

**Geologic map of the Oracle Junction
7.5' Quadrangle and the eastern third of
the Tortolita Mountains 7.5' Quadrangle,
Pima and Pinal Counties, Arizona**

by

Steven J. Skotnicki

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416 W. Congress, Suite #100, Tucson, Arizona 85701

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INTRODUCTION

This study encompasses the whole of the Oracle Junction 7.5' quadrangle and the eastern third of the Tortolita Mountains 7.5' quadrangle (see figure 1). Late Tertiary basin-fill deposits and younger Quaternary surficial deposits dominate most of the region and are well-exposed along the length of Oro Valley. The western third or so is underlain by a broad, flat pediment on the east side of the Tortolita Mountains. The pediment was etched into Proterozoic and Tertiary granitic rocks and is punctuated by more resistant hills of Pinal Schist and an east-northeast-trending band of younger metasedimentary rocks. Middle and Late Pleistocene sandstones and conglomerates lap up onto the pediment. These deposits contain material eroded from the granitic rocks and show very little topographic relief relative to the pediment. As a result, in aerial photographs, and locally even from a short distance away (tens to hundreds of meters), these deposits are nearly indistinguishable from the bedrock pediment.

On the east side of the study area the early Pleistocene Cordones surface (McFadden, 1981) caps a sequence of at least two separate and distinct basin-fill deposits. Biosphere2 is built on this surface just outside the map area. A series of well-defined early to late Pleistocene and Holocene fluvial terraces is exposed along the Canada del Oro in the southeast corner of the region.

Field work was carried out between November 1999 and January 2000. The surficial deposits were mapped by fieldwork and by using black-and-white aerial photographs, approximately 1:36,000 scale and dated 4-16-82 (USGS VFCH photoset).

PREVIOUS WORK

Hoffman (1963) analyzed the heavy-mineral distribution in sands shed off the Tortolita Mountains pediment. Budden (1975) mapped the study area as part of a much larger study of the Tortolita-Santa Catalina Mountains complex. Dockter and Banks (1976) produced a map showing photo lineaments in the Tortolita Mountains. Banks and others (1977) produced a 1:62,500 scale geologic map of the Tortolita Mountains 15' quadrangle. Dickinson (1987 and 1991) created a general 1:125,000 scale geologic map of the Catalina core complex and the San Pedro Trough. McFadden (1981) studied the geomorphology of the Canada del Oro Valley and described the different Quaternary terraces in the area.

GEOLOGY

Pinal Schist

The Pinal Schist is the oldest rock exposed in the study area. It is dominantly quartz+ muscovite +biotite schist, though phyllite is common locally. Compositional banding is common and is defined by light-colored leucocratic bands of mostly quartz and less abundant micas, and dark-colored melanocratic bands containing quartz and abundant micas. Bands are commonly between 2-5mm thick. Compositional banding is best displayed in the hills north of Faraway Tank on the northwest side of the Oracle Junction quadrangle, where tight isoclinal folds are locally visible.

The Pinal Schist is deformed by a strong, pervasive primary foliation (S_1). This foliation is very prominent and obvious in the hills north of Faraway Tank but becomes less distinct to the west. To the west the rock appears to contain more quartz, especially as white ptigmatic veins, and the rock is more contorted and folded on the centimeter to meter scale, rather than displaying a pervasive foliation. The primary foliation dips moderately to steeply to the northwest and strikes consistently to the northeast. However, north of Carpas Wash (near Falcon Divide) and on the north side of the Guild Wash Fault the primary foliation dips moderately to the northeast (except locally) and strikes variably to the northwest. It should be noted that where the primary foliation strikes northwest, nowhere was it cut by the secondary foliation. Because the primary foliation in these areas has an orientation similar to the secondary foliation farther south and east, it is possible that the foliation measured in these areas is really the secondary foliation.

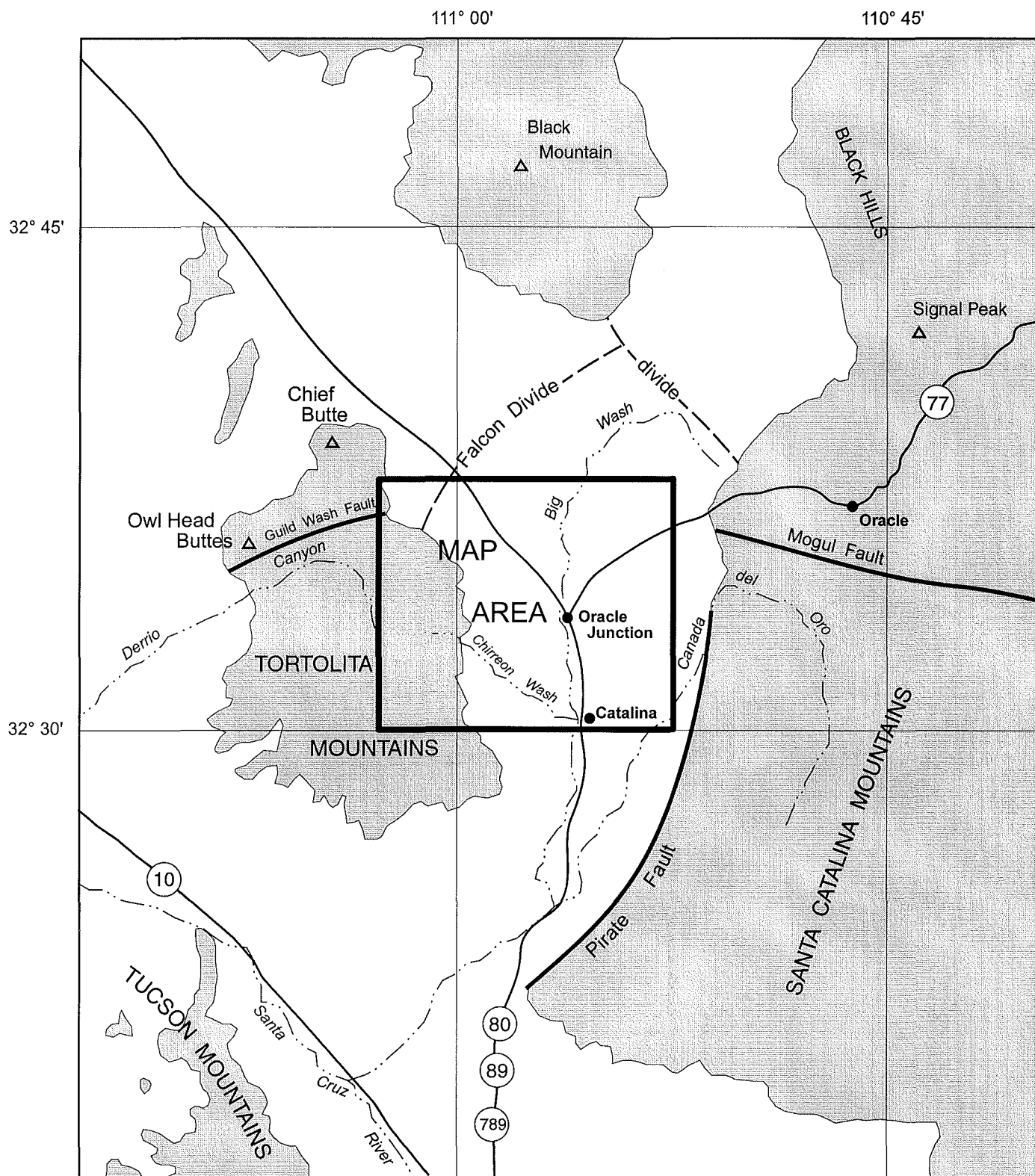


Figure 1. Location map for the Oracle Junction and eastern third of the Tortolita Mountains 7.5' quadrangles.

The secondary foliation (S_2) strikes rather consistently north-northwest and dips moderately to steeply to the east-northeast. Locally, it forms a pervasive, weak crenulation, but in most areas it forms beautiful kink-bands showing right-lateral movement.

Most outcrops are exposed in the northwest corner of the map area. However, a few small exposures were mapped in the far southwest corner of the map area along the contact between the medium- to coarse-grained granite (map unit Tg) and the fine-grained mafic granitoid (map unit Tgm). Their position between the two granites suggests the Pinal Schist is a screen between them. About 1-2 miles east-northeast of these exposures TYg is locally strongly foliated, schistose, and locally gneissic. The deformed rock occurs in a band up to 10-20 meters wide locally along the contact between Tg and Tgc. It is not clear if this rock is Pinal Schist or strongly deformed Tg.

Band of Metasedimentary rocks

A discontinuous band of metasedimentary rocks crops out in the southwest corner of the map area. The sedimentary sequence includes quartzite, psammite, marble, and metaconglomerate. Banding in these rocks is common but it is not certain if it represents original bedding or metamorphic foliation. Hence, the up-direction of this sequence is uncertain.

The gray to purple quartzite is mostly recrystallized. Banding is common, and locally resembles thin iron-oxide laminations. The light gray marble (metamorphosed limestone) is composed of medium-grained interlocking calcite crystals up to 1-3 mm wide. Slight textural differences and partings define layering. The marble commonly exhibits lens-like forms tens of centimeters long and ~1-3 cm wide that are tan-colored and weather out in relief on weathered surfaces. The forms resemble chert stringers, but when the stringers are broken open they are composed of medium-grained calcite crystals. They may have been originally chert now replaced by calcite. The psammite contains light gray to green, laminated and/or banded fine-grained siliceous layers. Locally, quartzite beds in the psammite unit are more resistant and stand out in relief. Fine-grained epidote and coarse-grained pyrope garnet are locally abundant. Locally up to 5% of the psammite consists of interbeds of light gray carbonate 5-30 cm thick. At the eastern end of the band small isolated exposures of metaconglomerate contain subrounded to well rounded pebbles to large cobbles of vein quartz and light gray quartzite. Some of the larger quartzite clasts show bedding defined by iron-oxide laminae. The matrix of this rock is locally bedded iron-oxide-rich sand that has been smeared out into wavy bands. Many of the clasts are partially deformed. Many are broken or are slightly elongated and lens-like. The metaconglomerate is in contact with marble on one small hill, suggesting it is on the opposite side of the sequence as the quartzite.

All of the exposures of the metasedimentary rocks occur as lens-like enclaves surrounded by coarse-grained granite (map unit Tgc). It is apparent that the granite intruded these rocks, both by the outcrop pattern and by the presence of coarse tremolite (?) crystals in the marble locally at the contact. The granite body itself was intruded and incorporated as enclaves in younger granitic intrusions. The relationship of the metasedimentary rocks to the Pinal Schist is unclear. Nowhere are they in contact. However, the homogeneity of the Pinal Schist with respect to the other rocks, and the presence of pervasive foliation, secondary kink bands, and abundant ptigmatic quartz veins in the schist, suggests the Pinal schist was buried and deformed at a deeper crustal level than was the marble and related rocks. Therefore the Pinal Schist is probably older.

The clean, purple quartzite may be the Cambrian Bolsa Quartzite, overlain by the psammite unit that contains lithologies similar to the Cambrian Abrigo Formation and also to the Pennsylvanian-Permian Earp Formation. The marble may represent baked Paleozoic carbonates, possibly the Devonian Martin and/or Mississippian Escabrosa Formations, or possibly even younger carbonate formations. The metaconglomerate may be remnants of the basal upper Jurassic(?)—lower Cretaceous Bisbee Group—the Glance conglomerate, or possibly the late Cretaceous-early Tertiary American Flag Formation (Force, 1997). These correlations fit better than correlation with the Apache Group. This means that although the undated coarse-grained granite resembles the 1.4 Ga plutons in other parts of the state, if the metasedimentary rocks are Paleozoic, then the

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Quaternary surficial deposits

Qy ₂	Qy
Qy ₁	
Qyl	
Ql ₂	Ql
Ql ₁	
Qm ₂	Qm
Qm ₁	
Qo ₂	
Qo ₁	

Tertiary deposits

Tcy	
Tsg	Tcg
Tcp	
Tcb	
Tb	Tri

Tertiary granitic rocks

Tgf
Tgm
Tg
Tgc

Paleozoic/Mesozoic rocks (?)

Kc
Pzm
Cs
Cq

Middle Proterozoic rocks

Yd
Yg

Early Proterozoic rocks

Xp

Figure 2. Correlation diagram for rocks in the Oracle Junction and eastern Tortolita Mountains quadrangles.

granite must be younger than Paleozoic. Much of the pediment on the west side of the Santa Catalina Mountains south of the Mogul Fault (east of the study area) is coarse-grained, porphyritic Catalina Granite (DuBois, 1959, McCullough, 1963). It has been dated by several techniques at between about 21.1 and 29.1 Ma (Keith et al., 1980; Reynolds et al., 1986). The band of coarse-grained granite surrounding the metasedimentary rocks in the Tortolita Mountains may also be the Catalina Granite.

Granites

There are five major granitic intrusive rocks in the study area. The oldest is exposed in the northwest. The other four are in close association in the same northeast-trending zone that includes the enclaves of metasedimentary rocks. Just as the metasedimentary rocks formed enclaves and screens within what is probably the Catalina Granite (map unit Tgc), the Catalina Granite formed enclaves and screens within and between the medium- to coarse-grained granite (map unit Tg) and the mafic granitoid (map unit Tgm)—strangely in the same area. The Catalina Granite was engulfed, surrounded, and partially digested by the younger plutons. A medium-grained felsic granite intrudes the mafic granitoid in the south part of the map area. All of the plutons in the study area are foliated to some extent.

Banks (1980) and Keith and others (1980) recognized two distinct “phases” of granitic rocks on the west side of the Santa Catalina Mountains and in the southern part of the Tortolita mountains: (1) a coarse-grained, porphyritic, sphene- and hornblende-bearing biotite granite called “Catalina Granite”, and (2) a finer-grained biotite granite called “Tortolita Granite” (Dickinson, 1991). These two granites have been interpreted as phases of a single composite pluton or batholith based on the concordance of inferred Rb-Sr isochron ages for both rocks and their concordance with a single U-Pb age (Dickinson, 1991). There is some confusion as to which rock various workers have called the “Tortolita Granite”. In this report the term Tortolita Granite will be used for the mafic granitoid (map unit Tgm) exposed in the southwest part of the study area. Whether or not the Catalina Granite and Tortolita Granite are phases of a single batholith, the Tortolita Granite everywhere intrudes the Catalina Granite, both in the Tortolita Mountains and in the Santa Catalina Mountains. Additionally, the Tortolita Granite itself is intruded by a medium-grained felsic, equigranular granite (map unit Tgf). Contacts are sharp and the felsic granite commonly forms dikes and narrow sills in the Tortolita Granite. Is this felsic granite a phase of the Tortolita Granite? An apatite fission-track age (cooling age) of 17.00 ± 2.10 Ma (Creasey et al., 1977), if their sample is from map unit Tgf, suggests that it may be appreciably younger. However, this conclusion should be taken with caution without comparable K-Ar age-dates.

Coarse-grained granite (map unit Yg)

The oldest pluton, a coarse-grained, K-feldspar porphyritic biotite granite (map unit Yg), is exposed in the northwest corner of the study area. Here it intrudes Pinal Schist on both the north and south sides of the Guild Wash Fault. It is easily distinguished from the younger granites (except for Tgc) by the ubiquitous presence of large, 1-3 cm-long K-feldspar phenocrysts and thin books of relatively fresh black biotite. It erodes readily and commonly forms low rounded hills covered with grussy regolith. On Falcon Divide it is intruded by dark green diabase that forms two small, irregularly shaped pods. Because the surface exposures are typically poor, fabrics within the granite were difficult to observe. In many areas where exposures were good, however, it is at least locally foliated. The foliation is mostly weak and is defined by alignment of biotite phenocrysts. It is strongest in the southwest corner of section 4, T. 10 S., R. 13 E. where quartz is slightly elongated and feldspars are augen-shaped. The strike of the foliation is variable but is generally northwest—approximately parallel to the strike of the primary foliation in the nearby Pinal Schist.

This granite is mineralogically and texturally similar to the suite of 1.4 Ga granite plutons in other parts of Arizona, and was assigned this age on that basis and also because it is intruded by diabase which in other parts of the state is middle to late Proterozoic in age (Shride, 1967; Reynolds et al., 1986). On the far western edge of the map this granite is intruded by dikes(?) of fine- to medium-grained leucocratic granite,

but because exposures were so poor it was not mapped separately. The age of the leucocratic granite is uncertain. Banks and others (1978) reported a K-Ar biotite age of 1438 ± 110 Ma for "Madera Diorite" exposed about 2 miles to the west of the northwest corner of the map. However, Banks and others (1977) mapped a body of quartz diorite in approximately the same area. These units may be equivalent. Apparently, this body is intruded by the granite and its age may have been reduced by effects of the intrusion (Reynolds et al., 1986).

Catalina Granite (map unit Tgc)

The next youngest granite (map unit Tgc) was originally mapped as equivalent to Yg because of their mineralogical and textural similarity. Banks (1976) also called this pluton the Quartz Monzonite of Samaniego Ridge. It forms an east-northeast trending band in the southwest corner of the study area, where it intruded and partially metamorphosed a sequence of Paleozoic(?) sedimentary rocks. The metasedimentary rocks occur as lens-like enclaves from several meters across to hundreds of meters long. The granite is coarse-grained and K-feldspar porphyritic and is virtually indistinguishable from the older granite to the north (map unit Yg). It was mapped separately on the assumption that the metasedimentary rocks are of Apache Group age or younger, demanding that the granite must be younger still. Locally, this granite contains dark, biotite-rich inclusions (restite?). Where visible, these inclusions are elongate parallel to the local foliation direction and show that the granite was deformed while at least still partially molten. This will be discussed in more detail below in the Structure section of this report. The Catalina Granite has been dated by several techniques at between about 21.1 and 29.1 Ma (Keith et al., 1980; Reynolds et al., 1986).

Coarse- to medium-grained granite (map unit Tg)

The most voluminous plutonic rock is a coarse- to medium-grained granite underlying most of the west-central part of the study area (map unit Tg). Its texture varies between coarse-grained K-feldspar porphyritic, to medium-grained nearly equigranular. This granite contains abundant biotite and minor amphibole, and because of this it is slightly darker than the other coarse-grained granites. The mafic minerals are commonly partially altered to chlorite and weathered outcrops are typically slightly green-colored. A primary foliation is common, and is locally cut by kink-bands defining a second foliation. Most of the exposures of this rock on the western margin of this map and beyond are permeated by abundant high-angle pegmatite dikes. Locally, the dikes consist of more than 60% of the exposures and nearly completely obscure the underlying granite. This granite with its varying texture is very similar to granites also mapped as unit Tg to the north in the Ninetysix Hills (Skotnicki, 1999). As mapped the southern margin of this granite contains zones of schist and banded gneiss. The deformed rock occurs in a band up to 10-20 meters wide locally along the contact between Tg and Tgc. It is not clear if this rock is Pinal Schist or is strongly deformed Tg. North of Crow Windmill several finger-like bodies of granite appear to intrude southward across the trend of the metasedimentary rocks. Parts of these fingers look very much like the medium-grained mafic granitoid described below. They seem to grade into more normal Tg to the north. However, it is not clear which pluton these zones belong to. Because they are continuous with exposures to the north, they were mapped as part of Tg.

Banks and others (1978) called this rock the pluton of Chirreon Wash, or Chirreon Wash Granodiorite and reported a K-Ar biotite age of 25.10 ± 0.50 Ma. Their sample, however, as reported in Reynolds and others (1986), was taken from the west side of the divide at the head of Batamote Wash, two miles to the south of Chirreon Wash. Chirreon Wash is a minor east-flowing tributary to Big Wash that flows north to south on the east side of the Tortolita Mountains. Hence, the name Chirreon Wash Granodiorite is not very useful because the type locality is barely within the pluton, and not along Chirreon Wash. Dickinson collectively called this rock part of the Wilderness Canyon suite. Keith and others (1980) named the pluton the Derrio Canyon Granodiorite. The name Granite of Derrio Canyon is preferable because Derrio Canyon is a major west-flowing drainage that slices through most of the pluton and affords good

exposures of the rock. Also, without a more extensive analysis it is uncertain whether this rock is a granite or granodiorite.

Banks and others (1978) reported a K-Ar biotite age of 24.0 ± 0.50 Ma on an unfoliated "quartz monzonite" dike apparently cutting this rock. Their sample was taken from near Bass Spring about 1 mile west of the map area.

Mafic granitoid (map unit Tgm)—"Tortolita Granite"

In the southwest corner of the study area a fine- to medium-grained mafic granitoid (map unit Tgm) cross-cuts Tgc, Tg, and the metasedimentary rocks. Locally this granite contains stringy inclusions of Tgc. A slightly more mafic phase containing abundant hornblende is only locally distinguishable from the less mafic phase containing mostly biotite. The hornblende-rich phase contains the Tgc inclusions, and both the host rock and the inclusions are cross-cut by the biotite-rich phase. Locally, the attitude of the Tgc inclusions was measured and labeled on the map. Foliation is weak in the mafic granitoid and was not visible in most areas. This granitoid appears to extend far to the southwest into the Tortolita Mountains.

As with the name "Catalina Granite", there has been some confusion as to which rocks workers have assigned the name "Tortolita Granite". Keith and others (1980) cite an unpublished manuscript by Moore and Tolman (date uncertain but may be 1939, 1941, or 1949) who used the term Tortolita Granite. The copy of the report at the Arizona Geological Survey is almost illegible. It mentions the term Tortolita Granite only in the report, but on the map the label Tcg (=Catalina Granite) is used for the granite in the Tortolita Mountains exposed in the northwest corner of the Tucson 15' map. McCullough (1963) used the name Cargadero Canyon Granite. Budden (1975) used the term Tortolita Granodiorite. Banks (1976) used the name Quartz Monzonite of Tortolita Mountains for rocks at the far southeast end of the Tortolita Mountains, and may really be equivalent to map unit Tgf in this study. Since it is not clear whether or not these workers were referring to the same rock or not, in this report the term Tortolita Granite is used only for the mafic granitoid (map unit Tgm) which is exposed in the southeast part of the map area and the southern part of the Tortolita Mountains. It should be noted that previous mappers did not distinguish between the felsic granite (map unit Tgf) and the mafic granitoid, so the term as used in the past may refer to both collectively.

Medium-grained felsic granite (map unit Tgf)

The youngest granite body is a medium-grained, equigranular felsic granite. It forms a large, light-colored mass in the southwest corner of the Oracle Junction quadrangle where it intrudes the mafic granitoid. Abundant dikes of this granite cross-cut Tgm. In most areas a weak to moderate foliation is visible, defined by alignment of biotite phenocrysts. The granite is cut by leucocratic dikes and light gray aplite dikes. South of Chalk Reservoir, at the easternmost exposures, the granite and the dikes are pervasively fractured and microbrecciated. Creasey and others (1977) reported an apatite fission-track age of 17.00 ± 2.10 Ma for a "quartz monzonite" located about 3 miles south of Chalk Reservoir, in the Oro Valley quadrangle. This locality was not visited during this study but from a distance the rock resembles Tgf. This reported age is a cooling age and is probably younger than the age of crystallization.

Dikes

At least five different types of dikes cut across older rocks in the map area. A few small, rare, dikes of vein quartz intrude both Yg and Tg. They are fractured and contain some fine-grained hematite on fracture surfaces but show no other obvious mineralization. The dikes immediately to the west of Crescent Tank in section 34, T. 9 S., R. 13 E. have coarse graphic margins containing long, rod-shaped crystals of light gray K-feldspar and gray quartz. These dikes are not in contact with any of the other dikes so their relative age is uncertain, but because of the graphic margins it is likely they intruded shortly after or during the late stages of crystallization of the two plutons.

Probably the next oldest dikes are the leucocratic granite dikes. These dikes are probably related to intrusion of the medium-grained felsic granite (Tgf) as they have similar mineralogy and texture. Many of

these dikes strike east-west or west-northwest. Locally, some of these dikes (veins) are foliated near the southern margin of Tg. They are cut by north- and northwest-striking rhyolite dikes that form prominent light-colored ridges on the southern part of the pediment. The rhyolite dikes contain both feldspar and quartz 1-2 mm across and commonly exhibit a near-vertical flow-banding. Near the head of Batamote Wash in the southwest part of the study area, a lens-shaped body of rhyolite intrudes Tg. The rhyolite here has the same mineralogy as the rhyolite dikes and also tapers into short rhyolite dikes.

Dacite dikes are relatively crystal-rich and contain subhedral to euhedral K-feldspar 2-8 mm wide, and rarely as large as 1.5 cm, and anhedral books of green biotite. Where biotite is nearly absent these dikes appear similar in composition to the rhyolite dikes, except for the lack of quartz. The dacite and rhyolite dikes are nowhere in contact but both have the same orientations. The dacite dikes are exposed to the east whereas the rhyolite dikes are exposed in the west. It is possible that they are related to the same intrusive source, where the coarser-grained dacite dikes represent deeper levels and the finer-grained rhyolite dikes represent shallower levels.

Pegmatite dikes form dense swarms on the western side of the map. These thick, tabular, and locally irregularly shaped bodies contain very coarse intergrown, light gray K-feldspar and gray quartz from a few mm up to ~5 cm. No mafic minerals were seen. Locally, they exhibit graphic texture. These dikes are so abundant in the southwest part of the study area that they locally comprise over 60% of the exposed bedrock. In these areas their abundance, plus their erosion products, has nearly completely concealed the underlying granite. Most of these dikes are parallel and near-vertical, with attitudes of ~N70°W, 65°+N. Curiously, although these dikes are abundant in Tg, they rarely intrude the enclaves of Catalina Granite (map unit Tgc), even though Tgc is older than Tg. The reason for this is unknown.

TERTIARY SEDIMENTARY AND VOLCANIC ROCKS

The oldest Tertiary supracrustal rocks are exposed in the northwest corner of the study area. Fine-grained basalt (map unit Tb) directly overlies Pinal Schist. It contains tiny <1 mm anhedral to subhedral phenocrysts of olivine everywhere altered to red opaques in an aphanitic matrix. The rock weathers to shades of maroon and dark red-gray and is commonly vesicular. Locally, vesicles are filled with silica. In the exposures on the south side of Parker Canyon some round, oval amygdules are as large as chicken eggs. Some amygdules are solid and are composed of banded chert. Others are mostly hollow and are lined with chert and coarse-grained quartz. Exposures are poor. Locally at the top of the unit is a sedimentary breccia composed of only basalt clasts (map unit Tcb). Banks and others (1978) reported a K-Ar biotite age of 26.7 ± 0.50 Ma for a quartz latite flow in the upper part of the volcanic section near Chief Butte just west of the map area. Damon and others (1996) reported a K-Ar age of 24.49 ± 0.6 Ma for andesite at Owl Head, northwest of the study area.

A sequence of four distinct conglomerates overlies the basalt. The oldest (map unit Tco) is thin and discontinuous and contains abundant poorly sorted foreign clasts including granites, quartzite, and limestone. This conglomerate likely filled topographic lows in the underlying basalt. Overlying this unit is a conglomerate containing mostly clasts of Pinal Schist. Bedding in this dark brown unit dips about 30° to the southeast. Resting on top of the tilted rocks is a striking different conglomerate composed almost completely of very poorly sorted sand- to boulder-size clasts of coarse-grained granite (map unit Tcg). This conglomerate does not appear to be tilted. All of these units are cut by the Guild Wash Fault. Unconformably overlying these faulted rocks is the main basin-filling conglomerate exposed in the map area (map unit Tcy). It is composed of interbedded poorly to moderately sorted conglomerate and grussy sandstone containing diverse clasts from all rock types in the area.

In the southeastern corner of the map area south and north of Canada del Oro, older sandstone and conglomerate containing only granite clasts are overlain by younger sandstone and conglomerate containing diverse clasts. This succession mimics the succession in the northwestern corner of the map area. As with the units on the north side of the Tortolita Mountains, the older, granite-rich conglomerate on the west side of the

Santa Catalina Mountains is cut by the basin-bounding Pirate Fault but the overlying conglomerate with diverse clasts is not. The similarity between the sequences suggests that the entire basin between the Santa Catalina Mountains and the Tortolita Mountains may be underlain by the same succession of units. The hanging wall of the Pirate Fault at depth may contain volcanic rocks as well.

The similar sequence of at least the upper two conglomerates along the Pirate and Guild Wash Faults suggests a similar mode of formation. The very poorly sorted, nonbedded and monolithic nature of the lower granite-rich conglomerate suggests it was deposited as avalanche debris flows close to a source composed only of exposed granite. Both areas have sources exposed today on the opposite side of the faults. It seems likely, therefore, that rapid movement and vertical offset on the Pirate and Guild Wash Faults produced high topographic scarps that shed material via mass movement. Conversely, the uppermost conglomerate is unfaulted and composed of moderately sorted, clast-supported fluvial sandstones and conglomerates containing many diverse lithologies. These deposits were deposited after faulting had ceased and subsequent deposition reflected slower erosion of the topographically more subdued hanging walls. The fact that the contact (where visible) between the two conglomerate units is so sharp suggests either that there is an erosion surface separating the two, or that the gradational part is buried, possibly in lower structural levels of a fanning-dip sequence.

QUATERNARY GEOMORPHOLOGY

The marked lithologic contrast between the older, faulted granitic conglomerate and the younger, unfaulted poly lithic conglomerate suggests a change from relatively rapid erosion of steep, active fault scarps to less energetic, more widespread alluvial-fan deposition. The change was heralded by the cessation of faulting along the Pirate and Guild Wash Faults. The younger, unfaulted conglomerate (map unit Tcy) grades upward into the oldest geomorphic surface in the area, the Cordones surface. Based on the magnetostratigraphy of a similar sedimentary sequence in the Sonoita Creek Basin (Menges and McFadden, 1981) map unit Tcy was probably deposited between about 6 to 3 Ma.

Erosional pediments 2-4 km-wide are etched into granitic rocks on both sides of the valley. Within the map area, only the pediment on the eastern side of the Tortolita Mountains is exposed. In the northwest part of the study area the Tortolita pediment appears to be overlain by the younger conglomerate (map unit Tcy). Pediments can only form during periods of tectonic quiescence when there is relatively little downcutting. Therefore, the pediment here developed after faulting ceased and probably over a considerable amount of time (at least 2-5 m.y. according to Menges and McFadden, 1981). If the pediment was already formed prior to younger basin-fill deposition then it already existed prior to sometime between 6 to 3 Ma. Most of the pediment to the south is overlain by middle Pleistocene alluvial surfaces (map unit Qm). From a distance these deposits are nearly indistinguishable from the granitic rocks. Basin-fill conglomerates may have once existed on the southern pediment but were subsequently removed prior to the middle Pleistocene.

The oldest geomorphic surface in the area, the Cordones surface, is exposed as a high, dissected plateau in the southeast part of the study area. It is defined by a mature soil horizon 1-3 meters thick and a rather flat, though deeply dissected, constructional surface. Where exposed, the most obvious feature of the soil horizon is a thick accumulation of calcium carbonate, up to 2 meters thick locally and commonly forming wavy laminae. On the upper reaches of the surface a dark red-brown argillic horizon is exposed at the surface. Farther down, however, erosion has removed most of the argillic horizon and the carbonate horizon is exposed. This distinction can be seen on aerial photos where the argillic zones appear dark-colored and the carbonate zones appear light-colored. Apart from the soil accumulation, the Cordones surface itself is sedimentologically indistinct from the underlying basin-fill deposits. Map unit Tcy appears to grade upward without break into the soil horizon. McFadden (1981) observed that the Cordones surface contains some large boulders 2-3 meters across. Good exposures of map unit Tcy are rare but towards the eastern part of the study area similarly large boulders appear to be weathering out of the conglomerate as well.

Unfortunately, a mantle of loose rubble and dark, clay-rich soil blankets and obscures almost all of the exposures of the basin-fill conglomerate. Rare exposures can be found in road cuts and a few stream cuts. Because of the poor exposures interpretations should be taken with some caution.

As McFadden (1981) pointed out, even though the drainage basin of Big Wash, the main axial drainage, is greater than that of Canada del Oro, the Canada del Oro drains the steep western front of the high-standing Santa Catalina Mountains. Because more moisture accumulates on the high mountain range the Canada del Oro is supplied with much more runoff. Probably because of this the Quaternary stream terraces along Canada del Oro are wider and better developed than those along Grand Wash.

McFadden (1981) described and named six distinct terrace levels along the Canada del Oro. He noted the general correlation between increasing clay content, thickness of the argillic horizon, and progressively redder soil color, with progressively older soils. In general, older soils show increasing accumulation of clay and calcium carbonate. He observed, however, that although the early Pleistocene Cordones surface contains very abundant carbonate, the next younger middle and late Pleistocene soils contained almost no carbonate. His interpretation was that the soil formation and carbonate accumulation was not only a function of age but of climatic change. During the middle and late Pleistocene infiltration and leaching rates were higher than they were in the early Pleistocene, possibly due to increased precipitation, and less carbonate accumulated. During this study, eight distinct stream terrace levels were mapped along Canada del Oro. They formed in response to renewed downcutting, probably in response to climatic changes during the Pleistocene.

STRUCTURE

The Guild Wash Fault strikes northeast along the north side of the Tortolita Mountains. It downdrops Tertiary sedimentary and volcanic rocks, and middle Proterozoic granite on the north against Tertiary granite (map unit Tg), middle Proterozoic granite, and early Proterozoic Pinal Schist on the south. The attitude of the fault was not visible, but the steep, north-sloping edge of the Tortolita Mountains suggests it is a normal fault. As described above, the fault was active up through deposition of the older granitic conglomerate (map unit Tcg) but is overlain by unfaulted younger conglomerate (map unit Tcy). The basalt north of the fault is generally extensively altered. All mafic minerals are altered to red opaques and locally the rock has been extensively silicified. In thin-section, the cavities in what was once very porous basalt have been filled with granular microcrystalline chert of at least two generations. Locally the rock is rusty brown-colored and fractures easily.

An east-dipping normal fault strikes northwest across the eastern Tortolita Mountains where it intersects the Guild Wash Fault. Unfortunately, Holocene deposits bury the intersection itself, so it is not clear which fault is older. Slight apparent offset in the Guild Wash Fault suggests it is older but variation in the strike may cause the same effect. Other northwest-striking normal faults are locally visible but identifying faults within granite is difficult, and thus they may be more extensive than shown.

South of Chalk Reservoir, at the southeastern-most exposures of the pediment, the felsic granite (map unit Tgf) and intruding dikes (not shown) are pervasively fractured and microbrecciated. This fabric suggests there may be a larger structure buried immediately to the east of these exposures. Maybe the Tortolita detachment fault forms a reentrant along the east side of the range. McFadden (1981) suggested that the Canada del Oro Valley is a graben formed by the Pirate Fault bounding the Santa Catalina Mountains and another fault bounding the east side of the Tortolita Mountains. If a graben exists then displacement along the Pirate Fault apparently was much greater than that along the fault to the west, owing to the enormous amount of relief between the Tortolita and Santa Catalina Mountains. This one-sided graben makes more sense if the Tortolita Mountains rotated as one block down along the Pirate Fault, rather than the Tortolita Mountains being a horst and the valley a graben.

The strike of the primary foliation (S_1) in the Pinal Schist shows an interesting pattern. South of the Guild Wash Fault it strikes consistently to the northeast, and dips moderately to steeply to the northwest. North of the fault, however, it strikes almost at right angles to this to the northwest. The reason is unclear.

The secondary foliation (S_2) strikes rather consistently north-northwest and dips moderately to steeply to the east-northeast. Locally, it forms a pervasive, weak crenulation, but in most areas it forms beautiful kink-bands showing right-lateral movement. Lineation in both S_1 and S_2 are defined by mineral alignment and elongation.

All of the plutonic rocks in the study area are at least locally foliated. Interestingly, the attitude of the foliations (both S_1 and S_2) mimic those in the Pinal Schist and younger metamorphic rocks. In the north S_1 in map unit Tg strikes northeast as it does in the Pinal Schist. North of the Guild Wash Fault S_1 in map unit Yg strikes northwest but is parallel to S_1 in the Pinal Schist (map unit Tcp). To the south the strike of the foliation in the granitic rocks shifts to the northwest. In the same area foliation in the enclaves of metamorphic rocks also strikes in the same direction.

The concordance of foliation between younger and older rocks suggests foliation was developed after intrusion of the youngest plutons. However, the early Proterozoic age of the Pinal Schist and its highly deformed character throughout other parts of the state suggests that, here too, the Pinal Schist was deformed in the middle Proterozoic. That conclusion may be incorrect. Compositional banding defining S_1 in the Pinal Schist is well defined and deformed locally by minor isoclinal folding. If a second, much later generation of foliation deformed the rock it is likely that it would not exactly parallel the first episode and there should be some evidence for it. If the second generation of foliation was strong enough to obliterate the previous generation, then the granitic rocks should be much more strongly deformed than they are.

Other evidence indicates that deformation occurred both during and after intrusion of at least one of the plutons. The Catalina Granite (map unit Tgc) locally contains mafic inclusions. Where visible, these inclusions are elongate parallel to the local foliation direction, but the amount of their elongation is clearly much greater than that required to create the foliation. Further evidence for this can be seen in weakly foliated zones that grade into zones showing no visible foliation, yet the inclusions display the same elongation in the same direction. The elongation suggests the inclusions were deformed and aligned while the pluton was still partially molten. Since the elongate inclusions are parallel to the plane of foliation, the granite probably intruded an area that was undergoing differential stress and being actively deformed. Foliation in the older metasedimentary enclaves within the Catalina Granite is also parallel to foliation in the Catalina Granite.

Since the Catalina Granite is the oldest of the four Tertiary plutons exposed in the study area, deformation either ceased after its intrusion and resumed after the youngest pluton had intruded (map unit Tgf), or deformation was continuous over the entire time period of intrusion of the plutons.

MINERALIZATION

Very little mineralization was seen. A few small, widely separated pits were dug into granite (map unit Tg) and showed fractures coated with minor amounts of chrysocolla and malachite.

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**UNIT DESCRIPTIONS
FOR THE ORACLE JUNCTION QUADRANGLE
AZGS OFR-00-04**

Quaternary Surficial Deposits

- d** **disturbed by human activity (Modern).** Thoroughly disturbed areas where human modifications of the landscape have obscured the geology.
- Qy₂** **Modern alluvium (< 100 yr).** Unconsolidated sand and gravel in active stream channels. Deposits consist of stratified, poorly to moderate sorted sand, gravel, pebbles, cobbles, and boulders. These deposits are highly porous and permeable. Soils are generally absent.
- Qy₁** **Holocene alluvial deposits (>100 yr and < 10 ka).** Unconsolidated sand to small boulders reaching sizes up to 25 cm in diameter upstream but smaller and fewer downstream. Larger clasts are metamorphic rocks and medium-grained granites. Smaller clasts are subangular fragments and crystals derived from weathered granitoids. Qy₁ deposits are characterized by stratified, poorly to moderately sorted sand, gravel, and cobbles frequently mantled by sandy loam sediment. On this surface the main channel commonly diverges into braided channels. Locally exhibits bar and swale topography, the bars being typically more vegetated. Soil development is relatively weak with only slight texturally or structurally modified B horizons and slight calcification (Stage I). Some of the older Qy₁ soils may contain weakly developed argillic horizons. Because surface soils are not indurated with clay or calcium carbonate, these surfaces have relatively high permeability and porosity.
- Qy** **Holocene alluvial deposits, undivided (< 10 ka).**
- Qyl** **Late Pleistocene to Holocene alluvial deposits, undivided.**
- Ql₂** **Late Pleistocene alluvial deposits, younger member (10 to 130 ka).** The top 30-40 cm is tan, thinly bedded, coarse and fine sand and less silt. Below is a dark brown (organic?) zone 50-80 cm thick, gradational at the bottom, containing sandy grus and abundant roots and root clasts. Below this, layers of moderately to poorly consolidated tan sand contain minor subangular to rounded pebbles and minor red clay. No carbonate is visible. Grass and mesquite grow on this surface.
- Ql₁** **Late Pleistocene alluvial deposits, older member (10 to 130 ka).**
- Ql** **Late Pleistocene alluvial deposits, undivided (10 to 130 ka).**
- Qm₂** **Middle Pleistocene alluvial deposits, younger member (130 to 750 ka).** Very similar to Qm₁. Consists of sandy to grussy sandstone and conglomerate containing subangular to rounded cobbles up to about 10 cm. The top 1 meter or so contains abundant clay that forms vertical columns/peds. Abundant clay films on clasts. Locally contains thin, wavy accumulations and irregularly shaped nodules of carbonate. Prickly pear and cholla grow on this surface.
- Qm₁** **Middle Pleistocene alluvial deposits, older member (130 to 750 ka).** Along Canada del Oro the top 30-80 centimeters of these deposits contain poorly sorted, subangular to well rounded pebbles

and cobbles up to 40 cm across, in a light to dark brown, grussy matrix. This horizon locally contains much clay, but crumbles easily. The underlying 40-100 centimeters is hard, dark, red-brown grus-rich clay with peds. Moderately to strongly consolidated. Most roots are in this layer. Below this is a carbonate-rich clay zone of uncertain thickness. Grass, prickly pear and chain-fruit chollas grow on this surface.

Qm Middle Pleistocene alluvial deposits, undivided (130 to 750 ka).

Qo₂ Early Pleistocene alluvial deposits, younger member (750 ka to 2 Ma). These deposits are poorly exposed. They contain subrounded to well rounded pebbles and cobbles up to about 30-40 cm, and less common boulders. Clasts are mostly quartzite, with less abundant Yg, fine-grained schist, metadacite, gray-green crystal-rich hypabyssal(?) felsic rock, metaconglomerate, vein quartz, and medium- to fine-grained granite. Boulders are quartzite and medium- to fine-grained granite. Clay-rich soil is dark red-brown. Clast lag mantles the tops of smooth hills south of The Cordones.

Qo₁ Early Pleistocene alluvial deposits, older member (750 ka to 2 Ma). This unit is poorly to moderately sorted conglomerate and minor interbedded sandstone. The clast lithologies are similar to those in the underlying Tcy deposits. The matrix contains abundant platy laminae of carbonate (Stage III). The top surface is sandy, tan, and rather flat. Locally carbonate is exposed at the surface. In many areas a thick, dark brown argillic soil forms the uppermost 1 meter. Even though this unit is lithologically similar to the underlying Tcy deposits, it exhibits a well-developed soil horizon and forms a discrete stable surface that was probably the uppermost level of the aggrading basin-fill deposits. Equivalent to the Cordones Surface (McFadden, 1981).

Tertiary Sedimentary and Volcanic Rocks


Tcy Younger conglomerate (late Tertiary). In the eastern part of the map area, beneath The Cordones, interbedded conglomerate and sandstone is moderately to poorly sorted and contains subangular to well-rounded clasts of coarse-grained granite (map unit Yg), fine-grained leucogranite, light green crystal-rich hypabyssal(?) dacite, diabase, fine-grained schist, and abundant quartzite. Moderately to strongly consolidated. This unit grades upward into sedimentologically identical alluvial deposits of map unit Qo₁. West of Falcon Valley, in the northwest part of the map area, these deposits are composed of interbedded poorly to moderately sorted conglomerate and grussy sandstone. The unit contains angular to subrounded clasts derived from map units Yg, Tg, Xs, and grus, all in a tan silty matrix containing minor carbonate cement. Largest clasts are ~30 cm across, but most are pebble- to cobble-size.

Tsg Sandstone and conglomerate with granite clasts (late Tertiary). This unit is mostly medium-bedded, tan, grussy sandstone and minor conglomerate. Exposed in the southeast corner of the study area on either side of the Canada del Oro. These light gray, moderately to poorly sorted sediments contain subrounded clasts of almost exclusively biotite-rich K-feldspar megacrystic coarse-grained granite, and minor fine-grained leucocratic granite. The matrix is thin to medium bedded sand and abundant gravely grus. No other clasts are visible. Locally, channels cut down into lower beds. The base of the channels locally have linings of thin carbonate layers a few centimeters thick. Interbedded light tan layers may be incipient soil horizons. A few large, scattered boulders form a lag on the surface but are not common in outcrops. These deposits are moderately to poorly consolidated and generally crumble easily. Where more strongly consolidated the matrix contains minor carbonate. Rill erosion is common. Bedding, where visible, appears to be nearly horizontal. Good exposures are

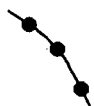
visible only in road cuts. Exposures down-slope of The Cordones are almost everywhere mantled by cobbles eroded from the upslope.

- Tcg Conglomerate with granite clasts (late Tertiary).** These deposits contain exclusively coarse-grained granite clasts (map unit Yg). Clast sizes range from sand to large, round boulders over 1 meter across. Good exposures are rare, but the unit appears to be massive. No bedding is visible, although good exposures are rare. Minor carbonate is present locally in the matrix. Moderately consolidated. Forms light gray rounded hills in the northeast corner of the Tortolita Mountains quadrangle. These deposits may be time-equivalent to map unit Tsg.
- Tcp Conglomerate with Pinal schist clasts (late Tertiary).** These interbedded conglomerates and sandstones contain mostly subangular to subrounded clasts of Pinal Schist (map unit Xp), cobble-size and smaller. Less abundant clast lithologies include pink, biotite-muscovite granite, minor basalt, and rare gritty metaconglomerate and maroon quartzite. Matrix is sand and fine tan silt, with minor carbonate. Locally grussy. From a distance this unit looks dark gray to brown and forms rounded hills. A dark red-brown soil on the surface is common.
- Tco Older conglomerate (middle to late Tertiary).** This conglomerate is exposed in one small area overlying basalt in the northwestern part of the study area. It is poorly sorted and contains subangular to rounded pebble- to cobble-size clasts of granite, dacite, granite porphyry, red sandy metaconglomerate, fine-grained felsic dikes, lithic tuff, rounded cobbles of quartz and quartzite, rare limestone and fine-grained metasandstone/slate, all in a red, sandy matrix. Exposures are poor and the unit forms gentle slopes.
- Tcb Conglomerate with basalt clasts (middle to late Tertiary).** This conglomerate contains angular to subrounded basalt clasts up to about 50 cm in diameter, in a light tan sandy to silty matrix with siliceous cement. Strongly consolidated. Appears to overlie basalt (map unit Tb).
- Tb Basalt (Tertiary).** Contains tiny <1 mm anhedral to subhedral phenocrysts of olivine altered to red opaques in an aphanitic matrix. Weathers to shades of maroon and dark red-gray. Commonly vesicular. Locally, vesicles are filled with silica. In the exposures on the south side of Parker Canyon some round, oval amygdules are as large as chicken eggs. Some amygdules are solid and are composed of banded chert. Others are mostly hollow and are lined with chert and coarse-grained quartz.
- Tri Intrusive rhyolite (Tertiary).** Very similar in composition to the rhyolite dikes. Contains abundant subhedral pink to light gray feldspar and clear quartz, both 1-2 mm across, in a light gray aphanitic matrix. Forms one large, lens-like body in section 20, T. 10 S., R. 13 E.

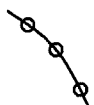
Dikes



Dacite (?) dikes (Tertiary). These light gray to tan crystal-rich dikes contain subhedral to euhedral K-feldspar commonly 2-8mm wide and rarely as large as 1.5 cm, and anhedral books of dark green biotite/chlorite. The matrix is light tan and aphanitic. Locally biotite is nearly absent. These dikes are up to 2-3 meters thick and form prominent, resistant stripes across the landscape. They commonly exhibit a weak to moderate varnish on which many petroglyphs were carved.



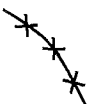
Rhyolite dikes (Tertiary). These light gray dikes contain abundant subhedral pink to light gray feldspar and clear quartz, both 1-2 mm across, in a light gray aphanitic matrix. Locally, these dikes show weak to moderate, near-vertical flow-banding.



Quartz veins (Tertiary? Proterozoic?). These dikes contain mostly light gray vein quartz, commonly fractured and locally brecciated. In section 33, T. 9 S., R. 13 E., in the northwest part of the map area, the margins of at least two of the have pegmatitic margins and include graphically intergrown K-feldspar and quartz that forms very long, near-vertical rods.



Pegmatite dikes (Tertiary?) [not mapped individually]. These thick, tabular, and locally irregularly shaped bodies contain very coarse, intergrown, light gray K-feldspar and gray quartz from a few mm up to ~5 cm. No mafic minerals were seen. Locally exhibits graphic texture. These dikes are so abundant in the southwest part of the study area that they locally comprise over 60% of the exposed bedrock. In these areas their abundance, plus their erosion products, has nearly completely concealed the underlying granite. Most of these dikes are parallel and near-vertical, with attitudes of ~N70°W, 65°N.



Leucocratic granite dikes (Tertiary). These fine-grained granite dikes contain phenocrysts of subhedral, K-feldspar up to 3 mm wide in a matrix of fine-grained light gray feldspar, quartz, and minor biotite. The rock resembles map unit Tgf and the two may be equivalent.

Tertiary Intrusive Rocks

Tgf Medium-grained felsic granitoid (Middle Tertiary). This medium-grained felsic granite contains phenocrysts of light gray anhedral to subhedral feldspar and quartz up to 4 mm, and less than about 5-10% biotite mostly to partially altered to hematite. Exposed in the southern part of the study area where it forms resistant, light tan hills and dikes cutting map unit Tgm. Locally, the rock is prominently jointed. In most areas a weak to moderate foliation is visible, defined by alignment of biotite phenocrysts. The granite is cut by leucocratic dikes and light gray aplite dikes. South of Chalk Reservoir the granite and the dikes are pervasively fractured and microbrecciated, and contain abundant epidote and slickensides. Tiny, clear, euhedral secondary quartz crystals line cavities between breccia clasts. Some major fractures are filled with white, fine-grained silica up to 1 cm thick.

Tgm Fine-grained mafic granitoid (Middle Tertiary)—Tortolita Granite. This fine- to medium-grained mafic granitoid contains ~30-40% biotite in fresh anhedral to subhedral thin books 2-6 mm wide and locally up to 1 cm wide. Locally, the biotite phenocrysts are lath-like and resemble amphibole. The rest of the rock is light gray plagioclase and quartz. Dark subhedral hornblende phenocrysts up to 1 cm are common only locally, at the expense of biotite. Yellow sphene (titanite) 1-2 mm is common. Where hornblende is more abundant so is sphene. In thin-section abundant biotite and hornblende exhibit deep green pleochroism and are partially to mostly altered to chlorite. Higher relief, light green, subhedral clinopyroxene is locally abundant. Plagioclase is subhedral and commonly partly sericitized. K-feldspar is poikilitic to all other minerals. Quartz is rare. Hexagonal cross-sections and stubby laths of apatite are common. Locally this granite contains stringy inclusions of granite of map unit Yg. A slightly more mafic phase containing abundant hornblende is only locally distinguishable from the less mafic phase containing mostly biotite. The hornblende-rich phase contains the Yg inclusions, and both the host rock and the inclusions are cross-cut by the biotite-rich phase. Weathers dark gray and erodes readily into low hills and slopes.

Tg Medium- to coarse-grained granite (Middle Tertiary)—“Derrio Canyon Granodiorite”? Contains light gray anhedral to subhedral feldspar, quartz, abundant biotite, and locally minor amphibole. The grain-size and texture of this rock varies. Locally it is medium-grained and relatively equigranular to marginally K-feldspar-porphyritic and in other areas it is coarse-grained and contains K-feldspar megacrysts up to 1.5-2 cm across. Where coarse-grained the rock resembles granite of map unit Yg, but elsewhere it commonly contains more abundant biotite which is almost everywhere weakly to strongly altered to dark green chlorite. Locally, yellow sphene (titanite) crystals up to 2 mm wide are common. Although barely noticeable locally, this unit exhibits a widespread foliation defined by alignment of biotite phenocrysts. In thin-section, K-feldspar phenocrysts are large and anhedral. Quartz is smaller with jagged, irregularly shaped, sutured borders. Biotite is mostly altered to chlorite. Sphene is subhedral to euhedral. High relief, clear-pleochroic, high-birefringent anhedral minerals occur in fine-grained clots and as individual grains. Some show suggestions of cleavage and one is twinned. The birefringence resembles zircon but the mineral is uncertain. Banks and others (1978) called this pluton the Chirreon Wash Granodiorite and reported a K-Ar biotite age of 25.10 ± 0.50 Ma. Their sample, however, as reported in Reynolds and others (1986), was taken from the west side of the divide at the head of Batamote Wash, two miles to the south of Chirreon Wash. Banks and others (1978) reported a K-Ar biotite age of 24.0 ± 0.50 Ma on an unfoliated “quartz monzonite” dike apparently cutting this rock. Their sample was taken from near Bass Spring about 1 mile west of the map area.

Tgc Catalina Granite (Middle Tertiary). This coarse-grained, K-feldspar porphyritic granite contains phenocrysts of subhedral, light gray to pink K-feldspar 1.5-2.5 cm wide, subhedral light gray plagioclase, clear gray quartz, and ~10-15% anhedral to subhedral books of biotite, locally partially altered to hematite. In several places, particularly just north of the Crow Windmill in the southeast corner of the Tortolita Mountains quadrangle, this granite contains dark, aligned inclusions parallel to a weak foliation. The inclusions are similar in composition to the granite but contain more abundant biotite (restite?). Several radiometric geochronologic analyses have yielded reliable ages between 24 and 29 Ma (Keith et al., 1980; Reynolds et al., 1986).

Paleozoic/Mesozoic? Metamorphic Rocks

Kc Metaconglomerate (Cretaceous?). This unit is poorly sorted to moderately sorted and contains subrounded to well rounded pebbles to large cobbles of vein quartz and light gray quartzite. Some of the larger quartzite clasts show bedding defined by iron-oxide laminae. The matrix of this rock is locally bedded iron-oxide-rich sand that has been smeared out into wavy bands. Many of the clasts are partially deformed. Many are broken or are slightly elongated and lens-like. Exposed only as tiny enclaves, each only a few meters across, in sections 26, 27, 34, and 35 in T. 10 S., R. 13 E., in the southern part of the map area. This unit is tentatively correlated with the Glance Conglomerate member of the Bisbee Group.

Pzm Marble (Paleozoic). This metamorphosed light gray limestone is composed of medium-grained interlocking calcite crystals up to 1-3 mm wide. Layering defined by slight textural differences and partings may be original bedding, but may be metamorphic foliation as well. Because of the uncertainty it was mapped with a foliation symbol. In thin-section, the rock is composed of coarse-grained, interlocking calcite crystals. Minor faint trains of tiny opaque minerals define foliation/layering. The unit commonly exhibits lens-like forms tens of centimeters long and ~1-3 cm wide that are tan-colored and weather out in relief on weathered surfaces. The forms resemble chert

stringers, but when the stringers are broken open they are composed of medium-grained calcite crystals. They may have been originally chert now replaced by calcite. In one place where in contact with Yg, the rock contains large, white, fibrous crystals (tremolite? wollastonite?). Typically the unit is very resistant and forms the tops of hills in the southwest part of the map area. The pure marble that has been quarried is thought to be metamorphosed Escabrosa Limestone of Mississippian age (J.E. Spencer, written communication, 2000).

- Es** **Metasedimentary rocks, undivided (Cambrian?).** Includes psammite, pelite, and calcareous pelite. This unit contains light gray to green, laminated and/or banded fine-grained siliceous layers. Some beds are quartzite. Finer, more massive green beds locally contain elongated, light gray lenses that may have once been chert in limestone or clasts in a conglomerate. Locally, quartzite beds are more resistant and stand out in relief. Fine-grained epidote and coarse-grained pyrope garnet are locally abundant. Locally up to 5% of the unit consists of interbeds of light gray carbonate 5-30 cm thick. This unit is generally resistant and forms blocky slopes and small ledges. Fresh surfaces are light green to tan. Weathered surfaces are dark. Clasts littering the surface commonly exhibit an orange varnish. This unit is tentatively correlated with the Cambrian Abrigo Formation.
- Cq** **Quartzite (Cambrian).** Gray to purple quartzite. Mostly recrystallized. Banding is common, but it is not clear if it is original bedding or a metamorphic foliation. In some areas the banding resembles bedding defined by iron-oxide laminations, but because of the uncertainty it was mapped with a foliation symbol. In thin-section, most of the section is highly strained and elongated quartz crystals have very irregularly shaped borders. Garnet occurs as isolated crystals and as long trains of crystals that resemble veins, cutting across elongation of the quartz. Garnet is anhedral to subhedral and is not strained. Rare, isolated clear grains with high relief and moderate to high birefringence may be pyroxene(?). This unit occurs either at the base or the top of the section of metamorphic rocks (up-direction is uncertain). It is best exposed on the large hill at the Catalina Marble mine (north of the area mapped as “disturbed by human activity”), and on the divide about 1 mile west-southwest of the mine. Forms dark resistant ledges with blocky outcrops.

Middle Proterozoic Intrusive Rocks

- Yd** **Diabase (Middle Proterozoic).** Contains rectangular lath-like phenocrysts of light gray plagioclase and dark green pyroxene up to 6 mm long. Pyroxene is partially altered to red opaques. Forms dark green crumbly slopes. Intrudes coarse-grained granite (map unit Yg) in the northwest part of the study area.
- Yg** **Coarse-grained granite (Middle Proterozoic).** Contains abundant light tan to pink K-feldspar megacrysts commonly 1.5-2.5 cm wide, and locally as long as 4 cm. Also contains smaller phenocrysts of light gray subhedral plagioclase, clear-gray quartz, and ~10% fresh, thin, anhedral books of biotite 1-3 mm wide. In the northwest corner of the map area this rock is cut by a pink, medium-grained granite of similar composition plus minor muscovite. Exposures there are round and grussy so mapping contacts was not attempted. Both granites are foliated, with foliation defined by aligned biotite and locally augen-shaped feldspar phenocrysts. This unit erodes readily into low, grus-covered hills and pediment.

Early Proterozoic Metamorphic Rocks

Xp **Pinal Schist (Early Proterozoic).** Quartz-muscovite±biotite schist. In section 31, T. 9 S., R. 13 E., the rock is fine-grained, tan-colored schist that breaks into blocks. In most areas, however, the rock is dark tan to gray. In the northwest corner of section 4, T. 10 S., R. 13 E subrounded, slightly elongated quartz grains are visible in weakly foliated outcrops. Overall, though, this unit exhibits a strong, planar S_1 foliation, locally cut by narrow S_2 kink-bands. Thin compositional banding is common and locally defines small nearly isoclinal folds axial planar to S_1 . This unit forms resistant dark-colored hills shedding angular, cobble-sized platy fragments.