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

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U.S. FOREST SERVICE (San Bernardino National Forest) and the
CALIFORNIA DIVISION OF MINES AND GEOLOGY

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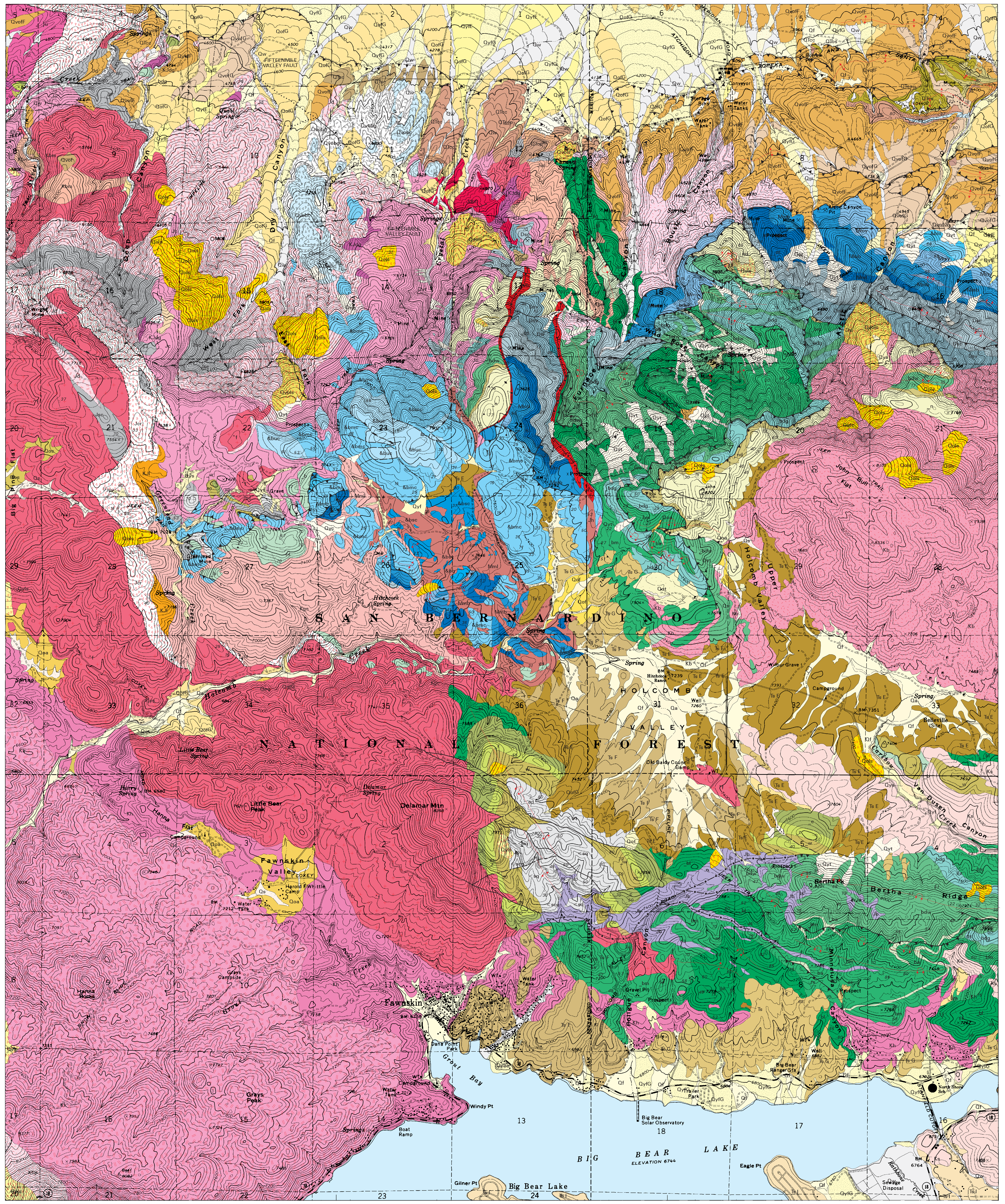
Version 1.1



Base from U.S. Geological Survey 7.5' Fawnskin quadrangle, 1971

Lambert conformal conic projection

SCALE 1:24,000

CONTOUR INTERVAL 40 FEET

Geology mapped by F.K. Miller, 1975-1976, 1995-1996; J.C. Matti, 1991-1996; H.J. Brown, 1978-1982; R.E. Powell, 1977

LOCATION MAP

GEOLOGIC MAP OF THE FAWNSKIN 7.5' QUADRANGLE, SAN BERNARDINO COUNTY, CALIFORNIA

Version 1.1

By

Fred K. Miller[1], Jonathan C. Matti[2], Howard J. Brown[3], and Robert E. Powell[1]

Digital preparation by

P.M. Cossette[1] and Gregory Morton[4]

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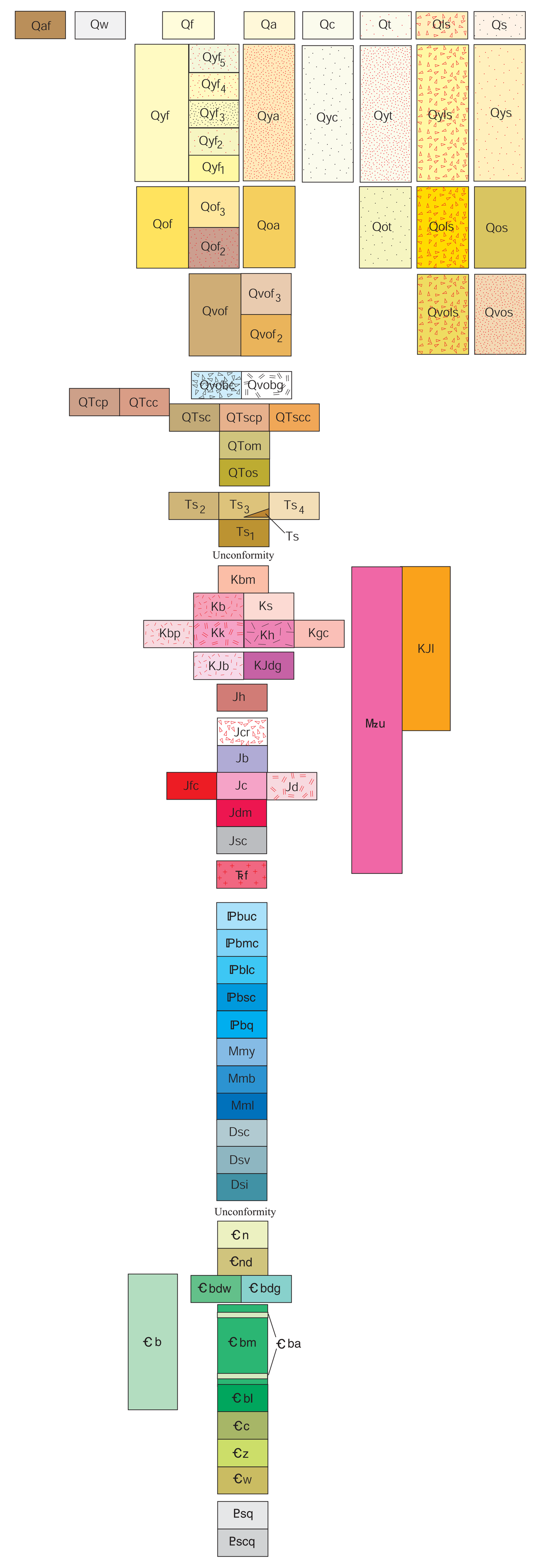
[1] U.S. Geological Survey, 904 W Riverside Avenue, Room 202, Spokane, WA 99201

[2] U.S. Geological Survey, University of Arizona, 520 N Park Avenue, Tucson, AZ 85719

[3] Pluess-Staufer (California) Inc., P.O. Box 825, Lucerne Valley, CA 92356

[4] U.S. Geological Survey, Department of Earth Sciences, University of California, Riverside, CA 92521

CORRELATION OF MAP UNITS



Contact—Solid where located within ±15 meters; dashed where located within ±30 meters

Contact—Separates terraced alluvial units, hachers point towards topographically lower surface. Solid where located within ±15 meters; dashed where located within ±30 meters

Fault—High angle. Solid where located within ±15 meters; dashed where located within ±30 meters; dotted where concealed. Hachures indicate scarp; hachures on down-dropped block. Arrows indicate relative movement

Thrust fault—Older over younger. Solid where located within ±15 meters; dashed where located within ±30 meters; dotted where concealed. Hachures indicate scarp; hachures on down-dropped block

Thrust fault—Younger over older. Solid where located within ±15 meters; dashed where located within ±30 meters

Fault—Variable angle, rotational normal slip, inferred, dashed where located within ±30 meters

Fault—Intruded. Pre-intrusive existence inferred

Anticline

Overturned anticline

Overturned syncline

Strike and dip of beds
- Inclined
- Vertical
- Overturned

Strike and dip of metamorphic foliation
- Inclined
- Vertical

Strike and dip of primary igneous foliation
- Inclined

Strike and dip of foliation related to faulting
- Inclined

Bearing and plunge of linear features
- Crushed and streaked mineral grains

DESCRIPTION OF MAP UNITS

MODERN SURFICIAL DEPOSITS—Sediment recently transported and deposited in channels and washes, on surfaces of alluvial fans and alluvial plains, and on hillslopes. Soil-profile development is non-existant to minimal. Includes:

Qaf **Artificial Fill (late Holocene)**—Sand, gravel, and bedrock from pits and quarries; mapped primarily where used for construction of highways and water catchment basins

Qw **Active-wash deposits (late Holocene)**—Unconsolidated to locally cemented sand and gravel deposits in active washes of streams and on active surfaces of alluvial fans. Typically shows fresh flood scours and channel-and-bar morphology. Locally includes small areas of older surficial deposits. Most deposits are centimeters to a few meters thick

Qf **Deposits of alluvial fans (late Holocene)**—Unconsolidated to locally cemented, undissected deposits of gravel and sand that form active parts of alluvial fans. Essentially no pedogenic soil development

Qa **Deposits of axial valley floors (late Holocene)**—Unconsolidated to locally cemented sand and gravel deposits

Qc **Colluvial deposits (late Holocene)**—Unconsolidated to slightly consolidated sandy and pebbly deposits of hillslopes and base of slopes. No pedogenic soil development

Qt **Talus deposits (late Holocene)**—Slightly consolidated to cemented deposits of angular and sub angular pebbles, cobbles, and boulders that form scree and rubble on hillslopes and base of slopes

Qls **Landslide deposits (late Holocene)**—Slope-failure deposits that consist of displaced bedrock blocks and (or) chaotically mixed rubble. Most deposits are probably active or recently active

Qs **Undifferentiated surficial deposits (late Holocene)**—Sand and pebble to small-cobble gravel not assigned to any specific surficial materials unit. Unconsolidated to moderately consolidated. Includes active wash, colluvium, and valley-filling deposits

YOUNG SURFICIAL DEPOSITS—Sedimentary units that are slightly consolidated to cemented and slightly to moderately dissected. Alluvial fan deposits (**Qyf** series) typically have high coarse:fine clast ratios. Younger surficial units have upper surfaces that are capped by slight to moderately developed pedogenic-soil profiles (A/C to A/AC/$B_{cambric}C_{ox}$ profiles). Includes:

Qyf **Young deposits of alluvial fans (Holocene and late Pleistocene)**—Slightly consolidated to cemented, undissected to slightly dissected deposits of unsorted boulders, cobbles, gravel, and sand that form inactive parts of alluvial fans. Many have unsorted clast and matrix-supported debris-flow fabrics. Subunits of Qyf generally form a nested series of thin fills that include from younger to older:

Qyf_5 **Young deposits of alluvial fans, unit 5 (late Holocene)**—Sand and pebble-boulder gravel. Unconsolidated to slightly consolidated; sand is fine to coarse grained. Occupies topographically highest position relative to other Qyf units

Qyf_4 **Young deposits of alluvial fans, unit 4 (late Holocene)**—Sand and pebble-boulder gravel. Unconsolidated to slightly consolidated; sand is fine to coarse grained. Differs from Qyf_5 and from Qyf_3 by relative topographic position

Qyf_3 **Young deposits of alluvial fans, unit 3 (late and middle Holocene)**—Sand and pebble-boulder gravel. Unconsolidated to slightly consolidated; sand is fine to coarse grained. Differs from Qyf_4 and from Qyf_2 by relative topographic position

Qyf_2 **Young deposits of alluvial fans, unit 2 (early Holocene)**—Sand, silty sand, and granule-pebble gravel. Slightly to moderately consolidated; sand is fine to coarse grained. Differs from Qyf_3 by relative topographic position and slight differences in degrees of consolidation and average grainsize and from Qyf_1 by relative topographic position and slight differences in average grain size

Qyf_1 **Young deposits of alluvial fans, unit 1 (early Holocene and late Pleistocene)**—Sand and pebble-boulder gravel. Slightly to moderately consolidated; sand is fine to coarse grained. Differs from Qyf_2 by relative topographic position and slight difference in average grainsize

Qya **Young deposits of axial valley floors (Holocene and late Pleistocene)**—Slightly to moderately consolidated sand and pebble-cobble gravel

Qyc **Young colluvial deposits (Holocene and late Pleistocene)**—Slightly dissected, slightly to moderately consolidated deposits of hillslopes and base of slopes

Qyt **Young talus deposits (Holocene and late Pleistocene)**—Slightly to moderately dissected, consolidated to cemented deposits of angular to subangular pebbles, cobbles, and boulders that form scree and rubble on hillslopes and base of slopes

Qyls **Young landslide deposits (Holocene and late Pleistocene)**—Slope-failure deposits that consist of displaced bedrock blocks and (or) chaotically mixed rubble. Deposits are probably inactive under current climatic conditions and under moderate to strong ground-shaking conditions

Qys **Young surficial deposits undifferentiated (Holocene and late Pleistocene)**—Slightly dissected, slightly to moderately consolidated deposits

OLD SURFICIAL DEPOSITS—Sedimentary units that are moderately consolidated and slightly to moderately dissected. Older surficial deposits have upper surfaces that are capped by moderately to well-developed pedogenic soils (A/AB/B/C_{ox} profiles and Bt horizons as much as 1 to 2 m thick and maximum hues in the range of 10YR 5/4 and 6/4 through 7.5YR 6/4 to 4/4 and mature Bt horizons reaching 5YR 5/6). Includes:

Qof **Old deposits of alluvial fans (late to middle Pleistocene)**—Sedimentary units that are moderately consolidated and slightly to moderately dissected. Includes from younger to older:

Qof_3 **Old deposits of alluvial fans, unit 3 (late Pleistocene)**—Slightly to moderately dissected alluvial fan deposits. Moderately to well consolidated brownish sand, gravelly sand, and granule-boulder gravel mainly having matrix-supported debris-flow fabrics; lenses of sediment having clast-supported, imbricated fluvial fabrics are subordinate

Qof_2 **Old deposits of alluvial fans, unit 2 (late Pleistocene)**—Slightly to moderately dissected alluvial fan deposits. Moderately to well consolidated brownish sand, gravelly sand, and granule-boulder gravel mainly having matrix-supported debris-flow fabrics

Qoa **Old deposits of alluvial-valley floors (late to middle Pleistocene)**—Forms low terraces of gravelly sand

Qot **Old talus deposits (late to middle Pleistocene)**—Moderately dissected, consolidated deposits of scree and rubble on hillslopes and base of slopes

Qols **Old landslide deposits (late to middle Pleistocene)**—Slope-failure deposits that consist of displaced bedrock blocks and (or) chaotically mixed rubble. Deposits are probably inactive under current climatic conditions and under moderate to strong ground-shaking conditions

Qos **Old surficial deposits undifferentiated (late to middle Pleistocene)**—Moderately dissected, moderately consolidated deposits

VERY OLD SURFICIAL DEPOSITS—Sediments that are slightly to well consolidated to indurated, and moderately to well dissected. Upper surfaces are capped by moderate to well developed pedogenic soils (A/AB/B/C_{ox} profiles having Bt horizons as much as 2 to 3 m thick and maximum hues in the range 7.5YR 6/4 and 4/4 to 2.5YR 5/6)

Qvof **Very old deposits of alluvial fans (middle to early Pleistocene)**—Sedimentary units that are moderately consolidated and moderately to well dissected. Includes from younger to older:

$Qvof_3$ **Very old deposits of alluvial fans, unit 3 (early Pleistocene)**—Moderately dissected. Sandy pebble-cobble deposits incised into uplifted parts of $Qvof_2$

$Qvof_2$ **Very old deposits of alluvial fans, unit 2 (early Pleistocene)**—Moderately consolidated to indurated, sandy, pebble-boulder gravel. Well dissected

Qvols **Very old landslide deposits (middle to early Pleistocene)**—Slope-failure deposits that consist of displaced bedrock blocks and (or) chaotically mixed rubble. Deposits of this unit inferred to have accumulated during Pleistocene uplift of San Bernardino Mountains

Qvos **Very old surficial deposits, undifferentiated (late to middle Pleistocene)**—Moderately to well dissected, moderately to well consolidated deposits ranging in grain size from boulders to silt

Qvobc **Very old deposits of catastrophic carbonate breccia (early Pleistocene)**—Shattered blocks and fragmented carbonate rock emplaced by mega-landslide processes

Qvobg **Very old deposits of catastrophic granitic breccia (early Pleistocene)**—Shattered and fragmented granitoid rock emplaced by mega-landslide processes. Some highly broken blocks probably slid almost intact

QTcp **Conglomerate, porphyry-bearing facies (Pleistocene? and Pliocene?)**—Consolidated to indurated, interbedded porphyry- and carbonate-clast conglomerate and conglomeratic sandstone; sediment source from north and south

QTcc **Conglomerate, Cushenberry facies (Pleistocene? and Pliocene?)**—Consolidated to cemented, very thick bedded, pebble to boulder conglomerate; most abundant clast type is medium to coarse grained marble

QTsc **Sandstone and conglomerate (Pleistocene? and Pliocene?)**—Consolidated pebble to boulder, marble- and granitic-clast conglomerate interbedded with lesser medium to very coarse grained lithic arkose; sediment source from south

QTscp **Sandstone and conglomerate, porphyry facies (Pleistocene? and Pliocene?)**—Consolidated, lithic, arkosic, and conglomeratic sandstone. Mixed clast composition, but dacitic volcanic clasts predominate. Interbedded with pebble to cobble conglomerate; sediment source from north

QTscc **Sandstone and conglomerate, Cushenberry facies (Pleistocene? and Pliocene?)**—Consolidated, lithic, arkosic, and conglomeratic sandstone. Chief clast-type is marble. Interbedded with pebble to cobble, marble-clast conglomerate; sediment source from south

QTom **Old Woman Sandstone, mudrock and sandstone member (Pleistocene? and Pliocene?)**—Arkosic sandstone interbedded with subordinate pebble to boulder conglomerate, siltstone, and mudstone. Clasts are mainly marble; sediment source from south

QTos **Old Woman Sandstone, sandstone member (Pleistocene? and Pliocene?)**—Lithic, arkosic sandstone interbedded with conglomeratic sandstone and conglomerate; volcanic clasts predominate, but also has abundant marble; sediment source from north

Ts_4 **Sedimentary rocks south of Big Bear Lake (Miocene?)**—Siltstone, fine- to coarse sandstone, pebbly sandstone, and minor greenish mudstone. Unit is moderately well consolidated, thin to thick bedded, locally indistinct stratification. White, pale-brown, and brownish-gray

Ts_3 **Sedimentary rocks south of Bertha Ridge and John Bull Mountain (Miocene?)**—Two distinct lithologies: (1) Limestone-clast conglomerate. Consolidated to cemented; medium- to thick-bedded; light- to medium-gray, (2) Siltstone, fine- to coarse-grained sandstone, and pebbly sandstone;white, brownish-gray, and greenish-gray. Locally includes yellowish-brown sandstone and siltstone near base (Ts)

Ts_2 **Sedimentary rocks of Poligue Canyon (Miocene?)**—Pebbly and cobbly sand and sandy pebble-cobble conglomerate. In Poligue Canyon area unit is brown to reddish-brown, well consolidated, medium bedded to crudely stratified, and has clasts of metaquartzite and metacarbonate rocks. In Holcomb Valley area unit is brown and has clasts of granitoid and metasedimentary rock. Forms low terraces cut into unit Ts_1

Ts_1 **Sedimentary rocks of Holcomb Valley (Miocene?)**—Clay-rich conglomerate. Matrix of rock generally greater than 50 percent, consisting of silt, sand, and angular to round pebbles in clay submatrix. Clay makes up about 25 to 100 percent of rock matrix. Almost all large clasts are angular to subrounded white quartzite ranging from boulder to cobble size. Attains 2.5 YR to 10 R hues locally

Mzu **Undivided granitic rocks of range front (Mesozoic)**—Monzogranite and granodiorite; ranging to diorite. Includes several small noncontiguous bodies that cannot be assigned to larger granitic units in quadrangle. Fine- to coarse-grained; massive to foliate and lineate. Monzogranite and granodiorite form homogeneous bodies and resemble nearby Cretaceous rocks; color index generally less than 12. Monzodiorite and diorite bodies form heterogeneous and homogeneous bodies and resemble nearby Cretaceous and Jurassic rocks; color index ranges from 10 to 50

KJl **Leucocratic granitic rocks (Cretaceous to Jurassic)**—Fine- to coarse-grained leucocratic granitic rocks, chiefly monzogranite; color index typically less than 3. Forms dikes, sills, pods, and small bodies in many parts of quadrangle, most too small to map. Includes alaskite, pegmatite, aplite, and heterogeneous monzogranite. Rocks are generally nonfoliate, nonlineate, and spatially associated with Cretaceous plutons

Kbm **Biotite monzogranite (Cretaceous)**—Fine- to coarse-grained granitic rock, chiefly monzogranite. Forms several noncontiguous bodies west of Bousic, Furnace, and Deep Canyons. Distinguished by small, sparse potassium feldspar phenocrysts; most potassium feldspar is in groundmass and has pink hue. Color index ranges from 5 to 10. Biotite is only mafic mineral; unevenly distributed in rock. Granitic texture; no foliation

Kb **Monzogranite of John Bull Flat (Cretaceous)**—Medium-grained biotite monzogranite. Potassium feldspar more abundant than plagioclase. Distinguished by uniform grain size (except near borders), abundant potassium feldspar, low color index, and fine-grained rock in outer part. Color index averages about 7; biotite is only mafic mineral. Nonporphyritic; has no directional or penetrative fabric. Probably related to monzogranite of Stanfield Cutoff

Ks **Monzogranite of Stanfield Cutoff (Cretaceous)**—Biotite monzogranite. Distinguished by consistent medium to fine grain size, seriate texture, and absence of other distinctive characteristics. Color index ranges from 3 to 9. Biotite is only mafic mineral; forms thin crystals in much of unit. Has very fine-grained chilled border, which in places contains bipyramidal quartz. Locally has sparse 1.5-cm-long orthoclase phenocrysts. Texture is hypidiomorphic-granular; rock has no directional fabric

Kbp **Monzogranite of Butler Peak (Cretaceous)**—Fine- to medium-grained muscovite-biotite monzogranite. Found in southwest corner of quadrangle, but continues southwestward. Distinguished by even-grained texture and presence of muscovite. Color index averages 6; biotite is only mafic mineral. Biotite:muscovite ratio averages 3:1 but varies widely. Texture is hypidiomorphic-granular; rock has no directional fabric. Highly broken and cut by numerous subhorizontal fractures and gouge zones probably related to landsliding. Completely surrounded by, grades into, and probably related to monzogranite of Keller Peak

Kk **Monzogranite of Keller Peak (Cretaceous)**—Coarse-grained biotite monzogranite; grain size ranges from very coarse to medium. Irregularly porphyritic; has 2-cm-long, well-formed, scattered phenocrysts, which, in places are pink. Average color index 9. In eastern part has trace amounts of hornblende, and in western part has trace amounts of muscovite. Texture is hypidiomorphic-granular; rock has no directional fabric. Conventional K-Ar age on biotite is 71.1 Ma

Kh **Granodiorite of Hanna Flat (Cretaceous)**—Coarse-grained hornblende-biotite granodiorite. Irregularly porphyritic; has 2-cm-long, poorly formed, scattered phenocrysts. Average color index 15 in eastern part, grading to 10 in western part; concentration of hornblende and sphene decreases from east to west also. Body probably represents outer part of monzogranite of Keller Peak that was contaminated where it intruded Triassic Fawnskin monzonite. Conventional K-Ar ages on hornblende and biotite, respectively, are 70.5 Ma and 71.5 Ma $^{40}Ar/^{39}Ar$ incremental age on same hornblende sample is 76.5 (R.J. Fleck, written commun., 1996)

Kgc **Monzogranite of Greenlead Creek (Cretaceous)**—Coarse-grained, leucocratic biotite monzogranite. Distinguished by low color index, high quartz content, and coarse grain size. Color index averages 5. Biotite is only mafic mineral, occuring as 3 mm grains and as concentrations of submillimeter grains interstitial to other minerals. Quartz in 7 mm-long grains makes up 30 percent of rock. Texture is hypidiomorphic-granular; rock has no directional fabric

KJb **Granodiorite of Bousic Canyon (Cretaceous or Jurassic)**—Medium-grained hornblende-biotite granodiorite. Relatively homogeneous with respect to composition and appearance. Color index averages 16; hornblende:biotite ratio averages 1:10. Contains abundant sphene. Texture is hypidimorphic-granular; rock has no directional fabric. Conventional K-Ar age on biotite is 70.8 Ma, but probably represents a cooling age

KJdg **Mixed mafic diorite and gabbro (Cretaceous or Jurassic)**—Biotite-hornblende diorite and quartz diorite, and hornblende-biotite diorite and quartz monzodiorite. Fine- to coarse-grained. Appears to have some spatial relation to Paleozoic carbonate rocks and intermediate composition Mesozoic plutons. Rocks of this unit have wide compositional and textural range, but are distinguished from other units by their very high color index. Average color index 45. Unit may include rocks of more than one period of intrusion

Jh **Volcanic and hypabyssal rocks of Holcomb Valley area (Jurassic?)**—Fine-grained, porphyritic trachyandesite to dacite. Medium to dark gray groundmass of quartz, plagioclase, potassium feldspar, biotite, opaque minerals, and sericite; contains phenocrysts of plagioclase, orthoclase, and biotite. Much of rock shows flow banding, but uncertain if unit is extrusive, intrusive, or both

Jcr **Cataclastic rocks (Jurassic)**—Fine-grained to near-aphanitic cataclastic rocks. Mediun- to dark-gray, commonly having green tint. Derived primarily from extreme deformation of granitic units. In central part of zone rocks are very comminuted, nearly aphanitic; grades outward to borders of zone by appearance of grains and grain aggregates into progressively less deformed rock

Jb **Bertha Peak pluton of Cameron (1981) (Jurassic)**—Unit as mapped by Cameron appears to be a composite of two distinct and possibly unrelated igneous types: (1) medium-grained hornblende monzodiorite to granodiorite, and (2) dark, very fine-grained, hypabyssal quartz diorite to diorite. Medium-grained rock has 15 to 20 percent quartz and moderate amount of potassium feldspar; very fine-grained rock has very little of either mineral. Hornblende from medium grained rock gave a K-Ar model age of 127 Ma, considered a minimum age (Cameron, 1981)

Jfc **Quartz monzonite porphyry of Furnace Canyon (Jurassic)**—Biotite-plagioclase-potassium feldspar porphyry of quartz monzonite composition. Noticably quartz deficient compared to Cretaceous rocks. Forms two long dike-form bodies at least partly localized along pre-existing faults. Fine-grained holocrystalline matrix contains 2 to 3 mm phenocrysts of biotite, plagioclase, and potassium feldspar. Color index averages 4. Dikes are probably related to Jurassic leucocratic quartz monzonite of Crystal Creek

Jc **Leucocratic quartz monzonite of Crystal Creek (Jurassic)**—Hornblende-biotite quartz monzonite and biotite quartz monzonite, ranging to monzonite. Leucocratic. Coarse grained. Distinguished by low quartz content and presence of hornblende and sphene in most samples. Average color index is 5, locally as high as 12. U-Pb age on monazite is 151 Ma (J.L. Wooden, written commun., 1997)

Jd **Quartz monzodiorite of Dry Canyon (Jurassic)**—Biotite quartz monzodiorite, ranging to monzodiorite. Medium- to coarse-grained. Distinguished by relatively low quartz content and relatively high color index in a rock having biotite as its only mafic mineral. Quartz content ranges from 3 to 8 percent; color index averages 15. Has wide gradational contact with fine grained rocks of Silver Canyon (Jsc)

Jdm **Deformed monzogranite of hill 4970 (Jurassic)**—Porphyritic biotite monzogranite, possibly ranging to quartz monzonite. Distinguished by very pale pink tectonically rounded phenocrysts of potassium feldspar in light-gray amorphous-looking groundmass. All minerals have undergone severe tectonic grainsize reduction

Jsc **Fine-grained rocks of Silver Canyon (Jurassic)**—Pale-gray to medium-gray, very fine-grained porphyroblastic rock made up predominently of quartz, plagioclase, and potassium feldspar. Inferred to be metamorphosed mylonitic or cataclastic rocks of possible monzogranite to quartz monzodiorite composition. Differs from cataclastic rock unit in that recrystallization has erased nearly all traces of penatrative fabric. Lithic assignment and age very uncertain

Ŧf **Monzonite of Fawnskin (Triassic)**—Hornblende monzonite, ranging to quartz monzonite and monzodiorite. Medium- to coarse-grained, locally porphyritic. Distinguished by very low quartz content and abundance of hornblende and sphene. Quartz generally less than 5 percent; hornblende commonly has altered pyroxene cores. Color index averages 18. Smaller, noncontiguous body near mouth of Deep Canyon is distinctly more leucocratic, having average color index of 10. Zircon U-Pb age is 231 Ma (J.L. Wooden, written commun., 1996)

Bird Spring Formation (Pennsylvanian)—Upper part of Furnace Limestone of Vaughan (1922) as mapped by Guillou (1953), Richmond (1960), Dibblee (1964), Hollenbaugh (1968), and Sadler (1981); correlated with Bird Spring Formation of southern Great Basin by Cameron (1981) and Brown (1984, 1987, 1991). Five members recognized in quadrangle:

IPbuc **Upper Carbonate Member**—Generally light-colored, medium- to thick-bedded, medium to coarsely crystalline calcite marble; locally is pelmatozoan bearing. Typical lithologies include white, gray, or mottled marble and cherty, silicified marble that are interstratified in packages as much as 12 m thick. Yellowish- to brownish-gray phyllite is a subordinate rock type

IPbmc **Middle Carbonate Member**—Medium- to thick-bedded, generally medium- to dark-gray, chert-bearing calcite marble containing lenses and thin layers of quartz silt and fine sand. Locally pelmatozoan-bearing

IPblc **Lower Carbonate Member**—Medium- to thick-bedded, light-gray to white, medium to coarsely crystalline, calcite marble containing intermittent layers up to 3 m thick of minor brown-weathering dolomite marble and (or) siliceous marble horizons and thick- to very thick-bedded, medium- to dark-gray calcite marble

IPbsc **Siltstone and Carbonate Member**—Thin- to medium-bedded olive-green metasiltstone, and orange-brown to gray interbedded chert and metalimestone overlain by heterogeneous light and dark colored metalimestone and metadolomite that is burrow mottled (?) and locally cherty

IPbq **Quartzite Member**—Very thick bedded white quartzite

Monte Cristo Limestone (Mississippian)—Upper part of Furnace Limestone of Vaughan (1922) as mapped by Richmond (1960), Dibblee (1964), and Sadler (1981). Correlated with the Monte Cristo Limestone of the southern Great Basin by Cameron (1981), and mapped by Brown (1984, 1987, 1991) who recognized several formal stratigraphic members named originally by Hewitt (1931). Three members recognized in quadrangle:

Mmy **Yellowpine Member**—Heterogeneous, medium- to thick-bedded, interlayered, light- and dark-gray, calcite and dolomite marble

Mmb **Bullion Member**—Thick- to very thick-bedded, light-gray to white, texturally massive, very pure bioclastic calcite marble. Grain size varies from fine to coarsely crystalline depending on metamorphic grade

Mml **Lower Member**—Interlayered dark-gray and light-gray calcite marble that is thin to thick bedded, pelmatozoan bearing, texturally massive to mottled, and chert bearing. Includes the Dawn and Anchor members of the southern Great Basin that could not be differentiated at the map scale

Sultan Limestone (Devonian)—Middle part of Furnace Limestone of Vaughan (1922) as mapped by Richmond (1960), Dibblee (1964), and Sadler (1981). Cameron (1981) and Brown (1984, 1987, 1991) correlated rocks in this interval with members of Sultan Limestone of Hewitt (1931) in southern Great Basin. Three members recognized in quadrangle:

Dsc **Crystal Pass Member**—Thin- to thick-bedded, white calcite marble having intermittent thin intervals of dark-gray calcite and dolomite marble. Lower part of unit commonly is irregularly dolomitized and contains greater number of gray metalimestone layers. White marble layers locally are pyrite-bearing, and commonly are stained with iron oxide on fracture surfaces and layering surfaces

Dsv **Valentine Member**—Thin- to very thick-bedded, light-gray, pale-yellowish-brown, and white, finely crystalline metadolomite that is laminated to texturally massive; some intervals contain lenticular to irregular nodules of white to very pale-brown chert. Lithologically resembles Sevy Dolomite of Basin and Range Province. Is more dolomitic than the type Valentine Limestone Member described by Hewett (1931)

Dsi **Ironside Member**—Medium- to very thick-bedded, dark-gray dolomite marble that is texturally massive; locally has thin, white calcite stringers resembling worm tubes

Ꞓn **Nopah Formation (Cambrian)**—White to light-gray, thin-bedded to very thick-bedded, fine to medium grained crystalline dolomite that mainly is texturally massive but locally is laminated. Middle part of Furnace Limestone of Vaughan (1922) as mapped by Richmond (1960), Dibblee (1964), and Sadler (1981). Much of unit lithologically resembles Smoky Member of upper Nopah Formation as recognized in southern Great Basin by Christiansen and Barnes (1966); their Halfpint Member of Nopah is more calcareous than typical rocks in north-central San Bernardino Mountains, but thin bedded and laminated dolomite units in map area may be lithologic counterparts of flaggy splitting and very thin-bedded calcareous Halfpint. Includes:

Ꞓnd **Dunderburg Shale Member**—Brownish to greenish hornfels, metaquartzite, phyllite, and silty, impure calcitic and dolomitic marble; lithologically indistinguishable from silty argillaceous marker units in middle member of Bonanza King Formation. Lower part of Furnace Limestone of Vaughan (1922) as mapped by Dibblee (1964), Richmond (1960), and Sadler (1981). Correlative with Dunderberg Shale Member of Nopah Formation as used by Christiansen and Barnes (1966) in southern Great Basin

Bonanza King Formation (Cambrian)—Lower part of Furnace Limestone of Vaughan (1922) as mapped by Guillou (1953), Richmond (1960), Dibblee (1964), and Sadler (1981). Originally named by Hazzard and Mason (1936) from exposures in Providence Mountains. In type area, Hazzard and Mason (1936) recognized five informal subdivisions of Bonanza King Formation. In north-central San Bernardino Mountains, Bonanza King is variably metamorphosed, but at most places it is subdivided into informal members. Where not possible to distinguish discrete members, mapped as undivided

Ꞓb **Bonanza King Formation, undivided**—Dark and light dolomite marble lacking characteristics diagnostic of specific members

Ꞓbdg **Gray dolomite member**—Mainly consists of medium- to thick-bedded, medium-gray, texturally massive to mottled, fine- to medium-grained crystalline dolomite marble and calcareous metadolomite interlayered with subordinate light-gray to white dolomite marble and calcareous metadolomite

Ꞓbdw **White dolomite member**—Thin- to very thick-bedded, uniformly white to light gray, texturally massive to laminated, finely crystalline dolomite marble. This lithology is very similar to dolomite in the Nopah Formation, and in some structurally complex sequences it is not possible to be certain if white dolomite outcrops belong to the Bonanza King or to Nopah

Ꞓbm **Middle Member**—Thin- to thick-bedded, light- to medium-gray, laminated to texturally massive to mottled dolomite marble and calcareous metadolomite; grain size varies from fine to coarse and sugary. This member contains two or more mappable intervals a few meters to a few tens of meters thick consisting of greenish brown and grayish brown metasiltstone, argillite, hornfels, and impure limestone (Ꞓba). These clastic marker units are lithologically similar to Dunderberg Shale Member of Nopah Formation, and in deformed sequences of light-colored dolomite containing argillaceous zones it is not possible to be certain whether rock sequence is middle member of Bonanza King or Dunderberg Shale Member of overlying Nopah Formation. Argillaceous zones in middle Bonanza King member may correspond to silty impure carbonate intervals in lower part of Banded Mountain Member of the Bonanza King in the southern Great Basin (Barnes and others, 1962; *see also*, Burchfiel and Davis, 1977)

Ꞓbl **Lower Member**—Thin- to thick-bedded limestone and calcite marble and subordinate dolomitic marble and metadolomite; textures vary from texturally massive to mottled to laminated. Color and texture appear to depend on proximity to bodies of plutonic rock: in Furnace Canyon area and in vicinity of Bertha Peak, lower-member outcrops surrounded by bodies of Kbm, Kh, and Jb are white, texturally massive, and recrystallized; elsewhere in Furnace Canyon lower member is light to medium gray, well bedded, and finely laminated. South of Bertha Ridge lower member is texturally massive and light- to dark-gray colored. In areas where member is faulted, fractured, or tightly folded, rock is secondarily dolomitized and difficult to distinguish from other dolomitic members. Probably correlative with Papoose Lake Member of Bonanza King Formation as used by Barnes and Palmer (1961)

Ꞓc **Carrara Formation (Cambrian)**—Heterogeneous mixture of interbedded calcite marble, phyllite, calc-silicate rock, schist, and minor quartzite. In general, upper part contains large proportion of carbonate rock; lower part contains large proportion of phyllite and quartzite. Carrara is equivalent to lower part of Furnace Limestone of Vaughan (1922) as mapped by Guillou (1953), Richmond (1960), Dibblee (1964), and Sadler's Furnace Limestone units F1-F3 (1981 and 1982m). Correlated with Carrara Formation of southern Great Basin by Stewart and Poole (1975, fig. 3), but name first used in map area by Tyler (1975 and 1979) and Cameron (1981). Latham Shale, Chambless Limestone, and Cadiz Formation of the Marble and Providence Mountains (Hazzard and Mason, 1936) occupy same approximate stratigraphic interval as Carrara, but is not possible to map these three distinct formations in quadrangle

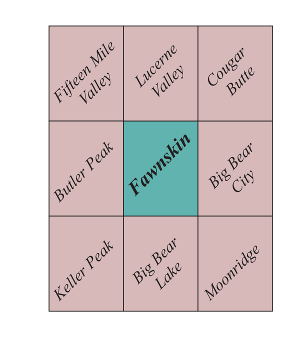
Ꞓz **Zabriskie Quartzite (Cambrian)**—Dense, quartz-cemented quartzite. Distinguished from quartzites of Cambrian Wood Canyon Formation and Late Proterozoic Stirling Quartzite by purity, lack of feldspar grains, whiteness, and massive structure. Uniformly white, but some fracture surfaces are stained yellow, orange or hematite-red by iron oxides. Very pure; quartz is almost only mineral in rock. Medium- to fine-grained, but contains scattered grains up to 5 mm across which are not aligned to define bedding. Thick bedded to massive; bedding unrecognizable in many exposures. Locally, unit contains bedding plane partings of phyllitic argillaceous rock, which may or may not be restricted to a particular part of formation. Correlated with the Zabriskie Quartzite of the southern Great Basin by Stewart and Poole (1975). Average thickness as calculated from outcrop width is 400 m, but where exposed, upper and lower contacts are sheared. Variation in thickness in quadrangle is probably due to faulting and does not represent changes in stratigraphic thickness

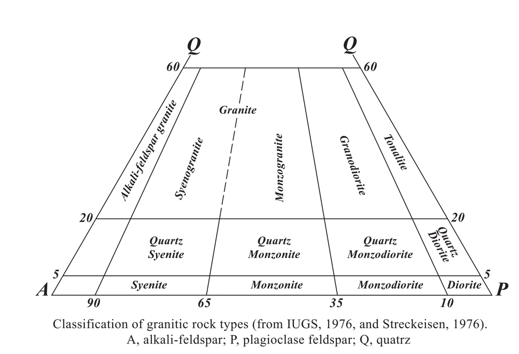
Ꞓw **Wood Canyon Formation (Cambrian)**—Quartzite, quartzose phyllite, and minor calc-silicate rock. Consists of five subunits that are described here, but not subdivided on map. (1) Lower 15-20m is black, biotite-rich, quartz-bearing phyllite. Consists of very fine-grained biotite matrix containing variable amounts of matrix-supported, very fine-grained, angular quartz. Metamorphic tourmaline is sparse but ubiquitous. Contains locally abundant Scolithus and flaser-laminated zones. (2) Over a few meters, phyllite grades upward into 20-25m of interbedded coarse-grained quartzite, pebbly quartzite, and quartzose phyllite. Quartzite is feldspathic, chiefly potassium feldspar. Much of quartzite contains up to five percent mica and some quartzite is cross-bedded. (3) Relatively uniform lavender-gray, fine- to coarse-grained, trough-cross-bedded quartzite. In quadrangle to east, subunit is 25-35m thick; in Delamar Mountain area, subunit appears to be thinner and in part interbedded with rocks similar to subunit (2). (4) Black, quartzose phyllite. Thickness uncertain due to structural thickening and thinning. (5) Medium gray and brownish gray, finely interbedded quartzite, phyllite and siltite. Thickness up to 20m. In Greenlead area, rocks shown as Wood Canyon Formation locally include structurally interleaved dolomite marble of Bonanza King Formation

Stirling Quartzite (Late Proterozoic)—Part of Saragossa Quartzite of Vaughan (1922) as mapped by Dibblee (1964, 1982). Lower part of the Chicopee Formation as mapped by Guillou (1953); lower member of the Chicopee Canyon Formation as mapped by Richmond (1960). Correlated with the Stirling Quartzite and Johnnie Formation of the southern Great Basin by Stewart and Poole (1975). We recognize two members of the Stirling Quartzite, an upper member of metaquartzite and a lower member of metacarbonate rock and quartzite

Zsq **Quartzite member**—Light-gray, yellow-gray, and white feldspathic meta-quartzite and conglomeratic metaquartzite. Approximately lower two-thirds of member is medium- to thick-bedded, poorly sorted, fine- to coarse-grained feldspathic quartzite containing sparse matrix-supported pebbles up to 1 cm across. Upper third is medium- to thin-bedded, poorly to moderately well sorted, fine- to medium-grained feldspathic quartzite. Bedding in this part of member is parallel-planar, weathering slabby, but current and oscillation ripple-marked surfaces are common. Ripple cross-lamination is faint and difficult to see. Thickness at Delamar Mountain as calculated from outcrop width is approximately 230 m

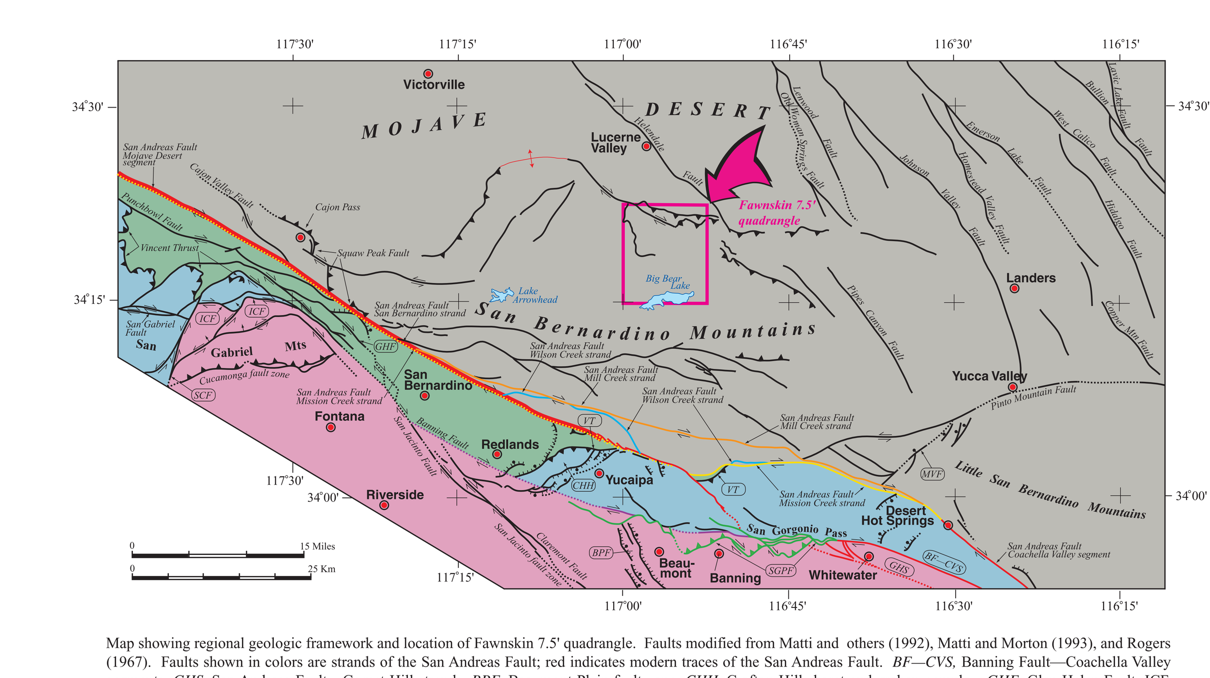
Zscq **Carbonate and quartzite member**—Wavy bedded, light-gray to light-tan-weathering dolomitic limestone interbedded with medium- and thick-bedded, medium-grained quartzite, laminated to texturally massive calcite marble, quartz-sand-bearing marble, and calc silicate rock. Poorly and incompletely exposed, but dolomitic limestone and quartzite appear to predominate. Base not exposed in San Bernardino Mountains; unit is about 120 m thick in Jacoby Canyon in quadrangle to east





Classification of granitic rock types (from IUGS, 1976, and Streckeisen, 1976). A, alkali-feldspar; P, plagioclase feldspar; Q, quartz

- Basement rocks of Peninsular Ranges-type
- Basement rocks of San Bernardino Mountains- and Mojave Desert-types
- Basement rocks of San Gabriel Mountains-type (upper plate of Vincent Thrust)
- Basement rocks of San Gabriel Mountains-type (Pelona Schist in lower plate of Vincent Thrust)



Map showing regional geologic framework and location of Fawnskin 7.5' quadrangle. Faults modified from Matti and others (1992), Matti and Morton (1993), and Rogers (1967). Faults shown in colors are strands of the San Andreas Fault; red indicates modern traces of the San Andreas Fault. *BF—CVS*, Banning Fault—Coachella Valley segment; *GHS*, San Andreas Fault—Garnet Hill strand; *BPF*, Beaumont Plain fault zone; *CHH*, Crafton Hills horst-and-graben complex; *GHF*, Glen Helen Fault; *ICF*, Icehouse Canyon Fault; *MVF*, Morongo Valley Fault; *SCF*, San Antonio Canyon Fault; *VT*, Vincent Thrust