U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
OPEN-FILE REPORT 03-301

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

DESCRIPTION OF MAP UNITS

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2003

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TABLE OF CONTENTS

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 (see Summary Pamphlet). 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 Mill Creek, unit consists of cobble-boulder gravel and poorly sorted gravelly sand having boulders as much as 2 m in dimension; in Yucaipa Valley and elsewhere in quadrangle, unit consists of fine to very coarse sand and pebbly-cobbly sand

Qvyw2 **Very young wash deposits, Unit 2 (latest Holocene)**—Very slightly consolidated sandy cobble-boulder gravel that forms thin strath veneer in the Mentone area; identification based mainly on geomorphic analysis of aerial photographs. Surface supports immature trees and weak pedogenic soils having thin organic horizons (Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10). Formed from recent stream flows of Mill Creek; appears to be intermittently active based on fresh channel scouring

Qvyw1 **Very young wash deposits, Unit 1 (latest Holocene)**—Very slightly consolidated cobble-boulder gravel that occurs in the Mentone area; identification based mainly on geomorphic analysis of aerial photographs. Surface supports mature trees and pedogenic soils having thin organic horizons (Hanford coarse loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10). Unit is thin strath fill deposited from recent stream flows of Mill Creek

Qvyf **Very young alluvial-fan deposits (latest Holocene)**—Very slightly consolidated to slightly consolidated, undissected deposits of sand, slightly gravelly sand, and sandy gravel that form active parts of alluvial fans; units near base of Yucaipa Ridge are more gravelly than elsewhere in quadrangle. Unit lacks pedogenic-soil development, or is capped by weak A/AC soils (Hanford coarse sandy loam to Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10). 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

Qvyc **Very young colluvial deposits (latest Holocene)**—Very slightly consolidated and incoherent sediment and (or) rock fragments transported by slow continuous downslope creep and rainwash and deposited at the base of gentle slopes or hillsides

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 Yucaipa quadrangle are very coarse grained (as in the Mentone area). 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 five subunits:

Qyf5 **Young alluvial-fan deposits, Unit 5 (late Holocene)**—In southeast part of quadrangle consists of sandy and gravelly sediment derived from unit Mzmg. Here, unit occupies tributary valleys of Yucaipa Creek, a through-going stream system that formed the 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 Hanford coarse sandy loam and Tujunga gravelly loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10)

Qyf4 **Young alluvial-fan deposits, Unit 4 (late Holocene)**—Forms extensive slightly dissected deposits downstream from canyon mouths of Mill Creek and Santa Ana River. Consists of sandy cobble-boulder gravel and poorly sorted gravelly sand that is white (10YR 8/1 to 8/2) to light-gray (10YR 7/1). Unit capped by thin A/C soil (Soboba stony loamy sand of Woodruff and Brock, 1980, map sheet 10)

Qyf3 **Young alluvial-fan deposits, Unit 3 (middle Holocene)**—Forms remnant terrace risers downstream from canyon mouths of Mill Creek and Santa Ana River; consists of sandy pebble-cobble-boulder gravel and poorly sorted gravelly sand that is white (10YR 8/2) to very pale brown (10YR 8/3 to 8/4). Also forms fine-grained alluvial-fan cones that flank the Crafton Hills, Yucaipa Ridge, and the San Bernardino Mountains, and that locally accumulated downslope from fault scarps of Yucaipa Valley graben. Unit capped by medium to thick A/C and A/AC/C_{ox} soils (Hanford coarse sandy loam and Oak Glen gravelly sandy loam as mapped by Woodruff and Brock, 1980, map sheet 10). Deposit appears to form a significant mid-Holocene fill

Qyf2 **Young alluvial-fan deposits, Unit 2 (early Holocene)**—Unit occurs as local deposits of pebbly and cobbly sediment in east-central part of quadrangle

Qyf1 **Young alluvial-fan deposits, Unit 1 (early Holocene and latest Pleistocene)**—In east-central part of quadrangle unit consists of sand-and-gravel deposits that form small alluvial fans flanking Yucaipa Ridge (Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10). These deposits have Bcambic horizon and well developed Cox horizon as described by Harden and Matti (1989). East of mouth of Mill Creek Canyon unit consists of pinkish gray pebbly sand deposits that form veneer a few meters thick on older deposits. In northwest corner of quadrangle, unit consists of gravelly alluvium containing clasts of bedrock found in drainage basin of Santa Ana River north of San Andreas fault zone, including granodioritic rocks like 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 Cox horizon. Unit rests unconformably on fine grained deposits of unit Qvos. In Yucaipa quadrangle, unit appears to be part of major fill event that occurred throughout the San Bernardino Valley region during transition between late Pleistocene and Holocene (McFadden and Weldon, 1987; Morton and Matti, 1987; Bull, 1991)

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. Includes four subunits:

Qya5 **Young axial-valley deposits, Unit 5 (late Holocene)**—Adjacent to Santa Ana and Mill Creek washes, unit consists of grayish brown (10YR 5/2), pale brown to very pale brown (10YR 6/3 to 7/3), and yellowish brown (2.5Y 7/3), sandy cobble-boulder strath fills incised into units Qya_4 and Qya_3; identification based mainly on distribution of subdued terrace tread and relatively fresh channel-and-bar geomorphology observed on aerial photographs. There, unit capped by weak A/AC soil (Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10). In south part of quadrangle, unit forms upper part of late Quaternary fill that occupies valleys of Oak Glen and Yucaipa Creeks. There, unit consists mainly of thin- to thick-bedded very fine to medium 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); sandy sediment is interlayered with subordinate pebbly fine sand and dark-colored organic-rich layers. Unit commonly capped by weak A/C soil (San Emigdio fine sandy loam and Hanford coarse sandy loam coarsening upstream to Tujunga loamy sand and gravelly loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10). Unit incised by Yucaipa and Oak Glen Creeks

Qya4 **Young axial-valley deposits, Unit 4 (late Holocene)**—Adjacent to Santa Ana and Mill Creek washes, unit consists of grayish brown (10YR 5/2), pale brown to very pale brown (10YR 6/3 to 7/3), and yellowish brown (2.5Y 7/3), sandy cobble-boulder strath fill incised into unit Qya_3; identification based mainly on distribution of subdued terrace tread observed on aerial photographs. There, unit capped by weak A/AC soil (Soboba stony loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10). In east-central part of quadrangle in valleys of Oak Glen and Wilson Creeks, unit forms thin veneer resting on a strath terrace incised into unit Qya_3 or forms a low terrace riser standing a meter or less above the active wash. There, unit consists of pale brown and very pale brown (10YR 6/3 to 8/3) fine to coarse sand and pebbly sand that coarsens upstream to poorly sorted fine to coarse sand and sandy pebble-small cobble gravel. Unit capped by weak $A/AC/C_{ox}$ soils (Hanford coarse sandy loam and Tujunga loamy sand as mapped by Woodruff and Brock, 1980, map sheet 10)

Qya3 **Young axial-valley deposits, Unit 3 (middle Holocene)**—In northwest part of quadrangle, unit forms gently west-sloping alluvial plain that formed by sediment aggradation from combined streamflows of Mill Creek and Santa Ana River. Underlying this plain, unit Qya_3 probably is no more than 5 m thick and consists of sandy boulder-cobble gravel to cobble-pebble gravel and gravelly sand; south of Colton Avenue, grain size decreases to sand. Unit capped by weak to moderate A/AC soils (Soboba gravelly loamy sand with localized Hanford coarse sandy loam as mapped by Woodruff and Brock, 1980, map sheet 10). In east-central part of quadrangle in the valleys of Oak Glen and Wilson Creeks, unit forms terrace riser standing 1 to 2 m above the active wash. Unit probably is no more than 2 to 5 m thick, and consists of 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 upstream to poorly sorted fine to coarse sand and sandy pebble/small-cobble gravel. Unit capped by weak to moderate A/AC/Cox soils (Tujunga loamy sand and gravelly loamy sand as mapped by Woodruff and Brock, 1980; locally includes Soboba gravelly loamy sand). In Yucaipa Valley region, unit Qya_3 represents an aggradational event, and formed as fluvial sediment back-filled valleys and buttressed unconformably against high-standing older alluvial deposits

Qya1 **Young axial-valley deposits, Unit 1 (early Holocene and latest Pleistocene)**—Occurs in central part of quadrangle in the valley of Oak Glen Creek, where unit forms terrace riser standing several meters above the active wash. Unit probably is no more than 5 m thick and consists of pale brown and very pale brown (10YR 6/3 to 8/3) fine to very coarse sand and pebbly sand that coarsens upstream to poorly sorted sand and sandy pebble/small-cobble gravel. Unit is capped by moderately developed A/AC/Bcambic/Cox soils (grouped variously by Woodruff and Brock, 1980, into Greenfield and Tujunga loamy sand and sandy loam and Oak Glen gravelly sandy loam). In Yucaipa Valley region, unit formed as fluvial sediment backfilled valleys and buttressed unconformably against high-standing older alluvial deposits

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 soils and weaker soils of the Ramona series

Old alluvial-fan deposits (late to middle 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. Includes three units recognized regionally:

Qof3 **Old alluvial-fan deposits, Unit 3 (late to middle Pleistocene)**—Moderately dissected inter-stratified sand and gravel capped by soils having Bt horizons a few tens of centimeters thick (Greenfield soils as mapped by Woodruff and Brock, 1980).

Unit occurs in alluvial fans that flank Yucaipa Ridge and the San Bernardino Mountains west of mouth of Mill Creek Canyon

Qof2 **Old alluvial-fan deposits, Unit 2 (late to middle Pleistocene)**—Moderately dissected 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 occurs in alluvial fans that flank the Crafton Hills, Yucaipa Ridge, and the San Bernardino Mountains

Qof1 **Old alluvial-fan deposits, Unit 1 (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 occurs only in north margin of quadrangle

Old axial-valley deposits (late to middle 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. Consists of two main deposits (Qoa_1 and Qoa_2) that filled valley areas as the result of deposition by Oak Glen and Yucaipa Creeks and their tributaries, and a third unit (Qoa_3) that forms a thin strath veneer. These three units are recognized regionally:

Qoa3 **Old axial-valley deposits, Unit 3 (late to middle Pleistocene)**—Deposit forms thin veneer of sand and pebbly sand overlying a strath terrace incised into unit Qoa_3. Capped by soils having thin to moderate Bt horizons (Greenfield soils as mapped by Woodruff and Brock, 1980). Unit recognized only in south-central part of quadrangle

Qoa2 **Old axial-valley deposits, Unit 2 (late to middle Pleistocene)**—Moderately dissected 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 occurs in south-central and east-central parts of quadrangle. In the valley of Oak Glen Creek, unit Qoa2 forms a widespread fill more than 10 m thick that rests unconformably on unit Qoa1; on the bench beneath the City of Yucaipa, unit Qoa_2 is more restricted in distribution and forms a thin veneer deposited on a strath incised into Qoa_1

Qoa1 **Old axial-valley deposits, Unit 1 (late to middle Pleistocene)**—Moderately dissected interstratified sand and gravel capped by soils having Bt horizons as much as 50 to 150 cm thick (Ramona soils as mapped by Woodruff and Brock, 1980). Unit occurs in east part of quadrangle. In the valley of Oak Glen Creek, Qoa1 consists of poorly sorted sand and pebble-cobble-boulder gravel that locally is preserved beneath overlying unit Qoa_2. In Yucaipa Valley, Qoa_1 forms a widespread body deposited by streamflows of Yucaipa and Oak Glen Creeks that converged southwest and flowed down ancestral Live Oak Canyon

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; clasts in gravel and conglomerate layers are highly weathered and easily disaggregated. 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 Ramona series

Qvos **Very old surficial deposits, undifferentiated (middle to early Pleistocene)**—Well dissected, slightly to moderately consolidated alluvium 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 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

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. Includes one of three units recognized in the San Bernardino Basin region (see summary pamphlet):

Qvof3 **Very old alluvial-fan deposits, Unit 3 (middle to early Pleistocene)**—Well dissected sand and gravel capped by AB/B/C_{ox} soils having Bt horizons as much as 1 to 3 m thick (Ramona soils as mapped by Woodruff and Brock, 1980). Locally forms relict alluvial-fan deposits around margins of the Crafton Hills, but mainly occurs between Mill Creek and Santa Ana River southwest of the San Bernardino strand of the San Andreas fault. There, $Qvof_3$ consists of interlayered sand, gravelly sand, and sandy cobble-boulder gravel; sand intervals and matrix in the gravel layers are very pale brown to light yellowish brown (10YR 8/4 to 6/4). Clasts are rounded to subangular, and consist of sandstone derived from the Mill Creek Formation as well as granitoid and gneissose rock types derived from crystalline bedrock sources in the San Bernardino Mountains east of the Mill Creek strand of the San Andreas fault

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_{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. Includes one of three units recognized regionally (see summary pamphlet):

Qvoa3 **Very old axial-valley deposits, Unit 3 (middle to early Pleistocene)**—Well dissected sand and gravel capped by A/AB/B/C_{ox} soils having Bt horizons as much as 2 to 3 m thick (Ramona soils as mapped by Woodruff and Brock, 1980). Occurs mainly in southwest part of quadrangle where unit rests conformably on the San Timoteo beds of Frick (1921). In the vicinity of Sand Canyon, $Qvoa_3$ consists of brownish yellow (10YR 6/6 to 6/8) to dark yellowish brown (10YR 4/4) sand and gravel layers interstratified with Bt-bearing paleosols having 7.5YR to 5YR hues. In the hills north of Live Oak Canyon, $Qvoa_3$ is uniformly more reddish in color, is more dissected, and the pedogenic surface soil is thicker and better developed. There, materials locally mapped as $Qvoa_3$ are similar lithologically to underlying deposits of the San Timoteo beds of Frick (1921), and the reddish coloration partly may be pedogenic regolith developed on the San Timoteo beds. In northeast part of quadrangle in walls of Oak Glen Creek and its tributaries, unit $Qvoa_3$ consists of cobble-boulder gravel and gravelly sand containing rounded to subangular clasts of bedrock types found on Yucaipa Ridge

ROCKS EAST OF SAN ANDREAS FAULT

Kcc **Monzogranite of City Creek (Cretaceous)**—In Yucaipa quadrangle consists of biotite monzogranite, although to the north and northwest the unit is very heterogeneous, containing included masses of older monzogranite, granodiorite, diorite, and gabbro ranging in length from centimeters to hundreds of meters (Morton and Miller, in press). In Yucaipa quadrangle, unit is relatively uniform, even-grained to subporphyritic, medium- to coarse-grained monzogranite, some of which contains muscovite. Most monzogranite is quartz-rich, but quartz is deformed and sutured. Biotite is only mafic mineral, and in much of unit is intergranular to felsic minerals and slightly disaggregated. In some monzogranite muscovite is primary; rarely exceeds one percent of rock. Plagioclase averages an_{20}, and is subordinate to potassium feldspar; potassium feldspar is both orthoclase and microcline. Conventional potassium-argon age of biotite from muscovite-biotite monzogranite northwest of Yucaipa quadrangle is 66 Ma, but is considered cooling age by Miller and Morton (1980, sample 59A)

Kga **Granodiorite of Angelus Oaks (Cretaceous)**—Coarse-grained, texturally massive, nonporphyritic granodiorite having biotite dominant over hornblende; biotite forms centimeter-wide grains in places. Color index averages 15. Plagioclase averages an_{35}; potassium feldspar is microperthitic orthoclase. Quartz forms large, multi-grain masses that show moderate deformation and suturing. Deeply weathered in most places. Hornblende and biotite from a sample 15 km northeast of Yucaipa quadrangle yielded conventional potassium-argon ages of 71 Ma and 72 Ma, respectively (Miller and Morton, 1980, sample 90); considered cooling ages, not emplacement ages

Ꞧm **Porphyritic monzogranite (Triassic)**—Medium- to coarse-grained porphyritic hornblende-biotite monzogranite to quartz monzonite; characterized by euhedral to subhedral phenocrysts of potassium feldspar as much as 5 cm long. Emplacement age of 215 Ma determined by the U/Pb method (Frizzell and others, 1986). Rock intruded by dikes of mafic hornblende-rich rock and by dikes and small bodies of fine- to coarse-grained biotite granodiorite to monzogranite that locally comprise dominant rock type. Some of these are similar to Granodiorite of Angelus Oaks (unit Kga)

ROCKS BETWEEN WILSON CREEK AND MILL CREEK STRANDS, SAN ANDREAS FAULT

Tw **Formation of Warm Springs Canyon (Miocene?)**—Nonmarine sandstone and conglomerate. Unit occupies same structural position as unnamed sedimentary rocks mapped by Morton and Miller (1975, figs. 1c-1g) along southwest margin of San Bernardino Mountains; mapped as Mill Creek Formation by Gibson (1964, 1971) and by West (1987), as Potato Sandstone by Dibblee (1982), and as Potato Formation by Hillenbrand (1990). Base faulted against orthogneiss of Alger Creek, but equivalent rocks in adjacent Forest Falls quadrangle rest depositionally on crystalline rocks of San Bernardino Mountains block (J.C. Matti, unpubl. mapping, 1988-1991). Upper contact erosional. Consists of heterogeneous sedimentary rocks dominated by well sorted to poorly sorted sandstone, conglomerate, and conglomeratic sandstone interlayered with localized intervals of mudrock:

Sandstone: Color and bedding characteristics variable. *Greenish fine-grained sandstone*.—Thin- to medium-bedded, moderately to well sorted, fine- to coarse-grained lithic and feldspathic sandstone that is parallel bedded and texturally massive to flat laminated and cross laminated; pillow-and-ball structure developed locally.

Sandstones typically greenish and grayish colored; representative hues include light olive gray to pale olive (5Y 6/2 to 5/2), olive gray (5Y 4/2 to 5/2), and light gray (5Y 7/2). These beds commonly are associated with greenish-colored mudrock intervals, and the sandstone-mudrock sequences resemble similar intervals in Mill Creek Formation of Gibson (1971). *Buff to grayish arkosic sandstone*.—Thin- to thick-bedded, moderately to poorly sorted, fine- to very coarse-grained lithic and feldspathic sandstone and pebbly sandstone; texturally massive to flat laminated and cross laminated (including shallow trough laminations). Typically grayish to buff colored; representative hues include white (10YR 8/1 and 8/2 to 2.5Y 8/2), light gray (10YR 7/1 to 7/2), and very pale brown (10YR 8/3 to 8/4). *Pinkish gray to reddish sandstone*.—Compositionally and texturally immature rocks that are medium- to very thick-bedded, moderately to poorly sorted, medium- to very coarse-grained lithic and feldspathic sandstone and pebble-granule-bearing sandstone; texturally massive to laminated and cross laminated, including large-scale trough laminations and tabular cross laminations. Lenticular bedding geometry dominates locally. These rocks typically are pinkish to reddish colored; representative hues include pinkish gray, reddish gray, and reddish brown (5YR 7/2, 6/2, 5/2, and 5/3), pale red (10R 6/2), and grayish red purple (5RP 4/2). Quartz, feldspars, and lithic framework grains are angular to subrounded; biotite and muscovite are common accessory minerals.

Conglomerate: Medium- to very thick-bedded pebble-cobble conglomerate and conglomeratic sandstone. Conglomerate intervals are dominantly pinkish-gray, but also are yellowish-gray to pale brownish depending on composition of matrix and clasts. Typical pinkish hues include pinkish gray, reddish gray, and reddish brown (5YR 7/2, 6/2, 5/2, and 5/3), pale red (10R 6/2), and grayish red purple (5RP 4/2). Yellowish gray and light-brown hues include white to pale yellow (2.5Y 8/2 to 7/4) and white to very pale brown (10YR 8/1 through 8/4). Clasts range from pebbles to large cobbles, although typically are pebbles and small cobbles. They are subangular to subrounded, and are dominated by leucocratic to mesocratic gneissose rocks and leucocratic granitoid rocks; greenish hornblende diorite-gabbro clasts are minor but distinctive components.

Mudrock: Recessive, laminated to medium bedded grayish green to brownish siltstone, mudstone, and claystone. Generally texturally massive, but faint to well developed flat to irregular lamination is common

Mzga **Orthogneiss of Alger Creek (Mesozoic?)**—Light-gray fine- to medium-grained biotite-hornblende granodiorite having well developed lenticular laminated fabric created by segregations of quartz, pink feldspar, and mafic minerals. Locally encloses thin lenses of dark foliated amphibolite. Unit commonly is sheared and fractured, and weathers dark brown. Informally named for Alger Creek in the adjacent Forest Falls 7.5' quadrangle where unit crops out directly northeast of Mill Creek Strand of the San Andreas Fault (B.F. Cox and J.C. Matti, unpublished mapping, 1978-1980)

ROCKS BETWEEN MISSION CREEK AND WILSON CREEK STRANDS, SAN ANDREAS FAULT

Mill Creek Formation (of Gibson, 1971) (Miocene)—Nonmarine claystone, mudstone, sandstone, and conglomerate; Miocene, probably late Miocene (Woodburne, 1975). Nonconformably overlies crystalline rocks of Wilson Creek block; upper contact is erosional. Gibson (1964, 1971) applied the name Mill Creek Formation to outcrops Vaughan (1922) originally grouped within his Potato Sandstone. Vaughan's original characterization of the Potato Sandstone was only generalized, and since that time sedimentary rocks within the Potato outcrop belt have been mapped and classified differently by various workers (Smith, 1959; Owens, 1959; Gibson, 1964, 1971; Dibblee, 1982; Matti and others, 1985, 1992; Demirer, 1985; West, 1987; Hillenbrand, 1990). We restrict the name Mill Creek Formation to beds between the San Bernardino and Wilson Creek strands of the San Andreas fault. Lithologies include:

Conglomerate: Ledge-forming, medium- to very thick-bedded, sandy pebble and small-cobble conglomerate and conglomeratic sandstone. Conglomerate intervals are yellowish to grayish to pale-brown depending on matrix and clast composition; representative hues include pale yellow (5Y 8/3 to 7/3), light-gray, white, and pale yellow (2.5Y 7/2, 8/2, and 8/4), and white, light-gray, and very pale brown (10YR 8/1 to 8/3 and 7/1 to 7/3). Beds are lenticular on a scale of tens to hundreds of meters. Depositional fabrics mainly are grain supported and fluvial in origin; matrix-supported debris-flow fabrics are rare. Clast sizes range from pebbles to medium cobbles, and are rounded to subangular. Clast populations dominated by leucocratic to mesocratic granitoid and gneissose types but locally include Pelona Schist and volcanic clasts.

Sandstone: Ledgeforming, thin- to thick-bedded, poorly sorted to well sorted very fine to coarse lithic and feldspathic sandstone. Beds generally are lenticular over distances of a few tens of meters to several hundred meters; more persistent strata are parallel bedded. Sandstone intervals are yellowish to grayish to pale-brown depending on grain size, biotite content, and framework-grain composition; representative hues include pale yellow to light yellowish brown (2.5Y 7/4 to 6/4), light-gray (10YR 7/1 and 7/2 to 2.5Y 7/2), olive gray to gray (5Y 5/1 to 5/2), light-gray to light brownish gray (2.5Y 7/2, 6/2), and very pale brown to light yellowish brown (10YR 8/3 and 7/3 to 6/4). Textures vary from massive to flat laminated to cross laminated to graded; some sand beds are convolute-laminated and locally have pillow-and-ball structure. Most sandstones are fluvial in origin, but some were deposited from turbidity currents and sediment-gravity flows in lacustrine settings.

Mudrock: Recessive, very thin- to medium-bedded claystone, mudstone, siltstone, and very fine-grained sandstone. Mudrock intervals are distinctly greenish to brownish colored. Representative hues for fresh rock include gray and greenish-gray (5Y 5/1 to 5GY 5/1), olive gray to gray (5Y 5/2 and 4/2 to 4/1), pale olive (5Y 6/3), grayish brown to brown and dark grayish brown (10YR 5/2 to 5/3 and 4/3), and pinkish gray (7.5YR 6/2); weathering colors are more reddish and brownish, including pale red (5R 6/2 to 10R 6/2), reddish gray (5YR 5/2), and reddish brown to dark reddish brown (5YR 4/3 to 3/3) to dark yellowish brown (10YR 4/4). Generally texturally massive, but faint to well developed flat to irregular lamination is common. Mudcracks occur locally, and flat-pebble conglomerate or conglomeratic sandstone associated with mudrock intervals may represent rip-up breccias. Dark organic fragments are abundant in some mudrocks together with deciduous and coniferous plant fossils (see Axelrod *in* Smith, 1959, p. 31-33 and *in* Gibson, 1964, p. 8-9)

Tmm **Mudstone unit**—Stratigraphic interval where mudrock predominates over sandstone

Tmcv **Volcanic-clast-bearing unit**—Unit of ledgeforming, thick- to very thick-bedded, buff-weathering, moderately to well sorted, fine- to coarse-grained sandstone and pebble-cobble-bearing sandstone. Contains aplitic, granitoid, and gneissose clasts, but characterized by rounded to subrounded pebbles and small cobbles of volcanic rock (latite, quartz latite, basaltic andesite, and andesite). Representative sandstone hues include very pale brown to light-gray (10YR 7/3 to 7/2) and pale olive to light-gray (5Y 6/4 to 7/2)

Tms **Sandstone unit**—Stratigraphic interval where sandstone predominates over mudrock

Tma **Arkosic-sandstone unit**—Stratigraphic interval dominated by pale-brown to yellowish weathering sandstone that is so feldspathic we describe it as arkosic. Typical hues include very pale brown to pale brown (10YR 7/3 to 7/4, 6/3), light-gray (5Y 6/1 and 10YR 7/2), yellow (10YR 7/6 to 7/8) and light yellowish brown (10YR 6/4). Pebbly and cobbly sandstone and conglomerate lenses locally abundant; clasts are rounded to subangular, consist mainly of leucocratic granitoid and gneissose rocks, some muscovite-bearing. Framework grains and conglomerate matrix are feldspar-rich and locally muscovite-bearing. Contact with Tmm is gradational

Tmcp **Pelona Schist-bearing conglomerate unit**—Unit of ledgeforming, thick- to very thick-bedded, brownish-gray to greenish-gray weathering, moderately to poorly sorted coarse sandstone, pebbly sandstone, and pebble-cobble conglomerate characterized by clasts of bluish-gray coarsely crystalline Pelona Schist, dark green gneissose diorite, intermediate granitoids, milky vein quartz, leucocratic aplitic rock, and rare volcanic rocks. Schist clasts are similar to bedrock of unit Mzpsg that depositionally(?) underlies Mill Creek Formation in east part of quadrangle

Mzpsg **Pelona Schist, greenstone unit (Mesozoic protolith)**—Dark blue-green to light-gray, highly schistose, medium to coarsely crystalline porphyroblastic chlorite-albite-actinolite greenstone; light-gray to yellowish-gray quartzofeldspathic schist is rare. Unit Mzpsg is a distinctly different facies of Pelona Schist than occurs in the Crafton Hills southwest of the San Bernardino and Mission Creek strands of San Andreas Fault. Lithologically similar to Pelona Schist in Blue Ridge window of Pelona Schist in southeastern San Gabriel Mountains (Smith, 1959). Relation with suprajacent beds of Mill Creek Formation uncertain; probably overlain nonconformably by Tmm, but may be landslide sheet interlayered with Tmm or (less likely) fault slice juxtaposed with Tmm. Pre-metamorphic protolith probably is Jurassic and (or) Cretaceous, and metamorphism under lower greenschist conditions probably occurred in late Mesozoic or earliest Tertiary time (Jacobson, 1990, 1997; Jacobson and Dawson, 1995; Jacobson and others, 1996)

Mzg **Granitoid rock (Mesozoic)**—Light-gray to pinkish-gray texturally massive to slightly foliated, medium- to coarse-grained, biotite-bearing leucocratic granitoid rock that is monzogranitic to granodioritic in composition. Rock locally has potassium-feldspar phenocrysts as much as 1 cm in dimension

Mzgr **Mesocratic granitoid rock (Mesozoic)**—Fine- to coarse-grained granodiorite, tonalite, and quartz diorite that is highly weathered

Mzi **Inclusion-rich granitoid rock (Mesozoic)**—Narrow elongate zones of mafic inclusions enclosed by gneissose granitoid rock (gg). Most inclusions are dioritic to quartz dioritic, but some are gabbroic. Inclusions typically are flattened and ovoid

Mzc **Diorite of Cram Peak (Mesozoic)**—Medium- to coarse-grained, texturally massive to slightly foliated, equigranular hornblende diorite and quartz diorite. Relations with unit gg ambiguous: in some outcrops Mzc appears to intrude gg; in others, unit gg appears to in part be a deformed phase of unit Mzc

gg **Gneissose granitoid rock and gneiss (Mesozoic and Paleozoic and Proterozoic)**—Crystalline rocks characterized by compositional and textural heterogeneity; forms Wilson Creek block of Matti and others (1992). 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 are marked by wispy discontinuous layering that resembles schlieren. In thin section, quartz has slight to profound undulatory extinction and some plagioclase and potassium feldspar are ragged and strained. Mafic-rich layers generally are granodiorite to tonalite; quartzofeldspathic layers mainly are biotite-bearing granodiorite, but include monzogranite, tonalite, and less common quartz monzodiorite. 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; some of these are mappable (unit Mzi), but most are only a few meters wide and cannot be mapped laterally. 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 and Pliocene)**—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. Beds texturally massive to flat laminated and cross laminated. Sandy intervals distinctly yellowish colored throughout much of the unit, and includes hues such as light yellowish-brown (2.5Y 6/4), olive yellow (2.5Y 6/6), and light olive brown (2.5Y 5/6); toward top of unit, beds are more brownish, including brownish-yellow (10YR 6/6), yellowish-brown (10YR 5/6), and strong brown (7.5YR 6/6 to 5/6). 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). Clasts in gravel and conglomerate layers are subrounded to subangular, and include most of the basement rocks in the quadrangle (granitoids from upper plate of the Vincent thrust and granitoid and gneissic rocks of San Bernardino Mountains-type derived from Yucaipa Ridge). 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 alluvial deposits

Tgr **Granodiorite (Tertiary?)**—Granodioritic quartz porphyry; occurs as sills and small bodies intrusive into Pelona Schist. North of Mill Creek, unit is texturally massive to foliated, medium- to coarse-grained granodiorite that forms small stock-like mass containing xenoliths of biotite-bearing Pelona Schist. South of Mill Creek, unit Tgr is mixed Pelona Schist and igneous rock, and forms sill-like bodies in which igneous rock is dominant lithology. There, white to light-gray, fine- to medium-grained quartz porphyry contains lenticular, light yellowish-brown and pale yellowish-brown to light-gray, well foliated semischist. Original igneous fabric is largely obscured by shearing and recrystallization. Probably correlative with Mountain Meadows Dacite (as described by Shelton, 1955)

Ta **Andesite to dacite (Tertiary)**—Dikes of black to very dark grayish-brown, finely crystalline to aphanitic porphyritic andesite to dacite that is texturally massive. Has phenocrysts of plagioclase, quartz, and biotite

₥psm **Pelona Schist, muscovite schist unit (Mesozoic protolith)**—Metasedimentary and metaigneous rocks in lower plate of Vincent thrust. Consists mainly of light- to medium-gray, foliated to laminated (transposed layering), quartzofeldspathic muscovitic schist containing white lenses of vein quartz. Protolith of muscovite schist was fine to coarse-grained quartzofeldspathic sedimentary rock. Layers of foliated fine- to medium-grained albite-actinolite schist (greenstone) locally are abundant throughout the unit, especially. directly beneath Vincent Thrust. Age of protolith of schist and greenstone probably is Jurassic and (or) Cretaceous, and metamorphism under low greenschist conditions probably occurred in late Mesozoic or earliest Tertiary (Jacobson, 1990, 1997; Jacobson and Dawson, 1995; Jacobson and others, 1996).

In the northeast corner of the Crafton Hills, near the center of Section 24, Pelona Schist east of unnamed fault is fine-grained, thinly layered, and crenulated, and consists almost entirely of quartz and biotite with minor potassium feldspar and white mica. Most biotite is oriented at slight angle to compositional layering. Contains scattered, very fine-grained opaque minerals having dust-like appearance. Detrital zircon is present but sparse. Tentatively included within Pelona Schist, but association not certain. Differs from typical Pelona Schist by abundance of biotite, and unlike transposed layering that characterizes most Pelona Schist, compositional layering here appears to be relic bedding. Probably higher metamorphic grade than Pelona Schist elsewhere in the Crafton Hills area. Derived from protolith that is compositionally more mature than any other part of the Pelona Schist

₥d **Diorite (Mesozoic)**—Medium- to coarse-grained, texturally massive to slightly foliated hornblende-biotite diorite and quartz diorite. Age and intrusive relations with units ₥mg and ₥fg uncertain

₥mg **Mylonitic and cataclastic granitoid rock (Mesozoic)**—Fine- to coarse-grained granodiorite, tonalite, and quartz diorite that has a variety of non-penetrative and penetrative fabrics, including fractured, sheared, and crushed rock, brittle cataclastic fabrics (grain crushing and fracturing), and ductile mylonitic fabrics (milling, fluxion structure). Locally includes small hornblende-bearing monzogranitic bodies of Triassic Mount Lowe intrusion as described in the San Gabriel Mountains (see Ehlig, 1981, Joseph and others, 1982, and Barth and Ehlig, 1988). Separated from underlying Pelona Schist by thrust fault correlated with Vincent Thrust of eastern San Gabriel Mountains

₥fg **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

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