DEPARTMENT OF THE INTERIOR

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Geologic map of the Ajo and Lukeville 1° by 2° quadrangle, southwest Arizona

By

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This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards (and stratigraphic nomenclature).

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INTRODUCTION

The Ajo and Lukeville 1° by 2° quadrangles are located in south central Arizona in the Sonoran desert. The sheet lies within the Basin and Range physiographic province, and is characterized by elongate north-trending mountain ranges separated by broad alluvium-filled valleys.

Previously published geologic studies covering the area either have been limited in scope and area, or have largely been of a reconnaissance nature (Wilson and others, 1969). Due to these limitations, no complete geologic synthesis for the quadrangle as a whole has been possible. The current investigation, based on geologic mapping, geochemistry, and geophysics provide a comprehensive regional geologic and tectonic framework for the quadrangle.

Previous studies directly pertaining to the quadrangle include the Ajo mining district (Gilluly, 1937; 1946), Vekol Mountains (Carpenter, 1947), geology of the Ajo Range (Jones, 1974), Aguila Mountains quadrangle (Tucker, 1980), K-Ar geochronology of southwestern Arizona (Shafiqullah and others, 1980).

Generally, geologic mapping, U-Pb, and K-Ar isotopic geochronology have demonstrated that pre-Neogene lithologic assemblages and the inferred geologic history of the southern part of the quadrangle differs in several aspects from those typical of the terrane to the north (Haxel, 1980, 1984). The southern Papago terrane and its extension into north-central Sonora (Anderson and Silver, 1979) constitutes a region within which Precambrian and Paleozoic rocks are sparse to absent, and the few bodies that are present are demonstrably allochthonous. The Mojave-Sonora megashear delimits the region on the southwest (Silver and Anderson, 1974) and on the north and east the area is defined by an arcuate gradational boundary that passes from west to east through the southern Growler Mountains, the northern Gunsight Hills, and the Cimar-Sheridan Mountains divide. Thus the quadrangle and adjoining areas to the west and east can be divided into a northern terrane and southern terrane. Much of the area occupied by these terranes are overlapped by the Tertiary Ajo volcanic field (May and others, 1981; Gray and Miller, 1984a, b).

Precambrian rocks

The Precambrian rocks of southwestern Arizona evolved within a convergent continental- margin environment, however, many of the features found at present-day convergent-subduction boundaries (i.e. melange, blueschist terrane) are absent.

In the study area, Precambrian metamorphic and intrusive rocks form widely scattered outcrops consisting mainly of muscovite-biotite or muscovite-quartz-feldspathic gneiss and schist. The Early Proterozoic Pinal Schist consists mainly of sedimentary rocks with subordinate silicic volcanic rocks with a strong foliation coincident with lithologic layering and a penetrative lineation in the plane of foliation. Limited occurrences of granitic to granodiorite, gneiss and mylonite, leucocratic to mesocratic, fine to medium-grained, epidote biotite-hornblende tonalite and quartz diorite crop out in widely scattered areas such as at Sierra Blanca and the Ajo mine area along with the Oracle Granite of Peterson (1938) and the Chico Shunie Quartz Monzonite of Gilluly (1946). Most of the Precambrian rocks in the quadrangle represent Late to Middle Proterozoic crystalline rocks that are overlain by the Middle Proterozoic Apache Group which is intruded by diabase sills and dikes.

Paleozoic Rocks

During the Paleozoic, what is now Arizona was part of a stable cratonic platform where many kilometers of carbonate and clastic sediments accumulated (Chaffee, 1974, Peirce, 1976). However, outcrops of Paleozoic rocks are sparse in the Ajo area, therefore shore-line configurations at various times are only inferred (Wilson, 1962). Sparse Paleozoic sections in this part of southwestern Arizona crop out mainly in the southern Growler Mountains (south of Ajo), and includes the Bolsa Quartzite and Abrigo Formation. The Cambrian Bolsa Quartzite, a basal unit prominent in the more complete sections of southeastern areas, is a white to brown or maroon quartzite which measures 20 m or less in thickness. The overlying Abrigo Formation in the study area consists of shale interbedded with locally calcareous, fine-grained quartzite. Locally the section includes the Naco and Escabrosa Limestones and the Martin Formation which crops out just south of Growler Pass, as well as in widely scattered, isolated outcrops in low lying areas to the east (i.e., Sand Tank Mountains).

Mesozoic Rocks

In middle Mesozoic time, southwestern Arizona was located within a northwest trending magmatic arc that was related to an east- or northeast-dipping subduction zone that extended across southern Arizona (Coney and Reynolds, 1977; Coney, 1978; and Haxel and others, 1984). Upper(?) Jurassic rocks underlie significant parts of the La Abra Mountains, Quitobaquito Hills, and Puerto Blanco Mountains (Haxel and others, 1984). The principal lithologic types occurring within the extreme south-central part of the quadrangle are rhyolitic metaporphyry with conspicuous relic quartz phenocrysts and locally with relic volcanic fabric or texture, medium- to coarse-grained equigranular or porphyritic metagranite, quartzofeldspathic metasedimentary phyllite and semischist with subordinate marble, and fine-grained leucocratic granite to metagranite. Relations suggest that rocks of the La Abra area originally formed part of a single volcanic-plutonic complex. Similar rocks to the south in Sonora, Mexico mapped as a continuation of the La Abra unit (granite porphyry and porphyritic granite) have a Early or Middle Jurassic U-Pb zircon isotopic age (Anderson and Roldan-Quintana, 1979, p. 80).

Granitic rocks of Jurassic age also crop out in Ko Vaya Mountains and the Agua Dulce Mountains as typically pinkish-weathering hornblende-biotite granite. Latest Jurassic(?) conglomerate and sandstone with subordinate volcanic and hypabyssal rocks underlie the Sheridan Mountains in the eastern-most part of the quadrangle. Jurassic granitic and supracrustal rocks in the Sierra Blanca, Quijotoa, and Brownell Mountains are predominately quartzofeldspathic and epidote-quartz paraschist.

The Jurassic rocks within the Ajo 2^{o} by 1^{o} quadrangle are locally overlain by Cretaceous strata, locally intruded by latest Cretaceous hornblende- and biotite-bearing granodiorite plutons, and widely affected by latest Cretaceous and (or) early Tertiary (Laramide) regional metamorphism and intruded by early Tertiary garnet-two-mica granites.

Upper Jurassic and (or) Cretaceous rocks of Gu Achi in the Sheridan Mountains near the eastern boundary of the quadrangle consists variably of metamorphosed arkose and arkosic conglomerate, arenitic sandstone, graywacke, siltstone, rhyolite, and andesitic volcanic and hypabyssal rocks (Briskey and others, 1978).

The period between approximately 80 and 40 m.y. ago (i.e., Late Cretaceous to late Eocene) is informally termed "Laramide" time. The Laramide orogeny involved uplift, compressional deformation, plutonism, and minor associated volcanism as a response to convergence of crustal plate boundaries to the west.

Leucocratic muscovite and garnet-bearing granitic to tonalitic rocks of Late Cretaceous age, based on a concordant zircon age of 68 m.y. from the Cimar Mountains and 3 biotite K-Ar ages of 67 m.y. (Johnston, 1972) from the Lakeshore stock, occur in the Cimar and Vekol Mountains. Some of the rocks constitute a differentiation sequence from biotite-hornblende granodiorite through biotite monzogranite to monozogranitic pegmatite and aplite. The hornblende bearing-biotite granite and orthogneiss unit of the Gunsight Hills has yielded K-Ar biotite ages of 59 m.y. (Tosdal, 1979). However, this age is suspect due to possible partial argon loss, and the granite may be of either Jurassic age or Late Cretaceous or early Tertiary age. Granodorite and granites similar to the hornblende-biotite granite of the Gunsight Hills have yielded three K-Ar dates of 64 to 65 m.y. at Ajo (McDowell, 1971), have K-Ar and U-Pb age of 68 to 69 m.y. in the northern Papago Reservation. Cretaceous volcanic rocks crop out as areally limited eruptive rocks or bodies in the Ajo mine area (Concentrator Volcanics) and in the Mohawk Mountains. Early Tertiary granitic rocks cropping out within the Ajo 1^{o} by 2^{o} sheet include the informally designated granite of Senita Basin, granite of Palomas Mountains, and granite of Schuchuli. These are generally leucocratic, equigranular to locally porphyritic, muscovite-, hornblende-, biotite-bearing quartz monzonite and granite.

Tertiary Volcanic Rocks

Tertiary volcanic rocks within the Ajo and Lukeville 1^{o} by 2^{o} quadrangle form a constructional volcanic field composed predominantly of lavas that include the entire compositional range between basalt and rhyolite. Parts of this field has been informally referred to as the Ajo Volcanic Field. (May and others, 1981; Gray and Miller, 1984a, b; Gray and others, 1984; Gray and others, 1984; Tosdal and others, 1986). The Tertiary volcanic rocks of the 2^{o} by 1^{o} sheet crop out over an area of approximately 5,000 km^2 extending from the Mexican border to just north of U.S. Interstate Highway 8 and from the Growler and Aguila Mountains on the west to the Vekol-San Simon valleys on the east. Scattered Tertiary volcanic rocks to the east of this area in the Vekol Mountains and to the northwest in the Palomas Mountains, (Dockter and Keith, 1977; Rytuba and others, 1978; Briskey and others, 1979) are considered older than and apparently not related to the main Miocene units occurring in the central part of the quadrangle. Much of the area lies within the restricted access areas of Luke Air Force Range.

Tertiary volcanic rocks in the area are divided into 3 sequences separated by angular unconformities: (1) the oldest sequence is late Oliogocene and early Miocene in age and consists of red fanglomerate and coarse arkosic sandstone intercalated with andesite, rhyolite, rhyodacite, and local pyroclastic rocks, (2) a complex intermediate-age (middle) sequence consists of early and middle Miocene basalt, latite, silicic flows, and associated pyroclastic rocks, and (3) the youngest sequence, of middle Miocene age, is composed of basaltic andesite and andesite (Gray and Miller, 1984a, b).

The oldest sequence is exposed in scattered areas along the western edge of the field, mainly northwest and southwest of the Sauceda Mountains. It is characterized by steeply tilted volcanic rocks intercalated with coarse clastic sedimentary strata. Initiation of volcanism was contemporaneous with local uplift and unroofing of crystalline basement rocks. In the Ajo area (Gilluly, 1946), Growler Mountains (Gray and others, 1984), and northwest Sauceda Mountains massively bedded coarse fanglomerate and coarse arkosic pebbly sandstone consists mostly of locally derived Proterozoic granite and gneiss. The coarse fanglomerate grades upward into coarse arkosic sandstone. Volcanic interbeds are increasingly abundant in the upper part of the sequence. An age of 23.8±0.8 m.y. was obtained on the volcanic rocks near Ajo Peak. These flows are in the upper part of the tilted fanglomerate-andesite sequence and thus represent a minimum age for the accumulation of the fanglomerates. A tuff lying nonconformably immediately above the tilted andesite-fanglomerate sequence yielded an age of 22.0±0.7 m.y.

The middle sequence is the most widespread of the three and forms a heterogeneous assemblage of basalt, andesite, and rhyolitic rocks. The oldest rocks in the sequence are rhyolitic to rhyodacitic flows and pyroclastic tuffs. Silicic volcanism migrated southward for the Sand Tank Mountains into the Sikort Chuapo Mountains and the Ajo Range, eventually forming the tuffaceous rocks and rhyolitic flows of the Mt. Ajo area at around 15.4 m.y. (Tosdal unpub. data; Miller unpublished data; Jones, 1974; May and others, 1981; Gray and others, 1985).

Contemporaneous with silicic volcanism approximately 21 m.y. ago basalt, olivine basalt, and basaltic andesite were extruded in the region from the northern Sauceda Mountains to the southern Sand Tank Mountains. The most distinctive rock type of the middle sequence is the coarsely porphyritic Childs Latite in the Ajo area (Gilluly, 1946; Gray and others, 1985).

Basaltic andesite extrusive rocks dated between 16 and 14 m.y. were the next materials to be erupted. The major source for flows in the western part of the Ajo volcanic field was Batamote Mountain, a dissected shield volcano. Minor vents and oxidized cinder-cone deposits are present in the Cipriano Hills and the Growler and Bates Mountains farther west.

The Sentinel and Pinacate basalt flows located adjacent to the northern and southwestern parts, respectively, of the volcanic field, postdate most Basin and Range block faulting. These basalts range in age from 5 m.y. to 1 m.y. and are not considered here as part of the Ajo volcanic field Tertiary sequence (Eberly and Stanley, 1978, no. 1-6; Gutmann, 1976).

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DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS AND VOLCANIC ROCKS

Qa **Alluvium (Quaternary)**--Unconsolidated gravel, sand, and silt in stream channels; weakly consolidated gravel and conglomerate near and on bedrock; talus and debris flows deposited on steep slopes

QTls **Landslide deposits (Quaternary and Tertiary)**--Massive slump blocks composed primarily of basalt ranging from 200-1,500 m in width on west front of range, between Charlie Bell Pass and Temporal Pass; slumping was due to the instability of poorly consolidated Daniels Conglomerate that underlies flows

QTg **Gravel deposits (Quaternary and Tertiary)**--Weakly consolidated sand and minor silt forming colluvial and alluvial deposits; poorly stratified with moderately to shallow-dipping bedding surfaces; surfaces are strongly dissected

QTbs **Basalt of Sentinel plains (Quaternary and Tertiary)**--Dark-bluish-gray, fine-grained, olivine basalt occurring in northern part of quadrangle. Crops out as low-lying, thinly-bedded, extrusive sheets. Scattered reddish brown to brown cinder deposits occur near sentinel peak. K-Ar ages of 1.75 MA at Sentinel Peak and 3.0 MA for flows south of the Gila River (Eberly and Stanley, 1978)

QTbp **Pinacate basalt (Quaternary and Tertiary)**--Numerous flows and pyroclastic units of porphyritic alkali basalt and hawaiite (Gutmann, 1976). Alkali olivine basalt and hawaiite contain phenocrysts of plagioclase, clinopyroxene, and olivine in a groundmass of these same phases plus opaque oxides, apatite, rare amphibole and glass. Gabbroic xenoliths composed of plagioclase, pyroxene and spinel occur in some pyroclastic deposits. The basaltic rocks (alkali olivine basalt and hawaiite) contain abundant megacrysts (to 6 cm) of plagioclase and clinopyroxene, and less common spinel, olivine and amphibole. The differentiated rocks contain phenocrysts of plagioclase, alkali feldspar, clinopyroxene, in matrices of these same phases plus opaque oxides and glass

QTbc **Vent breccia and Cinder Cone deposits of Sentinel plain (Quaternary and Tertiary)**--Reddish brown, brecciated, crudely bedded, oxidized scoriaceous basaltic rubble. Crosscut by basalt dikes, intrusive plugs

Ajo volcanic field

Crater Range, Batamote Mountain, Childs Mountain, Growler Mountains and Little Ajo Mountains

Batamote volcanic complex and equivalent extrusives (Miocene)
Consists of:

Tba **Basaltic andesite flows**--Forms numerous 2 to 6 m thick mesa-capping flows with outcrops mainly occurring at Batamote Mountain, Childs Mountain, and Growler Mountains; also occur in scattered pediment surfaces in the central area of the quadrangle. K/Ar whole rock ages of 14.4±0.7 m.y. (Gray and Miller, 1984), 15.0±2.0 m.y. (Eberly and Stanley, 1978) and 15.52±0.54 (Shafiquallah and others, 1984)

Tbav **Basaltic andesite vent breccias and intrusive rocks**--Located at dissected shield volcano of Batamote Mountain and scattered along the trend of the Growler Mountains. Reddish-brown, oxidized, scoriaceous poorly bedded cinder deposits with cross-cutting basaltic andesite dikes and plug

Trg **Rhyolite of Growler Pass (Miocene)**--Rhyolite flows, flow breccias, and pyroclastic tuff of limited distribution in southern Growler Mountains near Bates Well

Td **Daniels conglomerate and associated rocks (Miocene)**--Light-tan to gray, shallow-dipping coarse conglomerate, sandy conglomerate, subordinate pebbly sandstone, minor sandstone, and welded tuff (Gilluly, 1946)

Tl **Lake deposits (Miocene?)**--Purplish-pink to light-tan, fine-grained silt and mudstone containing gypsum in layers up to 5 cm thick. Unit crops out in irregular, discontinuously exposed, small lenses interbedded with the Daniels Conglomerate and landslide debris; may be remnants of deposits of lacustrine facies rocks spacially associated with the Daniels conglomerate

Tt **Ash-flow tuff in Growler Mountains (Miocene)**--Pink to tan, densely welded, sparsely lithic tuff. Unit contains sparse biotite and sanidine in a glassy matrix. Locally the maximum thickness reaches 30 to 60 m, but the unit more commonly is 6 to 9 m thick. K/Ar age on plagioclase 18.4±0.9 m.y. (Gray and Miller, 1984)

Childs latite (Miocene)--Consists of:

Tc **Childs latite flows**--Coarsely porphyritic, gray to maroon-brown to gray aphanitic to holocrystalline flows. One to three cm andesine phenocrysts typically comprise 30-40 percent of rock. Intergranular to intersertal groundmass composed of plagioclase, K-feldspar, olivine, clinopyroxene apatite and Fe and Ti-oxides. Three to 20 m thick flows locally accumulated to a total thickness of greater than 300 m. K-Ar age on plagioclase 184±0.9 m.y. (Gray and Miller, 1984)

Thc **Holocrystaline Childs latite flows and intrusives**--light gray locally columnar jointed flows and subvolcanic intrusive bodies mapped as a distinct unit only in Crater Range

Tsa **Sneed andesite, and associated andesitic flows tuffs and intrusive rocks (Miocene)**--Light-pinkish-tan to gray, medium-grained, porphyritic, glomeroporphyritic, locally fragmental flows, associated tuffs, and intrusive rocks (Gilluly, 1946). K/Ar age on biotite in tuffs locally occurring on top of sneed andesite flows 22.0±0.7 m.y. (Gray and Miller, 1984)

Tab **Alkali basalt (Miocene)**--Dense, slightly vescicular, medium-gray to dark-gray alkali basalt

Tav **Ajo volcanics and associated flows and volcaniclastic rocks (Miocene and (or) Oligocene)**--Purplish-brown to bluish-gray, typically biotite-, hornblende-, and plagioclase-porphyritic flows and pyroclastic tuffs (Gilluly, 1946). K-Ar determination on biotite yielded an age of 23.8±.8 m.y. (Gray and Miller, 1984). A whole rock age date of 25±2.2 m.y. was obtained from the Ajo volcanics type locality at Ajo Peak (Eberly and Stanley, 1978)

Tf **Fanglomerate (Miocene and (or) Oligocene)**--Coarse to very coarse, reddish-brown rocks composed of poorly sorted, subangular to subrounded, crudely bedded clasts in a well-cemented, reddish (oxidized), sandy matrix. Clasts are mainly unroofed basement rocks. Unit is equivalent to and includes the Tertiary Locomotive Fanglomerate (Gilluly, 1946), but is considered of regional extent in this study. Age is Oliocene and (or) early Miocene

Monzogranite of Little Ajo Mountains (Miocene and (or) Oligocene)— Consists of:

Tml **Monzodiorite to monzogranite**--Includes monzodiorite, granodiorite, monzogranite and quartz monzonite. Monzogranite contains oikocrysts of quartz and K-feldspar in a groundmass of plagioclase, K-feldspar, quartz, hornblende, biotite and minor pyroxene. Unit comprises much of the main mass of the Little Ajo Mountains. East part of unit is extensively cut by feldspar porphyry and hornblende andesite dikes

Tgl **Granite and monzogranite**--Forms elongate east west trending bodies within the monzogranite of unit Tml. Composed of a fine grained, allotriomorphic granular textured aggregate of quartz, K-feldspar, plagioclase and biotite

Ajo Range, Sikort Chuapo Mountains, Bates Mountain, Puerto Blanco Mountains, and Cimarron Peak

Andesite suite of Batamote and associated extrusive rocks (Miocene)--Consist of:

Tba **Basaltic andesite flows**--Mesa-capping flows in the Bates Mountains, Pozo Redondo Mountains and Ajo Range. K/Ar whole rock ages of 16.7±0.8, 16.1±0.7 m.y. (Gray and Miller, 1984) and 15.39±0.45 (Shafiquallah and others, 1980) have been determined on this unit.

Tbav **Basaltic andesite vent breccias and intrusive rocks**--Breccias occur as reddish-brown to brown, crudely bedded pyroclastic deposits consisting almost entirely of subrounded to angular scoriaceous ejecta in fragments varying from less than 1 mm to 3 cm in diameter; intrusive rocks consist of dikes and volcanic plugs that are dark-colored fine- to medium grained intergranular to pilotaxitic rock

Ttt **Ash-flow tuff near Tillotson Peak (Miocene)**--Brown to orange, variably welded, crystal-lithic tuff exposed as prominent cliffs in the Diablo Mountains

Trr **Rhyolite, rhyodacite, and minor dacite flows and plugs (Miocene)**--Phyric to aphyric flows; plagioclase, biotite, and, much less commonly, clinopyroxene phenocrysts present. Forms prominent cliffs and steep slopes in the Ajo Range; in the Bates and Pozo Redondo Mountains the unit is restricted to local occurrences of flows and tuffs. K/Ar whole rock age 17.4±0.5 m.y. (Shafiquallah and others, 1984)

Ttba **Air-fall tuff, tuff breccia, agglomerate, and tuffaceous sandstone (Miocene)**--Buff, yellow, or white, crystal-lithic, and crystal-lapilli tuff; thickness variable up to 100 m. Texture is typically vitroclastic with strongly embayed quartz and plagioclase

Tdf **Dacite flows in Ajo Range (Miocene)**--Porphyritic flows with phenocrysts of plagioclase, clinopyroxene, and sparse orthopyroxene, hornblende, and biotite. Composition of mafic phenocrysts varies between flows. Matrix is glassy with crystallites defining flow banding. Form prominent reddish-brown cliffs in the Ajo Range

Tfa **Fanglomerate and minor andesite (Miocene)**--Poorly stratified, semi-consolidated, red fanglomerate, laharic breccias, conglomerate, sandstone, and minor tuffs exposed beneath Montezumas Head in the Ajo Range

Tqb **Quartz-bearing basalt in Ponzo Redondo Mountains (Miocene)**--Dark gray flows and flow breccia containing partially resorbed quartz zenocrysts in an aphanitic groundmass

Tc **Childs latite (Miocene)**--See previous description

Tax **Heterogenous mixture of andesite, basalt, and dacite flows and breccias (Miocene)**--Includes gray-weathering olivine- and plagioclase-porphyritic basaltic andesite, hornblende-porphyritic andesite, plagioclase-porphyritic andesite and monolithic breccias of biotite- and hornblende-bearing dacite exposed beneath the Childs Latite in the Bates and Puerto Blanco Mountains

Tm **Monzodiorite porphyry in Ajo Range (Miocene)**--Porphyritic monzodiorite with plagioclase phenocrysts in a fine- to medium-grained groundmass of plagioclase, orthoclase, augite, biotite, hornblende, and quartz. Forms a heterogenous pluton possibly coeval with the Childs Latite

Tafb **Augite andesite flow and flow breccias (Miocene)**--Flows are locally interbedded with flows of the Childs Latite; occurs in the southern part of the Ajo Range and Bates Mountains. Porphyritic to aphanitic flows with sparse phenocrysts of plagioclase and glomeroporphyritic clots of augite and plagioclase in a groundmass of feldspar, clinopyroxene, and iron oxides

Trp **Rhyolite of Pinkley Peak (Miocene)**--Rhyolite flows and minor tuffs; texture and phenocryst content is variable; phenocrysts may include plagioclase, sanidine, biotite or quartz; flows are often highly irregular in thickness and areal extent; associated tuffs are lenticular and discontinuous. K/Ar age on sanidine 18.7 ± 0.5 m.y. (Gray and Miller, 1984)

Tds **Dacite in Sikort Chuapo Mountains (Miocene)**--Reddish-brown, dacitic lava flows and densely welded ash flow tuff. Unit is biotite and plagioclase phyric and locally contains abundant flatened pumice lappilli

Tbbm **Basalt flows in Bates Mountains (Miocene)**--Heterogenous sequence of basaltic andesite and minor dacite generally exposed in low-lying areas beneath the Childs Latite and rhyolite of Pinkley Peak

Tr **Rhyolite (Miocene)**--Light-grayish-tan- to tannish-yellow banded, silicified, rhyolite flows, flow breccias, and pyroclastic deposits. Contains a number of deeply oxidized and silicified zones interpreted as vent areas. Age is early Miocene

Tbt **Basaltic breccia and tuff breccia (Miocene)**--Variably textured sequence. The upper part of the unit consists of light-tan, brown to yellowish-buff, fine-grained sandy, well-bedded, tuffaceous rocks, possibly water lain; the lower part is tan to dark-brown, coarse-grained, oxidized, crudely bedded, poorly sorted tuff breccia consisting of basalt fragments

Tbc **Basalt and basaltic andesite of Cimarron Peak (Miocene)**--Basalt, basaltic andesite flows, tuffs, and agglomerates comprising the main mass of Cimarron Peak Volcano. Lavas are light gray, and sparsely porphyritic with 0.-5 percent microphenocrysts of iddingsite-altered olivine. Zeolites and silica common as vesicle fillings

Taf **Ash-flow tuff near Cimarron Peak (Miocene)**--Pink, moderately to densely welded, crystal-lithic tuff; accidental lithic fragments are dominantly small angular clasts of aphyric basalt. Occurs as patches exposed beneath flows of the unit Tbc near Cimarron Peak. Unit includes interbedded air fall and ash flow tuffs exposed in the central part of the Sikort Chuapo Mountains

Trd **Rhyodacite flows, flow breccias, and minor tuff (Miocene)**--Black to gray, reddish, typically flow-banded to granular rocks with minor phenocrysts of biotite, hornblende, or plagioclase. Exposed along the southern margin of Cimarron Peak

Ta **Andesite flows and interlayered andesite flow-breccia (Miocene)**--Medium gray to black or reddish-brown, sparsely porphyritic volcanic rocks with phenocrysts of olivine and (or) plagioclase. Forms scattered hills in the Quijotoa Valley. Locally the andesite flow-breccia reaches a maximum thickness of 150 m

Tts **Tuffaceous sandstone (Miocene)**--Yellow-tan to buff-brown, coarse poorly sorted, friable, tuffaceous sandstone and pebbly sandstone with clasts consisting predominantly of granitic rocks with minor metasedimentary rock, basalt, and pumice fragments

Tgc **Granite of Schuchuli (Tertiary)**--Medium-gray, rusty-weathering, fine-grained, inequigranular to porphyritic, hornblende-biotite granodiorite porphyry, and grayish and pinkinsh-tan, knobby-weathering, fine-grained, inequigranular alaskite porphyry

Sauceda and Sand Tank Mountains

Tba **Basaltic andesite flows (Miocene)**

Tbas **Basaltic andesite of Sauceda Wash (Miocene)**--Dark-gray to black, vesicular flows with rubble margins. Flows form mesas in central Sauceda Mountains. Rocks consists of up to 40 percent phenocrysts of andesine to labradoritic plagioclase and minor clinopyroxene. Based on stratigraphic position flows of unit are interpreted as being equivalent to andesite suite of Batamote and associated extrusive rocks (Tba, Tbar)

Trc **Porphyritic rhyolite, and rhyodacite flows and tuffs of Chuli-kam (Miocene)**--Light-gray to tannish-gray, reddish-brown to buff-brown feldspar- and biotite-porphyritic flows and tuffs. Phenocrysts make up approximately 30 to 35 percent of rock consisting of sanidine, quartz, and minor biotite and hornblende. K/Ar age on biotite 19.5±0.6 m.y. (Gray and Miller, 1984)

Trct **Rhyolitic air-fall tuff of Chuli-kam (Miocene)**--Yellow- to tan-weathering, well-bedded tuff associated with rhyolitic rocks (unit Trc). Contains variable amounts of plagioclase, quartz, and biotite up to several millimeters in diameter in a poorly sorted, glassy, pumiceous matrix

Ttrf **Tuffs and minor rhyolite flows (Miocene)**--Light-grayish-pink and light-tan to yellow-buff-brown, fragmental tuffs and aphanitic flows

Tdh **Dike complex of Hat Mountain (Miocene)**--Light-gray and light-tan to yellow, devitrified, rhyolite flows and tuffs, and black, tan, or gray dikes. Contorted, irregular flows and tuffs are intruded by numerous rhyolitic dikes 6 to 15 m-thick that trend northwest. A K/Ar age of 20.1 and 20.7± m.y. was obtained from flows in upper part of unit (Gray and others, 1985)

Tbss **Porphyritic basalt in southern Sauceda and Sand Tank Mountains (Miocene)**--Light- to medium-gray to black, slightly vesicular, coarsely porphyritic, mesa-forming basalt with minor aphyric basalt lenses. Consists of phenocrysts of plagioclase, orthopyroxene, clinopyroxene, and magnetite in oxide-rich glass. Forms deeply dissected mesas in the southeast Sauceda Mountains and southern Sand Tank Mountains

Trlb **Rhyolite breccia (Miocene)**--Angular flow-breccias composed of fragments of aphanitic rhyolite. Bedding is generally lacking; occurs a a mappable unit only in the southeast part of the quadrangle near Stinson Peak. Unit is possibly related to local rhyolitic dome or vent area. Age is early Miocene

Trh **Rhyolite suite of Hat Mountain (Miocene)**--Light-yellowish-tan- to pinkish-tan- to brownish-gray-banded, contorted rhyolite flows, breccias, domes, dikes, and tuffs occurring in northwestern Sauceda Mountains. Zeolitic alteration ubiquitous. K/Ar age on biotite 20.7±0.6 m.y. (Gray and Miller, 1984)

Taft **Ash-flow tuff (Miocene)**--Light-gray to white, tan to yellowish-tan, partly welded, ash-flow unit; minor reworked volcaniclastic sedimentary form thick capping-units in northern Kaka and Estrella quadrangles

Tbrd **Biotite-rhyodacite domes (Miocene)**--Maroon to reddish-brown, porphyritic, biotite-rhyodacite, composite domes approximately 300 m high. Vitrophyric, brecciated base is locally exposed lapping ortho flows (Tbr)

Tbr **Biotite rhyodacite (Miocene)**--Extensive, undifferentiated, light-tan to pinkish-brown and purple to maroonish-brown, porphyritic, biotite rhyodacite flows, with minor andesitic, silicic tuffs and tuff breccias. K-Ar age on hornblende 21.8±0.7 m.y. (Gray and Miller, 1984)

Twt **Welded tuff (Miocene)**--Purplish-gray-zoned, lithic, ash-flow tuff; occurs as several cooling units in southwestern part of Hat Mountain quadrangle. Age is early Miocene

Tbb **Basalt of Black Butte (Miocene)**--Dark-gray to black, coarsely phenocrystic to locally aphyric, basalt flows and minor dikes in northern Sauceda Mountains. Forms mesas in Blue Plateau area. Exposed thickness approximately 1,000 ft

Ttb **Tuff of Black Butte (Miocene)**--Unwelded, biotite hornblende bearing, well-bedded air-fall tuff. K/Ar age on biotite 21.7±0.7 m.y. 21.9±0.7 m.y. (Gray and Miller 1984)

Tur **Rhyolite flows, flow breccias, and tuffs, undivided (Miocene)**--Yellow, sanidine-bearing, rhyolite flows and associated breccias and tuffs in southern Sand Tank Mountains

Tcst **Conglomerate in Sand Tank Mountains (Miocene and Oligocene)**--Conglomerate and conglomeratic sandstone composed predominantly of granitic debris and minor andesite. Maximum size of clasts exceeds 2 m. Unit is interbedded with andesite (Tam) and a thin unmapped tuff. Biotite from the tuff yields a K/Ar age of 21.7± m.y. (Gray and Miller, 1984). Age is late Oligocene and early Miocene

Tam **Andesite of Mesquite Well (Miocene)**--Gray to reddish, vesicular basalt flows and breccia olivine phenocrysts abundant but ubiquitously altered to iddingsite. Unit is intercalated with conglomerate

Tfs **Fanglomerate in Sauceda Mountains (Miocene and (or) Oligocene)**--Locally tan to reddish brown weathering to light tan to yellow fanglomerate and coarse arkosic sandstone. Consists of angular to subrounded clasts in poorly sorted, well indurated silty matrix. Clasts are composed of granitic and metamorphic rock fragments. Unit is dipping 50° greater and is correlative with the locomotive fanglomerate. Age is late Oligocene and (or) Miocene

Tbd **Basal dacitic andesite (Miocene)**--Purplish gray, to reddish buff brown color porphyritic volcanic flows and breccia rock. Age is early Miocene

Tgh **Granitic stock in Hat Mountains (Tertiary?)**--Pinkish gray to light gray, sparsely to abundantly porphyritic subvolcanic rock; phenocrysts are chalky white, 2 to 3.5 mm, anhedral, altered plagioclase crystals and smaller sized oxidized mafic minerals (hornblende?). Unit exposed as smoothly eroded low lying hills in southern part of quadrangle. Margin of pluton appears slightly finer grained than main body, however, intrusive contacts were not exposed

Tv **Volcanic (Rocks Miocene and Oligocene)**--Porphyritic gray, green, tan to maroon colored andesitic, minor rhyodacite, and local rhyolite flows. Occurs commonly as low-lying hills. Age is late Oligocene and early Miocene

Castle dome, palomas, copper, and Cabeza Prieta Mountains

Tdc **Dacite in Cabeza Prieta Mountains (Miocene)**

Tsc **Sedimentary rocks (Miocene)**--The Copper Mountains consists of Arkosic sanstone and boulder conglomerate. Consists of debris flow, channel fill and sheet flood deposits probably shed from the Copper Mountains due to detachement faulting. In the

Ttcd **Tuff in Castle Dome Mountains (Miocene)**--Biotite and feldspar phyric, variably welded ash flow tuff

Tdcd **Dacite in Castle Dome Mountains (Miocene)**--Dark weathering, non-resistant porphyritic dacite volcanics with phenocrysts of quartz, hornblende plagioclase

Tbcd Basalt in Castle Dome Mountains (Miocene)

Tap **Andesite of Palomas Mountains (Miocene and (or) Oligocene)**--Spheroidal weathering andesite flows and agglomerate characterize by highly altered phenocrysts. Flows are intercalated with red conglomerate and red-brown to creamy tuffaceous sandstone

Trf **Rhyolite flows (Miocene and (or) Oligocene)**--Flow banded, pinkish gray, quartz-feldspar-biotite-phyric rhyolite flows and dome

Tgp **Granite of Palomas Mountains (Tertiary)**--Light brown weathering, light gray to pinkish colored, leucocratic, equigranular or locally porphyritic, hornblende-bearing biotite quartz monzonite K-Ar age of 23 m.y., has been determined on biotite from the unit (R. M. Tosdal, unpub. data)

Aguila Mountains

Tbaa **Basalt and basaltic andesite in Aguila Mountains (Miocene)**--Medium gray, dark gray to black iddingsite phenocryst bearing basalt and basaltic andesite. K/Ar whole rock age of 14.0 ± 0.32 m.y. Shafiquallah and others, 1980)

Ttr **Air-fall tuff, pyroclastic rocks, and minor rhyolite (Miocene)**--Light-tan to yellow, yellowish brown to light reddish brown poorly sorted lithic tuff, minor light purplish gray to reddish porphyritic rhyolite. Source for unit is believed to be central Aguila Mountains where vent breccia is exposed (Tucker, 1980)

Tle **Latite eruptive suite (Miocene)**--Volcanic breccia, deformed contorted rhyolite and latite flows, tuff, agglomerate and pyroclastic rocks occurring in the central portion of the range

Tda **Dacite in Aguila Mountains (Miocene)**--Dark gray to purplish-gray to gray to brownish-red coarsely porphyritic flows

Ts **Sandstone (Miocene and (or) Oligocene)**--Light purplish-brown sandstone, occurs in scattered areas in southern Aguila Mountains; interbedded with dacite (Td) flows in upper portion of section; interpreted as being equivalent to similar stratigraphically lower sequences in other parts of the Volcanic field that are between 23 and 25 m.y. B.P.

Painted Rock Mountains and Sentinel Plain

Tbap **Basaltic andesite of Painted Rock Mountains (Miocene)**--Scattered dark gray to black coarsely crystalline intergranualr to subophitic basalt flows

Tat **Ash-flow tuff of Painted Rock Mountains (Miocene)**--Welded ash flow tuff deposited unconformably on top of unit Tdap

Tdap **Rhyodacite, dacite, dacitic andesite, and associated clastic rocks of Painted Rock Mountains (Miocene and (or) Oligocene)**--Predominantly dacite to dacitic andesite flows minor basalt, rhyolite, rhyolitic ash flows and local volcaniclastic sediments including conglomerate and volcanic derived sandstones

Tvp **Volcanic flows and minor conglomeratic sandstone of Painted Rock Mountains (Miocene and (or) Oligocene)**--Rhyodacitic to andesitic flows, crystal rich tuff and intercalated volcaniclastic sediments. Section steeply tilted approximately 40° to 80°. K/Ar age on biotite 23.8 ± 0.8 m.y. (Gray and Miller, 1984) and on whole rock 25 m.y.

Tgpr **Granite of Painted Rock Mountains (Miocene and Oliogocene)**--Medium ground, holocrystalline variably porphyritic granitic rock. Rock with phenocrysts of biotite hornblende quartz and feldspar. Margins of pluton is extensively epidotized and finer grained then central exposures. Age is Oligocene and early Miocene

Table Top, Vekol, Castle, Brownell, and Quijotoa Mountains

Tob **Olivine basalt (Miocene)**--Gray to black vesicular basalt. Flows are porphyritic and glomeroporphyritic with olivine altered to iddingsite, clinopyroxene and labradorite phenocrysts

Ta **Andesite (Miocene)**--See previous descriptions

Tb **Basalt of Table Mountain (Miocene)**--Brownish gray to dark gray, locally grayish red basalt flows and flow breccia. Commonly contains phenocrysts of olivine, clinopyroxene and plagioclase. Unit locally include aphanitic andesite

Tlv **Latite suite of Vekol Mountains (Miocene and (or) Oligocene)**--Pale to dark-maroon, pink, orange-brown, and black porphyritic biotite-latite flows, welded tuffs, breccias, dikes and sills, minor pale yellow crystal-rich lithic airfall tuff. Age is early Oligocene and (or) Miocene

Tcg **Conglomerate**--Gray age, brown and pink conglomerate, conglomeratic sandstone and minor tuffaceous sandstone. Clasts commonly up to 10 cm in diameter but locally may exceed 1 m. Clasts are locally derived and reflect underlying units exposed in the area

Tau **Andesitic rocks undivided (Miocene and (or) Oligocene)**--Andesite flows and flow breccias, minor hornblende bearing latite. Age is early Oligocene and (or) Miocene

Tdr **Dacitic to rhyolitic flows, dikes, and sills (Miocene and (or) Oligocene)**--Light gray to pink gray to greenish gray silicic rock with phenocryst of hornblende, feldspar and biotite in a dense K-spar rich, pinkish-gray to greenish gray groundmass. Age is early Oligocene and (or) Miocene

Tgs **Granite of Senita Basin (Tertiary?)**--White to light-gray or green colored, leucocratic muscovite-biotite-bearing granite, consisting of two mesoscopically distinct phases. The older phase being a medium to coarse grained, typically equigranular and locally coarsely K-spar porphyritic moderately to strongly foliated biotite to muscovite-biotite bearing. The younger phase is typically a very fine- to medium-grained, unfoliated to subly goliated garnet muscovite-bearing microcline granite. Age is early Tertiary?

Tgsb **Granite of Sierra Blanca (Tertiary)**--White to beige, leucocratic to rarely mesocratic, yellowish weathering, medium grained, garnet-muscovite granodiorite to granite occurring as a tripartite group; as pre- or synmetemorphic mylonitized or strongly foliated granite, as synmetamorphic(?) slightly to equivocably deformed granitic sills, and as unfoliated, postmetamorphic granite. Age is early Tertiary

TKd **Diorite and Monzodiorite (Tertiary and (or) Cretaceous)**--Medium gray fine grained equigranular rock composed of plagioclase pyroxene, partially chloritized hornblende, and minor quartz, K-feldspar and biotite. Outcrops along the western margin of the Little Ajo Mountains. The age and relationship to adjacent plutonic units is uncertain

TKc **Comelia quartz monzonite (Early Tertiary and (or) Late Cretaceous)**--In the vicinity of Cornelia mine the unit consists of granodiorite porphyry which is typically potassicability altered and mineralized. The porphyry grades into equigranular granodiorite north of the pit. Unit includes a fine grained diorite border phase present on the east side of Camelback Mountain

TKv **Siliceous volcanic rocks in Vekol Mountains (Tertiary and (or) Cretaceous)**

TKgk **Gneissic granodiorite and granite in Kupk Hills (Tertiary and Cretaceous)**—Pink, unfoliated to weakly foliated, biotite-hornblende granite grading to foliated, lineated, brown to reddish-brown, relatively unresistant K-spar megacrytic, biotite-bearing augen orthogneiss

Kgs **Granite of Sierra Pinta (Cretaceous)**--Light to medium gray or pink, distinctively white-weathering, highly leucocratic, unfoliated, fine-grained to coarse grained and locally pegmatitic, equigranular to slighlty microcline porphyrytic ± garnet ± muscovite-biotite-bearing granite to granodiorite. Age is Late Cretaceous

Granodiorite of new Cornelia (Cretaceous)—Consists of:

Kgg **Granodiorite of Gunsight Hills (Cretaceous)**—Light- to medium-gray, medium grained, porphyritic, inequigranular, hornblende-biotite granodiorite with subordinate biotite-leucogranodiorite, biotite granite and aplite

Kgcv **Gneiss of Chagit Vo (Cretaceous)**--The gneiss of Chagit Vo is derived from the granodiorite of Gunsight Hills (Kgg). Greenish-gray to dark-green, strongly foliated to protomylonitic or blastomylonitic, floggy-weathering, granodiorite augen gneiss and schist, diorite gneiss and minor amphibolite gneiss (K-Ar, 59.4 m.y. hornblende, 32.3 m.y. biotite, minimum ages, Haxel and others, 1983)

Kgb **Granodiorite of Bandeja Well (Cretaceous)**--Predominantly, light-gray, leucocratic, equigranular to coarsely porphyritic, hornblende-bearing biotite-granodiorite and biotite-bearing granite. Subordinate lithology includes sphene diorite and biotite-hornblende quartz monzonite

Granodiorite of Cimar Mountains (Cretaceous)--Consists of:

Kgc **Granite**--Medium grained, equigranular biotite-bearing granite and quartz monzonite

Kgdc **Granodiorite and quartz diorite**--Medium- to locally fine-grained, equigranular, leucocratic to mesocratic, biotite-hornblende granodiorite, quartz diorite, and quartz monzonite

Kc **Concentrator volcanics (Cretaceous?)**—White to light gray, greenish-gray, red or brown andesitic volcanics which include predominantly flow breccias and subordinate tuffs and flows (Gilluly, 1946)

Kga **Granite of Aguajita Spring (Cretaceous)**--White- to light-cream weathering, highly leucocratic, equigranular to foliated to variably cataclasized and/or recrystallized to protomylonitic, biotite granite. Age is Late Cretaceous

Kms **Monzodiorite of Sierra Arida (Cretaceous)**--White to medium-gray, tan- or pale-orange weathering, leucocratic to mesocratic, equigranular, medium to coarse grained, foliated and unfoliated, epidote-bearing, sphene-biotite-hornblende granitoids ranging in modal composition from diorite to granodiorite and quartz monzonite to granite

Kcv **Conglomerate of Vekol Mountains (Cretaceous?)**--Red-brown boulder conglomerate, red feldspathic sandstone, volcanic breccia, quartzite, and minor andesite flows. As mapped includes the Late Cretaceous Vekol Formation, Late Cretaceous Chiapuk Rhyolite, and Cretaceous(?) Phonodoree Formation (Heindl, 1965)

Ks **Sand Wells Formation (Cretaceous?)**--Generally a poorly- to well-bedded, slope-forming, pink and drab-red to gray quartzite cobble conglomerate, gray-green to brown pebbly quartzite and arkose, and minor siltstone

Kcs **Conglomerate of Scarface Mountain (Cretaceous?)**--Medium- to dark gray or black, tan to orange weathering, indurated, unfoliated, quartz pebble conglomerate with a graywacke matrix and thick, weakly crossbedded 10 cm interbeds of arkosic sandstone

KJm **Granodiorite of Mohawk Pass (Cretaceous and (or) Jurassic)**--Light-gray to pink, medium- to coarse-grained

KJo **Granite of Owl Station (Cretaceous and (or) Jurassic)**--Medium to dark-gray or pale-green or orangish, faint reddish weathering, equigranular to slightly porphyritic, mesocratic, sphene-epidote-bearing biotite-hornblende granite, which is only locally foliated and weakly so. Microclase and/or andesene as a porphyritic phase up to 0.5 cm at greatest dimension

KJc **Quartz monzonite of Copper Mountain (Cretaceous and (or) Jurassic)**--White to pale-gray, beige to tan weathering, most often highly leucocratic, medium to coarse grained, porphyritic to less commonly equigranular, sphene-biotite-bearing quartz monzonite to granite

KJg **Heterogeneous or mixed of Gu Achi (Cretaceous and (or) Jurassic)**--Arkosic sandstone and conglomerate, graywacke, quartzo-feldspathic schist, quartz-muscovite schist, epidote-bearing sandstone, greenschist and hornblende bearing greenstone. Age is latest Jurassic and (or) Cretaceous

Granitoid rocks of Agua Dulce Mountains (Jurassic)--Consist of:

Jag **Granite**--Maroon to lavendar, brown to black weathering, leucocratic to melanocratic, cataclasized, generally porphyritic biotite granite

Jad **Diorite**--Leucocratic, medium grained, equigranular hornblende monzonite and plagioclase feldspar porphyritic, coarse grained, biotite diorite

Jgk **Granite of Ko Vaya (Jurassic)**--Lavender or moderate green to gray, highly leucocratic to leucocratic, medium grained, locally porphyritic granitoids ranging in composition from biotite-bearing quartz monzonite to ± hornblende quartz diorite

Jgkp

Granitic rocks in Puerto Blanco Mountains and Quitobaquito Hills (Jurassic and Jurassic(?))--Consist of:

Jpg **Granite**--White to gray or red, red- to brown weathering, highly leucocratic, equigranular, very fine to coarse grained, foliated muscovite-biotite-bearing microcline granite and syenogranite

Jpgd **Granodiorite**--Light-pink to red or pale-to dark green, pink or brown weathering, equigranular and porphyritic, very-fine to coarse grained, unfoliated, leucocratic, hornblende diorite and biotite granodiorite

Jpp **Granite porphyry of Pozo Nuevo**--Light- to dark-greenish-gray and silvery brown weathering, leucocratic to mesocratic, feldspar porphyroclastic to inequigranular, coarse grained unfoliated to slightly foliated, biotite granite

Jvw **Volcanic wacke in western Agua Dulce Mountains (Jurassic?)**--Very dark gray, very fine to fine grained, dirty sandstone or wacke, with cross bedding and graded bedding, typically hornfelsed

Jvs **Volcanic and sedimentary rocks in the Quijotoa Mountains (Jurassic and Jurassic?)**

Mixed rocks of La Abra, Quitobaquito Hills, and Puerto Blanco Mountains, undivided (Jurassic and Jurassic?)--Consist of:

Jlq **Quartz porphyry**--Variably colored, typically leucocratic, very fine to fine grained, strongly foliated to mylonitic, quartz porphyry, meta-quartz porphyry, phyllite, mica-poor quartzo-feldspathic schists

Jrp **Rhyolite of Quijotoa (Jurassic)**--Gray to maroon porphyritic rhyolite with phenocrysts of quartz, potassium feldspar and plagioclase. Unit includes welded tuff and rhyolite intrusives

Jlg **Greenschist and metaconglomerate**--Variably folded, foliated, lineated, feldspar porphyritic muscovite-biotite quartzo-feldspathic meta-intrusive and meta-extrusive lithology

Jlm **Metasedimentary rocks**--Light gray to silvery or lavender, dark-red brown to black weathering, very fine to medium-grained, equigranular to slightly porphyritic, sericite quartzo-feldspathic schist and subordinate phyillite or metaconglomerate

Js **Quartzofeldspathic and quartz-epidote schist and metaconglomerate (Jurassic)**--Diverse lithologies including light and dark, psammitic schists, calc-silicate schists, amphibole-epidote bearing muscovite-quartz-calcite schists, quartzo-feldspathic schists and schists of tuffaceous protolith(?) and meta-conglomerate

Pzl **Limestone and dolomite (Paleozoic)**--Consists of the Naco Limestone, Escabrosa Limestone, Martin Formation, and locally, strata assigned to the Ouray and Picacho de Calera Formations by Carpenter (1947). Age is late Paleozoic

P zs **Sedimentary rocks (Paleozoic)**--Consists of the Abrigo Formation and Bolsa Quartzite. Age is early Paleozoic also locally consists of undivided sediments

Yd **Diabase (Middle Proterozoic)**--Dark-green to black-olivine diabase in silla and dikes. Inlcudes some gray to pinkish-gray feldspathic to granophyric differentiates

Ya **Apache group (Middle Proterozoic)**--Consists of from youngest to oldest: Brownish to pinkish light-gray arkose and Apache Group members which include basalt, mescal limestone, dripping Springs quartzite and Pioneer Shale

Yg **Granite (Middle Proterozoic and Middle Proterozoic?)**--Consists of the Oracle Granite of Peterson (1938) and Chico Shunie Quartz Monzonite of Gilluly (1937). In Ajo mine area consists of light gray, light brown weathering, slightly foliated to massive coarsely feldspar porphyritic biotite quartz monzonite. Ubiquitously brecciated and cataclasized. Conspicuous blue quartz and pink feldspar are characteristic. In Haley Hills consists of pinkish, gray or pale maroon, unfoliated edium-grained, equigranular, only locally porphyritic, garnet-muscovite-bearing biotite granite. Distinctly weathering to smooth boulders

YXo **Orthogneiss and Orthogneiss(?) (Middle and (or) early Proterozoic)**--Consists of include a variety of gneissic lithologies listed below from oldest to youngest: (a) layered biotite quartzo-feldspathic schists and gneisses (YXgl); (b) hornblende-biotite augen gneiss (Yg); (c) granitic, typically highly leucocratic gneiss; (d) amphibolite gneiss; (e) biotite aggregate, spotted granitoid gneiss

YXgl **Layered gneiss (Middle and (or) early Proterozoic)**--In Agua Dulce Mountains consists of beige to pale gray, typically equigranular, muscovite-biotite or muscovite-quartzo-feldspathic gneiss and schist. Occurs as megascopic inclusions in unit Yg. In Sierra Pinta consists of biotite quartzo-feldspathic gneiss and greenschist-facies chlorite schist with quartzo-feldspathic segregations as spatially distinct subunits, not interfoliated. Contact between these is sharp and unequivocable

YXg **Granitoid rocks (Early Proterozoic and middle?)**--In Booth Hills consists of leucocratic to mesocratic, fine-to medium-grained, ± epidote-biotite-hornblende tonalite and quartz diorite. Conspicuous 2-3 mm quartz eyes are characteristic. Intrude the Pinal Schist (unit Xp). In Ajo mine area consist of the Cardigan Gneiss (Gilluly, 1936). In Sierra Blanca consists of variably foliated gneisses and mylonites of granitic to granodioritic composition. Includes equigranular, porphyritic and seriate, sphene-bearing epidote-biotite quartzo-feldspathic orthogneiss. Blastomylonitic along tectonic boundaries. In Isabella Mina area consists of fine to medium grained, equigranular to porphyritic, highly leucocratic, white-mica quartz-monzonites to quartz-diorites. Grades texturally to gneiss and blastomylonite

Xp **Pinal schist (Early Proterozoic)**--Fine to medium grained biotite and(or) muscovite quartzo-feldspathic schist, with generally a strong foliation coincident with lithologic layering and a penetrative lineation in the plane of foliation. Locally includes minor Pioneer Shale

Xgs **Quartzo-feldspathic gneiss and dioritic schist (Early? Proterozoic)**--Muscovite quartzo-feldspathic schists intruded by leucocratic to mesocratic biotite-hornblende tonalite. Schists are leucocratic, locally with a strong mylonitic foliation

Xhm **Hornblendic gneiss in Mohawk Mountains (Early? Proterozoic?)**

Xgm **Granitic gneiss in Mohawk Mountains (Early Proterozoic)**

Xpm **Paragneiss in Mohawk Mountains (Early? Proterozoic)**

Mzbg **Granite and gneiss of Buck Peak (Mesozoic?)**--Weakly foliated, moderate-gray medium- to coarse-grained, equigranular monzogranitic to granodioritic gneiss

Mzbl **Leucocratic granite of Buck Peak (Mesozoic?)**--Very resistant, brown-weathering, white to beige ± hornblende-biotite monzogranitic to syenogranitic gneiss

Mzg **Granite (Mesozoic)**--Weakly foliated light gray to moderate gray colored Proterozoic or Paleozoic or Mesozoic equigranular granitic rock

pTp **Paragneiss (Pre-Tertiary)**--Dark-brown to black-weathering, melanocratic to leucocratic, compositionally banded epidote-hornblende and quartzo-feldspathic schists and gneisses. Age is Early or Middle Proterozoic or Paleozoic or Mesozoic

pTo **Orthogneiss and Orthogneiss(?) (Proterozoic or Paleozoic or Mesozoic Pre-Tertiary)**--In Agua Dulce consists of gray, mesocratic, fine grained, epidote bearing hornblende quartz-rich gneiss and biotite quartzo-feldspathic gneiss. In Sierra Pinta consists of black, equigranular, meta-mafic. In Haley Hills consists of light colored, ± muscovite-biotite granite and biotite-hornblende quartz diorite and gabbro. In North Cabeza Prieta Mountains consists of light gray, leucocratic mylonitic hornblende granodiorite gneiss, locally including tonalite and granitic gneiss. In Aztec Hills consists of gray weathering, leucocratic, distinct seperable granitoids including foliated, corase grained equigranular biotite quartz monzonites, biotite granites, and hornblende tonalites. Overall age of unit is here considered to be Early and (or) Middle Proterozoic and (or) Mesozoic