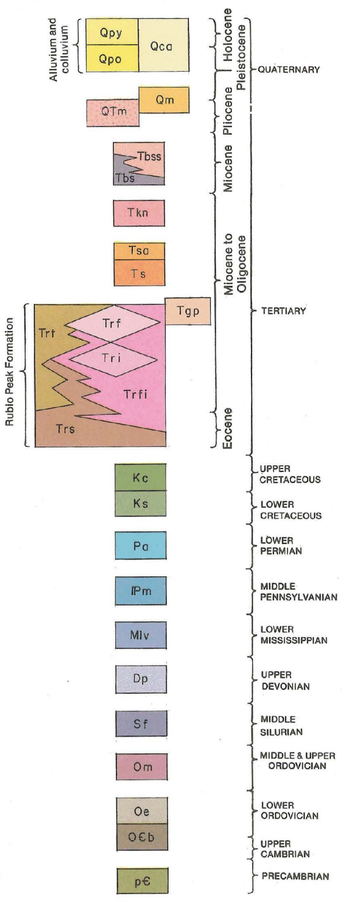
NEW MEXICO BUREAU OF MINES & MINERAL RESOURCES A DIVISION OF NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY

GEOLOGIC MAP 51

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qca **Undifferentiated colluvium-alluvium**—Thin talus-slope veneers and colluvial and alluvial fills on arroyo valley sideslopes, in mountain canyons, and on piedmont slopes

Qpy **Younger piedmont-slope arroyo alluvium**—Fills (silty to gravelly) of shallow drainages cut below older fan and erosion surfaces graded to closed basins

Qpo **Older piedmont-slope alluvium**—Unconsolidated fan deposits, piedmont-valley fills, and erosion surface veneers; associated with surfaces graded to closed basins; uppermost beds often cemented with pedogenic carbonate

Qm **Mimbres formation** (Pleistocene)—Piedmont-slope facies; fan gravel and fanglomerate with interbedded sandy zones; includes thin erosion-surface veneers near mountain fronts; upper layers contain thick carbonate accumulations (caliche); thickness to 40 ft

QTm **Mimbres formation** (Pliocene-Pleistocene)—Similar to Qm except contains more intensely weathered boulders and thicker carbonate zones and is often preserved in higher level terrace remnants than those composed of Qm

Tbss **Sedimentary member** of Bear Springs Basalt—Interbedded tuffaceous sandstone and sandy conglomerates; thickness generally less than 100 ft

Tbs **Undifferentiated flows and intrusives** of Bear Springs Basalt—Dark-gray to black basaltic andesite (hawaiite) and basalt; includes some agglutinated scoriaceous material

Tkn **Kneeling Nun Tuff** (Oligocene)—Pale-red crystal-vitric ash-flow tuff, weathers orange brown; contains 18 to 38 percent phenocrysts of sanidine, quartz, oligoclase, and biotite; abundant flattened pumice fragments; thickness 80 ft

Tsa **Ash-flow tuff unit** of Sugarlump Formation—Grayish-pink crystal-vitric ash-flow tuff, weathers pale red; contains 18 to 33 percent phenocrysts of oligoclase, sanidine, quartz, and biotite; abundant flattened pumice fragments; thickness 70 ft

Ts **Sedimentary unit** of Sugarlump Formation—Interbedded light-colored, tuffaceous volcaniclastic mudstones, sandstones, and conglomerates; includes a lower 12-ft-thick vitric ash-flow tuff and middle 32-ft-thick vitric ash-flow tuff; total thickness to 400 ft

Tgp **Granodiorite porphyry** (Oligocene)—Light- to medium-gray with abundant white feldspar and few hornblende phenocrysts in matrix of orthoclase, plagioclase, quartz, and minor clinopyroxene; stocks and sill-like masses

Trfi **Undifferentiated flows and intrusives** (Eocene) of Rubio Peak Formation—Dark-gray, greenish-gray, and reddish-brown basalts, basaltic andesites, andesites, and latites; thinly laminated to dense massive, intrusive-extrusive complexes; mineralogy similar to Tri

Trf **Flows** of Rubio Peak Formation—Dark-gray to black, basalts, basaltic andesites, andesites, and latites; dense to vesicular; slightly porphyritic to nonporphyritic

Tri **Intrusives** of Rubio Peak Formation—Light- to dark-gray and brownish basalts, basaltic andesites, andesites, and dacites; dikes, plugs, and small stocks; contain up to 50 percent phenocrysts of plagioclase, hornblende, augite, hypersthene, and biotite

Trt **Tuff breccias and conglomerates** of Rubio Peak Formation—Grayish-orange, light- to dark-gray, talus, lahars, and volcaniclastic deposits; boulders to 5 ft surrounded by tuffaceous material; bedding generally indistinct except in sandy and conglomeratic lenses; maximum thickness about 1,000 ft

Trs **Starvation Draw member** of Rubio Peak Formation—Interbedded pebble to boulder conglomerates, red sandstones, mudstones, and shales; clasts in lower conglomerates mostly from Precambrian, Paleozoic, and Cretaceous rocks; mostly volcanic rock clasts in upper beds; thickness to about 500 ft

Kc **Colorado Formation**—Interbedded, gray, fossiliferous shales, thin-bedded limestones, calcarenites, and flint clays; thickness to 170 ft

Ks **Sarten Sandstone**—Light-gray to yellowish-gray, medium- to massive-bedded, fine- to medium-grained sandstone; few pebble conglomeratic beds; crossbedding and ripple marks fairly common; fossiliferous, gray, shaly marls at base and calcareous sandstone at top; thickness to 300 ft

Pa **Abo Formation**—Interbedded, reddish, chert-pebble breccias, chert-limestone-pebble conglomerates, red shale, shaly limestone, and fine sandstone; thickness to 300 ft

IPm **Magdalena Group**—Basal white chert conglomerate overlain by interbedded limestones, shale, and calcareous siltstones; thickness to 180 ft

Mlv **Lake Valley Formation**—Light-gray to black, thin- to medium-bedded, fossiliferous limestones and marls; abundant chert lenses and knotty nodules; some shale in lower members; intensely altered except in Rattlesnake Ridge and small outcrop 0.3 mi northwest of Lucky mine; thickness to 400 ft

Dp **Percha Shale**—Dark-gray shale with limestone nodules in upper part; only exposure is at east end of Fluorite Ridge; thickness about 200 ft

Sf **Fusselman Dolomite**—Medium-gray, massive-bedded dolomite and dolomitic limestone; only exposure is at southeast end of Fluorite Ridge; partly silicified; complexly faulted; thickness about 500 ft

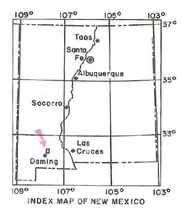
Om **Montoya Dolomite**—Dark-gray, medium- to thick-bedded, dolomite and dolomitic limestone; abundant chert; only exposures are at southeast end of Fluorite Ridge; altered and faulted; thickness about 300 ft

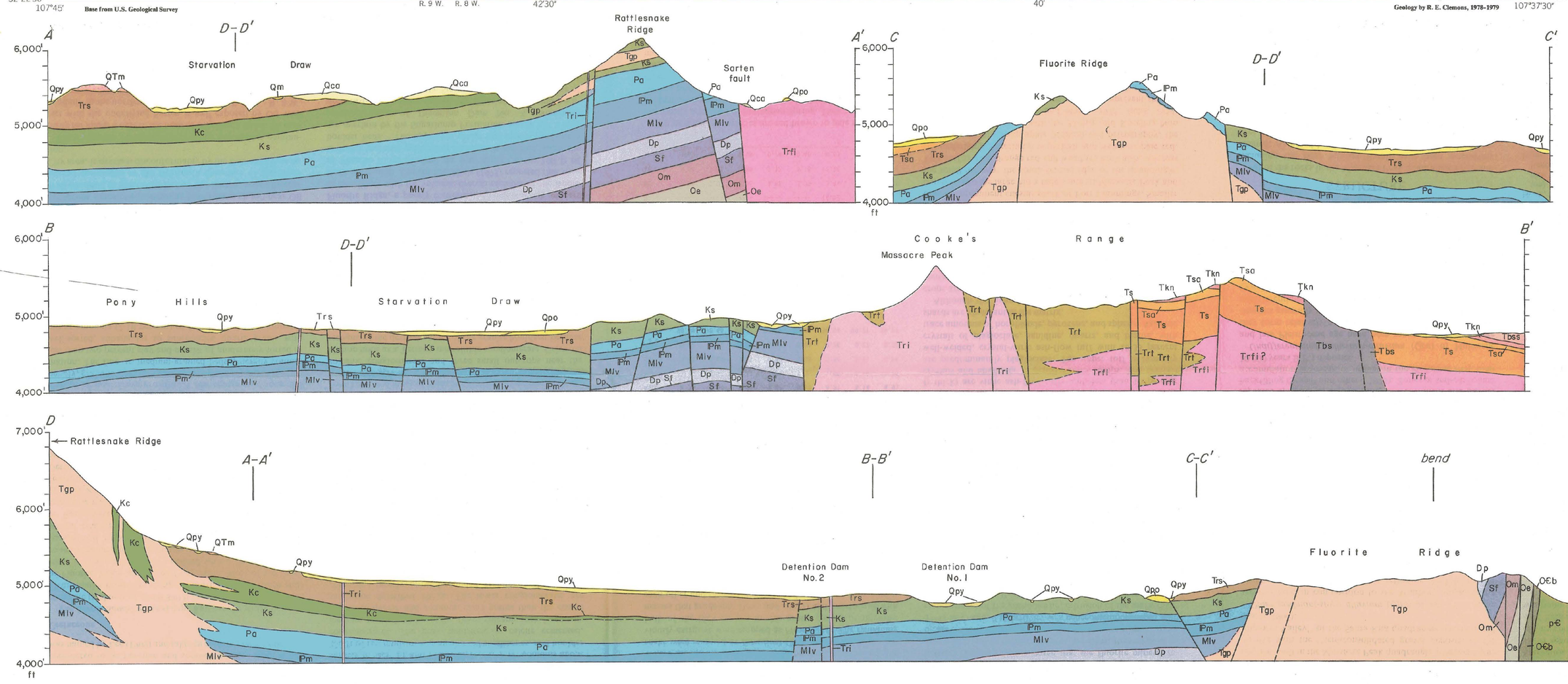
Oe **El Paso Limestone**—Medium-gray, medium-bedded limestone and dolomitic limestone; only exposures are at southeast end of Fluorite Ridge; altered and faulted; thickness about 400 ft

O€b **Bliss Sandstone**—Dark-reddish-brown and greenish-gray, thin- to thick-bedded sandstone; only exposures are at southeast end of Fluorite Ridge; thickness about 100 ft

p€ **Precambrian**—Gray and red granite, diorite(?), amphibolite, and feldspar-quartz-mica gneiss and schist; only exposed at southeast end of Fluorite Ridge

Location of sample analysis (table 1)





Geology of Massacre Peak quadrangle, Luna County, New Mexico

by Russell E. Clemons, 1982

SCALE 1:24000

1 0 1 mi

1 .5 0 1 km

APPROXIMATE MEAN DECLINATION, 1980

Base from U.S. Geological Survey

Geology by R. E. Clemons, 1978-1979

INTRODUCTION

Massacre Peak quadrangle is in north-central Luna County about 8 mi north-northeast of Deming (fig. 1). Gravel roads connecting with NM-26 and maintained by the county provide access to the area. The Cooke's Spring Station of the Butterfield Trail was near Fort Cummings about a mile south of the Hyatt Ranch in the northeastern part of the quadrangle.

The southern Cooke's Range crosses the quadrangle from northwest to southeast, covering about half the area. Starvation Draw separates Cooke's Range from Pony Hills and Fluorite Ridge in the southwestern part of the area. Elevations range from 4,560 ft along the southern edge to 5,655 ft on Fluorite Ridge, 5,667 ft on Massacre Peak, and 6,780 ft on Rattlesnake (formerly Sarten) Ridge near the northwest corner of the map.

The Massacre Peak quadrangle was included in Darton's (1916) map of Luna County and in the Deming Folio (Darton, 1917). Griswold (1961) mapped Fluorite Ridge as part of his study of the mineral deposits of Luna County. The fluorite deposits had been described by Lindgren and others (1910), Darton and Burchard (1911), Johnston (1928), Rothrock and others (1946), and Russell (1947). Williams (1966) presented an updated summary of the fluorite deposits; McAnulty (1978) included information on the most recent prospect. Corbitt and Nials (1975) mapped the Pony Hills area. Jicha (1954) mapped the Lake Valley quadrangle north and northeast of the Massacre Peak quadrangle, and Elston (1957) mapped the Dwyer quadrangle to the northwest.

ACKNOWLEDGMENTS—The New Mexico Bureau of Mines and Mineral Resources provided financial support for the field work, preparation of thin sections, radiometric age determinations, and also supplied the chemical analyses. Nancy Stoll aided in the petrographic examinations, and Dan Barker kindly provided the norm calculations. Access to the map area was permitted by the cooperation of T. Hyatt and B. McCauley. William Seager and George Griswold critically reviewed the manuscript.

STRATIGRAPHY

Precambrian

Precambrian (*p€*) rocks crop out at the southeast end of Fluorite Ridge. The total exposure is less than one-quarter square mile, much of it covered by a thin veneer of colluvium. The dominant rock at the western end of the outcrop is a dark-gray, medium-grained granite composed of about 50 percent perthite and 25 percent each of quartz and biotite. Fine-grained feldspar-quartz-biotite-muscovite gneissic schist is also quite abundant. The relation between these two rocks is uncertain but the boundaries appear to be gradational. Both are cut by coarse red granite pegmatite composed of microcline, quartz, and muscovite. At the eastern end coarse red granite appears to intrude dark-colored rocks resembling diorite and amphibolite as described by Griswold (1961).

Lower Paleozoic

At the southeast end of Fluorite Ridge approximately 1,900 ft of much faulted and altered lower Paleozoic strata overlie Precambrian rocks. This section includes 100 ft of *Bliss Sandstone* (*O€b*), 400 ft of *El Paso Limestone* (*Oe*), 300 ft of *Montoya Dolomite* (*Om*), 500 ft of *Fusselman Dolomite* (*Sf*), 200 ft of *Percha Shale* (*Dp*), and 400 ft of *Lake Valley Formation* (*Mlv*). These strata dip steeply north at angles of 52°-90°; Darton (1916, 1917) and Griswold (1961) briefly described them. No attempt was made to measure and describe them more completely because of the extensive faulting and silicification by the intrusion of the nearby granodiorite porphyry and by fluorite mineralization.

Several queried Lake Valley exposures are mapped on Fluorite Ridge. These exposures are all intruded and intensely altered by granodiorite porphyry; the only indication that they belong to the Lake Valley Formation is abundant crinoid fragments in the marble or crinoid-stem molds in the silicified rocks. Laudon and Bowsher (1949) measured 180 ft of Percha Shale overlain by 333 ft of Lake Valley Formation on the north slope of Rattlesnake Ridge. The uppermost Lake Valley (Tierra Blanca Member) strata crop out in section 7 at the northern edge of the Massacre Peak quadrangle.

Pennsylvanian

The Lake Valley Formation is overlain in Fluorite and Rattlesnake Ridges by interbedded chert and limestone-chert conglomerates, cherty limestone, nodular limestone, light-gray to black limestone, calcareous siltstone, and black shale. All these rock types are not present in all localities; thicknesses vary from 40 to 180 ft. Darton (1916, 1917) mapped part of these Pennsylvanian rocks as Gym Limestone of "late Carboniferous age." Studies by Kelley and Bogart (1952), Bogart (1953), and Jicha (1954) have shown that: 1) the Gym Limestone at the type locality in the southern Florida Mountains contains beds ranging in age from Silurian to Cretaceous(?), 2) the restricted Gym is equivalent to the Hueco Limestone, and 3) the name Gym Limestone should be abandoned. Jicha (1954) mapped equivalent Pennsylvanian rocks in the adjacent Lake Valley quadrangle as Magdalena Group. Brachiopod and fusulinid faunas indicate a middle Pennsylvanian (Desmoinesian-Missourian) age (Jicha, 1954; Kottlowski, 1958).

Laudon and Bowsher (1949) referred to the basal white chert conglomerate in Rattlesnake Ridge as Derryan on the basis of lithologic similarity to the Derryan sections in the San Andres Mountains. The basal white chert conglomerate was not recognized on Fluorite Ridge during this study; it could be among the highly silicified rocks and indistinguishable from the brecciated and silicified carbonate beds. On the north and east slopes of Rattlesnake Ridge, a white chert conglomerate, ranging in thickness from 10 to 80 ft, rests disconformably on Lake Valley strata. The variable thickness represents deposition on an incised erosional surface. Darton (1917) included the chert conglomerate and six feet of overlying beds in the Lake Valley Formation. The conglomerate is overlain by about 100 ft of interbedded light-gray limestone, black shale, wavy-bedded nodular limestone, red shale, and chert and chert-limestone pebble conglomerate.

The upper contact of the *Magdalena Group* (**IPm**) is more difficult to map because the only resistant beds in the Magdalena and overlying Abo Formation are chert-pebble and chert-limestone-pebble breccias and conglomerates. These are interbedded with shale and shaly, nodular limestone beds. The uppermost medium-bedded, light-gray limestone bed was arbitrarily chosen as the top of the Magdalena Group. This limestone, as well as some lower nodular limestones, may be Hueco Limestone equivalents in the Abo Formation.

Permian

About 300 ft of *Abo Formation* (*Pa*) red beds overlie the Magdalena Group on the northeast slope of Rattlesnake Ridge. A small gully in the northeast corner of sec. 7, T. 21 S., R. 8 W. exposes an almost continuous Abo section consisting

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of interbedded chert-pebble breccias, chert-limestone-pebble conglomerates, red shale, and lesser amounts of nodular shaly limestones and fine sandstones. In general, the breccias and conglomerates are more abundant in the lower part while red shale and limestones predominate in the upper part. The coarser clastic beds are cemented with calcite; the breccias and conglomerates contain sand lenses. Scouring and channel filling is evident with chert and limestone clasts up to small cobble size present in some channel fills. The fine sandstone beds contain about equal amounts of well-rounded quartz and angular chert grains.

A much thinner section (probably less than 100 ft) of correlative strata crops out on Fluorite Ridge. Jicha (1954) measured and described 150 ft of similar rocks north of Cooke's Peak about three miles north of the Massacre Peak quadrangle.

Darton (1916, 1917) mapped these rocks as Lobo Formation and classified them as Triassic(?) although he recognized that they might be Permian. Spencer and Paige (1935) described similar beds five miles southeast of Santa Rita and correlated them and the red beds of the Cooke's Range with the Abo. Jicha (1954) mapped the red beds between the Magdalena Group (Pennsylvanian) and the overlying Sarten Sandstone (Lower Cretaceous) in the Cooke's Range as Lobo Formation but correlated it with the Abo. Elston (1957) mapped the equivalent red beds in the Dwyer quadrangle as Lobo-Abo red beds of Permian age. Corbitt and Nials (1975) described the equivalent strata in the Pony Hills area as Abo. The many separate outcrops labeled as Lobo Formation around Luna County and adjacent areas may contain several units of different ages as suggested by Kottlowski (1958).

The age of the Lobo at its type locality in the Florida Mountains is still uncertain (Kottlowski, 1963; Corbitt, 1971). The red beds in the map area overlie Pennsylvanian rocks and are overlain by Lower Cretaceous. Neither Triassic nor Jurassic rocks occur in this area; therefore, the red-bed sequence is considered to be Permian and should be called Abo, which was named by Lee (1909) and takes precedence over Lobo.

Cretaceous

The *Sarten Sandstone* (*Ks*) caps Rattlesnake Ridge where a complete thickness of about 300 ft is exposed. Partial sections form smaller exposures along the northern and western ends of Fluorite Ridge and in the Pony Hills. Most of the sandstone is medium to massive bedded with a few thin-bedded zones. Crossbedding is common in the thin to medium beds; symmetrical ripple marks are present on bed surfaces at several localities. Borings were observed in many of the beds on Rattlesnake Ridge. The sandstone is predominantly light gray to light yellowish gray, but a few reddish beds are present in some sections. Gray and yellowish, very fine sandstone, shale, and marl form the basal part of the Sarten west of Detention Dam No. 4 at the south end of Rattlesnake Ridge. Similar beds are exposed in a small gully at the boundary between secs. 7 and 8, T. 21 S., R. 8 W. at the north end of the ridge. Elsewhere colluvium obscures the lower contact of the Sarten; therefore the extent and continuity of this basal unit is unknown.

Most of the sandstone is fine to medium grained and cemented by quartz overgrowths. A few coarse sandstone and pebbly, granular conglomerate beds occur throughout the formation. The fine- to medium-grained beds generally contain less than two percent clay and consist of moderately sorted to well-sorted, subangular to subrounded quartz grains with minor amounts (2-10 percent) of feldspar and trace amounts of chert grains. Common accessory minerals are zircon, tourmaline, pyrite, hematite, and magnetite. The vast majority of the strata are classified as fine- to medium-grained sandstone: siliceous submature to mature feldspar-bearing quartz arenites of Folk's classification.

Darton (1916, 1917) reported an Early Cretaceous fauna (Fredericksburg) from marly sandstone near the middle of the Sarten. Stephen C. Hook (personal communication, 1978) has collected late Comanchean faunas from the basal beds at the southern end of Rattlesnake Ridge and from the uppermost calcareous sandstone (containing limestone nodules) near Oil Well windmill in Starvation Draw. The Sarten, generally considered correlative to the Beartooth Quartzite of the Silver City area, is overlain disconformably by the Colorado Formation.

The *Colorado Formation* (*Kc*) crops out almost continuously for about a mile in the head of Starvation Draw. Its contact with the underlying Sarten is well exposed by Oil Well windmill in the northwest corner of sec. 18, T. 21 S., R. 8 W. The upper contact is obscured by colluvium and alluvium except for one spot just northeast of a fault near the center of sec. 13, T. 21 S., R. 9 W. where the upper contact is overlain unconformably by the Starvation Draw member (new informal name) of the Rubio Peak Formation (Cenozoic). Smaller exposures are mapped in the extreme northwest corner of the area and in the northeast corner of sec. 19, T. 21 S., R. 8 W. The Colorado Formation was eroded from the Pony Hills and Fluorite Ridge areas before the deposition of the Starvation Draw member. In these latter areas, the Starvation Draw conglomerates rest unconformably on Sarten Sandstone.

In the map area the Colorado Formation contains about 170 ft of interbedded shale, calcareous shale, thin-bedded limestone, and calcarenites. Its base is marked by a three-foot bed of conglomeratic sandstone. The fossiliferous section near Oil Well windmill includes 17 thin laminae of bentonite or flint clay (Stephen C. Hook, personal communication, 1978). Several of the dark-gray flaggy limestone beds in the lower part of the formation are composed wholly of disarticulated globigerinids. A large molluscan fauna indicates a Late Cretaceous (Cenomanian-Turonian) age for the Colorado Formation (Darton, 1916, 1917; Jicha, 1954; Hook and Cobban, 1977).

Cenozoic

The southern end of the Cooke's Range is composed mostly of rocks belonging to the Rubio Peak Formation forming a wide band covering about one-quarter of the Massacre Peak quadrangle. Included in the Rubio Peak Formation are: Starvation Draw member; tuff breccias and conglomerates; intrusives clearly delineated; obvious flows; and undifferentiated flows and intrusives. The lithology of these rocks closely resembles the Rubio Peak mapped in the Dwyer quadrangle (Elston, 1957) to the northwest, Lake Valley quadrangle (Jicha, 1954) to the north and northeast, Good Sight Mountains (Clemons, 1979) to the east, and to some extent, the "agglomerate" to the south in the northern Florida Mountains (Darton, 1916, 1917; Corbitt, 1971). Several radiometric dates for Rubio Peak Formation intrusions indicate a middle Eocene to early Oligocene age. For mapping purposes the Rubio Peak has been informally subdivided into six units.

The *Starvation Draw member* (*Trs*) is introduced here as a new informal name. This unit is composed of interbedded conglomerates, red-gray-brown sandstones, and red silty shales. Most of these rocks are poorly cemented; the soft muddy or tuffaceous matrix material is easily eroded, leaving surfaces strewn with residual pebbles, cobbles, and boulders. The large, angular to subrounded clasts (up to 10 ft) are predominantly medium- to coarse-grained red granite and pegmatitic granite with lesser amounts of gray granite, gneiss, schist, and white quartz; all rocks are assumed to be Precambrian. Most are similar to the Precambrian exposed south of Fluorite Ridge or in the northern Florida Mountains. Clasts of most of the Paleozoic rocks and Sarten Sandstone exposed in the surrounding areas are abundant.

Because of poor exposures, measuring a complete section was not feasible. The best exposures of partial sections occur on the gullied steep slopes in the northwest corner of the map and on the west slope of the high hill located near the southeast corner of sec. 32, T. 21 S., R. 8 W. about a mile south-southeast of Detention Dam No. 4. Near the center of sec. 13, T. 21 S., R. 9 W. a 30-ft unit of well-cemented, sandy, cobble conglomerate (composed wholly of Precambrian clasts) overlies the Colorado Formation. Above this unit is a partly covered 100-ft section containing reddish-gray-purple coarse sandstone and pebble conglomerate, gray, slightly conglomeratic sandstone, red shale, and mudstone. The sandstone is composed chiefly of poorly sorted, very angular plagioclase grains and mafic volcanic rock fragments with minor quartz grains. The rock section beveled by the pediment surface in secs. 11 and 14, T. 21 S., R. 9 W. contains about 250 ft of red mudstone, gray and red sandstones, and boulder conglomerates. The gray sandstone is calcite cemented, medium grained, and contains fewer volcanic rock fragments but more quartz and common chert grains than the coarse sandstone described above. The lower conglomerates are composed largely of well-rounded granite porphyry clasts resembling the porphyroblastic granite south of Capitol Dome described by Corbitt (1971), with lesser amounts of limestone and quartzite (Sarten?). Upward the interbedded conglomerates contain increasing amounts of mafic volcanic clasts in a matrix of weathered andesitic material. Several channel fills are exposed and the deposits are considered of fluvial origin with a probable southward(?) source. About 300 ft of interbedded conglomerates, red mudstone, and red and brown fine sandstones are exposed in the hill a mile south of Detention Dam No. 4. Here also the lower conglomerates contain granite, limestone, and quartzite clasts; the upper beds contain mostly volcanic clasts.

Darton (1916, 1917) mapped these rocks as "Tertiary agglomerate and associated rocks" and thought the areas containing abundant huge granite boulders were outcrops of Precambrian faulted up against Sarten Sandstone. Griswold (1961) mapped most of them as Gila Conglomerate; he designated those between the Sadler and Lucky mines as a Tertiary volcanic conglomerate and three small outcrops near the Hilltop mine as a Tertiary monolithic conglomerate. Griswold recognized the detrital nature of the granite boulders; because some of the beds were overlain by rhyolite (Sugarlump and Kneeling Nun Tuffs), he thought they ranged in age from middle to late Tertiary. Corbitt and Nials (1975) referred to some as "Lobo-Love Ranch formation" and some as Rubio Peak Formation but showed them all on their map as "Tertiary andesite."

In the eastern Pony Hills and south end of Rattlesnake Ridge the basal conglomerate rests unconformably on the Sarten. In the northwestern corner of the map this conglomerate rests unconformably on the Colorado Formation. South of Wilson Ranch, about two miles east-southeast of Fluorite Ridge, a poorly consolidated conglomerate appears to interfinger with the volcanic breccia member of the Rubio Peak Formation. Corbitt and Nials (1975) reported that west of Fluorite Ridge (beyond the map area) "about 100 ft of andesitic material containing no clasts is exposed below the boulder beds." The upper red shales and brown sandstones are overlain by the Sugarlump Formation on the hill a mile south-southeast of Detention Dam No. 4. Numerous northeast- and northwest-trending dikes of basalt and hornblende andesite intrude the Starvation Draw member. One of these, between Fluorite Ridge and Detention Dam No. 1, was dated at 37.6 ± 2.0 m.y. The Cooke's Peak and Fluorite Ridge granodiorite porphyry intruded the conglomerates. Excellent intrusive contacts are exposed in the deep arroyo in the southwest corner of sec. 12, T. 21 S., R. 9 W. and just northeast of the Hill Top mine at the southeast end of Fluorite Ridge. Corbitt and Nials (1975) also reported an intrusive contact in the NW¼ sec. 16, T. 21 S., R. 9 W., two miles west of the northwest corner of the Massacre Peak quadrangle.

The Starvation Draw member is considered to be Eocene in age; present data does not exclude the possibility of some of the basal beds being as old as Paleocene. The Starvation Draw member may be correlative to part of the Lobo Formation in the Florida Mountains and may be correlative to part of the Love Ranch Formation in the southern San Andres Mountains. In the Old Hadley mining district Jicha (1954) described one small outcrop of similar rocks that may belong to the same unit. William Seager (personal communication, 1979) stated that similar conglomerates are interbedded at the base of the Rubio Peak Formation in the southern Black Range.

Tuff breccias and conglomerates (*Trt*) with a tuffaceous matrix are intimately associated with Rubio Peak flows and intrusives throughout the southern Cooke's Range in much the same way as described in the Good Sight Mountains (Clemons, 1979) 10 mi to the east. However, the massive monolithic tuff breccias so prominent in the Good Sight Mountains are not present in the Cooke's Range. In the Massacre Peak quadrangle, the tuff breccias consist mostly of hornblende dacite and hornblende-andesite clasts (ranging up to 10 ft but averaging 2-4 inches) in a light- to medium-gray tuffaceous matrix. These breccias are poorly sorted, poorly bedded, and generally poorly consolidated, probably representing lahar, talus, and fluvial deposits. The lahar or talus types are well exposed along the Butterfield Trail northwest of Massacre Peak. The well-bedded fluvial types are exposed in the arroyo southeast of Massacre Peak and in the arroyo northeast of Puma Spring. A conglomerate included in this unit crops out in the low hills by the small tank in the SE½ sec. 15, T. 22 S., R. 8 W. The tuffaceous, poorly bedded rocks grade laterally into sandy, well-bedded conglomerates and conglomeratic, tuffaceous sandstones with local lenses of these latter rocks. In the map area southwest of the Cooke's Range, the Rubio Peak Formation consists primarily of the fluvial, sandy, tuffaceous breccias and conglomerates.

Darton (1916, 1917) mapped these rocks as Tertiary agglomerate and described them as irregularly stratified agglomerate, tuff, volcanic ash, flows of volcanic mud, flow breccias, and beds of sand, gravel, and conglomerate. He noted that much of the finer material was windborne. Nevertheless, portions have been deposited or rearranged by water. In recent years the term agglomerate has been used to define an agglutinated volcanic bomb deposit. Therefore tuff breccias and conglomerates better describe this map unit. Some of these rocks have been intruded by rocks 38-44.5 m.y. old with the same lithology as the clasts in the breccias; therefore, the breccias are considered to be middle to late Eocene age.

The remainder of Rubio Peak Formation consists of dikes, plugs, stocks, and irregular intrusive masses of dense, nonvesicular, nonporphyritic to porphyritic basalt, hawaiite, andesite, and dacite, and vesicular olivine basalt that underlie, intrude, and interfinger extensively with the tuff breccias in the southern Cooke's Range. Basalt and andesite dikes 1-30 ft wide and up to a mile in length intrude rocks as young as the Starvation Draw member and Cooke's Peak-Fluorite Ridge granodiorite throughout the western half of the map area. Dikes, stocks, and irregular-shaped intrusions constitute a large percentage of the rocks in the southern Cooke's Range. Chemical analyses and norms of eight samples of these rocks are shown in table 1 with their locations shown on the map. Where the intrusive contacts could be clearly delineated, the rocks were mapped as *Intrusives* (*Tri*). Rocks which are obviously extrusive were mapped as *Flows* (*Trf*). The remaining bulk of the rock masses in this group consist of intrusive masses that grade into flows and sills(?) and intertongue with each other and the tuff breccias, and were mapped as *Undifferentiated flows and intrusives* (*Trfi*).

TABLE 1—Chemical composition and weight norms of Rubio Peak samples. Adjusted for classification of Irvine and Baragar (1971). Locations shown on map.

Sample →	2	3	4	5	6	7	9	10
SiO_2	62.51	63.55	60.27	57.72	64.38	49.27	60.54	46.95
TiO_2	0.55	0.54	0.51	1.10	0.60	1.17	0.56	1.67
Al_2O_3	15.99	15.68	16.63	16.65	15.38	15.21	16.96	17.53
FeO_t	3.83	3.80	4.68	7.10	3.80	8.98	3.98	10.11
MnO	0.09	0.09	0.12	0.08	0.08	0.15	0.05	0.20
MgO	1.40	1.77	2.31	1.38	1.69	8.42	1.68	5.30
CaO	5.03	3.69	4.60	6.27	4.03	8.86	4.93	7.09
Na_2O	4.79	5.14	4.61	4.87	4.30	4.21	5.14	4.93
K_2O	3.14	3.54	3.23	2.85	3.90	1.55	2.79	1.16
LOI	0.85	0.64	1.11	0.92	0.38	0.56	2.31	4.64
P_2O_5	0.22	0.22	0.24	0.31	0.20	0.26	0.27	0.36
Total	98.40	98.66	98.31	99.25	98.64	98.64	99.21	99.94
Q	12.41	11.48	9.58	4.70	15.61	-----	8.96	-----
Or	18.98	21.29	19.39	17.08	22.80	9.31	16.98	7.17
Ab	41.46	44.28	39.64	41.80	36.95	25.28	44.79	32.10
An	13.15	9.43	15.39	15.37	11.62	18.33	15.41	23.30
Ne	-----	-----	-----	-----	-----	5.93	-----	6.25
Di	8.75	6.18	5.03	11.83	5.84	19.82	6.37	8.99
Hy	0.61	2.76	6.44	2.54	2.44	-----	2.66	-----
Ol	-----	-----	-----	-----	-----	14.52	-----	13.20
Mt	3.04	3.01	2.96	3.82	3.09	3.94	3.08	4.81
Il	1.07	1.04	0.98	2.12	1.16	2.26	1.10	3.32
Ap	0.53	0.53	0.58	0.74	0.48	0.63	0.66	0.89

The porphyritic varieties are red brown to pale red and occur mostly northeast of Fryingpan Spring. They contain 30-40 percent phenocrysts of plagioclase, hornblende, and biotite up to one centimeter long in a matrix of acicular and blocky plagioclase laths, hornblende, biotite, hypersthene, and magnetite. Oscillatory-zoned andesine phenocrysts are the most abundant comprising 24-29 percent of the rock. Most are euhedral but some are rounded due to resorption. Euhedral hornblende phenocrysts (5-9 percent) are slightly to completely oxidized. Biotite (1-2 percent) occurs as fresh euhedral books.

A potassium-argon age of 38.0 ± 1.5 m.y. was determined on a biotite separate from a dacite sample collected in NE¼ SW¼ sec. 16, T. 21 S., R. 8 W. Biotite from a dacite sample collected in NW¼ SW¼ sec. 33, T. 21 S., R. 8 W. yielded a potassium-argon age of 44.7 ± 1.9 m.y.

Slightly porphyritic rocks (1-10 percent phenocrysts) with oxidized hornblende as the principal phenocrysts grade into nonporphyritic types. These andesites and dacites are medium to dark gray and are the dominant rock in the southeastern part of the map area. The Massacre Peak stock is typical of the nonporphyritic andesite variety. It is dense, grading to microvesicular near the border, and well foliated. Microphenocrysts of andesine-labradorite, oxidized hornblende, and augite are enclosed in a finely crystalline matrix with a fluidal texture. Chlorite, calcite, and hematite are common secondary minerals. The dike that fed the flows capping the hill a mile south of Massacre Peak is an alkali olivine basalt. Microphenocrysts of olivine (0.2-0.5 mm), partly replaced with iddingsite, occur in a hyalopilitic or intersertal matrix of labradorite-andesine laths, pyroxene(?), magnetite, and glass. This dike and the associated flows are part of a dissected and partly buried vent structure. A potassium-argon whole rock analysis from a sample collected at the northwest end of the dike yielded an age of 38.0 ± 1.9 m.y. A sample collected from the northwest-trending dike in NW¼ NW¼ sec. 1, T. 22 S., R. 9 W. is an olivine-bearing hawaiite with an almost diabasic texture produced by the long slender plagioclase crystals. A potassium-argon whole-rock analysis of this rock gave an age of 37.6 ± 2.0 m.y.

The Cooke's Peak *Granodiorite porphyry* (*Tgp*) of Oligocene age crops out near the northwest corner of the quadrangle and in Rattlesnake Ridge. In sections 11 and 12, this unit is chiefly a thick sill-like mass between the Sarten Sandstone and Colorado Formation crosscutting both and intruding rocks as young as the Starvation Draw member of the Rubio Peak Formation. Along Rattlesnake Ridge the granodiorite porphyry occurs as a sill in the lower Sarten varying in thickness from 50 to 200 ft. About 3-4 mi south and southwest of these outcrops, the bulk of Fluorite Ridge is composed of granodiorite porphyry. These two masses probably join in the subsurface.

The granodiorite porphyry is light to medium gray or greenish gray with abundant white feldspar phenocrysts and a few smaller hornblende phenocrysts. Small quartz phenocrysts are present locally. In thin sections the feldspar is oligoclase to andesine, extensively altered to sericite. The hornblende is green and altering to biotite, chlorite, and magnetite. The groundmass consists of orthoclase, plagioclase, and quartz, with minor clinopyroxene. Lindgren and others (1910) collected a sample of the Cooke's Peak granodiorite for a chemical analysis. The analysis and norm have been reproduced by Jicha (1954) and Elston (1957).

The granodiorite intruded the basal Rubio Peak conglomerate and is closely associated with the Rubio Peak volcanic rocks compositionally and areally. If all the dikes in Fluorite Ridge, Pony Hills, and Rattlesnake Ridge are about the same age, and if the age of 37.6 m.y. for the dike north of Fluorite Ridge is accurate, the granodiorite would have to be older than 37.6 m.y. This age correlates well with the potassium-argon 38.8 ± 1.4 m.y. age from biotite that Loring and Loring (in press) report for the Cooke's Peak granodiorite. Similar dikes intrude both the Cooke's Peak and Fluorite Ridge masses. Griswold (1961) stated that the fluorite mineralization postdated the emplacement of the dikes. Present data indicate that the Rubio Peak volcanic rocks were erupted about 37-44 m.y. ago. This activity was penecontemporaneous with emplacement of the granodiorite, intrusion of the mafic dikes (part of the Rubio Peak), and fluorite mineralization.

Southwest of Cooke's Canyon the Rubio Peak Formation is overlain by the Sugarlump Formation, which is divided into two units: the lower, *Sedimentary unit* (*Ts*), consists of light-colored, tuffaceous, volcaniclastic beds and lower and middle ash-flow tuffs; the upper, *Ash-flow tuff unit* (*Tsa*), is most extensive and about 70 ft thick. Thickness of the Sugarlump below the upper ash-flow tuff ranges from about 50 ft (0.3 mi northeast of Massacre Peak and southeast of Fluorite Ridge) to about 400 ft (1.8 mi southeast of Massacre Peak). About 1.3 mi south of Massacre Peak, 200 ft of *Ts* rest angularly unconformable on the Rubio Peak Formation. South of Fluorite Ridge the upper ash-flow tuff appears to rest on the Rubio Peak Formation. These sedimentary beds and ash-flow tuffs are correlated with the Sugarlump Formation in the Dwyer quadrangle (Elston, 1957) and Lake Valley quadrangle (Jicha, 1954).

The lower tuff (about 12 ft thick) and middle tuff (about 32 ft thick) are vitric ash-flow tuffs with less than 10 percent crystals and abundant flattened pumice lumps. The crystals are predominantly plagioclase. The upper tuff is typically well-welded, crystal-vitric ash-flow tuff with 18-33 percent crystals of plagioclase, sanidine, quartz, and biotite, with trace amounts of hornblende, pyroxene, and sphene. Axiolitic shards are abundant in the matrix.

Although the Sugarlump and granodiorite porphyry outcrops are close to each other south of Fluorite Ridge, certain contact could not be determined nor could the nature of a possible contact—whether depositional, intrusive, or a fault. A potassium-argon age of 36.9 ± 1.5 m.y. obtained on the lower Sugarlump ash-flow tuff in the Mimbres Valley is slightly less than the age of the granodiorite.

Overlying the Sugarlump is the Oligocene *Kneeling Nun Tuff* (*Tkn*), about 80 ft of densely welded ash-flow tuff capping the prominent cuestas south of Fort Cummings. Smaller outcrops cap the large hill a mile south of Massacre Peak and the small hill near the south-central edge of the quadrangle. This tuff is dark orange red and weathers brownish, whereas the underlying Sugarlump is pinkish and weathers pale red. On the basis of stratigraphic position and petrography, the upper tuff is correlated with the 33-m.y.-old Kneeling Nun Tuff (Elston, 1957; Elston and others, 1975; Jicha, 1954; Clemons, 1979). These outcrops probably represent the approximate southernmost extent of the Kneeling Nun. Darton (1916, 1917) combined the Sugarlump and Kneeling Nun in his rhyolite flows map unit and described their distinctive colors.

In the Massacre Peak quadrangle the Kneeling Nun Tuff is a single flow of crystal-vitric ash-flow tuff. The unit contains 18-36 percent phenocrysts of plagioclase, sanidine, quartz, and biotite with sparse amounts of hornblende, pyroxene, sphene, and apatite. Flattened pumice fragments are common and axiolitic shards are scattered throughout the matrix.

In the vicinity of the Hyatt Ranch and Fort Cummings, *Undifferentiated flows and intrusives* (*Tbs*) of the Bear Springs Basalt (or basaltic andesite) of Miocene age intrude and overlie the Kneeling Nun Tuff and older rocks. A vent area is located at the mouth of Clark Draw where agglutinated scoriaceous material probably represents part of a cinder cone. Dikes and flows crop out for a mile to the north and several miles to the southeast. This unit is correlated with the *Bear Springs Basalt* in the Lake Valley (Jicha, 1954) and Dwyer (Elston, 1957) quadrangles. The *Sedimentary member* (*Tbss*) (of the Bear Springs Basalt) consisting of interbedded sandstones and sandy conglomerates has been differentiated wherever possible. Some overlying beds of similar lithology are queried *Tbss* because they are thought to be more closely associated in time with the Bear Springs Basalt than the overlying Santa Fe Group.

Bear Springs Basalt is black, fine grained, and dense to vesicular. Plagioclase (An_{40-60}) is the dominant mineral with lesser augite, hypersthene, olivine (mostly altered to iddingsite), and magnetite. Vesicles contain zeolites that Darton (1917) reported as thompsonite and heulandite. Elston (1957) reported a chemical analysis (sample from the Dwyer quadrangle) of 51.17 percent silica and classified the rock a basaltic andesite.

The Bear Springs Basalt is about 28 m.y. old (Elston and others, 1975) and approximately correlative with the Uvas Basaltic Andesite (26-27 m.y.) to the southeast.

The piedmont-slope facies of the *Mimbres formation* (*QTm*) and (*Qm*) of Pliocene-Pleistocene age is composed chiefly of alluvial-fan and coalescent-fan deposits. This unit also includes thin alluvial and colluvial veneers on pediment surfaces. *Qm* is correlative to the youngest unit of the Santa Fe Group (*Qcrp*-Camp Rice pediment facies) in south-central New Mexico. *TQm* is probably correlative in part to the basal Camp Rice Formation (*Qcrc*) but may include some older beds of Pliocene age. Exposures of colluvial veneers cemented with caliche are prominent in the northeast and northwest corners of the map. In the northeast the colluvial veneer rests on poorly consolidated, light-colored, and tuffaceous sediments. In the northwest corner, north and south of Puma Spring, the caliche-cemented colluvial veneer rests on surfaces that truncate the Starvation Draw member. The *Qm* south of Fluorite Ridge has extensive caliche development and probably belongs to alluvial deposits of early to middle Pleistocene age.

Composition of the boulder gravels in the veneers varies depending upon the lithology of the adjacent slopes. Granodiorite, Sarten Sandstone, and limestone clasts comprise the gravel in the northeast; granodiorite and Sarten with minor Rubio Peak comprise the gravel in the northwest. In the vicinity of Puma Spring, ash-flow tuff and Rubio Peak debris predominate with minor Sarten clasts.

The name Mimbres conglomerate was introduced by Hernon and others (1953) but was later dropped in favor of either Gila Conglomerate or Santa Fe Group. The piedmont-slope facies of the Mimbres formation is probably correlative to the similar facies of the Camp Rice Formation (Seager and Hawley, 1973; Hawley, oral communication, 1979). I propose that Mimbres formation be used informally in the closed Mimbres Basin until more detailed work is done on these rocks and the Gila Conglomerate in southwestern New Mexico. This unit in the Massacre Peak quadrangle is believed correlative with the "semiconsolidated gravel deposits in the Mimbres Valley" of the Santa Rita quadrangle (Hernon and others, 1964).

Older piedmont-slope alluvium (*Qpo*) of late Pleistocene age is similar in composition to the Mimbres conglomerate piedmont-slope facies, invariably reflecting the lithology of local source areas. This unit includes arroyo terrace and fan deposits and thin (less than 10 ft) veneers on erosion surfaces generally of late Pleistocene age (15,000-500,000 m.y.). Sporadic, thin, caliche-cemented horizons cap the thicker veneers. Well-developed surfaces are inset about 100 ft below the Mimbres surface and are 40-50 ft above present drainages in the northwest corner of the map. Southeastward, Starvation Draw (the geographic feature) is flanked by alluvial fan deposits (Qpo) that are covered by younger alluvium adjacent to modern arroyos.

Arroyo channel, terrace, and fan deposits associated with these modern arroyos are mapped as *Younger piedmont-slope alluvium* (*Qpy*). This unit contains deposits ranging in age from late Wisconsinan to the present (less than 25,000 years B.P.). They and the late Pleistocene deposits are products of repeated episodes of arroyo-valley entrenchment and partial backfilling (Seager and others, 1975). Zones of soil-carbonate accumulation are weak or absent in the Holocene (less than 10,000 years B.P.) deposits.

Undifferentiated colluvium-alluvium (*Qca*) of Holocene and late Pleistocene age have been mapped in areas where they form relatively continuous cover on older units. These deposits generally are less than 10 ft thick on slopes but some undifferentiated piedmont-slope alluvium may be included. *Qca* reflects the lithology of nearby higher slopes and ledges. Most of the unit is an age equivalent of older (*Qpo*) and younger (*Qpy*) piedmont-slope alluvium. Locally, *Qca* may correlate with the piedmont-slope facies of the Mimbres conglomerate (*Qmp*) and Camp Rice Formation. In several instances, where the underlying rock could be determined by abundant nearby exposures, the combined symbol *Qca/Trt* was used.

STRUCTURE

All of the rocks in the Massacre Peak quadrangle up to and including the Bear Springs Basalt have been extensively faulted. As noted by Griswold (1961) for the Fluorite Ridge area, three prevailing fault trends are present in the map area: north, northwest, and northeast.

The Sarten fault (Jicha, 1954) trends northward up Fryingpan Canyon and into the Lake Valley quadrangle for a distance of about 6 mi before it swings northwestward for another 11 mi into the Dwyer quadrangle (Elston, 1957) before being covered by Santa Fe gravels. Rocks west of the fault have been uplifted 1,200-2,000 ft throughout most of its extent. The fault is covered by alluvium at the mouth of Fryingpan Canyon; its southward continuation is unknown. Darton suggested the fault may swing southwest and connect with the north-trending fault that cuts the east end of Fluorite Ridge. Discontinuous outcrops of the Starvation Draw member across this projection indicate that if the fault does extend through the area, its throw is greatly reduced.

Northwest-trending faults are most abundant. A couple of small faults on the northeast flank of Fluorite Ridge have downdropped the northeast block. The larger faults on the southwest flank of the southern Cooke's Range are down to the southwest; on the northeast flank they are down to the northeast. None seems to have more than a couple hundred feet of displacement but collectively they may account for the doming effect of the Sugarlump and Kneeling Nun Tuffs. The tuffs dip southwestward a mile south of Massacre Peak, are nearly horizontal 0.4 mi northeast of Massacre Peak, and dip northeastward for several miles south and southeast of Fort Cummings.

Northeast-trending faults are most prominent in Rattlesnake Ridge. They offset Sarten Sandstone, granodiorite sills, and older rocks up to 200 ft.

The faults are mostly Miocene to Pliocene in age. Their appearance on the map, cutting Sarten Sandstone in the Pony Hills and being older than Rubio Peak, is probably anomalous. They could be related to Laramide deformation but exposures are very poor in the poorly consolidated basal Rubio Peak rocks; the faults probably continue across the Pony Hills. The basalt dikes have small displacements along northwest- and northeast-trending faults. The dikes have prominent northwest and northeast trends and may have been intruded along basement fractures of Laramide or older origin continuing up through younger rocks.

The combined effect of southward doming (off the Cooke's Peak granodiorite) and westward tilting by the Sarten fault produced a southwest-plunging syncline. Remnants of the Colorado Formation are preserved in this syncline. Griswold (1961) described the structure of Fluorite Ridge and its anticlinal nature produced by intrusion of the Fluorite Ridge granodiorite.

MINING

Fluorite mines in the Fluorite Ridge district have produced more than 80 percent of the total fluorspar for Luna County. According to McAnulty (1978), mining was intermittent from 1909 to the early 1950's with greatest activity taking place in the late 1930's and early 1950's. Darton and Burchard (1911), Johnson (1928), Rothrock and others (1946), Russell (1947), and Griswold (1961) described the geology and various mines. Williams (1966) updated and summarized information on the mines. McAnulty (1978) described the White Bluff prospect which was discovered after Williams' report. The White Bluff claims are located in T. 22 S. (not T. 27 S. as McAnulty states on page 39 or shows in fig. 13); the granodiorite porphyry is late Eocene (not Precambrian as McAnulty states on page 41).

The Cooke's Peak district, several miles north of the Massacre Peak quadrangle, produced about $4 million of lead-silver-zinc ore between 1876 and 1927 (Griswold, 1961). Several small mines and placer deposits in the low hills just south of the map area produced several hundred tons of manganese ore between about 1918 and 1959. The greatest part of the ore came from a placer south of the hills (Farnham, 1961). There are no active mines in the area at the present time but re-examination of the area and active claims are continually taking place.

A small quarry in the Sarten Sandstone was excavated near Starvation Draw Dam No. 4 prior to 1916. Darton (1916, 1917) reported that it was opened to supply stone for the county courthouse at Deming. Apparently other material was used because the size of the quarry indicates not much stone was removed.

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