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

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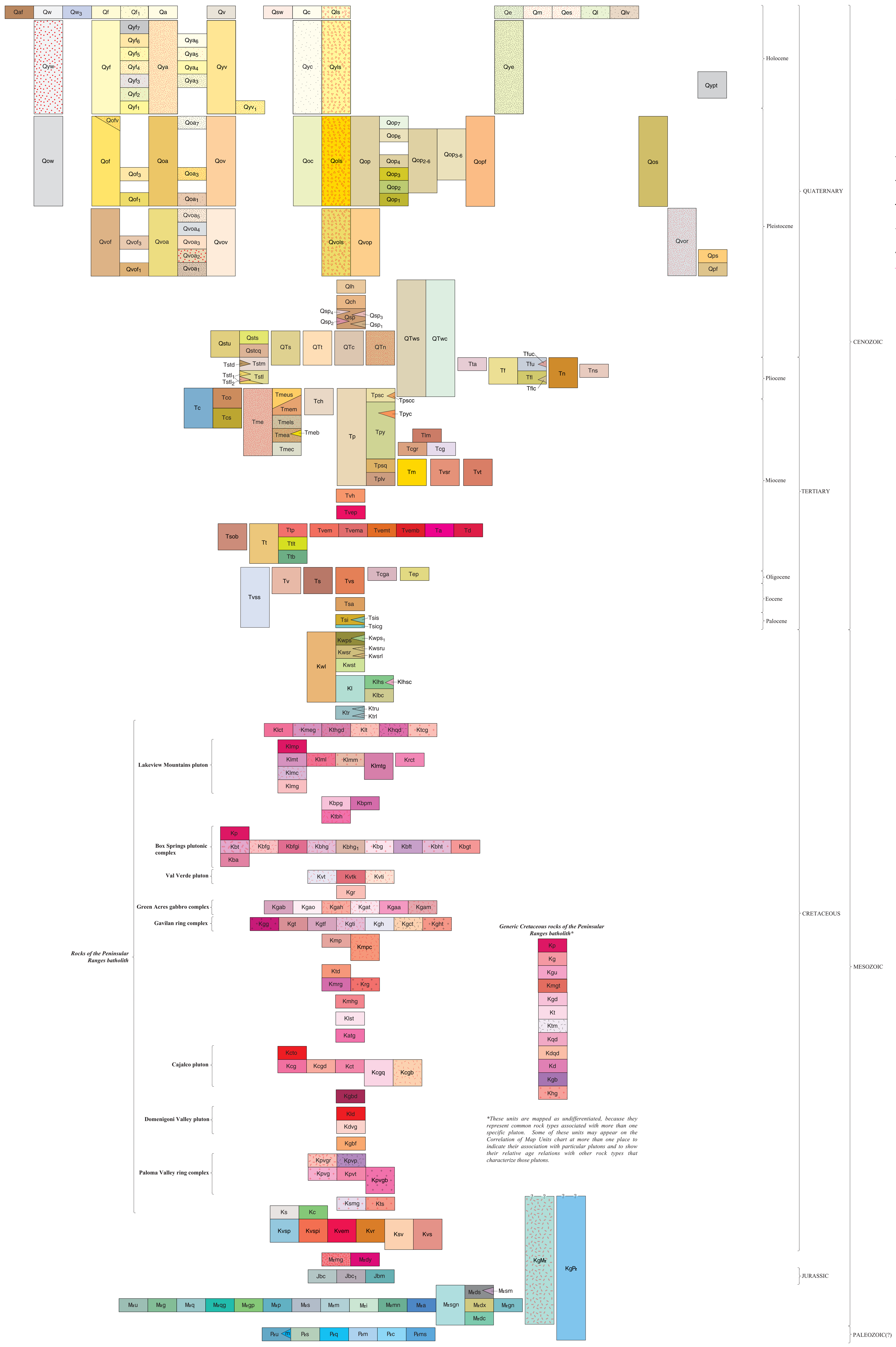
Sheet 2 of 2
SCAMP - *Southern California Areal Mapping Project*

CORRELATION OF MAP UNITS



**These units are mapped as undifferentiated, because they represent common rock types associated with more than one specific pluton. Some of these units may appear on the Correlation of Map Units chart at more than one place to indicate their association with particular plutons and to show their relative age relations with other rock types that characterize those plutons.*

PRELIMINARY DIGITAL GEOLOGIC MAP OF THE SANTA ANA 30' X 60' QUADRANGLE, SOUTHERN CALIFORNIA

Version 2.0

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2004

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EXPLANATION

Contact—Accuracy of location ranges from well-located to approximately located

Fault—Solid where accurately located; dashed where approximately located or inferred; dotted where concealed; queried where location or existence uncertain. Includes strike-slip, normal and reverse dip-slip, oblique-slip, and thrust faults. Arrow and number indicate measured dip of fault plane

Fault scarp—Solid where accurately located; dashed where approximately located. Hachures on upthrown block

Landslide scarp—Solid where accurately located. Hachures on upper part of headscarp

Subsidence scarp—Solid where accurately located. Hachures on upper surface

Anticline—Solid where accurately located; dotted where concealed. Arrowhead on axis shows direction of plunge

Syncline—Solid where accurately located; dotted where concealed. Arrowhead on axis shows direction of plunge

Overturned anticline—Solid where accurately located. Arrowhead on axis shows direction of plunge

Overturned syncline—Solid where accurately located. Arrowhead on axis shows direction of plunge

Suture—Location approximate

Ground fissures—San Jacinto Valley area

Strike and dip of beds

70 **Inclined**

Vertical

70 **Overturned**

Horizontal

Strike and dip of metamorphic foliation

70 **Inclined**

Vertical

Strike and dip of primary igneous foliation

70 **Inclined**

Vertical

Bearing and plunge of linear features

70 **Inclined**

Dike and dike-like bodies

Kp—granitic pegmatite dike

Kcto—zone of tourmalinized monzogranite

Kgbd—gabbroic dike

Kld—quartz latite dike

Klmp—granitic pegmatite dike

Kgbf—fine-grained hornblende gabbro dike

Kpvp—pegmatite dike

Kg—granitic dike

Kvspi—porphyritic dike

Mzmn—manganese bearing rock

DESCRIPTION OF MAP UNITS

(See sanana2dmu.pdf for detailed descriptions of map units)

Qaf **Artificial fill (Recent)**—Deposits of fill resulting from human construction or mining activities; most large deposits mapped, but in some areas, no deposits are shown

Qw **Wash deposits (late Holocene)**—Alluvium in active and recently active washes; bouldery to sandy, unconsolidated

Qw_3 **Wash deposits, Unit 3 (late Holocene)**—Unconsolidated bouldery to sandy alluvium of active and recently active washes. Young part of Qw

Qf **Alluvial fan deposits (late Holocene)**—Deposits of active and recently active alluvial fans and headward drainages of fans; bouldery, cobbly, gravelly, sandy, or silty alluvium, unconsolidated

Qf_1 **Alluvial fan deposits, Unit 1 (late Holocene)**—Recently active alluvial fans. Unconsolidated, boulders, cobbles, gravel, sand, or silt. Old part of Qf

Qa **Axial channel deposits (late Holocene)**—Active and recently active fluvial deposits restricted to canyon floors; gravel, sand, and silt, unconsolidated

Qv **Alluvial valley deposits (late Holocene)**—Active and recently active fluvial deposits along valley floors; gravel, sand, and silt, unconsolidated

Qsw **Slope wash deposits (late Holocene)**—Unconsolidated sand, cobbles, and pebbles deposited by water not confined to channels

Qc **Colluvial deposits (late Holocene)**—Active and recently active deposits of colluvial deposits on hillsides; unconsolidated

Qls **Landslide deposits (late Holocene)**—Active or recently active landslides; unconsolidated to consolidated. Includes many early Holocene landslides that in part have been reactivated during late Holocene

Qe **Eolian deposits (late Holocene)**—Active or recently active sand dune deposits; unconsolidated

Qm **Marine deposits (late Holocene)**—Active or recently active beach deposits; sand, unconsolidated

Qes **Estuarine deposits (late Holocene)**—Sand, silt, and clay; unconsolidated, contains variable amounts of organic matter

Ql **Lacustrine deposits (late Holocene)**—Clay, silt, and fine-grained sand; unconsolidated to moderately consolidated

Qlv **Lacustrine and fluvial deposits (late Holocene)**—Mixed lacustrine and fluvial deposits. Clay, silt, and fine-grained sand; unconsolidated to moderately consolidated

Qyw **Young wash deposits (Holocene and late Pleistocene)**—Sand and gravelly sand deposits flanking active Santa Ana River; unconsolidated

Qyf **Young alluvial fan deposits (Holocene and late Pleistocene)**—Gravel, sand, and silt, mixtures, some contain boulders; unconsolidated. Includes:

Qyf_7 **Young alluvial fan deposits, Unit 7 (late Holocene)**—Gravel, sand, and silt, mixtures, some contain boulders; unconsolidated. Most recent Qyf unit

Qyf_6 **Young alluvial fan deposits, Unit 6 (late Holocene)**—Gravel, sand, and silt, mixtures, some contain boulders; unconsolidated. Young part of Qyf unit

Qyf_5 **Young alluvial fan deposits, Unit 5 (late Holocene)**—Gravel, sand, and silt, mixtures, some contain boulders; unconsolidated. Intermediate Qyf unit

Qyf_4 **Young alluvial fan deposits, Unit 4 (late and middle Holocene)**—Gravel, sand, and silt, some contain boulders; unconsolidated. Intermediate Qyf unit

Qyf_3 **Young alluvial fan deposits, Unit 3 (middle Holocene)**—Gravel, sand, and silt, mixtures, some contain boulders; unconsolidated. Old part of Qyf unit

Qyf_2 **Young alluvial fan deposits, Unit 2 (early Holocene)**—Gravel, sand, and silt, some contain boulders; unconsolidated. Old part of Qyf unit

Qyf_1 **Young alluvial fan deposits, Unit 1 (early Holocene and late Pleistocene)**—Gravel, sand, and silt, mixtures, some contain boulders; unconsolidated to incipient consolidation. Oldest Qyf unit

Qya **Young axial channel deposits (Holocene and late Pleistocene)**—Gravel, sand, and silty alluvium; gray, unconsolidated. Includes:

Qya_6 **Young axial channel deposits, Unit 6 (late Holocene)**—Gravel, sand, and silty alluvium; gray, unconsolidated. Young part of Qya unit

Qya_5 **Young axial channel deposits, Unit 5 (late Holocene)**—Gravel, sand, and silty alluvium; gray, unconsolidated. Young part of Qya unit

Qya_4 **Young axial channel deposits, Unit 4 (late and middle Holocene)**—Gravel, sand, and silty alluvium; gray, unconsolidated. Intermediate part of Qya unit

Qya_3 **Young axial channel deposits, Unit 3 (middle Holocene)**—Gravel, sand, and silty alluvium; gray, unconsolidated. Intermediate part of Qya unit

Qyv **Young alluvial valley deposits (Holocene and late Pleistocene)**—Silty to sandy alluvium on valley floors; gray, unconsolidated

Qyv_1 **Young alluvial valley deposits, Unit 1 (early Holocene and late Pleistocene)**—Silty to sandy alluvium west of Casa Loma Fault; gray, unconsolidated

Qyc **Young colluvial deposits (Holocene and late Pleistocene)**—Sand and silt colluvial deposits on hillsides and at bases of slopes. Appear to be inactive

Qyls **Young landslide deposits (Holocene and late Pleistocene)**—Rock debris and rubble, unsorted. All or parts of many Qyls landslides subject to renewed movement; primary landslide morphology typically preserved

Qye **Young eolian deposits (Holocene and late Pleistocene)**—Very fine- to medium-grained sand, unconsolidated; dune morphology apparent

Qypt **Young peat deposits (Holocene and late Pleistocene)**—Peat and peaty deposits, low density peat, unconsolidated

Qow **Old alluvial wash deposits (late to middle Pleistocene)**—Sand and gravelly sand flanking Santa Ana River

Qof **Old alluvial fan deposits (late to middle Pleistocene)**—Sandy alluvium; reddish brown, indurated, surface of most fans slightly dissected. Includes:

Qofv **Old alluvial fan deposits and young alluvial valley deposits (late Pleistocene)**—Sandy alluvium; reddish brown, moderately indurated. Has thin, discontinuous cover of Qyv

Qof_3 **Old alluvial fan deposits, Unit 3 (middle Pleistocene)**—Sandy alluvium; reddish brown, indurated, surface of most fans slightly dissected

Qof_1 **Old alluvial fan deposits, Unit 1 (middle Pleistocene)**—Sandy alluvium; reddish brown, indurated, surface of most fans slightly dissected. Old part of Qof

Qoa **Old axial channel deposits (late to middle Pleistocene)**—Gravel, sand, and silt; gray, unconsolidated to indurated. Includes:

Qoa_7 **Old axial channel deposits, Unit 7 (middle Pleistocene)**—Gravel, sand, and silt; gray, unconsolidated to indurated. Young part of Qoa

Qoa_3 **Old axial channel deposits, Unit 3 (middle Pleistocene)**—Gravel, sand, and silt; gray, unconsolidated to indurated. Intermediate part of Qoa

Qoa_1 **Old axial channel deposits, Unit 1 (middle Pleistocene)**—Gravel, sand, and silt; gray, unconsolidated to indurated. Old part of Qoa

Qov **Old alluvial valley deposits (late to middle Pleistocene)**—Silty alluvium on valley floors; gray, unconsolidated to indurated

Qoc **Old colluvial deposits (late to middle Pleistocene)**—Cobble- to boulder-colluvium; indurated

Qols **Old landslide deposits (late to middle Pleistocene)**—Rock debris; most is fragmented, unconsolidated to consolidated

Qop **Old paralic deposits, undivided (late to middle Pleistocene)**—Silt, sand and cobbles. Interfingered strandline, beach, estuarine, and colluvial deposits. Includes:

Qop_7 **Old paralic deposits, Unit 7 (late to middle Pleistocene)**—Silt, sand and cobbles resting on 9-11 m Bird Rock terrace. Age about 80,000 years

Qop_6 **Old paralic deposits, Unit 6 (late to middle Pleistocene)**—Silt, sand and cobbles resting on 22-23 m Nestor terrace. Age about 120,000 years

Qop_4 **Old paralic deposits, Unit 4 (late to middle Pleistocene)**—Silt, sand and cobbles resting on 34-37 m Stuart Mesa terrace. Age about 200,000-300,000 years

Qop_3 **Old paralic deposits, Unit 3 (late to middle Pleistocene)**—Silt, sand and cobbles resting on 45-46 m Guy Fleming terrace. Age about 320,000-340,000 years

Qop_2 **Old paralic deposits, Unit 2 (late to middle Pleistocene)**—Silt, sand and cobbles resting on 55 m Parry Grove terrace. Age about 413,000 years

Qop_1 **Old paralic deposits, Unit 1 (late to middle Pleistocene)**—Silt, sand and cobbles resting on 61-63 m Golf Course terrace. Age about 450,000 years

Qop_{2-6} **Old paralic deposits, Units 2-6, undivided (late to middle Pleistocene)**—Silt, sand and cobbles on 22-55 m terraces

Qop_{3-6} **Old paralic deposits, Units 3-6, undivided (late to middle Pleistocene)**—Silt, sand and cobbles on 45-55 m terraces

Qopf **Old paralic deposits (late to middle Pleistocene) overlain by alluvial fan deposits**—Old paralic deposits capped by sandy alluvial-fan deposits

Qos **Old surficial deposits, undivided (late to middle Pleistocene)**—Silt, sand and cobbles. Interfingered strandline, beach, estuarine, and colluvial deposits

Qvof **Very old alluvial fan deposits (middle to early Pleistocene)**—Sandy alluvium; reddish-brown, well-indurated, fan surfaces well-dissected. Includes:

$Qvof_3$ **Very old alluvial fan deposits, Unit 3 (early Pleistocene)**—Gravel, sand, and silt; reddish-brown, surfaces well-dissected. Intermediate to young part of Qvof

$Qvof_1$ **Very old alluvial fan deposits, Unit 1 (early Pleistocene)**—Gravel, sand, and silt; reddish-brown, fan surfaces well-dissected. Old part of Qvof

Qvoa **Very old axial channel deposits (middle to early Pleistocene)**—Gravel, sand, and silt; reddish-brown, well-indurated, surfaces well-dissected. Includes:

$Qvoa_5$ **Very old axial channel deposits, Unit 5 (middle to early Pleistocene)**—Gravel, sand, and silt; reddish-brown, well-indurated; dissected. Younger part of Qvoa

$Qvoa_4$ **Very old axial channel deposits, Unit 4 (middle to early Pleistocene)**—Gravel, sand, and silt; reddish-brown, well-indurated; dissected. Younger part of Qvoa

$Qvoa_3$ **Very old axial channel deposits, Unit 3 (middle to early Pleistocene)**—Gravel, sand, and silt; reddish-brown, well-indurated; dissected. Intermediate part of Qvoa

$Qvoa_2$ **Very old axial channel deposits, Unit 2 (early Pleistocene)**—Gravel, sand, and silt; reddish-brown, well-indurated, well-dissected. Intermediate part of Qvoa

$Qvoa_1$ **Very old axial channel deposits, Unit 1 (early Pleistocene)**—Gravel, sand, and silt; reddish-brown, well-indurated, well-dissected. Older part of Qvoa

Qvov **Very old alluvial valley deposits (late to early Pleistocene)**—Fluvial deposits flanking valley floors or perched erosional remnants

Qvols **Very old landslide deposits (middle to early Pleistocene)**—Rock debris; moderately well- to well-consolidated. Almost no primary landslide morphology preserved

Qvop **Very old paralic deposits (middle to early Pleistocene)**—Silt, sand and cobbles on emergent wave-cut abrasion platforms

Qvor **Very old regolith (Pleistocene)**—Deeply weathered rock and soil regolith; reddish brown, highly dissected

Pauba Formation (Pleistocene)—Siltstone and sandstone. Includes two informal members:

Qps **Sandstone member**—Sandstone containing sparse cobble-to boulder-conglomerate beds; brown, cross-bedded, moderately well indurated

Qpf **Fanglomerate member**—Fanglomerate and mudstone; grayish-brown, poorly sorted, well-indurated

Qlh **La Habra Formation (Pleistocene)**—Nonmarine mudstone, fluvial sandstone, and conglomerate

Sandstone and conglomerate of Wildomar area (Pleistocene and late Pliocene)—Sandstone and conglomerate; nonmarine. Includes:

QTws **Sandstone unit**—Sandstone; pale yellow-green, moderately indurated, friable, abundant caliche

QTwc **Conglomerate unit**—Conglomerate; cobble and boulder. Clasts are locally derived

Qch **Coyote Hills Formation (Pleistocene)**—Mosty mudstone and pebbly sandstone, nonmarine

Qsp (Qsp_4, Qsp_3, Qsp_2, Qsp_1) **San Pedro Formation (Pleistocene)**—Sandstone and pebbly sandstone; shallow marine depositional environment. Qsp_4, sandstone; Qsp_3, siltstone and claystone; Qsp_2, sandstone; Qsp_1, siltstone and claystone

San Timoteo beds of Frick (1921) (Pleistocene and Pliocene)—Nonmarine sandstone and conglomerate. Includes three informal members:

Qstu **Upper member (Pleistocene)**—Interbedded sandstone and conglomerate; gray, coarse-grained, moderately indurated. Includes:

Qsts **Conglomeratic sandstone beds**—Locally derived conglomeratic sandstone; forms small lens-shaped body

Qstcq **Quartzite-bearing conglomerate beds**—Conglomerate, quartzite-bearing, well-indurated

Tstm (Tstd) **Middle member (Pliocene)**—Sandstone and conglomerate; contains abundant red-hued stratigraphic intervals. Includes highly deformed sandstone, pebbly sandstone, and conglomerate (Tstd) that is restricted to western part of San Timoteo badlands

Tstl ($Tstl_1$, $Tstl_2$) **Lower member (Pliocene)**—Sandstone, gray, fine-grained, well-sorted; contains subordinate pebble lenses. Moderately well indurated. Claystone, siltstone, and sandstone characterized by ripple lamination ($Tstl_2$); arkosic sandstone ($Tstl_1$)

QTs **Unnamed late Cenozoic sedimentary rocks in Riverside and Corona areas (early Pleistocene to late Pliocene?)**—Sandstone and conglomerate in Riverside area, nonmarine. Contains clasts derived from San Bernardino Mountains. Local clasts in area southeast of Riverside

QTt **Late Cenozoic conglomerate of Temescal area (early Pleistocene to late Pliocene?)**—Cobble conglomerate on Paleocene(?) surface

QTc **Conglomeratic sedimentary rocks of Riverside West 7.5' quadrangle (early Pleistocene to late Pliocene?)**—Conglomerate in Riverside area, nonmarine. Upper part contains boulders derived from Peninsular Ranges; lower part contains cobbles derived from San Bernardino Mountains

QTn **Late Cenozoic sedimentary rocks of Norco area (early Pleistocene to late Pliocene?)**—Conglomerate and conglomeratic sandstone in Norco area, nonmarine. Contains cobbles derived locally and from Transverse Ranges

Tta **Temecula Arkose (Pliocene)**—Sandstone, medium- to coarse-grained, indurated, fluvial

Tf **Fernando Formation (Pliocene)**—Siltstone, sandstone, pebbly sandstone, and conglomerate; marine. Includes two members separated by regional erosional unconformity

Tfu (Tfuc) **Upper member**—Sandstone, pebbly sandstone, and sandy conglomerate. Where mostly conglomerate, subdivided as Tfuc

Tfl (Tflc) **Lower member**—Siltstone, sandstone and conglomerate. Where mostly conglomerate, subdivided as Tflc

Tn **Niguel Formation (Pliocene)**—Interbedded marine sandstone, conglomeratic sandstone, and conglomerate

Tns **Sandstone of Norco area (Pliocene)**—Sandstone containing local conglomerate lenses; greenish-yellow, unconsolidated

Tc **Capistrano Formation (early Pliocene and Miocene)**—Marine sandstone. Includes one member and one "facies"

Tco **Oso Member**—Sandstone, medium- to coarse-grained, massively bedded, friable. Includes:

Tcs **Siltstone facies**—Siltstone and mudstone; white to pale gray, massive to crudely bedded, friable

Tme **Mount Eden Formation of Fraser (1931) (early Pliocene and Miocene)**—Nonmarine sandstone, mudrock, and pebbly sandstone. Includes five informal members:

Tmeus **Upper sandstone member (early Pliocene and Miocene)**—Sandstone and fissile to hackly-fracturing mudrock; pale brown, well-sorted, thin-to medium-bedded, indurated

Tmem **Mudrock member (early Pliocene and Miocene)**—Mudrock, dark gray-green, hackly fracturing to locally fissile

Tmels **Lower sandstone member (Miocene)**—Sandstone, pebbly sandstone, and minor limestone

Tmea (Tmeb) **Arkosic sandstone member (Miocene)**—Sandstone, pebbly sandstone, and conglomerate, coarse-grained, thick-bedded. Includes tongues of monolithologic tonalite boulder breccia (Tmeb)

Tmec **Conglomeratic sandstone member (Miocene)**—Coarse-grained sandstone, pebbly sandstone, and conglomerate; massive to indistinctly bedded

Tch **Sandstone and conglomerate in southeastern Chino Hills (early Pliocene and Miocene)**—Sandstone and conglomerate; marine and nonmarine

Tp **Puente Formation (early Pliocene and Miocene)**—Marine shale, siltstone, sandstone, and conglomerate. Includes four members:

Tpsc (Tpscc) **Sycamore Canyon Member (early Pliocene and Miocene)**—Predominately sandstone and pebble conglomerate. Where mostly conglomerate, subdivided as Tpscc

Tpy (Tpyc) **Yorba Member (Miocene)**—Predominately siltstone and sandstone. Where mostly conglomerate, subdivided as Tpyc

Tpsq **Soquel Member (Miocene)**—Predominately sandstone and siltstone. Massive to well bedded. Contains some pebbly sandstone beds

Tplv **La Vida Member (Miocene)**—Predominately siltstone interbedded with some sandstone

Tlm **Lake Mathews Formation (Miocene)**—Mudstone, minor conglomerate, and poorly bedded sandstone; massively bedded, nonmarine

Tcgr **Rhyolite-clast conglomerate of Lake Mathews area (Miocene?)**—Cobble conglomerate; coarse-grained sandstone matrix, massively bedded, indurated. Cobble clasts are red rhyolite

Tcg **Conglomerate of Lake Mathews area (Miocene?)**—Cobble conglomerate; coarse-grained sandstone matrix, massively bedded, indurated. Lacks red rhyolite clasts of Tcgr

Tm **Monterey Formation (Miocene)**—Marine siltstone and sandstone; siliceous and diatomaceous

Tvsr **Santa Rosa basalt of Mann (1955) (Miocene)**—Vesicular basalt flows. Relatively unmodified flow surfaces

Tvt **Basalt of Temecula area (Miocene)**—Vesicular basalt flows. Sparse, restricted exposures

Tvh **Basalt of Hogbacks (Miocene)**—Remnant of a channel-filling basalt flow. Breaks into slabby fragments

Tvep **Basalt of Elsinore Peak (Miocene)**—Vesicular basalt flows. Overlies Paleogene sandstone. Restricted to Elsinore Peak area

Tsob **San Onofre Breccia (middle Miocene)**—Breccia and interbedded conglomerate, sandstone, siltstone, and mudstone. Well indurated, marine

Tt **Topanga Formation (middle Miocene)**—Marine sandstone, siltstone, and locally conglomerate. Includes:

Ttp **Paulerino Member**—Massive tuffaceous sandstone and thin bedded siltstone; contains some breccia interbeds

Ttlt **Los Trancos Member**—Siltstone and sandstone. Thin to medium bedded; pale gray to brownish gray

Ttb **Bommer Member**—Medium-to coarse-grained sandstone interbedded with fine-grained sandstone and siltstone

Tvem **El Modeno Volcanics (middle Miocene)**—Basaltic and andesitic, tuffaceous extrusive rocks, and intrusive rocks. Includes:

Tvema **Andesitic volcanic rocks**—Extrusive flow rocks of primarily andesitic composition

Tvemt **Tuff and tuff breccia**—Clastic volcanic rocks, primarily tuff and tuff breccia. Restricted

Tvemb **Basalt**—Extrusive flow rocks, mainly basalt composition. Restricted occurrence northwestern Santa Ana Mountains

Volcanic intrusive rocks associated with El Modeno Volcanics (middle Miocene)—Dikes, sills, and irregular-shaped bodies. Includes:

Ta **Andesitic intrusive rocks**—Porphyritic andesitic intrusive rocks. Most are highly altered and decomposed

Td **Diabase intrusive rocks**—Diabase dikes and sills. Most are highly altered and decomposed

Tvss **Vaqueros, Sespe, Santiago, and Silverado Formations, undifferentiated (early Miocene, Oligocene, and Paleocene)**—Sandstone, siltstone, and conglomerate

Tv **Vaqueros Formation (early Miocene, Oligocene, and late Eocene)**—Sandstone and sandy siltstone; massive- to thick-bedded, marine

Ts **Sespe Formation (early Miocene, Oligocene, and late Eocene)**—Conglomeratic sandstone and clayey and silty sandstone; varied colored, poorly defined massive- to thick-beds, nonmarine

Tvs **Vaqueros and Sespe Formations, undifferentiated (early Miocene, Oligocene, and late Eocene)**—Interbedded sandstone and conglomerate; marine and nonmarine

Tcga **Conglomerate of Arlington Mountain (Paleogene?)**—Cobble conglomerate; composed of exotic welded tuff clasts

Tep **Sandstone of Elsinore Peak (Paleogene?)**—Sandstone and pebbly sandstone. Well indurated, white to pale gray, coarse grained

Tsa **Santiago Formation (middle Eocene)**—Sandstone and conglomerate, marine and nonmarine

Tsi (Tsis, Tsicg) **Silverado Formation (Paleocene)**—Sandstone, siltstone, and conglomerate; nonmarine and marine. Much of unit is thoroughly weathered. Basal conglomerate (Tsicg) and Serrano clay (Tsis) are subdivided locally

Kwl **Williams and Ladd Formations, undifferentiated (Late Cretaceous)**—Sandstone, conglomerate, and siltstone

Williams Formation (Late Cretaceous)—Feldspathic sandstone, pebbly sandstone, and conglomeratic sandstone; chiefly white and brown hues, poorly sorted, massive-bedded, very resistant, cliff-forming. Marine. Includes:

Kwps ($Kwps_1$) **Pleasants Sandstone Member**—White to very pale colored feldspathic marine sandstone. Includes ($Kwps_1$) consisting of coarse-grained conglomeratic sandstone

Kwsr (Kwsru, Kwsrl) **Schulz Ranch Member**—Marine, coarse-grained sandstone. White to brownish gray; forms cliffs. Includes (Kwsru) consisting of conglomeratic sandstone and (Kwsrl) consisting of siltstone interfingering with silty conglomerate

Kwst **Starr Member**—Fanglomerate and sandstone; nonmarine. Pale gray, deeply weathered

Kl **Ladd Formation (Late Cretaceous)**—Conglomerate, sandstone, siltstone, and shale; marine and locally nonmarine. Includes:

Klhs (Klhsc) **Holz Shale Member**—Sandstone, siltstone, and shale. Unit subdivided locally where sandstone and conglomerate predominate (Klhsc); entire unit is marine

Klbc **Baker Canyon Conglomerate Member**—Conglomerate, conglomeratic sandstone and pebble conglomerate; marine and locally nonmarine(?)

Ktr (Ktru, Ktrl) **Trabuco Formation (Late Cretaceous)**—Nonmarine conglomerate; locally interbedded sandstone and siltstone. Ktru, conglomerate; Ktrl, fanglomerate

Rocks of the Peninsular Ranges batholith

Klct **Tonalite of Lamb Canyon (Cretaceous)**—Hornblende-biotite tonalite; massive, sphene-bearing

Kmeg **Granite of Mount Eden (Cretaceous)**—Granite; white to gray, leucocratic, medium-to coarse-grained, massive to foliated

Kthgd **Granodiorite of Tucalota Hills (Cretaceous)**—Biotite granodiorite; massive, light-colored

Klt **Tonalite near mouth of Laborde Canyon (Cretaceous)**—Biotite-hornblende tonalite; medium-grained, foliated, intensely fractured

Khqd **Hypersthene quartz diorite (Cretaceous)**—Hypersthene-biotite quartz diorite; fine-to medium-grained, massive

Ktcg **Monzogranite of Tres Cerritos (Cretaceous)**—Biotite monzogranite; leucocratic, medium- to coarse-grained, subporphyritic

Lakeview Mountains pluton (Cretaceous)—Predominantly biotite-hornblende tonalite. Includes:

Klmp **Pegmatite dikes**—Granitic, rare earth-bearing pegmatites. Common in central part of pluton, rare elsewhere

Klmt **Tonalite**—Biotite-hornblende tonalite containing no potassium-feldspar; medium- to coarse-grained, massive to foliated

Klml **Leucocratic rocks**—Plagioclase-quartz rock; white. Occurs as localized elongate masses

Klmm **Melanocratic rocks**—Melanocratic and hypermelanic rock consisting primarily of biotite and hornblende. Occurs as lenticular masses

Klmtg **Lakeview Mountains tonalite and granodiorite, undifferentiated**—Intermixed tonalite and granodiorite

Klmc **Comb-layered gabbro**—Gabbro, comb-layered. Found along south margin of Lakeview Mountains pluton

Klmg **Hypersthene-hornblende gabbro**—Hypersthene-hornblende gabbro; forms small masses in Lakeview Mountains

Krct **Tonalite of Reinhardt Canyon pluton (Cretaceous)**—Biotite-hornblende tonalite; gray, medium-grained, most is well foliated

Kbpg **Monzogranite of Bernasconi Pass (Cretaceous)**—Biotite and biotite-hornblende monzogranite; pale tan- to tan-weathering, medium grained, hypidiomorphic-granular or porphyritic, foliated. Includes:

Kbpm **Migmatitic rocks within monzogranite of Bernasconi Pass**—Monzogranite containing abundant masses of mafic rock

Ktbh **Tonalite of Bernasconi Hills (Cretaceous)**—Biotite hornblende tonalite; gray, medium-grained, hypidiomorphic-granular, massive to indistinctly foliated

Box Springs plutonic complex (Cretaceous)—Chiefly tonalite, granodiorite, and monzogranite. Includes:

Kp **Granitic pegmatite dikes**—Granitic pegmatite dikes, some containing rare-earth-phosphate minerals

Kbt **Biotite tonalite**—Biotite tonalite; massive, but some has faint, regular compositional layering. Fine to medium grained

Kbfg **Biotite granodiorite and tonalite**—Biotite granodiorite and tonalite; foliated. Medium to coarse grained

Kbfgi **Biotite granodiorite and tonalite containing abundant inclusions**—Biotite granodiorite and tonalite; contains abundant mesocratic inclusions

Kbhg **Heterogeneous porphyritic granodiorite**—Granodiorite and subordinate tonalite; porphyritic, heterogeneous with respect to mineral composition

$Kbhg_1$ **Layered heterogeneous porphyritic granodiorite**—Granodiorite; porphyritic, has pronounced layering, heterogeneous with respect to grain size

Kbg **Porphyritic granodiorite**—Biotite granodiorite and subordinate tonalite; light gray, porphyritic, foliated

Kbft **Biotite-hornblende tonalite**—Tonalite; light-to medium-gray, medium- to coarse-grained, foliated. Color index averages about 25

Kbht **Heterogeneous biotite tonalite**—Biotite tonalite; light-gray, inequigranular, medium- to coarse-grained, foliate. Heterogeneous with respect to composition

Kbgt **Heterogeneous granodiorite and tonalite**—Hornblede-biotite tonalite and granodiorite; light-to medium-gray, medium- to coarse-grained, texturally heterogeneous, foliated

Kba **Amphibolitic gabbro**—Hornblende-gabbro; dark gray to black, fine- to medium-grained, foliated

Val Verde pluton (Cretaceous)—Biotite-hornblende tonalite. Relatively uniform composition and texture. Includes:

Kvt **Val Verde tonalite**—Biotite-hornblende tonalite; gray, medium grained, foliated. Subequal hornblende and biotite

Kvtk **Potassium feldspar-bearing tonalite**—Biotite-hornblende tonalite; contains small amounts of potassium feldspar, heterogeneous

Kvti **Inclusion-rich tonalite**—Tonalite; contains abundant melanocratic inclusions, most with compositionally gradational borders

Kgr **Granophyre (Cretaceous)**—Granophyric-textured granitic rock; pale gray, aphanitic-to very fine-grained

Green Acres gabbroic complex (Cretaceous)—Olivine-pyroxene-hornblende gabbro; heterogeneous with respect to composition. Includes:

Kgab **Heterogeneous mixture of olivine, pyroxene, and hornblende gabbros**—Olivine-pyroxene-hornblende gabbro; very heterogeneous mix intruded by quartz diorite and tonalite

Kgao **Olivine gabbro**—Olivine-gabbro; predominatly coarse-grained Ranges from a few percent to about 30 percent olivine

Kgah **Hornblende-rich gabbro**—Hornblende gabbro; fine- to medium-grained, melanocratic

Kgat **Troctolite**—Subporphyritic troctolite; contains large phenocrysts of anorthitic plagioclase

Kgaa **Anorthositic gabbro**—Gabbro; abundant plagioclase of labradorite to anorthite composition. Leucocratic, gray-weathering

Kgam **Metagabbro**—Metamorphosed gabbro. Occurs as small masses included within mixed granitic rocks in southern part of Lakeview Mountains

Gavilan ring complex (Cretaceous)—Monzogranite to tonalite, latter predominates; complex composed of wide variety of granitic rocks. Includes:

Kgg **Hypersthene monzogranite**—Hypersthene monzogranite; black, massive, weathers dark brown

Kgt **Massive-textured tonalite**—Biotite-hornblende tonalite, hypersthene-bearing; massive, relatively heterogeneous composition, brown-weathering

Kgtf **Foliated tonalite**—Biotite hornblende tonalite; medium grained, foliated. Hypersthene absent in most of unit

Kgti **Tonalite containing abundant mesocratic inclusions**—Biotite-hornblende tonalite; relatively fine-grained. Contains abundant, small, platy mesocratic inclusions

Kgh **Hypabyssal tonalite**—Tonalite and subordinate granodiorite; fine-grained to nearly aphanitic, massive

Kgct **Coarse-grained biotite-hornblende tonalite**—Biotite-hornblende tonalite; coarse-grained to extremely coarse-grained

Kght **Heterogeneous tonalite**—Biotite-hornblende tonalite; admixed with biotite hornblende granodiorite. Heterogeneous with respect to composition

Kmp **Micropegmatite granite (Cretaceous)**—Micropegmatitic granite; leucocratic, has pale pink tint

Kmpc **Micropegmatite and granodiorite of Cajalco pluton, undifferentiated (Cretaceous)**—Micropegmatitic granite and granitic rocks of the Cajalco pluton, undifferentiated

Ktd **Tonalite dikes of Mount Rubidoux (Cretaceous)**—Mafic-rich tonalite; fine- to medium-grained

Kmrg **Granite of Mount Rubidoux (Cretaceous)**—Fayalite-hypersthene-biotite-hornblende granite; coarse-grained, black, massive

Krg **Granite of Riverside area (Cretaceous)**—Leucocratic biotite granite; medium- to coarse-grained, massive to faintly foliated

Kmhg **Mount Hole Granodiorite (Cretaceous)**—Hornblende-biotite granodiorite; pale gray, massive

Klst **La Sierra Tonalite (Cretaceous)**—Biotite-hornblende tonalite; medium gray, weak to strong alteration

Katg **Granodiorite of Arroyo del Toro pluton (Cretaceous)**—Biotite-hornblende granodiorite; light gray, medium-grained, massive, homogeneous

Cajalco pluton (Cretaceous)—Monzogranite, granodiorite, and tonalite; lithologically diverse. Widespread tourmalinized rock. Includes:

Kcto **Tourmalinized monzogranite and granodiorite**—Massive tourmaline rock, commonly containing minor amounts of quartz and felsic minerals. Product of pervasive tourmalinization of monzogranite and granodiorite

Kcg **Monzogranite**—Hornblende-biotite monzogranite and lesser granodiorite; fine- to medium-grained

Kcgd **Granodiorite**—Biotite and hornblende-biotite monzogranite and granodiorite; medium-grained

Kct **Tonalite**—Biotite-hornblende tonalite, massive, highly mafic. Probably represents deep part of pluton

Kcgq **Granodiorite and quartz latite, undifferentiated**—Intermixed granodiorite and quartz latite porphyry; near-equal amounts of each

Kcgb **Granodiorite and gabbro, undifferentiated**—Intermixed granodiorite and gabbro

Kgbd **Gabbroic dikes, Domenigoni Valley area (Cretaceous)**—Hornblende gabbro; black, relatively fine-grained, massive

Domenigoni Valley pluton (Cretaceous)—Granodiorite to tonalite; relatively uniform. Cut by quartz latite dikes. Includes:

Kld **Quartz latite dikes**—Biotite, biotite-hornblende, and hornblende quartz latite; light to dark gray, fine-grained, massive to well-foliated

Kdvg **Granodiorite to tonalite of Domenigoni Valley**—Hornblende-biotite granodiorite to tonalite; contains equant mafic inclusions

Kgbf **Fine-grained hornblende gabbro, Rail Road Canyon area (Cretaceous)**—Hornblende gabbro; fine-grained dikes, sills, and small plutons

Paloma Valley ring complex (Cretaceous)—Composite ring structure composed of granophyre, pegmatite, granite, granodiorite, and tonalite. Includes:

Kpvgr **Granophyre**—Porphyritic granophyre; gray, very fine-grained. Groundmass contains altered plagioclase phenocrysts

Kpvp **Pegmatite dikes of Paloma Valley ring complex**—Leucocratic pegmatite dikes

Kpvg **Monzogranite to granodiorite**—Biotite monzogranite, and less abundant hornblende-biotite granodiorite; gray, medium grained, hypidiomorphic-granular, massive

Kpvt **Tonalite**—Biotite-hornblende tonalite; foliated. Grades to granodiorite in eastern part of Paloma Valley ring cmplex

Kpvgb **Granodiorite and gabbro, undifferentiated**—Mixed biotite granodiorite and hornblende gabbro

Ksmg **Monzogranite of Squaw Mountain (Cretaceous)**—Biotite monzogranite; coarse-grained, moderately leucocratic, massive

Kts **Tonalite of Slaughterhouse Canyon (Cretaceous)**—Biotite-hornblende tonalite; dark gray, fine-grained, massive

Generic Cretaceous granitic rocks of the Peninsular Ranges batholith

Kp **Granitic pegmatite dikes (Cretaceous)**—Pegmatitic textured granitic dikes; leucocratic, most are roughly tabular bodies

Kg **Granitic dikes (Cretaceous)**—Variety of leucocratic granitic dikes composed mainly of quartz and alkali feldspars

Kgu **Granite, undifferentiated (Cretaceous)**—Granite; leucocratic, fine- to coarse-grained, massive

Kmgt **Monzogranite and tonalite, undifferentiated (Cretaceous)**—Biotite monzogranite and biotite-hornblende tonalite. Only in eastern Box Springs Mountains

Kgd **Granodiorite, undifferentiated (Cretaceous)**—Intermediate composition granitic rocks, mainly biotite-hornblende and biotite granodiorite

Kt **Tonalite, undifferentiated (Cretaceous)**—Mainly biotite-hornblende tonalite not associated with specific plutons

Ktm **Tonalite and mafic rocks, undifferentiated (Cretaceous)**—Mainly biotite-hornblende tonalite containing mixed with subequal amounts of mafic inclusions. Inclusion borders mostly gradational and ill-defined

Kqd **Quartz diorite, undifferentiated (Cretaceous)**—Mainly biotite-hornblende quartz diorite; coarse-grained

Kdqd **Diorite and quartz diorite, undifferentiated (Cretaceous)**—Mainly mixed biotite-hornblende quartz diorite and hornblende diorite

Kd **Diorite, undifferentiated (Cretaceous)**—Mainly hornblende diorite; fine- to medium-grained, massive

Kgb **Gabbro (Cretaceous)**—Hornblende gabbro; medium- to very coarse-grained, commonly weathers brown

Khg **Heterogeneous granitic rocks (Cretaceous)**—Includes heterogeneous, compositionally diverse granitic rocks mostly of tonalitic and granodiorite composition, but includes some monzogranite and gabbro

End rocks of the Peninsular Ranges batholith

Ks **Serpentinite (Cretaceous)**—Serpentinite within Santiago Peak Volcanics; greenish-brown, highly deformed, slickensided

Kc **Carbonate-silicate rock (Cretaceous)**—Carbonate-silicate rock spatially associated with serpentinite (Ks); reddish-brown

Kvsp **Santiago Peak Volcanics (Cretaceous)**—Andesitic basalt, andesite, dacite, and rhyolite; mainly extrusive rocks, but some associated volcaniclastic rocks

Kvspi **Intrusive rocks associated with Santiago Peak Volcanics (Cretaceous)**—Hypabyssal dikes, sills and small intrusions

Kvem **Estelle Mountain volcanics of Herzig (1991) (Cretaceous)**—Rhyolite and rare andesite; heterogeneous mix of extrusive and volcaniclastic rocks

Kvr **Rhyolite of Estelle Mountains volcanics of Herzig (1991) (Cretaceous)**—Rhyolite; relatively homogeneous extrusive rocks

Ksv **Intermixed Estelle Mountain volcanics of Herzig (1991) and Cretaceous(?) sedimentary rocks (Cretaceous?)**—Rhyolitic volcanic rocks and Mesozoic sedimentary rocks. Tectonically and probably stratigraphically mixed

Kvs **Intermixed Estelle Mountain volcanics of Herzig (1991) and Mesozoic sedimentary rocks (Mesozoic)**—Predominantly Mesozoic metasedimentary rocks, but including some volcanic rocks

Deformed granitic rocks of Transverse Ranges province (Mesozoic)—Deformed Mesozoic sedimentary rocks. Includes:

Mzmg **Mylonitic and cataclastic granitic rocks**—Cataclastic granodiorite, tonalite, and quartz diorite, fine- to coarse-grained

Mzdy **Diorite, Yucaipa area (Mesozoic)**—Biotite-hornblende diorite and quartz diorite; medium- to coarse-grained, massive to incipiently foliated

Jbc **Bedford Canyon Formation (Jurassic)**—Interlayered argillite, slate, graywacke, conglomeratic graywacke, impure quartzite, and small masses of limestone; slightly metamorphosed. Includes:

Jbc_1 **Bedford Canyon Formation, Unit 1**—Brown-weathering, massive-appearing quartz-rich metasandstone and impure quartzite

Jbm **Marble and limestone**—Fine-grained marble and limestone; gray-weathering. Small elongate- to equant-shaped bodies

Mzu **Mesozoic metasedimentary rocks, undifferentiated (Mesozoic)**—Quartz-bearing metasedimentary rocks, chiefly biotite schist; includes unknown Mesozoic metasedimentary rocks and rocks of other designated Mesozoic units

Mzg **Graywacke (Mesozoic)**—Predominately lithic metagraywacke. Thickly layered to massive. Contains angular fragments and discontinuous layers of phyllite

Mzq **Quartz-rich rocks (Mesozoic)**—Impure quartzite and quartz-rich metasandstone. Quartzite may or may not be feldspathic

Mzqg **Intermixed quartzite and graywacke (Mesozoic)**—Intermixed impure quartzite and lithic metagraywacke

Mzgp **Intermixed graywacke and phyllite (Mesozoic)**—Intermixed lithic metagraywacke and phyllite

Mzp **Phyllite (Mesozoic)**—Phyllite, black, fissile. Locally contains prisms of fine-grained white mica, possibly pseudomorphs after chiastolite

Mzs **Schist (Mesozoic)**—Wide variety of fissile schist including andalusite biotite schist, cordierite biotite schist, sillimanite biotite schist, and less commonly garnet-bearing schist

Mzm **Marble (Mesozoic)**—Light colored tremolite and diopside-bearing marble and calc-silicate rock

Mzi **Interlayered phyllite (or schist) and quartzite (Mesozoic)**—In low metamorphic grade rocks, relatively pure quartzite interlayered with phyllite. In higher grade metamorphic rocks, quartzite interlayered with biotite schist

Mzmn **Manganese-bearing rocks (Mesozoic)**—Quartz-rich metasedimentary rocks containing black manganese-oxide and silicate minerals

Mza **Amphibolite (Paleozoic?)**—Hornblende-plagioclase amphibolite; black. Locally contains garnet in vugs

Mzsgn **Mixed low metamorphic grade and upper amphibolite grade rocks (Mesozoic)**—Schist, graywacke, and impure quartzite; tectonically intermixed. Includes all metaserpentine-metadunite and related rocks:

Mzds (Mzsm) **Metadunite and serpentinite (Mesozoic)**—Talc-bearing olivine dunite and dunite altered to magnesite-bearing serpentinite; brown-weathering. Thoroughly serpentinized metadunite containing magnesite veins (Mzsm)

Mzdx **Amphibole- and pyroxene-bearing rocks associated with metadunite-serpentinite (Mesozoic)**—Heterogeneous mixture of amphibolite, pyroxenite, and altered schist

Mzdc **Marble associated with metadunite (Mesozoic)**—Silicate-bearing marble; pale gray, coarse-grained, spatially associated with dunite

Mzgn **Biotite gneiss and schist (Mesozoic)**—Biotite-quartz-feldspar gneiss and schist. Coarse grained; locally contains sillimanite and cordierite

KgMz **Intermixed Mesozoic schist and Cretaceous granitic rocks (Mesozoic)**—Heterogeneous mixture of schist and granitic rocks

KgPz **Intermixed Paleozoic(?) schist and Cretaceous granitic rocks (Cretaceous and Paleozoic?)**—Intermixed Paleozoic(?) schist and gneiss and Cretaceous granitic rocks, mostly of tonalite and granodiorite composition

Pzu (m) **Paleozoic(?) rocks, undifferentiated (Paleozoic?)**—Biotite schist, quartzite, gneiss, and lesser amounts of hornblende gneiss, marble and associated skarn and calc-silicate rock. Coarse- and very coarse-grained marble bodies (m) mapped separately

Pzs **Biotite schist (Paleozoic?)**—Biotite schist and biotite-quartz-feldspar schist; medium- to dark-gray, fine-grained

Pzq **Impure quartzite (Paleozoic?)**—Quartzite; impure, light-gray to light-greenish-gray, fine-to medium-grained, layered to massive

Pzm **Marble (Paleozoic?)**—Marble; white to light-gray, locally bluish-gray, and blue, coarse- to extremely coarse-grained

Pzc **Calc-silicate rocks (Paleozoic?)**—Heterogeneous, massive to well-layered calc-silicate rocks

Pzms **Marble and schist, undifferentiated (Paleozoic?)**—Intermixed marble, calc-silicate rock, and biotite schist

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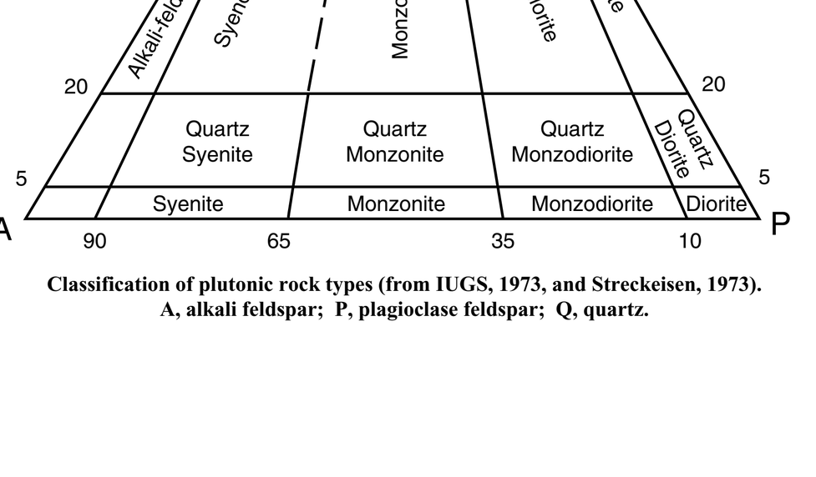

Classification of plutonic rock types (from IUGS, 1973, and Streckeisen, 1973). A, alkali feldspar; P, plagioclase feldspar; Q, quartz.