

# **Geologic Map of the Copper Mountain Quadrangle, Gila County, Arizona**

by

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## **INTRODUCTION**

The Copper Mountain quadrangle is centered just north of the southwest-facing escarpment on the southwest side of the crest of the Sierra Ancha (see Figure 1). Elevations range from about 4200 feet in the southwest corner of the map to 6676 feet at Copper Mountain. The lower elevations in the southwest part of the map contain a mix of open Pinyon-Juniper forest and grassland and thick stands of oak mostly along the drainages. The Pinyon-Juniper gives way higher up to larger oak woodlands. The higher elevations up on the plateau are a mix of thick tangles of oak and manzanita and Ponderosa Pine conifer forest. The proliferation of dense brush in the higher elevations makes travel and mapping very difficult. This is especially true for the south-facing cliffs and slopes along the main escarpment where a thin cover of colluvium and dense chaparral form an almost impenetrable barrier (particularly at the aptly named Malicious Gap). The conifer forest is locally fairly open beneath the canopy but the litter of pine needles and leaves effectively obscures most of the rock exposures.

The best access to the region is Forest Road 609, which connects Forest Road 71 on the west with the Young road (State Route 288) on the east. Forest Road 609 is passable with a 2-wheel-drive vehicle. Although it is only partially marked on the map the road extends all the way across the quadrangle on a winding route in and out of canyons on the north side of Copper Mountain. Forest Road 486 splits off Forest Road 609 and dives down a steep, slippery slope into Buzzard Roost Canyon where it connects with the well-maintained Forest Road 416. Heading south, Forest Road 486 is steep but passable with a 4-wheel-drive at least as far as Greenback Peak. Besides these roads, most of the trails marked on the map no longer exist. There are, however, a few logging roads north of Copper Mountain, but most are partially overgrown.

## **PREVIOUS WORK**

Bergquist and others, 1981, mapped Apache Group rocks and underlying granite to the south and east as part of a larger study of the Sierra Ancha Wilderness and Salome Study area. Spencer and others (1999) mapped the northwestern part of the Greenback quadrangle to the southwest. Wessels (1991) mapped the northwest corner of the Picture Mountain quadrangle in a larger geologic study of the Jakes Corner area. The Picture Mountain quadrangle to the west was mapped concurrently with this study.

## **TERTIARY CONGLOMERATES**

There are two distinct conglomerate units in the study area (see figure 2). The oldest (map unit Tco) forms thick, deeply dissected deposits in the central and northern parts of the map. In places the unit is more than 600 feet thick and is interbedded with thin basalt flows. This older conglomerate fills paleochannels previously cut into Apache Group rocks. Remnants of a major channel are exposed on the west side of Middle Mountain and extend southward all the way to the top of the divide just west of Greenback Peak. Another channel underlies the east side of Redman Mesa and extends at least as far south as Thoroughbred Pasture Tank. The outcrop patterns suggests that these channels were associated with a northward-flowing drainage system.

The middle conglomerate (map unit Tcm) forms thin deposits sloping southward away from the plateau of the Sierra Ancha in the southwest corner of the map. These sediments were deposited after extension and erosion had formed the southern escarpment of the Sierra Ancha. Tcm deposits are very thin compared to the older conglomerate.

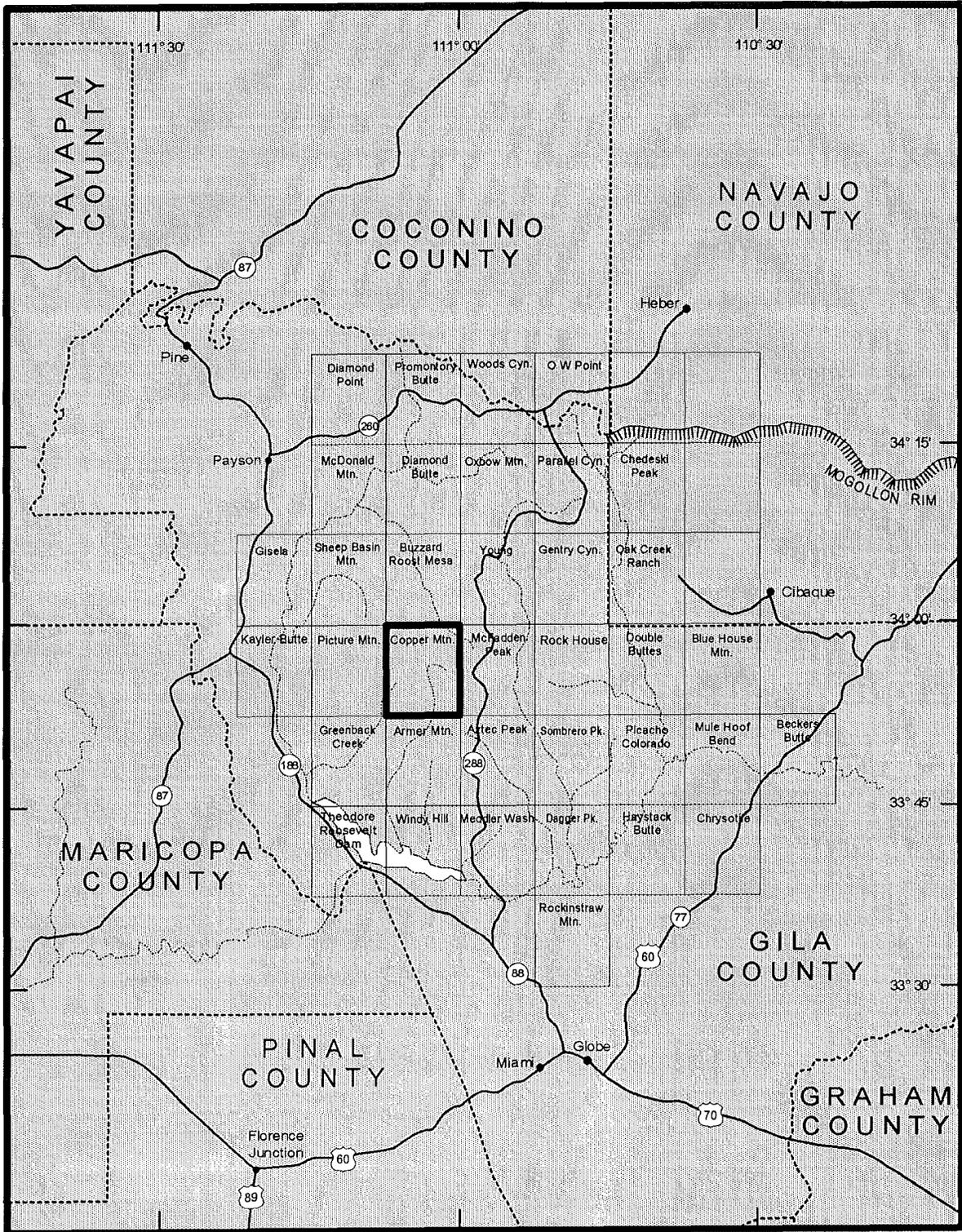


Figure 1. Location map of the Copper Mountain quadrangle.

## APACHE GROUP ROCKS

The Scanlan Conglomerate at the base of the Pioneer Formation is exposed only in a few places in the study area. Good exposures are present south of Redman Mesa and in the upper reaches of Salome Creek. In Salome Creek 2-3 meter-thick exposures form a cliff resting nonconformably on coarse-grained granite. The Scanlan contains well-rounded moderately sorted clasts of quartz and quartzite in a sandy, arkosic matrix. The Scanlan conglomerate rests on an erosional surface on the underlying granite that was beveled remarkably flat sometime between about 1.4 and 1.15 Ga. There is very little relief on the erosion surface which probably represents a hiatus of at least 100 million years.

The Scanlan grades rather abruptly upward into dark purple argillites and quartzites of the Pioneer Formation. Almost everywhere in the Copper Mountain quadrangle the Pioneer Formation is dominantly fine-grained quartzite with only very minor argillite. In general, it is darker in color than the overlying Dripping Spring quartzite, but locally it is nearly the same color on weathered outcrops. The diabase preferentially intruded along bedding planes in the Pioneer, and as a result much of the formation was assimilated by the mafic magma. Locally, only thin slivers of the unit are exposed.

The Dripping Spring quartzite overlies the Pioneer Formation. It is made up of a lower, cliff-forming quartzite member and an upper, slope-forming argillite member. The upper member is typically a light yellow mustard color and contains conspicuous partings along finely planar beds. The lower member commonly has a light pink hue and is characterized by apparently more massive beds with fewer partings. Shride (1967) described the lower member as actually thinly bedded as well, but on most weathered surfaces the bedding is not well expressed. In the map area the upper member forms most of the high plateau of the Sierra Ancha. Exposures on relatively level surfaces are poor due to disruption by and development of clay-rich soil. The canyons generally contain the best exposures.

The Mescal Limestone overlies the Dripping Spring quartzite in the north half of the map. Exposures on the north side of Bear Head Mountain are almost everywhere light grey limestone. Based on extensive field observations Shride (1967) concluded that the limestone was originally dolomite, but was altered due to heating associated with intrusion of the diabase. The unit contains very little chert. Where chert is visible it is light grey to white and pitted with irregularly shaped cavities. Somewhere northeast of Bear Head Mountain the limestone gives way to chert breccia which developed during subaerial exposure and karsting of the limestone during the Proterozoic. At least the algal member, and possibly up to a third of the underlying lower member of the Mescal, have been karsted, altered and silicified. Broken and/or rounded original, primary Mescal chert clasts are surrounded by secondary chert that commonly forms thin laminae draping over and between the clasts. Beeunas and Knauth (1985; see also Knauth and Beeunas, 1987) measured  $\delta^{18}\text{O}$  values that were consistent with precipitation by light,  $\delta^{18}\text{O}$ -depleted meteoric waters. Excellent exposures of these laminated cherts can be found along the ridge connecting Copper Mountain with Lookout Point.

Overlying the chert breccia of the Mescal Limestone is a thin deposit of tan to purple, thin bedded argillite or bedded chert. The exposure is mostly covered in brush and is very poor. Microscopic examination of thin-sections of samples from this unit near Copper Mountain show the rock to be composed mostly of granular microcrystalline chert. Laminae are very regular and continuous, even where they drape over the underlying chert breccia. Tiny subrounded to subangular quartz grains 'floating' within the microcrystalline chert suggest the unit may at least be partially colian in origin.

Basalt overlies the argillite on the west side of the map. The basalt is generally dark grey to dark brown and commonly contains small, white amygdules composed of coarse-grained quartz.

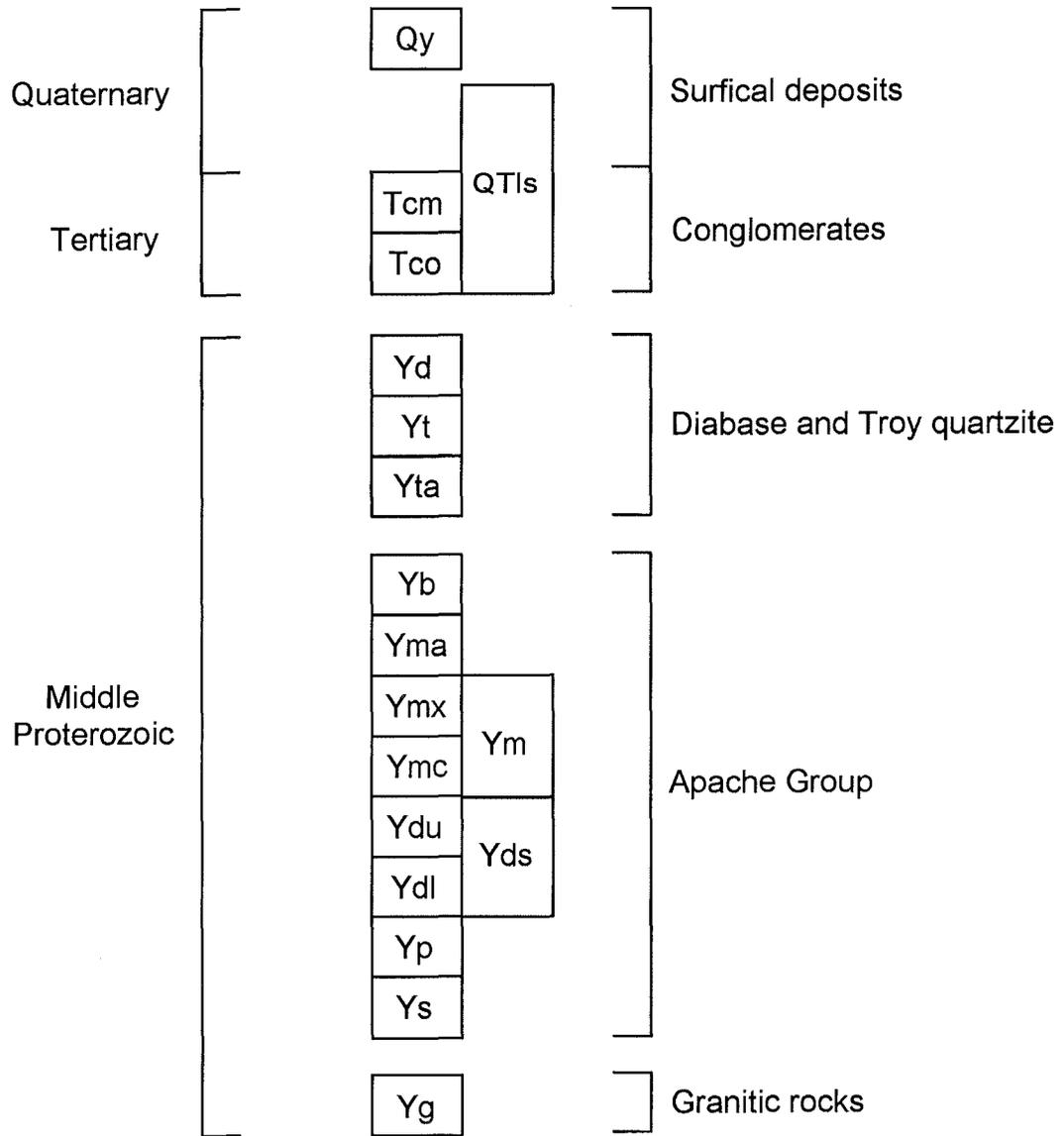


Figure 2. Correlation diagram for the Copper Mountain quadrangle.

Shride (1967) described these amygdules as weathering out and littering the surface. However, in this quadrangle, they are commonly between 2-5 mm in diameter and disintegrate readily upon weathering. In thin-section the amygdules commonly have a thin lining of subhedral crystals that resemble zeolites. The basalt is mostly deeply weathered. Most of the mafic minerals are unrecognizable except locally. Locally, the rock contains fine-grained specular hematite. In thin-section many of the pyroxene phenocrysts are almost completely altered to serpentine.

Capping the basalt is Troy Quartzite. In the western part of the map the Troy is mostly fine- to medium-bedded tan fine- to coarse-grained quartzite. Low-angle planar cross-beds are well exposed on the ridge northwest of Copper Mountain. On the east side of the quadrangle, capping the east-west trending ridge, the rock here is the arkose member of the Troy. It is rusty red and contains abundant rounded pebbles and cobbles of quartz, quartzite, and metarhyolite, all in an arkosic matrix.

## STRUCTURE

As a whole, the Apache Group rocks making up the plateau dip very gently to the north-northeast. They have been extensively intruded by dark green diabase sills that have assimilated much of the Pioneer Formation exposed in the southern part of the map. Locally, the diabase has deformed the sedimentary rocks into broad, low-amplitude folds. As seen from a distance the bedding undulates slightly but with no apparent preferred orientation. In the upper reaches of Salome Creek shallow outward dips in the Pioneer Formation form a small, northeast-plunging anticline. Farther south, in Hells Hole, Bergquist and others (1981) mapped a west-facing, northeast-striking monocline.

Tertiary basalt is in a sharp linear contact with Dripping Spring quartzite immediately west of Lookout Point. This contact is probably a fault. The fault projects northwest and northeast where it downdrops rocks on the north side about 250 feet. A splay of this fault down-drops Lookout Point with respect to Copper Mountain.

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UNIT DESCRIPTIONS FOR THE COPPER MOUNTAIN QUADRANGLE  
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Quaternary deposits

- Qy** **Holocene alluvium (< 10 ka)**—Unconsolidated sand to small boulders reaching sizes up to 25 cm in diameter upstream but smaller and fewer downstream. Larger clasts are quartzite and granite. Smaller clasts are subangular granitic grus. Qy deposits are characterized by stratified, poorly to moderately sorted sands (in many areas a dark diabase sand), gravels, and cobbles frequently mantled by sandy loam sediment. On this surface the main channel commonly diverges into braided channels. Locally exhibits bar and swale topography, the bars being typically more vegetated. Soil development is relatively weak with only slight texturally or structurally modified B horizons and slight calcification (Stage I). Some of the older Qy soils may contain weakly developed argillic horizons. Because surface soils are not indurated with clay or calcium carbonate, these surfaces have relatively high permeability and porosity.
- QTls** **Landslide deposits? (Late Tertiary or Quaternary)**—Broken and disoriented rock masses and debris flows that generally occur where diabase has been eroded along cliffs and steep slopes (from Bergquist and others, 1981).

Tertiary rocks

(The two conglomerate units, Tco and Tcm, were subdivided mostly on the basis of relative position in the landscape. Tco is at this higher elevations, Tcm is much lower.)

- Tcm** **Middle conglomerate (middle Tertiary)**—This conglomerate is intermediate in elevation between the lower, younger conglomerate deposited to the southwest of the Copper Mountain quadrangle and near Tonto Basin, and the older conglomerate exposed at high elevations in the Sierra Ancha. It contains mostly angular to subrounded sand- to cobble-sized clasts of Dripping Spring quartzite, with minor clasts of diabase and possibly lighter-colored Troy Quartzite. Unlike both the younger and older deposits this unit forms a very thin layer a few meters thick that slopes gently away from the escarpment of the Sierra Ancha. Looking edge-on towards the southeast across the southwest corner of the map this unit once formed a continuous sheet, now expressed as a series of parallel, deeply dissected mesas capping mostly diabase. The unit contains a well-developed brown argillic soil, which is exploited by abundant grasses.
- Tco** **Older conglomerate (early to middle Tertiary)**—This unit contains medium-bedded, moderately consolidated conglomerate interbedded with moderately sorted sandstone, pebble and cobble layers. Clasts are angular to subrounded and range in size from sand to boulders >1 meter across. The deposits contain clasts derived from all Apache Group rocks, Troy Quartzite, and diabase. Calcite cement is locally abundant and gives the rock a light grey to tan color. Outcrops are almost everywhere mantled by lag gravel. Rare exposures along the bottom of canyons are not very extensive and imbrication could not be measured with confidence. These deposits fill paleochannels cut into older rocks in the northeast corner of the quadrangle. Locally, thin basalt flows are interbedded with these sediments.

**Tmi Mafic intrusive (early to middle Tertiary)**—This dark blue-grey, fine-grained volcanic rock contains phenocrysts of 1-8 mm subhedral olivine(?) completely altered to red opaques, light grey feldspar (plagioclase? nepheline?) and abundant altered brown minerals ~1 mm wide which reflect light on at least one good cleavage and have a subhexagonal shape--probably biotite. The phenocrysts are altered and difficult to identify in the field. Weathered surfaces are dark grey. This rock forms a small plug or stock on the north side of Copper Mountain. The plug contains abundant subrounded, pebble- to cobble-size lower-crustal xenoliths of amphibolite, tonalite, and what looks like eclogite. The mineralogy of the rock resembles the xenolith-bearing latite/dacite exposed farther to the west at Cave Creek and Camp Creek (Leighty et al., 1997, Skotnicki et al., 1997).

### Diabase and Troy Quartzite

**Yd Diabase (Middle Proterozoic)**—Dark grey and dark green-grey sills exhibiting a subophitic, diabasic texture. The rock consists of 35-45% 1-3 mm plagioclase laths in a dark green matrix that contains pyroxene. Smaller crystals of magnetite are common. Locally the rock contains very localized accumulations of light orange feldspar and in these areas the rock looks granitic. Where competent this unit weathers into irregularly shaped dark grey-green boulders. However, almost everywhere the rock crumbles easily and weathers into smooth slopes covered by a thin obscuring mantle of colluvium. This colluvium is so pervasive but was not mapped separately.

**Yt Troy Quartzite (Middle Proterozoic)**—The Troy Quartzite in the west-central part of the quadrangle is light tan, medium-bedded, fine- to coarse-grained quartzite. Moderately well-sorted beds displaying large planar cross-bedding cap the prominent northeast-striking ridge about 1 mile northwest of Copper Mountain. There the rock is slightly red-orange. In most areas the unit commonly forms blocky cliffs and slopes.

**Yta Arkose member of the Troy Quartzite (Middle Proterozoic)**—This unit is interbedded dark red-tan arkosic sandstone and pebble to cobble conglomerate. The clasts include white plutonic(?) quartz, light blue-grey to light purple quartzite, and felsic metavolcanic rocks (Red Rock rhyolite?). The larger clasts are subrounded to well rounded. Some beds contain red cherts from the Mescal chert breccia (map unit Ymx). This unit caps the ridge in the northeast part of the Copper Mountain quadrangle and caps Pine Mountain in the west-central part of the McFadden Peak quadrangle.

### Apache Group

**Yb Basalt (Middle Proterozoic)**—This dark grey to brown rock contains 1-2 mm-long phenocrysts of fine-grained plagioclase, and faint red opaques, in a dark aphanitic matrix. In thin section the mafic minerals are extensively altered to fine-grained hematite. In many outcrops hematite is visible as fine-grained specular hematite in fractures. Many exposures contain silica amygdules commonly 2-5 mm in diameter composed of coarse-grained quartz. The unit locally overlies the argillite (map unit Yma) and underlies the Troy Quartzite (map unit Yt). Dense vegetation favors growing on weathered exposures of this rock so good outcrops are not easy to find. It generally forms dark-colored slopes.

- Yma Argillite (Middle Proterozoic)**—Thinly laminated tan and grey chert layers characterize this unit. In marked contrast to the underlying chert-breccia deposits, these deposits contain continuous, unbroken laminae with no brecciation visible. In thin-section the rocks are composed of very fine-grained granular microcrystalline chert with laminations defined by zones of fibrous chalcedony and fine-grained opaque crystals. This unit was deposited after the karst event that created the chert breccia.
- Ymx Chert breccia of the Mescal Limestone (Middle Proterozoic)**—Patchy, but good exposures north and northeast of Copper Mountain contain light to medium grey clasts of what are probably early diagenetic cherts formed in the Mescal Limestone, now brecciated and surrounded by a locally laminated matrix of red to grey, hematite-rich secondary chert. Primary chert nodules locally have been broken and separated into angular fragments. In other places, the primary chert clasts are rounded. In most areas the angular and rounded cherts are still within the same stratigraphic position as they were in the original dolomite, but the intervening dolomite has been leached away and partially replaced by secondary chert. The secondary chert commonly forms very thin red, tan and grey laminae that drape over and between primary chert clasts. In thin-section, both types of chert are composed primarily of granular microcrystalline quartz. In the secondary chert locally, fibrous silica occurs both as thin layers and as spherical botryoids. This unit was probably formed during subaerial karsting of the Mescal Limestone prior to deposition of the overlying argillite (map unit Yma).
- Ym Mescal Limestone, undivided (Middle Proterozoic)**—This formation contains both a lower member composed of chert-rich, thinly bedded dolomite, and an upper member composed of stromatolitic dolomite. Thick vegetation, leaf litter, and lack of time necessitated lumping the two members together in the map area. Outcrops are mostly covered but some good exposures can be found on the steep slopes of canyons on the north side of Copper Mountain. Here, thin discontinuous chert layers and stringers are composed of dark to medium grey granular microcrystalline quartz.
- Ymc Mescal basal conglomerate (Middle Proterozoic)**—This unit is massive and commonly mottled in shades of dark grey and tan. Locally the color resembles the underlying Dripping Spring Quartzite, but the absence of bedding sets this unit apart. Locally, the rock contains discontinuous lens-like layers and nodules of dark grey to black chert. North of Bear Head Mountain some lenses form extensive sheets several meters across. These dark cherts commonly contain spherical pits a few mm in diameter. These pits are commonly filled with light grey silica and terra rosa. In thin-section, one of the pits contained a subhedral dolomite rhomb. The terra rosa suggests the unit was exposed to weathering before deposition of the overlying Mescal Limestone. However, except for the pits, these dark cherts also resemble the dark cherts in the lower part of the Mescal. Shride (1967) described this unit as a chip conglomerate representing an interval of erosion between deposition of the Dripping Spring quartzite and the Mescal Limestone.
- Ydu Upper member of the Dripping Spring Quartzite (Middle Proterozoic)**—This unit is composed of thinly bedded light tan-yellow argillite and fine-grained quartzite. Bedding is thin and platy and locally slightly wavy. In general, this unit forms a slope on top of the cliff-forming lower member. Locally, the top of this unit is weathered and pitted, and in places there are thin accumulations of reworked material. Where the accumulations are

large enough, they were mapped as map unit Ymc. The argillite commonly displays oriented mud cracks and rare tool marks.

- Ydl Lower member of the Dripping Spring Quartzite (Middle Proterozoic)**—This unit is mostly medium to fine-grained quartzite. Shride (1967) described the unit as an arkose and feldspathic quartzite, but feldspar grains are very difficult to distinguish in hand samples. The rock is generally pale pink to tan and is thin- to thick-bedded. Most exposures appear thick-bedded but along strike thinly bedded layers are revealed on some weathered surfaces. Low-angle planar cross-bedding and both regular and interference ripple marks are visible locally. In general, this unit forms cliffs which are capped by the slope-forming upper member (map unit Ydu).
- Yds Dripping Spring Quartzite, undivided (Middle Proterozoic).**
- Yp Pioneer Formation (Middle Proterozoic)**—Throughout the map area the Pioneer Formation is a dark purple, fine-grained, thin to medium bedded quartzite. Exposures are in most places at least partially consumed by diabase sills that preferentially intruded the Pioneer Formation. Locally, the rock contains light yellow and green bleached zones 5-20 cm long parallel to bedding. Pale grey to tan reduction spots are common. The basal Scanlan Conglomerate member is discontinuous throughout the study area and is rarely more than about 3 meters thick. The Pioneer Formation forms dark-colored cliffs and steep slopes below lighter tan colored cliffs of the Dripping Spring quartzite. Where weathering has produced a light tan patina, the two units are difficult to distinguish from a distance.
- Ys Scanlan Conglomerate member of the Pioneer Formation (Middle Proterozoic)**—This metaconglomerate is moderately sorted and very strongly cemented. It contains well rounded clasts of white to grey vein quartz and grey quartzite in a sandy matrix of grey quartz and pink feldspar. Feldspar grains are angular and poorly sorted. This unit forms a small resistant cliff at the base of the Pioneer Formation. Locally it is between 3-4 meters thick, but in other places it pinches out such that psammitic rocks of the Pioneer Formation rest directly on granite. The unit is shown on the map where it is thicker than about 1.5 meters.

#### Granitic rocks

- Yg Coarse-grained granite (middle Proterozoic)**—This coarse-grained granite contains large 1-4 cm-long subhedral phenocrysts of pink to dark orange K-feldspar, in a matrix of milky grey quartz, light grey plagioclase, and biotite. Where plagioclase is very light grey it may be sericitized. In areas where the rock is orange, biotite occurs as felty masses. Where the rock is fresher, biotite occurs in small fresh books up to about 6 mm wide. This rock forms rather smooth, light tan exposures. Outcrops are typically deeply weathered and crumble after a few blows with a hammer. The rock generally erodes into grus. Good exposures are found in Salome Creek and in Hells Hole, both in the southeast part of the map.