# Geologic map of the Corona de Tucson 7 ½' Quadrangle, Pima County, Arizona

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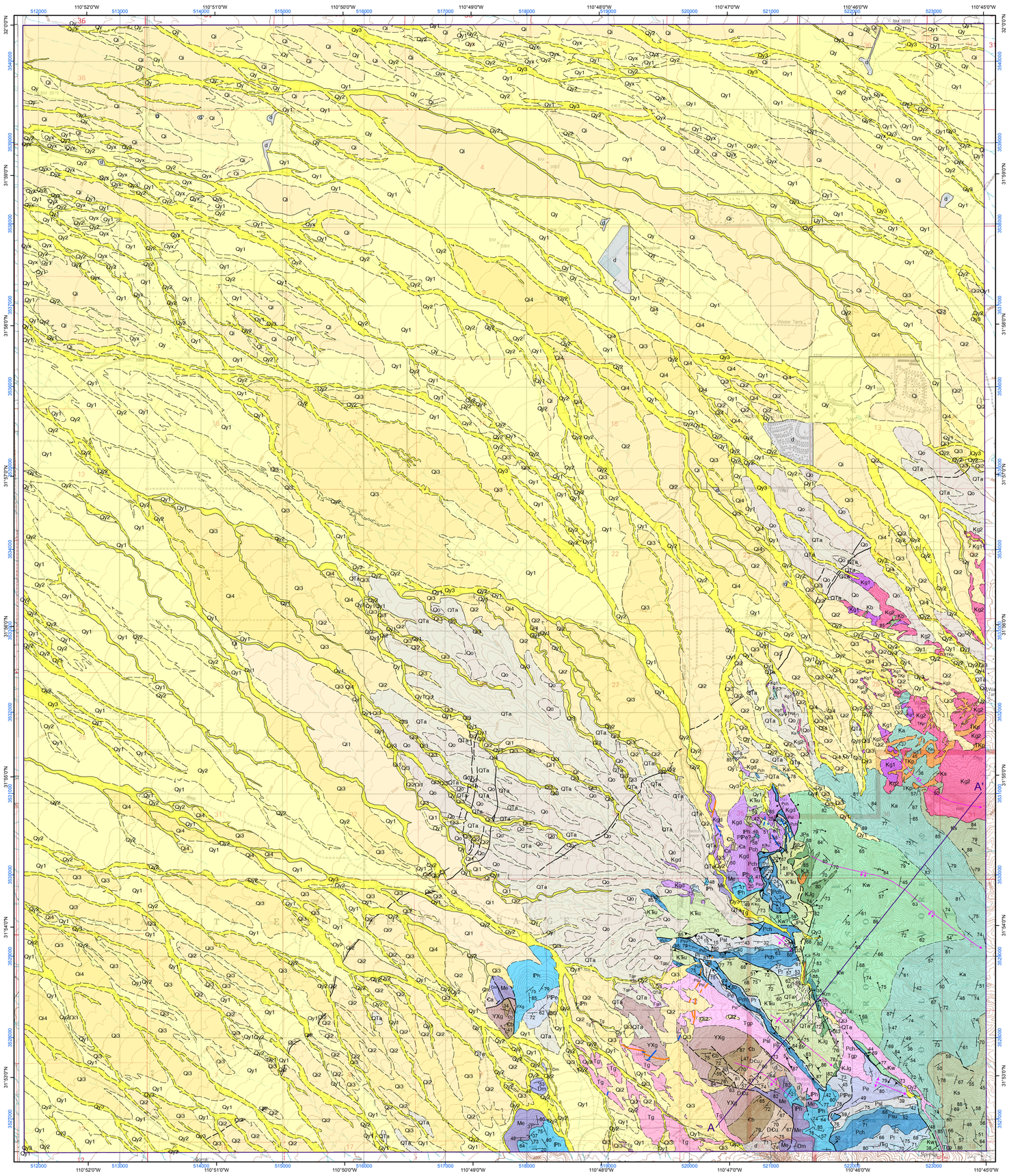
Arizona Geological Survey
Digital Geologic Map 115 (DGM-115) v.2
September 2021




**Citation for this map:**

Johnson, B.J., Pearthree, P.A., and Ferguson, C.A., 2021, Geologic map of the Corona de Tucson 7 ½' Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-115, v.2, scale 1:24,000.

*Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G14AC00424. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.*

## Introduction

The Corona de Tucson 7 ½' Quadrangle is located in the southeastern margin of the Tucson basin in Pima County, southeastern Arizona. The map area encompasses developed and undeveloped portions of the southern and southeastern suburban fringe of the Tucson metropolitan area. It includes the northwest flank of the Santa Rita Mountains and the piedmont that extends west and northwest toward the Santa Cruz River. Geologic mapping was done under the joint State-Federal STATEMAP program, as specified in the National Geologic Mapping Act of 1992, and was jointly funded by the Arizona Geological Survey and the U.S. Geological Survey under STATEMAP assistance award #G14AC00424. Mapping was compiled digitally using ESRI ArcGIS software.

## Surficial Geology

The surficial geology of the Corona de Tucson 7 ½' Quadrangle is diverse. On the upper piedmont near the mountain front, there are impressive high-standing relict alluvial fan deposits and many generations of nested inset alluvial fans and terraces. Topographic relief is much less in middle and lower piedmont areas, where deposits include widespread successions of Pleistocene alluvium with clay-rich soils, widespread late Pleistocene and early Holocene deposits forming fairly young but mainly inactive alluvial fans, and unconsolidated Holocene alluvial fan, terrace, and channel deposits associated with complex distributary channel networks.

Surficial geologic units were mapped using field observations, digital aerial imagery, and digital elevation models (DEMs). Relative ages of alluvial deposits were estimated using characteristics of clast weathering, soil development, carbonate accumulation, and position in the landscape (Gile et al., 1981; Machette, 1985; Bull, 1991; Birkland, 1999). Soil development and carbonate accumulation begin once a deposit is isolated from active alluvial processes. As a result, the degree of soil development and carbonate accumulation are one of the criteria used to identify the approximate ages of surficial units (Pearthree and Calvo, 1987).

Younger alluvial deposits have minimal soil development, retain the original brown or tan color of the alluvial sediment, and little or no carbonate accumulation. Clasts in these deposits have no weathering rinds or light-colored surface patinas and thus appear much fresher than older clasts. If reasonably coarse, young alluvial surfaces commonly retain original depositional characteristics such as bars and swales, but fine-grained young surfaces may be fairly planar. Conversely, older alluvial deposits have more strongly developed orange, reddish brown, or red soils, with soil horizons reflecting moderate to strong clay and carbonate accumulations. Clasts on older alluvial deposits often exhibit darkened weathering rinds or reddish or orange rock varnish, and thus appear darker on the ground and in aerial photographs. Preserved alluvial surfaces may be smooth and flat (Qi3), becoming variably rounded and coarser with age (Qi2). Yet older alluvial surfaces (Qi1, Qo) are typically relatively high in the landscape and have very strong soil development on well-preserved surfaces, but most of the original alluvial surfaces have been eroded. On aerial imagery these surfaces appear red where well-preserved, and gray or white where they are more eroded do to widespread exposure of the carbonate horizon. The oldest surficial deposits (QTa) formed well-rounded ridges with relatively weak soil development due to erosion.

This map provides insights into several geologic hazards in the quadrangle. The complex pattern of distributary and anastomosing channels and associated young deposits in many piedmont areas is indicative of the potential for complicated and extensive flooding. Areas of extensive young deposits and distributary channel networks (active alluvial fans) have some potential for instability and channel changes during floods. Other areas covered with young deposits are probably fairly stable, but nonetheless may be subject to broad, shallow inundation during floods. The extensive deposits of early to middle Holocene in age (Qy1) probably record increased sediment supply from the mountains during or after the global transition from glacial to interglacial climatic conditions (e.g., Bull, 1991). This mapping also provides insights into the history of Quaternary displacement on the northern part of the Santa Rita fault zone. The fault zone is 1-2.5 km outboard from the topographic mountain front, and the general trend of this fault zone is NE-SW, parallel to the mountain front. Surface faulting probably links at relatively shallow depth to a W- to NW-dipping low-angle fault (Johnson and Loy, 1992). Late to early Pleistocene alluvial fan deposits are clearly displaced by the fault zone; latest Pleistocene and younger deposits are not displaced. Fault scarps range in height from about 1 to 4 m, and are generally higher on middle and early Pleistocene fans than on late Pleistocene fans and terraces, indicating that recurrent movement has occurred on this fault during the Quaternary with the most recent surface faulting event in the late Pleistocene (Pearthree and Calvo, 1987).

## Bedrock Geology

The southeast corner of the Corona de Tucson quadrangle encompasses a small part of the northwestern edge of the Santa Rita Mountains. Bedrock is exposed in the mountains and foothills, on pediment marginal to the mountain front, and in a few inselbergs that rise from the adjacent piedmont. Bedrock map units include Proterozoic granitic basement rocks overtain unconformably by Paleozoic carbonate and subordinate siliciclastic sedimentary rocks, in turn overlain unconformably by Mesozoic clastic sedimentary rocks. These rocks have been intruded by Laramide (Late Cretaceous to Paleogene) dioritic and granitic stocks. Contact metamorphism has converted most of the carbonate rocks to marble and thinly interbedded siliciclastic and carbonate rocks to siliceous and calcsilicate hornfels. Cretaceous rocks at higher structural levels are relatively unmetamorphosed.

The Paleozoic and Mesozoic rocks have been deformed by close folds with northwest-striking, steeply southwest-dipping axial planes, moderately southeast-plunging to steeply south-plunging (nearly reclined) axes, and near-vertical northeast-facing limbs. Limbs of many of the folds have been partially sheared out along northwest-striking, steeply dipping shear zones characterized by tectonite foliation, transposed bedding, and attenuation of stratigraphic units. The most prominent of these zones extends from Bluejay Mine northwestward for at least 2 km and is delineated by a belt of upper Naco Group, including an attenuated section of unit Pch, along the contact with foliated Mesozoic rocks. Laramide and older rocks in the map area are also cut by moderate- to low-angle faults that mostly dip easterly and that appear to be of more than one generation. Drewes (1971, 1972) interpreted most of the moderately east-dipping faults and the high-angle northwest-striking faults in the northern Santa Rita Mountains as Laramide thrusts and tear faults, respectively, and described complex cross-cutting relationships between multiple generations of thrusts. Hardy (1997) interpreted the folds, thrusts, and high-angle faults in the context of oblique contraction during Laramide orogenesis. Some of the complexities and possible exceptions to these scenarios are described in the following.

An elongate granitic intrusion of unit Tgp occupies the space between the belt of upper Naco Group along the Bluejay shear zone and lower Paleozoic rocks to the southwest that strike at a high angle to the zone. Projected cutoffs of Paleozoic units are separated by 3 km or more in a left-lateral sense across the intrusion. The intrusion shows little evidence of internal deformation, although it locally contains narrow zones (a few meters thick) of mylonitic foliation and its contacts with Paleozoic rocks are in part brittle high-angle faults. A thin section from the mylonitic granite displays S-C fabric that indicates right-lateral sense of shear, at odds with the left-lateral separation of units across the zone. These relationships suggest that the granite was emplaced into an older fault or shear zone and was later deformed by relatively minor ductile shearing and brittle faulting. Hardy (1997) obtained a $^{40}Ar$-$^{39}Ar$ plateau date of 51.9 +/- 0.2 Ma on muscovite from the sheared granite, and concluded that this represents the time of secondary muscovite growth during shearing (muscovite is only present where the rock is sheared).

Southeast of the Bluejay Mine, the steeply dipping Bluejay shear zone and the Tgp intrusion are truncated by a moderately to gently east-dipping fault that carries folded Paleozoic rocks in its hanging wall. About 1 km northeast of Bluejay Mine, the northwest-striking high-angle fault contact between Paleozoic and Mesozoic rocks in Sycamore Canyon may be the displaced equivalent of the Bluejay shear zone, in the hanging wall of the east-dipping fault. Like the Bluejay zone, the high-angle fault in Sycamore Canyon is marked by a sliver of attenuated Pch and an elongate intrusion of Tgp that appears to have intruded the fault, with subsequent local faulting along its margins. The distance between the displaced remnants of the high-angle fault would constrain a minimum of ~1 km of normal-sense displacement on the east-dipping fault in the context of this interpretation. However, crosscutting relationships between the faults in Sycamore Canyon have not been clearly established, the slip vector of the east-dipping fault is uncertain, and other interpretations involving either thrust or normal displacement on that fault are admissible. A structurally higher east-dipping fault that carries Naco Group and Mesozoic rocks in its hanging wall is almost certainly a thrust.

The northernmost remnants of Paleozoic rocks (including units Psl, Psu, Pch, and Pr) are in the hanging wall of a low-angle fault that has Late Cretaceous plutonic rocks (unit Kgd) and pendants of mostly Mesozoic rocks in its footwall. The uppermost few meters of the footwall is marked by heterogeneous chloritic tectonite derived from the footwall rocks. This fault is interpreted as a low-angle normal fault. Sedimentary rocks in the hanging wall are imbricated by low-angle faults that may be subsidiary normal faults or older thrusts, or may include both.

## Acknowledgments

Much of the bedrock exposure is on or adjacent to property owned by Ocotillo Ranch, and access was greatly facilitated by the generous cooperation of caretaker Brad Smith and his family. Simone Hunyor of the University of Arizona shared unpublished (2016) U-Pb geochronology data indicating Late Cretaceous ages for both intrusive phases of unit Kgd.

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## Map Unit Descriptions

**other units**

**d** — **disturbed areas** - Areas that have been profoundly altered by human activity, including intense urban development and mining activity

**Qtc** — **Talus and colluvium** - Unconsolidated talus and colluvium on moderate to steep slopes. Very poorly sorted, angular to subangular gravel clasts.

**Piedmont Alluvium**

**Qy3** — **Deposits in active channels and low terraces** - Pebbles, cobbles, sand and silt deposits located along active drainages, including channels, adjacent gravel bars and low terraces. Deposits more laterally extensive in distributary multi-channel expansion reaches. Qy3 deposits are poorly sorted and unconsolidated, gravel clasts are not varnished unless reworked from older deposits, and soil development is minimal.

**Qy2** — **Deposits in low terraces and active alluvial fans** - Pebbles, cobbles, sand, silt and minor clay deposits forming low terraces and small alluvial fans, typically located near active washes. These deposits are unconsolidated, poorly sorted with subrounded to subangular pebble to cobble bars on the surface and beds and lenses in cross section. Surfaces commonly are covered by thin mantles of silt and clay. Soil development is minimal.

**Qy1** — **Deposits on young fans and low terraces** - Cobbles, pebbles, sand, silt and clay deposits forming young alluvial fans and terraces. Where Qy1 deposits are fairly coarse, they are composed of silt to pebbles in swales, and lightly to moderately varnished pebbles and cobbles in bars. More basinward, deposits are finer and surfaces typically are planar to gently undulating. These deposits are generally located on the margins of incised valleys away from the more active parts of the drainage systems, and are 1-2m above adjacent active washes. They are also extensive between channels in middle and lower piedmont areas. Soil development includes modest increased in silt and clay, and visible carbonate coatings on gravel clasts.

**Qy** — **Young alluvial deposits, undivided** - Undifferentiated sand, gravel, and silt deposits with weak minimal to weak soil development.

**Qyx** — **Eroded fine deposits** - Silt, clay, sand, and fine gravel outcrops in laterally extensive patches in middle and lower piedmont areas. Surfaces are typically 0.5-1.5m above active washes, similar to Qy1 surfaces. Fine networks of very small channels are common.These surfaces appear to be erosionally stripped equivalents of Qy1 surfaces, but locally the exposed sediment is slightly reddened and may be late Pleistocene in age.

**Qi3** — **Deposits in young intermediate terraces and alluvial fans** - Gravelly, sandy deposits in low terraces and inactive alluvial fans. Deposits consist of pebbles, cobbles, small boulders, sand, silt and clay. Terrace and fan surfaces are 1-2m above adjacent active washes. Surface topography varies with particle size - coarser deposits have obvious, subdued gravel bars and swales, finer deposits are fairly planar. Soil development includes weak reddening, so surfaces appear light orange in color, and visible carbonate accumulations.

**Qi2** — **Deposits in intermediate terraces and relict alluvial fans** - Very poorly sorted deposits including pebbles, cobbles, small boulders, sand, minor silt and clay. Deposits form laterally extensive relict alluvial fans and terraces. Surfaces are typically 1-5m above adjacent active washes, Surfaces typically are fairly planar, with orange varnish on surface gravel and orange to light reddish fine deposits. Soil development is moderate, with obvious reddening and clay accumulation, and stage II-III calcic horizon development II-III.

**Qi1** — **Deposits in higher intermediate fans and terraces** - Poorly sorted pebbles, cobbles, boulders, sand, clay and silt associated with moderately dissected remnant terraces ~2-10 m above active washes. Surfaces typically are quite planar and smooth, with margins rounded by erosion. Reddish rock varnish is quite strong, and soils are reddened and clay-rich, so surfaces are reddish brown in color. Carbonate rinds are thick, and locally carbonate horizons are weakly cemented.

**Qi** — **Intermediate fan and terrace deposits, undivided** - Undifferentiated terrace deposits with moderate to strong soil development. This unit is used primarily in middle and lower piedmont areas to depict fine-grained deposits with reddened soils. These deposit are commonly only slightly higher than surrounding Qy1 and Qy2 deposits.

**Qo1** — **Deposits in highest intermediate fan and terraces** - Poorly sorted pebbles, cobbles, sand, minor silt and clay, some boulders. associated with moderately dissected remnant fan surface ~5-20 m above active washes. Soil development and rock varnish are variable, quite strong on well-preserved surfaces and moderate to weak on more eroded surfaces. Soils are dark reddish brown on well preserved surfaces, and cemented calcic horizons (stage IV) are common. Typically surface margins are broadly rounded.

**Qo** — **Deposits in the highest preserved alluvial fans** - Gravel, sand, and clay deposits associated with high relict alluvial fan surface remnants. Soil development is very strong where surfaces are extensive and well-preserved, including cemented petrocalcic horizons and very clay-rich, dark reddish brown to red argillic soil horizons.

**QTa** — **Old alluvial fan deposits, slopes and eroded remnants** - Cobble, pebble, boulder, sand and silt deposits forming high eroded ridges. Landforms commonly are mantled with coarse gravel clasts (lag) due to long-term erosion. Soil development is variable, typically have weak to moderate on ridgecrests and most slopes, but locally fairly clay-rich on some lower slopes. These deposits underlie most of the middle and upper piedmont, and may grade upward into Qo deposits where they are preserved.

**Bedrock Units**

**Tgp** — **Porphyritic granite of Sycamore Canyon** - Granite or granodiorite containing 10-40% medium- to coarse-grained K-feldspar and 10-25% medium-grained quartz in a light-gray, fine-grained groundmass of quartz, plagioclase, K-feldspar, and 2-10% biotite. K-feldspar phenocrysts are tabular, euhedral, mostly 3-10 mm (locally up to 15 mm), light gray to light grayish-pink, and commonly Carlsbad-twinned. Quartz phenocrysts are 3-10 mm and are anhedral with rounded corners. Biotite forms flakes and fine-grained aggregates (1-3 mm) and is in part oxidized or sericitized. Where medium-grained K-feldspar is abundant it ranges from euhedral to subhedral and plagioclase ranges up to 5 mm.

**Tg** — **Helvetia granite** - White to light gray, medium- to coarse-grained monzogranite and granodiorite, typically containing 1-10% euhedral K-feldspar megacrysts 1-2 cm long. Mafic minerals, mostly biotite and magnetite, form fine-grained aggregates 1-5 mm across and constitute 5-12% of the rock. K-feldspar is grayish pink to salmon pink, euhedral to subhedral, forms crystals 5-20 mm long, and constitutes 20-30% of the rock. Plagioclase is white, euhedral to subhedral, 2-10 mm, and composes 30-50% of the rock. Quartz is anhedral to subhedral, forms 20-30% of the rock, and typically is <5 mm but is locally up to 10 mm.

**TKp** — **Porphyritic granite** - **Porphyritic granite** or granodiorite composed of approximately 20-50% phenocrysts 3-5 mm of quartz (round and partly resorbed to rarely euhedral hexagonal), K-feldspar (euhedral to locally ovoid, grayish-pink), and possibly plagioclase (weathered white), as well as ~2% biotite (1-mm flakes), in a fine-grained light-pink groundmass.

**Kg2** — **Monzogranite** - Medium-grained monzogranite composed of 30-50% K-feldspar (4-10 mm), 20-25% quartz (2-4 mm), 20-40% plagioclase (2-4 mm), and 8-10% biotite (1-3 mm), locally intruded by numerous aplite dikes and dikes of unit TKp.

**Kg1** — **Quartz monzodiorite** - Medium-grained, equigranular, hornblende-biotite quartz monzodiorite typically containing 15% or more biotite, trace to 2% hornblende, and 10-15% quartz. The composition may range from granodiorite to quartz diorite. Inclusions of fine-grained diorite a few cm across are common. The rock is weathered brown and forms crumbly, rounded outcrops.

**Kgd** — **Diorite and quartz monzodiorite** - Intrusive suite consisting of two distinct phases. Diorite is fine- to medium-grained and consists of 40% hornblende, a few percent biotite, 55-60% plagioclase, and 1-5% quartz; about half of the plagioclase is medium-grained and the rest is finely intergrown with hornblende in a fine-grained groundmass. Fine-grained secondary epidote is concentrated along thin veinlets and also is disseminated. The other intrusive phase is probably equivalent to unit Kg1; it may range from granodiorite to quartz monzodiorite to quartz monzonite, is medium-grained, and is composed of euhedral to subhedral K-feldspar (3-8 mm, grayish pink) and plagioclase (1-5 mm, white to light gray), ~10-20% quartz, and 12-15% biotite in 2- to 10-mm aggregates with trace to 2% hornblende.
In Sycamore Canyon near Jones Quarry, diorite and apophyses of quartz monzonite display contacts that are distinct but not chilled. Crystals of hornblende and plagioclase cross contacts and are constituents of both phases, but hornblende is only obviously present in the quartz monzonite near contacts with diorite, suggesting that it is xenocrystic. Both rocks contain inclusions of fine-grained hornblende diorite, which have distinct contacts but that closely resemble the groundmass of the diorite in both texture and composition. These relationships suggest that diorite was emplaced in at least two magmatic pulses, and the quartz monzodiorite was emplaced as the diorite was cooling but before it had fully crystallized.

**KJr** — **Rhyolite intrusions** - Small dikes or sills of aphyric to quartz-phyric rhyolite.

**Bisbee Group**

**Ks** — **Shellenberger Canyon Formation** - Siltstone interbedded with fine- to medium-grained, thin- to medium-bedded, feldspathic to lithic sandstone and minor pebble conglomerate. Most of these rocks are dark to medium gray and are weathered brown, but there are a few medium to thick beds of white to pinkish-gray, medium- to fine-grained arkose. Thin-bedded siltstone and mudstone in the lower part of the formation are dark gray to black and commonly are weathered rusty orange-brown. The middle of the formation is marked by a distinctive interval 2 m thick in which there are two 20-cm-thick limestone units with intervening shale and limey shale. The lower limestone unit consists of a 10-cm-thick pelecypod packstone bed overlain by pelecypod wackestone that grades up into more packstone.

**Ka** — **Apache Canyon Formation** - Siltstone and massive to shaly mudstone interbedded with limestone and medium- to fine-grained sandstone. Medium- to dark-gray laminated limestone forms thin to medium amalgamated beds, interbedded with black to greenish gray to olive-green mudstone and siltstone in intervals several meters thick. In some intervals, thin siltstone and mudstone beds have fine-grained basal sandstone displaying trough cross-lamination, graded bedding, and load structures. Medium- to fine-grained feldspathic sandstone forms medium- to thick-bedded intervals and ledges throughout the succession, some displaying trough crossbedding.

**Kw** — **Willow Canyon Formation** - A succession of fine- to very coarse-grained, locally pebbly, feldspathic sandstone interbedded with purple siltstone and silty mudstone. The sandstone is mostly arkosic arenite, composed of subrounded quartz, subrounded to angular feldspar, a variety of lithic grains, and <10% matrix, with framework ranging from well-sorted to poorly sorted. The sandstone is typically medium-grained and medium- to thick-bedded, and displays graded bedding, planar bedding, and cross-bedding. Pebbly and conglomeratic layers are common in some intervals and are typically polymictic, with rounded pebbles of chert, siltstone, and silicic volcanics. Siltstone, mudstone, and very fine-grained sandstone are mostly purple to purple-gray, ranging to light gray and green, and are locally metamorphosed to epidote hornfels. Dark- to medium-gray siltstone becomes predominant in the upper part of the formation.

**Bisbee Group cont.**

**Km** — **Bisbee Group mafic volcanic rocks** - Basalt or andesite containing fine-grained plagioclase and green, altered, mafic phenocrysts in a green, altered, aphanitic groundmass. Amygdules are present in the upper part of the unit, which is intercalated with sandstone and siltstone of the lower part of unit Kw.

**Kb** — **Bisbee Group undifferentiated** - Sandstone, siltstone, and hornfels in isolated exposures and incomplete sections where stratigraphic position is uncertain.

**KJg** — **Glance(?) Conglomerate** - Framework-supported conglomerate containing pebbles and cobbles of purple and light-gray volcanic rocks in medium-grained, poorly sorted, sandy matrix composed of quartz, feldspar, lithic grains, and typically abundant secondary epidote. Most of the pebbles are phenocryst-poor to aphyric felsic volcanics, possibly along with fine-grained sedimentary rocks such as chert and mudstone (now hornfels). Locally some feldspar-phyric volcanic clasts are phenocryst-rich. Some are of intermediate composition, containing mafic phenocrysts in addition to feldspar, and amygdaloidal volcanic clasts are also locally present. Phenocrysts are mostly ~1 mm, with some feldspar up to 2 mm. The pebbles and cobbles are mostly rounded to subrounded; some are subangular. The conglomerate is overlain by, and locally interfingered with, feldspathic sandstone and siltstone of unit Kw.

**KTiu** — **Undifferentiated Mesozoic clastic rocks** - Siltstone, feldspathic sandstone, conglomerate, and volcaniclastic rocks, generally metamorphosed in epidote-hornfels or lower greenschist facies and ranging from massive to schistose. Fine-grained quartz-feldspar-sericite schist is a common constituent of this assemblage, commonly grading to foliated, sericitic, fine- to medium-grained feldspathic sandstone and then to massive sandstone. Pebbly sandstone and conglomerate are intercalated with the sandstone in some intervals, as well as siltstone that commonly has been metamorphosed to fine-grained quartz-sericite schist or siliceous hornfels. Rhyolitic metatuff contains 10-15% 1- to 2-mm white feldspar grains (angular fragments) and traces of 1-mm quartz grains in an aphanitic white to pale green matrix; like the sandstone, it typically has been metamorphosed to fine-grained quartz-feldspar-sericite schist. Schists of this assemblage commonly exhibit spherical to ellipsoidal, light-green porphyroblasts of fine-grained chlorite(?), typically 1-3 mm but up to 10 mm locally, that weather in relief and form 10% to locally 50% of the rock.
This unit includes probable correlatives of the Gardner Canyon Formation in the basal part, and much of the overlying succession is probably of Jurassic age. However, arkosic sandstone and interbedded siltstone, and their metamorphosed equivalents, resemble the Willow Canyon Formation (Kw) and may be correlative.

**JTRg** — **Gardner Canyon Formation?** - Fine- to very fine-grained quartzose sandstone, siltstone, and medium-bedded limestone, generally metamorphosed to quartzite, siliceous hornfels, and marble respectively. Hornfels commonly has carbonate lenses and irregular layers, and marble beds commonly have siliceous hornfels layers. Conglomerate intervals a few cm thick contain siliceous pebbles.

**JPs** — **Quartz sandstone** - Fine-grained quartz sandstone resembling that of the Scherrer Formation (unit Psl) but spatially associated with Mesozoic rocks, in most cases structurally below the Glance Conglomerate (unit KJg). These rocks probably are fault-bounded slices of unit Psl.

**Naco Group**

**Pr** — **Rainvalley Formation** - Medium- to thick-bedded dolostone and limestone interbedded with minor quartzose sandstone and siliceous shale. Dolostone is micritic, light to dark gray, weathered light to medium gray, and is locally laminated. Limestone is medium to dark gray lime mudstone and wackestone, containing chert nodules and brachiopod or pelecypod fragments. Fine- to medium-grained quartz sandstone is light to dark gray, is weathered light orange-brown to grayish orange-pink, and forms intervals up to 1 m thick. Some of the sandstone is calcite-cemented.

**Pch** — **Concha Limestone** - Dark to medium gray, thick- to medium-bedded, fossiliferous limestone containing dark-brown chert nodules 10-30 cm across. Lime mudstone and wackestone are predominant. Fossils include brachiopods, gastropods, pelecypods, and bryozoans. Typically metamorphosed to fine-grained marble.

**Psu, Psl** — **Sherrer Formation** - A distinctive unit dominated by white, fine-grained, quartzose sandstone (quartz arenite) composed of rounded to well-rounded, well-sorted grains and forming tabular, medium beds. Planar lamination and planar crossbedding are common, and some intervals display trough crossbedding. The unit is subdivided into lower and upper divisions. The lower division (Psl) consists entirely of quartzose sandstone. The upper division (Psu) is marked by an interval of medium- to thick-bedded micritic dolostone up to 25 m thick, overlain by more quartz arenite.

**Pe** — **Epitaph Formation** - A mixed carbonate-siliciclastic unit, consisting of mostly white to light-tan, medium- to thick-bedded limestone and dolostone, interbedded with siltstone, mudstone, and fine-grained sandstone. The carbonate and siliciclastic components have commonly been metamorphosed to, respectively, fine-grained marble and light green hornfels. A prominent ledge 10-20 m thick of dark-gray, thick- to medium-bedded, fine-grained limestone near the top of the formation contains sparse gastropod fossils and local white calcite nodules.

**Pc** — **Colina Limestone** - Medium- to thick-bedded, white to light gray, micritic limestone characterized by tabular beds, creamy white to tan weathered surfaces (locally pinkish, rarely medium gray), and lack of resistant-weathered siliciclastic layers. Unit Pc has been faulted out at the current level of exposure in the map area, except for possibly the uppermost part, which grades into overlying unit Pe and is included with that unit.

**PIPe** — **Earp Formation** - A mixed siliciclastic-carbonate unit consisting of orange-brown to light green, thin- to medium-bedded, planar-laminated mudstone, siltstone, and very fine-grained sandstone, interbedded with subordinate light gray micritic limestone. The siliciclastic components have generally been metamorphosed to light green or orange-pink hornfels. The limestone is locally dolomitic and has been metamorphosed to fine-grained marble.

**IPh** — **Horquilla Limestone** - Thick- to thin-bedded, light-gray to white, fine-grained, recrystallized limestone with interbedded silty mudstone and fine- to very fine-grained quartzose sandstone. The lower part of the unit is dominated by thick bedsets of limestone with thin siliceous interbeds and laminations. In the upper part, carbonate-dominated intervals several meters thick alternate with siliciclastic-dominated intervals. In most of the map area, carbonate-dominated intervals are characterized by thick to medium beds of fine-grained marble, with thin interbeds of siliceous hornfels that form resistant ribs. The siliciclastic intervals consist of thin- to medium-bedded to laminated siliceous hornfels and fine-grained marble. The hornfels is pink to white to light green, is weathered light orange-brown to pink, and forms resistant outcrops with recessive layers and lenses of carbonate.

**Me** — **Escabrosa Limestone** - Light gray to white, thick-bedded, massive limestone is predominant throughout this unit, and is typically metamorphosed to medium- to coarse-grained marble. Medium-bedded intervals are uncommon, and few beds exhibit internal lamination. Siliciclastic layers are much less common than in the overlying Horquilla Limestone and are mostly 1-10 cm thick. Large nodules and lenses of pink recrystallized chert are common, however. Some intervals are dolomitic. A prominent dark-gray bed of calcitic marble in the middle part of the unit contains abundant fossil rugose corals.

**Dm** — **Martin Formation** - A carbonate-dominated succession characterized by medium-bedded, gray to brown to tan limestone and dolostone. Limestone and dolostone are fine-grained and recrystallized (typically metamorphosed to marble). The lower part of the unit contains thin- to medium-bedded limestone with thin interbeds and laminations of dolostone and calcsilicate hornfels. The upper part consists mainly of fine-grained, medium- to thick-bedded, massive to laminated limestone and brown to tan massive dolostone.

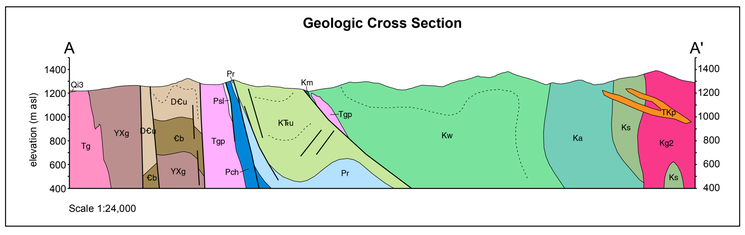
**DCu** — **Martin Formation and Abrigo Formation undifferentiated** - Thinly interbedded fine-grained limestone (metamorphosed to marble) and fine-grained siliceous hornfels with internal calcsilicate laminations. The hornfels layers are weathered orange-brown and are medium gray to olive green on fresh surfaces. There are a few medium beds of limestone (marble), weathered light tan to medium gray.

**Ca** — **Abrigo Formation** - A succession of thin- to medium-bedded, light-tan to medium-gray, micritic limestone with thin siliceous beds and laminations. These rocks have been metamorphosed to fine-grained marble and hornfels. The hornfels consists of alternate siliceous and calcsilicate laminations, is variably pink to green, and is weathered dark brown to orange-brown. Thinly interbedded to interlaminated marble and hornfels are common, forming alternating recessive and resistant layers. Hornfels also forms resistant outcrops with recessive thin beds, lenses, and laminations of carbonate. The lower part of the formation contains fine-grained silty to muddy sandstone, metamorphosed to micaceous quartzite with 1-cm white porphyroblasts tentatively identified as aggregates of very fine-grained quartz and sericite.

**Cb** — **Bolsa Quartzite** - Thick- to medium-bedded, white to pink, quartzose sandstone that forms cliffs and ledges. The lower part is trough crossbedded, medium- to very coarse-grained, and locally feldspathic, with composition apparently ranging from quartz arenite to subarkosic arenite. The framework is moderately sorted and grains are subrounded to rounded, although feldspar grains are commonly subangular. Pebbly to granular beds are common near the base of the unit, whereas the upper part is mostly medium- to fine-grained. Fine-grained silty to muddy sandstone (micaceous quartzite) occurs near the gradational contact with the overlying Abrigo Formation.

**YXg** — **Continental Granodiorite** - Granitoid rock ranging in composition from granodiorite to monzogranite, quartz monzonite, and quartz monzodiorite. The rock typically is medium-grained and contains 5-35% K-feldspar megacrysts, is pinkish gray on fresh surfaces, and weathers brown to orange-brown. The distinctive K-feldspar megacrysts are pink to grayish pink, euhedral to subhedral, typically are nearly equant and slightly to moderately ovoid, are generally 1-3 cm, and range up to 5 cm. Plagioclase is white to light greenish, subhedral to euhedral, 2-5 mm, and is commonly altered. Mafic minerals, mostly chloritized biotite with subordinate magnetite and sphene, form fine-grained aggregates and constitute 10-35% of the rock.

## Geologic Cross Section




SCALE 1:24,000

1 0.5 0 1 Miles

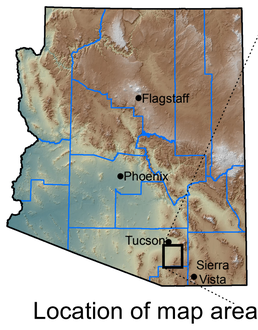
0.9 0.45 0 0.9 Kilometers

0 1000 2000 3000 4000 5000 Feet

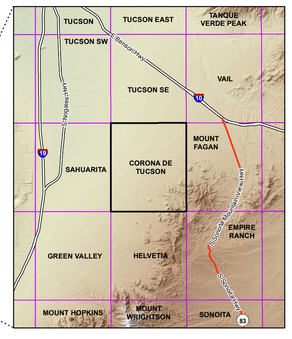
CONTOUR INTERVAL 20 FEET

11°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2013

Topographic base map derived from Corona de Tucson 7.5' USGS topographic quadrangle map originally with NAD27 datum. Reprojected to UTM NAD83 datum (zone 11) using iGage All Topo Maps V9. UTM NAD 83 grid and lat-long markers produced using ESRI ArcMap v. 10.4.




Location of map area




**Mapping responsibility**

- Johnson
- Pearthree
- Ferguson

## Legend

**Contacts and faults**

- Contact, accurate
- Contact, approximate
- Contact, gradational
- Fault, accurate
- Fault, approximate
- Fault, concealed
- High-angle normal fault, accurate
- High-angle normal fault, approximate
- Low-angle normal fault, accurate
- Low-angle normal fault, approximate
- Dip of contact

**Folds**

- Trace of axial surface of anticline
- Trace of axial surface of syncline
- Trace of axial surface of overturned anticline
- Trace of axial surface of overturned syncline

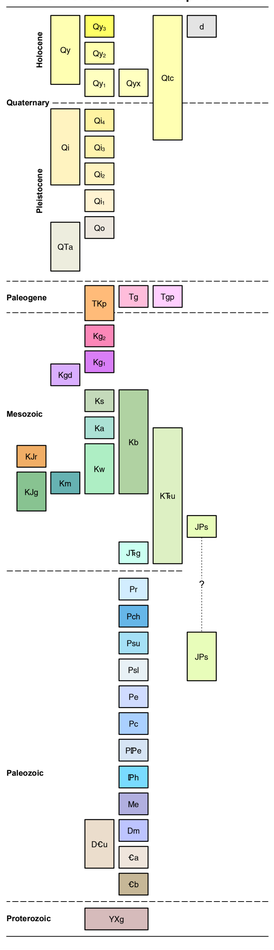
**Dikes**

- Felsic dike
- Mafic dike

**Structure symbols**

- Strike and dip of inclined bedding
- Strike and dip of inclined bedding, tops known from local features
- Strike of vertical bedding
- Strike and dip of overturned bedding
- Strike and dip of inclined axial-planar cleavage
- Strike and dip of inclined transposed bedding
- Strike of vertical transposed bedding
- Strike and dip of inclined tectonic-metamorphic foliation
- Strike of vertical tectonic-metamorphic foliation
- Trend and plunge of mineral-aggregate lineation

## Correlation of map units

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