Dibblee, 1982). Thickness as much as about 100 m

Qhc **High-level conglomerate (lower? Pleistocene)**—Well-rounded to subrounded light-tan, matrix-supported conglomerate; poorly indurated. Very well rounded cobbles less than 20 cm long; a few cobbles that are between 20-30 cm long are subrounded. Cobbles consist of about 70 percent granitic rocks and 30 percent sandstone. Deposit mantles flat ridge top, mostly in Sec. 32 and Sec. 33, T. 8 N., R. 20 W. (northeast corner of quadrangle); unconformably overlies sandstone and conglomerate of Seymour Creek. Less than 20 m thick

Quatal Formation (Pliocene)—Poorly to moderately indurated fluvial sequence of claystone, siltstone, sandstone, and conglomerate that conformably overlies the Lockwood Clay. No diagnostic fossils or dated material have been found in the formation, but latest Miocene age for the uppermost Caliente Formation (James, 1963) suggests Pliocene age for the formation, which is divided into the following informal members:

Tqc **Sandstone and conglomerate member—**Lower approximate 50 m is cream-colored, poorly indurated, arkosic, pebbly coarse-grained sandstone. Upper exposed 100 m is a poorly indurated cobble and boulder conglomerate with an orange-brown arkosic matrix; clasts are subrounded to well rounded, as large as one meter in diameter, and consist mostly of granitic rocks and subordinate felsic gneiss; apparent lack of dark augen gneiss clasts (aag) suggests that unit predates emplacement of Frazier Mountain thrust sheet. Contact with underlying sandstone and siltstone member gradational and approximately located. Included with Member Two of the Quatal Formation of Carman (1964). Total thickness greater than about 150 m

Tqa **Arkose member**--Coarse-grained, poorly sorted, light orange-brown to orange arkosic sandstone, conglomerate, and minor claystone. Approximately equivalent to Member 3 of Quatal Formation of Carman (1964). Top is not exposed, but total preserved thickness greater than 300 m

Tqs **Sandstone and siltstone member**--Buff, cream, and yellowish-brown silty, arkosic sandstone and pebbly conglomerate; poorly to moderately indurated. Locally contains brownish claystone beds and thin to knobby white limestone lenses. Clasts include granitic rocks, biotite gneiss similar to Frazier Mountain augen gneiss, and intermediate volcanic rocks. Beds are typically 0.5-2 m thick. Overlies Lockwood Clay near Seymour Creek (sec. 31, T. 8 N., R. 20 W.). Relationships to other Quatal members hidden by surficial deposits; may be in fault contact with other units (across buried Lockwood Valley fault of Carman, 1964). Weathers to a powdery (when dry) yellowish soil. Encompasses part of Member 2 of Quatal Formation of Carman (1964)

Tqb **Brown member**--Brown and reddish-brown sandy mudstone, siltstone, sandstone, and pebbly conglomerate; poorly to moderately indurated. Beds typically tabular and 0.5-2 m thick. Clasts include granitic rocks, biotite gneiss similar to Frazier Mountain augen gneiss (aag), and intermediate volcanic rocks. Approximately equivalent to part of Members 2 of Carman (1964). Thickness 150-330 m

Tqg **Green claystone and sandstone member**--Medium- to coarse-grained gray-green silty and clayey sandstone and pebbly conglomerate; minor claystone beds, which become more numerous near base. Clasts include granitic, metamorphic and volcanic rocks. Beds typically 1 to 3 m thick. Conformable above Lockwood Clay; pinches out in north part of quadrangle along the western border. Of all members of Quatal formation, this unit most closely resembles type section of Quatal Formation (Hill and others, 1958) in Ballinger Canyon, about 20 km northwest of northwest corner of quadrangle, which consists mostly of laminated, gray-green, locally gypsiferous, lacustrine claystone. Equivalent to Member 1 of Quatal Formation of Carman (1964). Total thickness 0-180 m

Tlc **Lockwood Clay (Pliocene or Miocene**)--Reddish-brown, massive clay. Age is poorly constrained by fossils found just below unit about 15 km northwest of quadrangle (reported in Carman, 1964). X-ray analysis indicates clay is almost entirely montmorillonite, with a small amount of kaolin (Carman, 1964). Unconformable on Caliente Formation. Weathers to red-brown clayey soil with sparse vegetation, except for wild onions (*Allium howellii* var. *clokeyi*) and buckwheat (*Erigonium ordii* and *Erigonium trichopes* var. *hooverii*). Protolith uncertain, but may be strongly altered tuff (Carman, 1964). Basal disconformity or a very-low-angle unconformity above the Caliente Formation. Thickness 0-50 m (typically about 30 m thick in quadrangle)

Tc **Caliente Formation, undifferentiated (Miocene)**—Pale gray-green, gray, and pale tan, poorly to well stratified, poorly to moderately consolidated, interbedded conglomerate, sandstone, siltstone, and claystone. Most deposits are fluvial. Commonly forms fluted badland topography. Middle

Hemingfordian to Hemphillian (late early to latest Miocene) fossils collected from the Caliente Formation in the Cuyama Badlands, about 20 km west of quadrangle (James, 1963; Kelley and Lander, 1988). Basalt flows in the type Caliente Formation, about 45 km northwest of quadrangle in the Caliente range, have recalculated K/Ar ages of 14.6-14.8 Ma (Turner, 1970), and a tuff from the middle of the Caliente Formation, collected from Dry Canyon, about 10 km west of quadrangle, has a recalculated K/Ar age of 15.6 Ma (James, 1963). Poorly exposed in most places in quadrangle, except in northwest corner. Base not exposed in quadrangle, but probably as much as 500 m. Maximum observed thickness in Lockwood Valley region about 700 m (Carman, 1964). In map area, divided into the following informal members:

Tcs **Green claystone and sandstone member**—Medium- to coarse-grained, gray-green clayey and silty sandstone, pebble and cobble conglomerates and interbedded claystone. Conformably underlies the Lockwood Clay. Unit resembles green claystone and sandstone member of Quatal Formation. Maximum exposed thickness about 325 m

Tcg **Granite-clast breccia member**—Poorly to moderately stratified, light-gray bouldery sedimentary breccia deposit consisting mostly of moderately rounded to subrounded boulders of coarse-grained granite (Mt Pinos granite or granite of Lockwood Peak [Kgl]). Contains subordinate clasts of Frazier Mountain augen gneiss (aag). Mapped only near western margin of quadrangle. Thickness in quadrangle about 50 m; much thicker to west in San Guillermo Mountain quadrangle (Minor, 1999)

Juncal Formation (Eocene)—Pale-yellow-weathering arkosic sandstone, conglomerate containing well-rounded pebbles and cobbles, and micaceous, fissile shale. Deposited in marine environment. Clasts predominantly felsic to mafic volcanic rocks and subordinately granite and red-brown chert. Weathered outcrops commonly limonite-stained along joints. Margin of Juncal depositional basin crosses southern part of Lockwood Valley quadrangle, where mostly sandstone and conglomerate is depositional on granite of Lockwood Peak (Kgl). Includes conglomerate and sandstone beds in thrust-bounded slices of South Frazier Mountain thrust system near San Guillermo Creek. Benthic foraminifera collected in quadrangle and in adjacent San Guillermo Mountain quadrangle are Ulatisian (middle Eocene); foraminifera assemblage indicate rocks deposited in water as deep as about 2,000 m (Stanley and others, 1998; Minor, 1999). Cumulative thickness in region greater than 3,000 m. In map area, divided into the following informal members:

Tjm **Mixed shale and sandstone member**—Interbedded light-tan, sandy, platy-weathering, micaceous, rusty-weathering shale, siltstone, and thin (typically less than 5 m thick) beds of tan, ledgy arkosic sandstone

Tjs **Sandstone member**—Pale-yellow weathering, moderately to poorly bedded, moderately well-sorted, moderately to well indurated, arkosic sandstone;

locally includes thin shale and siltstone interbeds and conglomeratic lenses containing volcanic, granitic, and chert pebbles

Tjc **Conglomerate member—**Interbedded pale-yellow sandstone containing pebbles and cobbles, and well rounded, clast-supported conglomerate. Clasts as much as 30 cm in diameter

Kqm **Quartz monzonite of Sheep Creek (Upper Cretaceous)**—Medium-grained, light-gray, hypidiomorphic, equigranular, quartz monzonite and granodiorite. Contains about 35 percent quartz, 35 percent oligoclase, 20 percent microcline, 5-8 percent biotite, 1 percent muscovite, 2-3 percent opaque minerals, and trace zircon and apatite. Forms irregular, volumetrically subordinate dikes and pods in granodiorite of Lockwood Peak; most exposures are not mapped. Weathers to light tan, rounded to angular blocky outcrops

Kgl **Granodiorite of Lockwood Peak (Upper Cretaceous)**—Coarse-grained, equigranular to porphyritic, hypidiomorphic granodiorite and subordinate quartz monzonite. Contains about 20 percent undulatory quartz, 25-50 percent zoned plagioclase (about An_{27}), 5-35 percent microcline 5-10 percent biotite, 10 percent hornblende, 1-2 percent sphene, 1 percent opaque minerals and trace apatite and zircon. Most exposures are equigranular, but potassium-feldspar megacrysts as long as 2 cm locally comprise as much as 20 percent of rock. Commonly weathers to light-tan grus and well-rounded boulders. Includes unmapped dikes and irregular bodies of quartz monzonite of Sheep Creek. Concordant uranium-lead zircon age of coarse-grained phase is 76.05$\pm$0.22 Ma (W.R. Premo, unpublished data, 1997; Stanley and others, 1998); sample site indicated on map, near center of quadrangle in Sheep Creek

aag **Frazier Mountain augen gneiss (Lower Proterozoic)**—Dark-gray to almost black, well-foliated to massive, xenomorphic augen gneiss, containing white to pink microcline porphyroblasts as long as 5 cm (most are less than 2 cm). Contains approximately 30-35 percent undulatory quartz, 40 percent sodic plagioclase, 10-15 percent microcline (almost entirely as augens), 10-20 percent biotite, 2-5 percent muscovite, 1 percent opaque minerals, and traces of apatite, zircon, and, rarely, garnet. Protolith is igneous as evidenced by: 1) microcline augens in massive (relatively unstrained) gneiss that are nearly euhedral, indicating relict porphyritic texture, and 2) dikes of augen gneiss that intrude quartzofeldspathic gneiss. Gneiss has discordant, upper-intercept uranium-lead zircon age of 1690$\pm$5 Ma (W.R. Premo, unpublished data, 1997; Stanley and others, 1998); sample site is in SE $^1/_4$ Sec. 31, T. 8 N., R. 20 W., near confluence of Seymour and Lockwood Creeks

abg **Biotite gneiss (Lower Proterozoic)—**Dark-gray to black, fine- to medium-grained, xenomorphic, well-foliated gneiss and schist. Contains approximately same percentage minerals as Frazier Mountain augen gneiss (aag), from which it was derived by high shear strain. Augens highly elongated in tectonic transport direction and commonly define either lensoidal crystal aggregates of microcline or ribbony leucocratic quartz-feldspar bands. Forms common sharp contacts with Frazier Mountain augen gneiss along shear boundaries. In places, contact with augen gneiss indistinct, but biotite gneiss generally differentiated from augen gneiss where ribbony texture is present and augens are mostly comminuted to fine- to medium-grained banded mosaics. Ductile shearing may be associated with previously recognized major orogenic episode in region at 1425-1450 Ma (Silver, 1971)

aqfg **Quartzofeldspathic gneiss (Lower Proterozoic)**—Fine- to medium-grained, tan to gray, commonly banded gneiss containing approximately 35-40 percent quartz, 40 percent sodic plagioclase (oligoclase), 10-30 percent microcline, 2-10 percent biotite, and traces of muscovite, zircon, apatite, and opaque minerals. Darker, more biotite-rich bands as thick as 2 cm. Unit is greenish in places due to alteration of feldspar to sericite and biotite to chlorite. Gneiss intruded by igneous protolith of Frazier Mountain augen gneiss. Protolith probably sandstone or felsic tuff that was deposited in region about 1750-1690 Ma (Silver, 1971)

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