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NATIONAL PARK SERVICE
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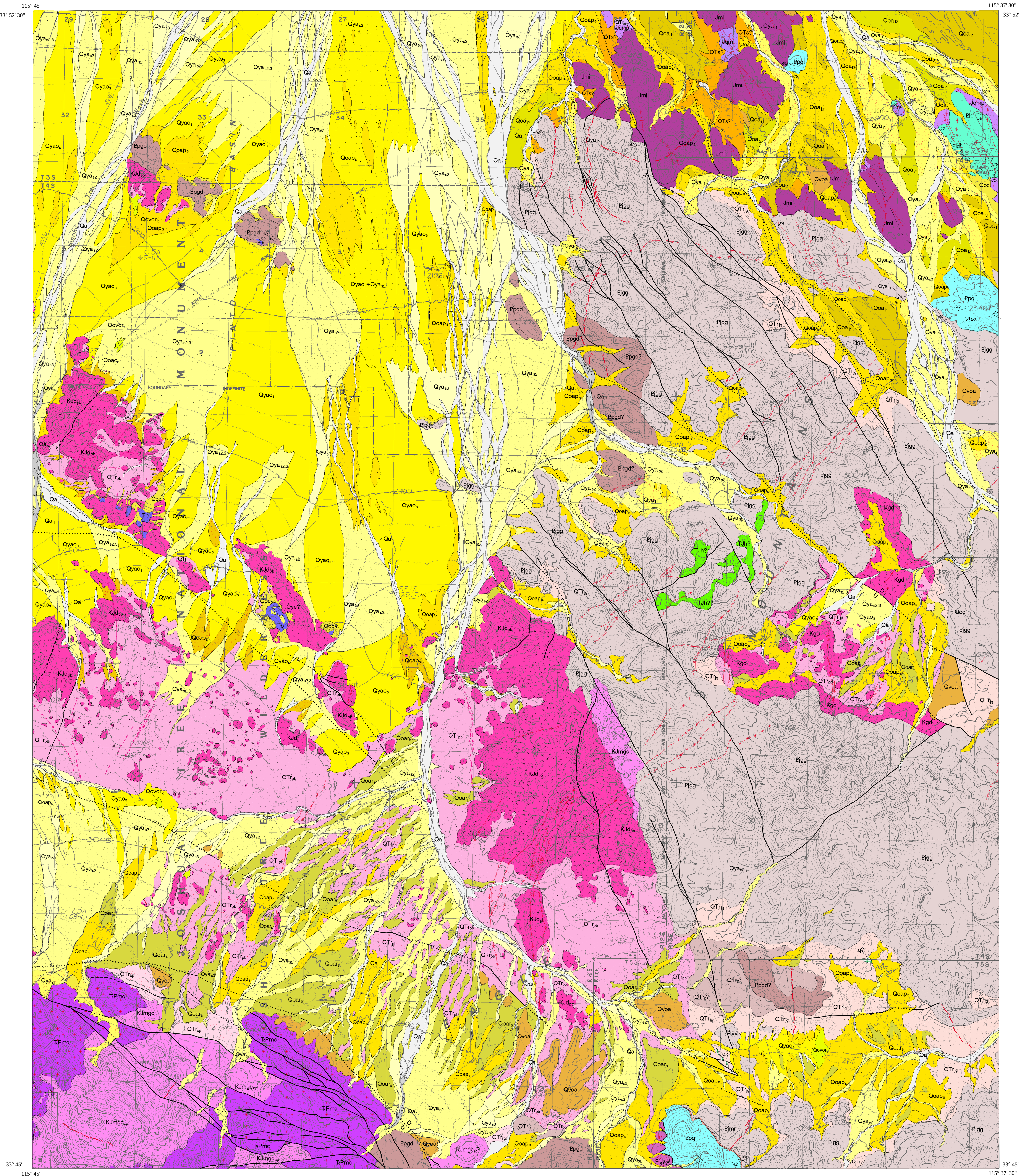
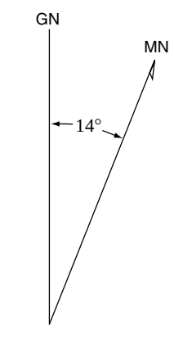
CALIFORNIA DIVISION OF MINES AND GEOLOGY

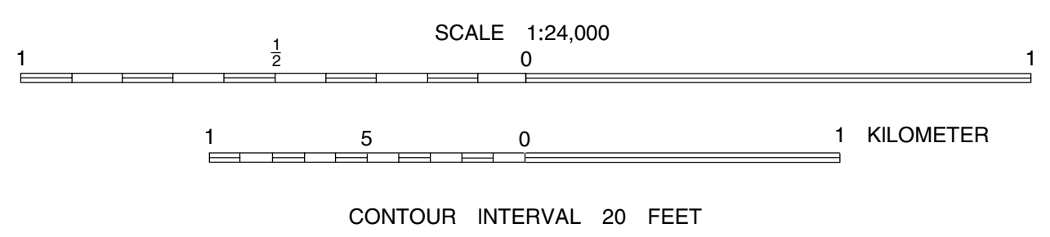
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 01-31
Version 1.0
Pamphlet accompanies map

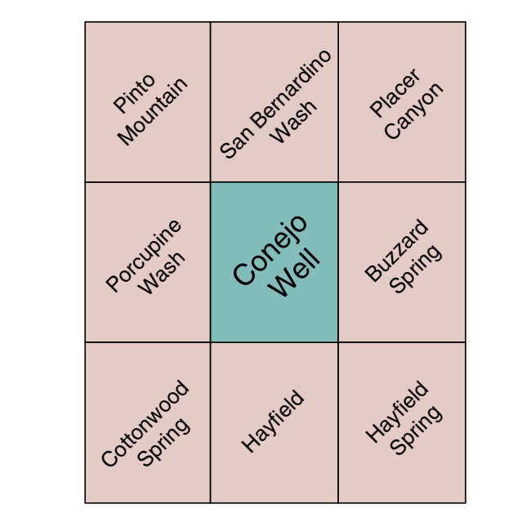


Base from U.S. Geological Survey
7.5' Conejo Well quadrangle, 1986
Lambert conformal conic projection

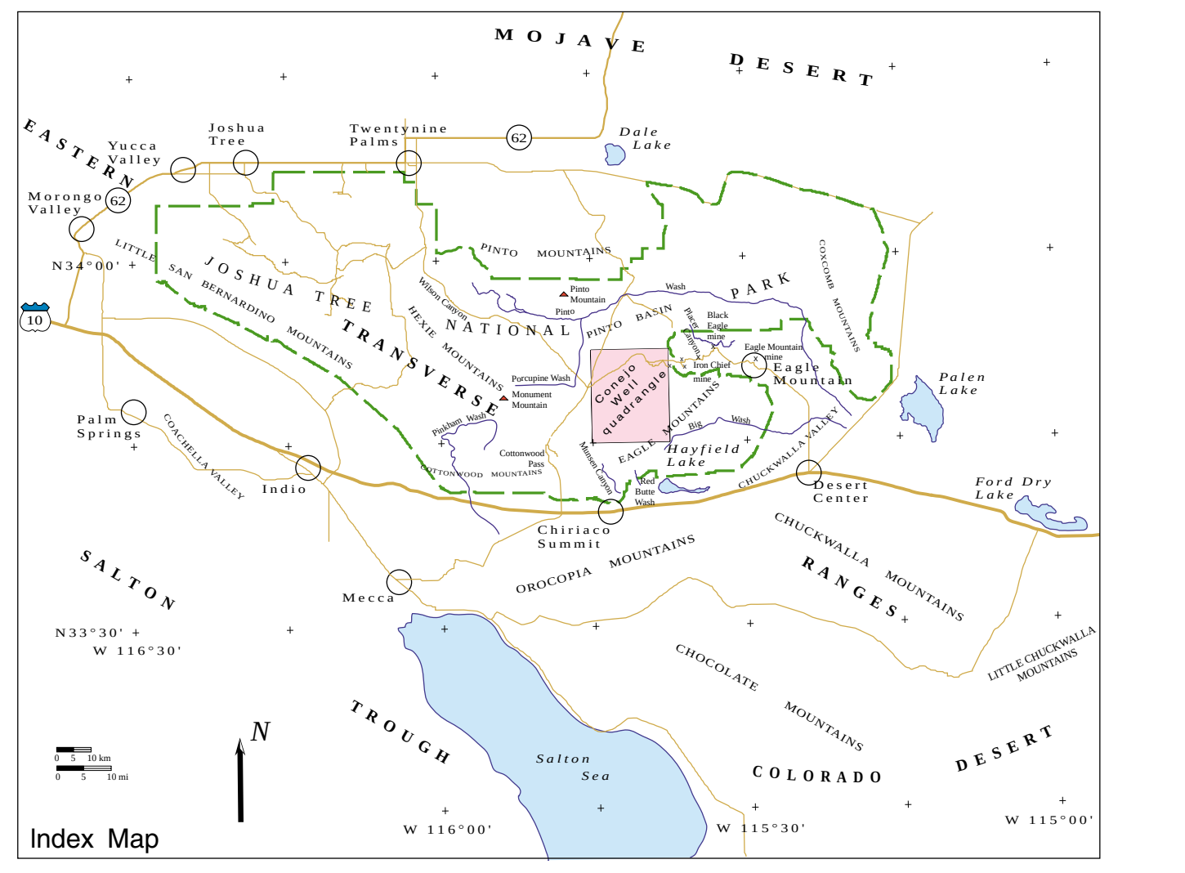




Geology mapped by
R.E. Powell, 1975-85;
1998-2000



SURROUNDING 7.5' QUADRANGLES



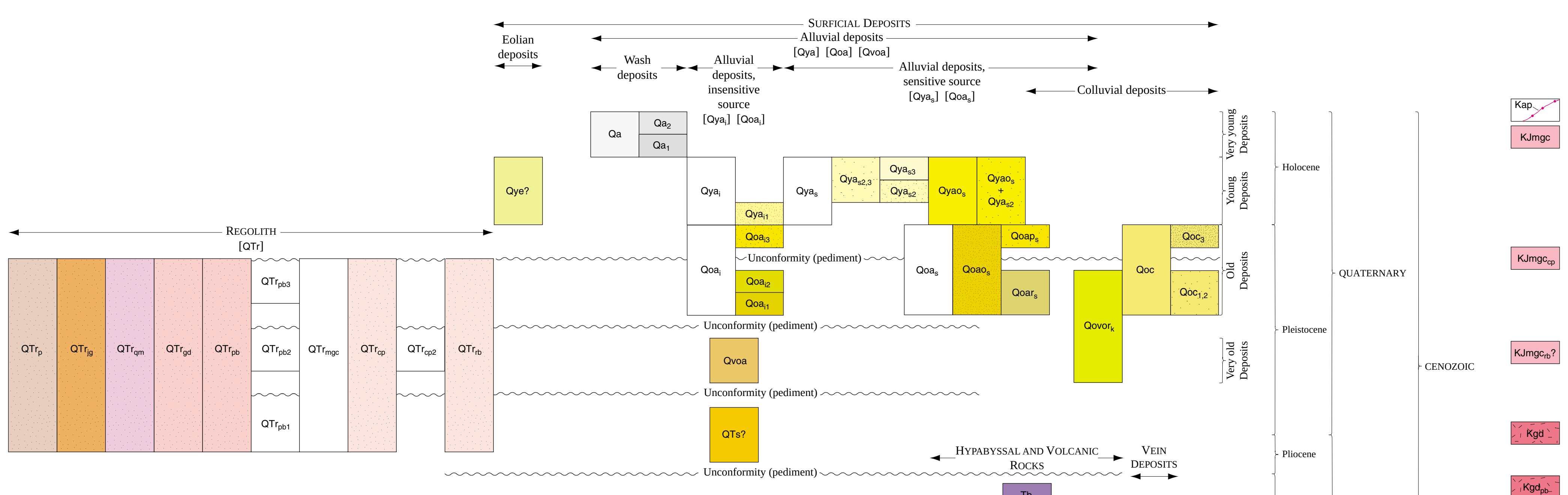
GEOLOGIC MAP AND DIGITAL DATABASE OF THE CONEJO WELL 7.5 MINUTE QUADRANGLE, RIVERSIDE COUNTY, CALIFORNIA

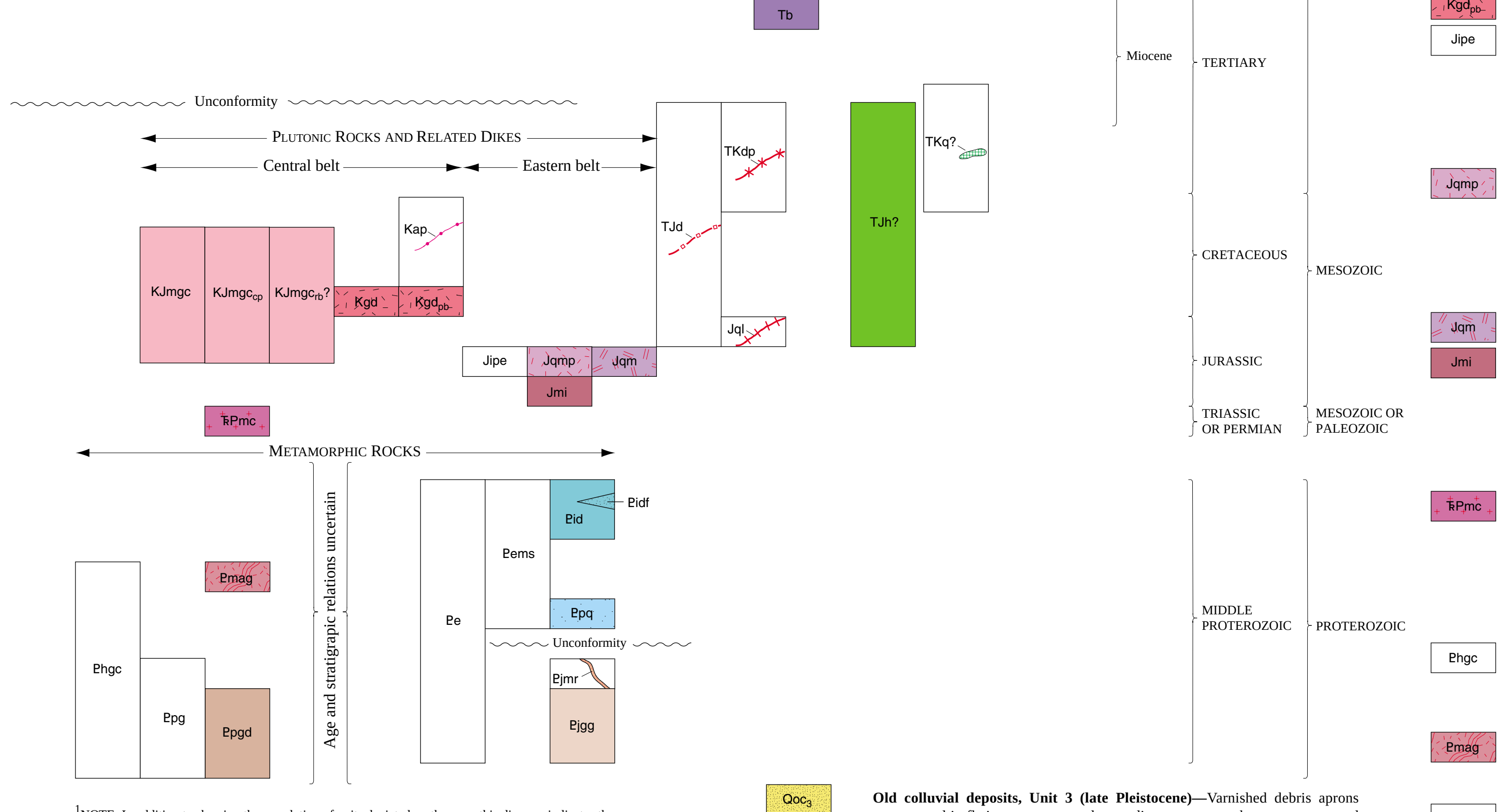
Version 1.0

By
Robert E. Powell

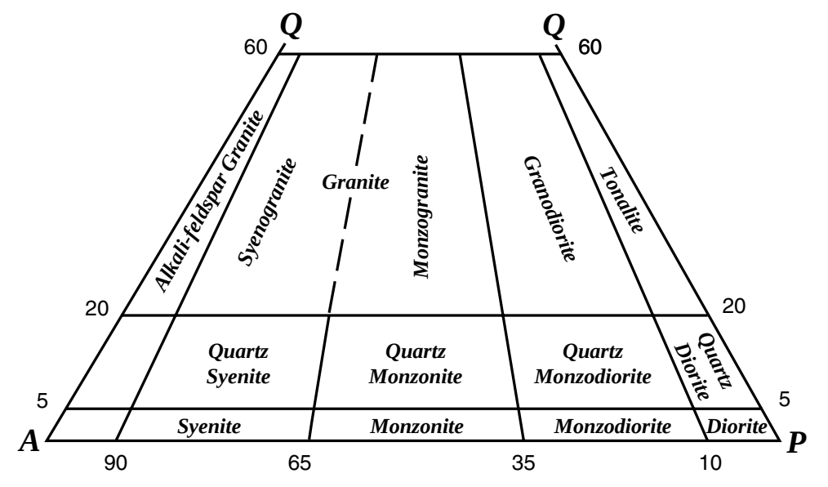
Digital preparation by
Pamela M. Cossette

CORRELATION OF MAP AND DATABASE UNITS[1]





[1]NOTE: In addition to showing the correlation of units depicted on the map, this diagram indicates the hierarchical relation of these units to selected others not shown on the map but included in the digital database and represented here by open boxes and brackets that contain database unit labels (see NOTE 2). The database also contains units that are not represented on the map or in its explanation.



Classification of plutonic rock types (from Streckeisen, 1976).
A, alkali feldspar; P, plagioclase feldspar; Q, quartz.

The matrix color of surficial materials and their pedogenic soils is classified according to the Munsell soil-color charts (Munsell, 1975).

Contact—Solid where location meets map accuracy standard (within 15 m); dashed where approximately located, may not meet map accuracy standard; dotted where concealed by mapped or unmapped covering unit

Contact—Internal. Approximately or well-located, may not meet map accuracy standard. Within alluvial units, separates alluvial deposits derived from different drainages

U D **Fault**—High angle, observed or inferred. Approximately located, may not meet map accuracy standard; dotted where concealed. Arrows and U/D indicate relative movement of fault blocks

Strike and dip of bedding in sedimentary strata

40 **Inclined**

Strike and dip of foliation and layering in metamorphic rocks

42 **Inclined**

15 **Bearing and plunge of minor fold axis and parallel lineation**

20 **Bearing and plunge of stretched pebble lineation**

DESCRIPTION OF MAP AND DATABASE UNITS[2]

VERY YOUNG SURFICIAL DEPOSITS—Loose to slightly consolidated alluvial deposits in washes incised into all older units and graded to base-level playa deposits in Chuckwalla Valley (Index Map). Geomorphic surfaces undissected to slightly dissected and characterized by active or recently active sediment accumulation

Qa **Very young alluvial deposits (late Holocene)**—Unconsolidated medium- to coarse-grained sand and sandy gravel with subordinate fine sand and silt; bar and swale morphology; unvarnished clasts. Sparsely to moderately vegetated; prominent riparian shrub lines. Chiefly degradational. Includes:

Qa_2 **Very young alluvial deposits, Unit 2 (late Holocene)**—White on aerial photographs; no soil profile development. Mostly sand in washes on slopes flanking granite inselbergs. Transported and deposited in most recently active channels; inset into Qa_1 and older deposits. Unit surfaces correlative with Q4b surfaces of Bull (1991)

Qa_1 **Very young alluvial deposits, Unit 1 (late Holocene)**—Light gray (2.5YR 7/2) to pale yellow; gray on aerial photographs; little or no soil profile development. Transported and deposited in channels or parts of channels less recently active than those in which unit Qa_2 deposited; incised into young alluvial deposits. Unit surfaces correlative with Q4a and (or) Q4b surfaces of Bull (1991)

YOUNG SURFICIAL DEPOSITS—Loose to moderately consolidated alluvial and eolian deposits on piedmont slopes. Alluvial deposits exhibit slightly to strongly dissected geomorphic surfaces characterized by Av/Cox or Av/Bw/Cox soil profiles typical of Holocene surfaces (McFadden, 1988; Bull, 1991). Deposits form a thin mantle spread across landscape inherited from Pleistocene

Qye? **Young eolian deposits? (Holocene?)**—Light-colored deposits in depressions on basalt in center of quadrangle; observed on aerial photographs only; interpreted as windblown silt and fine sand

Qya **Young alluvial deposits (Holocene and latest Pleistocene?)**—Loose to moderately consolidated alluvium deposited in canyon bottoms and on piedmont slopes. Piedmont alluvial deposits comprise two classes associated with geomorphically distinct piedmont settings: (1) Deposits that form alluvial aprons characterized by prominently cone-shaped, multi-lobed fans that coalesce into bajadas down-piedmont. Usually occur along base of steep mountain escarpments in resistant rock types, the weathering and denudation of which are relatively insensitive to climatic change (see Bull, 1991, p. 161-167). (2) Deposits that have accumulated on broad piedmont slopes along deeply embayed into mountain fronts in less resistant rock types, the weathering and denudation of which are relatively sensitive to climatic change. Consists of:

Qya_i **Young alluvial deposits, insensitive source (Holocene and latest Pleistocene?)**—Unconsolidated to consolidated alluvium deposited in fans and in feeder washes to fans; typically occur as prominent dark- and light-gray bajadas located along steep mountain escarpments. Chiefly derived from source terranes comprising rock types, the weathering and denudation of which are relatively insensitive to climatic change. In and east of Conejo Well quadrangle, insensitive source terrane chiefly consists of Jurassic plutonic rocks (Jqmp, Jmi). Fans spread out as aggradational aprons across inherited Pleistocene landscape and back-filled drainage washes from which they emanated. Fans grew progressively down piedmont in nested complexes, with oldest fans proximal to range-front and youngest fans on lower piedmont; successively younger fans are inset into older fans at their apices and either bury or feather out onto older fans distally. In Conejo Well quadrangle, exposures of this unit occur chiefly as canyon- and arroyo-filling deposits in northeast corner. Abandoned surfaces are characterized by pedogenic Av horizon of loess-like, vesicular light brown (10YR 6/4) calcareous silt. Includes:

Qya_{i1} **Young alluvial deposits, insensitive source, Unit 1 (middle and (or) early Holocene and (or) latest Pleistocene?)**—Largely interpreted from aerial photographs. Unit exhibits dark gray to black surfaces characterized by plumose anastomosing channels suggestive of bar and swale morphology. Consolidated gravel and sand; moderate to strong varnish on surfaces. Proximally, unit is inset into Pleistocene deposits (Qoa_{i3}; $Qoap_s$); distally, it overlaps them. Fans are generally adjacent to mountain-front escarpments that yield coarse, resistant, readily varnished debris. Locally, unit includes cobbly and bouldery debris flow deposits. Inferred stratigraphic position, strong desert varnish, and bar and swale morphology suggest early Holocene age. Surfaces correlative with Q3a surfaces of Bull (1991)

Qya_s **Young alluvial deposits, sensitive source (Holocene and latest Pleistocene?)**—Unconsolidated to consolidated aggradational piedmont alluvial deposits chiefly derived from source terranes comprising rock types, the weathering and denudation of which are sensitive to climatic change. Deposits typically located on piedmonts deeply embayed into mountain massifs, punctuated with inselbergs, rimmed with pediments, and eroded into highlands composed of quartz-rich, light-colored granitic rocks. In Conejo Well quadrangle, sensitive source terrane includes monzogranite ($KJmgc_{cp}$), granodiorite (Kgd_{pb}), monzodiorite (ŦPmc), and granite gneiss (Ᵽjgg). Piedmonts exhibit broad, multi-faceted slopes that drain via small intra-piedmont valleys between slope facets. Alluvium on slope facets originates as fans distributed from feeder drainage channels and as sheet wash on slopes between drainage channels. Fans of this association are characterized by low-convexity transverse profiles, and by surfaces having low-relief morphology. Fans and sheetwash on slopes between fans commonly merge imperceptibly. Down-piedmont, distributary slope drainage re-collects into intra-piedmont tributary valleys that, in turn, debouch onto fans still farther down-piedmont. Deposits are formed by channelized flow and by unconfined overland flow in distributed network of branching and coalescing washes, fans, and thin slope-blanketing sheets. Includes:

$Qya_{s2,3}$ **Young alluvial deposits, sensitive source, Units 2 and 3 (late and (or) middle Holocene)**—Unconsolidated to slightly consolidated aggradational piedmont alluvial deposits; medium- to coarse-grained sand and pebbly sand, poorly to moderately sorted. Light to very light gray on color aerial photographs. Comprise: (1) small fans that debouch from small canyons in mountains or inselbergs, are inset proximally into $Qyao_s$, and spread out distally to merge with the surface of $Qyao_s$; proximal surfaces exhibit braided bar and swale micromorphology; (2) pediment veneer over regolith. Little or no desert varnish. Includes:

Qya_{s3} **Young alluvial deposits, sensitive source, Unit 3 (late and (or) middle Holocene)**—Unconsolidated sand and pebbly sand, poorly to moderately sorted. Proximally, deposits are inset into Qya_{s2}; distally, they feather out onto Qya_{s2} surfaces. Surfaces correlated with Q3c surfaces of Bull (1991)

Qya_{s2} **Young alluvial deposits, sensitive source, Unit 2 (late and (or) middle Holocene)**—Unconsolidated sand and gravel, poorly to moderately sorted. Surfaces tentatively correlated with Q3b surfaces of Bull (1991)

$Qyao_s$ **Young alluvial deposits, oxidized, sensitive source (Holocene and latest Pleistocene?)**—Sand and pebbly to cobbly sand that occur as aprons on mountain-front and inselberg piedmonts where source terrane consists of Cretaceous granitic rocks. Thickest where buttressed against inselbergs or range-front; tapers down-piedmont into thin veneers on Pleistocene deposits. Where unit is exposed in arroyo walls high on piedmont slopes, loose surficial sediment passes down-section into firmer slope wash and alluvial deposits. Deposits of this unit redden with depth and probably contain one or more buried soil horizons. In places, reddened sediment contains scattered equant blebs of filamentous calcite, indicating an incipient (Stage I) calcic soil. Unit surfaces are smooth, sandy, and characterized by oxidized grains of potassium feldspar that range in color from reddish yellow (5YR 6/6 to 7/6) to yellowish red (5YR 5/6) to pink (5YR 7/4); appears orange on true-color aerial photographs. These grains occur as veneer underlain by pedogenic Av horizon of loess-like, vesicular very pale brown (10YR 7/3) calcareous silt, typically 1 to 4 cm thick. Av horizon underlain by pale-brown (10YR 6/3 to 6.5/3) to light yellowish-brown (10YR 6/4) sand. Unit inferred to include latest Pleistocene and (or) early to middle Holocene aggradational alluvial deposits as well as younger alluvial deposits that have accumulated as a result of sheet floods originating either as drainage basin discharge or as surface run-off across the older deposits. Proximal parts of unit are incised by channels in which young wash (Qa) and alluvial (Qya_{s2}, Qya_{s3}) deposits have accumulated. Down-piedmont, where Qya_{s2} and Qya_{s3} deposits feather out onto $Qyao_s$, $Qyao_s$ surfaces are slightly dissected by anastomosing network of braided channels surrounding small islands of $Qyao_s$. Unit typically occurs as thin alluvial apron deposited on weathered granitic basement (including Kgd_{pb}, QTr_{pb}) high on piedmont slopes and spread down-slope across older surficial deposits (including $Qovor_k$, Qopb, $Qoao_s$, Qoc, $Qoap_s$). As mapped, unit may include Qya_{s2} deposits. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

$Qyao_s + Qya_{s2}$ **Young alluvial deposits, oxidized, sensitive source + Young alluvial deposits, sensitive source, Unit 2 (Holocene and latest Pleistocene?)**—Areas provisionally interpreted on aerial photographs as having the orange color of unit $Qyao_s$ and surface bar and swale morphology of unit Qya_{s2}

OLD SURFICIAL DEPOSITS—Consolidated deposits in alluvial fans, on piedmont slopes, and in colluvial debris aprons. Old deposits exhibit slightly to strongly dissected geomorphic surfaces; gravelly deposits have well-developed and strongly varnished pavements; granitic debris characterized by Av/Bt/Bk/Cox soil profiles; Stage III-IV carbonate morphology. These deposits merge with one another to form a thin mantle that formed on an evolving Pleistocene landscape

Qoa **Old alluvial deposits (Pleistocene)**—Consolidated alluvium deposited in canyon and arroyo bottoms and on piedmont slopes. As with young alluvial deposits (Qya), piedmont alluvial deposits comprise two classes: (1) Deposits that occur in alluvial aprons characterized by prominently cone-shaped, multi-lobed fans that coalesce into bajadas down-piedmont. Usually have a source in resistant rock types, the weathering and denudation of which are relatively insensitive to climatic change (see Bull, 1991, p. 161-167). (2) Deposits that occur on broad, piedmont slopes embayed into less resistant rock types, the weathering and denudation of which are relatively sensitive to climatic change. Consists of:

Qoa_i **Old alluvial deposits, insensitive source (Pleistocene)**—Sand and gravel. Unit surfaces consist of very well-developed pavements of strongly varnished pebbles and cobbles; dark and smooth. Pavements underlain by pedogenic Av horizon of very pale brown (10YR 7/3) loess-like, vesicular silt. Relict pavements and underlying old alluvial deposits are increasingly dissected with increasing age. Includes:

Qoa_{i3} **Old alluvial deposits, insensitive source, Unit 3 (late Pleistocene)**—Sand and gravel. Pavements are generally continuous over broad relict surfaces; slightly to moderately incised by dendritic network of scattered to closely spaced gullies generated by surface-wash. Deposits are inset into moderately and very old alluvial deposits (Qoa_{i2}; Qvoa)

Qoa_{i2} **Old alluvial deposits, insensitive source, Unit 2 (middle? Pleistocene)**—Sand and gravel deposited in Porcupine Wash fan in northeast corner of Porcupine Wash quadrangle. Pavements extremely dark; moderately to deeply incised by dendritic network of gullies generated by surface-wash. Pavement and Av horizon underlain by reddened pedogenic B-horizon, in turn underlain by pervasively chalky-cemented sand and gravel. Deposits are inset into very old alluvial deposits (Qoa_{i1}; Qvoa)

Qoa_{i1} **Old alluvial deposits, insensitive source, Unit 1 (middle and early Pleistocene)**—Sand and gravel. Very well developed pavement with strongly varnished pebbles and cobbles. Prominent ridge-and-ravine (ballena) morphology; pavements extremely dark, deeply incised by dendritic network of ravines generated by surface-wash, and preserved only in discontinuous remnants along ridge crests. Moderately to well-cemented pedogenic K-horizon. Where pavement has been completely removed, erosional ridges are rounded and surface is littered with calcrete fragments. Pavement underlain by pedogenic Av horizon of very pale brown (10YR 7/3) loess-like, vesicular silt. Deposits debouch from channels incised into bedrock. Unit comprises three markedly different surficial morphological settings, each providing a distinct microenvironment: (1) dark pavement as discontinous relics on ridge crests; (2) colluvial debris on ridge slopes, including lighter-colored young(?) slope wash derived from parent rock and dark-colored slope-wash (Qoc?) shed from the varnished pavement surface; and (3) ravine-bottom alluvium. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

Qoa_s **Old alluvial deposits, sensitive source (Pleistocene)**—Consolidated deposits of alluvium and slope wash that accumulated as thin aprons on pediments beveled onto Mesozoic granitic rocks ($KJmgc_{cp}$, Kgd_{pb}, Kgd, ŦPmc) and Proterozoic gneiss (Ᵽjgg; Ᵽpg) and buttressed against base of inselbergs in the Eagle Mts. (Index Map). Much of mapping of these units is based on aerial photograph interpretation and needs additional field work; age assignments are tentative. Includes:

$Qoap_s$ **Old alluvial deposits, pavemented, sensitive source (late Pleistocene)**—Sand and pebbly to cobbly sand deposited as alluvial fill in canyons and arroyos and in aprons buttressed against base of inselbergs and mountain massifs. Deposits chiefly derived from granite gneiss of Joshua Tree (Ᵽjgg) and monzodiorite of Munsen Canyon (ŦPmc). Pavements are light-colored, smooth, and moderately incised by dendritic networks of closely spaced gullies generated by surface run-off. Deposits partially bury older erosional landscape on which pediment flatirons had developed on earlier alluvial-slope aprons

$Qoao_s$ **Old alluvial deposits, oxidized, sensitive source (middle? Pleistocene)**—Alluvium deposited by channelized and (or) overland flow in an apron buttressed against base of inselbergs. Rarely exposed beneath young alluvial deposits ($Qyao_s$). Where they overlie basement, $Qoao_s$ deposits fill once-exhumed joints in weathered granitic rocks. Relation with $Qoap_s$ has not been established and some of surficial reworking of $Qoao_s$ may include deposits correlative with $Qoap_s$. Just west of Conejo Well quadrangle, upper part of unit contains reddened (7.5YR 5.5/6) argillic B-horizon passing down into Stage III Bk/K horizon (mapped as old pedogenic B-horizon, Qopb)

$Qoar_s$ **Old alluvial and (or) regolithic deposits, sensitive source (middle? Pleistocene)**—Interpreted from aerial photographs. Unit occurs as thin blanket on bedrock pediment planed onto units Ᵽjgg, Kgd_{pb}, and $KJmgc_{cp}$. Unit is reddish orange and is moderately to strongly incised by dendritic networks of surface-wash gullies. Color and texture on photographs suggest presence of reddened argillic pedogenic B-horizon, now largely mantled by young, loose slope wash. Unit is either transported alluvium or reworked *in situ* regolith slope deposits; deposits inset into older alluvial deposits (Qvoa) and inset by $Qoap_s$ deposits. It seems likely that $Qoar_s$ and $Qoao_s$ are in large part correlative

Qoc **Old colluvial deposits (Pleistocene)**—Varnished debris aprons on recessive slopes below resistant cap rocks; varnished lag gravels. Around basalt-capped inselberg buttes, colluvial aprons of basalt debris blanket slopes on more readily eroded granite and saprolite, and sedimentary rocks that underlie the basalt. Colluvial debris also is shed from resistant gneiss ridges down recessive granite slopes onto pediments and from flat-topped, pavemented surfaces of Qoa_{i1} and Qoa_{i2} down steep banks eroded into the underlying deposits. On older sedimentary deposits, colluvial deposits consist of lag gravels of varnished pebbles and cobbles. Debris aprons typically are dissected and partially eroded, leaving resistant flatirons of relict colluvium on slopes eroded into less resistant substrate. On slopes mantled with more than one generation of colluvium, flatirons on successively older deposits crop out progressively lower on slopes, providing a record of erosional retreat of capping unit. Well-developed pavements on colluvial deposits are very dark and smooth, consist of strongly varnished pebbles and cobbles, and are underlain by pedogenic Av horizon of very palebrown (10YR 7/3) loess-like, vesicular silt. Includes:

Qoc_3 **Old colluvial deposits, Unit 3 (late Pleistocene)**—Varnished debris aprons preserved in flatirons on steeper slopes adjacent to cap rock; aprons connected with source rock outcrops

$Qoc_{1,2}$ **Old colluvial deposits, Units 1 and 2 (Pleistocene)**—Varnished debris aprons preserved in flatirons on slopes below cap rock

OLD AND (OR) VERY OLD SURFICIAL DEPOSITS

$Qovor_k$ **Old and (or) very old regolithic deposits, cemented (middle? and (or) early? Pleistocene)**—Pervasively chalky-cemented sand and pebbly sandstone; firm to hard; poorly sorted; cemented to well cemented. White on aerial photographs. Unit exhibits disorganized texture; and bedding features are typically absent or obscured by cementation process. Calcification is at least in part pedogenic. Thin veins of hard white laminar calcite 0.5 to 2 cm thick are abundant in these deposits. Pervasiveness and morphology of petrocalcic precipitation is consistent with Stage IV to VI calcic soil. Where exhumed, unit occurs as thin debris blanket mantling pediments beveled onto granodiorite and monzogranite and buttressed against base of inselbergs in Eagle Mts. Just west of center part of Conejo Well quadrangle, chalky-cemented pediment-mantling $Qovor_k$ contains rounded cobbles of aplite derived from dikes in underlying granodiorite and stratigraphically interfingers with Qoa_{i2} deposits that contain cobbles of gneiss transported from source several kilometers to west in Hexie Mts.; just west of southern part of quadrangle, $Qovor_k$ caps deposits photo-interpreted as sedimentary (QTs?). Within the quadrangle, $Qovor_k$ is interpreted from white color on aerial photographs and, as mapped, may include anomalously light-colored $Qoap_s$

VERY OLD SURFICIAL DEPOSITS—Deposits in alluvial fans and on piedmont slopes. Very old deposits exhibit strongly dissected geomorphic surfaces characterized by truncated Av/K soil profiles; carbonate morphology in K-horizon is consistent with pedogenesis in the range of Stage IV-VI; pervasive hard to very hard chalky cementation is typically accompanied by abundant veins of laminar calcrete

Qvoa **Very old alluvial deposits (middle and early Pleistocene)**—Moderately to well-cemented sand and gravel; exhibit ridge-and-ravine (ballena) morphology. Ridges are rounded and littered with calcrete fragments; no remaining pavement. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

QUATERNARY AND (OR) TERTIARY SURFICIAL DEPOSITS

QTs? **Sedimentary deposits? (Quaternary and (or) Tertiary)**—Interpreted from aerial photographs; could be Qvoa. Unit is beveled by a pediment and capped by a reddened deposit that may be equvalent to $Qoar_s$ or $Qoao_s$

QUATERNARY AND TERTIARY REGOLITH

QTr **Regolith (Quaternary and Tertiary)**—Weathered *in situ* regolith on granitic and gneissic rocks beneath piedmont erosion surfaces (pediments). Regolith formation is inferred to have begun in Tertiary with development of regional erosion surface. Weathering beneath this surface formed deep regolith in Mesozoic granitic rocks, remnants of which are exposed just west and just southeast of Conejo Well quadrangle. Upper part of Tertiary regolith is light gray to rusty brown and has a badlands morphology (ridges with flanks fluted by numerous parallel gullies) developed on nonresistant, relatively soft saprolite; lower part consists of weathered jointed rocks. Bouldery outcrops of resistant bedrock occur as islands surrounded by the softer weathered rock. Additional weathering may have occurred during planation of at least three successive Quaternary pediments. Exhumed rock pediments are beveled across the upper and lower parts of Tertiary regolith. In Conejo Well quadrangle, weathered jointed rock typically underlies pediments adjacent to inselberg and range-front escarpments, whereas saprolite, buried beneath Pinto Basin and largely stripped from surrounding highlands, typically is exposed down-piedmont as soft rock beneath pediments mantled with veneer of grus and alluvium. Includes:

QTr_p **Regolith, Pinto Gneiss (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto Pinto Gneiss (Ᵽpg) of Miller (1938). Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

QTr_{jg} **Regolith, granite gneiss of Joshua Tree (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto granite gneiss of Joshua Tree (Ᵽjgg); light-colored; grus

QTr_{qm} **Regolith, quartz monzonite, monzogranite, and granodiorite (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto Jurassic quartz monzonite and monzogranite (Jqmp); light-colored; grus

QTr_{gd} **Regolith, granodiorite (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto Cretaceous granodiorite (Kgd); light-colored; grus. Includes:

QTr_{pb} QTr_{pb3} QTr_{pb2} QTr_{pb1} **Regolith, granodiorite of Pinto Basin (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto granodiorite of Pinto Basin (Kgd_{pb}); light-colored; grus. Three pediments of decreasing age are overlain by successively younger deposits: where overlain by Qvoa, regolith is distinguished provisionally in digital database as QTr_{pb1} (Regolith, granodiorite of Pinto Basin, Unit 1), as QTr_{pb2} (Unit 2) where overlain by $Qoar_s$, and as QTr_{pb3} (Unit 3) where overlain by $Qya_{s2,3}$; these subunits not shown on map

QTr_{mgc} **Regolith, coarse-grained monzogranite (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto coarse-grained monzogranite ($KJmgc_{cp}$); grus. Includes

QTr_{cp} QTr_{cp2} **Regolith, monzogranite of Cottonwood Pass (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto monzogranite of Cottonwood Pass ($KJmgc_{cp}$); grus. Where surface is overlain by $Qoar_s$, pediment is likely to be of intermediate age and underlying regolith is distinguished provisionally as QTr_{cp2} (Regolith, monzogranite of Cottonwood Pass, Unit 2) in digital database but is not shown as such on map

QTr_{rb} **Regolith, monzogranite of Red Butte Wash (Quaternary and Tertiary)**—*In situ* regolith developed on monzogranite of Red Butte Wash ($KJmgc_{rb}$?); light-colored; grus

TERTIARY VOLCANIC ROCKS

Tb **Basalt (late Miocene)**—Basalt; olivine-bearing; massive; black. Microphenocrysts include euhedral laths of labradorite, euhedral olivine partially altered to iddingsite, and clinopyroxene. Occurs in flows in northern Eagle and southern Pinto Mountains and in pipes and (or) near-vent flows on small inselbergs that rise above pediment that forms south slope of Pinto Basin

TERTIARY AND (OR) CRETACEOUS VEIN DEPOSITS

TKq? **Quartz? (Tertiary or Cretaceous)**—Interpreted as pods of vein quartz from aerial photographs. As mapped, unit may include older Mesozoic or Proterozoic quartz

CENOZOIC(?) AND MESOZOIC HYPABYSSAL ROCKS

TJd **Dike (Tertiary?, Cretaceous, or Jurassic)**—Dikes observed in and around Conejo Well quadrangle include quartz latite or rhyodacite, dacite porphyry, and microdiorite. Names are based on phenocryst percentages. Microdiorite dikes typically exhibit propylitic alteration. Includes:

TKdp **Dacite porphyry dike (Tertiary or Cretaceous)**—Gray hornblende-feldspar porphyry containing abundant to sparse phenocrysts of zoned euhedral plagioclase (labradorite to andesine, as large as 1 cm), subordinate euhedral brown hornblende and brown biotite, and rare embayed quartz set in a gray microcrystalline groundmass of plagioclase, alkali feldspar, quartz, sphene, apatite, and zircon. Dikes occur in prominent swarms that trend northeast through the Eagle and Pinto Mountains. Individual dikes, typically a few meters thick and commonly several hundred meters long, dip steeply, form resistant ribs, and exhibit dark brown patina of desert varnish. Intrude Cretaceous granodiorite (Kgd, Kgd_{pb}) and monzogranite ($KJmgc_{cp}$)

Jql **Quartz latite dike (Jurassic)**—Light to medium gray, siliceous aphanitic rock with microphenocrysts of quartz, microcline, plagioclase, and biotite. Quartz latite dikes comprise swarms in eastern Chuckwalla, Eagle, and Pinto Mountains (Index Map). A dike in Big Wash in east-central Eagle Mts. yielded a zircon U-Pb intercept age of 145 Ma and a sphene U-Pb age of 142 Ma (James, 1989)

TJh? **Hypabyssal intrusive rocks? (Tertiary, Cretaceous, and (or) Jurassic)**—Interpreted from aerial photographs

MESOZOIC PLUTONIC ROCKS AND RELATED DIKES—Part of Mesozoic batholith, plutons of which comprise three lithologic belts in Transverse Ranges and adjacent parts of Mojave Desert (see digital database and Powell, 1993). Plutons of central belt (KJmgc, Kgd, ŦPmc) and eastern belt (Jqmp, Jmi) are present in Conejo Well quadrangle

Kap **Aplite dike (Cretaceous)**—Fine-grained, saccharoidal aplite. White to pinkish white; takes on light- to medium-brown patina of desert varnish

KJmgc **Monzogranite, coarse-grained (Cretaceous and (or) Jurassic)**—Medium- to coarse-grained biotite monzogranite. Typically equigranular; locally seriate, containing scattered small phenocrysts of alkali feldspar. Color index 5 to 10. Quartz-rich; allanite-bearing. Regionally widespread; typically occurs in plutons associated with older porphyritic biotite monzogranite. Disparate discordant ages interpreted on basis of zircon and sphene U-Pb systematics, and seemingly contradictory age relations for various bodies of monzogranite in region may indicate that unit includes plutons of different ages. In Conejo Well quadrangle, includes:

$KJmgc_{cp}$ **Monzogranite of Cottonwood Pass (Cretaceous or Jurassic)**—Intrudes Kpb (Hope, 1966; Powell, 1981). Discordant zircon U-Pb data from sample just southwest of Conejo Well quadrangle suggest Jurassic or early Cretaceous age (J.L. Wooden, written communication, 1997). Southwest of quadrangle, unit has been mapped as intrusive into porphyritic biotite-hornblende monzogranite that farther west has yielded late Cretaceous zircon and sphene U-Pb dates (Wooden and others, 1991; Fleck and others, 1997)

$KJmgc_{rb}$? **Monzogranite of Red Butte Wash? (Cretaceous or Jurassic)**—Lithologically the same as monzogranite of Cottonwood Pass; metamorphic screen and fault intervene between the two monzogranite bodies. Unit has been interpreted as Triassic (210 ± 10 Ma) on basis of highly discordant array of zircon U-Pb data from sample just south of Conejo Well quadrangle (Barth and others, 1997), but it is considered herein as equivalent to monzogranite of Cottonwood Pass

Kgd **Granodiorite (Cretaceous)**—Sphene-bearing biotite-hornblende granodiorite; medium- to coarse-grained; late Cretaceous zircon and sphene U-Pb dates in Little San Bernardino and Chuckwalla Mountains (Wooden and others, 1991; Fleck and others, 1997). Crops out in discrete plutons, including:

Kgd_{pb} **Granodiorite of Pinto Basin (Cretaceous)**

Jipe **Intrusive suite of Pinto and Eagle Mountains (Jurassic)**—Exposed in eastern Pinto and northeastern Eagle Mountains. Includes rock types ranging in composition from diorite to granite; predominantly quartz monzodiorite, quartz monzonite, and monzogranite. Rocks of this suite typically contain less than 25 percent quartz; porphyritic rocks are characterized by lavender-tinted phenocrysts of alkali feldspar; mafic minerals consist of hornblende, biotite, and locally clinopyroxene; abundant sphene. Rocks show widespread propylitic alteration. Includes:

Jqmp **Porphyritic quartz monzonite, monzogranite, and granodiorite (Jurassic)**—Medium- to coarse-grained porphyritic plutonic rocks; vary in composition from quartz monzonite to monzogranite and granodiorite. Unfoliated to foliated. Hornblende-biotite to biotite-hornblende; phenocrysts of lavendar-tinted to pinkish alkali feldspar; propylitic alteration. Has yielded Jurassic biotite K-Ar age of 167 Ma in the Pinto Mts. (Bishop, 1964) and zircon U-Pb age of about 165 Ma (Silver, 1978, oral communication; Wooden and others, 1994). Includes:

Jqm **Quartz monzonite, monzogranite, and granodiorite (Jurassic)**—Essentially same as Jqmp, but nonporphyritic; typically mafic-rich

Jmi **Mafic and intermediate intrusive suite (Jurassic)**—Intermingled mafic and intermediate rocks of varied composition and texture. Color index ranges from 50 to >95. Includes coarse- to very coarse-grained hornblendite and hornblende gabbro, medium- to coarse-grained biotite-hornblende diorite, fine-grained, dark-colored diorite to quartz diorite, medium-grained diorite and quartz diorite, and coarse- to extremely coarse-grained gabbro-dioritic pegmatite. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

ŦPmc **Monzodiorite of Munsen Canyon (Triassic or Permian)**—Leucocratic quartz-alkali feldspar-plagioclase plutonic rock with 5 to 10% quartz. Mafic minerals consist of clinopyroxene, hornblende, and biotite. Accessory minerals include zircon and sphene. Previously mapped as late Paleozoic(?) or early Mesozoic(?) (Powell, 1981) and represented as Triassic (Powell, 1993); subsequently interpreted as Permian or Triassic on basis of zircon U-Pb isotopic systematics (Barth and others, 1997)

PROTEROZOIC METAMORPHIC ROCKS—Constitute two assemblages:

Ᵽhgc **Gneiss complex of Hexie Mountains (Proterozoic)**—Orthogneiss and paragneiss. Stratigraphic, and intrusive relations between constituent units typically overprinted by metamorphic and deformational events (Powell, 1981, 1993). Widespread in the Hexie, western Pinto, southeastern Eagle, Orocopia, Chuckwalla and Little Chuckwalla Mountains (Index Map). Consists of:

Ᵽmag **Augen gneiss of Monument Mountain (Middle Proterozoic)**—Mesocratic megacrystic biotite-quartz-plagioclase-alkali feldspar gneiss. Monzogranitic to granodioritic composition. Elsewhere in region, unit has yielded zircon U-Pb dates of 1.65 to 1.68 Ga (Silver, 1971)

Ᵽpg **Pinto Gneiss of Miller, 1938 (Proterozoic)**—Intermingled ortho- and paragneiss. Widespread in the western Pinto, Hexie, Cottonwood, and Chuckwalla Mountains; also crops out in southwestern Eagle and easternmost Orocopia Mountains. Restricted to rocks included in Miller's original description of unit; does not incorporate expanded usage of Rogers (1961). Includes:

Ᵽpgd **Pinto Gneiss, dark (Proterozoic)**—From youngest to oldest, includes: (1) Biotite-quartz-feldspar layered gneiss; prominently banded, having alternating light-colored laminae rich in alkali feldspar and dark-colored laminae rich in biotite and oligoclase; light and dark laminae contain abundant quartz (30-50%); garnet is common; (2) amphibolite; and (3) metasedimentary and (or) metamorphosed hydrothermally altered rocks comprising (a) schistose garnet-sillimanite/andalusite-muscovite-biotite-quartz-feldspar pelitic gneiss, (b) compositionally laminated, siliceous granofels consisting predominantly of quartz and cordierite and containing varying amounts of sillimanite and (or) andalusite, garnet, staurolite, plagioclase, and K-feldspar, biotite, and muscovite, (c) bluish gray siliceous granofels consisting predominantly of coarse-grained quartz and very fine-grained sericite, (d) scattered thin layers of ferromagnesian schist and granofels. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain; as mapped, queried domains may include Jmi or Ᵽjgg that is darker than is typical

Ᵽe **Eagle Mountains assemblage (Middle Proterozoic)**—Regional grouping of metamorphic rock units comprising granitic basement terrane depositionally overlain by metasedimentary supracrustal section (Powell, 1981, 1993). Widespread in Eagle, Pinto, and Chuckwalla Mountains. Consists of:

Ᵽems **Metasedimentary rocks (Middle Proterozoic)**—Platform section of quartzite, pelitic schist, ferriferous feldspathic schist, granofels, hornfels, dolomite, and limestone, part of which crops out in Conejo Well quadrangle. Thermally metamorphosed throughout region. Deformed in the Chuckwalla, Eagle, and southern Pinto Mountains; undeformed in central Pinto Mountains. In Conejo Well quadrangle, includes:

Ᵽid **Dolomite of Iron Chief mine (Middle Proterozoic)**—Very coarse-grained dolomite marble with interlocking recrystallized grains as large as 1 cm. White to light gray, grayish orange (10YR 7/4) to buff to tan weathering. Thin to thick-bedded intervals rich in dark-brown weathering siliceous nodules, pods, and lenses; sporadic layers of very coarse-grained white calcite marble (≤ 3 m), quartzite, and dark-brown-weathering hematite-dolomite (iron ore). Contains scattered metamorphic calc-silicate minerals, including garnet, diopside, and phlogopite. Includes:

Ᵽidf **Ferriferous dolomite**—Very dark brown weathering hematite and dolomite

Ᵽpq **Quartzite of Pinto Mountain (Middle Proterozoic)**—Coarse to very coarse grained; vitreous; thin bedded to massive. Contains four intermingled lithosomes: (1) Mottled light- to dark-gray to bluish-gray quartzite (> 95% quartz); medium bedded to massive; contains andalusite and sillimanite. (2) Conglomerate occurs in layers and lenses as thick as 3 m near unconformity at base of quartzite unit. Clasts consist of pebbles and cobbles of very coarse-grained white quartzite or quartz (85-95%), tabular clasts of fine-grained black specular hematite-rich quartzite (5-15%), and rare fine-grained jasper. Matrix is mottled light to dark gray quartzite. Deformed clasts have aspect ratios as great as 10:2:1. Hematite imparts characteristic rusty brown stain. (3) Very coarse-grained, vitreous, white to light-gray quartzite (98-99% quartz) with interlocking grains as large as 1 cm; grains are strongly recrystallized and have sutured boundaries; no evidence of relict rounded sedimentary grains; massive; bedding obscure or obliterated; thin seams rich in reddish black hematite and aluminosilicate minerals. (4) Pelitic schist; chiefly quartz-muscovite-sillimanite±andalusite schist; subordinate biotite-bearing pelitic schist

Ᵽjgg **Granite gneiss of Joshua Tree (Middle Proterozoic)**—Biotite-plagioclase-quartz-alkali feldspar flaser augen gneiss. Light gray to white, leucocratic; light to moderate rusty brown patina on weathered surfaces. Augen are typically elongate, spindle-shaped aggregates of alkali feldspar, plagioclase, and quartz; some augen have cores of microcline megacrysts with "pressure shadow" tails of recrystallized finer-grained quartz and feldspar. Gneissic foliation exhibited as quartzo-feldspathic layers 1 to 2 cm thick separated by wispy, discontinous stringers of biotite. Folia typically are folded. Unit has yielded U-Pb zircon minimum age of 1650 Ma (L.T. Silver, 1978-1980, oral communication). Includes:

Ᵽjmr **Metamorphosed regolith (Middle Proterozoic)**—Aluminous horizon at top of granite gneiss beneath overlying quartzite; 3 to 5 m thick. Schistose here in Conejo Well quadrangle, where it overlies granite gneiss and underlies stretched-pebble conglomerate. To the north in Pinto Mountains, where it is caps porphyritic granite and is overlain by undeformed conglomerate, aluminous horizon is porphyroblastic hornfels. Consists of quartz (50-55%), muscovite, and as much as 40 percent andalusite and (or) sillimanite. Feldspar phenocrysts in granite beneath paleosol are increasingly altered upward toward contact (represented by increasingly abundant muscovite at the present metamorphic grade) and base of paleosol is marked by abrupt disappearance of feldspar. Quartz grains have about same size range and distribution as phenocrysts in underlying granite gneiss

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[2]NOTE: In addition to descriptions of units depicted on the map, this explanation contains descriptions of selected other units not shown on the map but included in the digital database. Each additional unit is represented in the Description of Map and Database Units by an open box that contains its database unit label; each open box in the DMU corresponds with either an open box or a pair of brackets that contains the database unit label in the Correlation of Map and Database Units.

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