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

EXPLANATION

Contact—Solid where accuracy of location ranges from well located to approximately located; dashed where very poorly located or inferred.

Fault—Solid where accurately located, dashed where approximately located, dotted where concealed. Includes strike slip, normal, reverse, oblique, and unspecified slip. Arrow and number indicate direction and amount of dip.

Thrust fault—Teeth on upper plate; solid where accurately located, dashed where approximately located, dotted where concealed. Arrow and number indicate direction and amount of dip.

Rotational slip normal fault—Bars on hanging wall side; solid where accurately located, dashed where approximately located, dotted where concealed.

Topographic lineaments— Aligned saddles, swales, and canyons.

Dike rocks—Includes basaltic, andesitic, latitic, and rhyolitic hypabyssal dike; fine-grained monzogranite to tonalite; and pegmatite dikes.

Monocline—Well located

Strike and dip of bedding

Horizontal

Inclined

Vertical

Overturned

Strike and dip of foliation, primary igneous

Inclined

Vertical

Strike and dip of foliation, metamorphic

Inclined

Vertical

GEOLOGIC NOTES

Regional structural subdivisions—Except for most of the Quaternary deposits, rocks within the San Bernardino 30' X 60' quadrangle fall into three, large, relatively well defined rock assemblages separated by major faults, the San Gabriel Mountains assemblage, Peninsular Ranges assemblage, and San Bernardino Mountains assemblage. A fourth, less extensive, wedge-shaped assemblage bounded by the Mill Creek Fault on the north, and by the southernmost strand of the San Andreas Fault Zone on the south (Fig. 1) is also distinguished, because the relations of units within it to units north and south of the San Andreas zone are not clear, and because some of the Tertiary units probably originated in basins that were at least partially defined by the bounding San Andreas strands.

Each of these four rock assemblages is characterized by relatively unique suites of rocks and mutually contrasting internal structure. Because rock units within each assemblage are notably different from those in adjacent assemblages, the **CORRELATION OF MAP UNITS** and the **DESCRIPTION OF MAP UNITS** are organized by rock assemblage, rather than treating all units as if they constituted a single cohesive geologic terrane. For example, the southernmost Pelona Schist on the west side of the San Andreas Fault is in the Crafton Hills, and there are no equivalent rocks east of the fault in the San Bernardino Mountains. The closest Pelona Schist-equivalent rocks on the east side of the San Andreas Fault are 120 km to the southeast in the Orocopia Mountains (Dillon and Ehlig, 1993).

The southwestern quadrant of the quadrangle includes the northern part of the Peninsular Ranges batholith and the northeastern part of the oil-producing Los Angeles basin (Jahns, 1953); both are included in the Peninsular Ranges assemblage. In the northern part of the quadrangle, the southern Mojave Desert is underlain by rocks similar to those found in the flanking San Bernardino Mountains assemblage, and is included as part of that assemblage.

Parts of three physiographic provinces fall within the quadrangle; the east-central part of the Transverse Ranges Province, the southern part of the Mojave Desert Province, and the northern part of the Peninsular Ranges Province. The physiographic provinces within the quadrangle are distinct from the geologically defined rock assemblages, and correspond to them only in a very approximate way; the respective boundaries of these two differently defined sets of divisions only locally coincide. The Transverse Ranges physiographic province includes most of the San Gabriel and San Bernardino Mountains assemblages, but does not encompass either the low lying area between the San Jacinto and San Andreas Fault Zones nor the poorly defined area south of the Sierra Madre Fault Zone, both of which fall within the San Gabriel Mountains rock assemblage.

Classification of Quaternary units—In this report, generic Quaternary sedimentary units, those not having formal or informal names, are classified using a system developed by J.C Matti (written commun., 1999), which is based on a combination of age and sedimentary processes. These generic Quaternary units are common to all of the rock assemblage subdivisions, and on the **CORRELATION OF MAP UNITS** diagram, are placed above the assemblage subdivisions. This classification is the most objective scheme we found for subdividing the complex array of Quaternary units in the region, but like any scheme attempting to classify such a wide variety of deposits, formed where very localized conditions exert strong influences on the character and appearance of the resulting map units, it has limitations. These limitations are not uniform across the classification scheme; for example, some concern only specific types of deposits and some are significant only where comparing widely occurrences of a specific unit. Users of this report should be aware of a few particular limitations, some of which are inherent to the scheme and some a result of how the scheme was applied. These include:

Age—In the San Bernardino 30' X 60' quadrangle, accurate dating is available for very few of the generic Quaternary units. Because of this, distinction between some units, e.g., Qyf_1 and Qyf_2, are based almost entirely on relative age relationships with adjacent or nearby units, and the temporal equivalence of a Qyf_1 deposit at one place compared to a Qyf_1 deposit at a distant locality may also be based largely on similar relative age relationships with local units at each locality.

Sedimentary processes—Interpretations of sedimentary processes are questionable for some units at some localities. For example, distinctions between axial-valley and wash deposits, between colluvial and slope-wash deposits, and between talus, landslide, and colluvial deposits may be unclear in places, particularly where identifications are made from aerial photography and field checking was not possible.

Character and appearance—Due to highly localized differences in source materials and localized differences in depositional conditions at specific sites, a Quaternary unit mapped as Qyf_1 at one place may differ greatly in character and appearance from a Qyf_1 deposit at another locality.

Location—Climatic conditions that influenced deposition of Quaternary units probably differed north and south of the Transverse Ranges during the Quaternary. Because of this, a specific generic Quaternary unit at one locality may not be temporally equivalent to the same unit at all other localities, and even if temporally equivalent, may differ in character and appearance.

Many of the generic Quaternary units are subdivided, e.g., Qyf is subdivided into Qyf_1 and Qyf_2. In these cases, Qyf is the undifferentiated young alluvial-fan unit, and Qyf_1 and Qyf_2 are subdivisions where they can be recognized. The relation between the undifferentiated units and their subdivisions is also the same for young (Q), old (Qo) and very old (Qvo) Quaternary units.

For most of the generic Quaternary units on the south side of the San Gabriel Mountains, characteristic grain-size information is recorded in the map database, but is not plotted on the map. Within the database, unit labels of units for which grain-size information is available carry an extra letter, or letters, denoting average grain size or range in grain size. Where more than one grain size is designated, the first listed is the most abundant and the last is least abundant. The following letters are used: lg, large boulders; b, boulders; g, gravel; a, arenaceous (very coarse through very fine sand); s, silty; c, clayey; m, marl; p, peat. In addition to the labels, approximate grain-size boundaries within individual units are recorded in the database, but not plotted on the map.

Units having limited areal extent—A number of units occur only as small areas of outcrop that are not large enough to show well on the 1:100,000 scale map plot. In addition, some units that have extensive areas of outcrop and are quite prominent on the 1:100,000 scale map plot may also have small areas of outcrop that are not large enough to show well. Even though they may not be discernible on the 1:100,000 scale map plot, these units can be located in the digital map coverage, or by making enlarged plots of specific parts of the coverage. Units having outcrop areas too small to readily discern their identity on the 1:100.000 scale map plot are listed below; units having small outcrop areas in addition to extensive outcrop areas are not listed.

Qa_1—**Very young alluvial-valley deposits, Unit 1**
Qa—**Very young alluvial-valley deposits**
$Qvoa_1$—**Very old alluvial-valley deposits, Unit 1**
$Qvoa_2$—**Very old alluvial-valley deposits, Unit 2**
Qvosw—**Very old slope wash deposits**
Qvor—**Very old regolith and (or) pedogenic soil**
QTjh—**Juniper Hills Formation**
QTjhr—**Juniper Hills Formation, Red arkose unit**
QTjhs—**Juniper Hills Formation, Siltstone unit**
QTjhb—**Juniper Hills Formation, Arkosic breccia unit**
QTjhf—**Juniper Hills Formation, Fine-grained unit**
QTjhsb—**Juniper Hills Formation, Sedimentary breccia unit**
QTjhp—**Juniper Hills Formation, Playa deposit unit**
QTjha—**Juniper Hills Formation, Arkosic sandstone unit**
QTjhcs—**Juniper Hills Formation, Conglomeratic sandstone unit**
Tvc—**Conglomerate and sandstone, San Sevaine Canyon area, Volcaniclastic conglomerate**
Tpls—**Soquel and La Vida Members, undifferentiated**
Tgrb—**Glendora Volcanics, Rhyolite and dacite breccia**
Tgi—**Glendora Volcanics, Andesite dikes**
Tmcp—**Mill Creek formation of Gibson (1971), Pelona Schist-bearing conglomerate unit**
Tvt—**Vasquez Formation, tuffaceous rocks**
Ttd—**Hypabyssal dikes**
Tgh—**Hypabyssal granitic rocks**
Tsfl—**San Francisquito Formation, Limestone lenses**
Tsfb—**San Francisquito Formation, Basal boulder conglomerate unit**
Kcdc—**Sedimentary rocks of Cosy Dell area, conglomerate**
KJsp—**Mixed granitic rocks of South Peak**
Jc—**Leucocratic quartz monzonite of Crystal Creek**
Jsc—**Fine-grained rocks of Silver Canyon**
JTRgb—**Gabbro and pyroxenite**
Mzpb—**Pelona Schist, biotite-quartz schist unit**
Mzpq—**Pelona Schist, quartzite unit**

Mzi—**Inclusion-rich granitoid rocks**
Ds—**Sultan Limestone**
Ɛqc—**Shay Mountain metamorphic complex of MacColl (1964), Quartzite and cataclastic rock of Little Pine Flat**
Ɛcc—**Shay Mountain metamorphic complex of MacColl (1964), Biotite schist of Cox Creek**
$Ɛgn_1$—**Layered gneiss, Unit 1**
gr—**Granitic rock undifferentiated**
gnb—**Gneiss of Blue Cut area**
mq—**Mixed metamorphic rocks of Ord Mountain area, Metamorphic rocks, quartzite dominant**

PENINSULAR RANGES ASSEMBLAGE

The Peninsular Ranges assemblage is made up of the northern part of the Peninsular Ranges batholith and a variety of highly recrystallized metasedimentary rocks. Also included in the assemblage are the Tertiary sedimentary rocks in the Puente and San Jose Hills, and the Glendora Volcanics, which span the boundary between the Peninsular Ranges and San Gabriel Mountains assemblages.

SAN GABRIEL MOUNTAINS ASSEMBLAGE

The San Gabriel Mountains assemblage is characterized by a unique suite of rocks that includes anorthosite, Proterozoic and Paleozoic gneiss and schist, the Triassic Mount Lowe Intrusive Suite, the Pelona Schist, and Oligocene granitic rocks. None of these units occur east of the San Andreas Fault within the quadrangle. Internal structure of the assemblage includes the Vincent Thrust Fault, at least two old, abandonded segments of the San Andreas Fault system, and extensive areas of well-developed to pervasive mylonitization.

The main body of the San Gabriel Mountains (Fig. 1) is bounded on the north by the San Andreas Fault and on the south by the Sierra Madre-Cucamonga Fault zone (Matti and Morton, 1993). East of the San Jacinto Fault, the San Bernardino basin is an asymmetric pull-apart basin bounded by the San Andreas Fault on the east, and underlain by many of the rock units that characterize the San Gabriel Mountains (Morton and Matti, 1993). Cretaceous and older rocks are divided into two structurally and lithologically distinct groups by the Vincent Thrust Fault, a regional, low-angle thrust fault that predates intrusion of Oligocene granitic rocks. It separates the Mesozoic Pelona Schist in its lower plate from highly deformed gneiss, schist, and granitic rocks in the upper plate. The Vincent Thrust along with its far-offset, dismembered parts in the Orocopia and Chocolate Mountains, may underlie much of southern California (Haxel and Dillon, 1978; Ehlig, 1982). Oligocene granodiorite of Telegraph Peak intrudes both the Vincent Thrust and upper and lower plate rocks in the eastern San Gabriel Mountains, and a similar Oligocene granitic rock intrudes the Pelona Schist in the Crafton Hills in the southern part of the low lying San Bernardino basin (Fig. 1).

ROCKS BOUNDED BY THE MISSION CREEK AND MILL CREEK STRANDS OF THE SAN ANDREAS FAULT ZONE

Nonmarine sandstone and conglomerate nonconformably overlie crystalline rocks similar to crystalline rocks found in the Little San Bernardino Mountains to the southeast, and appear to have been displaced about 50 km right laterally by the Wilson Creek and Mill Creek Faults of the San Andreas Fault system (Matti and Morton, 1993).

Two other Tertiary units are bounded on the south by the Wilson Creek Fault and on the north by the Mill Creek Fault. One of these units, the formation of Warm Springs Canyon (Tw), is nonmarine sandstone, conglomeratic sandstone, and conglomerate; the other is similar to Tw, and may be part of that unit, but includes what appears to be structurally intermixed Cretaceous marine rocks.

SAN BERNARDINO MOUNTAINS ASSEMBLAGE

The San Bernardino Mountains are bounded on the south by the San Andreas Fault Zone and on the north by a discontinuous series of south-dipping thrust faults. The interior of the range is cut by the east-striking north-dipping Santa Ana reverse fault, the left lateral Cleghorn Fault, and the Devil Canyon Fault of unknown slip sense (Fig. 1).

Within the quadrangle, about 80 to 85 percent of the San Bernardino Mountains bedrock is Mesozoic granitic rocks, and the rest, highly metamorphosed and deformed Late Proterozoic and Paleozoic metasedimentary rocks. Except for possible rocks of questionable affinity having limited extent in the Little Shay Mountain area (Fig. 1), all Middle Proterozoic rocks lie east of the quadrangle. Granitic rocks of the San Bernardino Mountains are similar to those in the Mojave Desert province to the north.

There is a pronounced gradient from east to west, and to a slightly lesser degree from south to north, in the magnitude of both deformation and metamorphism developed in the Late Proterozoic and Paleozoic metasedimentary rocks of the San Bernardino Mountains. At the east edge of the quadrangle, deformation and recrystallization has destroyed, or made questionable, most primary bedding features in carbonate units, and thicknesses of units are alternately highly attenuated or highly thickened. Stratigraphic continuity is minimal due to faulting, folding, and ductile deformation. The westernmost metasedimentary rocks in the range consist of coarsely crystalline schist, quartzite, marble, and calcsilicate rocks. All layering in the rocks is probably the result of transposition of bedding.

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CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS COMMON TO ALL ASSEMBLAGES