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GEOLOGIC MAP AND DIGITAL DATABASE OF THE REDLANDS 7.5' QUADRANGLE, SAN BERNARDINO AND RIVERSIDE COUNTIES, CALIFORNIA, v. 1.0

Description of Map Units

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[This Description of Map Units accompanies the geologic map and digital database of the Redlands 7.5' quadrangle, San Bernardino and Riverside Counties, California, version 1.0]

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SURFICIAL DEPOSITS—Earth materials that have accumulated at the land surface over the last 750,000 years or so. These are mainly unconsolidated materials that mantle the ground surface of valleys and hillslopes, or that form the uppermost fillings of alluvial fans and valleys.

Consists of several hierarchical categories of map units. Within a particular family of surficial deposits, map units are distinguished from each other on the basis of erosional dissection of the upper surface, consolidation, and pedogenic-soil development. Thus, within the alluvial-fan category (units Qvyf, Qyf, Qof, and Qvof) and the axial-valley category (units Qvya, Qya, Qoa, and Qvoa), older units progressively are more dissected erosionally, are firmer and better consolidated, and have pedogenic-soil profiles that are progressively better developed. A similar procedure is followed for subunits of a particular unit: subunits (for example, Qyf_3, Qyf_4, and Qyf_5 of unit Qyf) are distinguished on the basis of differences in terrace level and on subtle differences in pedogenic-soil development on the upper surface of each unit. Otherwise, the subunits have physical properties that are very similar.

VERY YOUNG SURFICIAL DEPOSITS—Sediment recently transported and deposited in channels and washes, on surfaces of alluvial fans and alluvial plains, and on hill slopes. Soil-profile development is non-existent to weak. Includes:

Qvyw — Very young wash deposits, active (latest Holocene)—Very slightly consolidated sand and gravel deposits in active washes of axial-valley streams and alluvial fans; has fresh flood scours and channel-and-bar morphology. Forms a variety of deposit types: (1) deposits in channels and arroyos incised into older map units; (2) deposits in networks of narrow, anastomosing channels distributed around terraces of older units; and (3) deposits in thin, continuous to discontinuous veneers that mantle older units. Where wash channels form dense distributary networks, unit Qvyw locally includes older deposits between channels. Pedogenic-soil development generally is nonexistent in areas of Qvyw. In washes of Santa Ana River and City Creek, consists of cobble-boulder gravel and poorly sorted gravelly sand having boulders as much as 1 m in size; in San Timoteo Canyon and elsewhere in quadrangle, unit consists of fine to very coarse sand and pebbly sand. Includes Soboba stony loamy sand (Spc) as mapped by Woodruff and Brock (1980), although pedogenic-soil development generally is nonexistent in areas of Qvyw. In lower San Timoteo Creek Qvyw is confined by flood-control workings

Qvyw2 — **Very young wash deposits, unit 2 (latest Holocene)**—Very slightly consolidated sandy cobble-boulder gravel; identification based mainly on geomorphic analysis of aerial photographs. In northeast part of quadrangle near Mentone, forms thin strath veneer incised into unit Qya_3; in Santa Ana River Wash forms low-lying terraces underlain by pebbly and cobbly sand. Surface supports immature trees and weak organic horizons (Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 9). Appears to be intermittently active based on fresh channel scouring

Qvyw1 — **Very young wash deposits, unit 1 (latest Holocene)**—Very slightly consolidated sand-and-gravel deposits that form slightly elevated terraces in or marginal to channelized washes of streams and rivers; identification based mainly on geomorphic analysis of aerial photographs. Surface supports mature trees and thin organic horizons (Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 9). Mainly abandoned by modern stream flows, but could become occupied by major flood events

Qvyf — **Very young alluvial-fan deposits (latest Holocene)**—Very slightly consolidated to slightly consolidated, undissected deposits of sand and sandy gravel that form active parts of alluvial fans. Unit lacks pedogenic-soil development, or is capped by weak A/AC soils (Soboba gravelly loamy sand and San Emigdio gravelly sandy loam as mapped by Woodruff and Brock, 1980, map sheet 9). Locally includes unmapped areas of unit Qyf_5

Qvya **Very young axial-valley deposits (latest Holocene)**—Very slightly consolidated sandy to gravelly alluvium of through-going stream valleys; usually not incised or channelized

Qvyls **Very young landslide deposits (latest Holocene)**—Slope-movement deposits that consist of chaotically mixed soil and rubble and (or) displaced bedrock blocks; most emplaced as debris slides and rock slumps or earth slumps (terminology follows Varnes, 1978, fig. 2.1). Locally may include older inactive landslide material

YOUNG SURFICIAL DEPOSITS—Sedimentary units that are slightly to moderately consolidated and slightly to moderately dissected. Alluvial-fan deposits (Qyf series) typically have high coarse:fine clast ratios; axial-valley deposits (Qya series) typically have low coarse:fine clast ratios, although some subunits of Qya in the northeast part of the Redlands quadrangle are very coarse grained. Younger surficial units have upper surfaces that are capped by slight to moderately developed pedogenic-soil profiles (A/AC to A/AC/Bcambic profiles having oxidized upper C horizon). Soil groups mapped by Woodruff and Brock (1980) include the Grangeville, San Emigdio, Tujunga, and Hanford series

Young alluvial-fan deposits (Holocene and latest Pleistocene)—Slightly to moderately consolidated sand and gravel having weak to moderately developed pedogenic soils (A/C to A/AC/Bcambic/C_{ox} profiles). Subunits are distinguished from each other on the basis of soil-profile development, relative position in the local terrace-riser succession, and degree of erosional dissection. Includes four subunits recognized regionally:

Qyf5 **Young alluvial-fan deposits, Unit 5 (late Holocene)**—In south part of quadrangle consists of white (10YR 8/2) to light brownish gray (2.5Y 6/2) sandy and gravelly sediment derived from uplifted San Timoteo beds of Frick (1921). Here, unit occupies tributary valleys of San Timoteo Creek, a through-going stream system that formed a local base level for Qyf_5 fills that built fan cones down onto the axial-valley stream floor. Here, unit is capped by A/C and A/AC soils (mainly San Emigdio fine sandy loam and Metz coarse sandy loam as mapped by Woodruff and Brock, 1980, map sheet 9). Locally includes unmapped areas of unit Qvyf. In northeast part of quadrangle, east of City Creek Wash, consists of grayish-brown silty fine to coarse sand and minor pebble gravel; there, unit was deposited in arroyos cut into older alluvial deposits, and as fans deposited on alluvium of unit Qya_4. West of City Creek Wash unit consists of cobble-boulder gravel and gravelly fine to very coarse sand (Tujunga gravelly loamy sand and Hanford coarse sandy loam as mapped by Woodruff and Brock, 1980, map sheet 9)

Qyf4 **Young alluvial-fan deposits, Unit 4 (late Holocene)**—Forms localized alluvial-fan fills in Reche Canyon and San Timoteo Canyon; recognized on the basis of aerial-photographic interpretation. In northwest corner of quadrangle, forms distal end of large, sandy alluvial-fan cone deposited by streamflows of East Twin Creek

Qyf3 **Young alluvial-fan deposits, Unit 3 (middle Holocene)**—Occurs as localized alluvial-fan fills in San Timoteo Canyon, where unit is recognized on the basis of aerial-photographic interpretation. South of Bryn Mawr in west part of quadrangle, unit forms large, thick alluvial-fan fills of sandy and gravelly sediment derived from aggressive erosion of uplifted San Timoteo beds of Frick (1921); these fan cones have built down onto the axial-valley plain of San Timoteo Creek. Here, unit is capped by A/C and A/AC soils (Hanford coarse sandy loam as mapped by Woodruff and Brock, 1980, map sheet 9), and locally includes deposits of Qyf_4 and Qyf_5 that have not been mapped separately because of poor exposures. In northeast part of quadrangle north of East Highlands, unit Qyf_3 consist of sand and gravelly sand. At north-central margin of map, unit forms large fan of pebbly and cobbly sand that coarsens upstream to sandy gravel deposited by City Creek; there, unit is capped by A/C and A/AC/C_{ox} soils (Hanford coarse sandy loam and Tujunga gravelly loamy sand as mapped by Woodruff and Brock, 1980, map sheet 9). Deposit appears to form a significant mid-Holocene fill

Qyf1 **Young alluvial-fan deposits, Unit 1 (early Holocene and latest Pleistocene)**—In northeast corner of map area, unit consists of gravelly alluvium containing bedrock clasts derived from Santa Ana River drainage basin north of San Andreas fault zone, including granodioritic rocks similar to those in Keller Peak area. Unit consists of light-gray cobble-boulder gravel, with clasts fairly unweathered but etched and fractured and draped by organic silty coats; unit capped by soil having thick A horizon and strong C_{ox} horizon. Unit rests unconformably on fine grained deposits of unit Qvos

Young axial-valley deposits (Holocene and latest Pleistocene)—Slightly to moderately consolidated silt, sand, and gravel having slightly to moderately developed pedogenic-soil profiles (A/C to A/AC/Bcambic profiles). Subunits are distinguished from each other on the basis of soil-profile development, relative position in the local terrace-riser succession, and degree of erosional dissection:

Qya5 **Young axial-valley deposits, Unit 5 (late Holocene)**—In south part of map area, unit occurs as isolated remnants of late Holocene deposits that filled valleys of San Timoteo and Yucaipa Creeks. These remnants consist mainly of thin- to thick-bedded very fine to medium sand and silty sand that varies from white and light gray (10YR 8/1 and 7/1) to very pale brown (10YR 8/3 and 8/4 to 7/3). Sand is interlayered with subordinate pebbly fine sand and locally with dark-colored organic-rich layers. In vicinity of Mentone, unit is recognized mainly on geomorphic basis and consists of thin bouldery, cobbly, and sandy strath veneers incised into units Qya_4 and Qya_3. In Santa Ana Wash, unit forms low terraces incised into older units or standing above wash deposits. In east part of the Wash, unit consists of bouldery and cobbly sand capped by weak A/C soil (Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 9). Grain size in unit fines downstream; in vicinity of the former Norton Air Force Base, unit consists of silty sand and subordinate pebbly cobbly sand with minor clay-rich intervals and traces of organic (peat) layers (Tujunga gravelly loamy sand as mapped by Woodruff and Brock, 1980, map sheet 9). Corps of Engineers borings in this vicinity indicate that the large body of Qya_5 under Norton AFB coarsens somewhat from west edge of Redlands quadrangle east toward intersection with City Creek. Here in its greatest outcrop area, borings indicate unit probably only a few meters thick and is underlain by coarser sediment of unknown age and unit assignment

Qya4 **Young axial-valley deposits, Unit 4 (late Holocene)**—Throughout map area, grain size in unit fines downstream to the west. In vicinity of Mentone, unit recognized mainly on geomorphic basis and consists of thin bouldery, cobbly, and sandy strath veneers incised into unit Qya_3. In east part of Santa Ana Wash and in City Creek Wash, unit consists of sandy boulder and cobble gravel and gravelly sand (Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 9). At the confluence of City Creek and Santa Ana River and north of the former Norton Air Force Base, unit consists of silty fine to coarse sand and minor pebble cobble gravel. Unit is capped by weak A/C soils (Tujunga loamy sand intermixed with Hanford coarse sandy loam as mapped by Woodruff and Brock, 1980, map sheet 9)

Qya3 **Young axial-valley deposits, Unit 3 (middle Holocene)**—Unit covers extensive area in central part of Redlands quadrangle, comprising a gently west-sloping alluvial plain formed by sediment aggradation from combined streamflows of Mill Creek, Santa Ana River, and San Timoteo Creeks. In west part of this alluvial plain, unit is relatively fine grained, and consists of light brownish-gray (2.5Y 6/2) to pale brown and very pale brown (10YR 6/3 to 7/3 and 7/4 to 8/4), fine to coarse sand and pebbly sand that coarsens eastward to poorly sorted fine to coarse sand and sandy pebble/small-cobble gravel. Farther east in Mentone area, unit consists of sandy boulder-cobble gravel to gravelly sand. Unit capped by weak to moderate A/AC soils (Tujunga loamy sand and Soboba stony loamy sand and gravelly loamy sand as mapped by Woodruff and Brock, 1980; locally includes Soboba gravelly loamy sand). Beneath this alluvial plain, borings and exposures in terrace wall of Santa Ana Wash indicate unit is at least 10 to 15 m thick, and thus appears to be a significant depositional fill in the Redlands quadrangle. We tentatively infer a mid-Holocene age for this fill.

Qya1 **Young axial-valley deposits, Unit 1 (early Holocene and latest Pleistocene)**—Occurs only in the vicinity of Redlands, where sandy alluvium that occupies a slightly higher terrace level than unit Qya_3 is assigned to Qya_1

Qyls **Young landslide deposits (Holocene and latest Pleistocene)**—Slightly dissected slope-movement deposits that consist of chaotically mixed rubble and (or) displaced bedrock blocks; most emplaced as debris slides and rock slumps or earth slumps (terminology follows Varnes, 1978, fig. 2.1). Slightly dissected, and probably inactive under current climatic and tectonic conditions. Locally may include old landslide deposits

OLD SURFICIAL DEPOSITS—Sedimentary units that are moderately consolidated and slightly to moderately dissected. Alluvial-fan deposits (Qof series) typically are gravelly, but include sand and silt. Valley-filling deposits (Qoa series) are dominated by sand with minor gravel. Older surficial deposits have upper surfaces capped by moderately to well-developed pedogenic soils ($A/AB/B/C_{ox}$ profiles and Bt horizons as much as 1 to 2 m thick and maximum hues typically in the range of 10YR 5/4 and 6/4 [yellowish brown and light yellowish brown] through 7.5YR 6/4 to 4/4 [light brown to dark brown] but reaching 5YR 5/6 [yellowish red]). Soil groups mapped by Woodruff and Brock (1980) include the Greenfield, Monserate, and weaker soils of the Ramona series

Old alluvial-fan deposits (late to middle Pleistocene)—Moderately consolidated silt, sand, and gravel having moderate to well developed pedogenic soils (A/AB/B/C profiles having Bt horizons). Subunits are distinguished from each other on the basis of soil-profile development and relative position in local terrace-riser succession. Includes three units:

Qof3 **Old alluvial-fan deposits, Unit 3 (late to middle Pleistocene)**—Moderately dissected lithologically variable alluvial-fan deposits. In Reche Canyon and San Timoteo Canyon, occurs on high-standing remnants of terraces eroded into San Timoteo beds of Frick (1921) (units QTstr and QTstu); in Redlands area, forms broad alluvial-fan apron downslope from scarp of Redlands fault. Unit is capped by soils having Bt horizons a few tens of centimeters thick (Greenfield soils as mapped by Woodruff and Brock, 1980, map sheet 9). In Reche and San Timoteo Canyons, consists of medium to thick-bedded, yellowish-brown sand and gravel derived from San Timoteo beds of Frick (1921); in Redlands area, driller's logs indicate unit consists of brown to reddish-brown and tan-brown, clayey and silty, fine to very coarse sand with minor pebbles and cobbles derived from unit $Qvoa_3$ on upthrown block of the Redlands fault. Pedogenic-soil profiles capping unit in Reche Canyon and San Timoteo Canyon have been described by Kendrick and others (1994, 2002) and by Kendrick (1996, 1999)

Qof2 **Old alluvial-fan deposits, Unit 2 (late to middle Pleistocene)**—Moderately dissected, brownish-colored, interstratified sand and gravel capped by soils having Bt horizons as much as 50 cm thick (Ramona soils as mapped by Woodruff and Brock, 1980). Unit recognized only in north margin of quadrangle

Qols **Old landslide deposits (late to middle Pleistocene)**—Moderately dissected slope-movement deposits that consist of chaotically mixed rubble and (or) displaced bedrock blocks; most emplaced as debris slides and rock slumps or earth slumps (terminology follows Varnes, 1978, fig. 2.1). Moderately to well dissected, and probably inactive under current climatic and tectonic conditions. Locally may include young landslide deposits

VERY OLD SURFICIAL DEPOSITS—Sedimentary units that are moderately to well consolidated to lithified, and moderately to well dissected. Alluvial-fan deposits (Qvof series) typically are gravelly, but include sand and silt. Valley-filling deposits (Qvoa series) are dominated by sand with minor gravel. Upper surfaces are capped by moderate to well developed pedogenic soils (A/AB/B/C_{ox} profiles having Bt horizons as much as 2 to 3 m thick and maximum hues in the range of 7.5YR 6/4 to 4/4 [light brown to dark brown] and 2.5YR 5/6 [red]). Soil groups mapped by Woodruff and Brock (1980) include stronger soils of the Monserate Ramona series

Very old alluvial-fan deposits (middle to early Pleistocene)—Moderately to well consolidated silt, sand, and gravel having moderate to well developed pedogenic soils (A/AB/B/C_{ox} profiles having Bt horizons). Subunits are distinguished from each other on the basis of soil-profile development and relative position in local terrace-riser succession.

Qvof3 **Very old alluvial-fan deposits, Unit 3 (middle to early Pleistocene)**—Occurs only at north margin of quadrangle, where unit forms brownish silty sand deposit a few meters thick that overlies unit $Qvof_2$. Consists of well consolidated, crudely stratified, light yellowish brown (10YR 6/4 to 5/4), texturally massive to faintly laminated, poorly sorted, fine to very coarse sand. Capped by A/AB/B soils having Bt horizons as much as 2 m thick (Ramona soils as mapped by Woodruff and Brock, 1980, map sheet 9)

Qvof2 **Very old alluvial-fan deposits, Unit 2 (middle to early Pleistocene)**—Occurs only at north margin of quadrangle, where unit forms sequence of sand and subordinate gravel as much as 30 m thick. Well dissected, well consolidated but friable, pale brown to very pale brown (10YR 6/3 to 7/3), well stratified, flat laminated to cross laminated (trough laminations), medium to very coarse sand having abundant angular granules and pebbles; minor thin layers of interbedded fine to medium sand are well sorted and biotitic. Many granule and pebble layers consist of pinkish potassium-feldspar rich material derived either from pegmatite or monzogranite. Clasts are granitic and gneissic types similar to basement rocks of San Bernardino Mountains north of San Andreas Fault zone; maximum clast size 20 cm. Locally capped by silty, pebbly sand veneer of unit $Qvof_3$, or by A/AB/B soils having Bt horizons as much as 3 m thick (Ramona soils as mapped by Woodruff and Brock, 1980, map sheet 9)

Very old axial-valley deposits (middle to early Pleistocene)—Moderately to well consolidated silt, sand, and gravel having moderate to well developed pedogenic soils (A/AB/B/C profiles having Bt horizons). Subunits are distinguished from each other on the basis of soil-profile development and relative position in local terrace-riser succession.

Qvoa3 **Very old axial-valley deposits, Unit 3 (middle to early Pleistocene)**—Consists of alluvial deposits throughout most of quadrangle, but locally includes residuum or pedogenic-soil profile developed on San Timoteo beds of Frick (1921); where possible, this residuum is distinguished as a separate map unit (Qvor; see below), but geographic distinction between *sedimentary deposit* (unit Qvoa$_3$) versus *weathering profile* (unit Qvor) has not been completely mapped out. Whether sedimentary or residuum, all exposures of unit Qvoa$_3$ are deeply dissected and are capped by mature A/AB/B soils having Bt horizons as much as 3 m thick (Kendrick, 1995, 1999; Kendrick and others, 1996, 2002; Ramona soils as mapped by Woodruff and Brock, 1980, map sheet 9). Although some deposits shown as Qvoa$_3$ may be regolith, only sedimentary deposits are described here; description of unit Qvor also applies to residuum parts of unit Qvoa$_3$.

Unit Qvoa$_3$ covers a large area mainly east of San Timoteo Canyon. East of mouth of San Timoteo Canyon and in the vicinity of Community Hospital, the unit is several tens of meters thick, and scours irregularly and unconformably into underlying San Timoteo beds of Frick (1921); in this area, unit Qvoa$_3$ consists of interlayered sandy and gravelly sediment that is slightly to moderately consolidated and brownish colored and easily distinguished from underlying lighter colored and better consolidated San Timoteo beds. Representative Qvoa$_3$ sediment types include: (1) medium to thick lenses and layers of light-gray pebble-cobble gravel with subangular to subrounded clasts of gneissic rock, leucocratic granitoid rocks (both massive and foliated), cataclastic and mylonitic rocks from upper plate of Vincent thrust (exposed in Yucaipa quadrangle to the east), porphyritic hypabyssal or dike rocks, sparse metaquartzite, and Pelona Schist (both grayschist and greenstone); (2) yellowish-brown to very pale brown (2.5Y 6/4 and 6/2 to 10YR 6/4, 7/1, and 7/2) and brownish (10YR 5/4 to 4/4) sandy sediment having various bedding and fabric characteristics. Major types are (i) crudely bedded, texturally massive, poorly sorted, fine- to very coarse-grained granule-bearing to pebble bearing sand; (ii) medium- and thick-bedded, well sorted, texturally massive to finely laminated fine to medium or coarse sand; (iii) crudely bedded, texturally massive, fairly well sorted, fine- to medium-grained sand that is slightly vesicular and possibly eolian in origin. Subsurface borings from areas of unit Qvoa$_3$ report sediment that is well consolidated, reddish-brown to brownish, silty fine to coarse sand with scattered pebble to cobble gravel

Southeast of Redlands Community Hospital to the vicinity of Hillside Cemetery, the contact between unit Qvoa$_3$ and underlying San Timoteo beds of Frick (1921) is queried because the two units are difficult to distinguish from each other. The contact here is placed considerably lower than placed by Morton (1978), who mapped as the boundary between the two map units the base of a red-colored interval higher up the canyon wall. Here, the contact is placed where shown because, a short distance to the northwest in the vicinity of Redlands Community Hospital, sediment of unit Qvoa$_3$ occurs low on the east wall of San Timoteo Canyon without any red zone marking its lower boundary. For this contact to climb abruptly to the southeast and become the red interval mapped by Morton (1978) would require drastic scouring, channeling, or faulting that cannot be demonstrated. We interpret the red boundary mapped by Morton (1978) as the argillic horizon of a pedogenic soil profile developed on top of strata we assign to unit Qvoa$_3$, and we place the map-unit boundary between Qvoa$_3$ and QTstu farther downslope. This boundary appears to climb gradually southeastward toward the red zone mapped by Morton in the vicinity of Hillside Cemetery, and there the area we map as unit Qvoa$_3$ in fact quite probably might be assigned to the residuum unit Qvor. Further studies in this area are needed to resolve these mapping and stratigraphic uncertainties

Qvor **Very old residuum or pedogenic soil (middle to early Pleistocene)**—Consists of residuum and (or) pedogenic-soil profile developed on the San Timoteo beds of Frick (1921); has mature A/AB/B soil profile having Bt horizon as much as 3 m thick (Kendrick and others, 1994, 2002; Kendrick, 1996, 1999; Ramona soils as mapped by Woodruff and Brock, 1980, map sheet 9). Some parts of unit $Qvoa_3$ possibly should be included in unit Qvor, for example strongly reddish intervals high on the east side of San Timoteo Canyon south of Sunset Drive. Near the mouth of San Timoteo Canyon on the high hill directly west of Redlands railroad siding, unit Qvor contains metaquartzite clasts recycled out of the quartzite conglomerate member of the San Timoteo beds of Frick (1921) (unit QTstcq)

Qvos **Very old surficial deposits, undifferentiated (middle to early Pleistocene)**—Well dissected, moderately to well consolidated surficial materials containing clasts of local basement rock; restricted to small area along mountain front west of canyon mouth of Santa Ana River. Outcrops crudely bedded to very thick bedded, light yellowish-brown to yellowish-brown (10YR 6/4 to 5/4 and 5/6 to 2.5Y 6/4). Dominant rock type is texturally massive to locally flat laminated, poorly sorted, medium- to very coarse-grained sand and granule-bearing sand; subordinate is lenticular, granule and pebble gravel that is lighter colored and more grayish. Granules and pebbles are angular to subangular clasts of locally derived gneissic and granitic rock. Deposit locally resembles grusy colluvium where it rests on underlying crystalline rock of unit gg. Locally cut by low-angle faults dipping toward San Bernardino Valley

ROCKS EAST OF MISSION CREEK STRAND, SAN ANDREAS FAULT

gg **Gneissose granitoid rock (Mesozoic and Paleozoic and Proterozoic)**—Crystalline rocks characterized by compositional and textural heterogeneity; forms Wilson Creek block of Matti and others (1992a). Dominant feature is gneissose fabric created by faint to pronounced compositional layering of mafic-rich and mafic-poor layers ranging from millimeter and centimeter lamination to layering on outcrop and hillside scales. Mafic layers are biotite-rich and typically foliated; felsic layers are quartzofeldspathic and range from texturally massive to foliated and commonly have wispy discontinuous layering resembling schlieren. Mafic-rich layers generally are granodiorite to tonalite; quartzofeldspathic layers mainly are biotite-bearing granodiorite, but include monzogranite and tonalite. Contacts between mafic and felsic layers are sharp or transitional, with both kinds of boundary occurring in the same outcrop. Intermixed with the layered rocks are zones consisting of mafic bodies several cm to several m in dimension. The mafic blocks are angular to elliptical or rounded, and probably are blocks of high-strength rock that have been disrupted by dynamic metamorphic or deformational processes; alternatively, some mafic blocks may be xenoliths and (or) inclusions and (or) dismembered and attenuated mafic dikes of diorite-gabbro and mafic granitoid rock. The crystalline complex locally is traversed by low-angle shear zones, and the rocks are highly fractured

ROCKS WEST OF SAN ANDREAS FAULT

San Timoteo beds of Frick (1921) (Quaternary and Tertiary)—Nonmarine sandstone and conglomerate. Forms upper part of thick sedimentary sequence Frick (1921, p. 314) referred to as Tertiary Deposits of the San Timoteo Badlands—specifically his "San Timoteo beds" or "Upper San Timoteo Deposition" (Frick, 1921, p. 283, 317). Until a type section is designated and described, the map unit is classified informally. We subdivide the informal unit according to scheme of Morton (1999). Includes:

QTstu **Upper member (Pleistocene)**—Forms upper part of Frick's San Timoteo beds. Unit consists of both unconsolidated sediment and consolidated rock. Unconsolidated materials typically are moderately consolidated. Consists mainly of medium- to thick-bedded, moderately to well sorted, very fine to coarse sand and sandstone interlayered with subordinate pebbly sand and sandstone and pebble to small-cobble gravel and conglomerate. Stratification defined by variations in grain size, color, and depositional fabric. Sandy intervals distinctly yellowish-colored throughout much of unit, including light yellowish-brown to olive yellow (2.5Y 6/4 to 6/6) and light olive brown (2.5Y 5/6); toward top of unit, beds are browner, including brownish-yellow to yellowish-brown (10YR 6/6 to 5/6) and strong brown (7.5YR 6/6 to 5/6) to pale brown (10YR 6/3). Sandy matrix of gravel beds is lighter colored than typical sand beds, and ranges from light gray to pale yellow and light yellowish brown (2.5Y 7/2 to 6/4) and white to light gray (10YR 8/1 to 7/1). Sandstone beds are moderately to well sorted, consisting of very fine to coarse sand; depositional textures range from massive to flat laminated and cross laminated. Gravel beds are parallel sided to lenticular. Clasts in gravel layers are subrounded to subangular, and include basement rocks found in the adjacent Yucaipa quadrangle, including Pelona Schist (grayschist and greenstone varieties), deformed granitoids from upper plate of Vincent Thrust, and granitoid and gneissic rocks of San Bernardino Mountains-type derived from Yucaipa Ridge in the Yucaipa quadrangle. Sandstone (sand) and conglomerate (gravel) intermittently are interstratified with reddish colored clay- and silt-rich layers as much as 40 cm thick that pass gradationally downward into yellowish-gray oxidized sediment; these intervals appear to be paleosols having Bt horizons (10YR 5/6 to 4/6 to 7.5YR 5/6 to 6/6) and C_{ox} horizons. Unit is cut by fractures and small faults that locally are filled or lined with caliche; pedogenic(?) carbonate is abundant subjacent to contacts between the San Timoteo beds and overlying older surficial materials of units $Qvoa_3$ or Qvor. Lower contact of member not exposed in quadrangle; upper contact is unconformable with units $Qvoa_3$ and Qvor. East of mouth of San Timoteo Canyon, San Timoteo strata overlain by brownish-colored deposits assigned to $Qvoa_3$, and contact interval is not easily distinguished except where a color contrast exists between yellowish-gray and brownish sediment. Upper part of member contains middle Pleistocene (Irvingtonian-II) Shutt Ranch local fauna dated as about 780 to 990 Ka (Albright, 1997, 1999)

QTstcq **Quartzite-bearing conglomerate member (Pleistocene)**—Forms large lenticular body within upper member of San Timoteo beds of Frick (1921). Consists of nonmarine sandstone and conglomerate containing cobbles and small boulders of bedrock types found in Santa Ana River drainage of the San Bernardino Mountains north of the San Andreas Fault zone (Morton and others, 1986). Clasts include metaquartzite typical of Proterozoic outcrops in the Sugarloaf Mountain area, Triassic megaporphyritic monzogranite (Frizzell and others, 1986; Matti and Morton, 1993) that crops out in adjacent Yucaipa quadrangle (Matti and others, 1992b, 2003), and equigranular biotite granodiorite typical of the Keller Peak area about 20 km northeast of Redlands. Member consists of medium- to thick-bedded sandstone, conglomeratic sandstone, sandy conglomerate, and cobble-boulder conglomerate; locally well lithified. Contains early Pleistocene (Irvingtonian-I) Olive Dell local fauna (Repenning, 1987; Albright, 1997, 1999) dated at about 1.3 Ma. Unit appears to be tongue within the upper member of the San Timoteo beds. Upper contact transitional into upper member (QTstu), lower contact faulted against upper member but probably underlain by it

Mzfg **Foliated granitoid rock (Mesozoic)**—Fine- to coarse-grained leucocratic granitoid rocks having heterogeneous compositions and textures. Some rocks are biotite-bearing and contain minor hornblende in irregular clots or streaked out aggregates; other rocks are hornblende-bearing and biotite poor. Compositions mainly are granodiorite to tonalite, but locally include monzogranite and quartz diorite

ROCKS WEST OF SAN JACINTO FAULT

Sedimentary Materials

QTstr **San Timoteo beds of Frick (1921), Reche Canyon member (Pleistocene)**—Nonmarine terrigenous-clastic sedimentary material that ranges from unconsolidated to lithified. Unconsolidated material is moderately consolidated, and consists of sandy and gravelly sediment that locally is crudely stratified but mainly is medium to very thick bedded. Consolidated rock mainly is well consolidated but locally is lithified, and consists of arenaceous and conglomeratic rock that is thin to very thick bedded. The member rests nonconformably on and against plutonic rocks of Peninsular Ranges-type, and with angular unconformity on ripple-laminated member, San Timoteo beds (unit QTstrl); upper contact erosional except where overlain unconformably by Qof_1.

Unconsolidated material consists of sandy and gravelly sediment. Sandy sediment includes muddy sand, sand, very slightly gravelly sand, and gravelly sand; sorting ranges from very poor to very good, but generally is moderate. Gravelly sediment typically is sandy gravel and gravel. Typical gravel layers are pebbly and cobbly, but locally contain boulder-sized clasts. Consolidated material consists of arenaceous and conglomeratic rock. Arenaceous rock includes muddy sandstone, sandstone, very slightly conglomeratic sandstone, and conglomeratic sandstone; sorting ranges from very poor to very good, but generally is moderate. Conglomeratic rock typically is sandy conglomerate and conglomerate. Typical conglomerate layers are pebbly and cobbly, but locally contain boulder-sized clasts. Both gravel and conglomeratic beds commonly are channelate and contain imbricated clasts. Matrix-supported fabrics are rare.

Clasts dominated by two assemblages: (1) granodioritic and tonalitic detritus derived from basement rocks of Peninsular Ranges, and (2) metamorphic and plutonic clasts of San Gabriel Mountains-type (Pelona Schist, mylonitic granitoids of upper plate, Vincent Thrust) and San Bernardino Mountains-type (granitic and gneissic rocks) that either are first-generation clasts derived from those sources or are recycled out of various members of the San Timoteo beds on the east side of the San Jacinto Fault

QTstrl **San Timoteo beds of Frick (1921), ripple-laminated member (Pliocene)**—Forms lower part of San Timoteo beds of Frick (1921). Lithified, light-gray to greenish, thin- to medium-bedded, nonmarine sandstone, siltstone, and claystone, locally gypsum-bearing. Convolute lamination common. Lower contact not exposed in quadrangle; overlain with angular unconformity by Reche Canyon member (QTstr). Rocks similar to QTstrl occur on opposite side of the San Jacinto fault in Mt. Eden area (unit 2 of Matti and Morton, 1975) 25 to 30 km southeast of Redlands quadrangle; on the basis of this correlation, we assign a Pliocene age to outcrops in the Redlands quadrangle

Granitoid rocks of Peninsular Ranges-type

Kmg **Monzogranite (Cretaceous)**—Light-colored coarse-grained, foliated, porphyritic biotite quartz monzonite. Phenocrysts are potassium-feldspar

Kgd **Granodiorite (Cretaceous)**—Light-colored coarse-grained, foliated, equigranular granodiorite

Kt **Tonalite (Cretaceous)**—Mainly gray, coarse-grained, equigranular biotite-hornblende tonalite. Generally foliated and contains widespread dark ellipsoidal inclusions

Kmgt **Monzogranite (Cretaceous)**—Intermingled monzogranite of unit Kmg and tonalite of unit Kt_1

Kt1 **Monzogranite (Cretaceous)**—Heterogeneous, medium- to coarse-grained, biotite tonalite, hornblende tonalite, and biotite-hornblende tonalite. Texturally massive to well foliated and contains locally abundant ellipsoidal inclusions

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