Geologic Map of the Reyes Peak Quadrangle, Ventura County, California

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

[1]Denver, Colorado

DESCRIPTION OF MAP UNITS

af **Artificial fill (Holocene)**—Mappable areas of soil-rock aggregate fill used for construction of Highway 33 near west edge of map area.

Qaa **Active alluvium (Holocene)**—Poorly sorted, poorly bedded, unconsolidated gravel, sand, silt, and clay. Gravel clasts are angular to rounded; sand grains are fine to very coarse. Unit mapped in channels of large, active stream washes; includes low (< 1 m) terrace deposits. Deposits are prone to flooding during periods of heavy precipitation and lack any appreciable soil development. Average thickness of active alluvium deposits less than 5 m.

Qa **Very young alluvium (Holocene)**—Very similar to active alluvium (Qaa) except that deposits form slightly higher stream terraces (up to about 3 m) that may be capped by weakly developed soils. Deposits rarely experience flooding. Locally may include minor deposits of active alluvium (Qaa) or very young alluvium and colluvium (Qac) that are too small to map separately. Unit mapped along margins of large active washes, where deposits are estimated to have an average thickness of about 5 m.

Qac **Very young alluvium and colluvium (Holocene)**—Poorly sorted to nonsorted, poorly bedded to nonbedded, unconsolidated to weakly consolidated blocks, gravel, sand, silt, and clay. Deposits underlie open swells and valley floors where they form broad, smooth, undissected to weakly dissected surfaces. Colluvium generally concentrated near bedrock uplands. Some low-lying deposits are vulnerable to flooding during periods of high precipitation; soil development generally is weak. Clasts are angular to rounded. Gravel is commonly silty to sandy. Unit includes broad, low-profile fan aprons that flank bedrock uplands, slope-wash deposits, alluvial terrace deposits, and in the larger valleys, loess deposits; also may include local, small deposits of young alluvium and colluvium (Qyac) too small to map separately. Most extensive and thickest (as much as 50 m?) deposits underlie canyon floors in Cuyama Badlands in northern part of map area.

Qls **Landslide deposits (Holocene)**—Poorly consolidated and poorly sorted landslide debris (blocks, gravel, sand, silt, and clay) in deposits commonly forming hummocky topography along or near base of steep bedrock slopes; arcuate headwall scarps are commonly preserved in or adjacent to the upper parts of the deposits. Composition of debris varies depending on source rock; large landslide deposits near central-eastern edge of quadrangle and on north flank of Pine Mountain are composed predominantly of Matilija Sandstone (Tma), whereas large landslide deposits concentrated on south flank of Pine Mountain (southwest part of quadrangle) are derived from shale- and siltstone-rich intervals of the Juncal Formation (Tjm and Tjsh). Largest landslide deposits as thick as 125 m.

Qya **Young alluvium (Holocene and Pleistocene?)**—Poorly sorted, poorly to moderately bedded, weakly to moderately consolidated gravel, sand, silt, and clay. Gravel clasts are angular to rounded. Sand and gravel are locally silty or clayey. Deposits are confined to the lower Alamo Creek, Wagon Road Canyon, and Reyes Creek trunk stream drainages south of and straddling the Big Pine fault where they form weakly to moderately dissected alluvial terraces whose upper surfaces rest as much as 12 m above adjacent active stream beds. Moderately developed soils commonly cap the terrace deposits. Deposits locally include minor amounts of colluvium where they lap against stream-canyon walls. Unit commonly distinguished from old (Qoa and Qoac) and very young to active (Qac, Qa, and Qaa) alluvium and colluvium by the relatively intermediate elevations of terraces above modern stream channels; elevated levels of terraces within most drainages probably are due to localized, differential tectonic uplift associated with the Big Pine fault. Deposits rarely thicker than about 10 m.

Qyac **Young alluvium and colluvium (Holocene and Pleistocene?)**—Very similar to young alluvium unit (Qya) except that deposits underlie broader, more extensive elevated alluvial surfaces and include a greater proportion of nonsorted and nonbedded colluvial material, especially near valley margins. Largest concentrations of deposits are near eastern edge of quadrangle where Alamo Creek and tributary stream drainages open up into small valleys south of the Big Pine fault. These deposits include small, coalescing fan remnants along their peripheries. Smaller, more isolated deposits are mapped along the flanks of larger stream canyons in the Cuyama badlands north of the Big Pine fault. Such deposits along Dry Canyon are more deeply dissected and, thus, may be older than Qyac deposits mapped elsewhere in quadrangle, but they are not as elevated as nearby old alluvium and colluvium deposits (Qoac). Young alluvium and colluvium unit locally includes loess deposits and younger alluvium and colluvium deposits (including slope wash deposits) that are too small to map separately. Maximum unit thickness estimated to be about 30 m.

Qoa **Old alluvium (Pleistocene)**—Orangish-tan, olive-gray, olive-brown, tannish-gray, and pale- to dark-gray, weakly to moderately consolidated, crudely to moderately bedded, alluvial breccia, conglomerate, gravel, and gravelly sand. Clast composition variable; subangular to subrounded clasts of Eocene sandstone, granitoids, and gneiss are most common, but clasts also include well-rounded, possibly reworked, volcanic cobbles and pebbles. Clasts, rarely more than 2 m in diameter, are poorly sorted and set in a sandy matrix. Deposits form flat-topped, moderately dissected alluvial terrace remnants that rest 30 to 60 m above the Cuyama River channel west of its confluence with Alamo Creek; terrace surfaces are commonly strewn with blocks and boulders of sandstone and, locally, granitoids up to 7 m long. Unit locally forms badlands topography. Moderately to well-developed soils typically cap terrace deposits. In map area, old alluvium (and associated old colluvium of unit Qoac) mostly represents ancestral Cuyama River and Alamo Creek valley fill deposits. Deposits average about 15 m in thickness, but north of the Cuyama River near the west edge of quadrangle unit has a maximum thickness of 45 m.

Qoac **Old alluvium and colluvium (Pleistocene)**—Very similar to old alluvium (Qoa) except that deposits include much greater amounts of nonsorted and nonbedded colluvial material. Unit mapped separately from old alluvium where deposits are more distal relative to the Cuyama River. Unit mapped mainly near the Big Pine fault where it forms alluvial terrace remnants perched along interfluves as much as about 120 m above modern, local stream channels.

Qols **Old landslide deposit (Pleistocene)**—Poorly to moderately consolidated and poorly sorted landslide debris forming a large deposit along spur flanking Beartrap Creek in east-central part of map area. Mostly composed of sandstone and siltstone debris derived from Matilija Sandstone (Tma). Deposit contains angular blocks as much as tens of meters in length. Older age of deposit indicated by relatively high degree of dissection and general lack of residual hummocky surface morphology. Maximum thickness about 50 m.

QTm **Morales Formation (Pleistocene and Pliocene)**—Pale-tan, beige, and pale-tannish-gray, weakly to moderately consolidated, interbedded conglomerate, sandstone, and rare tan-to-brown siltstone and mudstone. Sequences of alternating sandstone and conglomerate layers are common. Bedding thickness ranges from medium to thick and is typically laterally uniform, although some beds are broadly to narrowly lenticular. Conglomerate is characteristically polymict and sandy; clasts, which are subrounded to subangular and commonly no more than 0.3 m in diameter, include granitic, gneissic, schistose, basaltic, silicic-to-intermediate volcanic, sedimentary, and quartzitic rock types; granitic and gneissic clasts are dominant. Sandstone is commonly friable, poorly sorted, pebbly, weakly to moderately laminated, and arkosic to lithic. Mudstone is typically sandy and forms thin, discontinuous beds and partings. Generally poorly exposed except locally along the bottoms of narrow stream canyons and where beds are cemented by carbonate. Lowermost part of unit near northern edge of quadrangle contains greater abundance of siltstone and mudstone intervals that grade laterally into, or interfinger with, the clay-rich facies of the Quatal Formation (Tqcl). Adjacent to the Big Pine fault in lower Dry Canyon, the Morales appears to interfinger with Quatal-like pale yellowish-tan sandstone and conglomerate beds that contain abundant Eocene sandstone clasts. These stratigraphic relations suggest that lower Morales and uppermost Quatal Formations were syndepositional in the map area, although the Morales locally rests unconformably on rocks of the Quatal Formation (Tqs and Tqcl) in the northwest part of the quadrangle (see section A-A'). Much of the Morales Formation is likely Pliocene in age based on paleomagnetic data of Ellis and others (1993) and sparse vertebrate fossils identified northwest of quadrangle by Vedder (1970), but tuff bed present in upper part of Morales section a few kilometers north of quadrangle is interpreted to be middle Pleistocene (Stone and Cossette, 2000). Morales sediments probably formed by fluvial deposition on alluvial fans shed off of nearby uplands. Unit present only north of Big Pine fault within Cuyama Badlands, where it has a maximum thickness of about 550 m within the map area. Queried where identity uncertain.

Quatal Formation (Pliocene)—Primarily fluvial sedimentary sequence exposed north of the Big Pine fault and east of the Ozena fault within the Cuyama Badlands. The formation rests conformably on the Lockwood Clay (Tlc) or with questionable angular discordance on older rocks of the Caliente Formation (Tca, Tcc, and Tcgr). Sedimentary deposits of the Morales Formation overlie and locally interfinger with the upper part of the Quatal with small to no angular discordance. Age of the Quatal Formation is poorly constrained, but paleontologic and paleomagnetic data from surrounding units suggest that it is most likely Pliocene (Kelley and Lander, 1988; Ellis and others, 1993). Volumetrically most of the Quatal in the map area consists of sandstone facies (Tqs). The following map units are differentiated within the formation:

Tqcl **Clay-rich facies**—Brown and brownish-gray, massive, locally sandy, claystone; locally interbedded with light-gray and pale-tannish-brown, flaggy to tabular siltstone and fine-grained sandstone. Typically forms rounded slopes that are subject to landsliding and slumping and weathers into porous, shrinkage-cracked soil that typically supports profuse growths of wild onions and buckwheat. These geomorphic, weathering, and vegetative associations resemble those of the older Lockwood Clay (Tlc). Clay-rich facies, which forms the uppermost unit of the Quatal, laterally grades into, and interfingers with, uppermost sandstone facies of the Quatal (Tqs) as well as basal sediments of the Morales Formation (QTm). In northwestern exposures base of facies is marked by a thin, conspicuous, light-gray, sandy conglomerate bed that contains white subrounded clasts of siliceous Monterey Shale (Tm). Although mapped as lower Morales Formation by Stone and Cossette (2000), unit is included here with the Quatal due to its close resemblance to, and probable correlation with, claystone that forms the Quatal type section several kilometers northwest of map area (Hill and others, 1958; Dibblee, 1972). Exposed on flanks of anticlinal uplifts in northern part of quadrangle where unit has a maximum thickness of more than 300 m.

Tqs **Sandstone facies**—Yellowish-tan to pale-yellowish-tan (rarely tannish-brown, orangish-tan, or light-gray), poorly exposed, thin- to thick-bedded, interbedded conglomerate, pebbly to conglomeratic sandstone, sandstone, and siltstone; rare thin beds and partings of brown mudstone. Sandstones mostly lithic to feldspathic and have a silty to clayey matrix, but some light-gray beds are arkosic. Conglomeratic beds commonly lenticular. Lithic clasts within sandstones and conglomerates predominantly consist of subrounded to well-rounded cobbles and pebbles of locally derived Eocene sandstone (Tjs, Tma, Tcds, and Tcw?), but granitic and gneissic clasts are common in some beds; subordinate clasts include volcanic and quartzitic rock types. In the lower part of unit near the Ozena fault conglomeratic beds are predominantly of granitic provenance and appear to grade southward along strike into deposits of the granitic breccia facies (Tqgr). South of the Cuyama River near the Big Pine fault some thick conglomeratic beds containing subangular boulders and cobbles of Eocene sandstone resemble, and may be laterally equivalent to, deposits of the sedimentary breccia facies (Tqx). Some beds and intervals cemented with carbonate form resistant ledges. Typical yellowish-tan hues of the sandstone facies, which distinguish it from overlying tannish-gray sediments of the Morales Formation (QTm) and underlying variegated sedimentary rocks of the Caliente Formation (Tc, Tcc, and Tca), are attributed to high contents of silt and clay of local Eocene sedimentary-rock provenance. Upper part of sandstone facies locally interfingers with sediments of the Morales Formation adjacent to the Big Pine fault and grades laterally into the clay-rich facies of the Quatal (Tqcl) in the northern part of the map area. Where exposed, the sandstone rests conformably on the Quatal white sandstone facies (Tqw) or conglomerate facies (Tqc) near the northwest and northeast corners of the map area, respectively, and unconformably(?) on rocks of the Caliente Formation (Tc?) near the Ozena Fire Station along the Cuyama River. Partly equivalent to Quatal Formation Members Three and Two of Carman (1964) and Quatal fluvial sedimentary rocks of Minor (1999). Unit thickens southwestward from less than 75 m near northeast corner of map area to as much as 900 m northwest of Ozena Campground.

Tqgr **Granitic breccia facies**—Pale tan, yellowish-tan, and yellowish–gray, poorly exposed, crudely bedded, granitic-clast, arkosic-sandstone-matrix sedimentary breccia and conglomerate with subordinate interbeds of pebbly sandstone and rare mudstone. Angular to subrounded granitic clasts range in size up to boulders more than 1 m in diameter. Other, subordinate clasts include Eocene sandstone, gneissic to schistose rocks, and well-rounded volcanic rocks. Breccia typically clast supported. Surface exposures limited to small area north of intersection of Ozena and Big Pine faults, where laterally facies sediments interfinger with, and gradually pinch out against, lower sandstone facies (Tqs) deposits (see cross section A-A'). Along southern edge of exposure, unit rests depositionally on conglomerate facies (Tqc) rocks. Maximum exposed thickness about 300 m.

Tqx **Sedimentary breccia facies**—Tan, olive- to yellowish-tan, and greenish-gray, poorly exposed, thick- to medium-bedded, interbedded sedimentary breccia, conglomerate, sandstone, and rare siltstone; coarse-grained layers mostly crudely to moderately stratified, poorly sorted, and clast-supported, containing exclusively angular (breccia) to rounded (conglomerate) clasts of locally derived Eocene sandstone, siltstone, and shale (Tma, Tmam, Tcd, and Tcds) as much as 5 m (rare) in length; sandstone interbeds typically pebbly, coarse- to fine-grained, and well-stratified. In large river-cut exposure of facies near confluence of Alamo Creek and Cuyama River, sequence grades up section from basal oxidized Eocene-sandstone rubble that laps onto Eocene bedrock, to interbedded sandstone and breccia, to interbedded cobble conglomerate and sandstone, to upper well-bedded fine-grained sandstone and siltstone with minor lenses of pebble-cobble conglomerate. Facies inferred to be locally derived fan debris shed from uplifting hanging-wall block of Big Pine fault and deposited over older, southern strand of fault; younger northern stand of Big Pine, in turn, displaces breccia facies. To the north, breccia abruptly interfingers with, and grades into, sandstone facies of the Quatal (Tqs). Minimum thickness at surface about 100 m; probably much greater at depth.

Tqc **Conglomerate facies**—Pale-tan, pale-yellowish-tan, orangish-tan, pale-yellowish-gray, and light-gray, medium- to thick-bedded, variably resistant conglomerate and conglomeratic sandstone with subordinate interbeds of clayey to silty sandstone. Conglomeratic sequences are polymict, containing subrounded pebbles, cobbles, and rare boulders of granitic and gneissic rocks and lesser volcanic, schistose, and sandstone (locally derived Eocene?) rocks. Near Ozena fault, facies grades northward along strike into lowermost deposits of the sandstone facies (Tqs). Distinguished from overlying sandstone facies rocks (Tqs) by greater abundance of conglomerate beds and by its polymict, multihued character. Equivalent to the lower part of the Quatal Formation fluvial sedimentary rocks unit of Minor (1999) and the Quatal Formation, lower part, of

Stone and Cossette (2000). Exposed near northeast corner and in west-central part of map area where facies has thicknesses of 150 m and 300 m, respectively.

Tqg **Gypsum**—Medium-gray (weathered) to light-grayish-brown (fresh), bedded, microcrystalline gypsum (alabaster). Gypsum is intermittently exposed in core of anticline in northwest part of map area, suggesting that deposit has been tectonically mobilized and squeezed into surrounding sandstone facies (Tqs) rocks during folding.

Tqw **White sandstone facies**—Lowermost Quatal unit consisting of conspicuously white to light-gray, thick- to medium-bedded, arkosic to lithic-feldspathic sandstone, pebbly to conglomeratic sandstone, and conglomerate with sparse, thin ($\leq$0.3 m) interbeds and partings of brownish, silty to sandy, mudstone; some beds normally graded from pebble-cobble conglomerate at their base to mudstone at their top. Sandstone is mostly friable and poorly exposed, although it is locally cemented with carbonate, resistant, and tabular to flaggy. Conglomeratic intervals, mostly present in northeastern exposures, commonly lenticular or fill paleochannels; conglomerates are polymict, containing subrounded to well-rounded clasts of granitic rocks and lesser sandstone, intermediate-to-mafic volcanic rocks, and other rock types. Upper part of facies locally contains interbeds of yellowish (Tqs-like) sandstone, and near western border of map area unit grades southward into sandstone facies (Tqs). Equivalent to calcareous sandstone and diatomite subunit of the Quatal Formation of Minor (1999), and to sandstone of Nettle Spring and sandstone of lower Apache Canyon of Stone and Cossette (2000). Exposed only near northeast and northwest corners of map area where unit has maximum thicknesses of about 125 m and 250 m, respectively. In northwest exposures, unit abruptly thins (see cross section A-A') and locally pinches out on north flank of anticlinal uplift formed in unconformably underlying units of the Caliente Formation (Tcgr, Tcc, and Tca). White sandstone facies is absent where base of Quatal is exposed in west-central part of map area.

Tlc **Lockwood Clay (Pliocene?)**—Chocolate-brown, massive, hackly-fractured, locally gypsiferous and(or) sandy, claystone; weathers into porous, shrinkage-cracked soil that typically supports profuse growths of wild onions (*Allium howellii* var. *clokeyi*) and buckwheat (*Eriogonum ordii* and *Eriogonum trichopes* var. *hooveri*). Claystone is composed chiefly of pure, industrial-grade montmorillonite clay (Carman, 1964). The Lockwood Clay forms a conspicuous brown stripe on the land surface that forms rounded slopes where unit is exposed near the northwest and northeast corners of quadrangle. Clay, when wet, is prone to landsliding where it underlies steep slopes. The Lockwood locally thins and pinches out northward in vicinity of anticline near northwest corner of quadrangle, and unit is not present stratigraphically above rocks tentatively correlated with the Caliente Formation (Tc?) near the intersection of the Ozena and Big Pine faults in west-central part of quadrangle (see cross section A-A'), suggesting that the clay may unconformably overlie beds of the Caliente Formation that were mildly deformed prior to Lockwood deposition. Although age is uncertain, local basal unconformity and vertebrate paleontologic data from underlying Caliente rocks in the Dry Canyon area (James, 1963; Kelley and Lander, 1988) suggest that the Lockwood Clay is lowermost Pliocene.

Caliente Formation (Miocene)—Lithologically diverse fluvial sedimentary rocks exposed: (1) in anticlinal uplifts near the northwest and northeast corners of quadrangle (Tca, Tcc, and Tcgr), (2) in an upturned section adjacent to the Ozena fault (Tc?), and (3) along an overturned syncline in the footwall block of the Pine Mountain fault (Tc?). Probable Caliente beds conformably(?) overlie marine sedimentary rocks of the Santa Margarita Formation (Tsmg and Tsms) south of Pine Mountain fault, but the base of the formation is not exposed in the outcrops to the north. At depth, sedimentary rocks of the Caliente Formation inferred to lap onto granitic basement rocks similar to those that were penetrated in a drill hole located near the Ozena fault exposure (Vedder and others, 1973) (see cross section A-A') and that are exposed about 9 km north of the map area (Stone and Cossette, 2000). Miocene age of the Caliente is relatively well constrained from Hemingfordian through Hemphillian (~18-8 Ma) mammalian fossils collected in the Cuyama Badlands within and north of the map area (James, 1963; Kelley and Lander, 1988), and from the Miocene age of marine fossils from the underlying Santa Margarita Formation (Tsms) south of Pine Mountain fault. Also, basalt flows present in the type section in the Caliente Range 40 km to the northwest have recalculated K/Ar ages of 14.5 to 16.8 Ma (Turner, 1970), and a thin tuff layer identified in Caliente beds (Tca) in Dry Canyon has a recalculated K/Ar age of 15.6 Ma (James, 1963). In quadrangle, rocks of the Caliente Formation are differentiated into the following map units:

Tc? **Caliente Formation, uncertain**—Multihued (pale gray, green, olive-green, tan, yellow, and red), poorly to moderately exposed, moderate- to well-bedded, interbedded sandstone, siltstone, mudstone, and rare claystone; locally gypsiferous. Sandstone is commonly pebbly and, north of the Big Pine fault, contains lenses and paleochannels of conglomerate; clasts mostly granitic, but include rare Eocene sandstone and other rock types. Locally forms badlands topography. Correlation with Caliente Formation uncertain due to: (1) lack of Lockwood Clay (Tlc) at base of overlying Quatal beds (Tqc) near Ozena fault, and (2) poor exposures and lack of overlying units where mapped south of Pine Mountain fault. Latter deposits may correlate with upper Caliente beds exposed in Cuyama badlands, based on 11.0—11.8-Ma age of underlying rocks of the Santa Margarita Formation (Tsms) (Wilson and Prothero, 1997). Possibly equivalent to Members One and Two of the Caliente Formation of Carman (1964). Maximum inferred thickness about 250 m near Ozena fault.

Tca **Arkosic-lithic sandstone facies**—Pale-gray, -brownish-gray, and -tan, badlands-forming, arkosic to lithic, pebbly sandstone with subordinate interbeds of conglomerate, siltstone, and mudstone. Sandstone is fine to coarse grained, commonly silt and (or) clay rich, and contains subrounded pebbles of mainly granitic, gneissic, and volcanic provenance. Conglomerate generally pebble rich and forms thin lenses and discontinuous layers within sandstone intervals. Exposures limited to anticlinal uplifts near northwest and northeast corners of quadrangle. Northeastern sequence contains one, and possibly two, pale-gray, reworked (?), biotitic ash tuff layers 1—2-m thick; tuff has a recalculated K/Ar age of 15.6 Ma (James, 1963). Facies distinguished from underlying conglomerate (Tcc) facies mainly by the presence of relatively thick and homogeneous pebbly sandstone intervals. Equivalent to the following subunits of the Caliente Formation mapped in adjoining areas: Member One and(or) Member Three of Carman (1964); upper arkosic-lithic sandstone facies of Minor (1999); and upper and lower parts of Stone and Cossette (2000). Maximum inferred thickness in map area about 180 m.

Tcc **Conglomerate facies**—Light- to dark-gray, pale pinkish-gray and tan, badlands-forming, thick- and moderately well-bedded conglomerate and pebbly sandstone; rare thin interbeds of mudstone. Conglomerate forms tabular to lenticular beds that commonly grade upward into pebbly sandstone and rarely mudstone. Clasts consist predominantly of pebbles, cobbles, and boulders (as much as 5 m diameter) of subrounded, granitic and gneissic (including augen gneiss) rocks and well-rounded, volcanic, quartzitic, and other rocks; distinctive pink-to-purple, partly decomposed, intermediate-composition volcanic clasts diagnostic of the Caliente conglomerates; volcanic clasts likely derived from distant source(s). Sandstone is commonly coarse grained and lithic to arkosic. Although the conglomerate facies overlies granitic breccia facies (Tcgr) and underlies sandstone facies (Tca) at its single exposure near the northwest corner of the map area, it interfingers with several other Caliente facies at local and regional scales within the adjoining quadrangle to the east (Minor, 1999). Equivalent to Member One of the Caliente Formation of Carman (1964) and to conglomerate of lower Apache Canyon of Stone and Cossette (2000). Maximum inferred thickness in map area about 100 m.

Tcgr **Granitic breccia facies**—Light-gray and tannish-gray, massive to crudely bedded, granitic-clast sedimentary breccia and rare, very-coarse-grained (grussy), arkosic sandstone. Breccia typically composed of as much as 90 percent poorly sorted, angular to subangular clasts (up to 3 m in diameter; ≤1 m average) of leucocratic granitic and rare felsic schistose to gneissic rocks in a grussy arkose matrix; contains as much as about 10 percent clasts of dark-gray augen and migmatitic gneiss. Exposure limited to anticlinal uplift near northwest corner of map area where base of unit is not exposed, and breccia deposits are overlain by conglomeratic facies (Tcc) rocks. Likely represents alluvial-fan deposition. Maximum exposed thickness about 75 m.

Santa Margarita Formation (Miocene)—Lower shallow-marine fossiliferous sandstone and mudstone (Tsms) and upper peritidal to nonmarine gypsum (Tsmg) sequence exposed near southwest corner of quadrangle southwest of Pine Mountain fault. In map area, Santa Margarita deposits overlie sedimentary rocks of Monterey Formation (Tm) with slight angular discordance. Lower subunit contains abundant shallow-water marine molluscan fossils and foraminifers that together indicate a late Miocene (Mohnian) formation age (Vedder and others, 1973). Also, magnetostratigraphic constraints indicate that Santa Margarita in map area correlates with Chron C5r (11.0—11.8 Ma) (Wilson and Prothero, 1997). Formation, which has a composite thickness of about 150 m, divided into the following subunits:

Tsmg **Gypsum**—Greenish-gray, medium- to thin-bedded gypsum with common white, coarsely crystalline gypsum partings; some beds weakly calcareous and autoclastic.

Unit directly underlain by beige to pale-green marine sandstone (Tsms) containing oyster shell hash and overlain by pale-grayish-brown and –green, thinly interbedded gypsum, mudstone, and sandstone that grades into overlying deposits of the Caliente(?) Formation (Tc?). Maximum exposed thickness about 25 m.

Tsms **Sandstone and mudstone**—Interbedded white to light-tan, thick- to medium-bedded, laminated to massive, fossiliferous, arkosic sandstone and subordinate pale-brown to brownish-gray, thin-bedded, locally phosphatic mudstone and lesser siltstone; contains rare beds of pebble conglomerate. Sandstone friable and poorly exposed except where cemented by carbonate; contains common molluscan fossils that in some beds are complete and in growth positions, whereas in others they are disarticulated and form shell hash or, in rare cases, coquina; fossils include abundant, conspicuously large shells of *Crassostrea titan* (Conrad) (Vedder and others, 1973). Mudstone and siltstone rarely exposed. Maximum exposed thickness about 120 m.

Tm **Monterey Formation (Miocene)**—Light-gray, pale tannish- to brownish-gray, and beige, thin-bedded to laminated, siliceous to dolomitic marine shale, mudstone and siltstone; includes rare thin interbeds of sandstone. Mudstone and shale typically well stratified, platy to fissile, soft, and low density; locally sandy. Bedding commonly weakly to strongly contorted; mudstone and shale prone to landsliding. Benthic foraminifers and calcareous nannoplankton collected from map-area exposure near base of unit probably are Luisian to Relizian and correlate with zone CN 5A, respectively (R.S. Boettcher and S.A. Kling, written commun., 2003), consistent with a middle Miocene age. Biofacies represented by foraminifers indicate an upper middle bathyal depositional environment (R.S. Boettcher, written commun., 2003). Exposed near southwest corner of quadrangle southwest of Pine Mountain fault where unit has thickness of about 400 m. Thick intercalated sandstone intervals mapped separately as:

Tms **Sandstone**—Beige to light-gray, friable and poorly exposed (except where carbonate cemented), even medium- to thin-bedded, tabular, locally laminated and cross-bedded, fine- to coarse-grained sandstone. Sandstone contains abundant marine molluscan fossils of probable middle Miocene age (Vedder and others, 1973). Average thickness of mapped sandstone intervals about 50 m.

Trd **Rhyolitic intrusions (Oligocene)**—Rusty white (altered/weathered) to light-gray (fresh), 5—10-m-wide, discontinuous, rhyolitic dikes, sills, and irregular small intrusive masses that intrude Eocene sedimentary rocks of the Juncal Formation (Tjm) north of the Big Pine fault west of the Ozena fault. Intrusions are porphyritic, consisting of ~15 percent phenocrysts as long as 4 mm of sanidine (35 percent), white (mostly replaced by calcite and kaolinite) plagioclase (3—4 percent), partly rounded and embayed quartz (2—5 percent), and locally oxidized and clay-altered biotite (1—2 percent) in a microcrystalline (partly subophitic) groundmass. Sill exposed just south of Bear Canyon has an $^{40}Ar/^{39}Ar$ age of about 25.0 Ma (R.J. Fleck, written commun., 2000).

Ts **Sespe Formation (Eocene)**—Pale greenish- to olive-gray, tannish-gray, and reddish (rare), cliff-forming, thick-bedded, poorly stratified, medium- to coarse-grained, nonmarine fluvial sandstone, pebbly sandstone, and lenticular conglomerate; rare thin interbeds and partings of brown to reddish-brown silty to sandy mudstone. Sandstone and conglomerate beds mostly trough cross bedded; conglomerate clasts consist of well-rounded pebbles, cobbles, and rare small boulders of mainly quartzite, felsic volcanic rocks, granitoid and gneissic rocks, and sandstone. Sandstone locally nodular. Unit inferred to be approximately equivalent to Sespe lithofacies A of Howard (1995) of Mojave Desert provenance, which has a middle to late Eocene age. Exposed near southwest corner of quadrangle southwest of Pine Mountain fault where unit has thickness of about 450 m.

Tcw? **Coldwater Sandstone, uncertain (Eocene)**—Pale-tan and light- to medium-gray, medium- to thin-bedded, interbedded marine sandstone, siltstone, and shale. Siltstone and shale interbeds contain benthic foraminifers that are late Narizian, consistent with a late Eocene age (Vedder and others, 1973; K. McDougall, written commun., 2002). Biofacies represented by these foraminifers are outer shelf ($\pm$ 150 m depth) (K. McDougall, written commun., 2002). Exposures limited to just southwest of Pine Mountain fault near southwest corner of quadrangle. Lower part (adjacent to Pine Mountain fault) may include beds of upper Cozy Dell Shale (Tcd). Thickness about 125 m.

Tcd **Cozy Dell Shale (Eocene)**—Olive-greenish-gray to olive-brown, spheroidally- to hackly-fractured, slope-forming, poorly exposed, marine claystone, shale and siltstone; includes rare, thin (< 4 m), interbeds of tan to dark-brown (ferruginous), tabular, fine-grained limy sandstone and silty to sandy limestone. Sandstone interbeds increase in frequency downward near basal contact with Matilija Sandstone (Tma). Olive-greenish hues and spheroidal fracturing are diagnostic in the field. Cozy Dell contains abundant marine fossils, especially foraminifers and mollusks, that indicate a middle to late Eocene age (e.g., Vedder and others, 1973); benthic foraminifers collected from map area exposures in unit are Ulatisian to late Narizian (K. McDougall, written commun., 2002). Biofacies represented by foraminifers collected within individual beds range from outer shelf to bathyal ($\geq$ 150 m depth) (K. McDougall, written commun., 2002). Cozy Dell is present along axis of Piedra Blanca syncline and elsewhere along lower northern flank of Pine Mountain south of the Big Pine fault. Upper contact of formation not present in map area; maximum preserved thickness about 400 m. Thick intercalated sandstone intervals mapped separately as:

Tcds **Sandstone**—Beige, pale-tan, and pale-greenish-gray, thick- to thin-bedded, resistant, fossiliferous, fine- to medium-grained, arkosic to feldspathic sandstone intervals with rare, thin olive-greenish-gray interbeds of siltstone and shale; sandstone beds contain rare pebbly horizons. Maximum thickness of sandstone intervals about 100 m.

Tma **Matilija Sandstone (Eocene)**—Light-gray (fresh) to tan and orangish- to reddish-tan (weathered), cliff-forming, very thick- to medium-bedded, massive, coarse-grained, arkosic to feldspathic marine sandstone and conglomeratic sandstone; contains subordinate thin interbeds and partings of tabular-to-flaggy, laminated sandstone and olive-greenish-gray siltstone and shale, and local cross beds, dark-gray shale rip-up clasts, and dark-colored concretions. Conglomeratic zones common (up to 25 percent of local sections) especially in upper part, ranging from concentrations of isolated, rounded cobbles in sandstone to numerous thin (≤ 0.3 m) lenses and discontinuous layers of clast- and sand-supported conglomerate; clasts predominantly well-rounded (recycled?), polymict cobbles. Local concentrations of mollusks and other marine fossils indicate a middle to late Eocene age (Vedder and others, 1973). Outcrops characterized by knobby to bouldery tors where sandstone is jointed; weathered surfaces developed on massive sandstone locally exhibit tuffoni cavities and limonitic lysigong staining. In Alamo Creek area, includes conspicuous olive-green, thin (< 2-m) marker bed of argillaceous sandstone. Basal Matilija contact with underlying Juncal Formation shale facies (Tjsh) and interbedded sandstone, siltstone, and shale facies (Tjm) defined as base of lowermost thick sandstone layer. Matilija Sandstone exposed south of Big Pine fault over extensive areas along the north flank of Pine Mountain and in uplands north and south of Alamo Creek. Maximum thickness of Matilija about 500 m in map area. Formation includes the following, separately mapped, facies:

Tmam **Interbedded sandstone and shale facies**—Mostly dark-tannish-brown to dark-olive-brown weathering, medium- to thin-bedded, cliff-forming, tabular-to-flaggy, interbedded medium- to fine-grained, arkosic to feldspathic sandstone and subordinate, thin-bedded siltstone and shale; contains rare dark-brown, sandy to silty limestone beds and pebble conglomerate horizons; also contains very rare fossil wood fragments. Sandstone beds are commonly limy and contain abundant molluscan fossils. Thinner bedding, darker coloring, and greater proportion of siltstone and shale interbeds distinguish facies from rest of Matilija Sandstone. Facies forms a thick section (as much as about 325 m) capping the Matilija Sandstone sequence, and thinner, lenticular intervals near the base of the formation in the vicinity of Reyes Peak.

Juncal Formation (Eocene)—Thick marine sequence of interfingering shale, siltstone, and sandstone exposed in southern one-half of quadrangle in the western and southern upthrown blocks of the Ozena and Big Pine faults, respectively. Base of formation not exposed in map area and unit conformably overlain by the Matilija Sandstone (Tma); sequence has a minimum cumulative thickness of approximately 1,500 m. Benthic foraminifers collected in siltstone and shale facies rocks (Tjsh) from throughout the Juncal section in the adjacent San Guillermo Mountain quadrangle (Minor, 1999) and in the present map area are Ulatisian (K. McDougall, written commun., 1998, 2002), indicating a middle Eocene regional age for the formation. Biofacies represented by foraminifers collected within individual beds range from inner neritic to lower bathyal, indicating deposition at water depths as great as 1,500—2,000 m (K. McDougall, written commun., 1998, 2002; Stanley and others, 1998). Broad range of biofacies represented by commingled foraminifers suggests that some Juncal sediments were subaqueously transported, perhaps by turbidity currents, to greater depths and mixed with deeper sediments. Local, large-scale shale rip-up clasts in Juncal sandstone-facies (Tjs) channel conglomerates are consistent with such a sediment transport scenario. In quadrangle, the following three interfingering and intercalated Juncal facies are mapped; complex and intricate interfingering relations of facies are somewhat generalized on map due to mapping objectives and limitations of map scale:

Tjs **Sandstone facies**—Light- to medium-gray (fresh) and brown to tan (weathered), cliff- to ledge-forming, thick- to thin-bedded and tabular, coarse- to fine-grained, arkosic to feldspathic sandstone with common siltstone and shale interbeds and partings. Sandstone rarely accompanied by conglomerate lenses and paleochannels containing well-rounded cobbles of diverse composition and, locally, dark-gray shale rip-up clasts; also contains rare dark-colored concretions. Sandstone layers locally highly fractured and blocky. Shale and siltstone intervals commonly carbonaceous (fossil plant and wood fragments) and locally emit strong sulfurous odor.

Tjm **Interbedded sandstone, siltstone, and shale facies**—Stratigraphic intervals composed of roughly subequal proportions of sandstone, siltstone, and shale interbeds. Lithologically, these various sedimentary components are identical to the corresponding, separately mapped facies (Tjs and Tjsh); interbedded facies unit mapped where individual lithofacies could not be mapped due to map-scale limitations and(or) uncertain facies differentiation in the field.

Tjsh **Siltstone and shale facies**—Gray (fresh) to tan, brown, and pale greenish-gray (weathered), slope-forming, fissile to platy, finely bedded and laminated, micaceous shale and siltstone; includes rare to common, thin ($\leq$ 3-m-thick) interbeds of tabular, ledgy, generally fine-grained, arkosic to feldspathic sandstone. Shale and siltstone beds locally calcareous, carbonaceous (fossil plant and wood fragments), or emit a strong sulfurous odor; fracture and parting surfaces are commonly stained with rusty limonite; ripple laminations locally present in more sandy beds. Sandstone beds, which comprise as much as 50 percent of section in a few intervals, are locally conglomeratic and contain rare dark-grey shale rip-up clasts.

NOTES

New 1:24,000-scale geologic mapping in the Cuyama 30' by 60' quadrangle, in support of the U.S. Geological Survey (USGS) Southern California Areal Mapping Project (SCAMP), is contributing to a more complete understanding of the stratigraphy, structure, and tectonic evolution of the complex junction area between the NW-trending Coast Ranges and EW-trending western Transverse Ranges. The 1:24,000-scale geologic map of the Reyes Peak quadrangle, located in the eastern part of the Cuyama map area, is the final of six contiguous 7 ½' quadrangle geologic maps compiled for a more detailed portrayal and reevaluation of geologic structures and rock units shown on previous maps of the region (Carman, 1964; Dibblee, 1972; Vedder and others, 1973). SCAMP digital geologic maps of the five other contiguous quadrangles (see tectonic index map for locations) have recently been published (Minor, 1999; Kellogg, 1999, 2003; Stone and Cossette, 2000; Kellogg and Miggins, 2002).

This digital compilation presents a new geologic map database for the Reyes Peak 7½' quadrangle, which is located in southern California about 75 km northwest of Los Angeles. The map database, which is at 1:24,000-scale resolution, has been approved for release and publication by the Director of the USGS. Although this database has been subjected to review and is substantially complete, the USGS reserves the right to revise the data pursuant to further analysis and review. Furthermore, it is released on condition that neither the USGS nor the United States Government may be held liable for any damages resulting from its authorized or unauthorized use.

The map database, which is available in Arc Info EXPORT format, can be downloaded from http://pubs.usgs.gov/of/2004/1420/

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