GEOLOGIC MAP OF THE SOUTHERN PELONCILLO MOUNTAINS; SKELETON CANYON, GUADALUPE SPRING, AND GUADALUPE CANYON 7.5' QUADRANGLES, COCHISE COUNTY, ARIZONA, AND HIDALGO COUNTY, NEW MEXICO

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GEOLOGIC MAP UNITS

Quaternary Alluvium

Qc — **Colluvium**

Qy — **Holocene alluvium (<10 ka)**

Alluvial deposits in active stream channels composed of unconsolidated sand to small boulders that reach several tens of centimeters in diameter upstream but are smaller and fewer downstream. These deposits are locally dissected as much as 2 meters by narrow entrenched main channels and tributary channels (not mapped separately). Qy deposits are characterized by stratified, poorly to moderately sorted sands, pebbles, and cobbles commonly mantled by sandy loam sediment. The main channel (where not appreciably dissected) may diverge into braided channels. Surfaces locally exhibit bar and swale topography, with the bars being typically more vegetated. Soil development is weak with only slight textural and structural modifications of B horizons and slight calcification (Stage I). Some of the older Qy soils may contain weakly developed argillic horizons. Because surface soils are not indurated with clay or calcium carbonate, Qy surfaces have relatively high permeability and porosity. downstream into Qy deposits and upstream with Qcb deposits.

Qly — **Holocene and Late Pleistocene alluvium, undivided (<10 to 250 ka)**

Alluvial deposits along active channels that are intermediate between Qy and Ql surfaces. The surfaces are typically narrow and elongated parallel to the drainage and are of limited extent, although Qly surfaces in the southern San Simon Valley are more aerially extensive. The surfaces have weak soil development and limited incisement. Subtle differences in relative elevation are the main features used to distinguish Qly from lower Qy deposits and higher Ql surfaces.

Ql — **Late Pleistocene alluvium (10 to 250 ka)**

Alluvial fan deposits composed of moderately to poorly sorted, clast-supported conglomerates, sandstones, siltstones, and paleosols. Clasts are subangular to subrounded pebbles and small cobbles of felsic and mafic volcanic and, locally, sedimentary rocks. The surfaces are typically light gray to light brown in color. Ql surfaces are moderately incised by stream channels but retain constructional, relatively flat interfluvial surfaces. Ql soils typically have weak to moderately clay-rich argillic horizons, although some contain much pedogenic clay and some calcium carbonate, resulting in relatively low infiltration rates. Clasts may have thin discontinuous coatings of carbonate.

Qml — **Middle to Late Pleistocene alluvium, undivided (10 to 750 ka)**

Discontinuous alluvial surfaces, usually confined to stream terraces and remnants along the major washes, that exhibit subtle intermediate topographic position between definite Ql deposits and higher older Qm fan surfaces.

Qm — **Middle Pleistocene alluvium (250 to 750 ka)**

Alluvial fan deposits composed of moderately to poorly sorted conglomerate containing subangular to subrounded clasts of felsic volcanic rocks and limestone. Lenses of channel-fill fluvial sands, unsorted and interbedded debris flows, and argillic paleosols are also locally present. Typically the Qm deposits are coarser than the younger Ql sediments and the clasts commonly have thin coatings of carbonate. These deposits may locally contain thick argillic horizons and Stage II carbonate development, resulting in rapid sheet-flow runoff and low infiltration rates. In areas of the study area adjacent to limestone bedrock, these deposits contain limestone clasts surrounded by a moderately to strongly cemented matrix of carbonate (Stage III-IV). Variable clast lithologies make it difficult to correlate the unit between different areas of the study. Typically the Qm deposits are orange to orange-brown in the northern portion of the study area, but are medium brown to gray in the southern portion. Surface clasts commonly exhibit a weak to moderate orange-brown varnish. The deposits form relatively broad flat surfaces north of Paramore Crater and in the San Simon Valley, but they are deeply incised in the Silver Creek and Hay Hollow Wash drainage basins. In these incised areas in the southern and western portions of the study area, multiple Qm surfaces can be recognized based on relative topographic position.

Qm_3 — **Younger member of the Middle Pleistocene alluvium**

Qm_1 — **Older member of the Middle Pleistocene alluvium**

Qmo — **Middle and Early Pleistocene alluvium, undivided (750 ka to 1.2 Ma)**

These light-colored deposits occupy topographic positions intermediate between the middle Pleistocene Qm and the Pliocene-early Pleistocene TQo. In the southern portion of the study area (just west of Guadalupe Canyon quadrangle), the deposits are dominated by rhyolite-derived gravels which overlie limestone-dominated older sediments.

Quaternary Basalt and Basaltic Deposits

Qab — **Basaltic alluvium**

Alluvial deposits in active drainages emanating from or immediately adjacent to volcanic cones and on the surfaces of basalt lava flows. The deposits are characterized by partly stratified, poorly to moderately sorted sands, pebbles, and cobbles mantled by sandy loam sediment derived from basaltic parent material. Qab often grades downstream into Qy deposits and upstream with Qcb deposits.

Qcb — **Basaltic colluvium**

Unconsolidated to weakly consolidated, poorly sorted pebble- to boulder-sized basaltic material that forms a rubble apron at the base of volcanic cones and at some margins of lava flows. May be gullied by runoff, which is a main characteristic used in aerial photograph interpretation of the deposits. Qcb is typically transitional to Qbpc or Qbpb on the flanks of cinder cones and transitional with Qab at the slope break at the base of the cones.

Qbp — **Basaltic pyroclastic deposits, undifferentiated (Pleistocene)**

This unit includes basaltic materials that accumulated proximal to vents and formed the cones at each eruption site. Typically, the rocks are dark gray to dark reddish brown, often oxidized to rusty brown, scoriaceous, deposits that include abundant cinders, blocks, bombs, and agglutinate. Surfaces range from gentle to steep slopes with variable cover of very angular boulders and cinders interspersed with outcrops of lava or indurated cinders or breccia.

Qbf — **Basalt Lava**

Basalt lavas erupted as thin, low viscosity flows from any of the volcanoes in San Bernardino Valley and form a series of overlapping flows ranging from <5 up to 10 meters thick. Flow surfaces are gently sloping and planar with scattered basalt cobbles and boulders, to undulatory or hummocky surfaces covered with abundant basalt boulders and cobbles. Interiors of flows are massive and columnar jointing is common where exposed in cross section. Soils developed on flow surfaces are chocolate brown smectitic vertisols of variable thicknesses. The basalts range from fine grained to aphyric to microporphyritic and contain up to 3% anhedral to subhedral phenocrysts (up to 3 mm) of olivine, plagioclase, and minor pyroxene. Ground-mass textures are holocrystalline to aphanitic and are locally trachytic. Olivine is relatively fresh or slightly yellow, but in places the crystals have altered to red opaques (iddingsite). The rock is commonly vesicular, and vesicles are typically open, rounded to flattened, and locally lined or filled with calcite. Many, if not all, flows contain subrounded to well- rounded xenoliths ranging in size from a few millimeters to more than 40 cm in diameter. Ultramafic xenoliths are common and include lherzolite, dunite, pyroxenite, and other lithologies derived from the mantle (Kempton and Dungan, 1989; Kempton et al., 1990; Kempton et al., 1984b). Crustal xenoliths include Tertiary silicic volcanic rocks, Paleozoic sedimentary rocks, and fragments of granite and gneiss. Black, glassy, subhedral xenocrysts of pyroxene, spinel, and amphibole (kearsutite), up to 4 cm long, and light gray to white, translucent xenocrysts of anhedral to subhedral plagioclase and anorthoclase (?) up to 5 cm across are also common (see Kempton et al, 1982 and 1984 for details).

Late Tertiary to Early Quaternary Deposits

TQbf — **Basalt**

Contains anhedral to subhedral phenocrysts of olivine, mostly altered to red opaques, in a dark gray aphanitic to trachytic matrix. These basalts are mineralogically very similar to the younger basalts that cover the valley floor (map unit Qbf). TQbf basalts are typically fine-grained or aphyric to locally microporphyritic, with plagioclase and olivine phenocrysts; they also contain abundant xenocrysts of black, glassy pyroxene, spinel, and amphibole. Light gray to white translucent xenocrysts of subhedral plagioclase or anorthoclase (?) up to about 2 cm long (see Kempton et al, 1982 and 1984 for details) are also present. However, these basalts contain only rare lower-crustal xenoliths. The slightly vesicular Krentz Ranch flow (1.48 +0.02 Ma) exhibits crude vertical columnar joints with variable sub-horizontal platy joints.

Tsy — **Younger Basin-fill deposits**

These deposits are composed of interbedded fine-grained, tan siltstones, thin sandstones, and conglomerates typical of braided stream deposits. The beds have a slight dip (3°-7°), but it is uncertain if this represents primary deposition or later deformation. On the west side of the Guadalupe Canyon quadrangle, the sandstone and conglomerate beds contain dominantly clasts of felsic volcanic rocks (mostly welded tuff, with minor rhyolite and dacite), and very minor basalt. On the west side of the Guadalupe Spring quadrangle, the deposits contain mostly limestone clasts moderately to strongly cemented with carbonate. In all areas most clasts are subrounded and rarely larger than 20 cm across. Silty beds are light tan and erode easily. These deposits are probably equivalent to map unit TQo of Biggs and others (1999a).

Middle Tertiary Rocks

Tb — **Basalt**

These basalt flows contain anhedral to subhedral phenocrysts of olivine, mostly altered to red opaques, in a dark gray aphanitic to trachytic matrix. These basalts are mineralogically very similar to the younger basalts covering the valley floor to the west (map unit Qbf). They also contain abundant xenocrysts of black, glassy pyroxene and spinel and translucent subhedral plagioclase up to about 2 cm long. However, these basalts contain only rare lower-crustal xenoliths. In exposures along Sycamore Creek, the unit is interbedded with conglomerate (only locally mapped separately as Tc). This unit forms stacks of multiple flows several hundred feet thick on the western side of the Peloncillo Mountains. The flows are nearly horizontal and only slightly tilted locally. In the Skeleton Canyon quadrangle, the unit is offset by normal faults down-to-the-east. Small exposures on the eastern side of the range suggest the basalt flows may have been more extensive before erosion. One small exposure of basalt about 1 mile north of Bunk Robinson Peak appears to be interbedded with welded-tuff breccia (map unit Ttx).

Tcu — **Upper conglomerate**

Tc — **Conglomerate**

This unit is interbedded with basalt (map unit Tb). Exposures between Sycamore Creek and Cottonwood Creek contain rounded cobbles to boulders of light gray welded tuff, limestone, dacite, and basalt, all in a tan to red silty to sandy matrix, weakly to moderately cemented with calcium carbonate.

Ttd — **Tuff of Dutchman Canyon (26.67 ± 0.14 Ma)**

The Tuff of Dutchman Canyon is the least studied ignimbrite in the study area. It crops out in only a few isolated exposures. The exposure that gives the best age-relationship based on superposition is in the north, on the east side of Skeleton Canyon. Time constraints prohibited a detailed study of these rocks on the ground and their contacts were drawn from a distance and partially drawn using aerial photos. McIntosh and Byron (2000) collected a sample of this tuff near the eastern edge of the map area and obtained a date of 26.67 ± 0.14 Ma. This is the youngest ignimbrite in the study area.

Tr — **Rhyolite of Clanton Draw (27.34 ± 0.14 Ma)**

This unit is composed of many separate, crystal-poor rhyolite flows that commonly exhibit contorted flow-banding. Most exposures are light gray and contain very small subhedral phenocrysts of quartz, biotite, and clear-gray feldspar resembling sanidine. Phenocrysts are typically less than 1 mm wide and comprise 1-5% of individual flows. Many flows have a vitric base that commonly stands out as a dark band (locally mapped at the base of the unit). Interbedded light yellow lithic tuffs several meters thick are common, but appear to pinch out rapidly along strike. Good exposures of individual flows with interbedded tuff and vitric layers can be seen in section 35, T. 21 S., R. 32 E., and south of Clanton Draw in the southeast corner of the Skeleton Canyon quadrangle. Erb (1979) named the unit and reported a zircon fission-track age of 25.8 ? 1.2 Ma for this unit. McIntosh and Byron (2000) reported a more accurate 40Ar/39Ar sanidine age of 27.34 ± 0.14 Ma.

Trv — **Vitrophyre at the base of the rhyolite of Clanton Draw**

Ttr — **Welded Tuff (Tuff of Whitmire Canyon)**

This crystal-poor welded tuff contains very few subhedral phenocrysts of quartz, sanidine (?), and biotite (about 1% of rock or less) less than 1 mm wide. Pumice fragments are very flattened and resemble thin laminae from edge-on. Outcrops are dark tan and the rock breaks into platy fragments. Near the head of Whitmire Canyon the base of the unit is non-welded and light gray. Erb (1979) originally described this rock as the Tuff of Whitmire Canyon-the youngest rock in the area. This study has revealed that the tuff is interbedded with the Rhyolite of Clanton Draw. In the very southeast corner of the Skeleton Canyon quadrangle, a thin tuff bed interbedded with rhyolite flows contains a crystal-poor densely welded top, and may be the same unit.

Tt — **Bedded lithic tuffs**

These crystal-poor tuffs contain minor subhedral phenocrysts of quartz and biotite in a light yellow, bedded aphanitic matrix. The rock also contains subangular to subrounded lithic fragments of pumice, rhyolite, and dacite, all commonly 2 to 10 cm across. In outcrops in section 11, T. 22 S., R. 32 E., and in section 9, T. 32 S., R. 21 E., the tuffs are strongly welded and contain flattened pumice clasts. The welded exposures at the head of Whitmire Canyon are clearly interbedded with the Rhyolite of Clanton Draw.

Tsc — **Tuff of Skeleton Canyon (equiv. to Park Tuff; 27.44 ± 0.08 Ma)**

This unit contains abundant phenocrysts (~10% of rock) of clear subhedral to rounded quartz 1-2 mm wide, clear chatoyant sanidine 1-3 mm long, and minor subhedral biotite, all in a medium gray aphanitic matrix. Lenticular, flattened, light gray pumice clasts from 0.5 to 3 cm long are common. McIntosh and Byron (2000) reported a 40Ar/39Ar age sanidine age of 27.44 ± 0.08 Ma. Throughout most of the study area no flow-breaks are visible and the rock appears to consist of one cooling unit. Excellent exposures in Skeleton Canyon mantle a steep angular unconformity dipping approximately 60 degrees to the east. This unconformity may represent the margin of a buried cauldron. Also in Skeleton Canyon, the welded tuff is locally overlain and underlain by light gray non-welded tuff, mapped separately as map unit Tscn. The light gray pumice clasts contrast sharply with the medium gray matrix and make the tuff of Skeleton Canyon very distinct from all the other welded tuffs in the southern Peloncillo Mountains. The unit is thickest in Skeleton Canyon, where it is associated with a steep unconformity, but it is also very similar to the distinctive Rhyolite Canyon Tuff associated with the Turkey Creek Caldera in the Chiricahua Mountains to the northwest (Drewes, 1982; Du Bray and Pallister, 1991).

Tscn — **Tuff of Skeleton Canyon, non-welded**

This unit is mineralogically the same as the welded tuff of Skeleton Canyon, but forms light gray-colored slopes instead of darker gray cliffs. Pumice clasts are subspherical instead of lenticular. In the northwest corner of the Skeleton Canyon quadrangle, welded tuff is underlain by non-welded tuff locally at least 200 feet thick. In this area, on the west side of the hills in gullies next to the road (where the non-welded tuff is thickest), large spherical accretionary lapilli or "tuff balls" are abundant and weather out into spheres up to 10 cm in diameter.

Tql — **Quartz latite**

This rock contains subhedral phenocrysts of light gray feldspar (sanidine?) quartz, biotite, hornblende, and minor sphene, all in a light gray aphanitic matrix. Exposures on the north side of Sycamore Creek contain about 15-20% phenocrysts, whereas exposures in Baker Canyon are darker gray green and contain fewer phenocrysts. On the north side of Sycamore Creek in the Guadalupe Spring quadrangle, the contact with the underlying rocks is very sharp and inclined. Locally, there is a 1 to 2 meter thick crystal-poor sandy tuff at the base. The quartz latites form small intrusive bodies. Near Sycamore Canyon it cuts across coarse-grained dacite (map unit Tdc) but appears to be overlain by dacite breccia. In the Guadalupe Canyon quadrangle, the unit forms two small intrusions, one of which cross-cuts the Baker Canyon Fault.

(Ages for welded tuffs are 40Ar/39Ar from McIntosh and Bryan, 2000)

Tdc — **Coarse-grained dacite of Outlaw Mountain (31.81 ± 0.10 Ma)**

This crystal-rich lava contains abundant subhedral phenocrysts of light gray to translucent plagioclase up to 1.5 cm, anhedral biotite up to 5 mm, partially altered to hematite, and less abundant hornblende in a dark purple to dark brown aphanitic matrix. Locally small anhedral quartz is present. Plagioclase crystals are very conspicuous and resemble the plagioclase in both the younger and older basalts (map unit QTbf and Tb, respectively). Glomeroporphyritic clots of plagioclase are common. This unit is interbedded with autoclastic flow-breccia well-exposed in places along a west-facing cliff forming the central part of the mountain range. Locally contains subrounded xenoliths of very fine-grained holocrystalline rocks 1-15 cm wide that look like they have a similar composition as the dacite. Named by Erb (1979). McIntosh and Bryan (2000) reported a sanidine 40Ar/39Ar age of 31.81 ± 0.10 Ma for a sample of this rock from near the headwaters of Cottonwood Creek.

Tdm — **Medium-grained dacite of Outlaw Mountain**

This dacite lava is mostly roughly equigranular to slightly porphyritic and contains 1-2 mm wide subhedral phenocrysts of plagioclase, biotite, hornblende and minor quartz in an aphanitic matrix. The rock is purple to tan and commonly has a slightly lighter color than the coarse-grained dacite. No large plagioclase phenocrysts or inclusions were seen. This lava underlies the coarse-grained dacite of Outlaw Mountain (map unit Tdc).

Tco — **Older Conglomerate**

One small remarkable exposure of this unit overlies the fault near the center of the Guadalupe Spring quadrangle. This thinly bedded tan-colored conglomeratic sandstone contains clasts of welded tuff and dacite in a sandy matrix. Bedding within the exposure changes from 23 degrees west on the lower portion to 70 degrees west near the top.

Tdx — **Dacite breccia**

This unit coarsens upward from fine-grained conglomeratic sandstone to boulder conglomerate and breccia. It is exposed in the central part of the mountains from Sycamore Creek on the south to about 1 km north of Outlaw Mountain. On the north side of Sycamore Creek the lower portions are composed of fine-grained, tan-colored conglomeratic sandstone that is mostly buried by younger alluvium. Exposures here are best seen in the gullies and stream-cuts. To the north, on the south side of Cottonwood Creek, conglomeratic sandstone is locally interbedded with thin siliceous carbonate layers (marl?) 10 cm or so thick. Upward in the section the unit is dominated by coarse conglomerate. Bedding is medium to thick and is most easily discerned from a distance. Lower in the section, many clasts are welded tuff, but upward almost all the clasts are subrounded to angular dacite. The upper part is locally interbedded with dacite flows and grades upwards locally into non-bedded autoclastic dacite flow-breccia (mapped as part of the dacite lavas). Near 31° 27' 30", 109° 06' 00" light gray medium-grained dacite clasts are surrounded by a light gray, crystal-rich dacite(?) matrix. It is not clear if it is a flow-breccia or sedimentary breccia. Erb (1979) named the unit the breccia of Hog Canyon for excellent exposures there.

Tro — **Older rhyolite**

This rock is a sub-aphyric rhyolite lava and contains small phenocrysts of quartz and rare biotite less than 1 mm across. Spherulites are common. In exposures about 1 mile north of Devils Kitchen, the rhyolite is vitric near the contact with overlying dacite. A light-yellow bedded crystal-poor lithic tuff crops out at and near the base of the unit. The rhyolite is exposed only in the north along Skeleton Canyon, where the rocks weather into steep, light tan slopes with rough, jagged outcrops.

Tax — **Andesite breccia**

This unit is composed almost entirely of dark gray to purple clasts of andesite. It is exposed in the southern part of the map area in the Guadalupe Spring and Guadalupe Canyon quadrangles. The most extensive exposures are in the Guadalupe Canyon quadrangle where they form dark gray, non-bedded, featureless deposits at least 600 feet thick. Individual clasts range from pebble-size to large boulders and are angular to subrounded surrounded by a sandy andesitic matrix. Where deposits are mixed with welded-tuff breccia they are mapped separately as map unit Ttax. About 1.5 to 2 miles south of Bunk Robinson Spring in the Guadalupe Spring quadrangle, dark gray to purple deposits containing pebble- to cobble-size clasts of andesite form dark, subdued slopes beneath and intercalated with welded-tuff breccia. South and southeast of Guadalupe Mountain, the andesite is highly fractured but the fracture/joint orientations are consistent, and the cracks are filled with andesitic sand and carbonate. Nearby exposures are brecciated and jumbled. The exposures with consistent fracture orientations may represent large relatively coherent blocks.

Tai — **Intrusive andesite**

Ta — **Andesite**

This lava contains ~10-15% subhedral phenocrysts of light to medium gray plagioclase and dark gray to gray-green pyroxene, both up to 6 mm across in a purple-gray aphanitic matrix. Pyroxene crystals are often altered to hematite, and plagioclase phenocrysts are commonly chalky white. Thin siliceous veins have cut the lava, with red- and yellow-colored selvages 10 to 20 cm out from and parallel to the veins. The andesite flows appear to be interbedded with welded tuff (map unit Ttw) near the base of the section in the Guadalupe Canyon quadrangle. The rock locally cuts across foliation in the welded tuff, suggesting some exposures may be intrusive. A small body of andesite (Tai) intrudes the Bisbee Group in the very southwest corner of the Guadalupe Canyon quadrangle. In the east-central part of the Guadalupe Spring quadrangle, this unit is locally transitional between flow and breccia, which are mapped as Tax. Similar andesites are exposed in the southwestern corner of the project and are assumed to be equivalent.

Ttax — **Mixed breccia**

These poorly sorted deposits contain clasts of andesite, dacite, various welded tuff units, and rare limestone and sandstone. Most exposures crop out in the eastern half of the Guadalupe Canyon quadrangle. West and southeast of Guadalupe Canyon these deposits contain discrete zones of andesite and fine-grained crystal-poor welded tuff that has not been recognized elsewhere in the study area. The welded tuff and andesite zones have very irregular, but sharp, contacts and with more detailed work can probably be mapped as distinct units. The crystal-poor welded tuff zones only occur in the southeast corner of the map. In this same area the unit contains very localized accumulations of limestone clasts, ranging in size from cobbles to large boulders (some are located on the map). Abundant pelecypod fossils suggest the limestone clasts were derived from the Bisbee Group.

Ttw — **Tuff of Woodchopper Spring (32.58 ± 0.16 Ma)**

This welded ash-flow tuff unit is crystal-rich and contains 1-5 mm phenocrysts of clear quartz, light gray to almost clear sanidine, and minor biotite. In the northern part of the Skeleton Canyon quadrangle it is composed of two sub-units: a lower, slope-forming unit and an upper cliff-forming unit. Both sub-units are mineralogically similar. The rock forms light gray steep outcrops that contrast with the underlying older welded tuff (map unit Ttg). On weathered surfaces, the large quartz phenocrysts stand out in relief. In this respect it resembles map unit Ttg. McIntosh and Byron (2000) reported an 40Ar/39Ar date of 28.21 ± 0.14 Ma.

Thwn — **Upper welded ash-flow tuff, non-welded**

This unit is exposed in the southern part of the Guadalupe Canyon quadrangle where it forms light-colored slopes. It underlies the Tuff of Woodchopper Spring (map unit Ttw), and also underlies dacite (map unit Tdc).

Ttl — **Lithic tuffs**

Ttx — **Welded-tuff breccia**

This extensive unit is composed of very poorly sorted, angular to subangular clasts of welded tuff. The individual clasts are rotated with respect to the neighboring clasts such that the primary eutaxitic foliation is almost completely randomized and obscured. The matrix between clasts is composed of sandy, microbrecciated tuff. The clasts resemble both the Gillespie Tuff and the Oak Creek Tuff. As mapped, this unit includes both mesobreccia and megabreccia. One mile southeast of Eicks Spring (on the south side of Sycamore Creek) the unit contains an intact block over 50 meters across. From about Baker Canyon northward, the unit contains almost exclusively clasts of welded tuff. From about Baker Canyon southward, the unit contains variable amounts of clasts of welded tuff, andesite, and minor limestone. The different rock types occur as discrete lenses and layers. From a distance some of the layers can be discerned as dark- and light-colored bands, but in other areas the different rock types can only be distinguished up close. The differences are most obvious in the east-central part of the Guadalupe Spring quadrangle where dark-colored bands of andesite are intercalated with lighter-colored bands of welded tuff. Near the central part of the range the unit is over 800 feet thick. It erodes into steep, rough, featureless, tan-colored hills.

Th — **Hypabyssal welded tuff**

This welded tuff mineralogically resembles the Gillespie Tuff but contains neither eutaxitic foliation nor visible pumice fragments. Outcrops are slightly brecciated and spaces between fragments are reddish and aphanitic. This may be a small vent for some of the Gillespie Tuff.

Ttg — **Gillespie Tuff (32.72 ± 0.04 Ma)**

This crystal-rich welded tuff contains phenocrysts of about 15-20% clear, subhedral quartz, 10% sanidine, and 1-2% biotite, all between 1-5 mm across. Biotite is scarce and is partially altered to hematite. Some sanidine is chalky white, but most are clear to light gray. Quartz is abundant and commonly sticks out in relief on weathered surfaces, which gives the rock a rough, slightly coarse-grained appearance. Fresh surfaces are light pink to tan, but the rock weathers tan and is commonly slightly varnished. Where strongly welded, the rock forms cliffs and blocky ledges. Where less welded, the tuffs erode into light-colored crumbly slopes. Several welded tuff units are interbedded with welded-tuff breccia (map unit Ttx) in the southern Peloncillo Mountains. However, they are mineralogically very similar and not distinguished as separate units except where separated by breccia. Erb (1979) reported a zircon fission-track age of 27.1 + 1.5 Ma for a sample of welded tuff collected along the Geronimo Trail, about 1/2 mile west of Miller Spring next to Cottonwood Creek. McIntosh and Byron (2000) reported a more accurate 40Ar/39Ar age of 32.72 ± 0.04 Ma. Similar rocks are exposed in the southern end of the Perilla Mountains, in the southwestern corner of the project area (East of Douglas quadrangle) and may be equivalent to the tuffs in the Peloncillo Mountains.

Tto — **Oak Creek Tuff (33.50 ± 0.07 Ma)**

This crystal-rich welded tuff contains abundant quartz and sanidine and minor biotite, all 1-3 mm across in a dark pink aphanitic matrix. The tuff also contains lithic fragments of welded tuff and dacite. In the field the Oak Creek Tuff and the Gillespie Tuff (as mapped) are nearly indistinguishable. Both are crystal-rich tuffs bearing biotite, quartz, and sanidine. On weathered surfaces of the oak Creek Tuff the quartz phenocrysts are more resistant than the matrix and stand out in relief. These two tuffs were originally mapped as the same unit. They were only separated later on the basis of the older 40Ar/39Ar age of 33.50 ± 0.07 Ma for the Oak Creek Tuff.

Tfi — **Felsic hypabyssal dikes**

This light tan rock contains 1-3 mm phenocrysts of mostly clear quartz, minor sanadine, and rare biotite, all in a tan aphanitic matrix. It also contains what appear to be small pumice fragments less than about 2 cm across. The unit has sharp irregular contacts within both the chert conglomerate (map unit KJcc) and the limestone conglomerate (map unit KJcl) of the Bisbee Group, suggesting the rock is intrusive, although it may be interbedded. The mineralogy is similar to the ash-flow tuff unit (map unit Ttw) and may have been small vents.

Late Jurassic and Cretaceous Rocks

Kb — **Bisbee Group, undivided**

The sedimentary rocks of the Bisbee Group form ledges on steep, rounded hills in the southeast part of the study area and in the Pedregosa and Perilla mountains. The group contains thin to medium bedded, light gray to blue-gray limestones interbedded with light tan, pink, and gray fine-grained sandstones and limy sandstones. Locally, limestone beds contain very abundant fossil pelecypods (graphaea) up to 10 cm long, and the limy sandstones are particularly fossiliferous. The limestone and sandstone beds are difficult to distinguish from a distance. The Bisbee Group in the area is folded and several faults are identified. In the Pedregosa and Perilla mountains, the Bisbee Group rocks were not mapped separately for this report, but the Cintura, Mural, Morita, and Glance Conglomerate formations have been identified by other investigators (Drewes and Brooks, 1988). The three lower formations of the Bisbee Group are recognized in the southeastern portion of the study area:

Km — **Morita Formation**

This unit contains mostly red-brown to dark purple siltstone interbedded with thin sandstone layers 10-50 cm thick. The siltstone erodes easily into slopes and the sandstone erodes into small resistant ledges. The upper contact is gradational. The upper part of the unit contains more abundant interbedded limestone layers.

KJc — **Glance Conglomerate, undivided**

Two informal members of the Glance Conglomerate are recognized in the southeastern part of the study area:

KJcl — **Limestone conglomerate member of the Glance Conglomerate**

This sub-unit of the Glance Conglomerate overlies the cherty conglomerate (map unit KJcc) and contains subrounded to well-rounded clasts of limestone, 2 to 15 cm in diameter, in a moderately to well-cemented calcium carbonate matrix. Upper and lower contacts are sharp. The unit forms a rounded, cobble-covered ridge between the underlying cherty conglomerate and the subdued slopes of the overlying fine sandstones and siltstones of the Morita Formation.

KJcc — **Cherty conglomerate member of the Glance Conglomerate**

The basal conglomerate of the Bisbee Group contains subangular to well-rounded clasts of light to dark gray and tan chert, quartzite, and sandstone, all in a red sandy matrix. Clasts range in size from about 2 to10 cm, but larger clasts are up to 20 cm across and are rounded to well-rounded. Smaller clasts are more angular. Most clasts are stained red. This unit unconformably overlies the Paleozoic rocks of the study area.

Paleozoic Rocks

Pe — **Epitaph Dolomite**

Fresh surfaces are red-black to dark gray. On weathered surfaces the rock is light to medium gray to pale brown and typically very rough. Beds are typically 1-2 feet thick, but are locally as thick as 6-10 feet. Breccias and conglomerates containing pebble-size clasts occur throughout the formation. Outcrops are highly fractured and commonly permeated by abundant, small light gray calcite veins. Locally, the unit contains abundant dark red-brown irregularly shaped chert nodules less than 5 cm across. In the study area, the unit is bounded by a thrust fault at the base and an erosional unconformity at the top. The Epitaph Dolomite is about 800 feet thick (Kelly, 1966).

Pc — **Colina Limestone**

This limestone weathers light bluish gray to medium gray, but on a fresh surface it is dark gray to black. The lower portion contains abundant fossils of crinoids, echinoids, gastropods, and brachiopods. Beds are typically 2-4 feet thick. The formation can be recognized from a distance both by its ledge-forming outcrops and by its blue-gray color, which contrasts with the red siltstones of the underlying Earp Formation and with the brown dolomites of the overlying Epitaph Dolomite (Kelly, 1966).

PPe — **Earp Formation and Horquilla Limestone**

From oldest to youngest the Earp includes limestone, gray-orange pebble conglomerate up to 90 feet thick, a thick sequence of red to orange siltstone and calcarenite, and limestone, yellow dolomite, and brown cherty dolomite (see Kelly, 1966 for a more detailed description). The limestones at the base of the Earp Formation contain abundant fusulinids (probably Triticites), and less abundant echinoid spines and plates, and crinoid stems. The Horquilla Limestone is composed of thin- to thick-bedded cherty gray limestone with thin interbeds of calcareous shale or siltstone. In the study area, the units are at least 380 feet thick, but exposures are limited. The conformable contact with the overlying Colina Limestone is sharp. Three isolated outcrops of the Earp-Horquilla limestones are located 2-3 km south of Paramore Crater forming inselbergs surrounded by basalt flows that cover the buried pediment. Several adjacent areas of carbonate-rich, light-colored soils, which are clearly not derived from basalt or alluvium, are probably deeply eroded limestone inselbergs.

GEOLOGIC MAP SYMBOLS

STRUCTURAL MEASUREMENTS

- Inclined bedding
- Inclinded bedding, defined by aerial photographs
- Eutaxitic foliation in welded tuffs
- Flow-banding in lavas

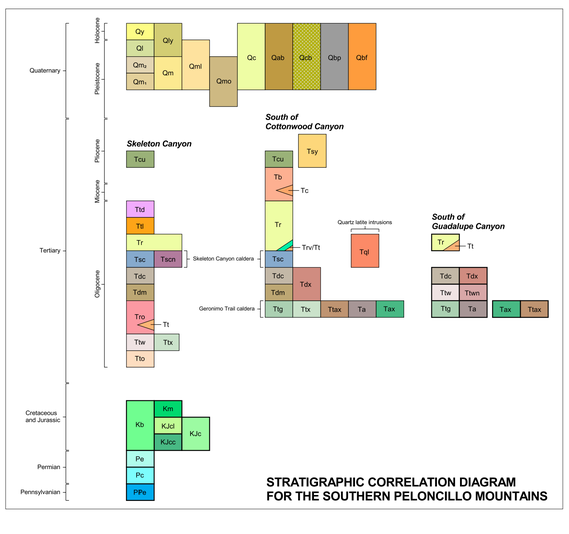
CONTACTS

- Contact (dashed where approximately located; queried where location guessed)
- Normal fault showing attitude of fault surface (dashed where approximate; queried where guessed; dotted where concealed; ball and bar symbol on downdropped side)
- Thrust fault (dashed where approximate; dotted where concealed)
- Marker bed or horizon

DIKES

- Felsic dike
- Basalt dike

N

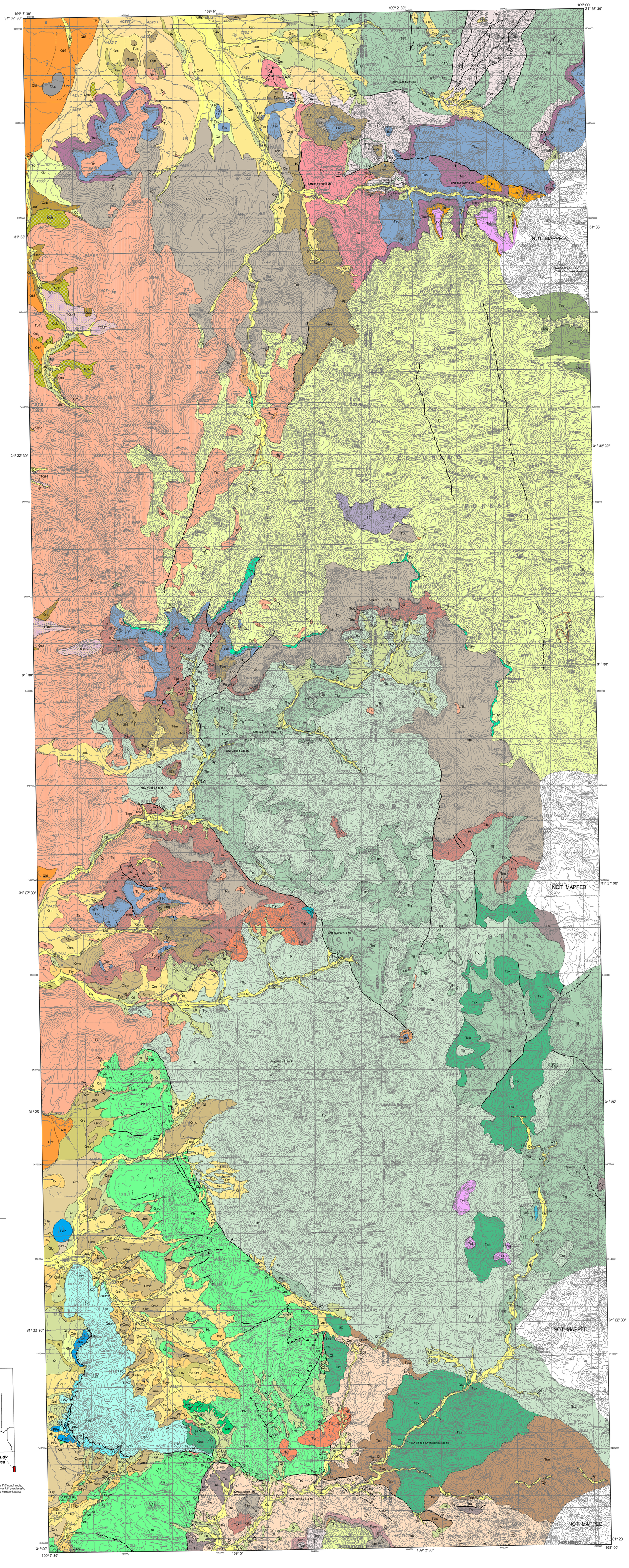


STRATIGRAPHIC CORRELATION DIAGRAM FOR THE SOUTHERN PELONCILLO MOUNTAINS

LOCATION MAP

Topographic base from Skeleton Canyon, New Mexico-Arizona 7.5' quadrangle, provisional edition 1987; Guadalupe Spring, New Mexico-Arizona 7.5' quadrangle, provisional edition 1985; and Guadalupe Canyon, Arizona-New Mexico-Sonora 7.5' quadrangle, provisional edition 1985.

Projection: Transverse Mercator
Grid: UTM, zone 12
Datum: North American Datum of 1927
Spheroid: Clarke 1866


109° 7' 30"
31° 37' 30"
109° 5'
109° 2' 30"
109° 00'
31° 35'
31° 32' 30"
31° 30'
31° 27' 30"
31° 25'
31° 22' 30"
31° 20'
NOT MAPPED
SAN 32.58 ± 0.16 Ma
SAN 27.64 ± 0.14 Ma
SAN 31.81 ± 0.10 Ma
SAN 26.67 ± 0.14 Ma (Tuff of Dutchman Canyon)
SAN 32.64 ± 0.16 Ma
SAN 32.67 ± 0.18 Ma
SAN 33.34 ± 0.18 Ma
SAN 32.77 ± 0.16 Ma
SAN 33.40 ± 0.14 Ma (misplaced?)
SAN 33.46 ± 0.14 Ma (misplaced?)
SAN 33.48 ± 0.16 Ma
CORONADO NATIONAL FOREST
Bunk Robinson Peak
Bisbee Junction
Geronimo Trail
Cottonwood Canyon
Skeleton Canyon
Sycamore Canyon
Guadalupe Canyon
Guadalupe Spring
Clanton Draw
Pickhandle Tank
Outlaw Mountain
Bisbee Junction
Lake Bunk Robinson
Lake Leopard
Lake Stephens
Lake Cottonwood
Lake Sycamore
Lake Skeleton
Lake Guadalupe
Lake Clanton
Lake Pickhandle
Lake Outlaw
Lake Bisbee
Lake Geronimo
Lake Miller
Lake Whitmire
Lake Paramore
Lake Silver
Lake Hay
Lake Hog
Lake Devils
Lake Stone
Lake Cintura
Lake Mural
Lake Morita
Lake Glance
Lake Perilla
Lake Pedregosa
Lake Earp
Lake Horquilla
Lake Colina
Lake Epitaph
Lake Paleozoic
Lake Tertiary
Lake Quaternary
Lake Cretaceous
Lake Jurassic
Lake Permian
Lake Pennsylvanian
Lake Holocene
Lake Pleistocene
Lake Pliocene
Lake Miocene
Lake Oligocene
Lake Skeleton Canyon
Lake South of Cottonwood Canyon
Lake South of Guadalupe Canyon
Lake Quartz latite intrusions
Lake Skeleton Canyon caldera
Lake Geronimo Trail caldera
Lake Felsic dike
Lake Basalt dike
Lake Contact
Lake Normal fault
Lake Thrust fault
Lake Marker bed
Lake Inclined bedding
Lake Inclinded bedding, defined by aerial photographs
Lake Eutaxitic foliation in welded tuffs
Lake Flow-banding in lavas
Lake Felsic hypabyssal dikes
Lake Oak Creek Tuff (33.50 ± 0.07 Ma)
Lake Gillespie Tuff (32.72 ± 0.04 Ma)
Lake Hypabyssal welded tuff
Lake Welded-tuff breccia
Lake Lithic tuffs
Lake Upper welded ash-flow tuff, non-welded
Lake Tuff of Woodchopper Spring (32.58 ± 0.16 Ma)
Lake Mixed breccia
Lake Andesite
Lake