U.S. DEPARTMENT OF THE INTERIOR

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Preliminary Geologic Map of the San Guillermo Mountain Quadrangle, Ventura County, California

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DESCRIPTION OF MAP UNITS

Qa **Modern alluvium (Holocene)—**Poorly sorted, poorly bedded, unconsolidated gravel, sand, silt, and clay. Gravel clasts are angular to rounded; sand grains are poorly sorted, fine to very coarse. Unit forms deposits 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 modern wash deposits less than 5 m

Qac **Modern and young alluvium and colluvium (Holocene and Pleistocene?)—** Poorly sorted to nonsorted, poorly bedded to nonbedded, unconsolidated to weakly consolidated blocks, gravel, sand, silt, and clay. Unit mapped where modern and young alluvium are not confined to narrow stream channels or washes; deposits underlie open swells and valley floors where they form broad, smooth, undissected to weakly dissected surfaces. Colluvium generally concentrated near margins of adjacent to bedrock uplands. Some low-lying deposits vulnerable to flooding during periods of high precipitation; soil development is generally weak. Clasts are angular to rounded. Gravel and sand are 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; may also include local, small deposits of older alluvium and colluvium too small to map separately. Largest and thickest (as much as 50 m?) deposits in map area underlie the eastern margin of Lockwood Valley and the tributaries and shoulders of Dry Canyon

Qls **Landslide deposits (Holocene and Pleistocene)—**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; for example, large composite landslide deposit straddling central-western edge of quadrangle is composed predominantly of Matilija Sandstone (Tma). Largest landslide deposits locally thicker than 100 m

Qya **Young alluvium (Holocene and Pleistocene?)—**Very similar to modern alluvium (Qa) except that deposits form slightly higher stream terraces (up to about 3 m) that may be capped by weakly developed soils. Young alluvium rarely experiences flooding. Locally may include minor deposits of modern alluvium (Qa) or young alluvium and colluvium (Qac) that are too small to map separately. Mapped in Dry Canyon and along Piru Creek, where deposits average about 4 m in thickness

Qma **Middle alluvium (Pleistocene)**—Poorly sorted, poorly to moderately bedded, 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 larger stream drainages south of the Big Pine fault where they form weakly to moderately dissected alluvial terraces whose upper surfaces rest as much as 20 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 locally distinguished from old (Qoa and Qoac) and young-to-modern (Qac, Qya, and Qa) alluvium and colluvium by the relatively intermediate elevations of terraces above modern stream channels; elevated levels of terraces within most drainages probably due to localized, differential tectonic uplift. Deposits rarely exceed about 10 m in thickness

Qmac **Middle alluvium and colluvium (Pleistocene)**—Very similar to middle alluvium unit (Qma) 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 concentration of deposits exist in north-central part of quadrangle where Wagon Road Canyon opens up into small valley. These deposits, which include small, coalescing fan remnants along their periphery, grade down stream into middle alluvium deposits (Qma) where canyon narrows. Deposits mapped as middle alluvium and colluvium on west side of Dry Canyon (northwest corner of quadrangle) are more deeply dissected and, thus, may be older than such deposits mapped elsewhere in quadrangle, but they are not as elevated as nearby old alluvium deposits (Qoa). Middle alluvium and colluvium unit locally includes loess deposits and young alluvium and colluvium deposits (including slope wash) that are too small to map separately. Maximum unit thickness about 30 m

Qoa **Old alluvium (Pleistocene)**—Olive-gray, olive-brown, and dark-gray, locally badlands-forming, weakly to moderately consolidated, massive to crudely bedded, alluvial breccia, gravel, and gravelly sand. Deposits commonly form sinuous, flat-topped, moderately dissected alluvial terrace remnants resting along interfluves 30 to 200 m above modern stream channels; elevated levels of terrace remnants probably due to localized, differential tectonic uplift. Clast composition varies depending on bedrock crossed “up stream” by paleodrainages in which alluvium was deposited; north of Big Pine fault subangular granitic and augen gneiss clasts and reworked well-rounded Caliente cobbles predominate, whereas in the area of Piru Creek granitic and Eocene sandstone clasts prevail. Clasts are poorly sorted and rarely exceed 2 m in diameter. Matrix is grussy where clasts of crystalline basement predominate. Large, thickest (~100 m) deposit near northeast corner of quadrangle forms spectacular dark-gray badlands such that it is difficult to distinguish from underlying badlands-forming Caliente conglomerate (Tcc).

Deposits average about 30 m in thickness. Unit equivalent, in part, to terrace deposits of Carman (1964)

Qoac **Old alluvium and colluvium (Pleistocene)—**Very similar to old alluvium (Qoa) except that deposits include nonsorted and nonbedded colluvial material. Unit mapped only in the Pine Springs area where it underlies a moderately-dissected, broad alluvial surface perched as much as about 120 m above modern, local stream channels. Clasts consists mainly of subangular, locally derived granitic rock. Unit equivalent, in part, to terrace deposits of Carman (1964)

Qols **Old landslide deposit (Pleistocene)—**Poorly to moderately consolidated and poorly sorted landslide debris forming a large composite deposit straddling central-eastern edge of map area. Debris composed of clay-rich Caliente Formation rocks (Tcl, Tcc, and Tcg) and, more rarely, of Lockwood Clay (Tlc). Deposit contains contorted 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. Deposit has locally been reactivated as indicated by the presence of numerous small, hummocky landslide deposits on its surface. Maximum thickness about 60 m

Qbd **Boulder diamicton (Pleistocene)—**Light-tannish-gray, massive, weakly consolidated, poorly exposed monomictic breccia consisting of nonsorted, angular-to-subangular, granitic detritus ranging in size from blocks several meters across to sand and silt; clasts mostly composed of granite of Lockwood Peak that is exposed about 5 km east of quadrangle (K.S. Kellogg, unpub. mapping, 1998). Forms deeply dissected, rounded hills in the Pine Springs area near the eastern edge of the map area. Distinguished from granitic fanglomerate facies of the Caliente Formation (Tcg), which diamicton deposits unconformably overlie, by weakly consolidated and nonbedded nature of diamicton. Appears to underlie old alluvium and colluvium (Qoac), but age otherwise poorly constrained. Deposits as much as 60 m thick. Unit equivalent, in part, to terrace deposits of Carman (1964)

Tm **Morales Formation (Pliocene?)—**Fluvial sequence consisting of pale-tan to pale-tannish-gray, weakly to moderately consolidated, interbedded conglomerate, sandstone, and rare tan-to-brown siltstone and mudstone. Bedding thickness ranges from medium to coarse and is typically laterally uniform, although some beds are broadly lenticular. Conglomerate is characteristically polymictic and commonly sandy; clasts, which are subrounded to subangular and commonly no more than 0.3 m in diameter, include granitic, gneissic, basaltic, silicic-volcanic, and quartzitic rock types. Sandstone is typically pebbly. Generally poorly exposed except locally along the bottom of narrow stream canyons and where beds are cemented by carbonate. Erosional remnants of formation cap ridges along interfluves north of the Big Pine fault where unit rests conformably (western deposits) or unconformably (eastern deposits) on fluvial sedimentary rocks of the Quatal Formation (Tqb). Age, although poorly constrained, is most likely Pliocene based on paleomagnetic data of Ellis and others (1993). Maximum preserved thickness in quadrangle about 60 m

Quatal Formation (Pliocene?)—Fluvial sedimentary sequence, present in the northeast and northwest parts of the map area north of the Big Pine fault, that rests conformably on the Lockwood Clay (Tlc) or with slight angular discordance on older rocks of the Caliente Formation. 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). In map area, Quatal calcareous and diatomaceous rocks (Tqc) are differentiated from the fluvial sedimentary rocks (Tqb) that comprise the bulk of the formation:

Tqb **Fluvial sedimentary rocks—**Orangish-tan to pale brown, poorly exposed, moderately consolidated, interbedded conglomerate, sandstone, siltstone, and mudstone. Conglomerate and coarse-grained, pebbly sandstone, which contain clasts predominantly of local provenance (i.e., granitic and gneissic basement rocks), commonly form lenticular, channelized beds and exhibit cross bedding. Sandstone varies from conspicuously white to light-gray, coarse- to medium-grained, friable, arkosic sandstone beds (1-3 m thick) to tan-to-buff, silty-to-clayey sandstone beds of greater thickness range. Subordinate medium to dark-brown siltstone and mudstone layers commonly grade and coarsen downward into sandstone. Unit becomes distinctively yellowish-tan to pale yellowish-olive-brown near Dry Canyon in the westernmost exposures due to a marked increase in silt and clay content; also, light-colored, clean arkosic sandstone beds become rare in this area. Sandstone beds locally form small, resistant, buff-to-cream ledges where cemented by carbonate; such beds are more common along the margin of Lockwood Valley (northeast corner of quadrangle) where they are rarely accompanied by similar-colored, knobby limestone beds. Partly equivalent to Quatal Formation Members Three and Two of Carman (1964). Maximum estimated thickness about 500 m

Tqc **Calcareous sandstone and diatomite—**Lower Quatal sequence of conspicuous white, buff, and pale greenish-white, cliff-forming, massive- to medium-bedded, weakly to strongly carbonate-cemented, arkosic to feldspathic sandstone with sparse, thin (<0.3 m) interbeds of brownish siltstone and mudstone. Unit also includes a local lens of yellowish-white impure lacustrine(?) diatomite exposed 1.1 km SW of Camp Three Falls near the northeast corner of quadrangle. Sandstone is mostly weakly cemented, friable, and tabular to flaggy where it is present at the base of the Quatal in the Dry Canyon area in the northwestern part of the map area. Unit is underlain by a thin interval of more typical Quatal fluvial sedimentary rocks (Tqb) where it is exposed in northeastern part of map area. The diatomite contains a diatom assemblage that is dominated by benthic taxa preferring somewhat saline water with a high chloride content (J. P. Bradbury, unpub. data, 1998). The species *Nitzschia*, *Fragilaria*, *Rhopalodia*, *Scoliopleura*, *Thalassiosira*, *Surirella*, *Amphora*, *Navicula*, *Denticula*, *Anomoeoneis* and *Cocconeis* characterize the assemblage. Several phytoliths of the palm family (Palmae) present in the sample suggest warmer climates or lower elevations during deposition of the deposit than presently exist (J. P. Bradbury, unpub. data, 1998). The diatomite taxa do not reveal the age of formation, but they are consistent with a Pliocene age. Maximum exposed total thickness of unit about 40 m

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, distinctive, thick (as much as 75 m), laterally persistent brown stripe that underlies rounded slopes where unit is present north of the Big Pine fault. Clay, when wet, is prone to landsliding where it underlies steep slopes. The clay locally thins or pinches out against underlying, slightly discordant beds of the Caliente Formation; in such areas the Lockwood commonly bifurcates into thin tongues that interfinger with upper Caliente-like (Tcau) or lower Quatal-like (Tqb) rocks. 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 post Miocene

Caliente Formation (Miocene)—Lithologically diverse fluvial sedimentary sequence, present north of the Big Pine fault in the northern part of the map area, that rests on the older Plush Ranch Formation with moderate to minor angular discordance. Miocene age of the formation is relatively well constrained from Hemingfordian through Hemphillian mammalian fossils collected in the Cuyama Badlands west of the map area (James, 1963; Kelley and Lander, 1988). Furthermore, basalt flows present in the type section in the Caliente Range 40 km to the northwest have recalculated K/Ar ages of 14.6 to 14.8 Ma (Turner, 1970), and a thin tuff layer identified in middle Caliente beds in Dry Canyon has a recalculated K/Ar age of 15.6 Ma (James, 1963). Several facies of the Caliente Formation have been differentiated and mapped in the quadrangle on the basis of bulk contrasts in lithology. Some of these facies units (Tcc, Tcv, Tcl, and Tcg) exist at multiple stratigraphic levels, in part due to intertonguing facies relations, whereas others (Tcau, Tcal, and

Tcp) exist only at specific stratigraphic levels. In quadrangle rocks of the Caliente Formation are separated into the following facies map units:

Tcau **Upper arkosic-lithic sandstone facies**—Multihued (light-gray, light gray-brown, tan, buff, and olive-green), badlands-forming, arkosic, lithic-pebble sandstone with subordinate interbedded conglomerate, siltstone, and mudstone. Sandstone is fine to coarse grained, commonly silt and 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. Upper arkosic-lithic sandstone facies forms top of Caliente Formation throughout most of map area and locally closely resembles basal Quatal Formation (Tqb) where it takes on tannish or brownish hues. Distinguished from underlying variegated sedimentary rocks (Tcv) and conglomerate (Tcc) facies mainly by the presence of relatively thick and homogeneous pebbly sandstone intervals having only subtle changes in color. Equivalent to Member One and (or) Member Three of the Caliente Formation of Carman (1964). Maximum inferred thickness in map area about 125 m

Tcc **Conglomerate facies**—Pale pinkish- to tannish-gray and pale olive-green, badlands-forming, moderately well bedded conglomerate and pebbly sandstone and subordinate, interbedded, olive-tan, olive greenish-gray, and reddish-brown sandstone, siltstone, and mudstone. Conglomerate forms medium-to-coarse (1 m average thickness), tabular to lenticular beds that commonly grade upwards into pebbly sandstone and rarely mudstone. Clasts consist predominantly of cobbles and small boulders (as much as 0.3 m diameter) of subrounded, locally derived granitic and gneissic rocks and well-rounded, volcanic, quartzitic, and plutonic rocks; distinctive pink-to-purple, partly decomposed, intermediate-composition volcanic clasts are diagnostic of the Caliente conglomerates; volcanic clasts are likely derived from distant source(s). Sandstone is commonly coarse grained and lithic to arkosic. Conglomerate facies is present at several stratigraphic levels of the Caliente; it forms the base of the formation in the San Guillermo Mountain area and in the northwestern part of the map area, and it interfingers with several other Caliente facies at both local and regional scales. Equivalent to Member One of the Caliente Formation of Carman (1964). Maximum inferred thickness in map area about 125 m

Tcv **Variegated sedimentary facies**—Multihued (pale gray, green, orange, tan, yellow, buff, brown, and red hues), moderately badlands-forming, interbedded sandstone, siltstone, mudstone, and rare claystone; locally gypsiferous. Sandstone is commonly pebbly and contains lenses and paleochannels of conglomerate. Beds (~5 m average thickness) commonly graded from lower conglomerate through middle sandstone to upper siltstone, mudstone, and (or) claystone. Map unit includes a concentration of granitic-clast conglomerate and breccia lenses just north of the Big Pine fault (near Wagon Road Canyon) that may be genetically related to similar granitic fanglomerate facies Caliente rocks (Tcg) present in the map area. Variegated sedimentary facies abruptly grades laterally into pale-green clay-rich sedimentary facies rocks (Tcl) near the eastern edge of the quadrangle; gradation, however, is more gradual than shown on map. Variegated facies interfingers with several other Caliente facies at both local and regional scales. Equivalent to Members One and Two of the Caliente Formation of Carman (1964). Maximum inferred thickness in map area over 250 m

Tcl **Clay-rich sedimentary facies**—Pale-green to pale greenish-gray and, rarely, brownish-red, well-bedded and well-laminated, clay-rich, interbedded sandstone, siltstone, and mudstone. Present only near central eastern edge of quadrangle. Some arkosic sandstone beds are buff to light gray and strongly carbonate cemented. Facies includes local channel conglomerate. Lower part of facies is characterized by a greater proportion of pebbly sandstone and conglomeratic layers (mostly granitic clast) and by interfingering with the underlying granitic fanglomerate facies (Tcg). Unit directly underlies Lockwood Clay (Tlc) and it grades laterally to the northwest into variegated sedimentary facies (Tcv); distinguished from variegated facies mainly by relatively uniform pale green color. Equivalent to Caliente Formation Member Two of Carman (1964). Maximum exposed thickness about 800 m

Tcg **Granitic fanglomerate facies**—Light-tan, tannish-gray, and gray, massive to poorly bedded, granitic-clast sedimentary breccia and subordinate, very-coarse-grained (grussy) arkosic sandstone. Breccia typically composed of as much as 95% poorly sorted, angular to subangular clasts (up to 3 m in diameter; $\leq$1 m average) of locally-derived, leucocratic granitic and rare felsic schistose and gneissic basement rocks in a grussy arkose matrix. In contrast, south of Pine Springs near eastern edge of map area breccia contains about 30% clasts of dark-gray augen gneiss in a gray, biotitic matrix. Forms basal Caliente facies in the San Guillermo Mountain area where unit rests unconformably on Eocene rocks (Tjs, Tjm, Tjsh, and Tjc), whereas near northwest corner of map area facies is underlain by conglomerate facies (Tcc). In the San Guillermo Mountain area upper part of unit interfingers with overlying basal clay-rich sedimentary facies (Tcl) and conglomeratic facies (Tcc) rocks. Represents alluvial-fan deposition. Maximum exposed thickness about 100 m

Tcal **Lower arkosic sandstone and breccia facies**—White to light-gray, interbedded arkose sandstone and breccia. Sandstone generally poorly sorted, coarse grained, and grussy. Breccia composed of greater than 95% subangular granitic and augen-gneiss clasts in a grussy arkose matrix. Unit is mapped only in one small area near northwest corner of map area where it forms a westward-thickening wedge that has a maximum exposed thickness of about

60 m. Facies resembles underlying arkosic sandstone and breccia facies of the Plush Ranch Formation (Tps and Tpb), but basal Caliente conglomerate facies (Tcc) lies stratigraphically between the two units. Although interpreted to be fanglomerate, the lower Caliente arkosic sandstone and breccia facies is distinguished from the overlying granitic fanglomerate facies by the presence of augen gneiss clasts

Tcp **Basal breccia facies—**Medium- to dark-gray, grussy, massive to crudely bedded, partly conglomeratic sedimentary breccia. Clasts composed predominantly of blocky, angular augen gneiss and leucocratic granitic and gneissic rocks reworked from the directly underlying Plush Ranch Formation, although rare, well-rounded, partly decomposed basaltic and pinkish volcanic clasts are also present. Grussy matrix has a distinctive greasy, foliated appearance, perhaps, due to incipient shearing. Unit present only along Lockwood Valley fault zone in northern part of map area where it appears to be conformable with basal Caliente beds. Facies probably deposited as debris flows and by mass wasting along steep slopes underlain by Plush Ranch rocks before and during initial Caliente fluvial deposition. Partly mapped as Member Three of the Frazier Mountain Formation of Carman (1964). Maximum exposed thickness about 75 m

Plush Ranch Formation (Miocene and Oligocene?)—Interfingering fan-delta and lacustrine deposits, exposed in the north-central part of the map area north of the Lockwood Valley fault zone, interpreted to have been deposited in a middle Tertiary extensional half-graben basin (Carman, 1964; Cole and Stanley, 1995). Fan-delta sequence, which consists chiefly of breccia and immature arkosic sandstone (Tpb, Tpbn, and Tps), thickens and coarsens southward towards the Lockwood Valley fault zone; sequence contains detritus shed off of a major north-facing normal fault scarp that was roughly coincident with the younger transpressional Lockwood Valley fault zone. The basin depocenter, expressed by fine-grained lacustrine deposits (Tpl) that overlap the northern edge of quadrangle, was apparently located just northeast of the map area (Carman, 1964; Cole and Stanley, 1995; Kellogg, 1998). Base of Plush Ranch is not exposed in quadrangle, and a fault contact separates the formation from older Eocene marine sedimentary rocks north of the map area (Carman, 1964; Kellogg, 1998); preserved cumulative thickness of formation exceeds 1,800 m. Caliente Formation rocks overlie the Plush Ranch with slight to moderate angular discordance. Basalt flows intercalated in the Plush Ranch north of the map area range in age from upper Oligocene and lower Miocene (Frizzell and Weigand, 1993), but the local presence of Caliente-like volcanic conglomerate clasts in arkosic sandstone facies rocks (Tps) suggests that the Plush Ranch is lower Miocene. In map area, the following Plush Ranch facies are differentiated:

Tpb **Breccia facies—**Light-gray to mottled light- and dark-gray, badlands-forming, crudely to well bedded, interbedded clast-supported breccia and coarse-grained, pebbly arkosic sandstone. Clasts in breccia and sandstone are as much as 4 m in diameter, angular to subangular, and characteristically bimodal, composed exclusively of locally derived white to light-gray granitic rock and dark-gray augen gneiss; ratio of light-to-dark clasts varies widely, but typically ranges from 2:1 to 1:2. Breccia matrix consists of coarse-grained, grussy arkose derived from the same rocks. Large range in bedding thickness (rarely exceeds 25 m). Bedding becomes more distinct and thins, and relative proportion of sandstone beds increases, upwards and northwards due to interfingering with arkosic sandstone facies (Tps). Some breccia beds contain discontinuous arkosic or clayey sandstone partings; others exhibit inverse grading. In southwest area of exposure some breccia and sandstone beds are variegated with pale-yellowish, -greenish, and -reddish hues. Facies inferred to be proximal deltaic fanglomerate (Carman, 1964; Cole and Stanley, 1995). Equivalent to Plush Ranch Formation Member Five of Carman (1964)

Tps **Arkosic sandstone facies—**Light- to medium-gray and pale-reddish-gray, badlands- to cliff-forming, coarse- to fine-bedded, tabular, arkosic sandstone with subordinate interbedded breccia, conglomerate, siltstone, and mudstone; locally variegated with yellowish, tannish, greenish and reddish hues. Sandstone generally coarse-grained, pebbly, and biotitic. Granitic/augen-gneiss breccia resembles breccia in breccia facies (Tpb) except that beds are typically thinner (< ~5 m). Conglomerate, which mostly forms thin ($\leq$ 1-m-thick) beds and lenses, contains Caliente-like rounded cobbles and pebbles of both local (granitic and gneissic rocks) and foreign (pinkish-to-purplish volcanic rocks) provenance. Thin siltstone and mudstone beds, which commonly have darker reddish to tannish hues, increase in frequency northward due to interfingering with lacustrine facies (Tpl). Arkosic sandstone facies also interfingers with the breccia facies (Tpb) to the south. Facies interpreted to be distal deltaic fanglomerate (Carman, 1964; Cole and Stanley, 1995). Mostly equivalent to Plush Ranch Formation Member Five of Carman (1964)

Tpl **Lacustrine facies—**Tan to orangish-tan, badlands-forming, interbedded (listed in order of decreasing abundance) laminated siltstone and mudstone/shale, pebbly arkosic sandstone, calcareous sandstone and siltstone, and limy, ferruginous sandstone. Bedding is generally fine, planar, and uniform. Arkosic sandstone is medium gray and fine to coarse grained; calcareous sandstone and siltstone are buff to tan and ledgey; ferruginous sandstone is rusty reddish brown. Mudstone/shale and siltstone beds increase in frequency northward. Facies, which is only exposed along the northern edge of quadrangle, interfingers with arkosic sandstone facies (Tps) to the south. Facies interpreted to have been deposited in a lacustrine (distal deltaic?) setting (Carman, 1964; Cole and Stanley, 1995). Equivalent to Plush Ranch Formation Members Three and (or) Four of Carman (1964)

Tpbn **Gneissic breccia facies—**Similar to breccia facies (Tpb) except that gneissic breccia is dark gray due to its high (~95%) augen-gneiss clast content. Bedding is massive to crude, and arkosic sandstone interbeds are rare. Breccia matrix is biotitic and grussy. Facies forms a localized, northward-tapering wedge near north edge of quadrangle; maximum exposed thickness of wedge about 150 m. Unit is equivalent to Plush Ranch Formation Member Five of Carman (1964)

Trd **Rhyolitic dikes (Oligocene)—**White to light-gray, 5-10-m-thick, rhyolitic dikes that intrude Eocene sedimentary rocks of the Juncal Formation in Wagon Road and Park Canyons and adjacent to the Big Pine fault. Dikes are porphyritic, containing phenocrysts as long as 4 mm of partly resorbed sanidine (~5%), white (mostly replaced by calcite and kaolinite) plagioclase (~3%), quartz (~2%), and rusty, oxidized biotite (~1%). Dike exposed in Wagon Road Canyon has an $^{40}Ar/^{39}Ar$ age of about 25.0 Ma (R.J. Fleck, unpub. data, 1998)

Tcd **Cozy Dell Shale (Eocene)—**Olive-greenish-gray (fresh) to dark-olive-brown (weathered), spheroidal- to hackly-fractured, slope-forming, marine claystone, shale and siltstone; includes rare, thin (< 1 m), interbeds of buff-to-tan, fine-grained sandstone, and gray (fresh) to dark-brown (weathered) limestone and silty limestone. Cozy Dell contains abundant marine fossils, especially foraminifers and mollusks, that indicate a middle or late Eocene age (e.g., Vedder and others, 1973). Sandstone interbeds increase in frequency downward near basal contact with Matilija Sandstone (Tma). Olive-greenish color and spheroidal fracturing are diagnostic. Cozy Dell present in southwest part of quadrangle where upper contact of formation is not preserved; maximum preserved thickness in map area about 300 m. Includes the following, separately mapped, facies:

Tcds **Sandstone facies—**Buff, pale-tan, and pale-greenish-gray, coarse- to fine-bedded, arkosic to quartzo-feldspathic sandstone with rare, thin olive-greenish-gray interbeds of siltstone and shale. Sandstone facies about 80 m thick

Tma **Matilija Sandstone (Eocene)—**Light-gray (fresh) to tan and orangish-tan (weathered), cliff-forming, massive to medium-bedded, conglomeratic, coarse-grained, arkosic to quartzo-feldspathic marine sandstone; contains rare, thin interbeds and partings of greenish-gray siltstone and shale, and local cross beds, dark-gray shale rip-up clasts and dark-colored concretions. Conglomeratic zones are common (up to 25% of local sections), varying 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 are predominantly well-rounded, polymict cobbles. Local concentrations of mollusks and other marine fossils indicate a middle to late Eocene age (Vedder and others, 1973). Basal Matilija contact with underlying Juncal Formation sandstone facies (Tjs) and interbedded sandstone, siltstone, and shale facies (Tjm) defined as base of lowermost massive sandstone layer. Matilija Sandstone exposed in southwest part of quadrangle where it is estimated to have a maximum thickness of about 650 m. Upper part of formation includes the following, separately mapped, facies:

Tmam **Interbedded sandstone and shale facies—**Tannish-brown weathering, coarse- to fine-bedded, cliff-forming, interbedded coarse- to fine-grained, arkosic to quartzo-feldspathic sandstone and subordinate, thin siltstone and shale. Finer bedding and greater proportion of siltstone and shale interbeds distinguish facies from rest of Matilija Sandstone. Facies forms a thick section (as much as about 225 m) at or near top of Matilija Sandstone

Juncal Formation (Eocene)—Thick marine sequence of interfingering shale, siltstone, sandstone, and subordinate conglomerate that underlies most of the central and southeastern parts of the quadrangle south of the Big Pine fault. Formation rests nonconformably on Cretaceous granitic basement rocks about 6 km east of the quadrangle (K.S. Kellogg, unpub. mapping, 1998); sequence estimated to have a cumulative thickness of approximately 2,900 m. Benthic foraminifers collected in siltstone and shale facies rocks (Tjsh) from throughout the local Juncal section are Ulatisian (K. McDougall, unpub. data, 1998), indicating a middle Eocene age for the formation in quadrangle. Furthermore, 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, unpub. data, 1998; 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 four interfingering and intercalated facies map units are differentiated within Juncal Formation; actual 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-gray (fresh) to buff and tan (weathered), cliff- to ledge-forming, massive to medium-bedded and tabular, locally conglomeratic, generally coarse-grained, arkosic to quartzo-feldspathic sandstone with common siltstone and shale interbeds and partings. Sandstone accompanied by local conglomerate lenses and paleochannels containing well-rounded cobbles of diverse composition and, rarely, dark-gray shale rip-up clasts as much as several meters in length; also contains rare concretions. Largest areal exposures of sandstone facies are in southeast part of map area, where unit obtains thicknesses as great as 350 m

Tjm **Interbedded sandstone, siltstone, and shale facies—**Juncal sedimentary intervals composed of roughly subequal proportions of sandstone, siltstone, and shale interbeds and rare lenticular beds of conglomerate. Lithologically, these various sedimentary components are identical to the corresponding, separately mapped facies (Tjs, Tjsh, and Tjc); 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—**Dark-gray (fresh) to olive-tan, olive-brown, and pale greenish-gray (weathered), slope-forming, fissile-to-platy, finely bedded and laminated, micaceous shale and siltstone; includes light-gray, rare-to-common, thin (≤ 1-m-thick) interbeds of tabular, ledgy, generally fine-grained, arkosic to quartzo-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% of section in a few intervals, are locally conglomeratic and contain rare dark-grey shale rip-up clasts. Siltstone and shale facies most common in lower part of Juncal sequence, but extends up to base of Matilija Sandstone (Tma) on north side of Alamo Creek in west-central part of map area

Tjc **Conglomerate facies—**Light-gray (fresh) to tannish-brown (weathered), lenticular, cobble conglomerate interbedded with pebbly, coarse-grained, arkosic to quartzo-feldspathic sandstone. Clast- and matrix-supported conglomerate composed of polymictic, well-rounded cobbles and subordinate pebbles in a coarse-grained sandstone matrix; clast compositions include volcanic, granitic, high-grade metamorphic, and chert(?) rock types; clasts commonly coated with iron oxides. Normally graded conglomerate-sandstone layers common. Conglomerate facies lenses and tongues most common in lower part of Juncal sequence in southeastern part of map area

GEOLOGIC OBSERVATIONS AND INTERPRETATIONS

New 1:24,000-scale geologic mapping in the Cuyama 30’ x 60’ quadrangle, in support of the 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-striking Coast Ranges and EW-striking western Transverse Ranges. The 1:24,000-scale geologic map of the San Guillermo Mountain quadrangle is one of six contiguous 7 ½’ quadrangle geologic maps in the eastern part of the Cuyama map area being compiled for a more detailed portrayal and reevaluation of geologic structures and rock units shown on previous geologic maps of the area (e.g., Dibblee, 1979). The following observations and interpretations are based on the new San Guillermo Mountain geologic compilation:

1. The new geologic mapping in the northern part of the San Guillermo Mountain quadrangle allows for reinterpretation of fault architecture that bears on potential seismic hazards of the region. Previous mapping had depicted the eastern Big Pine fault (BPF) as a northeast-striking, sinistral strike-slip fault that extends for 30 km northeast of the Cuyama River to its intersection with the San Andreas fault (SAF). In contrast the new mapping indicates that the eastern BPF is a thrust fault that curves from a northeast strike to an east strike, where it is continuous with the San Guillermo thrust fault, and dies out further east about 15 km south of the SAF. This redefined segment of the BPF is a south-dipping, north-directed thrust, with dominantly dip slip components (rakes > 60^o), that places Middle Eocene marine rocks (Juncal and Matilija Formations) over Miocene through Pliocene(?) nonmarine rocks (Caliente, Quatal, and Morales Formations). Although a broad northeast-striking fault zone, exhibiting predominantly sinistral components of slip (rakes < 45^o), extends to the SAF as previously mapped, the fault zone does not connect to the southwest with the BPF but instead curves into a southwest-directed thrust fault system a short distance north of the BPF. Oligocene to Pliocene(?) nonmarine sedimentary and volcanic rocks of the Plush Ranch, Caliente, and Morales(?) Formations are folded on both sides of this fault zone (informally named the Lockwood Valley fault zone [LVFZ] on the map). South-southeast of the LVFZ overturned folds have southward vergence. Several moderate-displacement (< 50 m), mainly northwest-dipping thrust and reverse faults, exhibiting mostly sinistral-oblique slip, flank and strike parallel to the overturned folds. The fold vergence and thrust direction associated with the LVFZ is opposite to that of the redefined BPF, providing further evidence that the two faults are distinct structures. These revised fault interpretations bring into question earlier estimates of net sinistral strike-slip displacement of as much as 13 km along the originally defined eastern BPF, which assumed structural connection with the LVFZ. Also, despite sparse evidence for repeated Quaternary movement on the LVFZ (e.g., Dibblee, 1982), the potential for a large earthquake involving coseismic slip on both the LVFZ and the central BPF to the southwest may not be as great as once believed.

2. Several generations of Pleistocene and younger dissected alluvial terrace and fan deposits sit at various levels above modern stream channels throughout the quadrangle. These deposits give testimony to the recent uplift and related fault deformation that has occurred in the area.

3. A vast terrane of Eocene marine sedimentary rocks (Juncal and Matilija Formations and Cozy Dell Shale) exposed south of the Big Pine fault forms the southern two-thirds of the San Guillermo Mountain quadrangle. Benthic foraminifers collected from various shale intervals within the Juncal Formation indicate a Middle Eocene

age (Ulatisian) for the entire formation (Stanley and others, 1998) and deposition at paleodepths as great as 2,000 m (i.e., lower bathal).

4. The Lockwood Clay, of probable Pliocene age, forms a thick seam of industrial-quality clay that extends westward into the quadrangle from the area where it is currently being mined in Lockwood Valley. New mapping of the Lockwood Clay in the quadrangle indicates that, although it extends across the northern part of the quadrangle, it locally pinches where it rests unconformably on rocks of the Caliente Formation. The distribution of this clay is important not only because of its economic importance, but also due to its susceptibility to landsliding.

MAP DATABASE

This digital compilation presents a new geologic map database for the San Guillermo Mountain 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 ArcINFO EXPORT format, can be downloaded from http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-99-0032/

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