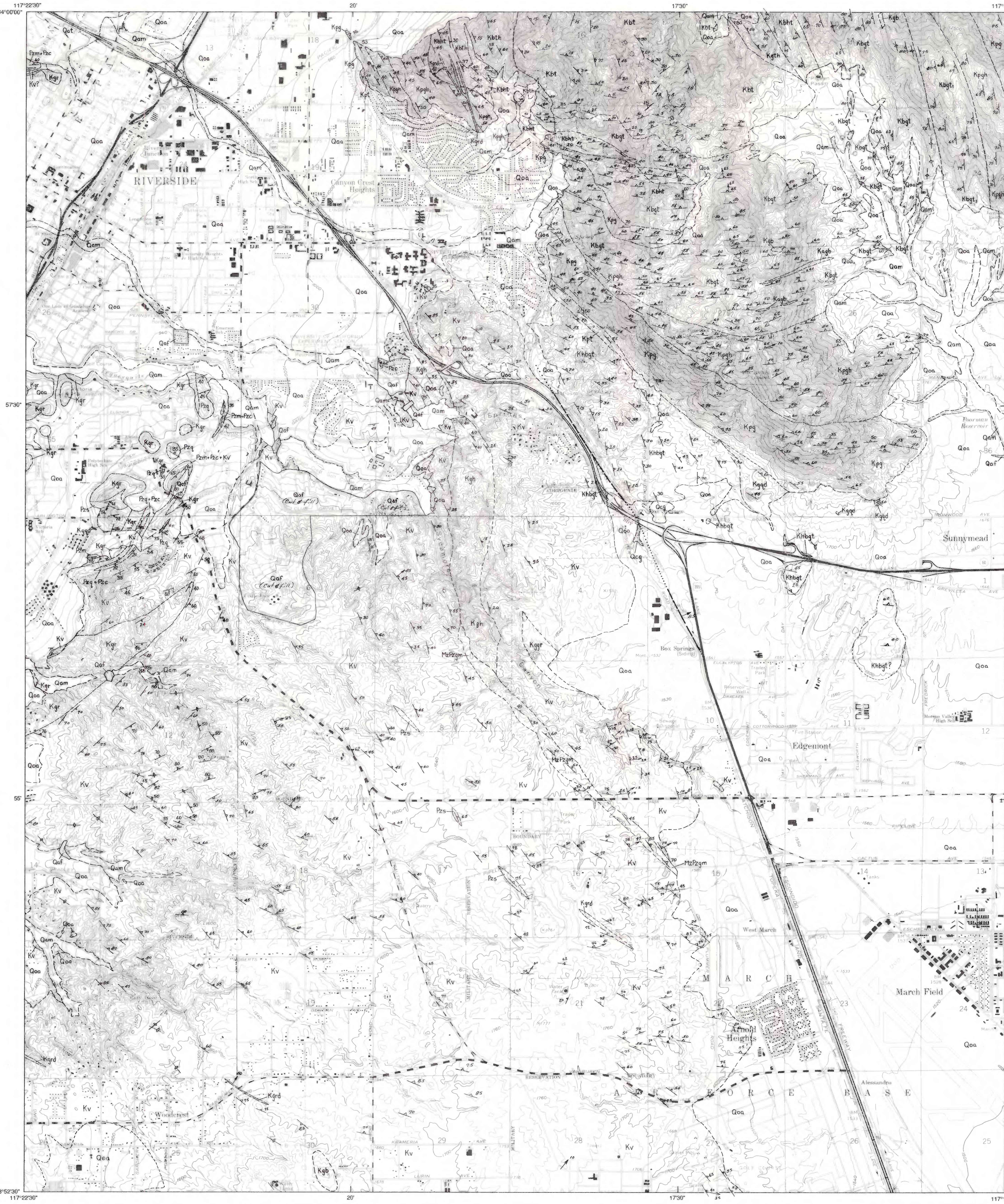


Base from U.S. Geological Survey, Riverside East, 1967
Photorevised 1973
Polyconic projection

APPROXIMATE MEAN DECLINATION, 1964

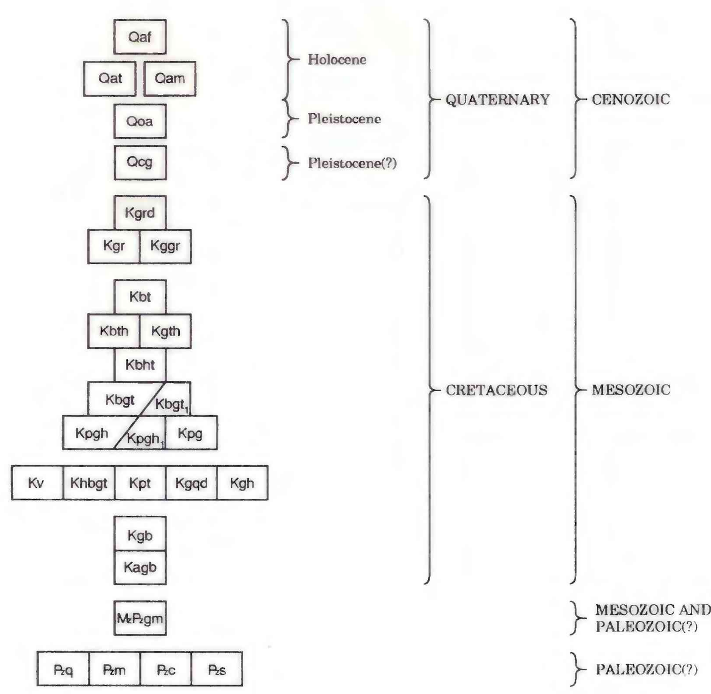
SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10 FOOT CONTOURS
NATIONAL GEODETIC DATUM OF 1929

QUADRANGLE LOCATION

Geology mapped by D.M. Morton and B.F. Cox 1976-1980
Manuscript approved for publication January 20, 1989

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Surficial deposits (Holocene to Pleistocene)—Divided into:

Qaf **Artificial fill (Holocene)**—Compacted fill in housing and industrial developments, earth-fill dams, and roadbeds. Includes some extensive areas of "cut-and-fill" grading

Qat **Alluvium of river terrace (Holocene)**—Unconsolidated, grayish to brownish, coarse-grained sandy alluvium. Forms low stream terrace of Santa Ana River at northwest corner of the map. Subject to infrequent reworking during major floods

Qam **Alluvium of minor streams (Holocene)**—Unconsolidated, brownish, sandy alluvium deposited within channels of ephemeral streams. Deposits typically are poorly sorted, containing abundant silt and clay eroded from older alluvium (unit Qoa)

Qoa **Older alluvium (Pleistocene)**—Weakly to moderately indurated, yellowish-brown to reddish-brown, coarse-grained sandy alluvium. Typically contains abundant silt and clay. Locally contains silica-cemented hardpan

Qcg **Conglomeratic sandstone (Pleistocene?)**—Moderately indurated, grayish, coarse-grained sandstone and conglomerate. Contains angular clasts of locally derived granitic rocks

Leucocratic plutonic rocks (Cretaceous)—Divided into:

Kgrd **Granite dikes**—Light-tan-weathering, inequigranular, medium-grained to pegmatitic, leucocratic granite. Forms texturally layered tabular dikes. Most dikes contain about 1-3 percent biotite; some contain traces of garnet. Locally forms compound dikes as much as 10 m thick

Kgr **Biotite granite**—Light yellowish-gray to greenish-gray, medium- to coarse-grained, massive to weakly foliated granite, with mean grain size of about 1-3 mm. Leucocratic, containing about 1-3 percent biotite. Inclusions typically are sparse or absent. Mostly homogeneous, but some relatively heterogeneous, fine- to coarse-grained, foliated rocks with compositions grading into granodiorite are found near contacts with tonalite, especially near northwest corner of the quadrangle (on North Hill) and along margins of lenticular granite body that passes through SW corner sec. 1, T3S, R5W. Granite unambiguously intrudes tonalite in roadcut at intersection of Central and Glenhaven Avenues (near south edge of sec. 36, T2S, R5W)

Kggr **Heterogeneous granodiorite and granite**—Light-gray, medium-grained, leucocratic plutonic rocks, consisting mostly of biotite granodiorite and granite; texturally and compositionally heterogeneous

Plutonic rocks of the Box Springs Mountains (Cretaceous)—Divided into:

Kbt **Biotite tonalite**—Light-gray, medium- to coarse-grained, massive to weakly foliated tonalite that forms structural core of the Box Springs Mountains. Contains about 35-40 percent quartz and 6-12 percent biotite. Hornblende is absent and potassium feldspar is sparse, about 1-4 percent. Equigranular texture, with grains mostly 1-4 mm in diameter. Mineral alignment is weak or absent, but much of the rock contains incipient to well developed compositional layering produced by variation in mineral abundances. Contains sparse equant to ellipsoidal inclusions of medium-gray, fine-grained rock with composition of biotite quartz diorite; some of the inclusions have relatively mafic rims. Ellipsoidal inclusions tend to be aligned parallel to compositional layering

Kbth **Heterogeneous biotite tonalite**—Light-gray, inequigranular, medium- to coarse-grained, foliated tonalite in the northwestern Box Springs Mountains. Dominant rock type is leucocratic tonalite with about 1-4 percent biotite. The biotite consists of thin euhedral tablets that are aligned to produce a wispy swirling foliation. The leucocratic tonalite engulfs common pods and lenses of darker tonalite that contains about 15 percent biotite as large ragged flakes. Both types of tonalite contain abundant quartz (30-40 percent) and sparse potassium feldspar (1 percent or less). Unit contains sparse discoidal inclusions of dark-gray, fine-grained biotite tonalite and is cut by abundant dikes of pegmatitic granite

Kgth **Heterogeneous granodiorite and tonalite**—Light- to medium-gray, medium- to coarse-grained, foliated, hornblende-biotite granodiorite and tonalite; restricted to northern Box Springs Mountains near Pigeon Pass. Texturally heterogeneous. Discoidal inclusions of dark-gray, fine-grained rock are aligned parallel to the foliation

Kbht **Biotite-hornblende tonalite**—Light- to medium-gray, medium- to coarse-grained, foliated tonalite. Contains about 20-25 percent quartz and about 25 percent mafic minerals, the latter consisting of subequal amounts of biotite and hornblende, each forming ragged grains up to 4 mm in diameter. Potassium feldspar very sparse, less than 2 percent. Conspicuous accessory sphene forms anhedral interstitial grains. Abundant ellipsoidal to discoidal inclusions of dark-gray, fine-grained rock (composition of biotite-hornblende quartz diorite) are aligned parallel to the foliation

Kbgt **Biotite granodiorite and tonalite**—Light-gray, medium- to coarse-grained, foliated granodiorite and tonalite. Mineral grains mostly 1-3 mm in diameter. The rocks contain about 25-35 percent quartz and about 8-15 percent mafic minerals consisting of biotite and minor amounts of hornblende. Potassium feldspar forms small interstitial grains and sparse subhedral phenocrysts as much as 1 cm in diameter; the phenocrysts are distinctly smaller and less abundant than those found in neighboring bodies of porphyritic granodiorite (units Kpg and Kpgh). The abundance of potassium feldspar seems to decrease inward toward higher structural levels, such that granodiorite is most abundant in the outer half of the unit and tonalite predominates in the inner half. Common discoidal inclusions of dark-gray, fine-grained rock (with composition of hornblende-biotite quartz diorite) are aligned parallel to the foliation; where such inclusions are particularly abundant, the rocks are designated as subunit $Kbgt_1$

Kpgh **Heterogeneous porphyritic granodiorite**—Light-gray, foliated, porphyritic granodiorite and subordinate tonalite. Medium to coarse-grained (1-3 mm) groundmass is composed of plagioclase, quartz (25-35 percent of the rock), and mafic minerals (10-15 percent of the rock), the latter consisting of biotite and lesser amounts of hornblende. The mafic minerals are unevenly distributed, imparting a heterogeneous appearance to the rocks. Subhedral phenocrysts of potassium feldspar range up to at least 2 cm long. Common discoidal inclusions of dark-gray, fine-grained rock (composition of hornblende-biotite quartz diorite) are aligned parallel to the foliation. The unit also contains abundant dikes and sills of leucocratic granite and granitic pegmatite. Subunit $Kpgh_1$ has pronounced layered structure produced by variation in grain size

Kpg **Porphyritic granodiorite**—Light-gray, foliated, porphyritic granodiorite and subordinate tonalite. Contains inequigranular, coarse-grained (1-6 mm) groundmass of plagioclase, quartz (30-40 percent of the rock), and mafic minerals (5-10 percent of the rock), the latter consisting of biotite and sparse hornblende. Mafic minerals are less abundant and more evenly distributed than in adjacent unit of heterogeneous porphyritic granodiorite (Kpgh). Subhedral phenocrysts of potassium feldspar range up to at least 2 cm long. Common discoidal inclusions of dark-gray, fine-grained rock (composition of hornblende-biotite quartz diorite) are aligned parallel to the foliation

Val Verde tonalite and associated rocks (Cretaceous)—Divided into:

Kv **Val Verde tonalite of Osborn (1939)**—Light- to medium-gray, medium- to coarse-grained, foliated hornblende-biotite tonalite. Fairly equigranular texture, with most grains about 1-3 mm in diameter. Mineralogically homogeneous over broad areas, containing about 25 percent quartz and about 15-25 percent mafic minerals, the latter consisting of nearly equal amounts of biotite and hornblende. Potassium feldspar typically very sparse, 1 percent or less. Abundant discoidal inclusions of dark-gray, fine-grained rock (composition of biotite-hornblende quartz diorite) are aligned parallel to the foliation. Locally contains compositional layering produced by variations in the abundance of mafic minerals. Northeastern parts of the unit are variable in composition, locally grading into granodiorite

Khbgt **Hornblende-biotite granodiorite and tonalite**—Heterogenous, light- to medium-gray, medium- to coarse-grained, foliated granodiorite and tonalite. Grains mostly 1-3 mm in diameter. Contains about 25-30 percent quartz and nearly equal amounts of biotite and hornblende totaling about 10-20 percent. Contains sparse to abundant discoidal inclusions of dark-gray, fine-grained rock; locally contains streaks and layers caused by variations in the abundance of mafic minerals. The unit may represent a marginal facies of the Val Verde tonalite (unit Kv)

Kpt **Porphyritic biotite-hornblende tonalite**—Light to medium-gray, medium-grained, foliated tonalite cropping out discontinuously at west edge of Box Springs Mountains. Generally resembles Val Verde tonalite (unit Kv), but contains euhedral phenocrysts of potassium feldspar

Kgqd **Heterogeneous granodiorite and quartz diorite**—Light-gray, fine- to medium-grained, foliated plutonic rocks of extremely variable composition, consisting mainly of biotite granodiorite, tonalite, and quartz diorite. Contains abundant discoidal inclusions of dark-gray, fine-grained rock. Forms several small outcrops at south edge of Box Springs Mountains and near west edge of the quadrangle north of Arlington Avenue

Kgh **Heterogeneous plutonic rocks**—Diverse, complexly intermingled plutonic rocks ranging from leucocratic biotite granite and granodiorite to mafic biotite-hornblende tonalite and quartz diorite; mostly foliated, variably fine- to coarse- grained

Mafic plutonic rocks (Cretaceous)—Divided into:

Kgb **Gabbro**—Dark-gray, medium- to coarse-grained, massive hornblende gabbro. Forms rare small masses engulfed by the Val Verde tonalite (unit Kv) near Woodcrest and by biotite granodiorite and tonalite (unit Kbgt) in the Box Springs Mountains

Kagb **Amphibolitic gabbro**—Dark-gray to black, fine-grained, foliated, hornblende-rich gabbroic rocks; forms elongate masses aligned parallel to foliation of biotite granodiorite and tonalite (unit Kbgt) in the Box Springs Mountains. These rocks are finer grained and more prominently foliated than gabbro of unit Kgb, and they contain more hornblende than typical mafic inclusions in the Box Springs Mountains

MzPzgm **Mixed granitic and metamorphic rocks (Mesozoic and Paleozoic?)**—Heterogeneous assemblage of foliated plutonic and metasedimentary rocks; generally weathering light tan. Plutonic constituents include leucocratic pegmatite and granite, leucocratic tonalite, mafic tonalite, and large masses of dark-gray, fine-grained, inclusion-like material. Metamorphic components include quartzite and biotite-quartz-feldspar schist

Metamorphic rocks (Paleozoic?)—Divided into:

Pzq **Quartzite**—Light-gray to light-greenish-gray, fine- to medium-grained, laminated, impure quartzite; intensely folded; weathers reddish brown or orangish brown

Pzm **Marble**—White to light-gray, locally bluish-gray, coarse-grained marble; locally includes calc-silicate hornfels, quartzite, biotite schist, and skarn. Most of the skarn is found along contacts between marble and tonalite. The skarn mainly consists of calc-silicate minerals. Skarn containing large amounts of magnetite and borates of the ludwigite-paigeite series is present at the New City quarry, which lies directly north of the intersection of Central and Glenhaven Avenues (S 1/2 sec. 36, T2S, R5W)

Pzc **Calc-silicate hornfels**—Heterogeneous, massive to well-layered calc-silicate hornfels, accompanied by variable amounts of marble, quartzite, and biotite schist. Most of the hornfels contains abundant clinopyroxene. A large mass of diopside-rich hornfels is found at the New City quarry. Some white wollastonite-quartz hornfels is present at North Hill, near the northwest corner of the map

Pzs **Biotite schist**—Medium- to dark-gray, fine-grained biotite schist and biotite-quartz-feldspar schist. Locally contains sillimanite. Commonly includes minor amounts of quartzite and calc-silicate hornfels

STRUCTURAL SYMBOLS

Contact—Dashed where approximately located. Arrow indicates dip

Fault—Dashed where approximately located; dotted where concealed. Arrow indicates dip

Strike and dip of inclined foliation

Strike of vertical foliation

Strike and dip of non-penetrative spaced foliation

Bearing and plunge of aligned mineral grains or elongate inclusions in plutonic rocks

GEOLOGIC SUMMARY

The Riverside East 7.5-minute quadrangle lies near the north end of the Perris block in the Peninsular Ranges province of southern California (see index map). The Perris block is a relatively stable and apparently internally unfaulted mass of crystalline rocks bounded on the southwest by the Elsinore fault and on the northeast by the San Jacinto fault. Plutonic rocks crop out across the quadrangle in a northeast-trending belt, forming low hills south of Riverside and the higher Box Springs Mountains east of the city. This upland of plutonic rocks is flanked on either side by extensive alluvial deposits that cover lowlands in the northwestern and eastern regions of the quadrangle. The plutonic rocks are products of the Cretaceous-age Peninsular Ranges batholith. They mostly consist of tonalite and granodiorite but also include scattered small bodies of granite, granitic pegmatite and gabbro. We classify the plutonic rocks using the system of Streckeisen (1976).

A large northwest-trending tonalite pluton, the Val Verde tonalite of Osborn (1939), forms the low hills south of Riverside. Mineral grains and discoidal inclusions in the tonalite are aligned to form a planar fabric or foliation that dips moderately to steeply northeastward throughout most of the pluton. Noteworthy structural complications are present directly south of Riverside where the foliation swings sharply into a northeast-striking, southeast-dipping orientation and the tonalite includes several northeast-trending septa of metasedimentary rocks. The transverse orientation of the foliation and septa suggests that the Val Verde tonalite narrows abruptly, possibly terminating beneath extensive alluvial cover near Riverside. A constricted northern tip of the pluton may extend as far as North Hill, near the northwest corner of the quadrangle, where similar tonalitic rocks are exposed.

The transverse structural grain south of Riverside is augmented by several northeast-trending lenticular bodies of granite that intrude the Val Verde tonalite and associated metasedimentary rocks. Local cross-cutting relations confirm that the tonalite solidified before the granite. However, some contacts are transitional, marked by broad zones of granodiorite that is compositionally intermediate between the granite and tonalite. The transitional contacts imply significant interaction between coeval granite and tonalite magmas.

Northeast of the Val Verde tonalite, the heterogeneous plutonic rocks of the Box Springs Mountains consist of inward-dipping layers of foliated granodiorite and tonalite surrounding a core of relatively homogeneous, massive tonalite. The concentric layers apparently converge beneath the range, forming a nested series of inverted cones or hemispheroids. Thus, the rocks of the Box Springs Mountains seem to represent a relatively deep structural level near the base of a composite granodiorite-tonalite pluton.

Septa of prebatholithic metasedimentary rocks north and south of Riverside consist of quartzite, marble, calc-silicate hornfels, and biotite schist, all metamorphosed to amphibolite grade. Some of the larger bodies of marble have been quarried for use as road metal. Judging from the abundance of quartzite and marble, the metasedimentary rocks probably were deposited within the North American Cordilleran geosyncline during Paleozoic time. More definitive evidence of their age and regional correlation was destroyed by intense deformation and metamorphism during emplacement of the surrounding plutons.

The Perris block was subjected to protracted uplift and erosion following the emplacement of the Cretaceous plutons. As a result, the region contains only a limited record of Tertiary geologic events, and much of this record consists of erosional features. One of the most prominent such features is the Perris surface, which includes the gently undulating terrain across the Val Verde tonalite south of Riverside (Woodford and others, 1971). Studies south of the quadrangle indicate that this surface has existed for at least the past 11 million years, having formed sometime before late Miocene time (Morton and Morton, 1979; Morton and Matti, 1989). Numerous ravines that dissect this surface near Riverside reflect the effects of subsequent, latest Tertiary and Quaternary, erosion cycles.

Several Quaternary-age alluvial units are present in the Riverside East quadrangle. The oldest deposits, presumed to be Pleistocene in age, form two small outcrops of locally derived conglomeratic sandstone near the intersection of U.S. Route 395 and California Route 60. These rocks are overlain by sandy alluvium of late Pleistocene age, which covers extensive areas in the eastern and northwestern parts of the quadrangle. Younger, Holocene-age, sandy alluvium covers the floors of modern stream channels that are incised into the Pleistocene alluvium. These channels include the bed of the Santa Ana River, at the northwest corner of the quadrangle, as well as several subsidiary drainage courses.

Geologic mapping in the Riverside East quadrangle was supported by the National Geologic Mapping and National Earthquake Reduction Programs of the U.S. Geological Survey.

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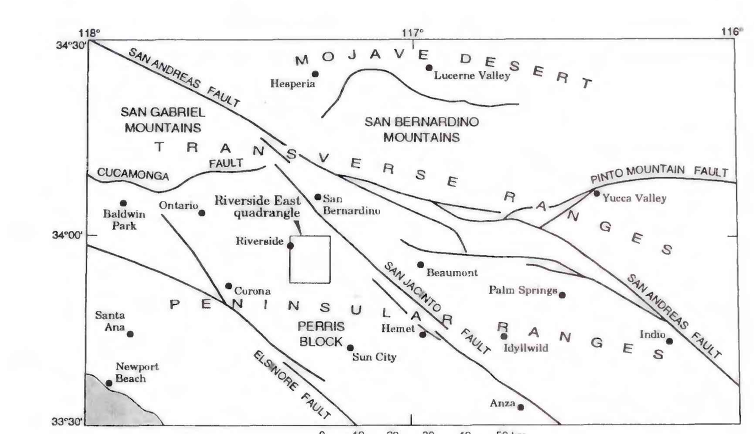

INDEX MAP SHOWING LOCATION OF THE RIVERSIDE EAST QUADRANGLE

GEOLOGIC MAP OF THE RIVERSIDE EAST QUADRANGLE, RIVERSIDE COUNTY, CALIFORN

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1994

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