NMBMMR Open-file Report 435

Text for the Circle Mesa Quadrangle

by
John Cunningham
Western NM University

INTRODUCTION

The Circle Mesa Quadrangle lies near the center of Grant County in southwestern New Mexico. Structurally it is in what Trauger (1965) has termed the Gila Block of a transition zone between the Colorado Plateau and Basin and Range Provinces (Figure 1). The major physiographic features of the quadrangle trend northwest, and are, from southwest to northeast, the eastern edge of the Big Burro Mountains, the Mangas Valley, and the Silver City Range, with its northern and topographically lower extension of LS and Circle mesas. Access to the area is via U. S. Highway 180, Forest Service roads 853 and 118, and a number of ranch roads extending northeast from the Mangas Valley.

Although the area around Treasure Mountain, at the eastern edge of the quadrangle, was described by Lindgren and others (1910), the first geological map of the overall area was Paige's Silver City Folio (1916). In recent years, quadrangles to the north, west, and south have mapped by Hedlund (1978) and Finnell (1982, 1987) of the United States Geological Survey. The Circle Mesa map is an outgrowth of the mapping of the Silver City Quadrangle to the east (Cunningham, 1974), since many of the rocks and structures encountered there extend into the Circle Mesa area. Field work was conducted primarily during the summers of 1972 through 1975, and the summer of 1982, with some additional field work, plus petrographic studies, carried on intermittently during the interim.

ACKNOWLEDGEMENTS

The New Mexico Bureau of Mines and Mineral Resources provided financial support for the field work preparation of thin sections, and radiometric age determinations. Access to the map area was obtained by the kind cooperation of personnel of the Franks, Richardson, and Pacific Western ranches. Special thanks are due James Ratte, David Hedlund, and the late Tommy Finnell, all of the U. S. Geological Survey, for suggestions and criticisms which greatly aided in formulation conclusions relative to the volcanic units in the Circle Mesa Quadrangle. James Ratte and Wiliam Seager reviewed the manuscript.

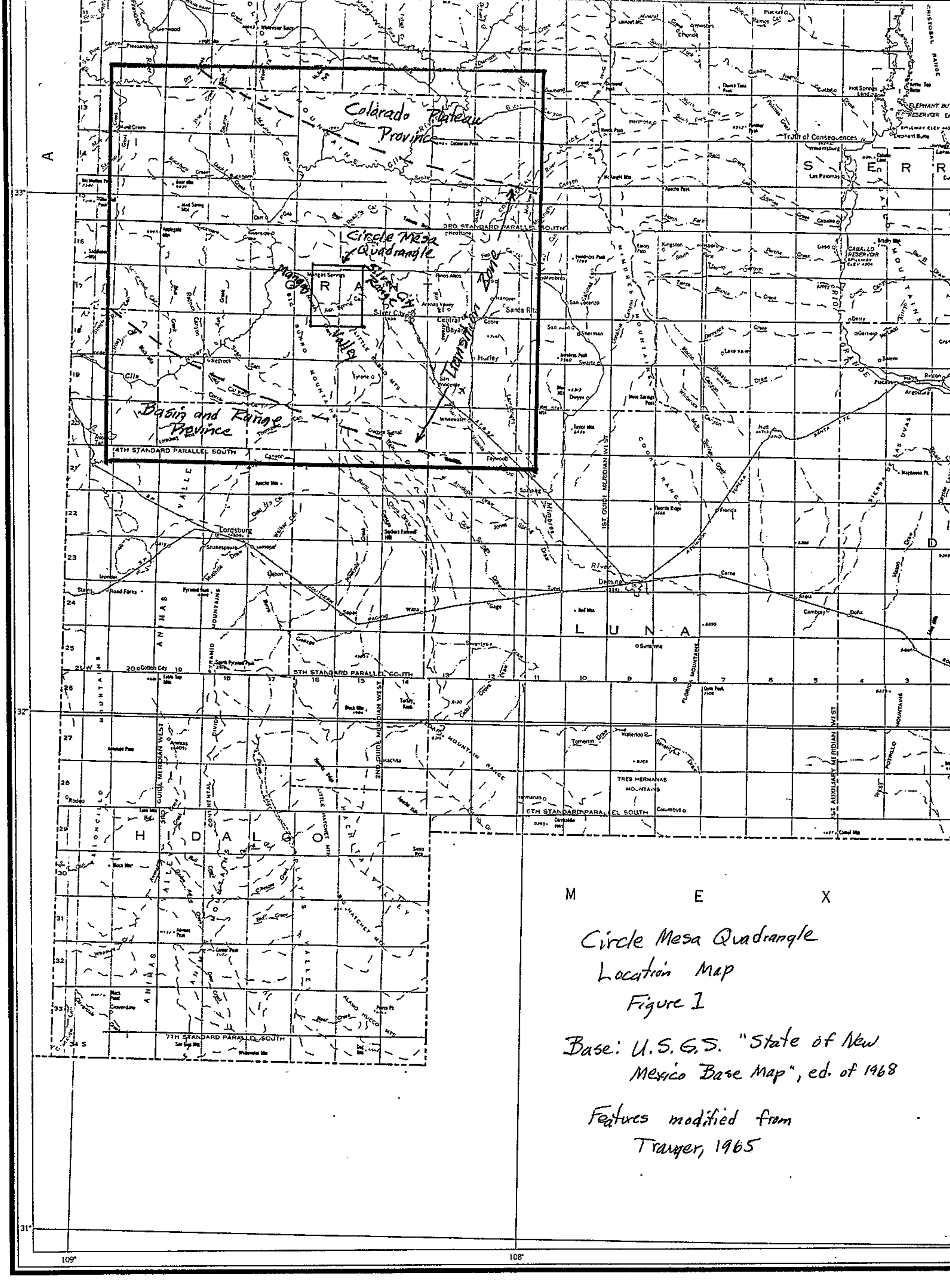
STRATIGRAPHY

PRECAMBRIAN

The oldest rock exposed in the Circle Mesa Quadrangle is granite, which underlies the Paleozoic section and is probably correlative with the Precambrian granite of the Big Burro Mountains to the southwest (Hewitt, 1959). A zircon U-Pb age of 1445 + 50 my has been obtained from the granite in the Big Burro Mountains (Stacy and Hedlund, 1983).

PALEOZOIC AND MESOZOIC

The Bliss Sandstone (OCb) overlies the Precambrian granite and indicates marine transgression from the west (Hayes, 1978). The Bliss is succeeded by a Paleozoic section which represents marine sedimentation interrupted by disconformities between lower and upper Ordovician (El



Circle Mesa Quadrangle
Location Map
Figure 1

Base: U.S.G.S. "State of New Mexico Base Map", ed. of 1968

Features modified from Trauger, 1965

Paso Dolomite-Montoya Group), upper Ordovician and Silurian (Montoya Group-Fusselman Dolomite), Silurian and Devonian (Fusselman Dolomite-Percha Shale, and Devonian and Mississippian (Percha Shale-Lake Valley Limestone. There is no evidence in the Circle Mesa Quadrangle of a disconformity between the Missisippian and the Pennsylvanian, but Pratt (1967) noted a hiatus indicated by fossils between the Lake Valley Limestone and the Oswaldo Formation in the Hurley West Quadrangle. At the close of the Paleozoic, the entire region was uplifted, as indicated by the change from pure Mississipian limestone through silty Pennsylvanian limestone to Permian red-beds of the Abo Formation, (which occur to the east of the Circle Mesa Quadrangle), and tilted to the east, so that when marine sedimentation was renewed during the Upper Cretaceous, the Beartooth Quartzite was deposited with a regional angular unconformity on a variety of rocks, ranging from Precambrian to the west of the Circle Mesa Quadrangle, to Ordovician, Mississippian, or Pennsylvanian within the Quadrangle, to Pennsylvanian or Permian to the east. Evidence of uplift and erosion continuing during the Triassic, Jurassic, and part of the Cretaceous includes not only the angular unconformity, but also the presence of scattered patches of terra rosa paleosol on, and cross -sections of Beartooth Quartzite breccia filling sinkholes in, Lake Valley Limestone: the sinkholes are exposed in a cliff face in Cane Spring Canyon (Sec. 8, T17S, R15W). The Colorado Formation conformably overlies the Beartooth Quartzite, and represents the last of marine sedimentation prior to the seas withdrawing at the close of the Cretaceous with the onset of the Laramide Orogeny.

CENOZOIC

Cenozoic rocks in the Circle Mesa Quadrangle include Tertiary volcanic and volcaniclastic rocks exposed to the northeast (Circle Mesa-LS Mesa area) and southwest (Saddle Rock Canyon area) of the Mangas Valley, the Gila Conglomerate of Pliocene-Pleistocene age, and Holocene alluvium. The two volcanic and volcaniclastic areas are discussed separately because they are lithologically distinct and probably represent different erruptive centers.

Circle Mesa-LS Mesa Section

The earliest of the Tertiary units (Tu) lies unconformably on Upper Cretaceous rocks, usually the Colorado Formation, but Beartooth Quartzite in one location, thus indicating a hiatus of sufficient duration to allow erosion to remove much or all of the Colorado Formation, which probably had a thickness of 300 meters or more prior to erosion. The early Tertiary assemblage (Tu) is extremely diverse, and changes laterally to the point that no two well-exposed sequences are the same: at the map scale it was deemed impractical to attempt to divide the unit, which has a maximum thickness of 73 meters. It includes siltstone, sandstone, and arkose, with intercalated welded tuffs and vari-colored intermediate flows. It is commonly capped by a dense, light-gray, pumiceous tuff, and often has a slabby purple tuff-breccia at or near the base. This latter unit closely resembles a tuff-breccia found at the base of gravels which have been correlated tentatively with the Rubio Peak Formation in the Silver City Quadrangle (Cunningham, 1979). The slabby nature of the tuff-breccia precluded the collection of a fresh sample for radiometric dating, but the gray tuff immediately above it yielded a potassium-argon date of 40.6 +/- 1.6 my (Dr. Frank Kottlowski, 1982,written communication: dates re- calculated with new IUGS constants): although this date is older than the 37 my Elston and others (1976) postulate for the Rubio Peak, it is within the time range of basal mid-Tertiary volcanics mentioned in that paper.

Above the basal Tertiary unit is a thick sequence of pyroclastic and volcaniclastic rocks. The lowest units of this sequence (Twt and Tut) represent a continuoum of explosive volcanism: the contact between them is gradational and may simply represent a change in degree of welding during a single volcanic event. Their combined thickness is 224 meters.

Volcanism continued, but intermittantly, for the succeeding units, from the lower tuff-breccia (Tlb) through the upper tuff-breccia (Tub) are mainly stream and possible mud-flow deposits. The increase in size and degree of angularity of clasts in the conglomerate (Tc) to the east suggest a former area of considerable relief in that direction .

Another interval of ash-flow tuff eruption is revealed on the west flank of Circle Mesa: these units are here termed red-brown ash-flow tuff (Ta), feldspar porphry and tuff-breccia (Tb),and poorly-welded tuff (Tt), but were mapped by Finnell (1982) as quartz latitic ash-flow tuff (Tvf). It is not certain how these units relate to the volcanic and volcaniclastic rocks described above, but they underly the upper tuff-breccia (Tub).

One small outcrop of lavender ash-flow tuff (Tvt) occurs on LS Mesa at the northern edge of the map (Sec. 33, T16S, R15W). It appears to overlie the bedded tuff and sandstone unit (Tbt), and probably the upper breccia (Tub) as well. A potassium-argon date of 33.0 +/- 1.3 my obtained from this unit (Kottlowski, 1982, written communication) serves as a marker for a change in the nature of igneous activity in the Circle Mesa area, from primarily volcanic to primarily plutonic.

Following deposition of the upper breccia (Tub), two varieties of plutons were emplaced. The earliest of these was a series of small scattered andesite bodies which have a domal aspect and which are concentrated in the north-central portion of the map. These were followed by intrusive rhyolites, often flow-banded, which are interpreted as remnants of flow domes. They closely resemble the intrusive rhyolite of Saddle Rock Canyon (Tkr). The final mid-Tertiary igneous pulse in the Circle Mesa-LS Mesa area formed several dikes of quartz latite along the eastern edge of Circle Mesa and a vent of the same along the southwestern edge of LS Mesa: the contact of the vent cuts across the layering in the bedded tuff (Tbt) and the quartz latite exhibits brecciation and slickensides near the contact. The vent extruded an ash-flow tuff, the faulted erosional remnants of which are scattered throughout the area, overlying units from Colorado Formation to upper breccia (Tub).

Saddle Rock Canyon Area

The Saddle Rock Canyon area of the Circle Mesa Quadrangle adjoins Wargo's Schoolhouse Mountain map (1959), Hedlund's Wind Mountain Quadrangle (1978), and Finnell's Cliff Quadrangle (1987), and obviously contains units all three of them named and described. Unfortunately, all used different breakdowns and terminalogy: Hedlund retained Wargo's Tx symbol for the Kerr Canyon Formation, although modifying the members, while Finnell altered it to Tk, which seems more logical, and his method is utilized for the Circle Mesa Quadrangle: Hedlund's Txw is thus mapped as Tkw, Txb as Tkb, and Txl as Tkl. A sample of Tkl yielded a potassium-argon date of 33.8 +/- 1.3 my (Kottlowski, 1982, written communication). Finnell considered Tkr to be earlier than Tkar, but at the intersection of Saddle Rock and Blackhawk canyons the rhyolite is seen to intrude both Tkl and Tkar. Tkr does not come into contact with Tmt, but since it appears later than the other ash-flow flow tuff units here, it is tentatively placed last in the sequence: this placement also fits better with the traditional cauldron model, in which ring-fracture intrusive rhyolites follow cauldron-forming ash-flow tuff erruptions.

Gila Conglomerate

The unit suceeding the mid-Tertiary igneous rocks is the Gila Conglomerate. This term has been used in a variety of ways, but is most commonly considered to represent sediments of Pliocene-Pleistocene age deposited in basins formed west of the Rio Grande drainage system due to Basin and Range faulting. A Pliohippus tooth found in the Gila Conglomerate near Cliff, north of the Circle Mesa Quadrangle (Cunningham, 1974), and an Equus jaw fragment recovered further north, near Glenwood and identified by G. E. Lewis of the U. S. Geological Survey (written communication, J. C. Ratte, 1978) indicate that this age range is correct for the Gila Conglomerate in this area.

Although Leopoldt (1981) subdivided the Gila Conglomerate into a considerable number of units, it was deemed most practical in this study to divide it into two units, older (TQgo) and younger (TQgy). Both appear to consist of sheet-flood deposits spread out on aggrading alluvial fans as streams emerged from the Big Burro and Silver City ranges. The older fan deposits are most commonly gray from a predominence of volcanic clasts, semi- to well-consolidated, coarse-grained, and tilted as much as 20 to the north or north-east, while the younger ones tend to be reddish, finer-grained, poorly consolidated, and gently dipping towards the Mangas Valley. However, these distinctions do not invariably hold true, and it is necessary to weigh all features and determine stratigraphic position to be certain of any single outcrop.

Basaltic volcanism, characteristically associated with Basin and Range events, is represented by a plug and associated flow in Cottonwood Canyon and a plug, dikes, and erosional flow remnants west of LS Mesa. At present, the even surface built up by the fan deposits is being dissected, the material removed lodging temporarily as alluvium (Qal) along modern drainages on its way to the Mangas Valley and the Gila River.

STRUCTURE

The major structural feature in the Circle Mesa Quadrangle is the northwest-trending Mangas Trench (Trauger, 1965). This feature more properly should be termed a graben, inasmuch as it appears to be bounded by faults on both sides. The northeast side is separated from the Silver City Range by the Treasure Mountain Fault (Clemons and Seager, 1978), which has been traced from west of the Cookes Range northwest past Lone Mountain and the Silver City Range. Trauger (1972) noted only localized fault control along the southwestern edge of the Mangas Valley, but Leopoldt (1981) concluded that there was a fault-line scarp there. To the south of the Circle Mesa Quadrangle, Hedlund (1978) traced the Mangas Fault northwest to the quadrangle boundary. All direct evidence of faulting on either side of the Mangas Valley is blanketed by Gila Conglomerate within the Circle Mesa Quadrangle: the inferred position on the map of the Mangas Fault was determined by extending Hedlund's line northwest, while the location of the Treasure Mountain Fault was determined by exposures in the Dorsey Ranch Quadrangle (Finnell, 1982) to the north and the Silver City Quadrangle (Cunningham, 1974) to the east.

The Silver City Range, and its topographically lower extension to the northwest, is a northwest-trending, eastward-dipping homocline, which is broken by a large number of mainly north- and northeast-trending faults. Although faults in southwest New Mexico are commonly considered to be related to Laramide and/or Basin and Range events, evidence here indicates older faulting as well. The Beartooth Quartzite in the vicinity of Silver City normally lies with an angular unconformity either on Pennsylvanian Oswaldo or Mississippian Lake Valley rocks, but at Treasure Mountain it rests on the Ordovician Montoya Group, suggesting faulting prior to the late Cretaceous. Some faults, such as the north-trending one in Sections 21 and 16 (T17S, R15W) appear to offset Paleozoic strata, but not the Beartooth. These faults are probably related to the late Paleozoic uplift and tilting described above. One fault, in the center of Section 6 appears to offset Beartooth and Colorado, but not the Tertiary volcanic rocks (Tu), and is probably Laramide. Others in the Treasure Mountain area may also be of that age, but since there are no Tertiary volcanics there, this cannot be proven. It was observed in the Silver City Quadrangle (Cunningham, 1974) that many faults in the lower Paleozoic do not continue through the Percha Shale, which apparantly diffused the stresses by its fissile nature, and so it is possible that many of the faults which displace only lower Paleozoic rocks may be of either late Paleozoic or Laramide age. Finally, a considerable number of faults offset Tertiary volcanic and volcaniclastic rocks as well as the earlier units, and are thus probably related to Basin and Range events. Examples of these faults include the Cane Spring Canyon fault and the Treasure Mountain Fault. The Mangas Graben and its boundary faults are, of course, typical Basin and Range structures.

Evidence that Basin and Range activity is continuous and still on-going include the fault which displaces the basalt flow within the older Gila Conglomerate in the southeast corner of Section 13, T17S, R16W, tilting of the older Gila Conglomerate (TQgo), faulting and displacement of the younger Gila Conglomerate (TQgy), and the sporadic occurrence of earthquakes in the Mangas Valley (eg. 3 December, 1975).

The laterally and vertically discontinuous nature of the Circle Mesa-LS Mesa volcanic sequence, the abundance of ash-flow tuffs and volcaniclastic units, and the presence of intrusive rhyolite bodies (Tir and Tkr), in the Circle Mesa Quadrangle suggest proximity to a cauldron or cauldrons. Flow-banded intrusive rhyolites have been interpreted as ring fracture features (Elston and others, 1975) related to cauldron margins. However, inasmuch as the ring fracture rhyolites may be found as far as 30 kilometers from the cauldron wall (Elston and others, 1975), the location of any cauldron responsible for the Tertiary rocks of the Circle Mesa Quadrangle is not certain: it could be the rather nebulous Schoolhouse Mountain cauldron proposed by Wahl (1980) to the west, to the Twin Sisters cauldron (McIntosh and others, 1992) to the east, or to as yet unresolved cauldrons to the north (Ratte, personal communication, 1991). Possibly all of these contributed rocks to the Circle Mesa assemblage. On the basis of the similarity of the volcanic sequence in the Circle Mesa Quadrangle to those in the Reading Mountain (Finnell, 1982) and Twin Sister (Finnell, 1976), quadrangles, Ratte (written communication, 1991) concluded that the Circle Mesa-LS Mesa volcanics represent intra-caldera fill of the Twin Sisters cauldron, while the Saddle Rock Canyon sequence better corresponds with the Schoolhouse Mountain cauldron.

Treasure Mountain has a rough pattern of radiating and concentric faulting, and thus appears to have undergone doming, possibly reflecting an underlying pluton..

MINERAL RESOURCES

Although there has been considerable mining in the surrounding areas, the only mineral resource which has been exploited to date within the Circle Mesa Quadrangle is the silver at Treasure Mountain (Fleming Camp). The deposit was described by Lindgren et al (1910) and Paige (1916). The ore occured as native silver, cerargyrite, and argentite with quartz, in pockets in the Beartooth Quartzite. Estimated production was between $200,000 and $300,000, but the ore was shallow, and serious mining was carried on only during the 1880's and 1890's. Probably the silver has been exhausted and the best hope for future production would be from any replacement bodies of base metals in the underlying carbonate rocks. However, since the upper Paleozoic provides the most favorable horizons for replacement bodies in the Grant County area mining districts, and since most of the Paleozoic section has been eroded at Treasure Mountain, the likelihood of such bodies being encountered seems very slight. There are sporadic stringers of calcite, quartz, and fluorite along the range front,near and parallel to the Treasure Mountain Fault, but the only evidence of past or current mining activity associated with them is the presence of claims and prospect pits on some of the calcite and fluorite veins. An assay taken from one of the calcite veins revealed no metal values, and it is likely that the calcite veins simply represent solution, transportation, and redeposition of Paleozoic limestone along the major fault zone. The fluorite veins are very thin and discontinuous, and probably have no commercial value. If there is any future potential for ore in the Circle Mesa Quadrangle, it is probably in or near the intrusive rhyolite (Tir) bodies, since Elston and others (1976) have noted a correlation of precious metals, molybdenium, tin, tungsten, and berylium with high-silica alkali rhyolites distributed around cauldron rims. However, no mineralization was observed in the intrusive rhyolites, and the only sign of hydrothermal activity observed in or around any of the mid-Tertiary plutons was the presence of mottramite, which is often associated with lead and vanadium mineralization, on the joint surfaces of the intrusive andesite (Tia).

REFERENCES

Clemons, R. E. and Seager, W. R., 1978, supplemental road log no.l, Central to Las Cruces: New Mexico Geol. Soc. Special Publication no. 7, Field Guide to Selected Cauldrons of the Datil-Mogollon Volcanic Field, New Mexico, p. 65

Cunningham, J. E., 1974, Geologic map and sections of Silver City quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geol. Map 30

- - - - - - , 1980, Revision of Tertiary volcanics in geologic map 30: New Mexico Bureau of Mines and Mineral Resources

Elston, W. E., 1957, Geology and mineral resources of Dwyer quadrangle, Grant, Luna, and Sierra counties, New Mexico, New Mexico Bureau of Mines and Mineral Resources, Bull. 3

Elston, W. E., Seager, W. R., and Clemons, R. E., 1975, Emory cauldron, Black Range, New Mexico: source of the Kneeling Nun Tuff: New Mexico Geol. Soc. Guidebook 26th Field Conference, Las Cruces Country, p. 283-292

Elston, W. E., Rhodes, R. C., Coney, P. J., and Deal, E. G., 1976, Progress report on the Mogollon volcanic field, southwestern New Mexico, no. 3 - surface expression of a pluton: New Mexico Geol. Soc., Special Publication 5, p. 3-28

Elston, W. E., Rhodes, R. C., and Erb, E. E., 1976, Control of mineralization by mid-Tertiary volcanic centers, southwestern New Mexico: New Mexico Geol. Soc., Special Publication 5, p. 125-130

Finnell, T. L., 1982, Geologic map of the Dorsey Ranch quadrangle, Grant County, New Mexico: U. S. Geol. Survey, Misc. Field Studies Map MF-1431

- - - - -, 1987, Geologic map of the Cliff quadrangle, Grant County, New Mexico, U. S. Geol. Survey, Misc. Investigations Series Map I-1768

Hayes, P. T., 1978, Cambrian and Ordovician rocks of southeastern Arizona and southwestern New Mexico: New Mexico Geol. Soc. Guidebook 29th Field Conference, Land of Cochise, p. 165-173

Hedlund, D. C., 1978, Geologic map of the Wind Mountain quadrangle, Grant County, New Mexico: U. S. Geol. Survey Misc. Field Studies Map MF-1031

- - - - , 1980, Geologic map of the Redrock NE quadrangle, New Mexico: U. S. Geol. Survey Misc. Field Studies Map MF-1264

Hewitt, C. H., 1959, Geology and mineral deposits of the northern Big Burro Mountains-Redrock area, Grant County, New Mexico: New Mexico Bureau of Mines and Mineral Resources Bull. 60

Leopoldt, W., 1981, Neogene geology of the central Mangas Graben, Cliff-Gila area, Grant County, New Mexico: M. S. thesis, University of New Mexico

Lindgren, W, Graton, L. C., and Gordon, C. W., 1910, The ore deposits of New Mexico: U. S. Geol. Survey Professional Paper 68, p. 304-305

McIntosh, W., Chapin, C., Ratte, J., and Sutter, J., 1992, Time-stratigraphic framework for the Eocene-Oligocene Mogollon-Datil volcanic field, southwest New Mexico: Geol. Society of America Bulletin, vol. 104, p. 851-871

Paige, S., 1916, Silver City, New Mexico: U. S. Geol. Survey Geologic Atlas of the U. S., Folio 199

Pratt, W. P., I967, Geology of the Hurley west quadrangle, Grant County, New Mexico: U. S. Geol. Survey Bull. 1241-E

Stacy, J. and Hedlund, D., 1983, Lead-isotopic compositons of diverse igneous rocks and ore deposits from southwestern New Mexico and their implications for early Proterozoic crustal evolution in western United States, Geol. Soc. of America Bull. v. 94, p. 43-57

Trauger, F. D., 1965, Geologic structure pattern of Grant County, New Mexico: New Mexico Geol. Society Guidebook 16th Field Conference, Southwestern New Mexico, p. 184-187

- - - - -, 1972, Water resources and general geology of Grant County, New Mexico: New Mexico Bureau of Mines and Mineral Resources Hydrologic Report 2

Wahl, D. E., 1980, Mid-Tertiary geology in parts of Greenlee County, Arizona, Grant and Hidalgo Counties, New Mexico: Ph. D. dissertation, Arizona State University

Wargo, J. G., 1959, Geology of the Schoolhouse Mountain quadrangle, Grant County, New Mexico: Ph. D. dissertation, University of Arizona

John Cunningham
Western N.M. University (ret.)

DESCRIPTION OF MAP UNITS

Qal ALLUVIUM (HOLOCENE) Poorly-sorted gravel, sand, and silt, with scattered boulders. Composition and grain size varies according to source and distance from source. Maximum thickness of 17 meters along Mangas Creek, but much thinner in tributaries. Unconformable on Gila Conglomerate.

QTgy YOUNGER GILA CONGLOMERATE (HOLOCENE AND/OR PLEISTOCENE) Fan and sheet-flood deposits of poorly-consolidated, medium-sorted, tan to orange-red sands and gravels. Arkosic matrix with larger clasts (5-8 cm.) which represent all units from Pre-cambrian through Tertiary. Generally thin- and even- bedded, but some cross-bedding and channeling present. Usually dips 10° or less towards Mangas Valley. Blanketed by discontinuous thin veneer (less than 1 meter) of Trauger's (1972) terrace gravels (not distinguished here). Maximum thickness estimated at 100 meters. Unconformable on older Gila in some places, gradational contact in others.

QTgb BASALT PLUG, DIKES, SILLS, AND FLOWS WITHIN OLDER GILA CONGLOMERATE (PLEISTOCENE AND/OR PLIOCENE) Dense plutons, dense to vesicular flows. Black to dark gray matrix of plagioclase microlites with sparse augite phenocrysts and flakes of iddingsite. Weathers to mottled medium-gray or red-brown. Maximum thickness of flows is 50 meters.

QTgo OLDER GILA CONGLOMERATE (PLEISTOCENE AND/OR PLIOCENE) Fan and sheet-flood deposits of poorly-sorted, semi- to well-consolidated silt, sand, and gravel. Mostly gray shades, but reddish-tan in upper reaches of Cottonwood Canyon and adjacent area. Larger clasts (up to .7 meter) are mainly Tertiary volcanics, but also include Pre-cambrian through Mesozoic rocks. Matrix silty to sandy and arkosic. Dips generally approximately 20° to north or northeast. May approach, or even exceed, 1000 meters in deeper portions of Mangas graben. Unconformable on older units.

Tmm LATITE AND BASALTIC ANDESITE MUDFLOW (OLIGOCENE?) Localized, below older Gila and above latite and basaltic andesite (Tml). Angular to subangular clasts of latite and basaltic andesite, commonly .5 meter across, with interstitial smaller angular fragments of same, and minor grayish-tan matrix. Rough bedding visible when viewed from a distance. Maximum thickness about 60 meters. Contact with underlying Tml shows progressive burial.

Tml LATITE AND BASALTIC ANDESITE FLOWS OF HEDLUND (1978) (OLIGOCENE?) Medium- to dark-gray aphanitic flows. Hedlund considered these flows to be equivalent to the latite flows in the Werney Hill Quadrangle to the southeast, and noted that they have an aggregate thickness of 90 meters.

TERTIARY IGNEOUS AND VOLCANICLASTIC ROCKS OF CIRCLE MESA-LS MESA

Tql QUARTZ LATITE (OLIGOCENE) Dikes and plug of dense red-brown to pink or purple quartz latite and erosional remnants of ash-flow tuff which locally contains lithophysal, vitrophyric, and spherulitic zones. Up to 30% phenocrysts of buff plagioclase (An_{48}), quartz, orthoclase, biotite, and magnetite. Local faint flow banding.

Tir INTRUSIVE RHYOLITE (OLIGOCENE) . Flow-domes of light lavender to light gray rhyolite with localized purple chill zones and vitrophyre at contacts. Matrix dense to sugary. Usually 3% phenocrysts of quartz, sanidine, and biotite, but one outcrop (Sec. 36, T16S, R16W) has about 20% quartz phenocrysts. Some outcrops exhibit pronounced and contorted flow-banding.

Tia INTRUSIVE ANDESITE (OLIGOCENE) Aphanitic red-brown to medium-gray and greenish-gray. Trachytic texture of plagioclase microlites with small pyroxene. Near contacts jointing is pronounced and parallels contacts with steep dips: interiors have less-developed joints with flatter dips. Brecciated at contacts. Mottramite $(Cu,Zn)Pb(VO_4)(OH)$ (Charles Chapin,1980, personal communication) on many joint faces.

Tvt QUARTZ LATITE ASH-FLOW TUFF OF FINNELL (1982) (Oligocene) Lavender welded ash-flow tuff with phenocrysts of sanidine, quartz, plagioclase, and biotite in a matrix of fine vitric shards. Only one small outcrop occurs at northern edge of Circle Mesa Quadrangle, but Finnell measured thicknesses of 198-370 meters in Dorsey Ranch Quadrangle.

Tub UPPER TUFF-BRECCIA (OLIGOCENE) Gray to yellowish-gray, tan, and brown tuffaceous breccia and tuff. Weathers to darker hues. Angular fragments of gray (most abundant), purple (largest), and red volcanic rocks, and yellow-green altered pumice(?), mostly 3 cm. or less across, but occasionally up to 15 cm. Maximum thickness estimated at about 173 meters. Base disconformable.

QUARTZ LATITIC ASH-FLOW TUFF (Tvf) OF FINNELL (1982) (OLIGOCENE) Red, lavender, and white, partially-welded ash-flow tuff, here divided into three mappable units.

Tt Gray to red-brown, poorly-welded member. Phenocrysts of biotite, quartz, sanidine, and magnetite. Small angular fragments of dark red-brown volcanic rock and greenish-gray pumice. Eutaxitic structure in places. Thickness about 60 meters.

Tb Dense gray feldspar porphyry at base, overlain by dense tuff-breccia, and coarse breccia of gray feldspar porphyry at top. Breccia has much iron oxide cement. Maximum thickness is 145 meters. Unit pinches out to south.

Ta Red-brown ash-flow tuff. Densely welded and highly silicified near base (and contact with buried Treasure Mountain Fault): less silicified and fragments of dense and flow-banded medium gray, light gray, and dense, structureless red-brown volcanic rocks more conspicuous near top. Aphanitic matrix with 3-20% phenocrysts of quartz, sanidine, and biotite. Maximum thickness exposed is 145 meters.

Tbt BEDDED TUFF AND SANDSTONE (OLIGOCENE) White to light gray, pink, brown, and light yellowish-gray air-fall tuff, waterlain tuff, and tuffaceous sandstone. Well-bedded and cross-bedded. Sandy to arkosic texture with scattered larger clasts of red-brown porphyry, pumice, and dense gray rock which resembles Beartooth Quartzite. Small crystals of biotite and quartz. Local basal conglomerate, one pebble thick, overlain by I meter of purple welded tuff. Local zones of lapilli, zeolitization. Maximum thickness about 97 meters. Base disconformable.

Tmb MIDDLE TUFF-BRECCIA (OLIGOCENE) Brown to reddish and lavender breccia with tuffaceous matrix. Fragments up to 0.3 meter, but most are 10 cm. or less. Most conspicuous fragments are of gray and purple flow-banded rhyolite, smaller ones are of white tuff and gray and purple volcanic rocks. Interbedded yellow- green tuff and sandstone. Cliff-forming with blocky outcrops. Maximum thickness about 203 meters. Base conformable.

Tts TUFF AND SANDSTONE (OLIGOCENE) Several thin units of buff-colored welded tuff; massive at base, slabby at top. Fragments up to 2 cm. of red and dark volcanic rocks and white pumice, with dark fragments predominent near base of unit. Uppermost part has 2 meters of thin- and even-bedded greenish-brown arkose, overlain by 3 meters of pink crystal tuff. Maximum thickness is 85 meters. Base appears conformable.

Tc CONGLOMERATE AND BRECCIA (OLIGOCENE) Coarse red-brown conglomerate to breccia with some interbedded welded tuff. Pebble conglomerate is bedded, but coarser material does not show bedding. Clasts mainly pink to red and purple ash-flow tuff, but also may be of buff, light and dark gray, and red-brown volcanic rocks. Most clasts are cobble size, but some boulders up 2 meters across Clasts are larger and more angular to east. Maximum thickness of 109 meters. Base disconformable.

Ts SANDSTONE (OLIGOCENE) Thin- to medium-bedded green-brown, green, brown, and white sandstone and arkose. Scattered pebbles of pink rhyolite. Minor intercalated lavender to gray ash-flow tuff. Maximum thickness about 139 meters. Base appears to show a low-angle unconformity.

Tlb LOWER TUFF-BRECCIA (OLIGOCENE) Light yellowish-gray to pink and red volcanic breccia and tuff-breccia. In the lower gray portion, the larger fragments weather out and produce a vuggy appearance; the upper portion is more resistant and yields ledges and knobs. Contains fragments of gray tuff, light gray, dark gray, brown, red, and purple and gray flow-banded volcanic rocks. Most is massive, but some is coarsely-bedded and cross-bedded. Minor dark brown to yellowish-brown arkose in lower portion. Maximum thickness estimated at 82 meters. Base is unconformable.

Tut UNWELDED RHYOLITIC ASH-FLOW TUFF (OLIGOCENE) White to reddish tuff with abundant (20%) phenocrysts of quartz, biotite, and potash feldspar. Fragments of gray, purple, and brown volcanic rocks weather out to produce a pitted surface, the pits commonly being iron-stained. Maximum thickness is 48 meters. Lower contact is gradational, and may simply represent a change in degree of welding of a single cooling unit.

Twt WELDED RHYOLITIC ASH-FLOW TUFF (OLIGOCENE) Gray to purple densely-welded ash-flow tuff, with abundant (30%) phenocrysts of quartz, sanidine, white plagioclase, biotite, and hornblende. Occasional lithic fragments. Sparse banding and eutaxitic structure. Becomes slabby at top and grades into overlying unwelded tuff. Maximum thickness l76 meters. Base disconformable.

Tu UNDIFFERENTIATED SEDIMENTARY AND VOLCANIC ROCKS (EOCENE?) Diverse assemblage of siltsone, sandstone, and arkose, with intercalated welded tuffs and vari-colored intermediate flows. Commonly capped by a dense, light gray, pumiceous tuff, and often has a slabby lavender tuff-breccia at or near the base. Maximum thickness is 73 meters. Base disconformable.

TERTIARY IGNEOUS ROCKS OF SADDLE ROCK CANYON

Tkr INTRUSIVE RHYOLITE OF SADDLE ROCK CANYON (OLIGOCENE) Fine granular, very light lavender rhyolite with contorted flow-banding, some visible quartz and biotite. Main mass has contorted but steep inward- to vertical-dipping fluted joints, while contact with latite to north and east (Tkl) is angular unconformity.

Tmt MANGAS CREEK FORMATION OF WARGO (1959) Quartz latite ash -flow tuff (Tmt)of Finnell (1987). Light brown to gray, welded to partly welded. Abundant phenocrysts of sanidine, plagioclase, quartz, and biotite. Local airfall tuff and tuffaceous sandstone beds. Finnell measured a maximum thickness of 1,375 meters in Cliff Quadrangle, but thickness here is only about 55 meters.

KERR CANYON FORMATION OF WARGO (1959)

Tkar Ash-flow tuff of Finnell (1987) Pale red to greenish-gray tuff-breccia described near top of unit. Dense tuffaceous matrix with larger fragments, up to 1 cm., of pumice and red and gray volcanic rocks. Finnell measured a maximum thickness of 220 meters: 65 meters thick here.

Tkl Latite of Hedlund (1978) Red-brown, light grayish lavender, and grayish-purple welded ash-flow tuff, with up to 30% phenocrysts of buff-weathering potash and plagioclase feldspar, quartz, and biotite in dense matrix. Small fragments of dense red-brown volcanic rock. Occasional lithophysal zones and basal vitrophyre. Maximum thickness of 110 meters. Probably correlative with latite in Wargo's Brown Breccia Member.

Tkb Ash-flow tuff of Hedlund (1978) Purple-gray, welded, devitrified, with phenocrysts of biotite, feldspar, and quartz. Weathers to very pitted surface. Probably correlative with Wargo's Brown Breccia Member. Hedlund measured a maximum thickness of 20 meters: here it is approximately 80 meters.

Tkw White tuff of Wargo (1959) White and buff crystal-vitric tuff and gray tuff-breccia, intercalated with brown and white sandstone beds. Thickness is 60 meters.

Kc COLORADO FORMATION (CRETACEOUS) Mixed lithologies of impure marine sedimentary rocks: sandstone, shale, arkose, and limestone. Light to dark drab shades. Maximum thickness is 73 meters, but much of former thickness has been eroded. Base conformable.

Kb BEARTOOTH QUARTZITE (CRETACEOUS) Thick-bedded, cross-bedded light gray quartz sandstone with local conglomerate beds. Thickness about 30 meters. Unconformable on Pennsylvanian, Mississippian, and, at Treasure Mountain, Ordovician.

Po OSWALDO FORMATION (PENNSYLVANIAN) Medium-gray limestone and mudstone with brown cherty lenses. Often mottled. Maximum thickness about 53 meters, but usually eroded from section prior to Beartooth deposition. Base probably disconformable.

Mlv LAKE VALLEY LIMESTONE (MISSISSIPPIAN) Gray crinoidal limestone consisting of four members: the basal Andrecito is slabby alternating limestone and shale, overlain by massive, light gray, cliff-forming limestone with chert nodules (Alamogordo), dark gray, coarsely crinoidal limestone (Nunn), and light gray coarsely crinoidal limestone (Tierra Blanca). In most areas at least part of the formation is missing, due either to faulting or erosion: composite maximum thicknesses observed were 12 meters of Andrecito, 40.5 meters of Alamogordo, 9 meters of Nunn, and 13.5 meters of Tierra Blanca. The base appears conformable, but probably is disconformable.

Dp PERCHA SHALE (DEVONIAN) Lower member (Ready Pay) is gray to black fissile shale, and grades upwards to light gray to buff limy shale (Box Member). In the only location where the entire formation may be present (Sec. 16, T17S, R15W), alluvium, poor outcrops, and probable multiple small faults render the measured thickness (54 meters of Ready Pay and 24 meters of Box) uncertain. The lower contact is generally hidden, but is probably disconformable.

Sf FUSSELMAN DOLOMITE (SILURIAN) Dark brownish-gray dolomite which weathers to dark gray and to a pitted and vuggy surface. Thickness about 12 meters. Base disconformable.

MONTOYA GROUP (ORDOVICIAN)

Omc CUTTER DOLOMITE Brownish-gray sub-lithographic dolomite which weathers to a smooth light gray. Thickness 63 meters. Base conformable.

Oma ALEMAN FORMATION Alternating thin bands of gray dolomite and pink to gray chert. Thickness is 15 meters. Base conformable.

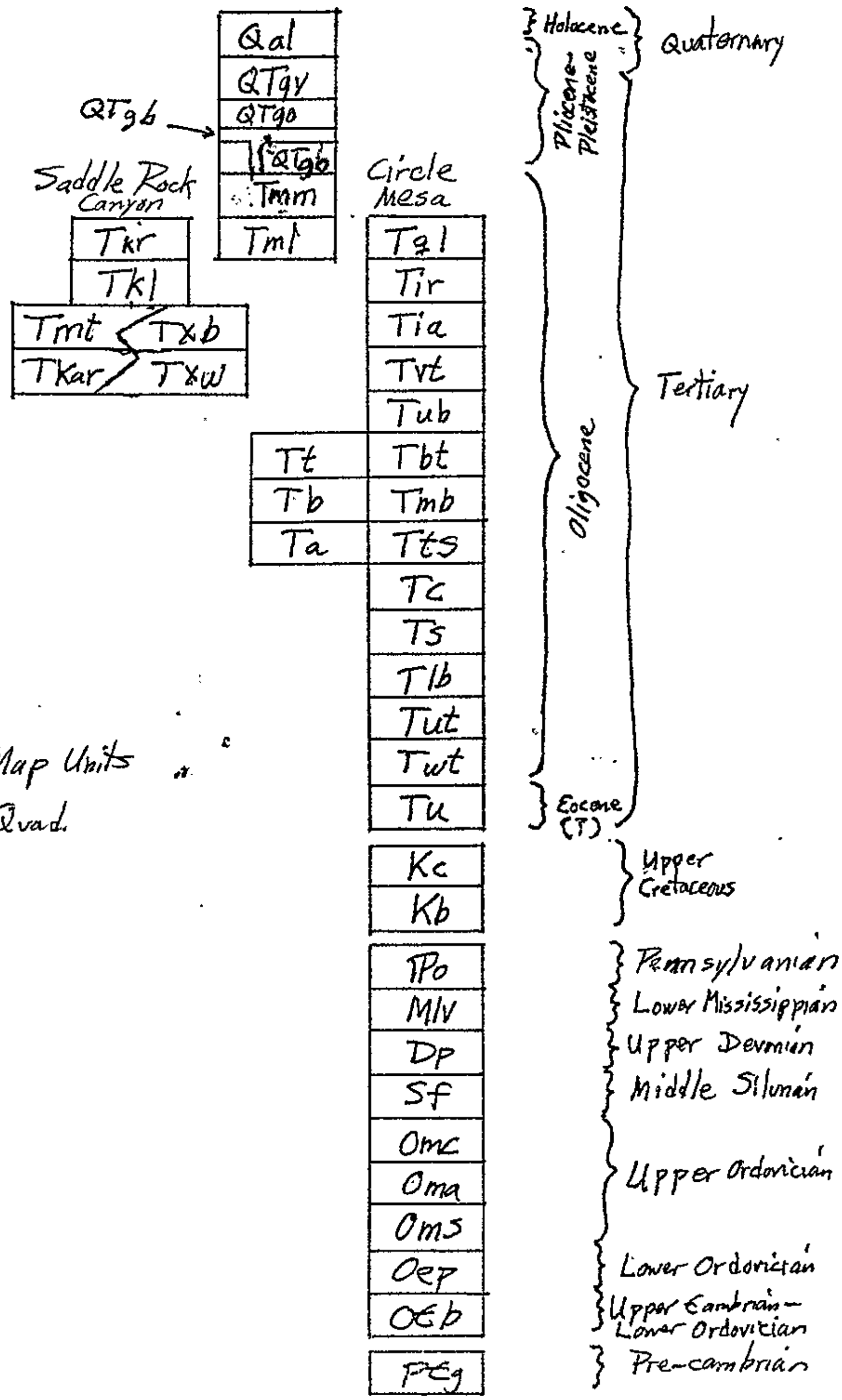
Oms SECOND VALUE DOLOMITE Basal Cable Canyon Member is about 6 meters of brown, coarse, dolomitic sandstone, overlain by 30 meters of medium-gray, fine-grained, silty Upham Dolomite Member. Base disconformable.

Oep EL PASO DOLOMITE (ORDOVICIAN) Medium-gray dolomite, sandy dolomite, and mudstone. Fuccoids in lower third, lenses and nodules of chert in upper two-thirds. Intraformational breccias,channel and mound structures common in lower units. About 124 meters thick. Base conformable and gradational.

O€b BLISS SANDSTONE (ORDOVICIAN-CAMBRIAN) Basal arkose overlain by red-brown hematitic and green glauconitic sandstone. Beds of oolitic hematite and dolomite: uppermost of dolomite beds within Bliss marks Ordovician-Cambrian boundary. Thickness about 6 meters.

p€g GRANITE (PRECAMBRIAN) Variable in grain size and color, but most is medium- and even-grained, pink to pinkish orange, with quartz, orthoclase, muscovite and/or biotite. Contains pegmatite pods and dikes.

Correlation of Map Units
Circle Mesa Quad.



Cunningham

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Map 1

CIRCLE MESA QUADRANGLE
NEW MEXICO-GRANT CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

Mapped, edited, and published by the Geological Survey

SCALE 1:24000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

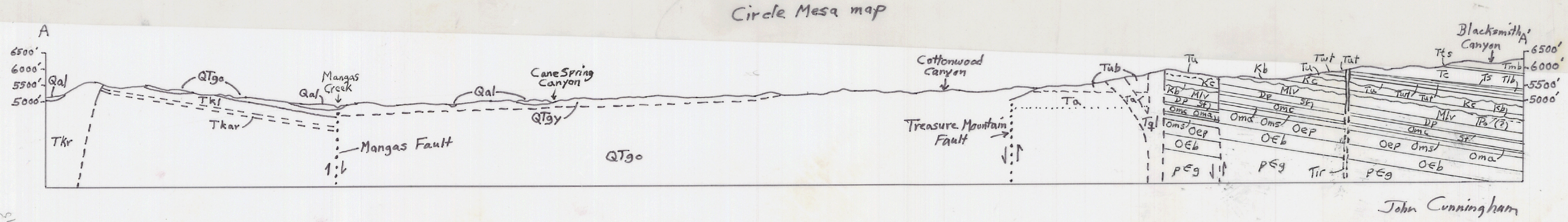
ROAD CLASSIFICATION

CIRCLE MESA, N. MEX.
N3245—W10822.5/7.5

1949

FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D.C. 20242

Cross-Section
for
Circle Mesa map



John Cunningham