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NATIONAL PARK SERVICE
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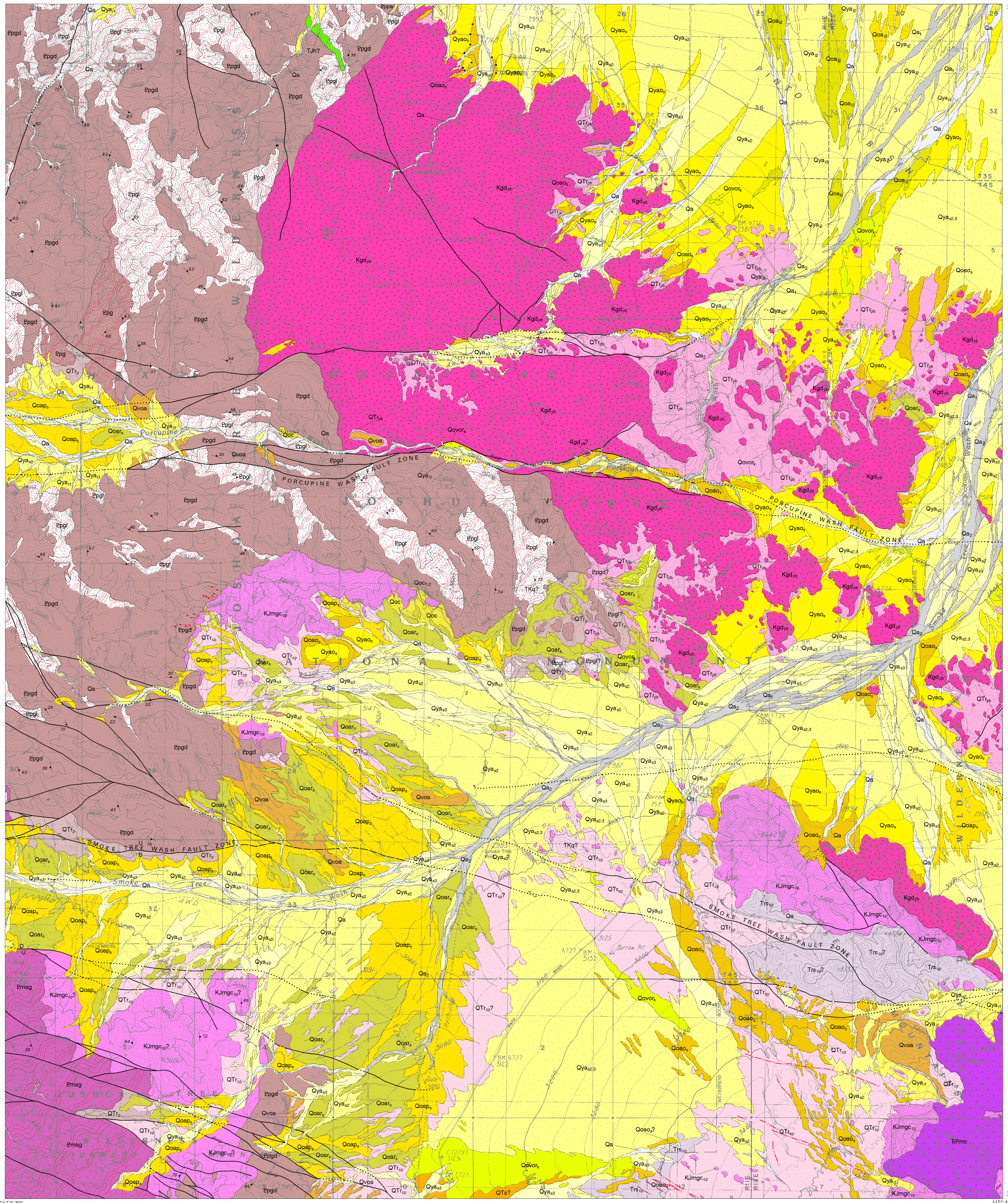
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 01-30
Version 1.0
Pamphlet accompanies map



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

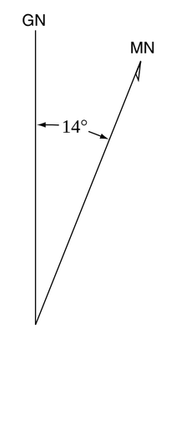
SCALE 1:24,000

1 ½ 0 1 MILE

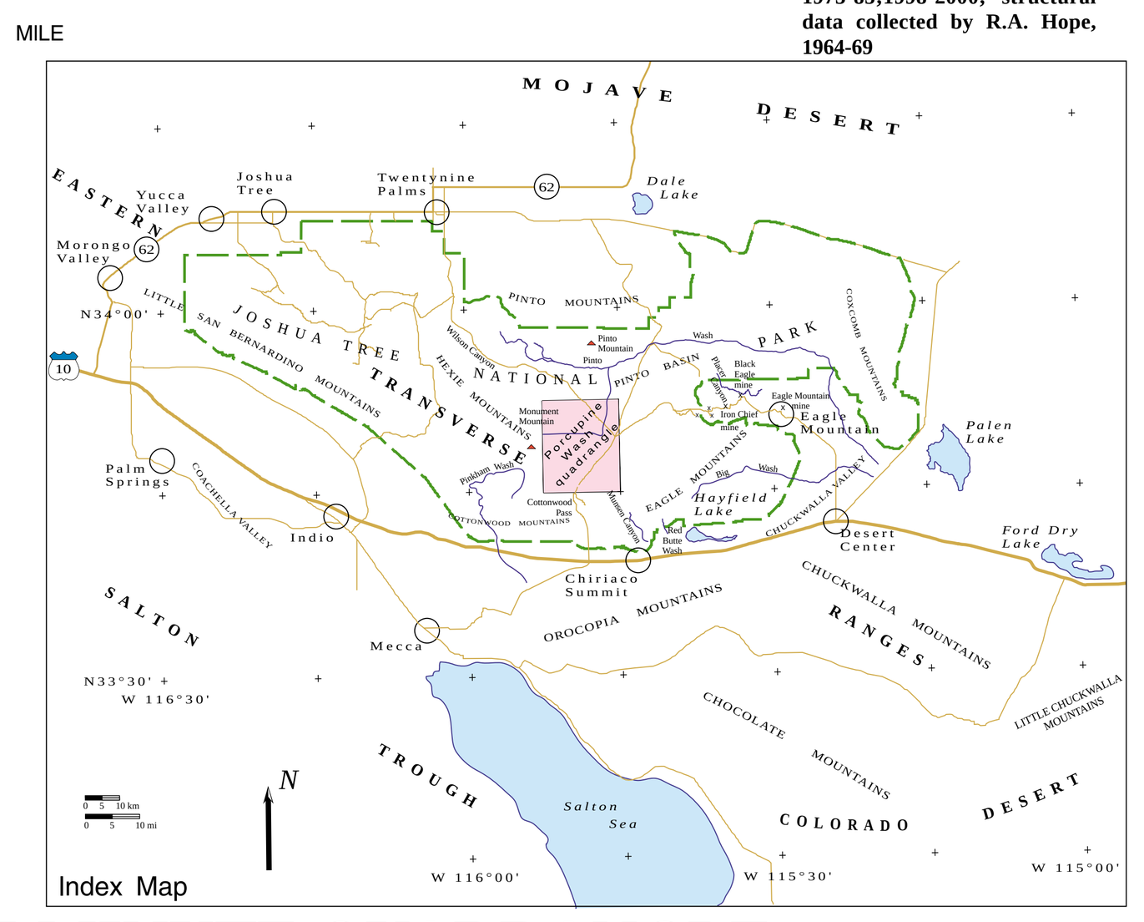
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

Geology mapped by R.E.Powell, 1975-85;1998-2000; structural data collected by R.A. Hope, 1964-69



SURROUNDING 7.5' QUADRANGLES



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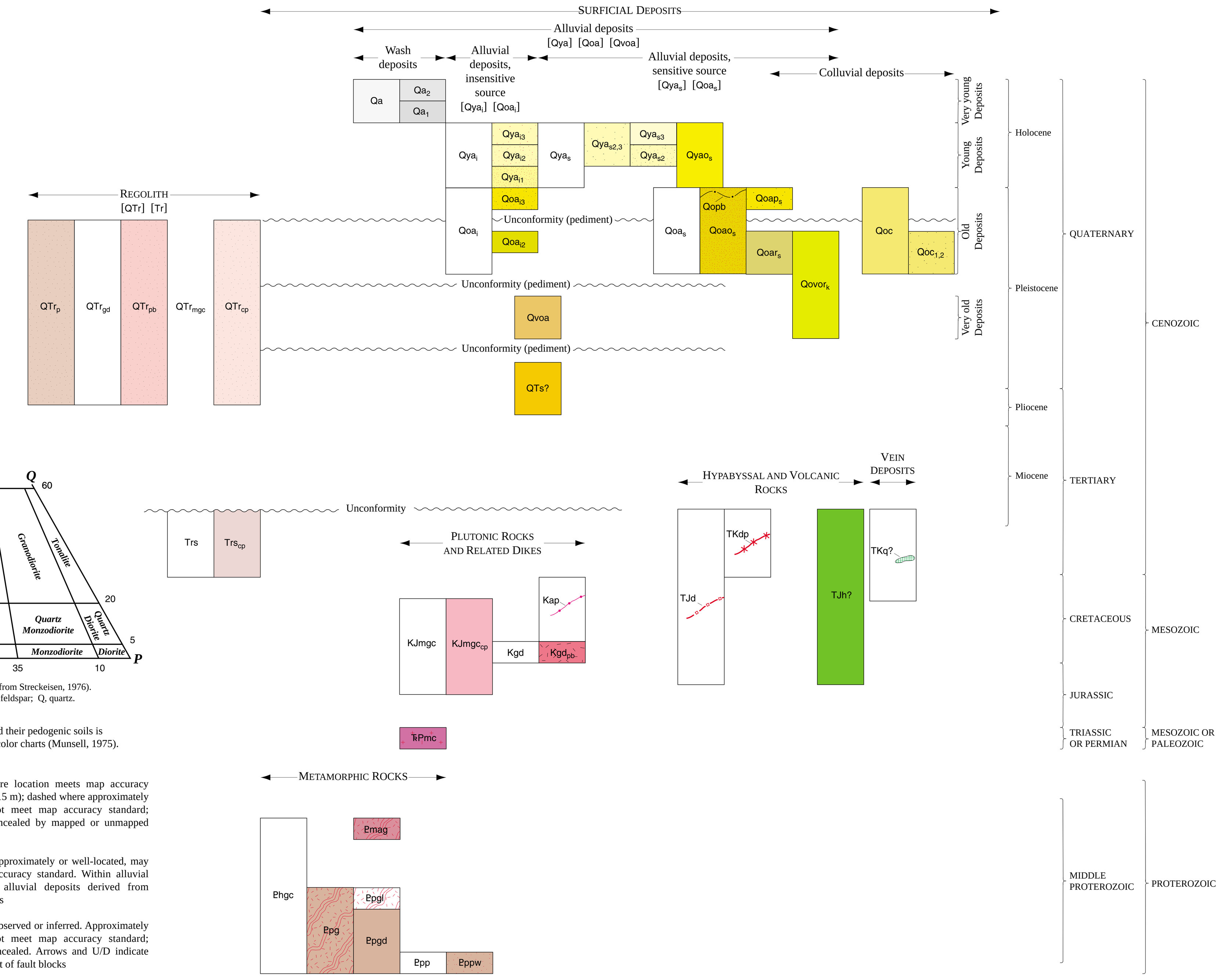
GEOLOGIC MAP AND DIGITAL DATABASE OF THE PORCUPINE WASH 7.5 MINUTE QUADRANGLE, RIVERSIDE COUNTY, CALIFORNIA

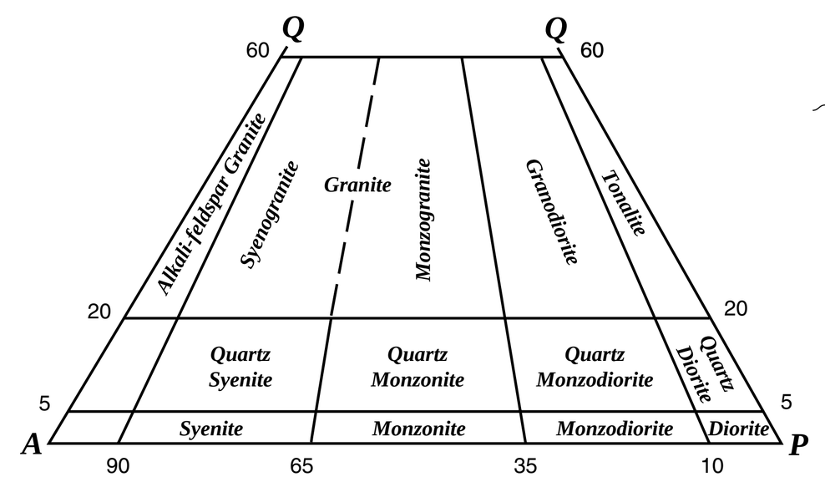
Version 1.0

By
Robert E. Powell

Digital preparation by
Pamela M. Cossette

CORRELATION OF MAP AND DATABASE UNITS[1]





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

10 Inclined

Strike and dip of foliation and layering in metamorphic rocks

40 Inclined

Vertical

22 Bearing and plunge of minor fold axis

[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.

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 deposits on piedmont slopes. 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

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 Porcupine Wash quadrangle, insensitive source terrane consists of biotite-rich paragneiss and orthogneiss (Ᵽpgl, Ᵽmag). 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. Abandoned surfaces are characterized by pedogenic Av horizon of loess-like, vesicular light brown (10YR 6/4) calcareous silt. Includes:

Qya$_{i3}$ — **Young alluvial deposits, insensitive source, Unit 3 (late and (or) middle Holocene)**—Pale brownish gray on color aerial photographs; surfaces exhibit braided bar and swale morphology generated by anastomosing channels. Unconsolidated sand and gravel, poorly to moderately sorted; more sand and less gravel than Qya$_{i1}$ or Qya$_{i2}$. Little or no desert varnish. Surfaces correlative with Q3c and (or) Q4b surfaces of Bull (1991)

Qya$_{i2}$ — **Young alluvial deposits, insensitive source, Unit 2 (middle Holocene)**—Gravelly proximal parts of fans gray on color aerial photographs; gravelly and sandy medial parts mottled gray and pale brownish gray; sandy distal parts pale brownish gray. Surfaces on gravelly parts of fans exhibit plumose bar and swale morphology; surfaces on sandy parts of fans exhibit braided bar and swale morphology generated by anastomosing channels. Unconsolidated to consolidated sand and gravel, poorly to moderately sorted. Moderate varnish on gravelly proximal parts of fans; swales exhibit pebbly pavements underlain by Av horizon. Surfaces correlative with Q3b surfaces of Bull (1991)

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$_{i3}$; Qoa$_{sp}$); 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 Porcupine Wash quadrangle, sensitive source terrane includes monzogranite (KJmgc$_{cp}$), granodiorite (Kgd$_{pb}$), monzodiorite (ŦPmc), and leucogranitic orthogneiss (Ᵽpgl). 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. Little or no desert varnish. 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. Area of Qyas$_{2,3}$ mapped along and southeast of Pinto Basin Road in SW1/4 of SE1/4 of quadrangle appears on aerial photographs to contain intricately intermingled exposures of alluvium and saprolitic regolith. 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 Qyas$_2$; distally, they feather out onto Qyas$_2$ surfaces. Surfaces correlative with Q3b or 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). Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

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

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 (Qvoa)

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 leucocratic Proterozoic gneiss (Ᵽpgl) 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 leucogranitic orthogneiss of Pinto Gneiss (Ᵽpgl) 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$_s$. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain. Includes:

Qopb — **Old pedogenic B-horizon (middle? Pleistocene)**—Reddened (7.5YR 5.5/6) to strongly reddened (5Y/R 5.5/6) arkosic sand with clay coatings on grains, interpreted as an argillic B-horizon. Soil profile developed on old alluvial deposits (Qoao$_s$). Ranges in thickness between about 10 cm and 1 m; as mapped, may represent more than one B-horizon occupying the same broad stratigraphic position. Locally mapped as a marker horizon on top of Qoao$_s$

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 Ᵽpgl, 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. Colluvial debris 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 pale brown (10YR 7/3) loess-like, vesicular silt. Includes:

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; 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 are consistent with Stage IV to VI calcic soil. Where exhumed, unit forms thin debris blanket mantling pediments beveled onto granodioritic and monzogranite and buttressed against base of inselbergs in Eagle Mts. Just east of paved highway through park (T. 4 S., R. 12 E., W1/2 sec. 6), chalky-cemented pediment-mantling Qovor$_k$ contains rounded cobbles of aplite derived from dikes in the underlying granodiorite and stratigraphically interfingers with Qoa$_{i2}$ deposits that contain cobbles of gneiss transported from source several kilometers to west in Hexie Mts. Along south-central margin of Porcupine Wash quadrangle, Qovor$_k$ caps deposits photo-interpreted as sedimentary (QTs?)

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

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 developed on granitic and gneissic rocks beneath piedmont erosion surfaces (pediments). Regolith formation is inferred to have begun in Tertiary (see Tsp description); additional weathering may have occurred during planation of successive Quaternary pediments. Exhumed rock pediments are beveled across the upper (saprolite) and lower (weathered jointed rock) parts of Tr. In Porcupine Wash quadrangle, weathered jointed rock typically underlies pediments adjacent to inselberg and range-front escarpments, whereas saprolite underlies same pediments farther down-piedmont. Includes:

QTr$_p$ — **Regolith, Pinto Gneiss (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto Pinto Gneiss (Ᵽpg) of Miller (1938)

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

QTr$_{pb}$ — **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. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

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$_{cp}$ — **Regolith, monzogranite of Cottonwood Pass (Quaternary and Tertiary)**—*In situ* regolith that underlies Quaternary pediments planed onto monzogranite of Cottonwood Pass (KJmgc$_{cp}$); grus. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

TERTIARY REGOLITH

Tr — **Regolith (Tertiary)**—*In situ* regolith developed on granitic and gneissic rocks beneath regional Tertiary erosion surface; thickest on Mesozoic granitic rocks. Largely interpreted from aerial photographs. Unit beveled by pediments formed during Quaternary. On granitic rocks, divided into:

Trs — **Saprolite (Tertiary)**—Upper part of regolith on granitic rocks is light-gray to rusty-brown saprolite; badlands morphology (ridges with flanks fluted by numerous parallel gullies) has developed on nonresistant, relatively soft saprolite. Includes:

Trs$_{cp}$ — **Saprolite, monzogranite of Cottonwood Pass (Tertiary)**—*In situ* regolith developed chiefly on monzogranite of Cottonwood Pass; grus. As mapped may include saprolitic ŦPmc. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

CENOZOIC AND MESOZOIC HYPABYSSAL ROCKS

TJd — **Dike (Tertiary, Cretaceous, or Jurassic)**—Dikes observed in and around Porcupine Wash 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$_{cp}$)

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

TERTIARY AND (OR) CRETACEOUS VEIN DEPOSITS

Tkq? — **Quartz? (Tertiary or Cretaceous)**—Interpreted as pods of vein quartz 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) are present in Porcupine Wash 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 Porcupine Wash quadrangle, includes:

KJmgc$_{cp}$ — **Monzogranite of Cottonwood Pass (Cretaceous or Jurassic)**—Intrudes Kgd$_{pb}$ (Hope, 1966; Powell, 1981). Discordant zircon U-Pb data from sample just south of Porcupine Wash 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). Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

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)**—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

Ᵽhgc — **Gneiss complex of the Hexie Mountains (Proterozoic)**—Regional grouping of ortho- and paragneiss units among which stratigraphic relations have been largely obscured 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. Herein, restricted to rocks included in Miller's original description of unit; does not incorporate expanded usage of Rogers (1961). Includes:

Ᵽpgl — **Pinto Gneiss, leucocratic granitic orthogneiss (Middle Proterozoic)**—Foliated, lineated leucocratic biotite granite to granitic gneiss; medium- to very coarse-grained. Consist of alkali feldspar, plagioclase, quartz, and biotite; garnet is commonly present as isolated tiny crystals or as large, recrystallized clots of tiny garnets. Unit label is queried where unit assignment based on interpretation of aerial photographs is uncertain

Ᵽpgd — **Pinto Gneiss, dark (Middle 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

Ᵽpp — **Metasedimentary and (or) metamorphosed hydrothermally altered rocks of Pinkham Canyon (Proterozoic)**—Includes:

Ᵽppw — **Siliceous granofels of Wilson Canyon**—Bluish gray siliceous granofels consisting predominantly of coarse-grained quartz and very fine-grained sericite

[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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