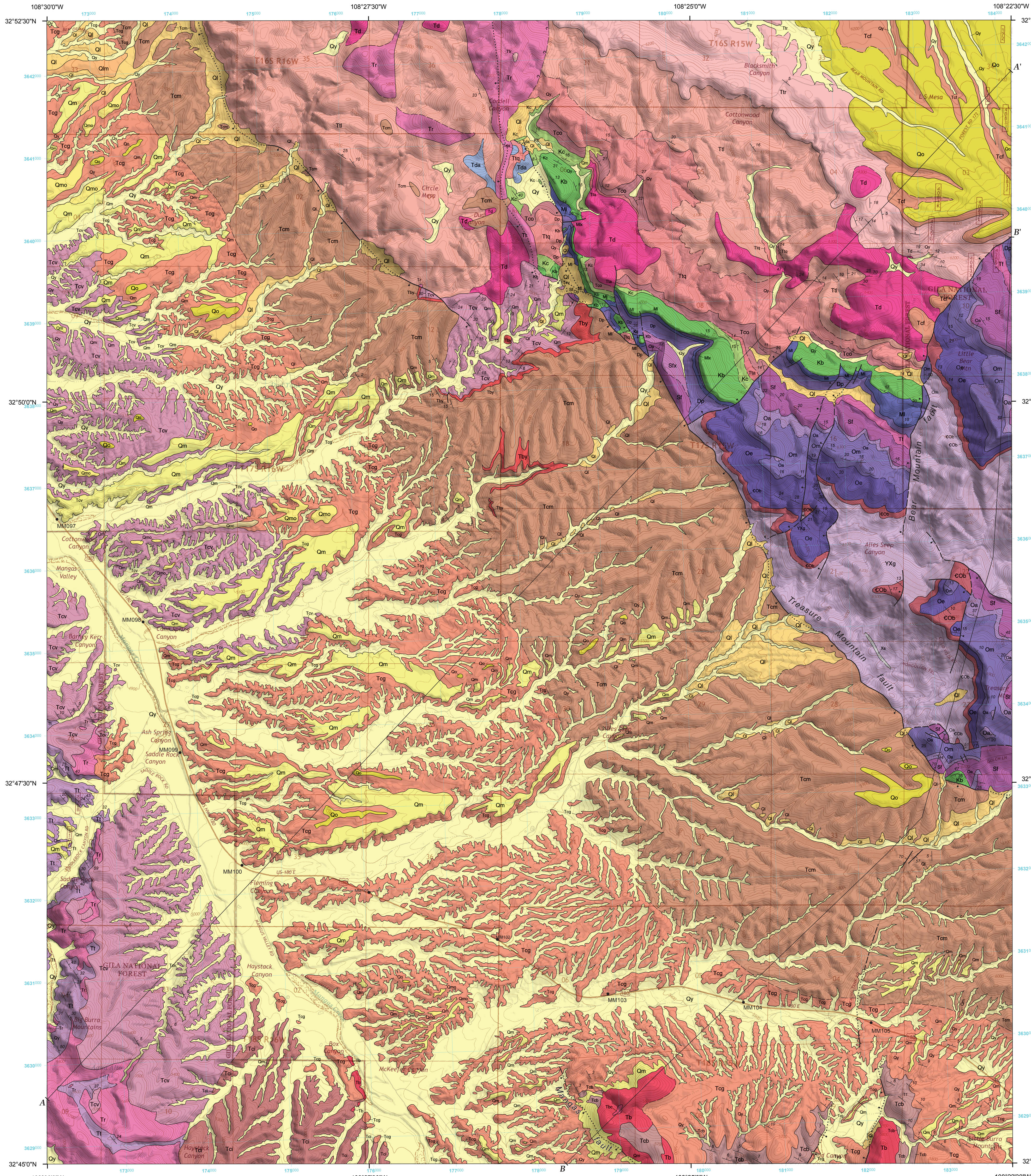


Base map from U.S. Geological Survey 1970, from photographs taken 1965, field checked in 1970, edited in 1983. 1927 North American datum, UTM projection -- zone 13N. 1000-meter Universal Transverse Mercator grid, zone 13, shown in blue.

1:24,000

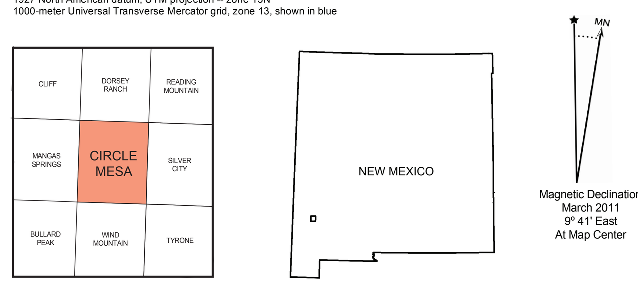
1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Magnetic Declination March 2011 9° 41' East At Map Center



Quadrangle Location

New Mexico Bureau of Geology and Mineral Resources
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Socorro, New Mexico
87801-4796

[575] 835-5490

This and other STATEMAP quadrangles are available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu

New Mexico Bureau of Geology and Mineral Resources Open-File Geologic Map 225

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act, administered by the U.S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (L. Greer Price, *Director and State Geologist*, Dr. J. Michael Timmons, *Assoc. Director for Mapping Programs*).

Geologic Map of the Circle Mesa Quadrangle, Grant County, New Mexico.

March 2011

by
Steven J. Skotnicki

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Explanation of Map Symbols

- Geologic contact--solid where well-known, dashed where inferred, dotted where concealed.
- Fault--solid where well-known, dashed where inferred, dotted where covered. Tick shows inclination of fault with dip value and direction. Normal offset when bar ball present on downthrown block.
- Small, minor vertical fault. Strike and dip shown.
- Small, minor fault. Strike and dip shown.
- Strike and dip of bedding
- Strike and dip of bedding, interpreted from aerial photo
- Strike and dip of inclined foliation
- Area of silicification
- Highway 180 mile marker
- Geologic cross section

Comments To Map Users

A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given contact onto a topographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist(s). Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes associated with recent development may not be shown.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical, and subsurface (drillhole) data. Cross-sections should be used as an aid to understanding the general geologic framework of the map area, and not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. 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 State of New Mexico, or the U.S. Government.

Descriptions of Map Units

Quaternary

Qy — **Holocene alluvial deposits–**Dominated by fine silt and sand, but also contains lenses of coarse gravel and cobbles. These deposits form the relatively flat valley floors, but have been dissected by the modern streams. Steep cliff exposures along some arroyos reveal multiple clay-rich soil horizons. The deepest dissection, up to 4.5-6 m (15-20 feet), is visible along Mangas Creek.

Ql — **Late Pleistocene alluvial deposits–**Interbedded sands and gravel. These deposits are typically a few meters thick at most and are between about 3-9 m (10 and 30 feet) above the elevation of the modern drainages. Soil development is characterized by moderate clay accumulations and generally well-developed dark organic horizons within a few feet of the surface. As mapped, this unit also contains what would be considered colluvium, in particular south of Treasure Mountain.

Qlm — **Middle to late Pleistocene alluvial deposits–**Mapped only in the northwest corner of the map where it is intermediate in elevation between units **Ql** and **Qm**.

Qm — **Middle Pleistocene alluvial deposits–**Interbedded sand and gravel. These deposits are typically a few meters thick at most and are characterized by a well-developed dark reddish-brown clay-rich soil on the upper surface. Commonly contains abundant subangular to subrounded clasts of foliated diorite/amphibolite, as well as less abundant rounded limestone, angular chert, and minor granite, basalt, vein quartz, and quartz-muscovite schist, even in deposits in the northwestern part of the map. Forms flat, dissected terraces about 15-24 meters (50-80 feet) above the modern drainages. One exposure is anomalously thick, at the confluence of Mangas Creek and Cottonwood Creek, on the north side, where a stream-cut creates a good exposure.

Qmo — **Early to middle Pleistocene alluvial deposits–**Mapped only in the northwest corner of the map and on the south side of Cottonwood Creek where it is intermediate in elevation between **Qm** and **Qo**.

Qo — **Early Pleistocene alluvial deposits–Interbedded sand and gravel–**In the northeast corner of the map these deposits are dominated by pebbles to large cobbles of hypabyssal felsic intrusive rocks that resemble the Bear Mountain intrusion, and less abundant light gray quartzite (resembles **Kb**) and sparse limestone. Forms small remnant deposits further west and south where deposits are dominated by dacite, tuff, quartzite, rounded limestone, chert, minor basalt, sparse foliated diorite, and smaller angular gravels of rhyolite. In some deposits, foliated diorite/amphibolite is quite common. Where exposed, the sandy matrix is composed mostly of volcanic fragments with minor quartz. All Qo deposits are characterized by thick dark reddish brown soils. Locally, pedogenic carbonate (caliche) is visible. About 2-3 meters thick (6-10 feet).

Qoc — **Early Pleistocene alluvial deposits, carbonate clasts–**Interbedded sand and gravel. This unit was mapped only in one location, on the south side of Cottonwood Canyon, about one mile east of its confluence with the Mangas Valley. It contains mostly subrounded limestone cobbles to boulders, then dacite, sparse granite (resembles orange-weathering **YXg**), hornblende-bearing hypabyssal intrusive rock, quartzite, and tuff. Pedogenic carbonate (caliche) is locally visible.

Tertiary

Tertiary basin-fill deposits

Tcf — **Conglomerate and sandstone, northeast deposits–**The only fresh exposure is in the road-cut near the northeast corner of the map where interbedded siltstone, sandstone, and conglomerate are visible. Contains angular to subrounded granule to small boulder-size clasts of andesite(?), less abundant sandstone/quartzite, smaller chert fragments, and sparse very dark-gray basalt containing olivine inclusions and black xenocrysts with no cleavage that may be spinel. This unit is almost everywhere mantled by a dark reddish brown clay-rich soil (mapped as **Qo**). Two faulted exposures on the south side of Cane Spring Canyon, on the west side of the Bear Mountain Fault, are dominated by limestone and chert clasts up to large cobble-size.

Tcg — **Conglomerate and sandstone, granitic unit–**This unit is predominantly sandy, with the sand fraction containing abundant quartz and feldspar and less abundant Tertiary volcanic and Precambrian metamorphic rocks. A smaller portion of the feldspar sand is composed of large light-gray feldspar grains commonly up to and exceeding 1 cm across. Subrounded gravel clasts can reach 30 cm across, but most are less than 15 cm, and are dominated by foliated to nonfoliated dark green diorite/amphibolite, vein quartz, quartzite (resembling the Beartooth Quartzite), granite, and less abundant clasts of nearly aphyric basalt, ash-flow tuff, and locally light greenish-gray feldspar porphyry that characteristically contains black needles of hornblende. Some granitic clasts resemble unit **YXg**, exposed around Treasure Mountain, but many are characteristically lighter gray with little or no hematitic alteration, contain abundant biotite, and are coarser grained. As such, the clasts more resemble Laramide granites than Precambrian granites. This unit also characteristically contains rare reddish-orange clasts of altered granite. According to Virginia McLemore (personal communication) these are episyenite that are exposed in the Big Burro Mountains to the south. Fresh exposures of **Tcg** are rare but are characteristically light pink to tan compared with the other sedimentary deposits. This unit is more easily eroded than the other Tertiary sedimentary deposits and mostly forms low rounded hills and dissected slopes.

Tcm — **Conglomerate and sandstone, mixed unit–**Interbedded conglomerate and sandstone. The composition of this unit is quite variable. To the northwest it is dominated by volcanic clasts composed of both dacite (**Td**) and lithic-rich tuff (**Ttl**). In the central part of the map it is a mixture of volcanic and sedimentary (Paleozoic and Cretaceous) clasts, and locally a significant amount of basalt clasts. To the southeast it is dominated by Paleozoic and Cretaceous clasts with a significant percentage of granite, diorite/amphibolite, and quartz-muscovite schist.

Tby — **Olivine basalt. Dark gray–**Contains subhedral olivine phenocrysts between 1-5 mm, mostly altered to red iddingsite, that appear as obvious red spots against the dark gray matrix. The matrix is aphanitic and contains tiny plagioclase microlites. Outcrops are typically extensively jointed. Rocks are very hard and difficult to break even with many blows of a hammer. There are at least two flows separated by a thin layer of sedimentary deposits identical to the material above and below (unit **Tcs**). Appears to thicken northeastward, and pinches out southeastward. A small isolated 'plug' of basalt in the SW corner of Section 7, T17S, R15W (UTM 3636300, 739600) may be the erosional remains of a conduit. A sample of this rock was collected for geochronology and sent to Bill McIntosh at New Mexico Tech.

Tci — **Conglomerate and sandstone, feldspar-porphyry unit–**No good, fresh exposures seen, but probably interbedded sandstone and conglomerate. The unit contains abundant clasts of foliated and nonfoliated dark green diorite/amphibolite, quartzite, and minor basalt and ash-flow tuff, but the larger clasts (up to ~25 cm) are dominated by light greenish gray feldspar porphyry. The feldspar porphyry contains light gray subhedral feldspar up to 2 mm across, and acicular, needle-like phenocrysts of black amphibole (or pyroxene?). These clasts are all angular and resemble a shallow hypabyssal intrusive rock. This type of clast becomes much smaller to the northeast, where it is seen as far as Fleming Canyon. This type of feldspar porphyry was not seen in the Silver City Range. The contact between **Tci** and **Tcv** is uncertain and is drawn rather arbitrarily.

Tcv — **Conglomerate and sandstone, volcanic unit–**This unit is exposed in the western and southwestern parts of the map, and in a small window in the upper reaches of Cottonwood Canyon. It is composed mostly of pebbly conglomerate containing dominantly angular pebble-size fragments of crystal-poor fine-grained (and lithic-rich) ash-flow tuff (some clasts show welding), and rhyolite, in a tan silty matrix. In the southwest, bedding is not easy to see, except north of Saddle Canyon where deep dissection and small cliffs reveal planar-bedded exposures dipping about 6° to the northeast. Along Cottonwood Canyon this unit characteristically contains no clasts of olivine basalt, and is tilted southeastward as much as 24°. The deposits erode into steep, resistant, gray-colored hills that are slightly darker in color than the overlying Tertiary units.

Tcb — **Conglomerate and sandstone, basaltic unit–**Coarse conglomerate. This deposit contains very poorly-sorted, subangular to subrounded clasts of aphyric basalt from granules to large cobbles, and locally boulders 1 m across. Locally, the unit also includes less abundant clasts of ash-flow tuff (sanidine + biotite) also up to boulders 1 m across, and less abundant flow-banded rhyolite. The sandy to silty tan-colored matrix contains abundant light gray sand-size to small-gravel-size clasts of ash-flow tuff. Where exposed in stream-cuts bedding is typically indistinct to non-existent. These deposits are typically strongly cemented with calcite, which locally forms sparry crystals up to 5 mm wide. This unit directly overlies the aphyric basalt (**Tb**) near the southern boundary of the map where it is tilted slightly to the northeast.

Tb — **Aphyric basalt–**This basalt contains no visible phenocrysts except tiny plagioclase microlites. Small exposures on the west side of Mangas Creek show sparse anhedral, almost clear feldspar up to 3 mm and tiny greenish glassy clots. Fresh surfaces are dark gray. Weathered surfaces are typically medium to light gray. Commonly vesicular. Locally, fractures contain light gray botryoidal silica (fibrous chalcedony). Forms steep resistant hills near the southern boundary of the map. South of the map area good exposures show basalt overlying a thick light gray colored deposit that, from a distance, resembles ash-flow tuff 76+ m (250+ feet) thick.

Tbc — **Scoria–**Dark red and black, massive to bedded scoria–Exposed in on location within basalt (**Tb**) near the southern edge of the map.

Ttr — **Yellow lithic tuff–**Both ash-flow and air-fall deposits–This unit is mostly non-bedded and massive west of the headwaters of Cane Spring Canyon and thinly bedded to the east. To the west the unit contains very abundant angular clasts of flow-banded rhyolite up to cobble-size. To the east, where bedded, clasts also include andesite-looking rocks. This unit covers an irregular topographic surface in the underlying **Td** lava (300+ feet thick).

Tr — **Rhyolite–**Contains 1-2% subhedral to euhedral black biotite in thin books and anhedral glassy phenocrysts (either quartz or feldspar—difficult to distinguish) between 1-2 mm across. The aphanitic matrix is typically light-tan to pink and commonly flow-banded. Outcrops commonly weather into thin, platy, angular fragments with less vegetation than other rocks. Outcrops exposed along Black Tank Canyon in the southwest corner of the map contain lenses of rhyolite autobreccia that may be the remnants of rampart breccias. As mapped this unit intrudes pyroclastic rocks (**Tt** in the southwest part of the map, and **Ttl** in the northern part of the map) and is overlain by lithic-rich tuff of unit **Ttr** near the northern edge of the map 0-213 m (0-700+ feet) thick.

Tt — **Tuff–**Contains sparse subhedral to euhedral black biotite and anhedral glassy phenocrysts (either quartz or feldspar—difficult to distinguish)—similar to the mineralogy of **Tr**. This unit was mapped in the southwest corner of the map were it is intruded by rhyolite (**Tr**). Locally, tuff also appears to be interbedded with rhyolite, suggesting the two units are coeval. Most exposures show planar bedding, which dips to the northeast between about 20° and 60°. Outcrops are commonly light yellow to light tan. Although most exposures are bedded, some are massive and resemble ash-flow tuff, particularly on the west side of Saddle Rock Canyon (near UTM 3630000, 734200) (Thickness unknown).

Td — **Dacite–**Contains 10-20% light-gray subhedral plagioclase 1-3 mm long in a dark tan to gray to purple aphanitic matrix. Flow-banding is locally common. Forms resistant, dark-colored and jagged outcrops. Some exposures are fragmental and appear to be autobreccias. Outcrop patterns suggest that some exposures represent dike-like bodies that intruded the ash-flow tuffs of unit **Tta**. Mineralogically, this unit resembles andesite, but the abundant flow-banding suggests the rock may be slightly more silica-rich. The term 'dacite' is here used as a useful field term. It is quite possible that a chemical analysis may reveal this rock to be andesite or quartz latite 0-121 m (0-400+ feet) thick.

Tda — **Aphyric dacite–**Dark-gray aphyric lava. Massive, pervasively fractured, and locally brecciated. Some areas appear glassy. This unit is interpreted to be part of the dacite because it appears to line up with other more obvious dacite exposures, and because it is in the same stratigraphic position as dacite.

Ttl — **Lithic-rich ash-flow tuff–**This tuff contains very sparse anhedral quartz phenocrysts 1-2 mm across. Characteristically contains very abundant angular lithic fragments of various types (apparently mostly rhyolite and less abundant quartzite) from granule to cobble-size surrounded by a deep red to pinkish tan aphanitic matrix. Bedding is almost non-existent, though there are suggestions of dipping layers from a distance locally. Where exposed along deep canyons it appears to be one and possibly two homogeneous flow units with no visible breaks except for a thin-bedded air-fall tuff about a third of the way up from the bottom. It is characteristically massive, with only incipient eutaxitic foliation. Pumice fragments up to a few centimeters across are common and typically altered yellowish-green. The lower portion contains rather sparse angular lithic fragments, but fragments increase in abundance upward where the unit forms steep tan-colored cliffs that appear rather smooth from a distance. Locally, the upper portions contain massive blocks up to several meters across or more. These blocks are composed of older lithic-rich ash-flow tuff, andesite-like lava rock, sparse siltstone that resembles the Percha Shale, and at least one clast of a foliated mafic granitoid. Some large blocks resemble ash-flow tuff but are altered shades of pink and light gray, suggesting that these blocks are fragments of an older ash-flow tuff that had already been hydrothermally altered prior to being incorporated into the enclosing tuff. Rare blocks form pedestal rocks on steep canyon walls. The area northwest of Circle Mesa is chaotic 304+ m (1,000+ feet) thick.

Ttq — **Quartz-sanidine ash-flow tuff–**This tuff contains only very sparse lithic fragments, and contains between 5-15% phenocrysts of large subhedral sanidine and rounded resorbed quartz, and biotite (?) both up to about 3 mm across. The percentage of phenocrysts is variable, but not enough time was spent to determine what trends, if any, exist. On weathered surfaces the darker-gray phenocrysts stand out slightly in relief. The base of the unit contains several meters of bedded tuff. The tuff is typically blue-gray to yellow gray and massive. A sample of this rock was collected for geochronology and sent to Bill McIntosh at New Mexico Tech. About 243 m (800 feet) thick.

Tco — **Older conglomerate–**This unit consists of interbedded dark-red to purple sandstone and conglomerate and, as mapped, at least two thin ash-flow tuff units. Granule to cobble-size clasts are subrounded to well rounded and are dominated by dark purple volcanic rock containing 10-20% light-gray feldspar phenocrysts up to a 1-2 mm long. As such, these clasts resemble unit **Td** above, but must have come from an older unit. Less abundant light purplish gray sandstone/quartzite resembles **Kb**. Locally, the unit contains sparse cobbles of granite, indicating that source areas of granite were already exposed nearby at this time (or were plucked from an older conglomerate). This unit is weakly lithified and crumbles relatively easily with a hammer, forming low rounded hills. East of Circle Mesa this unit contains large boulders of an intrusive rock that resemble the Tertiary intrusive rock at McComas Peak (in the Silver City quadrangle to the east) which contain large black hornblende/pyroxene crystals up to 1.5 cm long 0-91 m (0-300 feet) thick.

Tta — **Older ash-flow tuff–**This ash-flow tuff is everywhere weakly to moderately welded and contains only very sparse, tiny subhedral biotite crystals. No other phenocrysts are visible in hand-samples. This unit is characteristically medium blue-gray to yellow-gray and contains dark purple fiame that are probably altered flattened pumice. Mapped only locally. In other areas it is included with map unit **Tc**. Each tuff is about 15 m (50 feet) thick.

Tf — **Intrusive rhyolite–**Contains sparse (<1%) phenocrysts of clear quartz 2-4 mm across and even less abundant altered dark sports that may be the remains of biotite, all in a light tan to light pink aphanitic matrix. Flow foliation in places is sub-parallel to bedding in the Paleozoic rocks it intrudes. Locally, the flow foliation is kinked and folded. Pieces eroded from this unit have an almost lineated look to them and superficially resemble petrified wood. This unit may be equivalent to the unit **Tr** but because it intrudes the Paleozoic rocks in the northeastern part of the map and into the Silver City quadrangle it was mapped separately. The unit forms a thin sill-like body between the Fusselman Dolomite and Percha Shale

Cretaceous

Kc — **Colorado Formation–**Interbedded shale, siltstone, and fine-grained sandstone. Mostly medium to dark gray, very fine-grained sandstone and siltstone, with subordinate shale. Some siltstone beds contain septarian concretions. Though rare some weathered-out nearly spherical concretions are up to 40 cm across (small boulder-size). Thinly laminated dark siltstones locally exhibit low-angle cross-beds in sets up to 2 cm thick. The unit forms slopes and is not well exposed. The best exposures are along the upper reaches of Cottonwood Creek, about one mile east-northeast of Circle Mesa. The contact between the Colorado Formation and the underlying Beartooth Quartzite is well exposed here in the creek bed and appears sharp (0-30 m thick).

Kb — **Beartooth Quartzite–**This clean, light gray sandstone contains well sorted, fine-grained quartz grains that are partially to completely fused together to form protoquartzite and quartzite. Bedding is mostly medium to thick and commonly wavy. Ripple marks are locally visible and planar cross-beds are abundant in sets up to about 1 m thick, but more commonly in sets 20-40 cm thick. In most outcrops, however, cross-bedding but it is mostly indistinct. Sparse, thin conglomeratic layers several centimeters thick contain angular to subrounded red and yellow chert clasts, and what looks like gray quartzite clasts. The quartzite commonly breaks into angular, resistant clasts that form a lag down-slope. Forms a small but prominent cliff between Cane Spring Canyon and Cottonwood Creek (30-40 m thick).

Paleozoic

Mlx — **Red chert breccia atop the Lake Valley Limestone (Mississippian)–**This striking deposit is composed of light yellowish-gray angular chert fragments from sand-size to cobble-size, surrounded by a massive, deep red matrix containing abundant hematite and silica. In some areas bedding is nonexistent to faint, while in others the originally stratigraphy is preserved, yet highly fractured and completely silicified. Great exposures in Cane Spring Canyon are locally greater than 6 m (20 feet) thick. This deposit represents a silicified karst residuum (0-7 m thick).

Ml — **Lake Valley Limestone (Mississippian)–**Thick-bedded blue-gray fossiliferous limestone. Interbedded fossiliferous grainstone beds composed of very abundant crinoid stem debris, and fossil-poor laminated micrite beds. Pinkish-gray to almost black chert nodules up to a few meters long and up to 10 centimeters thick preferentially occur within the laminated beds but also occur with fossiliferous beds. Limestone laminae wrap around chert nodules. Overall, chert forms a minor component of the unit but are characteristic. Locally, a few crinoid stems and horn corals 1-2 cm across are silicified. A few widely spaced stylolites are visible on vertical faces. From top to bottom the unit looks very similar, dominated by thick, planar limestone beds. Gives off a fetted odor when broken. The thickness of the formation varies greatly because of Mississippian karsting (20-150 m thick).

Dp — **Percha Shale (Devonian)–**Dark green to yellowish-gray shale. Poorly exposed, this unit is mostly only exposed in gullies in talus-covered slopes. Locally, especially near the top, it contains abundant lenticular fine-grained limey siltstone beds several centimeters thick that pinch out laterally to form nodules between 10-30 cm long. This upper part is probably equivalent to the Box member of the Percha Shale, while most of the mapped unit is likely equivalent to the Ready Pay member. The unit crumbles easily (100-150 m thick).

Sfx — **Silicified chert breccia atop the Fusselman Dolomite (Silurian)–**This deposit forms a very resistant slightly darker colored cap atop the less altered dolomite. It is composed of what appears to be yellowish-brown granular microcrystalline quartz (chert) and younger, lighter-colored cavity-filling chert that appears to be fibrous chalcedony. Beautiful exposures in Cane Spring Canyon show tongues of chert filling vertical 'channels' in the underlying dolomite up to several meters deep. This deposit likely formed during subaerial karsting (0-5 m thick).

Sf — **Fusselman Dolomite (Silurian)–**Light gray to yellowish-gray finely crystalline dolomite and microdolospar. Mostly medium bedded. Some beds contain abundant partially silicified brachiopod shell debris. The unit characteristically contains light gray silicified colonial corals (*Favosites*?). Though not as abundant as in the Silver City quadrangle to the east, they are composed of hexagonal pillars between 2-5 mm across that radiate upward from a holdfast to form mushroom-shaped (the larger forms) and balloon-shaped (the smaller forms) colonies between 2 and 30 cm across. In contrast to all the other silicified fossils in the Paleozoic section this coral is replaced by light gray coarse-grained quartz (megaquartz). These corals, and the type of silicification, are found in no other unit. Most of the dolomite is highly fractured and forms small angular fragments. Its light gull-gray color and flat appearance help to distinguish this unit from the underlying darker gray and sandy Montoya Formation (50 m thick).

Oa — **Aleman member of the Montoya Formation (Ordovician)–**Finely crystalline dolomite and abundant planar-bedded chert. This unit characteristically contains greater than 50% thin sheet-like beds of pinkish-gray chert between 1-2 cm thick, interbedded very regularly with light gray laminated dolomite about 2-4 cm apart. Sparse silicified brachiopods are exposed on the surface of some chert beds. Some 'worm-like' chert exposed on the bedding planes may be silicified horizontal burrows. The contact with the underlying Montoya Formation, where exposed, is very sharp, with light gray finely crystalline dolomite overlying darker gray dolomite that is also finely crystalline but contains abundant fossiliferous debris. The chert beds tend to erode into small, angular, rectangular fragments a few centimeters across that are useful for identifying the formation where it is poorly exposed (15-20 m thick).

Om — **Montoya Formation (Ordovician)–**Medium gray finely crystalline to coarsely crystalline dolomite and limestone. The lower part of the unit forms steep ledgy massive outcrops composed of thick-beds containing very sparse light gray chert. Many of these beds are not obviously fossiliferous but some contain silicified tubes up to 1 cm in diameter than may be crinoid stems. Some areas contain abundant crinoid stem debris replaced by coarse calcite spar. Sparse brown corals up to 2 cm are silicified by light gray chert. Sheet-like bryozoans are rare. Most characteristically, some beds contain very abundant medium to very coarse rounded quartz grains. The quartz grains characteristically give outcrops a granular, sandy appearance, which erode into sandy lag deposits on the surface. The quartz-rich beds show chaotic internal structures and appear to have been extensively bioturbated. The lower portion of the unit characteristically contains irregularly shaped light gray to light pinkish-gray chert nodules up to 20 cm long or more in widely separated beds. Higher in the section the chert is darker gray. The base forms a prominent darker cliff (a few meters high) above the El Paso Formation. Most of this formation is rather massive and poorly bedded, more medium gray color than the overlying Fusselman Dolomite, and characteristically sandy (30-40 m thick).

Oe — **El Paso Formation (Ordovician)–**Thin-to medium-bedded finely crystalline to medium crystalline dolomite. Although beds are planar the surfaces exhibit a bumpy (erosional?) surface texture that is reflected in profile by small-scale undulations in the bedding. This unit is characteristically mottled pink and gray. Pink areas form both wispy and irregularly shaped laminae as well as 'wormy' areas that resemble in-filled, mostly bedding-parallel burrows. This worm-like light gray chert is very conspicuous on many bedding surfaces and may represent silicified burrows. Intraformational breccias consisting of granules to small cobble-size carbonate fragments are very common and typically form beds from a few centimeters up to a few tens of centimeters thick. Locally, larger boulder-size 'zones' of light gray massive dolomite are surrounded by apparently depositionally overlapping slightly darker carbonate. This unit forms slopes exhibiting ledgy, step-like outcrops. Locally, the unit contains thin lenses of sandstone associated with thin chert breccias that resemble small cavern-fill and cavern roof break-down deposits (130-180 m thick).

€Ob — **Bliss Formation (Cambrian and Ordovician)–**Quartz sandstone, dolomitic quartz sandstone, and less abundant dark greenish-gray dolomite. The rusty brown matrix contains abundant granular and some specular hematite. The lowermost part consists of medium-bedded, low-angle cross-stratified quartz sandstone containing abundant vertical Skolithos trace fossils, particularly within the lowermost meter of the formation. The remainder of the formation consists of thin- to thick-bedded, planar and trough cross-stratified sandstone. Throughout the map area, the unit contains a thin interval of dark yellowish gray thin bedded dolomite and sandy dolomite about 1-2 meters thick within the upper third of the formation. Pale green glauconite grains are common. The unit is typically dark brown to red-brown and locally forms a ledgy cliff. In other areas it forms a slope and is difficult to distinguish from the underlying granite from a distance (60 m thick).

Precambrian

YXg — **Granite (Early or Middle Proterozoic)–**Medium- to marginally coarse-grained and equigranular. This characteristically light orange-colored granite is almost everywhere texturally similar. It is composed of relatively equant crystals of K-feldspar, plagioclase, and quartz. Plagioclase appears altered (sericitized?). Biotite is almost completely altered to hematite and most outcrops appear leucocratic. As such, it is difficult to estimate the original percentage of the mineral. The rock is everywhere deeply weathered and outcrops are commonly grungy and crumbly. No foliation is visible within the study area, but this rock is locally foliated to the east in the Silver City 7.5' quadrangle where the northwest-striking foliation is defined by quartz crystals strung out into long lenses, and aligned mica.

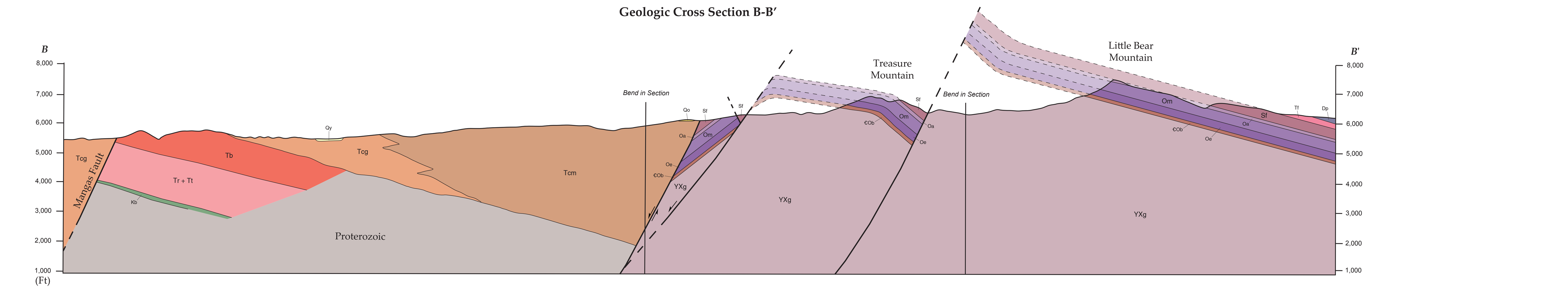
Xs — **Quartz-muscovite schist–**Contains quartz and coarse-grained muscovite. It is exposed in only one place in the map are, immediately east of Treasure Mountain, where it forms a lens-like enclave within **YXg** and is strongly foliated.

Correlation of Map Units

Ma	PERIOD	EPOCH	STRATIGRAPHIC UNITS	
0.01	QUATERNARY	Holocene	Qy	Sands and gravels that cover valley floors and form thin elevated terraces
0.25		Pleistocene, Late	Ql	
0.7		Pleistocene, Middle	Qlm, Qm, Qmo	
1.8		Pleistocene, Early	Qo	
5.3	TERTIARY	Pliocene	Gila Group: Tcg, Tby, Tcm, Tcf	Basin and Range orogeny-Sediments and lava that fill the Mangas Valley half-graben.
23.7		Miocene	Tcv, Tci, Tcb	
36.6		Oligocene	Tb, Ttr, Td, Tt, Tr, Ttl, Ttq, Tco, Tta	Mid-Tertiary volcanic and sedimentary rocks
57.8		Eocene		Laramide orogeny
66.4		Paleocene		
144.5	CRETACEOUS	Late, Early	Kc, Kb	Colorado Fm., Beartooth Quartzite — Cretaceous sedimentary rocks
318	MISSISSIPPIAN	Late, Early	Mlx, Ml	Lake Valley Lm.
359	DEVONIAN	Late, Middle, Early	Dp	Percha Shale
416	SILURIAN	Late, Early	Sfx, Sf	Fusselman Fm. — Paleozoic sedimentary rocks
444	ORDOVICIAN	Late, Middle, Early	Oa, Om, Oe	Montoya Fm., El Paso Fm.
488	CAMBRIAN	Late, Middle	€Ob	Bliss Fm.
521				
1000	PROTEROZOIC	Middle	YXg	Granite and metamorphic rocks
1600		Early	Xs	

* These samples have been submitted to Bill McIntosh at the New Mexico Bureau of Geology for geochronologic analysis.

Geologic Cross Section B-B'



Geologic Cross Section A-A'