Geologic Map of the Sawmill Mountain Quadrangle, Kern and Ventura Counties, California (Version 1.0)

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The data were compiled from unpublished mapping. One review was performed by Paul Stone.

DESCRIPTION OF MAP UNITS

Qlsr **Recent landslide deposits (Holocene)**—Mostly unsorted, unstratified debris deposited by recent and potentially active landslides. Deposits commonly have hummocky topography. Landslide scar partially vegetated to unvegetated, indicated landsliding less than several tens of years old. About 10-20 m thick

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

Qac **Alluvium and colluvium (Holocene)**-- Mapped where modern alluvium in small channels and sheetwash alluvium on gentle slopes are intimately intermixed with, or difficult to differentiate from, colluvium. 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 is derived from downslope movement of weathered bedrock. Includes minor loess deposits. Deposits commonly capped by moderately developed to well-developed soil profile. Many smaller deposits not mapped. Maximum thickness probably less than 10 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

Qw **Wetland deposits (Holocene)**—Brown to black, organic-rich water-saturated soil in generally flat areas, commonly containing standing water. Overgrown in places with willows and other water-intensive plants

Qls **Landslide deposits (Holocene and/or upper Pleistocene)**--Ranges from poorly sorted, unstratified to poorly stratified clay- to boulder-size consolidated debris. In places, includes almost intact slumped blocks of bedrock as long as several tens of meters. Younger deposits maintain hummocky topography and have identifiable breakaway scarp; older deposits are deeply dissected, with rounded topography. Thickness about 10 m to greater than 50 m

Qf1 **Younger fan deposits (Holocene)**—Mostly alluvial gravel underlying topographically lowest surface in San Andreas rift valley. Contains clasts as large as boulders. Includes minor debris-flow deposits. Base not exposed, but may locally be thicker than 50 m

Qf2 **Older fan deposits (Holocene? and upper Pleistocene)**—Mostly alluvial gravel containing clasts as large as boulders on surface about 30 m above younger fan deposits (unit Qf1). Deposit is locally dissected, especially west of Apache Saddle where deposits are also modified by landsliding. Thickness less than about 30 m

Qf3 **Highly dissected fan deposits (middle? Pleistocene)**—Occupies elevated surfaces along crests of some ridges, especially on north face of Mount Pinos in northeast quarter of quadrangle. Contains clasts as large as boulders. Thickness as much as about 50 m

Qd **Diamicton (middle? Pleistocene)**—Unsorted to poorly sorted, unstratified to poorly stratified, poorly consolidated deposits containing clasts as large as boulders. Mapped on south flank of Mt. Pinos; believed to be highly dissected remnants of debris-flow deposits and alluvial fans. Clasts of local origin include granitic and gneissic rocks from Mt. Pinos and recycled clasts from Caliente Formation. Unit is as thick as about 30 m

Qae **Alluvium of San Emigdio Mesa (middle? Pleistocene)**—Light tan, poorly sorted, poorly consolidated, poorly bedded sandy alluvium containing clasts as large as boulders (some as long as 6 m) that caps gently sloping San Emigdio Mesa on the east side of Cerro Noroeste. Clasts all locally derived. Forms fanglomerates shed from Mt. Pinos. Deeply dissected along flanks. Tentatively correlated (Davis, 1983) with the 0.13 to 0.45 Ma Riverbank Formation of the northeastern San Joaquin Valley (Marchand and Allwardt, 1981). Thickness as much as 60 m

Units South of San Andreas Fault

QTm **Morales Formation (Pleistocene and Pliocene)—**Light-gray to light-brownish-gray, medium- to coarse-grained fluvial mudstone, arkosic and lithic sandstone, pebbly sandstone, and conglomerate. Sand and lithic grains consist of quartz, feldspar, polycrystalline quartz, and volcanic rocks. Clasts consist of granitic rocks, sandstone, gneiss, volcanic rocks, chert, and quartz. Beds generally planer, typically 0.5 to 2 m thick. Unit is not well exposed in quadrangle and contact with similar rocks of the upper Quatal Formation is indistinct. Contact with Quatal mapped by projecting better-defined relationships in adjacent Apache Canyon quadrangle (P. Stone, 2000) into the Sawmill Mountain quadrangle. Age of the Morales based on sparse Blancan (Pliocene) vertebrate fossils collected northwest of quadrangle (Vedder, 1970) and from an ash near top of exposed unit in Apache Canyon quadrangle, tentatively identified as either the Bishop ash (~0.76 Ma) or ash of Glass Mountain (~0.8-1.2 Ma) (A.M. Sarna-Wojcicki, written commun., in Stone, 2000). Maximum exposed thickness in quadrangle about 330 m

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 Quatal. Formation divided into the following two informal members:

Tqb **Brown member**—Light brown to medium-brown sandy mudstone, siltstone, sandstone, and pebbly conglomerate; poorly to moderately indurated. Beds typically tabular and 0.5-2 m thick. Clasts predominantly granitic rocks, intermediate volcanic rocks, quartz and sandstone. In southwest corner of quadrangle, beds interbedded with thin, dark-brown or reddish-brown clayey sandstone beds about 5-10 cm thick, creating a striped appearance. Weathers to a light-tan sandy soil. Approximately equivalent to part of Members 2 of Carman (1964); equivalent to Morales Formation of Ziony (1958). Top not exposed in quadrangle but thickness is greater than 150-330 m

Tqw **White arkosic sandstone member**—Light-grayish-tan and creme-colored, poorly to moderately consolidated arkosic claystone, siltstone, and pebbly sandstone. Clasts as large as 30 cm (most much smaller) are predominantly granitic rocks, but also contain 5-10 percent intermediate volcanic rocks and

10-20 percent basalt. Sand grains typically 40 percent quartz, 45 percent plagioclase, 10 percent potassium feldspar, and 5 percent lithic fragments. Beds mostly planar with low-angle crossbeds. Interbedded light-brown clayey beds and light-tan sandy beds, each about 1-5 m thick, form striped appearance. Weathers to a light-tan, fine-grained sandy soil. Unlike Caliente Formation, does not form badland topography. Equivalent to the Nettle Spring Formation of Ziony (1958). Conformable above Lockwood Clay. Unit is as thick as about 210 m; pinches out abruptly to south in southwest corner of quadrangle

Tlc **Lockwood Clay (Pliocene?)**-- Reddish-brown, poorly consolidated, massive clay. X-ray analysis indicates clay is almost entirely montmorillonite, with a small amount of kaolin (Carman, 1964). Unconformable on Caliente Formation. Age is poorly constrained by fossils found just below unit in upper Caliente Formation in Dry Creek (James, 1963). 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) or deeply weathered loess deposit (P.L. Ehlig, personal commun., 1998). Base of unit is disconformable or forms a very-low-angle unconformity above the Caliente Formation. Placed in the lowermost part of Quatal Formation by Hill and others (1958). Thickness 0-50 m; typically about 30 m thick in quadrangle

Tc **Caliente Formation, undifferentiated (Miocene)—**Fluvial conglomerate, sandstone, siltstone, and claystone that typically forms well-developed badland topography. Deposits are fluvial. Commonly forms fluted badland topography. Vertebrate fossils indicate age is Middle Hemingfordian to Hemphillian (late early to latest Miocene) (James, 1963; Kelley and Lander, 1988). Basalt flows in the type Caliente Formation, about 35 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 in southwest part of quadrangle, has a recalculated K/Ar age of 15.6 Ma (James, 1963). In Dry Canyon, vertebrate fossil zones indicate that the top of the Caliente beneath Lockwood Clay youngs to the northwest (James, 1963). The Caliente disconformably overlies Granite of Mt. Pinos in south part of quadrangle, where it is as much as 500 m thick. Caliente Formation, undifferentiated, shown only on cross-section AA’, beneath Abel Mountain thrust. In map area, divided into seven informal members. Maximum observed thickness in Lockwood Valley region, immediately to the southeast of quadrangle, about 700 m (Carman, 1964)

Tcu **Upper Caliente Formation, undifferentiated—**Orange, light-tan, pale gray-green, and gray, poorly to well stratified, poorly to moderately consolidated, interbedded conglomerate, sandstone, siltstone, and claystone. Conformably overlies sedimentary breccia and sandstone of Cowhead Potrero in northwest part of quadrangle. Mapped only in northwest part of quadrangle beneath Abel Mountain thrust; correlation with Caliente units in Dry Canyon region unknown. Top of unit truncated by Abel Mountain thrust. Thickness greater than 250 m

Tcp **Sedimentary breccia and sandstone of Cowhead Potrero**—Dark-red, purple-gray, and reddish-tan, weakly bedded to massive, poorly sorted sedimentary breccia and sandstone. Matrix is argillaceous sandstone. Clasts are subrounded to angular, as long as about two meters, and consist entirely of units of local origin from south of the San Andreas fault (Ziony, 1958): granitic and gneissic rocks, and Pelona schist. No fossils known from member. Mapped as a separate formation by Ziony (1958), the Cowhead Potrero Formation. Base of unit not exposed, but is at least 450 m thick (Ziony, 1958)

Tcw **White sandstone and conglomerate member**—Interbedded white, light-gray, light-brown and light orange-brown, poorly sorted, locally silty, poorly to moderately indurated sandy mudstone, fine to medium-grained sandstone, and minor pebbly conglomerate. Grades downward from light gray to light orange brown; base of member locally marked by prominent white, 1-m-thick silty bed. Sparse vertebrate fossils indicate Hemphillian (latest Miocene) age (James, 1963; Kelley and Lander, 1988). Immediately beneath Lockwood Clay in Dry Canyon; overlies red sandstone and siltstone member. Thickness variable; as thick as about 50 m, but pinches out to east in quadrangle

Tcr **Red sandstone and siltstone member**—Red-brown, reddish-gray, and gray poorly to moderately indurated, clayey pebbly sandstone and conglomerate, grading locally into sandy clay. Contains well-rounded clasts as long as 10 cm. Interbedded red and gray beds form conspicuous striped appearance. Locally gypsiferous. In places, forms spectacular badlands topography, with numerous spires and closed depressions drained by well-developed piping. Lenses of brown-red, almost pure clay resembles Lockwood Clay. Abundant vertebrate fossils in Dry Canyon indicate a late Barstovian to late Clarendonian (late middle to early late Miocene) age (James, 1963; Kelley and Lander, 1988). Thickness variable; as thick as 275 m but pinches out to south

Tcc **Volcanic-clast conglomerate member**—Gray-brown, light buff, and greenish-brown clayey and silty sandstone and conglomerate. Clast well rounded, as long as 25 cm, and composed predominantly of intermediate to felsic volcanic rock; pink and purple felsite particularly common. Also contains clast of fine-grained to medium-grained granitic rocks, quartzo-feldspathic gneiss, quartz, and basalt. Lies conformably above and locally interfingers with granite-clast breccia member. Thickness in quadrangle variable and difficult to estimate; probably locally as thick as 1,000 m

Tcg **Granite-clast conglomerate member**—Poorly stratified, light-gray bouldery sedimentary breccia deposit consisting mostly of moderately rounded to subrounded boulders of coarse-grained granite (granite of Mt. Pinos or granite of Lockwood Mountain; Kellogg, 1999) as long as 2 m. Contains subordinate and generally smaller clasts of augen gneiss, quartzo-feldspathic gneiss, and volcanic rocks. Unconformably overlies granite of Mt. Pinos (unit Kgp), Eocene shale (unit Tmsh), and Plush Range Formation, but conformably overlies arkosic member of the Caliente Formation in southwest part of quadrangle. Thickness in quadrangle highly variable; ranges from 50 m to greater than 1,000 m thick

Tca **Arkosic member**—Orange-brown, poorly to moderately indurated, ledgy, silty arkosic sandstone and conglomerate. Includes lenses as thick as 50 cm of granitic-clast conglomerate containing clasts as long as 25 cm. Locally contains as much as 30 percent volcanic clasts. Color derived from underlying lacustrine member of the Plush Range Formation, which unconformably underlies the arkosic member. Crops out only near southern boundary of quadrangle. Thickness as much as 70 m

Plush Ranch Formation (lower Miocene and upper Oligocene)—The formation was first described in detail and named by Carman (1964). Cole and Stanley (1995) subsequently adopted the formation as a formal stratigraphic unit with a type section established along North Fork of Lockwood Creek in the Sawmill Mountain quadrangle. Cole and Stanley (1995) interpreted the Plush Ranch Formation as a lacustrine fan-delta sequence that formed during lower Miocene and upper Oligocene extension. The age is based on radiometric dates reported for the intercalated basalt flows (Frizzell and Weigand, 1993). Divided into:

Tps **Sandstone member**—Light-gray-brown, orange-brown, and olive-brown, flaggy to blocky, well indurated, medium- to coarse-grained, sandy mudstone, well-sorted arkosic sandstone, and subordinate pebble and cobble conglomerate; clasts mostly granitic with lesser amounts of gneiss and minor quartzite. Beds planar and 0.5-10 m thick. Interbedded light-gray-brown moderately consolidated sandy siltstone. Interpreted as alluvial-plain deposits and subaqueous fan-delta deposits (Cole and Stanley, 1995). The subaqueous fan-delta deposits consist mostly of thin- to medium-bedded, laterally continuous sandstone beds and interbedded mudstone, with Bouma (turbidite) sequences. The alluvial-plain deposits consist mostly of medium- to coarse-grained, well-sorted sandstone, with interbeds of pebble to cobble conglomerate, siltstone, and mudstone. Corresponds approximately to Carman's Plush Ranch members 1 and 2. Thickness variable; as much as 820 m thick

Tpbx **Granite-megabreccia member**—Gray, massive, poorly sorted, well consolidated, clast-supported, almost monolithologic breccia; clasts mostly angular blocks of Granite of Mt. Pinos as long as 10 m (15 m reported by Bohannon, 1976); less than 2 percent of clasts are aplitic to medium-grained granite. Matrix, where preserved, consists of medium- to coarse-grained grusy sandstone. Contact with surrounding mostly mudstone beds of the lacustrine member (Tpl) is sharp; indents underlying beds, indicating soft-sediment deformation during deposition. Interpreted as rockslide deposits that slid into subaqueous sediments of unit Tpl (Cole and Stanley, 1995). Unit forms oval-shaped outcrops as wide as 80 m and as long as 700 m

Tpl **Lacustrine member**—Light-olive-brown to orange-brown, commonly fissile shale and siltstone, evaporites, and fine- to very-fine-grained sandstone. Sandstone is thin-bedded, ledgy, tan, well consolidated, laterally continuous, and normally graded; some soft-sediment deformation in finer-grained beds.

Weathers yellowish tan. Orange-brown beds predominate in western exposures of unit. Near base of sequence, in and east of North Fork Lockwood Creek, are white, greenish, and light-brown ribbony clay, mudstone, and interbedded laminar fine- to medium-grained light-brown sandstone. Locally contains lenses of pebble conglomerate; pebbles almost entirely granite and gneiss. Near top of unit are thin-bedded (1 to 8 cm) closely spaced gypsum beds interbedded with dark-brown mudstone; this sequence is about 25 m thick. In eastern exposures, thin limestone and shale beds are interbedded with borax-bearing evaporite minerals, mostly colemanite, which was mined until World War I (Carman, 1964). Corresponds approximately to Plush Ranch members 3, 4, and 4a of Carman (1964). Interpreted as basin-center lacustrine deposits (Cole and Stanley, 1995). Thickness variable

Tpba **Basalt member**—Black, medium- to fine-grained, locally vesicular basalt flows and sills. Contains about 65 percent calcic plagioclase (An_{50}), 20 percent clinopyroxene, 15 percent olivine, partially altered to iddingsite, and 5 percent opaque minerals. Plagioclase forms small phenocrysts as long as 2 mm. Mostly massive; faint pillow structures reported at some localities (Carman, 1964; Cole and Stanley, 1995). Weathers to dark-brown sandy grus-like soil containing abundant basalt clasts. Flows or sills locally interlayered with subaqueous mudstone and evaporite deposits. Corresponds to part of member 4 of Carman (1964). Potassium-argon ages for the basalt range from 20.9 + 0.9 to 26.5 + 0.5 Ma (Frizzell and Weigand, 1995), or Late Oligocene to Early Miocene. Maximum thickness in quadrangle about 200 m

Tpb **Granite- and gneiss-breccia facies**—Light- to dark-gray massive to poorly stratified conglomerate and interbedded, moderately to well bedded medium-grained to pebbly creme-colored arkosic sandstone. Clasts in conglomerate are angular to subrounded and as long as 2 m and are composed of varying proportions of Cretaceous granite of Lockwood Peak (Kellogg, 1999) and Precambrian Frazier Mountain augen gneiss (Carman, 1964; Kellogg, 1999), both derived from southeast of northeast segment of Big Pine fault. Clast size decreases to north, which, along with clast imbrication (Cole and Stanley, 1995), also indicate source to southeast. Interpreted as coarse-grained fan-delta deposits adjacent to basin-bounding normal fault, proposed to exist at site of present northeast segment of Big Pine fault (Cole and Stanley, 1995). Corresponds to Carman's Plush Ranch member 5. Base of unit not exposed. Thickness variable but maximum thickness greater than 375 m just south of quadrangle (Minor, 1999)

Tpbn **Gneiss-breccia facies**—Similar to granite-and-gneiss breccia facies, except that greater than 80 percent of clasts are of Frazier Mountain augen gneiss

Ts **Simmler Formation (lower Miocene to upper Eocene)**—Massive to poorly bedded light-tan, maroon and orange-red, moderately well indurated to well-indurated sandstone and pebble to cobble conglomerate. Tan colors predominate, but locally unit is brick red or contains lensoidal red beds in overall light-brown or tan sequence. Beds as thick as about 10 m generally are not laterally continuous. Highly polymictic clasts, as long as 60 cm, consist of well rounded to subrounded granitic rocks, intermediate volcanic rocks, basalt, chert, and quartz. Basalt locally comprises as much as about 10 percent of clasts. Exposed only near bottom of Santiago Creek adjacent to San Andreas fault in northwest corner of quadrangle. Unit is fault bounded and neither base nor top is exposed in quadrangle. No fossils have been found in the Simmler and the age could be as young as early Miocene and as old as late Eocene (Vedder, 1975). Maximum thickness in quadrangle about 450 m

Tmsh **Marine shale (lower Eocene)**—Black to dark-brown fissile, marine, micaceous siltstone and shale with minor fine- to medium-grained, thin-bedded, tabular, brown, muddy sandstone. Contains black dolomitic concretions as long as 2 m. Bedding in finer-grained rocks commonly indistinct. Locally contains abundant mollusks. Shale weathers to light brownish gray and is rusty-colored along abundant joint surfaces. Early Eocene age and tentative correlation with extensive Juncal Formation to the southwest of quadrangle (Kellogg, 1999) is based on abundant mollusks and benthic foraminifera (Squires, 1988; the Juncal represents a transgressive sequence coeval with global early Eocene sea-level rise). Unit was deposited on deeply weathered granite of Mt. Pinos, but base of unit is faulted against granite, indicating either minor normal movement, probably coeval with southward tilting of sequence, or, more likely, due to Quaternary gravitational spreading of granite of Mt. Pinos (Kellogg, in press). Unit overlain unconformably by rocks of Plush Ranch Formation. One measured section about 200 m east of North Fork of Lockwood Creek was 605 m thick (Squires, 1988)

Tmy **Sawmill Mountain mylonite (Paleocene?)**— Greenish-gray to dark-green, very well indurated augen-rich mylonite along the trace of the Sawmill Mountain thrust fault. The rock is mostly chloritic and grades structurally upward into chloritic gneiss. Base is ribbony, with thin white quartz stringers. In most places, the contact between mylonite and structurally underlying unmylonitized Pelona schist is sharp. The degree of mylonitization generally decreases upward, although locally there are several discrete mylonite zones over a 100-m vertical range. There is considerable brittle deformation near the structural top of the mylonite zone, with small offsets in the mylonitic fabric and many slickensided surfaces. Lower few meters contain mylonitized Pelona schist, but most of protolith of the mylonite is hanging-wall gneiss, as shown by abundant augens of quartz, feldspar, and quartz-feldspar intergrowths. Greenschist-grade metamorphism and ductile deformation along the Sawmill Mountain fault reflect mid-crustal conditions during movement, which most likely predates regional uplift and deposition of unmetamorphosed lower Eocene rocks in the area. The Sawmill Mountain fault is correlated with the Vincent-Orocopia-Chocolate Mountain thrust system of southern California (Crowell, 1962; Jacobson and others, 2000) which is thought to be Late Cretaceous or Paleocene in age (Ehlig, 1968). An early Paleocene metamorphic age for the Pelona Schist requires that the mylonite be no older than Paleocene. The total thickness of the mylonite varies greatly and is as much as about 140 m

Tps **Pelona Schist (early Paleocene)**—Silvery-gray to rusty brownish-gray, medium-grained quartzo-feldspathic schist and micaceous quartzite. Typically contains 30-60 percent quartz, commonly as porphyroblasts as long as about 4 mm containing many small inclusions, 15-20 percent albite, 10-20 percent muscovite, 2-20 percent biotite, 10 percent epidote, 2-5 percent calcite, trace to 2 percent garnet, and traces of zircon and opaque minerals. Grades in a few places into micaceous quartzite; Davis (1983) reports small lenses of talc-actinolite schist, although not observed during mapping for this study. Bedding is parallel to foliation at all locations, based on common presence of graded beds. Generally shallow, east-dipping lineation defined by micaceous streaks on foliation surfaces. Correlated with the Pelona-Orocopia-Rand Schist in eastern California, across the San Andreas fault (Ehlig, 1968; Haxel and Dillon, 1978; Jacobson and others, 2000). The metamorphic age of the Pelona-Orocopia-Rand Schist is Paleocene or latest Cretaceous (Haxel and Dillon, 1978). A preliminary $^{40}Ar/^{39}Ar$ age on muscovite from the map area (location C) is 63.24±0.26 Ma; a $^{40}Ar/^{39}Ar$ age on biotite from the same locality is 56.66±0.15 Ma. The muscovite age is believed to be a better representation of the true metamorphic age for the sample

Kpb **Metabasalt**—Dark greenish-gray, massive, fine-grained, holocrystalline metabasalt. Contains about 65 percent chlorite, 20 percent quartz, 8 percent opaque minerals, 3 percent biotite, 2 percent calcite, 1 percent euhedral clinopyroxene, and 1 percent large (1 mm) garnets. Forms small prominent, blocky outcrop on ridge in SE ¼, Sec. 21T. 9 N., R. 21 W.

Kgp **Granite of Mt. Pinos (Cretaceous)**—Coarse-grained to very coarse grained, pink to pinkish-gray, massive, porphyritic granite. Contains approximately 10-25 percent quartz, 50-70 percent microcline, mostly as subhedral phenocrysts as long as 2 cm, 15 percent plagioclase, 3-10 percent biotite, commonly clumped and surrounding the microcline phenocrysts, and traces of sphene, zircon, and opaque minerals. Mostly forms grusy outcrops and soil. Outcrops blocky with many joints directions. Unit on Mt. Pinos undated, but correlated with very similar coarse-grained granite of Mt. Lockwood in Lockwood Valley quadrangle, several kilometers to the southeast of the quadrangle, which is dated by U-Pb zircon analysis at 76.05±0.22 Ma (Kellogg, 1999; analysis by W.R. Premo).

Kgpb **Border phase**—Gray, medium- to coarse-grained, massive to moderately well foliated, equigranular granodiorite or quartz diorite forming a relatively mafic border to granite of Mt. Pinos. Contains about 50 percent plagioclase, 25 percent quartz, 0-10 percent microcline, 15 percent biotite, 15 percent blue-green (in thin section) amphibole, 1 percent large sphene, and traces of zircon and opaque minerals. Unit clearly indicates that granite of Mt. Pinos is intrusive into other granititoid phases

Kgro **Orange granite (Cretaceous)**—Medium-grained, equigranular, very weakly foliated, tan biotite granite, containing in hand sample about 25 percent quartz, 65 percent white feldspar and 8 percent biotite. No thin sections prepared. Weathers into distinctive, orange-tan, rounded outcrops. Mapped only on west side of Cerro Noroeste near quadrangle boundary. Unit is undated but similar to dated Cretaceous granitic rocks

Kgrn **Granite of Cerro Noroeste (Cretaceous)**—Mostly medium-grained, massive to strongly foliated, light-gray, biotite granodiorite or quartz monzonite. Locally coarse grained. Grades into layered biotite gneiss, in which black biotitic layers interpreted to be planes of high strain. Typically contains 15-35 percent quartz, 25-50 percent plagioclase (An_{25}), 10-30 percent microcline, 5-20 percent biotite, 2-4 percent muscovite, trace-2 percent sphene, trace-1 percent garnet, and traces of zircon, apatite, and opaque minerals. Cut by numerous aplite and pegmatite dikes. Weathers into tan blocky outcrops. Preliminary $^{40}Ar/^{39}Ar$ age on biotite (location D) is 67.2$\pm$0.5 Ma

Kgdg Granodiorite gneiss (Cretaceous)—Gray to dark-gray, medium-grained to coarse-grained, massive to well foliated, equigranular to porphyritic granodioritic to tonalitic orthogneiss. Phenocrysts commonly deformed and sheared into augen. Grades into zones with well-defined light and dark layers, depending on biotite content, by ductile shearing and recrystallization. Relatively massive orthogneiss contains 25-30 percent quartz, 30-50 percent plagioclase (about An_{30}), 0-20 percent microcline, 10-20 percent biotite (much higher in some sheared schistose layers), 0-5 percent hornblende, 0-3 percent muscovite, 0-2 percent opaque minerals, and traces garnet, zircon, and apatite. Preliminary $^{40}Ar/^{39}Ar$ age on biotite (location E) is 65.9$\pm$ 0.2 Ma

KXgb Granite of Cerro Noroeste and biotite gneiss, undivided (Cretaceous and Lower Proterozoic?)—Mapped where medium-grained foliated biotite granite similar to granite of Cerro Noroeste (unit Kgrn) is intimately interlayered with layered biotite gneiss, similar to that of unit Xbg. Interpreted as injection of Cretaceous granite into highly strained, slightly older biotite gneiss

KXmg Migmatitic biotite gneiss (Cretaceous and lower Proterozoic?)—Biotite gneiss (same as unit Xbg) interlayered with abundant (greater than about 10 percent by volume) leucocratic quartzofeldspathic melt phase in layers mostly 1-5 cm thick. Many of these migmatitic layers were injected from external sources (Cretaceous granitic rocks), although others apparently derived by *in situ* partial melting, as shown by mafic residual selvages adjacent to melt layers (Johannes, 1988). Cut by numerous aplite and pegmatite dikes, many of which are presumed Cretaceous in age

JXqz Quartzite (Jurassic?, Triassic? and (or) Lower Proterozoic?)—White, vitreous, medium-grained, well-foliated quartzite. Forms small inlyers in granite of Cerro Noroeste (unit Kgrn) and mixed unit KYgb. Age unknown, but probably either early Mesozoic or Early Proterozoic

JXma Marble (Jurassic?, Triassic? and (or) Lower Proterozoic?)—Gray, medium-grained, well-foliated marble in small inlyers in granite of Cerro Noroeste. Age unknown, but probably either early Mesozoic or Early Proterozoic

Xbg Biotite gneiss (Lower Proterozoic?)—Gray and black, layered biotite gneiss. Leucocratic layers contain quartz, plagioclase, microcline (generally less than plagioclase), and biotite. Locally contains hornblende and is interlayered with streaks and pods of amphibolite. Melanocratic layers contain as much as 60 percent biotite. Layers are mostly 0.1-20 cm thick; typically 1-5 cm thick. Lineation defined by fold axes, mineral alignment and boudins; interpreted as ductile-stretching direction. Locally migmatitic and cut by numerous aplite and pegmatite dikes. Protolith may be part of 1750-1680 Ma supracrustal assemblage identified in the western Transverse Ranges that was subsequently deformed during high strain associated with major orogenic episode at 1425-1450 Ma (Silver, 1971)

.**Xbhg Biotite-hornblende gneiss (Lower Proterozoic?)**—Gray to black, medium-grained, very well foliated biotite-hornblende gneiss and schist. No thin sections prepared. Contains numerous black amphibolitic pods and interlayered black biotite schist. In places, contains deformed feldspar augen. Commonly cut by rusty joint surfaces. May represent relatively mafic, strongly sheared phase of biotite augen gneiss (unit Xag)

Xag Biotite augen gneiss (Lower Proterozoic?)—Dark-gray, moderately to well foliated, xenomorphic augen gneiss, containing white microcline porphyroblasts as long as about 3 cm. Contains approximately 30-35 percent undulatory quartz, 40 percent sodic plagioclase, 10-15 percent microcline (almost entirely as augen), 10-20 percent biotite, 2-5 percent muscovite, 1 percent opaque minerals, and traces of apatite, zircon, and, rarely, garnet. Protolith probably igneous, as shown by unsheared, nearly euhedral microcline augen, indicating relict porphyritic texture. Unit similar to augen gneiss of Frazier Mountain (Kellogg, 1999), which has a discordant, upper-intercept uranium-lead zircon age of 1690$\pm$5 Ma (W.R. Premo, unpublished data, 1997; Stanley and others, 1998)

Rocks north of San Andreas fault

Tt Temblor Formation (middle? Miocene)—Black to dark-gray, platy, silicic, rusty-weathering, marine siltstone and shale, and interbedded gray to gray-brown, medium-grained, well indurated, medium-bedded to very thick bedded carbonate-cemented arkosic arenite to feldspathic wacke. Sandstone cross bedded, locally with normal-graded bedding. Weathers to chocolate-brown soil containing abundant platy shale chips. On basis of sedimentary structures, sequence on south side of San Emigdio Mountain is overturned, in agreement with Crowell and others (1964) and Dibblee (unpublished mapping, 1980). This interpretation has silicic shaly beds grade upsection into sandstone beds. However, this interpretation is in disagreement with Ziony (1958) and Davis (1983), who interpreted sequence as upright, with sandstone-dominated beds grading up section into black silicic shales suggestive of Monterey Formation. No identifiable fossils have been recovered from the unit, although similar beds overlie lower Miocene beds to the northwest and have therefore been interpreted as middle Miocene in age (Ziony, 1958). Neither top nor bottom of sequence exposed in quadrangle; total exposed thickness about 1,000 m

TKmbx Mylonite breccia (lower Tertiary to Cretaceous?)—Pale green, gray, and brick red, very well indurated siliceous mylonite and mylonite breccia. Mylonitic bands appear as ribbony layers, locally in alternating pink and pale green bands. Contains abundant granitic clasts. Two periods of deformation are indicated: 1) shearing and mylonitization accompanied, or shortly followed by, silicification and chloritization, 2) shallower-level brecciation. Alteration and silicification similar to that in green silicified sedimentary rocks (unit Kgbx). Bounded by thrust faults. Protolith is granitic rock, which suggests that deformation and alteration is Cretaceous or younger

Kgr Granitic rocks (Cretaceous)—Light-gray, medium- to coarse-grained, equigranular, biotite quartz diorite, granodiorite, and monzogranite. At many places forms complex of small intrusive bodies into metasedimentary roof pendants and inlyers. Mapped in thrust-bounded blocks near crest of San

Emigdio Mountains. Poorly exposed at most localities, where unit weathers to light-tan grusy soil. Mostly equivalent to granite of Brush Mountain (Ross, 1989), with minor granodiorite of Lebec (Ross, 1989)

Kgd **Quartz diorite and granodiorite (Cretaceous)**—Gray, medium-grained to coarse-grained, equigranular, massive to moderately foliated quartz diorite, tonalite, and granodiorite. Contains 8-30 percent quartz, 0-30 percent microcline, 30-50 percent plagioclase, 5-15 percent biotite (commonly altered to chlorite), 0-20 percent hornblende, and traces to 1 percent opaque minerals, garnet, zircon, sphene, and epidote. Forms cliffs, rocky hillsides, and weathered grusy surfaces. Preliminary $^{40}Ar/^{39}Ar$ age on hornblende (location F) is 99.8$\pm$0.85 Ma. Approximately equivalent to granite of Brush Mountain and granodiorite of Lebec of Ross (1989), which were not differentiated on this map

Metamorphic rocks in roof pendants and inliers in granitic rocks (Jurassic, Triassic, and (or) Paleozoic)—Davis and Duebendorfer(1987) correlated these rocks with Jurassic and Triassic rocks in roof pendants in the Kings Canyon region of the Sierras (Saleeby and others, 1978). However, Ross (1989) suggests these rocks may be as old as Paleozoic. Consists of:

MzPzhf **Hornfels**—Greenish-gray to black hornfels and subordinate thin-bedded fine-grained quartz-rich micaceous sandstone

MzPzms **Meta-sandstone**—Dark gray and grayish-tan micaceous, fine- to medium-grained, laminated meta-sandstone and subordinate dark-brown and black hornfels. Laminations represent relict bedding. Mica is muscovite, locally giving rocks a silvery appearance

MzPzmw **White marble**—White, medium- to coarse-grained, mostly massive calcitic marble. Occurs as border phase of gray marble adjacent to granitic bodies; grades into gray marble. Formerly quarried locally for ornamental stone (mostly white gravel due to pervasive fracturing)

MzPzmg **Gray marble**—Gray, medium-grained strongly foliated calcitic marble in roof pendants and inlyers in granitic bodies

MzPzqz **Quartzite—**Gray, fine- to medium-grained, well-indurated, mostly foliated quartzite. Locally contains as much as about 10 percent muscovite. Feldspar and quartz content also varies and rock locally grades into meta-sandstone. Occurs as roof pendants and inlyers in granitic rocks

Rocks in the San Andreas fault zone

QTgo **Fault gouge (Holocene to Miocene)—**Yellow-tan, light green-brown, and brown, poorly indurated, very poorly sorted cataclastic material containing clasts that range in size from clay to boulders. Consists of a variety of rock types, including granitic rocks, sandstone, and quartzite. Easily eroded and underlies much of the San Andreas rift valley. Produced by intermittent slip and cataclasis along numerous splays of the San Andreas Fault. Movement along the San Andreas fault in the western Transverse Ranges began about 10-12 Ma (Crowell, 1979) so some fault gouge may have been generated as long ago as Miocene time

Twa **White arkosic sandstone and conglomerate (Miocene?)**—White to very pale tan, massive to poorly stratified, arkosic sandstone and conglomerate. Beds very thick, commonly more than 10 m. Contains large crossbeds and channel fills. About 10 percent of unit is matrix-supported conglomerate, containing moderately rounded to well rounded clasts as long as about 30 cm of Eocene? sandstone, intermediate to mafic volcanic rocks, granitic rocks, dark-purple quartzite, gneiss, and quartz. Matrix contains angular grains of quartz, feldspar, and sparse biotite. Contains a few thin (typically 1-10 cm) discontinuous, olive-brown silty stringers. Weathers very distinctively into massive, rounded, white outcrops. Dips steeply at all localities. Unit is fault bounded and total thickness unknown. Minimum thickness in quadrangle about 300 m. Correlated with Caliente Formation by Davis (1983) and Davis and Duebendorfer (1987), but unit is very distinct from recognized facies of Caliente.

Kgbx **Green silicified metasedimentary rocks (Cretaceous?)**—Pale-green, fine-grained to very coarse grained, very well indurated, massive to well bedded silicic siltstone, sandstone, conglomerate, and sedimentary breccia. Clasts predominantly fine-grained quartz, quartzite, or chert, but also include granitic rocks, black limestone, quartz, and basalt. Gray quartzite clasts are as long as 8 cm and clasts of granite as long as 20 cm. Graded bedding common. Matrix arkosic and overgrown by secondary epidote, chlorite, actinolite, and silica, indicating greenschist-facies metamorphism. Cut by numerous small white quartz veins. Lower age limit unknown, but assumed to be younger than that suspected of roof pendants. Unit bounded by faults. Occurs in two places just north of densest faulting of the San Andreas fault system. In the eastern outcrop, the section is overturned and rock becomes more massive and coarser grained upsection. In the western outcrop, the section is also overturned and consists of hard, quartz-rich meta-sandstone and meta-siltstone consisting of about 80 percent angular quartz grains and about 10 percent angular chert. Neither base nor top of unit exposed; unit is greater than about 150 m thick

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