appendix C

Geologic Description and Mineral Resource Zone Correlation

TECTONIC HISTORY AND MODERN GEOMORPHIC PROVINCES

The tectonic deformation and consequent volcanism along the Pacific-North American plate boundary have played a large roll in shaping the geology of San Diego region. Early on from the late Triassic (~200 Ma) to the early Cretaceous, San Diego region was largely submerged, and volcanism associated with subduction and dewatering of the Farallon Plate formed underwater seamounts and volcanic chains (Figure 1A and B). With continued volcanism, the underwater seamounts grew and became emergent and formed an archipelago. During the Cretaceous (145-65 Ma) and throughout the much of the early Tertiary (65-30 Ma) the subduction of the Farallon plate beneath the North American plate generated large volumes of magma that had both an extrusive and intrusive component. The extrusive component cools quickly as it is near the surface and the crystals in the rocks are fine-grained. The intrusive component cools slowly as it is insulated by kilometers of rock and crystals have time to grow. In addition, the emplaced magma heated and deformed the existing volcanic and sedimentary rocks resulting in metamorphic rocks such as marble, slate, schist, and quartzite. The surface expression of the volcanoes has been erased by millions of years of erosion. The intrusive magma that cooled at depth has been exposed at the surface by this erosion and isostatic uplift to form the Southern California Batholith. Over millions of years, tectonic uplift and erosion of the batholith resulted in mountains with peaks up to 3000 m elevation. Around 30 million years ago, the buoyant mid-ocean spreading center in the Pacific plate collided with the subduction complex. The spreading center is hot and buoyant and as such resists subduction, which caused cessation of the oblique subduction between the Pacific and North America plates and the formation of strike-slip boundary where the plates move past one another along the San Andreas Fault (Figure 1C). The strike-slip boundary extended to the north and south, and spreading began to open the Gulf of California to the south. The San Andreas Fault complex migrated eastward as the Pacific Plate began to drag coastal southern California to the northwest (Figure 1C). Consequently, the modern San Andreas Fault lies to the north and east of San Diego region, which is located on the Pacific Plate.

As a result of its tectonic origins, San Diego region coincides with three geomorphic provinces (Figure 2). A small eastern portion of the region coincides with the Salton Trough, the northern extent of the spreading center located in the Gulf of California. The largest province is the Peninsular Ranges, a mountainous region consisting of granitic, volcanic, and metamorphic rocks created due to Cretaceous subduction processes. The Peninsular Ranges Province is flanked on the west by the third province, the California Borderlands. The eastern part of the Borderlands consists of the coastal plain, which extends ~10 km inland from the modern coast, but the majority of the Borderlands are composed of the submerged seafloor extending offshore to the west. The topography of the seafloor in this area is characterized by numerous downdropped and uplifted blocks formed during tectonic extension and compression associated with the translation motion along the margin and the distributed strike-slip faults (Figure 2).

Several rivers dissect the margin and carry sediment from the mountains of the Peninsular Ranges westward to the ocean, or to where they are trapped by dams. The most prominent rivers are the Santa Margarita and the San Luis Ray (Figure 2). Processes associated with these event-dominated braided rivers deposit unconsolidated sediments such as coarse sand, cobbles, and boulders.

GEOLOGIC DESCRIPTIONS

Geology of the Peninsular Ranges

The Peninsular Ranges are largely composed of granitic rocks of the Southern California Batholith (Figure 2). Numerous intrusive plutons formed the batholith, resulting in various distinct lithologies ranging from gabbros to diorites to tonalities and granites (Silver, et al., 1979). Prebatholitic rocks include relatively unmetamorphosed volcanics to the west and progressively metamorphosed clastic rocks to the east. Along the western margin of the Peninsular Ranges the exposed volcanics were formed during submarine arc volcanism of the Jurassic (~150 Ma) prior to emplacement of the Southern California Batholith (Santiago Peak Volcanics; Figure 2). In and around San Diego region, outcrops of Santiago Peak Volcanics extend roughly 125 km from north to south with a width of no more than 15 km. These lightly metamorphosed volcanics include andesite lava and pyroclastic deposits, with smaller proportions of quartz latites, rhyolites, and basalts (Jennings, 2009). The clastic rocks to the east are likely similar in age to the western volcanics, were deposited in a marine environment between the island arc and the ancient coastline located farther to the east, and were subsequently metamorphosed (Figure 2). These rocks include graywackes, sandstones, and some carbonates. To the north and east of the Peninsular Ranges within San Diego region, increased strike-slip faulting is coincident with mixed exposures of pre-existing metamorphic rocks intruded by the granitic batholith.

Geology of the Coastal Plain/California Borderlands

Coastal Plain

A few outcrops of Cretaceous volcanics are exposed in the coastal plain, but younger Cretaceous and Tertiary marine and fluvial sediments cover much of the older topography (Figure 2). For example, in the vicinity of the rivers, unconsolidated alluvial, channel, and floodplain deposits include coarse sand, pebbles, and boulders. Most of the remaining sediments are marine deposits from the Cretaceous and younger cycles of marine transgressions and regressions. Late Cretaceous (76-72 ma) marine sedimentary rocks are exposed in the sea cliffs along the west side of the Point Loma Peninsula and in La Jolla from Bird Rock north to La Jolla Shores. Eocene-aged (48-42 ma) marine sedimentary rocks extend from the Rose Canyon Fault at La Jolla Shores to the north and are especially prominent in the sea cliffs from Scripps Institution of Oceanography to Del Mar. Mantling the Eocene deposits are coarse-grained poorly sorted Pleistocene beach terrace deposits.

Continental Shelf

The Cretaceous and Eocene marine sedimentary rocks exposed in the sea cliffs extend offshore and, when not exposed at the seafloor, underlie the more recent marine sediments. These recent sediments were deposited during repeated sea-level rise and fall during the Quaternary (2.6 Ma-present) glacial cycles of the Northern Hemisphere.

Figure 1
Paleogeography of the North American Continent
During the A) Triassic (~200 ma) and B) Cretaceous (~145-65 ma)

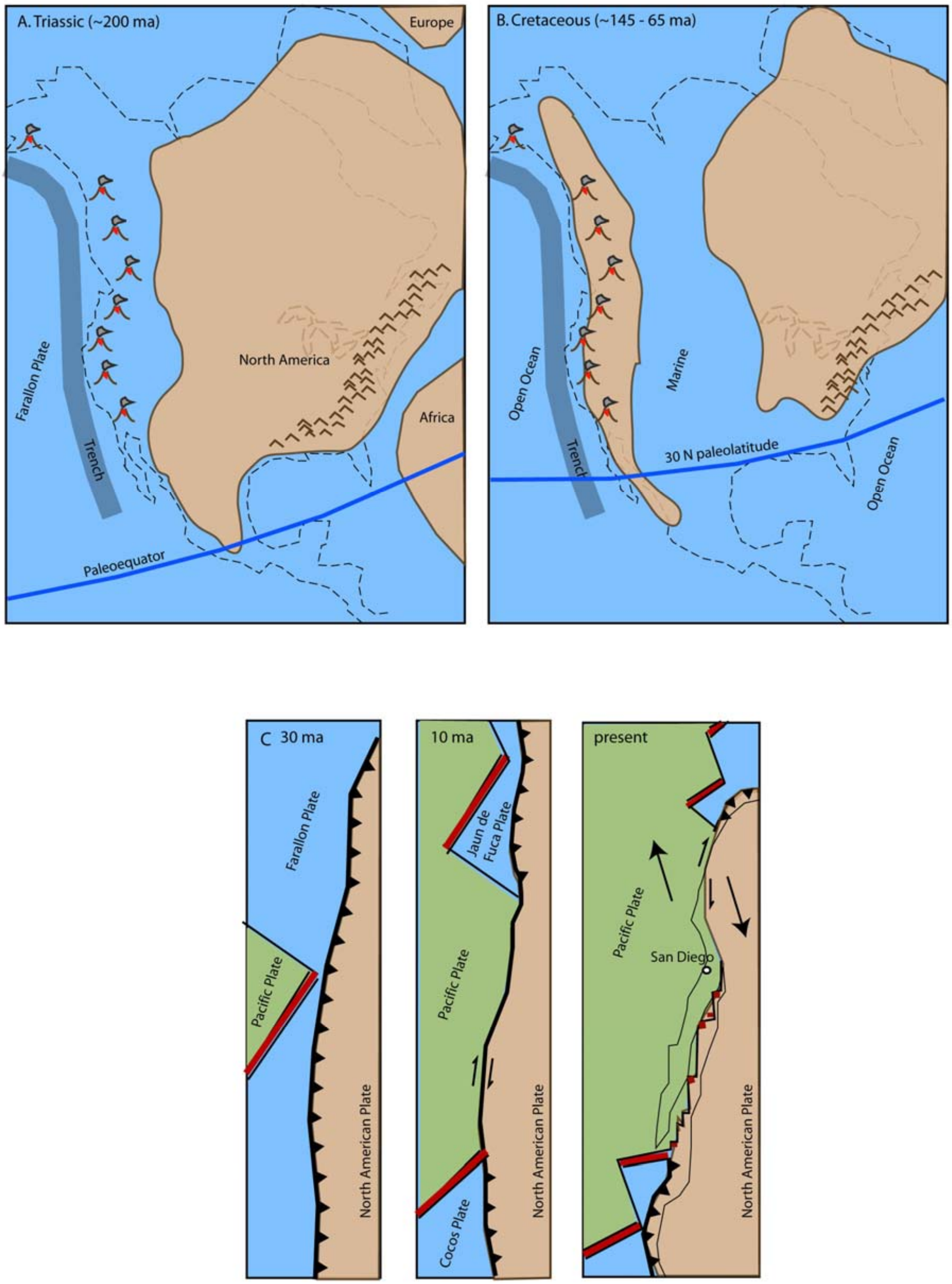
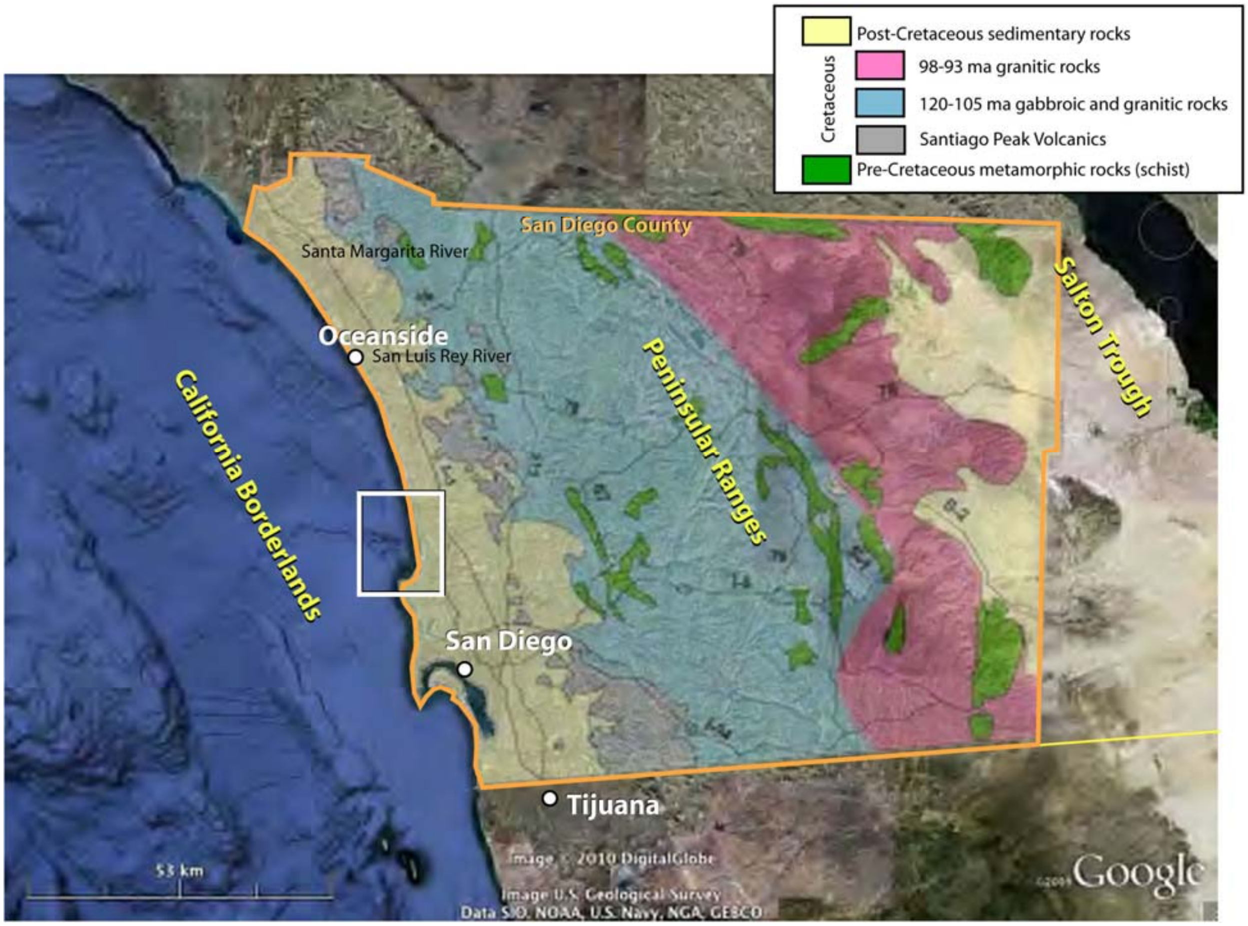


Figure 2
Regional Topographic Map of San Diego Region and Adjacent Offshore Bathymetry With Generalized Geology Overlain



MINERAL RESOURCE ZONE (MRZ) CORRELATION

Figure 3 shows available detailed geologic data for the San Diego region from the United States Geologic Survey (USGS). PDF copies of USGS 7.5-minute quadrangle geologic maps where available for the San Diego region were downloaded from the USGS web site (www.usgs.gov). For the San Diego region, the quadrangle geologic maps had limited coverage. Other regions in the state may have more or less coverage.

Figure 4-2 illustrates the results of the methodology. It shows those areas officially classified by the Department of Conservation as MRZ 1 through 4 and the correlated geology types.

PDF copies of USGS 7.5 minute quadrangle geologic maps were downloaded where available for San Diego region. The files were opened in Adobe Illustrator and edited to remove labels, legend items, and other text elements, leaving only the boundaries of geologic units. Depending on how the map was originally created, these boundaries were represented either as lines or polygons. In some cases, dashed lines were used to represent boundaries. These dashed lines were traced in Adobe Illustrator in order to create solid boundaries using the Pen tool. In cases where boundaries were represented using Bezier curves, paths were densified using the "Add Anchor Points" and "Simplify" commands. This step was necessary as Bezier curves cannot be directly imported to ArcGIS. The lines or polygons were then exported to generic CAD files (.dxf).

In ArcGIS, the CAD to Feature Class tool was used to convert the .dxf files to shapefiles. The shapefiles were georeferenced using the Spatial Adjustment tool set. The corners of each quadrangle were registered to the corners of the corresponding USGS quadrangle boundary feature class in the SANDAG database. These control points were used to transform the data to the California State Plane Zone VI coordinate system. In cases were lines were used to represent boundaries, the data was converted to polygon geometry using the Feature to Polygon tool. The polygons were then assigned a geology type based on the labels contained in the PDF maps through manual edits to the attribute table. Table 1 shows a listing and description of the geology types.

The attributed geology datasets then were merged into a single-feature class in a personal geodatabase. A topology was defined to not allow overlaps or gaps between polygons representing geologic units that resulted from the georeferencing process. Topology errors were manually corrected.

MRZ and Geology Type Correlation

The resulting geology feature class was used to identify areas outside the official MRZ classification that contain rock types similar to the officially classified zones. The geology feature class was intersected with the MRZ types 1 through 4 to determine correlations between geology type and MRZ classification based on overlapping area. Table 2 shows the percentage correlation of geology types to the MRZ classifications. If 95 percent or more of a geology type's area overlapped a single MRZ classification, it was considered to be highly correlated with that MRZ. For example, Table 2 shows that geology type Jcr-Cuyamaca Reservoir Grandodiorite (Jurassic) was classified as MRZ-3 100 percent of the time. Therefore, Jcr lands outside of the official MRZ classification zones were determined to be correlated to MRZ-3. Geology types that did not meet the 95 percent threshold were correlated with an MRZ classification in consultation with the geology consultant from Scripps Institute of Oceanography based on shared percentages as well as composition, grain size, etc.

In areas not covered by either the MRZ classification or the 7.5-minute quadrangle geologic maps, a 1:750,000 scale map was used to correlate geology type to MRZ classification in consultation with the Scripps geologist using similar criteria. Because of the relatively coarse scale of the data, geology type was correlated only to MRZ classification 3 or 4. Table 3 illustrates the correlation of geology types to MRZ-3 or MRZ-4 for coarse scale (1:750,000) Geology.

Figure 4 illustrates the results of the methodology. It shows those areas officially classified by the Department of Conservation as MRZ 1 through 4 and the correlated geology types.

Limitations

The MRZs are established by the Department of Conservation based on guidelines adopted by the California State Mining and Geology Board and under authority granted by the Surface Mining and Reclamation Act (SMARA) of 1975. The MRZs are classified on the basis of an aggregate resource appraisal that includes an analysis of geologic reports and maps, field investigations, an examination of active sand and gravel mining operations, analyses of drill hole data, interpretation of aerial photographs, and evaluation of private company data. The physical and chemical rock material specifications, as determined by laboratory testing, must be known before any specific geologic deposit is assigned an MRZ-2 classification.[1]

As explained earlier in this document, this analysis to correlate geology type with MRZ classification was limited to an examination of geologic reports and maps. The designation of regional or statewide significance was not undertaken as this falls under the authority of the State Mining and Geology Board. Designation is the process by which the State Mining and Geology Board formally recognizes the statewide or regional significance of classified mineral resources in meeting the future needs of the state or region.

Those areas officially classified by the Department of Conservation and designated by the State Mining and Geology Board as MRZ -2 are shown in Figure 1. (Areas were initially classified in 1982, designated in 1985, and several additional sites were classified later via the petition process.) It also illustrates those geology types that the SANDAG analysis showed to be the same or similar geology as MRZ-2, but that no determination for regional or statewide significance was made.

Uncertainty

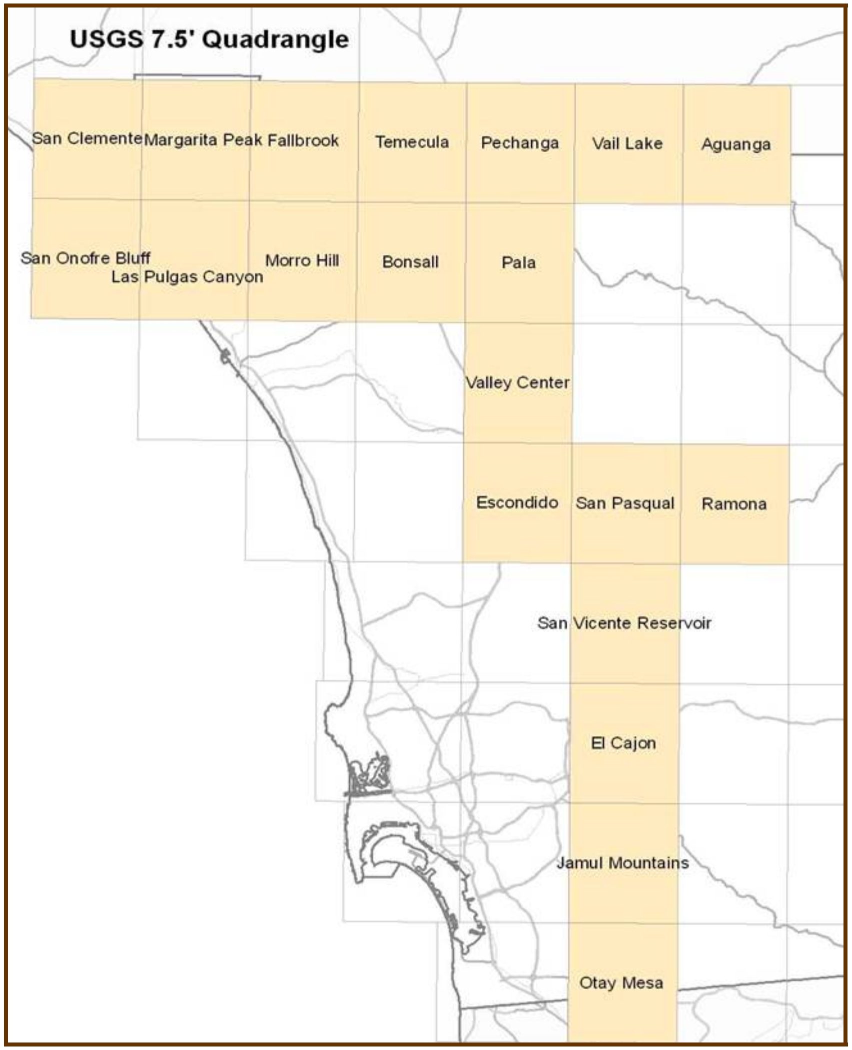
MRZ-3 (resource potentially present) and MRZ-4 (inconclusive) refer to levels of uncertainty about the presence of aggregate resources. While a geologic unit may correlate highly to MRZ-4, this should not necessarily be inferred as inconclusiveness about the geologic type as an aggregate resource. Areas classified as MRZ-4 may have been assigned to this category as a result of a lack of fieldwork or inaccessibility of the area in the original survey.

Data Sources

While geology type is important in determining the presence of an aggregate resource, other criteria also play a role. Factors, such as the weathering of rock or sediment thickness, can vary across geology type and as such, must be verified with fieldwork. A GIS-based analysis of geology type can identify areas for further investigation, but cannot identify the presence or absence of aggregate resource on its own.

[1] Kohler, Susan L. and Russell V. Miller, California Department of Conservation, Division of Mines and Geology, Mineral Land Classification: Aggregate Materials in the Western San Diego County Production-Consumption Region, 1982.

Figure 3 — USGS 7.5' Quadrangle



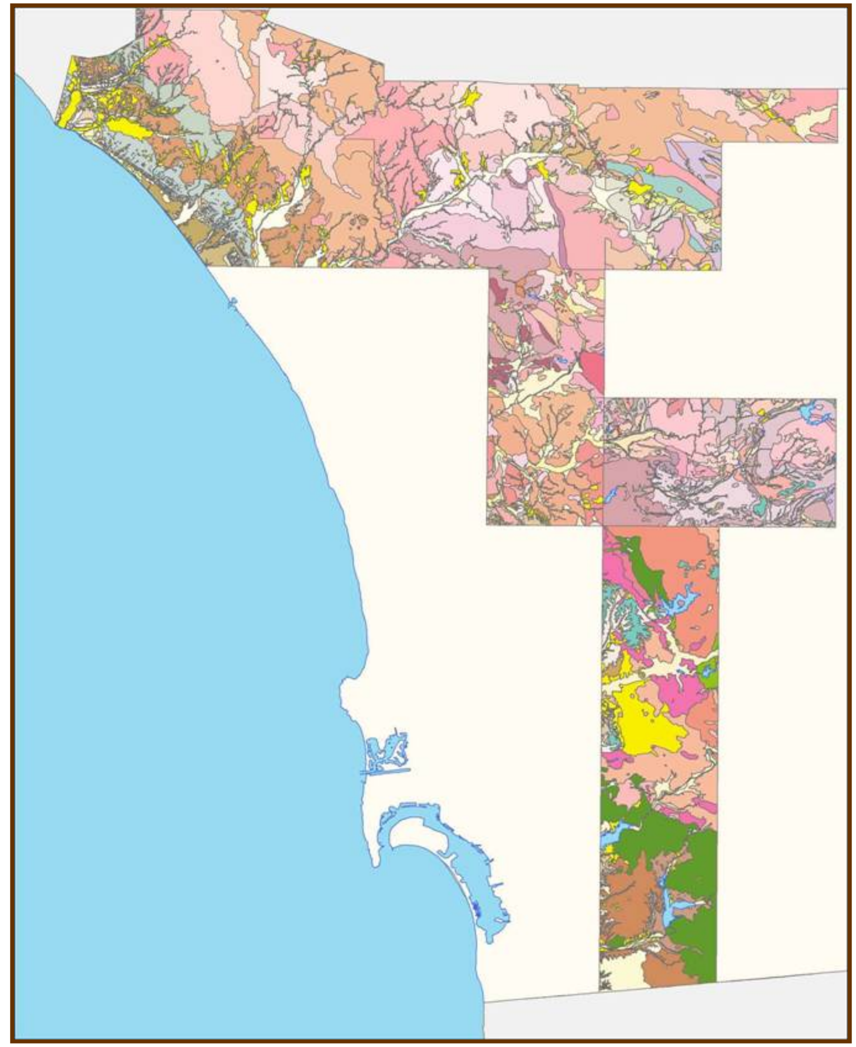


Figure 4 — MRZ Classification and Correlations

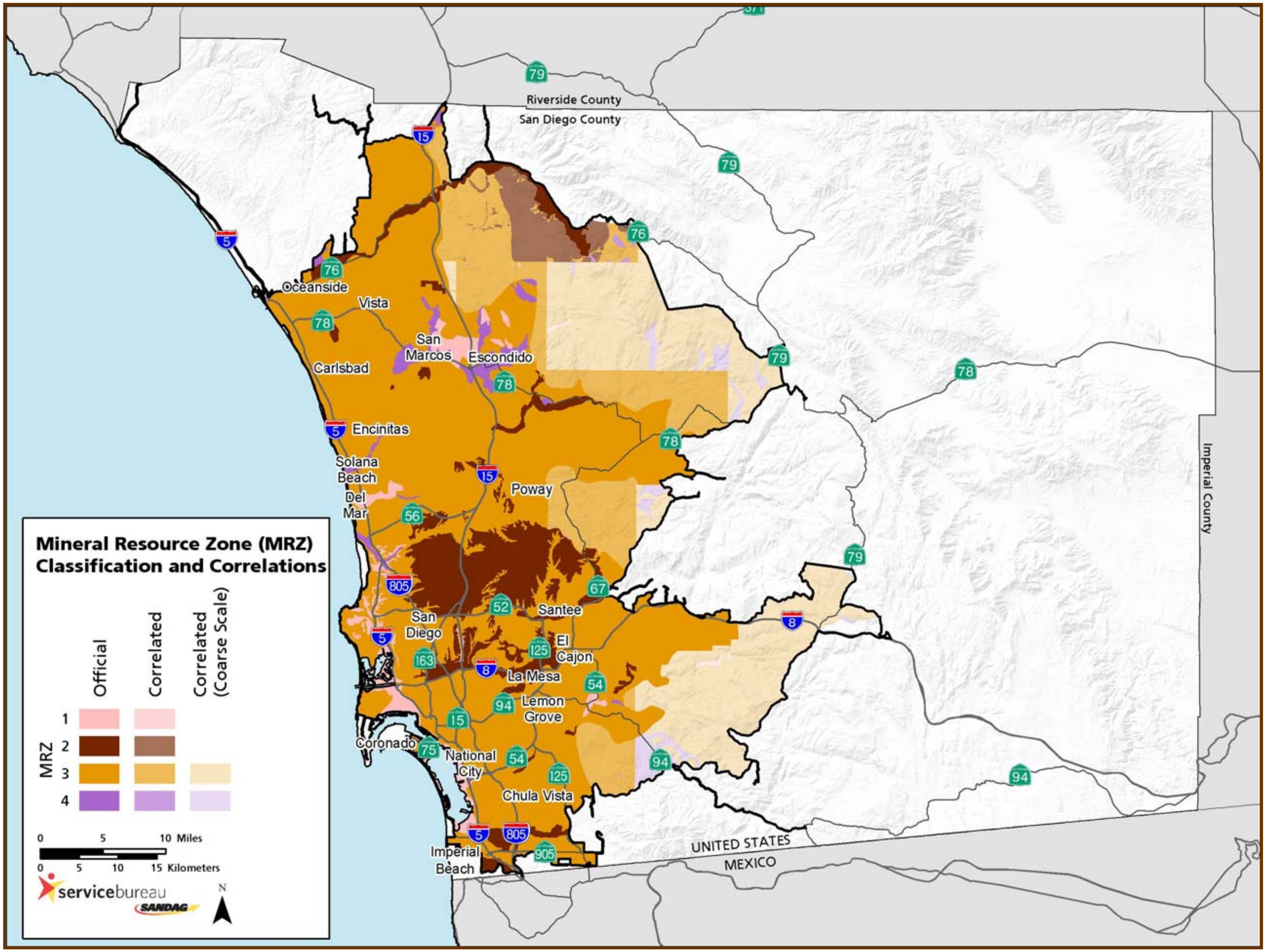


Table 1 — Geology Types

Geologic Unit	Geologic Unit Name	Description
af	Artificial fill (late Holocene)	
Jcr	Cuyamaca Reservoir Granodiorite (Jurassic)	Fine to medium-grained and light to dark-gray on fresh surfaces. Outcrops weather to an orange-tan color. Consists of subequal biotite and hypersthene-biotite granodiorite and tonalite; many samples have borderline granodiorite/tonalite compositions.
Jcr-w	Cuyamaca Reservoir Granodiorite (Jurassic)	Deeply weathered fine to medium-grained and light to dark-gray on fresh surfaces, orange-tan on outcrops. Consists of subequal biotite and hypersthene-biotite granodiorite and tonalite; many samples have borderline granodiorite/tonalite compositions.
Jmgd	Metagranodiorite (Jurassic)	Mostly medium-grained, foliated, biotite granodiorite. Also lesser amounts of biotite tonalite and biotite monzogranite.
Jmmg	Metamonzogranite (Jurassic)	Mostly medium-grained, foliated, biotite monzogranite. Also lesser amounts of biotite tonalite and biotite granodiorite.
Jmt	Metatonalite (Jurassic)	Mostly medium-grained, foliated, biotite tonalite Also lesser amounts of biotite granodiorite and biotite monzogranite.
JTrm	Metasedimentary rocks (Jurassic and Triassic)	Mostly quartzofeldspathic schist, pelitic schist, quartzite, and metabreccia.
Ka	Tonalite of Alpine (Cretaceous)	Consists of medium to coarse-grained biotite-hornblende tonalite, quartz diorite, and minor diorite.
Kat	Gabbro of the Agua Tibia Mountains (Cretaceous)	Mostly hornblende gabbro; medium to coarse-grained, massive to foliated and is locally quartz bearing gabbro.
Ka-w	Tonalite of Alpine (Cretaceous)	Consists of deeply weathered medium to coarse-grained biotite-hornblende tonalite, quartz diorite, and minor diorite.
Kbm	Granodiorite of Burnt Mountain (Cretaceous)	Leucocratic biotite granodiorite; very fine grained, massive.
Kbp	Granite of Bottle Peak (Cretaceous)	Leucocratic, hornblende-biotite granite, coarse grained.
Kc	Cuyamaca Gabbro (Cretaceous)	Consists of large gabbro plutons, smaller gabbro bodies, and gabbroic dikes. These rocks are fine to coarse-grained and dark colored on fresh surfaces but typically weather to form a reddish soil with sparse outcrop.
Kcc	Tonalite of Couser Canyon (Cretaceous)	Hornblende-biotite tonalite; coarse grained and massive. Contains some granodiorite and is characterized by an abundance of pegmatite dikes.
Kcg	Tonalite of Cole Grade (Cretaceous)	Mostly medium- to coarse-grained, hornblende-biotite tonalite.
Kcgw	Tonalite of Cole Grade (weathered) (Cretaceous)	Mostly deeply weathered medium- to coarse-grained, hornblende-biotite tonalite.
Kcm	Corte Madera Monzogranite (Cretaceous)	Corte Madera rocks consist of medium- to coarse-grained biotite leucomonzogranite, leucogranodiorite, and syenogranite as well as abundant dikes of leucogranite, alaskite, pegmatite, and aplite.
Kcp	Chiquito Peak Monzogranite (Cretaceous)	This unit is grayish-white weathering, medium to coarsegrained hornblende-biotite leucomonzogranite and granodiorite, with lesser tonalite, granite, alaskite and pegmatite. Biotite content is greater than hornblende in most outcrops.
Kcp-w	Chiquito Peak Monzogranite (Cretaceous)	This unit is deeply weathered, medium to coarsegrained hornblende-biotite leucomonzogranite and granodiorite, with lesser tonalite, granite, alaskite and pegmatite. Biotite content is greater than hornblende in most outcrops.
Kc-w	Cuyamaca Gabbro (Cretaceous)	Consists of large gabbro plutons, smaller gabbro bodies, and gabbroic dikes. These deeply weathered rocks are fine- to coarse-grained and dark colored on fresh surfaces but typically weather to form a reddish soil with sparse outcrop.
Kd	Diorite undivided (Cretaceous)	Mostly hornblende diorite; medium to coarse grained, dark gray, massive.
Kdl	Granite of Dixon Lake (Cretaceous)	Leucocratic biotite granite; very fine grained, sub-porphyritic.
Kg	Granite undivided (Cretaceous)	Mostly leucocratic granite; coarse to medium grained.
Kg(e)	Escondido Creek leucogranodiorite	Fine-grained light-colored rocks ranging from leucogranodiorite to leucotonalite, with minor granodiorite and tonalite.
Kg(gv)	Green Valley tonalite	Medium-grained gray tonalite with minor granodiorite, gabbro and other basic igneous rocks.
Kg(lw)	Lake Wolford leucogranodiorite	Fine-grained light-colored granodiorite with some coarser-grained granodiorite and minor tonalite.
Kg(sm)	San Marcos gabbro	Fine to coarse-grained rocks ranging from trocolite to quartz norite, with minor tonalite.
Kg(wm)	Woodson Mountain granodiorite	Coarse-grained light-colored granodiorite with some finer-grained granodiorites and minor tonalite.
Kgb	Gabbro undivided (Cretaceous)	Mostly biotite-hornblende-hypersthene gabbro; coarse grained, dark gray, massive.
Kgbd	Creatacious Granodiorite, mostly biotite-granodiorite	

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Kgbf	Gabbro undivided fault part (Cretaceous)	Mostly biotite-hornblende-hypersthene gabbro that has been extensively sheared along the Elsinore fault zone.
KgbKdKqbd	Mix of Kgb, Kd, and Kqbd (see individual descriptions)	
KgbKgd	Mix of Kgb and Kgd (see individual descriptions)	
Kgd	Granodiorite undivided (Cretaceous)	Mostly hornblende-biotite granodiorite; coarse to medium grained.
Kgd-f	Fine-grained Granodiorite undivided (Cretaceous)	Mostly hornblende-biotite granodiorite.
Kg-gb	Gabbro (Cretaceous)	Includes some peridotite, norite, quartz gabbro, medium-grained and dark colored.
Kg-gd	Granodiorite (Cretaceous)	Includes some tonalite and monzogranite, medium to coarse-grained.
Kg-gdf	Fine-grained granodiorite (Cretaceous)	Includes some tonalite, fine to medium-grained, mostly dark colored.
Kg-gr	Granite (Cretaceous)	Includes some granodiorite, mostly leucocratic, medium to coarse-grained.
Kg-t	Tonalite undivided (Cretaceous)	Mostly hornblende-biotite tonalite; coarse-grained, light gray.
Ki	Granodiorite of Indian Mountain (Cretaceous)	Biotite leucocratic granodiorite; white, fine to medium grained and massive.
Kis	Granite of Indian Springs (Cretaceous)	Biotite granite: fine grained granite similar in appearance to Kdl.
KJ	Metavolcanic and metasedimentary rocks undivided (Cretaceous and Jurassic)	Low grade (greenschist facies) rocks that are in part coeval with and in part older than the Cretaceous plutonic rocks they lie in contact with.
KJd	Metavolcanic dikes undivided (Cretaceous and Jurassic)	Dikes that cut KJ; very fine grained, dark gray, massive.
KJg	Metagranitic rocks (Cretaceous and Jurassic)	Mostly gneiss; very light gray to white, massive.
KJi	Intrusive rocks of the Santiago Peak Volcanics	Fine-grained granodiorite and related rocks, with minor amounts of rocks listed under KJsp and KJm.
KJm	Metavolcanic and metasedimentary rocks undivided (Cretaceous and Jurassic)	Low grade (greenschist facies) rocks that are in part coeval with and in part older than the Cretaceous plutonic rocks they lie in contact with.
KJm-s	Metasedimentary rocks (Jurassic and Cretaceous)	Mildly metamorphosed (greenschist facies) sandstone, siltstone and shale, schist, quartzite, metabasalt, metatuff-breccia with gneiss, fine-grained granodiorite, tonalite, and minor amounts of rocks listed under KJmv.
KJm-v	Metavolcanic rocks (Jurassic and Cretaceous)	Mildly metamorphosed volcanic, volcaniclastic and sedimentary rocks. Volcanic rocks range from basalt to rhyolite, but are mainly andesite and dacite. Metavolcaniclastic rocks are most abundant. Includes minor metasedimentary rocks listed under KJms.
KJq	Quartzite and quartz conglomerate (Cretaceous and Jurassic)	Mostly quartzite, quartz conglomerate and meta-arkose.
KJs	Schist with minor amphibolite and marble (Cretaceous and Jurassic)	Mostly quartz-mica-schist, quartz-mica amphibole schist, and feldspathic amphibole schist.
KJsp	Undifferentiatied Santiago Peak Volcanics	Mildly metamorphosed volcanic and volcaniclastic rocks. Volcanic rocks range from basalt to rhyolite, but are predominantly andesite. It also containes rocks listed under Kji and KJm.
KJv	Japatul Valley Tonalite (Cretaceous)	Consists of biotite-hornblende tonalite, hornblende-biotite tonalite, and borderline tonalite/granodiorite that grades to granodiorite. Japatul Valley rocks are medium- to coarsegrained, equigranular, and moderately to strongly foliated.
KJvs	Metavolcanic and metasedimentary rocks (Createaceous - Jurassic)	
KJv-w	Japatul Valley Tonalite (Cretaceous)	Consists of deeply weathered biotite-hornblende tonalite, hornblende-biotite tonalite, and borderline tonalite/granodiorite that grades to granodiorite. Japatul Valley rocks are medium- to coarsegrained, equigranular, and moderately to strongly foliated.
Kl	Lusardi Formation (Upper Cretaceous)	Poorly-cemented non-marine boulder conglomerate with sandstone intermix.
Klb	Las Bancas Tonalite (Cretaceous)	Homogeneous, mafic inclusion-free hypersthene-biotite tonalite with lesser quartz diorite, granodiorite, diorite, and quartz norite.

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Klb/Kjv	Las Bancas Tonalite and Japatul Valley Tonalite, gradational unit (Cretaceous)	Comprises the central pluton of Merriam's ring-dike structure. At two locations along the contact between Klb and the surrounding Japatul Valley Tonalite, the two units are separated by a zone of contact breccia that suggests mingling of coeval magmas.
Klb-w	Las Bancas Tonalite (Cretaceous)	Deeply weathered homogeneous, mafic inclusion-free hypersthene-biotite tonalite with lesser quartz diorite, granodiorite, diorite, and quartz
Kld	Lake Wolford Granodiorite (Cretaceous)	Lake Wolford granodiorite is primarily a fine-grained, light-gray leucogranodiorite.
Klp	Tonalite of La Posta (Cretaceous)	Rocks tentatively correlated with La Posta-type plutons of the eastern zone of the PRB. Consists of homogeneous, idiomorphic medium- to coarse-grained hornblende-biotite tonalite, trondhjemite (leucotonalite), and leucogranodiorite.
Klpm	Tonalite of La Posta, Mafic phase (Cretaceous)	Mineralogically and texturally similar to La Posta rocks but are more mafic. Unit consists of light-gray-weathering, strongly foliated, fine- to medium-grained tonalite that is less resistant to erosion than La Posta.
Klpm-w	Tonalite of La Posta, Mafic phase (Cretaceous)	Deeply weathered rocks; mineralogically and texturally similar to La Posta rocks but are more mafic. Unit consists of light-gray-weathering, strongly foliated, fine- to medium-grained tonalite that is less resistant to erosion than La Posta.
Klp-w	Tonalite of La Posta (Cretaceous)	Deeply weathered rocks tentatively correlated with La Posta-type plutons of the eastern zone of the PRB. Consists of homogeneous, idiomorphic medium- to coarse-grained hornblende-biotite tonalite, trondhjemite (leucotonalite), and leucogranodiorite.
Klw	Lake Wolford Granodiorite (Cretaceous)	Lake Wolford granodiorite is primarily a fine-grained, light-gray leucogranodiorite.
Klw-gr	Lake Wolford Granodiorite (Cretaceous)	Fine-grained, light-gray leucogranodiorite with marginal facies.
Km	Quartzdiorite of Mountain Meadows (Cretaceous)	Hornblende quartzdiorite; medium grained, dark gray.
Kmg	Monzogranite undivided (Cretaceous)	Mostly biotite-hornblende monzogranite, coarse grained.
Kmm	Monzogranite of Merriam Mountain (Cretaceous)	Leucocratic hornblende-biotite monzogranite; medium to coarse grained, massive.
Kmv	Western metavolcanic rocks (Cretaceous)	Metamorphosed silicic and intermediate volcanic rocks intruded by tonalite. Minor pelitic schist, feldspathic metaquartzite, and plutonic-cobble metaconglomerate interlayered with tuff, tuff-breccia, and andesitic, rhyolitic, and basaltic flows.
Kp	Granodiorite of Pala (Cretaceous)	Leucocratic granodiorite and migmatite; fine- to medium-grained.
Kqbd	Quartz bearing diorite undivided (Cretaceous)	Mostly biotite-hornblende quartz bearing diorite; medium grained, dark gray, massive.
Kqd	Quartz diorite and gabbro, undivided (Cretaceous)	Mostly massive, coarse-grained, dark-gray, quartz diorite. Contains gabbro and tonalite.
Kr	Granodiorite of Rainbow (Cretaceous)	Leucocratic hornblende-biotite granodiorite; medium to coarse grained, massive.
Krr	Granodiorite of Rimrock (Cretaceous)	Biotite granodiorite; fine grained, sub-porphyritic.
Kri	Tonalite of Rincon (Cretaceous)	Mostly medium- to coarse-grained, hornblende biotite tonalite extensively cut by pegmatite dikes.
Krm	Quartz bearing diorite of Red Mountain (Cretaceous)	Biotite-hornblende diorite; coarse grained, dary gray, massive.
Koa	Trabuco Formation (Cretaceous)	Non-marine fanglomerate with unsorted subangular clasts.
Kt	Tonalite undivided (Cretaceous)	Mostly hornblende-biotite tonalite; coarse grained, light-gray.
Kvc	Monzogranite of Valley Center (Cretaceous)	Leucocratic biotite monzogranite; coarse grained, massive.
Kw	Gabbro of Weaver Mountain (Cretaceous)	Hornblende gabbro; coarse grained and massive.
Kwm	Woodson Mountain Granodiorite (Cretaceous)	Light-tan to pale brownish-gray, medium- to coarse-grained granodiorite.
Kwmd	Woodson Mountain Apatite Dikes (Cretaceous)	Light-tan to pale brownish-gray, medium- to coarse-grained granodiorite with dikes present.
Kwm-w	Woodson Mountain Granodiorite (Cretaceous)	Deeply weathered light-tan to pale brownish-gray, medium- to coarse-grained granodiorite.
Kwp	Williams Formation	Pleasant Sandstone Member. Marine fine to medium grained sandstone, silty sandstone and siltstone; poorly cemented; thin-bedded siltstone, massive to thick-bedded sandstone.

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Ocean	Pacific Ocean	
Qa	Active alluvial flood plain deposits (late Holocene)	Unconsolidated to locally poorly consolidated sand and gravel deposits in active alluvial flood plains.
Qa+Qya	Active alluvial flood plain and young alluvial flood plain deposits undivided (late Holocene and Pleistocene)	
Qaf	Artificial fill (late Holocene)	Artificially compacted fill deposits.
Qb	Beach deposits	
Qc	Colluvium (late Holocene)	Active and recently active slope wash deposits along base of slopes. Consists of unconsolidated, sandy, silty, or clay bearing colluvium.
Qof_ds	Dripping Springs Formation (early Pleistocene)	Pebble, cobble and boulder fanglomerate in a reddish-brown, poorly consolidated, poorly sorted sandstone matrix. Equivalent to Qof .
Qds	Debris slide deposits (Holocene to Pleistocene)	Shallow slope-failure deposits consisting of soil material and poorly sorted rock fragments. May be susceptible to renewed slope movements.
Qf	Alluvial fan deposits (late Holocene)	Consists of unconsolidated, bouldery, cobbley, gravelly, sandy, or silty fan deposits, and headward channel parts of alluvial fans. Trunk drainages and proximal parts of fans contain greater percentage of coarse-grained sediment than distal parts.
Qfls	Alluvial fan and landslide deposits, undivided (Holocene to Pleistocene)	Over steepened alluvial fan deposits that have undergone post depositional downslope movement as rock avalanches, debris flows, slumps and rock falls.
Ql	Active lake/lacustrine deposits (late Holocene)	Unconsolidated sandy silt with clay and gravel.
Qlas	Active lake deposits	Submerged sediments; as = sandy silt with clay.
Qlcs	Quaternary lake deposit coarse sand	
Qls	Landslide deposits (Holocene to Pleistocene)	Highly fragmented to largely coherent landslide deposits. Unconsolidated to consolidated. Most mapped landslides contain scarp area as well as landslide deposit.
Qlsc	Active (Holocene) lake (lacutrine) deposits	Mostly submerged and manmade- sc = silty clay with sand and gravel.
Qmb_a	Active marine beach deposits; unconsolidated sediments; a = sand with some gravel	
Qoa	Older alluvial flood plain deposits (Pleistocene, younger than 500,000 years)	Mostly moderately well consolidated, poorly sorted, permeable flood plain deposits; sand, silt and clay.
Qoa_1-2ga	Older (Pleistocene, younger than 500,000 years) alluvial river deposit; moderately consolidated sediments	Age of the river-cut platform is estimated between 413,000 (2 = Parry Grove Terrace) and 450,000 years (1 = Golf Course Terrace); ga = gravelly sand with clay and silt.
Qoa_2-6ga	Older (Pleistocene, younger than 500,000 years) alluvial river deposit; moderately consolidated sediments	Age of the river-cut platform is estimated between 120,000 (6 = Nestor Terrace) and 413,000 years (2 = Parry Grove Terrace); ga = gravelly sand with clay and silt.
Qoa_6ga	Older (Pleistocene, younger than 500,000 years) alluvial river deposit; moderately consolidated sediments	Age of the river-cut platform is estimated to be 120,000 (6 = Nestor Terrace); ga = gravelly sand with clay and silt.
Qoa_6sa	Older (Pleistocene, younger than 500,000 years) alluvial river deposit; moderately consolidated sediments	Age of the river-cut platform is estimated to be 120,000 (6 = Nestor Terrace); sa = silty sand with clay and gravel.
Qoa_7sa	Older (Pleistocene, younger than 500,000 years) alluvial river deposit; moderately consolidated sediments	Age of the river-cut platform is estimated to be 80,000 (7 = Bird Rock Terrace); sa = silty sand with clay and gravel.

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Qoa_sa	Older (Pleistocene, younger than 500,000 years) alluvial river deposit; moderately consolidated sediments	sa = silty sand with gravel and clay.
Qoa_sa+Qoc_sa	Mix of Qoa_sa and Qoc_sa (see individual descriptions)	
QoaQoc	Mix of Qoa and Qoc (see individual descriptions)	
Qoc	Old colluvial deposits (late to middle Pleistocene)	Mostly consolidated sand and silt bearing slopewash deposits that are slightly dissected.
Qoc_sa	Older (Pleistocene, younger than 500,000 years) alluvial river deposits	Moderately consolidated sediments; sa = silty sand with gravel and clay.
Qof	Old alluvial fan deposits (late to middle Pleistocene)	Reddish-brown, sand, gravel, cobble and boulder alluvial fan deposits that are usually indurated and slightly dissected.
Qof_ab	Older fanglomerate	
Qof1	Older fan deposits (Pleistocene, younger than 500,000 years but older than Qof2 deposits)	Mostly poorly consolidated fan, debris flow and talus deposits. Clasts are distinctly deeply weathered and the matrix distinctly reddish brown in color.
Qof2	Older fan deposits (Pleistocene, younger than 500,000 years)	Mostly poorly consolidated fan, debris flow and talus deposits. Clasts possess a moderately well developed clay coating but are otherwise fresh.
Qols	Older landslide deposits (Holocene to Pleistocene) - Landslide slump and rock fall deposits	
Qomt_1-2ga	Older (Pleistocene, younger than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of river-cut platform is estimated between 413,000 years (2 = Parry Grove Terrace) and 450,000 (1 = Golf Course Terrace); ga = gravelly sand with clay and silt.
Qomt_1-2sa	Older (Pleistocene, younger than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of river-cut platform is estimated between 413,000 years (2 = Parry Grove Terrace) and 450,000 (1 = Golf Course Terrace); sa = silty sand with clay and gravel.
Qomt_2-6sa	Older (Pleistocene, younger than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated between 120,000 (6 = Nestor Terrace) and 413,000 years (2 = Parry Grove Terrace); sa = silty sand with clay and gravel.
Qomt_2ga	Older (Pleistocene, younger than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 413,000 years (2 = Parry Grove Terrace); ga = gravelly sand with clay and silt.
Qomt_4-6ga	Older (Pleistocene, younger than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated between 120,000 (6 = Nestor Terrace) and 300,000 years (4 = Stuart Mesa Terrace); ga = gravelly sand with clay and silt.
Qomt_4sa	Older (Pleistocene, younger than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 300,000 years (4 = Stuart Mesa Terrace); sa = silty sand with clay and gravel.
Qomt_6sa	Older (Pleistocene, younger than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 120,000 years (6 = Nestor Terrace); sa = silty sand with clay and gravel.
Qomt_7sa	Older (Pleistocene, younger than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 80,000 years (7 = Bird Rock Terrace); sa = silty sand with clay and gravel.
Qop_1-7	Older paralic deposits (Pleistocene, younger than 500,000 years)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Qop_1-8+Qvop13	Mix of Qop_1 through Qop_8 and Qvop (see individual descriptions)	
Qop_3-8	Older paralic deposits (Pleistocene, younger than 500,000 years)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qop_4	Older paralic deposits (Pleistocene, younger than 500,000 years)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qop_6+Qvop11	Mix of Qop_6 and Qvop11 (see individual descriptions)	
Qop_6-7	Older paralic deposits (Pleistocene, younger than 500,000 years)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qop1	Older paralic deposits (Pleistocene, younger than 500,000 years)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qop1-Qvop13	Mix of Qop_1 and Qvop13 (see individual descriptions)	
Qop3	Older paralic deposits (Pleistocene, younger than 500,000 years)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qop4	Older paralic deposits (Pleistocene, younger than 500,000 years)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qp	Pauba Formation (early Pleistocene)	Light-brown moderately well-indurated, extensively crossbedded, channeled and filled sandstone and siltstone that contains occassional intervening cobble-and -boulder conglomerate beds.
Qpf	Pauba Formation fanglomerate facies (Pleistocene)	Well-indurated poorly sorted sedimentary breccia and mudstone.
QTf	Fanglomerate (Quaternary or Tertiary(?))	Moderately to well-indurated, massively bedded, poorly sorted to unsorted, micaceous, silty, fine- to medium-grained, brown (10YR5/3) arkosic sandstone.
QTf-l	Fanglomerate (Quaternary or Tertiary(?))	Moderately to well-indurated, massively bedded, poorly sorted to unsorted, micaceous, silty, fine- to medium-grained, brown (10YR5/3) arkosic sandstone. May include cobble lag deposits.
QTsm	San Mateo Formation of Woodford (1925) (early Pleistocene and late Pliocene)	Yellowish gray, nearshore marine and paralic, siltstone, sandstone and conglomerate.
Qvoa	Very old alluvial flood plain deposits, undivided (middle to early Pleistocene)	Fluvial sediments deposited on canyon floors. Consists of moderately to well-indurated, reddishbrown, mostly very dissected gravel, sand, silt, and clay-bearing alluvium.
Qvoa_12-15sa	Very old (Pleistocene, older than 500,000 years) alluvial river deposit	Moderately consolidated sediments. Age of river-cut platform is estimated between 510,000 years (15 = San Elijo Terrace) and 800,000 years (12 = Tecolote Terrace); ga = gravelly sand with clay and silt.
Qvoa_13ga	Very old (Pleistocene, older than 500,000 years) alluvial river deposit	Moderately consolidated sediments. Age of river-cut platform is estimated to be 698,000 years (13 = Clairemont Terrace); ga = gravelly sand with clay and silt.
Qvoa_14ga	Very old (Pleistocene, older than 500,000 years) alluvial river deposit	Moderately consolidated sediments. Age of river-cut platform is estimated to be 630,000 years (14 = Fire Mountain Terrace); ga = gravelly sand with clay and silt.
Qvoa_15ga	Very old (Pleistocene, older than 500,000 years) alluvial river deposit	Moderately consolidated sediments. Age of river-cut platform is estimated to be 510,000 years (15 = San Elijo Terrace); ga = gravelly sand with clay and silt.
Qvoa_6ga	Very old (Pleistocene, older than 500,000 years) alluvial river deposit	Moderately consolidated sediments. Age of river-cut platform is estimated to be 1,290,000 years (6 = Aqueduct Terrace); ga = gravelly sand with clay and silt.
Qvoc	Very old colluvial deposits (middle to early Pleistocene)	Reddish-brown, consolidated, sand and gravel deposits that formed as slopewash aprons over deeply weathered older rock.
Qvof	Young alluvial flood plain deposits (Holocene and late Pleistocene)	Mostly poorly consolidated, poorly sorted, permeable flood plain deposits

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Qvomt_10-15sa	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated between 510,000 years (15 = San Elijo Terrace) and 930,000 years (10 = Tierra Santa Terrace); sa = silty sand with clay and gravel.
Qvomt_10ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 930,000 years (10 = Tierra Santa Terrace); ga = gravelly sand with clay and silt.
Qvomt_11ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 855,000 years (11 = Linda Vista Terrace); ga = gravelly sand with clay and silt.
Qvomt_12-15ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated between 510,000 years (15 = San Elijo Terrace) and 800,000 years (12 = Tecolote Terrace); ga = gravelly sand with clay and silt.
Qvomt_12-15sa	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated between 510,000 years (15 = San Elijo Terrace) and 800,000 years (12 = Tecolote Terrace); sa = silty sand with clay and gravel.
Qvomt_13ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 698,000 years (13 = Clairemont Terrace); ga = gravelly sand with clay and silt.
Qvomt_14ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 630,000 years (14 = Fire Mountain Terrace); ga = gravelly sand with clay and silt.
Qvomt_1ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 1,760,000 years (1 = Carroll Canyon Terrace); ga = gravelly sand with clay and silt.
Qvomt_2ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 1,670,000 years (2 = Pendleton Terrace); ga = gravelly sand with clay and silt.
Qvomt_3ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 1,525,000 years (3 = Eagle Terrace); ga = gravelly sand with clay and silt.
Qvomt_4ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 1,445,000 years (4 = Flores Hills Terrace); ga = gravelly sand with clay and silt.
Qvomt_5ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 1,375,000 years (5 = Aliso Canyon Terrace); ga = gravelly sand with clay and silt.
Qvomt_6ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 1,290,000 years (6 = Aqueduct Terrace); ga = gravelly sand with clay and silt.
Qvomt_7ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 1,160,000 years (7 = Rifle Range Terrace); ga = gravelly sand with clay and silt.
Qvomt_9ga	Very old (Pleistocene, older than 500,000 years) marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments. Age of platform is estimated to be 975,000 years (9 = Mira Mesa Terrace); ga = gravelly sand with clay and silt.
Qvop_11-12	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Qvop_2-3	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop_6-7	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop_8-9	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop_9-10	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop1	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop10	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop11	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop12	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop13	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop2	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop3	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop4	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop5	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop7	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop8	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qvop9	Very old paralic deposits (early Pleistocene)	Strandline and colluvial deposits conposed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Qw	Active wash/stream deposits (late Holocene) along major drainage courses	Unconsolidated gravelly sand with silt.
Qw_ga	Active channel and wash deposits	Unconsolidated sediments; ga = gravelly sand with silt.
Qw1	Wash deposits (late Holocene)	Unconsolidated sand and gravel deposited in intermittently active washes. Consists of light brownish-gray (2.5Y 6/2), fine- to medium-grained sand, silt, and coarse sand to fine gravel.
Qw2	Wash deposits (late Holocene)	Unconsolidated sand and gravel deposited in active washes. Consists of light brownish-gray (2.5Y 6/2) to grayish-brown (10YR 5/2), fine- to medium-grained sand, silt, and coarse sand to fine gravel.
Qya	Young alluvial flood plain deposits (Holocene and late Pleistocene)	Mostly poorly consolidated, poorly sorted, permeable flood plain deposits
Qya_as	Younger (Holocene, not active) alluvial flood plain deposit	Unconsolidated sediments; as = sandy silt with clay.

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Qya_ga	Younger (Holocene, not active) alluvial flood plain deposit	Unconsolidated sediments; ga = gravelly sand with clay and silt.
Qya_sa	Younger (Holocene, not active) alluvial flood plain deposit	Unconsolidated sediments; sa = silty sand with clay.
Qya_sa+Qyc_sa	Mix of Qya_sa and Qyc_sa (see individual descriptions)	
Qya+Qoa	Young alluvial flood plain deposits and old alluvial flood plain deposits undivided (Holocene and late to middle Pleistocene)	
QyaQyc	Mix of Qya and Qyc (see individual descriptions)	
Qyc	Young colluvial deposits (Holocene and late Pleistocene)	Mostly poorly consolidated sandy, silty or clay-bearing slope wash deposits.
Qyc_as	Younger (Holocene, not active) colluvial (slope wash) and stream deposits along small drainage courses	as = sandy silt with some gravel and clay.
Qyc_ga	Younger (Holocene, not active) colluvial (slope wash) and stream deposits along small drainage courses	ga = gravelly sand with clay and silt.
Qyc_sa	Younger (Holocene, not active) colluvial (slope wash) and stream deposits along small drainage courses	sa = silty sand with clay and gravel.
Qyf	Young alluvial fan deposits (Holocene and late Pleistocene)	Mostly poorly consolidated and poorly sorted sand, gravel, cobble and boulder alluvial fan deposits.
Qyf_as	Younger (Holocene, not active) alluvial fan deposits	as = silty sand with gravel and clay.
Qyf_ga	Younger (Holocene, not active) alluvial fan deposits	ga = gravelly sand with clay and silt.
Qyf_sa	Younger (Holocene, not active) alluvial fan deposits	sa = silty sand with gravel and clay.
Qyfa	Younger (Holocene, not active) alluvial fan deposits	
Qyls	Landslide deposits (Holocene to Pleistocene)	Landslide slump and rock fall deposits.
Qyv	Young alluvial valley deposits (Holocene to late Pleistocene)	Unconsolidated to moderately consolidated gently sloping fluvial deposits within broad valleys. Consists of grayish-brown (2.5Y 5/2) to dark grayish-brown (10YR 4/2) fine- to medium-grained sand, silt, and fine gravel.
Tc	Capistrano Formation of Woodford (1925) (early Pliocene and late Miocene)	Mostly thin bedded, dark gray, micaceous, marine, siltstone and sandstone with fossil rich limestone lenses.
Tcs	Capistrano Formation Siltstone facies	Marine siltstone, mudstone, silty and diatomacious shale, poorly to moderately consolidated and poorly bedded. Also known as the turbidite facies of the Capistrano Formation.
Tf	Friars Formation (middle Eocene)	Poorly indurated, non-marine claystone and sandstone, with lenses of cobble conglomerate. The formation contains many landslides.
Tm	Monterey Formation	Marine diatomaceous shale interbedded with silty shale, siliceous shale and siltstone, with minor chert, limestone and clacareous shale lenses. Generally thin bedded, hard but severely fractured/jointed and fissile.
Tmv	Mission Valley Formation (middle Eocene)	Poorly to moderately indurated, light-colored, medium-to fine-grained, marine, sandstone with cobble conglomerate lenses. Interfingers with underlying Stadium Conglomerate.

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
To	Otay Formation (Oligocene to Miocene)	Poorly indurated massive light-colored sandstone, siltstone and claystone, interbedded with bentonite lenses.
Tof	Otay Formation - fanglomerate facies (Oligocene to Miocene)	Poorly cemented bouldery conglomerate and coarse-grained sandstone. Interfingered with overlying To.
Tp	Pomerado Conglomerate (middle Eocene)	Poorly to moderately cemented massive nonmarine cobble conglomerate with sandstone interbeds.
Tp1	Paralic deposits undivided (Pliocene)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Tp2	Paralic deposits undivided (Pliocene)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Tp4	Paralic deposits undivided (Pliocene)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Tp5	Paralic deposits undivided (Pliocene)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Tp6	Paralic deposits undivided (Pliocene)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Tp7	Paralic deposits undivided (Pliocene)	Strandline and colluvial deposits composed of siltstone, sandstone and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift.
Tpmt2	Pliocene marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments of gravelly sand with clay and sand. Age of platform is estimated to be 3,090,000 years (2 = San Onofre Terrace).
Tpmt3	Pliocene marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments of gravelly sand with clay and sand. Age of platform is estimated to be 2,630,000 years (4 = Cuate Hill Terrace).
Tpmt4	Pliocene marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments of gravelly sand with clay and sand. Age of platform is estimated to be 2,360,000 years (4 = Foley Canyon Terrace).
Tpmt5	Pliocene marine and non-marine terrace deposits above marine wave-cut platform	Moderately consolidated sediments of gravelly sand with clay and sand. Age of platform is estimated to be 2,130,000 years (5 = Horno Hill Terrace).
Tsa	Santiago Formation (Eocene)	Marine sandstone with siltstone interbeds.
Tsa-ss	Santiago Formation (Eocene) Sandstone	Marine sandstone with siltstone interbeds.
Tsd	San Diego Formation (Pliocene)	Poorly indurated, fine- to medium-grained sandstone, typically yellowish to light brown.
Tsi	Silverado Formation (Paleocene)	Sandstone and claystone.
Tsl	Silverado Formation	Lower beds: non-marine coarse grained sandstone with interbedded siltstone and basalt conglomerate; local brownish and whitish clay bed with minor shale and lignite. Upper beds: marine medium to fine grained sandstone, conglomerate, siltstone and shale.
Tsm	San Mateo Formation	Marine coarse grained arkosic sandstone with conglomerate and conglomeratic sandstone lenses; weakly cemented and poorly bedded. Also know as the turbidite facies of the Capistrano Formation.
Tso	San Onofre Breccia (middle Miocene)	Gray, brown and reddish, medium to very coarse grained breccia composed of very angular blueshist and greenshist fragments supported in a well lithified mudstone matrix.
Tsr	Santa Rosa Basalt (Miocene)	Dark-gray and black, fine
Tst	Stadium Conglomerate (middle Eocene)	Poorly to moderately cemented massive cobble conglomerate with sandstone interbeds. Interfingers with overlying Mission Valley Formation.
Tsv	Sespe and Vaqueros formations	Undifferentiated; marine interbedded siltstone, mudstone and sandstone, and non-marine coarse grained sandstone, clayey and silty sandstone and conglomeratic sandstone. Poorly bedded; massive to thick bedded except minor thin-bedded siltstone.
Tt	Temecula Arkose (late Pliocene)	The Temecula Arkose is pale greenish-yellow, well-indurated, medium- and coarse-grained sandstone with thin interstratified beds of fine-grained, tuffaceous sandstone, siltstone and claystone.
Ttl	Temecula Arkose (late Pliocene)	The lower part of the Temecula Arkose that consists of white and verylight-gray, poorly sorted, coarse- and medium-grained, moderately well indurated, but, locally friable, cross-bedded arkosic sandstone
Ttu	Temecula Arkose (late Pliocene)	The upper part of the Temecula Arkose that consists of pale-yellowish-brown, olive gray dark yellowish brown, fine-, medium- and coarse grained sandstone, siltstone and claystone.

Table 1 (cont'd)

Geologic Unit	Geologic Unit Name	Description
Tv	Volcanic rocks undivided (Miocene)	Flows of dacitic composition.
Water	Lakes, reservoirs, and ponds	
99	No information	

Table 2 — Correlation of Geology Types to MRZs for 7.5-Minute Quadrangle Geologic Maps

GeolType	Name	MRZ-1	MRZ-2	MRZ-3	MRZ-4
af	Artificial fill (late Holocene)	–	–	100.00%	–
Jcr	Cuyamaca Reservoir Granodiorite (Jurassic)	–	–	100.00%	–
Ka	Tonalite of Alpine (Cretaceous)	–	0.26%	99.74%	–
Kat	Gabbro of the Agua Tibia Mountains (Cretaceous)	–	100.00% -		–
Ka-w	Tonalite of Alpine (Cretaceous)	–	–	96.98%	3.02%
Kbm	Granodiorite of Burnt Mountain (Cretaceous)	21.17%	–	78.83%	–
Kbp	Granite of Bottle Peak (Cretaceous)	–	–	87.78%	12.22%
Kc	Cuyamaca Gabbro (Cretaceous)	–	–	100.00%	–
Kcc	Tonalite of Couser Canyon (Cretaceous)	–	0.92%	99.08%	–
Kcg	Tonalite of Cole Grade (Cretaceous)	–	100.00%	–	–
Kcgw	Tonalite of Cole Grade (weathered) (Cretaceous)	–	100.00%	–	–
Kcm	Corte Madera Monzogranite (Cretaceous)	–	–	100.00%	–
Kcp	Chiquito Peak Monzogranite (Cretaceous)	–	–	100.00%	–
Kcp-w	Chiquito Peak Monzogranite (Cretaceous)	–	–	100.00%	–
Kc-w	Cuyamaca Gabbro (Cretaceous)	–	–	100.00%	–
Kd	Diorite undivided (Cretaceous)	–	–	–	100.00%
Kdl	Granite of Dixon Lake (Cretaceous)	0.40%	–	97.75%	1.86%
Kg(e)	Escondido Creek leucogranodiorite	–	–	100.00%	–
Kg(gv)	Green Valley tonalite	–	0.15%	98.91%	0.93%
Kg(lw)	Lake Wolford leucogranodiorite	–	4.97%	90.25%	4.78%
Kg(sm)	San Marcos gabbro	–	0.01%	99.99%	–
Kg(wm)	Woodson Mountain granodiorite	–	0.18%	99.82%	–
Kgb	Gabbro undivided (Cretaceous)	–	1.32%	98.68%	–
Kgbd	Createcious Granodiorite, mostly biotite-granodiorite	9.60%	–	77.07%	13.33%
KgbKdKqbd	Mix of Kgb, Kd, and Kqbd (see individual descriptions).	–	100.00%	–	–
Kgd	Granodiorite undivided (Cretaceous)	0.52%	0.32%	96.59%	2.57%
Kg-gb	Gabbro (Cretaceous)	0.07%	6.46%	93.47%	–
Kg-gd	Granodiorite (Cretaceous)	–	2.83%	97.17%	–
Kg-gdf	Fine-grained granodiorite (Cretaceous)	–	0.35%	99.65%	–
Kg-gr	Granite (Cretaceous)	–	0.42%	99.58%	–
Kg-t	Tonalite undivided (Cretaceous)	0.60%	1.39%	97.79%	0.22%
Ki	Granodiorite of Indian Mountain (Cretaceous)	–	2.18%	97.82%	–
Kis	Granite of Indian Springs (Cretaceous)	59.33%	–	34.07%	6.60%
KJ	Metavolcanic and metasedimentary rocks undivided (Cretaceous and Jurassic)	79.76%	0.23%	18.80%	1.21%
KJd	Metavolcanic dikes undivided (Cretaceous and Jurassic)	100.00%	–	–	–
KJg	Metagranitic rocks (Cretaceous and Jurassic)	–	100.00%	–	–
KJi	Intrusive rocks of the Santiago Peak Volcanics	–	–	100.00%	–
KJm	Metavolcanic and metasedimentary rocks undivided (Cretaceous and Jurassic)	–	0.40%	99.60%	–
KJm-s	Metasedimentary rocks (Jurassic and Cretaceous)	–	2.08%	97.92%	–
KJm-v	Metavolcanic rocks (Jurassic and Cretaceous)	0.25%	4.89%	94.85%	–
KJsp	Undifferentiatied Santiago Peak Volcanics	–	0.20%	99.80%	–
KJv	Japatul Valley Tonalite (Cretaceous)	–	0.00%	99.97%	0.03%
KJvs	Metavolcanic and metasedimentary rocks (Createaceous - Jurassic)	–	–	100.00%	–
KJv-w	Japatul Valley Tonalite (Cretaceous)	–	–	100.00%	–

Table 2 (cont'd)

GeolType	Name	MRZ-1	MRZ-2	MRZ-3	MRZ-4
Kl	Lusardi Formation (Upper Cretaceous)	–	–	100.00%	–
Klb	Las Bancas Tonalite (Cretaceous)	–	0.19%	99.81%	–
Klb-w	Las Bancas Tonalite (Cretaceous)	–	–	100.00%	–
Kld	Lake Wolford Granodiorite (Cretaceous)	–	–	100.00%	–
Klp	Tonalite of La Posta (Cretaceous)	–	–	100.00%	–
Klpm	Tonalite of La Posta, Mafic phase (Cretaceous)	–	–	100.00%	–
Klpm-w	Tonalite of La Posta, Mafic phase (Cretaceous)	–	–	100.00%	–
Klp-w	Tonalite of La Posta (Cretaceous)	–	–	100.00%	–
Klw-gr	Lake Wolford Granodiorite (Cretaceous)	–	–	100.00%	–
Kmg	Monzogranite undivided (Cretaceous)	11.39%	–	88.61%	–
Kmm	Monzogranite of Merriam Mountain (Cretaceous)	3.48%	0.25%	94.52%	1.74%
Kmv	Western metavolcanic rocks (Cretaceous)	–	0.00%	100.00%	–
Kp	Granodiorite of Pala (Cretaceous)	–	100.00%	–	–
Kqd	Quartz diorite and gabbro, undivided (Cretaceous)	–	100.00%	–	–
Kr	Granodiorite of Rainbow (Cretaceous)	0.09%	1.05%	91.69%	7.17%
Kri	Tonalite of Rincon (Cretaceous)	–	100.00%	–	–
Krm	Quartz bearing diorite of Red Mountain (Cretaceous)	–	–	98.29%	1.71%
Kt	Tonalite undivided (Cretaceous)	–	0.25%	99.53%	0.22%
Kvc	Monzogranite of Valley Center (Cretaceous)	–	–	85.63%	14.37%
Kwm	Woodson Mountain Granodiorite (Cretaceous)	–	–	100.00%	–
Kwmd	Woodson Mountain Apatite Dikes (Cretaceous)	–	–	100.00%	–
Kwm-w	Woodson Mountain Granodiorite (Cretaceous)	–	–	100.00%	–
Qa	Active alluvial flood plain deposits (late Holocene)	–	50.90%	43.97%	5.13%
Qaf	Artificial fill (late Holocene)	11.23%	70.54%	0.59%	17.63%
Qf	Alluvial fan deposits (late Holocene)	–	100.00% -		–
Qfls	Alluvial fan and landslide deposits, undivided (Holocene to Pleistocene)	–	100.00% -		–
Ql	Active lake/lacustrine deposits (late Holocene)	–	–	100.00%	–
Qls	Landslide deposits (Holocene to Pleistocene)	–	14.41%	85.59%	–
Qlsc	Active (Holocene) lake (lacutrine) deposits	–	0.00%	100.00%	–
Qoa	Older alluvial flood plain deposits (Pleistocene, younger than 500,000 years)	–	7.35%	88.63%	4.02%
Qoa_sa	Older (Pleistocene, younger than 500,000 years) alluvial river deposit; moderately consolidated sediments	6.97%	5.56%	34.19%	53.29%
Qoa_sa+Qoc_sa	Mix of Qoa_sa and Qoc_sa (see individual descriptions).	–	–	18.85%	81.15%
QoaQoc	Mix of Qoa and Qoc (see individual descriptions).	–	100.00%	–	–
Qoc	Old colluvial deposits (late to middle Pleistocene)	–	7.27%	88.43%	4.30%
Qoc_sa	Older (Pleistocene, younger than 500,000 years) alluvial river deposits	61.21%	–	10.58%	28.21%
Qof	Old alluvial fan deposits (late to middle Pleistocene)	–	100.00%	–	–
Qof_ab	Older fanglomerate	–	–	100.00%	–
Qof1	Older fan deposits (Pleistocene, younger than 500,000 years but older than Qof2 deposits)	–	100.00%	–	–
Qof2	Older fan deposits (Pleistocene, younger than 500,000 years)	–	100.00%	–	–
Qols	Older landslide deposits (Holocene to Pleistocene) - Landslide slump and rock fall deposits	–	9.95%	90.05%	–
Qp	Pauba Formation (early Pleistocene)	–	100.00%	–	–
QTf	Fanglomerate (Quaternary or Tertiary(?))	–	–	100.00%	–
QTf-l	Fanglomerate (Quaternary or Tertiary(?))	–	–	100.00%	–

Table 2 (cont'd)

GeolType	Name	MRZ-1	MRZ-2	MRZ-3	MRZ-4
Qvoa	Very old alluvial flood plain deposits, undivided (middle to early Pleistocene)	–	0.19%	99.81%	–
Qvoc	Very old colluvial deposits (middle to early Pleistocene)	–	100.00%	–	–
Qvof	Young alluvial flood plain deposits (Holocene and late Pleistocene)	–	100.00%	–	–
Qw	Active wash/stream deposits (late Holocene) along major drainage courses;	12.05%	59.87%	28.08%	–
Qw1	Wash deposits (late Holocene)	–	99.93%	–	0.07%
Qw2	Wash deposits (late Holocene)	–	21.77%	78.23%	–
Qya	Young alluvial flood plain deposits (Holocene and late Pleistocene)	5.80%	44.28%	48.94%	0.98%
Qya_sa	Younger (Holocene, not active) alluvial flood plain deposit	0.09%	55.12%	33.59%	11.21%
Qya_sa+Qyc_sa	Mix of Qya_sa and Qyc_sa (see individual descriptions).	–	–	100.00%	–
QyaQyc	Mix of Qya and Qyc (see individual descriptions).	–	100.00%	–	–
Qyc	Young colluvial deposits (Holocene and late Pleistocene)	–	100.00%	–	–
Qyc_sa	Younger (Holocene, not active) colluvial (slope wash) and stream deposits along small drainage courses	–	1.65%	98.34%	0.00%
Qyf	Young alluvial fan deposits (Holocene and late Pleistocene)	–	100.00%	–	–
Qyv	Young alluvial valley deposits (Holocene to late Pleistocene)	–	72.98%	25.21%	1.82%
Tf	Friars Formation (middle Eocene)	–	13.40%	86.60%	–
Tmv	Mission Valley Formation (middle Eocene)	–	51.06%	48.94%	–
To	Otay Formation (Oligocene to Miocene)	–	0.12%	99.88%	–
Tof	Otay Formation - fanglomerate facies (Oligocene to Miocene)	–	6.52%	93.48%	–
Tp	Pomerado Conglomerate (middle Eocene)	–	79.49%	20.51%	–
Tsa	Santiago Formation (Eocene)	–	5.71%	91.57%	2.72%
Tsd	San Diego Formation (Pliocene)	–	–	100.00%	–
Tst	Stadium Conglomerate (middle Eocene)	–	78.95%	21.05%	–
Tv	Volcanic rocks undivided (Miocene)	–	–	100.00%	–
Water	Lakes, reservoirs, and ponds.	–	1.80%	98.20%	–

Table 3 — Correlation of Geology Types to MRZ-3 or MRZ-4 for Coarse Scale (1:750,000) Geology

GeolType	Name	Correlated MRZ
Ec	Sandstone, shale, conglomerate; moderately to well consolidated.	3
gb	Gabbro and dark diorotic rocks, chielfy Mesozoic	3
gr-m	Granitic and metamorphic rocks, mostly gneiss and other metamorphic rocks injected by granitic rocks. Mesozoic to Precambrian.	3
grMz	Mesozoic granite, quartz monzonite, granodiorite, and quartz diorite.	3
m	Undivided pre–Cenozoic metasedimentary and metavolcanic rocks of great variety. Mostly slate, quartzite, hornfels, chert, phyllite, mylonite, schist, gneiss, and minor marble.	4
Mc	Sandstone, shale, conglomerate, and fanglomerate; moderately to well consolidated.	3
Mzv	Undivided Mesozoic volcanic and metavolcanic rocks. Andesite and rhyolite flow rocks, greenstone, volcanic breccia and other pyroclastic rocks; in part strongly metamorphosed. Includes volcanic rocks of Franciscan Complex: basaltic pillow lava, diabase, greenstone, and minor pyroclastic rocks.	4
Q	Alluvium, lake, playa, and terrace deposits; unconsolidated and semi-consolidated. Mostly nonmarine, but includes marine deposits near coast.	4
sch	Schists of various types; mostly Paleozoic or Mesozoic age; some Precambrian.	4
water	Body of Water	1