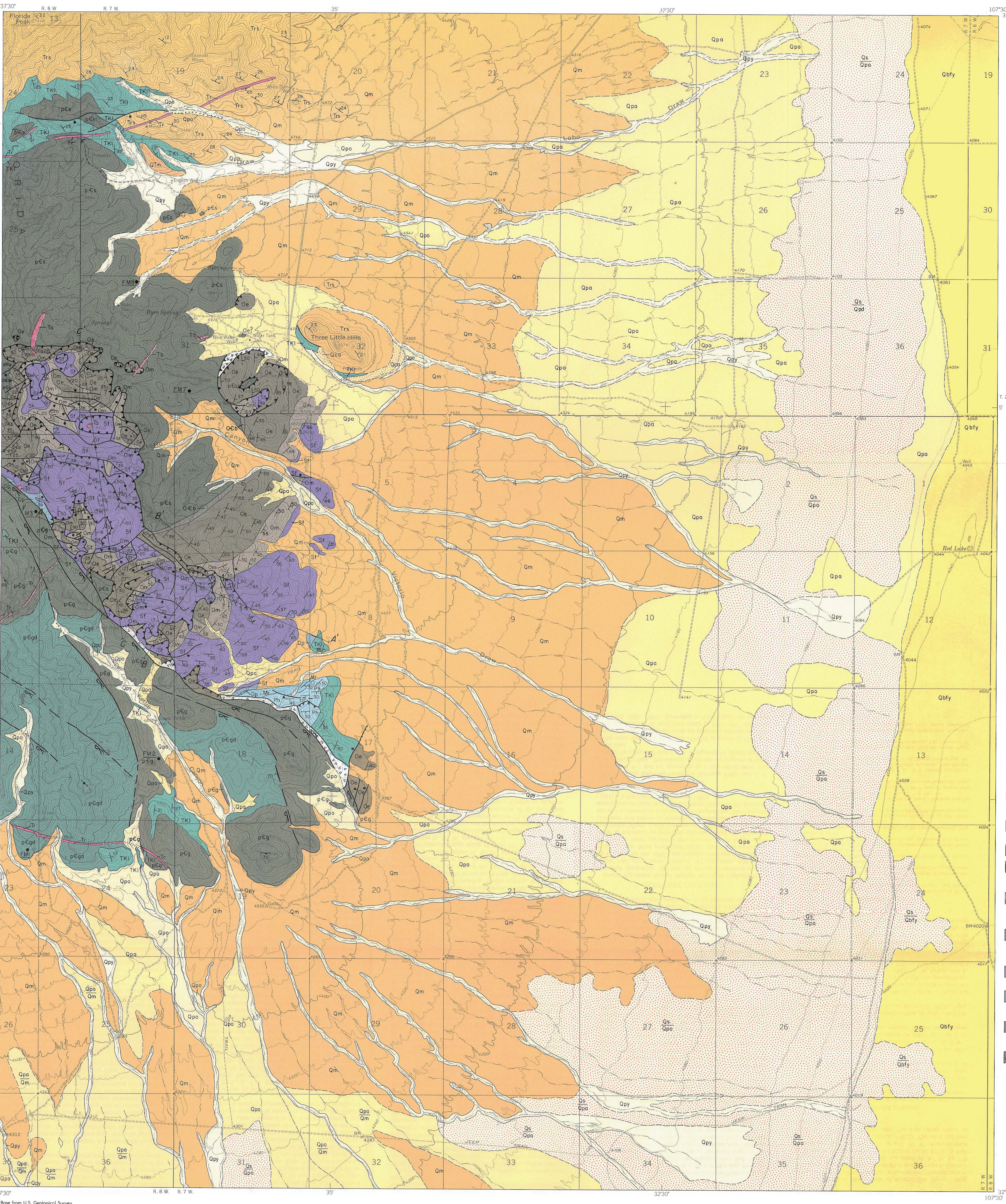
NEW MEXICO BUREAU OF MINES & MINERAL RESOURCES A DIVISION OF NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY



Base from U.S. Geological Survey

Drafted by Debra Vetterman and James Brannan

CORRELATION OF UNITS

- Qs, Qca, Qpa, Qpy, Qpo, Qbfy — HOLOCENE
- disconformity
- Qm, QTm — PLEISTOCENE / PLIOCENE
- angular unconformity
- Ta, Tb, Tr — MIOCENE–UPPER EOCENE
- Trs — EOCENE
- angular unconformity
- TKl — PALEOCENE–UPPER CRETACEOUS
- angular unconformity
- Ph — LOWER PERMIAN
- disconformity
- Mr — MISSISSIPPIAN
- disconformity
- Dp — DEVONIAN
- disconformity
- Sf — SILURIAN
- disconformity
- Om — ORDOVICIAN
- disconformity
- Oe — ORDOVICIAN
- O€b — CAMBRIAN
- angular unconformity
- p€gd, p€g, p€s — PRECAMBRIAN

DESCRIPTION OF UNITS

Qs — Windblown sand—Unconsolidated dunes up to 10 ft high; mostly underlain by caliche horizon; forms cover over map unit shown by symbol under the line (for example, *Qs/Qpa*)

Qbfy — Younger basin-floor sediments—Predominantly nongravelly to slightly gravelly alluvium in the Mimbres Basin unaffected by arroyo incision; contain very little pedogenic carbonate

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

Qpa — Undifferentiated piedmont-slope alluvium—Complexly intermixed older piedmont-slope alluvium and younger piedmont-slope alluvium (*Qpo* and *Qpy*)

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

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

Qm — Formation of Mimbres Basin—Fan gravel and interbedded, sandy lenses representing piedmont-slope facies; includes thin, erosion-surface veneers near mountain fronts; upper layers contain carbonate accumulations (caliche) up to several feet thick; formation is up to 100 ft thick

QTm — Formation of Mimbres Basin—Similar to *Qm* but found on higher terrace and alluvial-fan remnants; igneous-rock clasts are much more intensely weathered; up to 200 ft thick

Ta — Diorite/andesite—Intensely altered and deeply weathered dikes and small irregular intrusions; exposed only in arroyos and on a few bare slopes and ridges

Tb — Basalt or basaltic-andesite dikes—Dark-gray to black, dense, aphanitic rock; a few dikes are diabasic; some of the rocks are slightly vesicular, with carbonate and chlorite fillings

Tr — Rhyolite dikes—Very light gray dikes ranging from 1 to 18 ft in thickness; holocrystalline, generally nonporphyritic; fractures commonly stained with manganese oxides

Trs — Starvation Draw member of Rubio Peak Formation—Grayish-purple and reddish breccias of polylithic volcanic clasts grading upward into greenish-gray breccias and conglomeratic sandstones; basal beds contain abundant granite and limestone clasts; upper beds are sand-sized volcanic arenites with abundant epidote concretions; entire section is everywhere strongly propylitized; up to 1,600 ft thick

TKl — Lobo Formation—Interbedded reddish shale and chert-limestone conglomerate, calcareous gray siltstone, sandstone, and pebble to cobble conglomerate; this unit is Darton's (1916) Lobo Formation; up to 500 ft thick

Ph — Hueco Formation—Thin- to medium-bedded, medium- to dark-gray limestone, slightly dolomitic near base; lenses of yellow to red sandstone interbedded near top; includes 30-ft Abo(?) tongue overlying the fossiliferous limestones; approximately 430 ft thick

Mr — Rancheria Formation—Thin- to medium-bedded, dark-gray to black, fine-crystalline, fossiliferous limestone; containing up to 50% chert near top; 220 ft thick

Dp — Percha Shale—Dark-gray to olive-gray fissile shale, with 1-ft black fossiliferous limestone bed 10 ft above base; 250 ft thick

Sf — Fusselman Dolomite—Thin- to massive-bedded, light- to dark-gray, medium- to coarse-crystalline dolomite; two coral-rich zones near base and one near top; sparse chert in basal and uppermost beds; 1,480 ft thick

Om — Montoya Formation—Basal, coarse sandy dolomite (*Cable Canyon*) overlain by dark-brown, coarse-crystalline dolomite (*Upham*), thin-bedded, medium-gray limestone and cherty limestone (*Aleman*), and medium-bedded limestone and dolomite; fossiliferous lower part; chert near top (*Cutter*); up to 180 ft thick

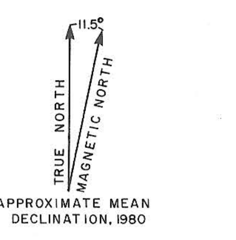
Oe — El Paso Formation—Basal unit of dark-gray, medium-crystalline dolomite overlain by thick middle unit of thin- to medium-bedded, light- to medium-gray limestone and cherty limestone, and upper unit of thin- to medium-bedded, medium- to dark-gray limestone with abundant chert; middle and upper units are fossiliferous; 1,263 ft thick

O€b — Bliss Sandstone—Thin- to medium-bedded arkosic to quartzose sandstone; grades up to calcareous sandstone and silty limestone; up to 120 ft thick

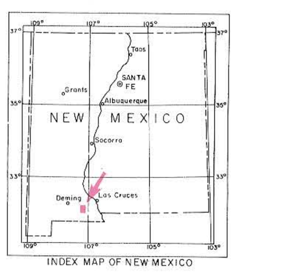
p€gd — Granite with abundant xenoliths—Fine- to coarse-crystalline alkali-feldspar granite containing up to 50% meladiorite, diorite, and diorite-porphyry xenoliths; predominant bedrock type in lower slopes and ridges south of south Florida Mountains reverse fault

p€g — Granite—Coarse-crystalline, brown, alkali-feldspar granite; contains approximately 65% perthite and microcline, 28% quartz, 5% chlorite (altered mafics), and 2% magnetite, zircon, sphene, and apatite; predominant bedrock type south of south Florida Mountains reverse fault

p€s — Syenite and quartz syenite—Predominantly coarse crystalline with many aplitic zones; unweathered rock is bluish gray but prevailing outcrops are yellowish brown; composition ranges from alkali-feldspar syenite with only a trace of quartz to quartz alkali-feldspar syenite; hastingsite (typically altered) is common mafic mineral; predominant plutonic rock north of south Florida Mountains reverse fault



APPROXIMATE MEAN DECLINATION, 1980



INDEX MAP OF NEW MEXICO

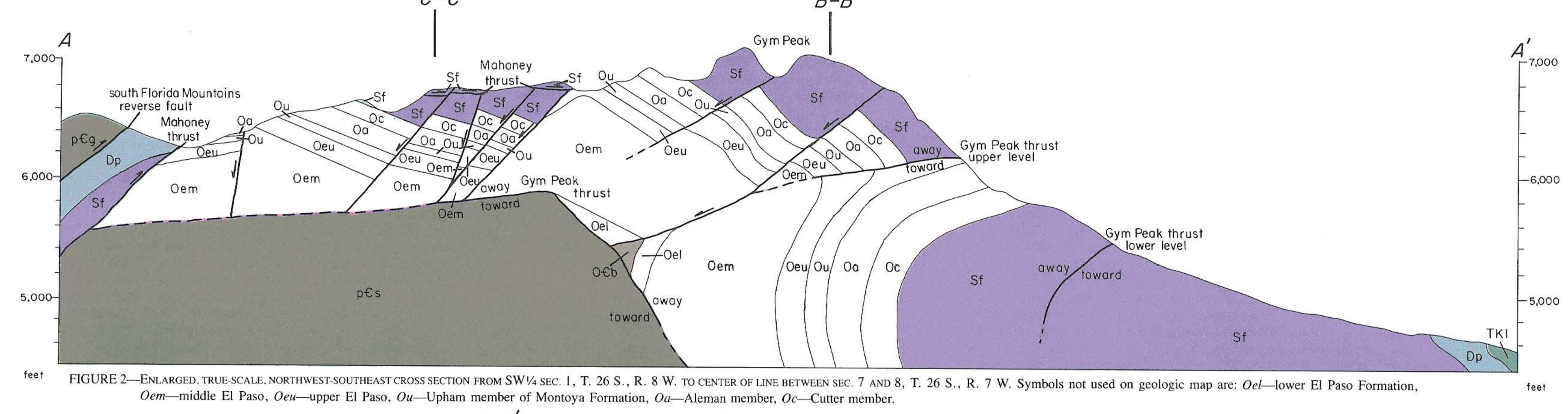


FIGURE 2—Enlarged, true-scale, northwest-southeast cross section from SW¼ sec. 1, T. 26 S., R. 8 W. to center of line between sec. 7 and 8, T. 26 S., R. 7 W. Symbols not used on geologic map are: *Oel*—lower El Paso Formation, *Oem*—middle El Paso, *Oeu*—upper El Paso, *Ou*—Upham member of Montoya Formation, *Oa*—Aleman member, *Oc*—Cutter member.

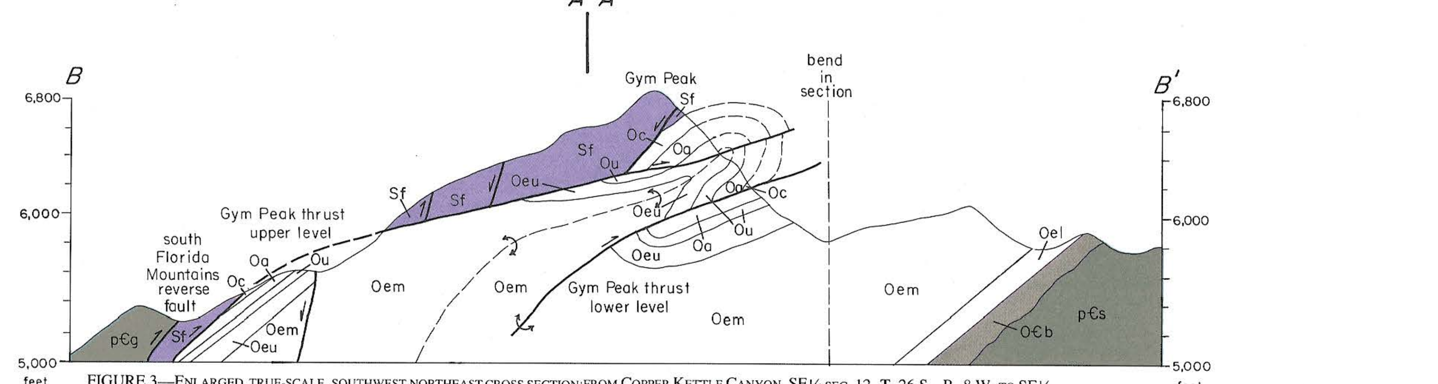


FIGURE 3—Enlarged, true-scale, southwest-northeast cross section from Copper Kettle Canyon, SE¼ sec. 12, T. 26 S., R. 8 W. to SE¼ sec. 1, T. 26 S., R. 8 W., with bend in cross-section line 0.3 mi northeast of Gym Peak. Symbols same as fig. 2.

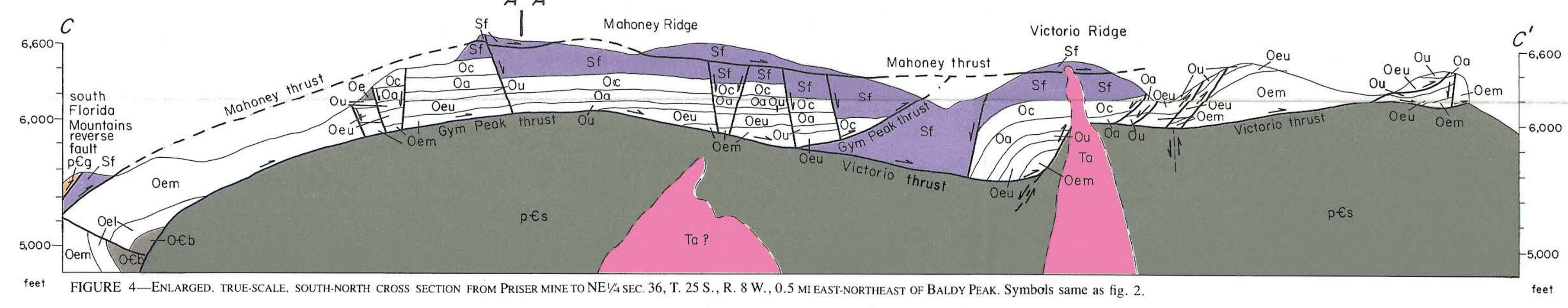
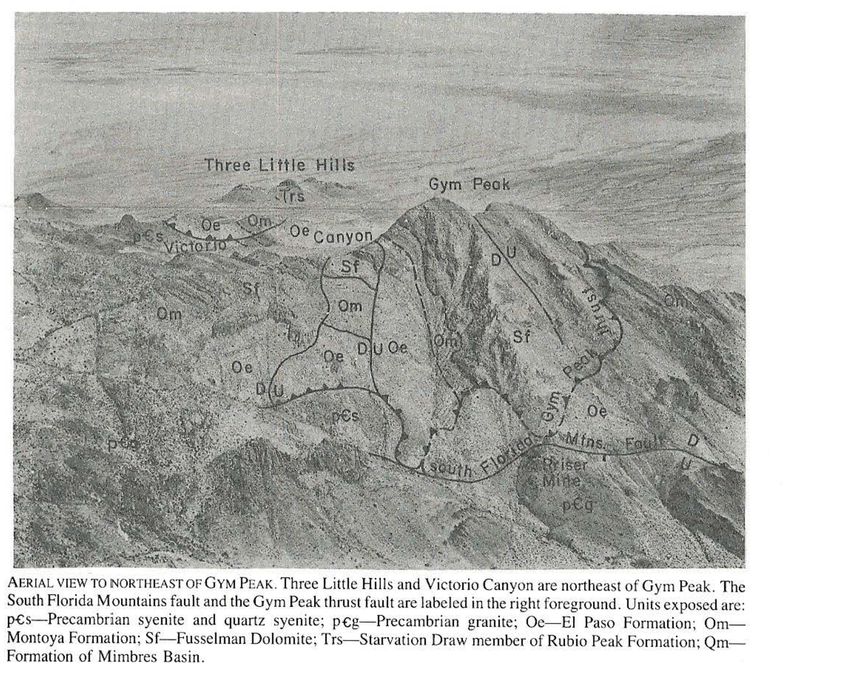


FIGURE 4—Enlarged, true-scale, south-north cross section from Priser mine to NE¼ sec. 36, T. 25 S., R. 8 W., 0.5 mi east-northeast of Baldy Peak. Symbols same as fig. 2.



Aerial view to northeast of Gym Peak. Three Little Hills and Victorio Canyon are northeast of Gym Peak. The South Florida Mountains fault and the Gym Peak thrust fault are labeled in the right foreground. Units exposed are: p€s—Precambrian syenite and quartz syenite; p€g—Precambrian granite; Oe—El Paso Formation; Om—Montoya Formation; Sf—Fusselman Dolomite; Trs—Starvation Draw member of Rubio Peak Formation; Qm—Formation of Mimbres Basin.

Geology of Gym Peak quadrangle, Luna County, New Mexico

by Russell E. Clemons and Glen A. Brown, 1983

scale 1:24,000

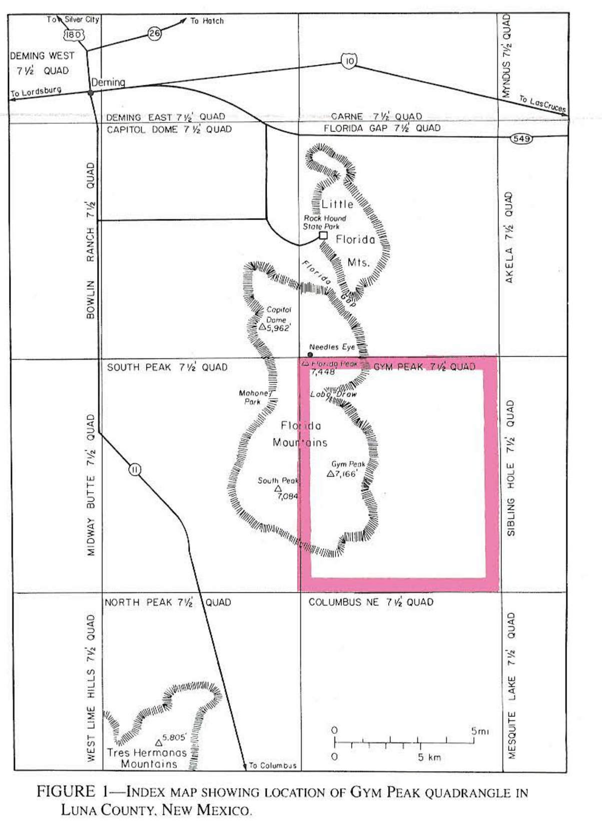


FIGURE 1—Index map showing location of Gym Peak quadrangle in Luna County, New Mexico.

TABLE 1—Summary of quartz-potassium feldspar content in plutonic rocks of the Florida Mountains.

	Number of thin sections	Quartz (%)		K-feldspar (%)	
		range	avg.	range	avg.
Syenite	46	0–4	3	68–93	84
Quartz syenite	47	5–19	11	58–87	78
Granite	42	20–43	28	47–75	62
Aplite	8	19–32	27	37–72	62

INTRODUCTION

Gym Peak quadrangle is in east-central Luna County, approximately 15 mi southeast of Deming (fig. 1). An all-weather gravel road through Florida Gap to Lobo Draw provides ready access to the northwest part of the quadrangle. Dirt roads from Lobo Draw and from NM–549 (to the northeast) and NM–11 (to the southwest) to cattle tanks and windmills provide access to the eastern and southern parts. A steep, 4-wheel-drive road from Mahoney Park to the crest of the Florida Mountains provides relatively easy access to Gym Peak and the area to the west. A locked gate crosses this road, and permission for entry should be obtained from Gene Cook in Deming.

The southeast part of the Florida Mountains occupies the northwest third of the Gym Peak quadrangle. Pediment and alluvial fans extend eastward and southward into the Columbus section of the eastern Mimbres Basin. Elevations range from 4,010 ft, in the southeast corner of the quadrangle, to 7,166 ft on Gym Peak and 7,448 ft on Florida Peak.

The Gym Peak quadrangle was included in Darton's (1916) geologic map of Luna County and in the Deming Folio (Darton, 1917b). Kelley and Bogart (1952) and Bogart (1953) provided detailed descriptions of Paleozoic rocks exposed near Gym Peak. Griswold (1961) included generalized descriptions of the geology and mines in his report on the mineral deposits of Luna County. Corbitt (1971) mapped the Florida Mountains, and other publications, based at least in part on this work, have been by Corbitt (1974), Corbitt and Woodward (1970, 1973a, 1973b), Brookins and Corbitt (1974), Brookins (1974a, 1974b, 1980a, 1980b), Brookins and others (1978), and Woodward and DuChene (1981). Brown (1982) mapped and described in detail the stratigraphy and structure of the Mahoney Park–Gym Peak area (fig. 1). Discussions on the relationships of rocks exposed in the Gym Peak quadrangle to surrounding areas are also included in Armstrong and Mamet (1978), Clemons (1982a, 1982b), Darton (1917a, 1928), Flower (1953a, 1953b, 1965), Greenwood and others (1970), Hawley (1981), Howe (1959), Jicha (1954), Kottlowski (1957, 1958, 1960, 1962, 1963, 1965, 1971, 1973), Kottlowski and Foster (1962), Kottlowski and Pray (1967), Kottlowski and others (1969a, 1969b), LeMone (1974), Lochman-Balk (1958, 1974), Loring and Armstrong (1980), Loring and Loring (1980), Lemley (1982), Thompson and Potter (1981), Wilson and others (1969), and Woodward (1970).

This report is the result of detailed geologic study conducted during 1981 and 1982 and is the third phase of a comprehensive geologic and mineral-resource investigation of the Florida Mountains. Phase one is presented as a geologic map of the Florida Gap quadrangle (Clemons, 1982b, 1982c); phase two is a geologic map of the Capitol Dome quadrangle (Clemons, in press). A geologic study of the South Peak quadrangle (phase 4) will be completed in 1982–83, followed by a comprehensive report on the geology of the Florida Mountains (phase 5).

Igneous rock names used in this report follow the I.U.G.S. classification of Streckeisen (1976, 1979). Sedimentary rocks are named according to Folk (1974).

STRATIGRAPHY

Precambrian rocks

Alkali-feldspar syenite, quartz alkali-feldspar syenite, and alkali-feldspar granite are the most extensively exposed bedrock in the Gym Peak quadrangle. Syenite and quartz syenite are prevalent north of the south Florida Mountains reverse fault, and granite with abundant diorite and meladiorite xenoliths prevails south of the reverse fault. Clemons (1982a, 1982d) summarized previous work done on these rocks and presented evidence for their Precambrian age.

Braid and string perthite is the predominant mineral in the granite and syenites. Microcline and orthoclase are locally common, but typically subordinate. All potassium feldspars are kaolinized and most show sericitization. Plagioclase more calcic than albite was observed in only one thin section of granite. Quartz with moderate to strong undulose extinction ranges to a maximum of 43% (table 1). The feldspars and quartz are commonly fractured, and alteration products of iron oxides, chlorite, epidote, and carbonate form fracture fillings. The primary mafic mineral in the less-altered alkalic rocks is predominantly hastingsite with minor biotite. The majority of thin sections examined contain secondary-alteration products that probably replaced the hastingsite and biotite. Most plutonic rocks in the central part of the Florida Mountains are jointed and sheared, and contain abundant hematite and limonite. Zircon, apatite, and magnetite are common accessory minerals. Aplite (fine-crystalline hastingsite, alkali-feldspar granite) dikes are common throughout the syenite and quartz-syenite outcrops. These dikes, which vary in width from a few inches to tens of feet and in attitude from vertical to horizontal, generally have gradational contacts with the host rock. They apparently represent late crystallizing phases of the quartz-syenitic magma. Alkali-feldspar syenites beneath horizontal or nearly horizontal aplite dikes are much more altered than the aplites or alkali-feldspar syenites above the aplites. This may be due to damming of ascending hydrothermal fluids beneath the less porous aplites.

The Barite of America Co. recently excavated a 775-ft tunnel about 1 mi southeast of Florida Peak in the extreme northwest corner of sec. 30, T. 25 S., R. 7 W. A horizontal, 900-ft, 2-inch diameter core was taken from the end of the tunnel. Thin-section and hand-specimen study of alkali-feldspar syenite and quartz alkali-feldspar syenite core samples showed: 1) approximately half of the core consists of intensely brecciated and altered rocks, 2) only three samples contained recognizable hastingsite—the rest have chlorite, epidote, and carbonate replacing hastingsite(?), 3) many of the microscopic- and megascopic-breccia zones contain carbonate minerals, fluorite, and barite, and 4) pyrite and chalcopyrite coat some of the fracture surfaces as well as being present in some breccia veins.

West of Copper Kettle Canyon, the granite below an elevation of about 6,000 ft contains abundant, large (up to 50 ft) xenoliths of diorite, diorite porphyry, and meladiorite. These mafic rocks locally comprise 50% of the outcrops in Box Canyon and along the ridge between Box and Copper Kettle Canyons. The diorites typically contain subequal amounts of intermediate plagioclase and hornblende totaling approximately 80%–90% of the rock. Biotite, pyroxenes, alteration products, and accessory zircon, apatite, sphene(?), and magnetite of varying proportions total 10%–20%.

A depositional contact of arkosic Bliss Sandstone on coarse quartz alkali-syenite is well exposed in the north-central part of sec. 6, T. 26 S., R. 7 W. The contact can be traced from the arroyo, northward up the slope for a couple of hundred feet before it is truncated by a low-angle thrust fault. Another well-exposed depositional contact between Bliss Sandstone and syenite is located in the central to west-central parts of the same sec. 6 on the northeast slope of Gym Peak. At this locality, the basal Bliss Sandstone is a cobble conglomerate composed of well-rounded syenite and quartz-syenite clasts. Granite is nonconformably overlain by Lobo Formation conglomerates along the southwest side of Copper Kettle Canyon. Lobo Formation nonconformably overlies syenite and quartz syenite near the northwest corner of the quadrangle in the vicinity of Lobo Draw. Elsewhere in the Gym Peak quadrangle, contacts between plutonic rocks and lower Paleozoic rocks are low-angle thrust faults (Brown, 1982).

Paleozoic rocks

Bliss Sandstone (*O€b*) — The Bliss Sandstone crops out at the base of the Paleozoic section in the center of sec. 36, T. 25 S., R. 8 W. on the western edge of the quadrangle and on the north and south slopes of Victorio Canyon, north of Gym Peak.

The Bliss is primarily an arkosic sandstone with hematite cement. Basal beds are locally conglomeratic, with clast composition reflecting source in the underlying syenitic to granitic basement. Compositional trends upsection include: 1) a decrease in feldspathic content, grain size, and hematite cement, and 2) an increase in carbonate, which mainly replaces hematite as a cement. Thus, lithologies grade from hematitic arkose upward to calcareous sandstone. Bliss strata are conformable with overlying silty dolomites of the lower El Paso beds, and the contact is arbitrarily assigned where carbonate predominates over sand content.

Thickness of the Bliss Sandstone varies due to relief on the Precambrian surface. Locally, east of Mahoney Park, the Bliss pinches out and El Paso strata rest nonconformably on Precambrian rocks. The Bliss, which was measured as 110 ft thick north of Gym Peak but ranges from 0 to 125 ft in the quadrangle, is absent over much of the area between Gym and Baldy Peaks due to tectonic elimination along thrust faults.

The Bliss typically forms a gentle, pale-reddish slope that is readily distinguished by its distinct bedding from underlying, massive, crystalline Precambrian rocks and is overlain by gentle slopes and dark ledges of silty dolomite in the lower El Paso Formation.

Regional aspects of the Bliss Sandstone, including its occurrence in the Florida Mountains, were described by Flower (1953a, 1953b, 1965), Hayes (1975), Kottlowski (1963), LeMone (1969b), and Thompson and Potter (1981). The Bliss is diachronous; it appears to be younger to the east, owing to regional onlap of the Precambrian. In the Florida Mountains its age is believed to be Late Cambrian (Dresbachian–Trempealeauan)–Early Ordovician (Canadian).

El Paso Formation (*Oe*) — El Paso Formation outcrops occur throughout the west-central map area but are best exposed northeast

(text continued on back)

of Gym Peak. Elsewhere, tectonic complications make stratigraphic relations obscure. In extreme cases of tectonic elimination, the entire El Paso Formation is missing and Montoya Formation or Fusselman Dolomite rest in fault contact on Precambrian plutonic rocks.

Lochman-Balk (1958, 1974) studied the El Paso Group at Capitol Dome, in the northwest Florida Mountains, and described informal lower, middle, and upper units. In the southern part of the Florida Mountains, Brown (1982) was able to utilize these three informal units while mapping at a scale of 1:6,200; however, these units could not be mapped at smaller scales. Flower (1965, 1969) and LeMone (1969b), in detailed stratigraphic studies, subdivided the El Paso Group into 10 formations. Their subdivisions could not be mapped even at a scale of 1:6,200. The American Commission on Stratigraphic Nomenclature (1961) specified that formations be mappable at about 1:25,000 scale and that a group consist of two or more formations. Therefore, we recommend usage of El Paso Formation and that the formations named by Kelley and Silver (1952), Flower (1969), and LeMone (1969b) be considered as members or biostratigraphic units.

The lower El Paso unit consists of thin- to medium-bedded, dark-gray, medium- to coarse-crystalline dolomite with biogenic grains. Silty limestone (biomicrite) is present at the base of some sections, but calcareous and silty components decrease upward. The upper part of the unit contains abundant, small (¼ inch diameter), concretionary nodules believed to be of algal origin (Lochman-Balk, 1958, 1974). The lower El Paso, which is 162 ft thick northeast of Gym Peak, forms dark-colored ledges and slopes above the slope of the pale-reddish-brown Bliss Sandstone.

The middle El Paso unit contains 905 ft of thin- to medium-bedded, light- to medium-gray limestones. Textural varieties include micrites, biomicrites, intrasparites, biosparites, and neosparites. Other characteristic features include: ubiquitous, twig-like burrow structures on bedding surfaces; common intraformational conglomerate beds; pale-red, partly dolomitized limestone interbeds; blue-gray, nonbedded, stromatolitic and sponge-reef limestones; sporadic, localized chert developments; and beds with abundant skeletal, oolitic, peloidal, and algal grains. Lochman-Balk (1958, 1974) concluded that repetitive sequences of lithologic subtypes exist due to shifting of facies caused by numerous fluctuations of sea level. The middle El Paso is a bluish-gray, cliff-forming unit beneath the reddish-brown ledges and steep slopes of the upper El Paso.

The upper El Paso unit is lithologically similar to the middle El Paso unit but is characterized by abundant chert in lenses, flattened nodules, and locally continuous beds. Generally, more dark-gray limestone beds occur in the upper unit than in the middle unit. The upper unit is 193 ft thick northeast of Gym Peak.

Darton (1916) referred to these rocks as El Paso limestone, which had been named by Richardson (1904). Bogart (1953) referred to them as El Paso Formation and Corbitt (1971) remapped them as El Paso Group. Discussions of depositional environments and regional correlations are included in Flower (1953b, 1965, 1969), Hayes (1975), Kottlowski (1963), Kottlowski and others (1969), LeMone (1969a), and Lucia (1969). The Florida Mountains Formation (top formation in El Paso Group) was named by Flower (1964) and a type section described by LeMone (1974) for exposures in the NE¼ sec. 6, T. 26 S., R. 7 W.

The El Paso Formation is diachronous and evidently is younger from west to east (LeMone, 1974). In the Florida Mountains, deposition occurred in shallow marine seas, with probable subaerial exposure at times. The El Paso (Lower Ordovician: Canadian) conformably overlies the Bliss Sandstone and is disconformably overlain by the Montoya Formation.

MONTOYA FORMATION (*Om*) — The Montoya "Limestone" was named by Richardson (1908) for a type locality at the southern end of the Franklin Mountains. Darton (1916) extended usage of the name westward through southern New Mexico including the Florida Mountains. Montoya Limestone was later subdivided into three members by Entwistle (1944). Kelley and Silver (1952) raised the Montoya to group status and named four formations within it: *Cable Canyon Sandstone, Upham Dolomite, Aleman Formation,* and *Cutter Formation*. The several previous nomenclatures were summarized by Pratt and Jones (1961). Hayes (1975) noted that Kelley and Silver's terminology is well established and should be used despite the fact that Entwistle's names had priority.

The four subdivisions of the Montoya named by Kelley and Silver (1952) are easily recognized in the Gym Peak quadrangle. None of the units are thick enough to be shown at the scale of the map (1:24,000), so they are designated as members of the Montoya Formation (Pratt and Jones, 1961; Kottlowski, 1963).

The erosional contact with the underlying El Paso strata is sharp and nearly parallel, with negligible relief. The Cable Canyon Sandstone represents a basal, transgressive, clastic phase of marine deposition. In many places, it changes to a distinctive sandy dolomite or limestone zone. The sandy zone is easily recognized by well-rounded, frosted, quartz grains weathering in relief on exposed surfaces. A small percentage of quartz grains exhibit a characteristic bluish tint when examined under 10× hand lens. The sand fraction decreases rapidly upsection and is generally absent 10 ft above the base. The contact with the overlying Upham is transitional.

The Montoya dolomite members were formed as a result of irregular dolomitization of marine limestones. Wide, lateral variations in dolomitization are common (Kottlowski, 1963); variations occur over small distances in the Mahoney Park–Gym Peak area. The Upham Dolomite Member contains 50–75 ft of massive, dark-gray, medium-crystalline dolomite that exhibits a mottled and pitted, weathered surface.

The Aleman Member consists of about 125–200 ft of limestone or dolomite with abundant chert. The carbonates are laminated to thin-bedded, buff-gray, fine-crystalline dolomites and dolomitic limestones (pelmicrites, biomicrites, and neosparites). Medium-gray chert occurs in nodules and lenticular beds that weather in contrasting relief and color to the carbonates. Chert may compose up to 30% of a carbonate bed and is most characteristic of the unit. Silicified brachiopods commonly stand out in relief on weathered surfaces.

The basal part of the Cutter Member is characterized by chert-poor, thin- to medium-bedded, medium-gray, dolomitic biosparite and packed biomicrite. Biostromal brachiopod layers, from two to six inches thick, are abundant in the lower beds. The limestones have a distinct mottled appearance on weathered surfaces due to selective dolomitization of burrow fillings and intraclasts. Dolomitization increases upsection until dark-gray dolomites predominate. Light-gray chert, which appears as scattered lenses in the middle of the section, increases upward, becoming lenticular and bedded near the top of the Cutter. The highest bed preserved in the Cutter in the Gym Peak quadrangle is a thin (3 ft), light-gray, finely crystalline dolomite. The Cutter is 181 ft thick south of Gym Peak.

An erosional disconformity is present between the Cutter (Ordovician) and the overlying Fusselman (Silurian). The precise contact is difficult to determine in some places, as noted by other workers in the Florida Mountains (Darton, 1916, 1917b; Bogart, 1953; Corbitt, 1971). This problem is attributed to slight relief of the unconformity, similar lithologies above and below the contact, and local tectonic complications. However, the boundary is recognizable if exposures are fair to good. The light-gray, fine-crystalline dolomite at the top of the Cutter Member is a distinctive marker if it is preserved. If not, the bedded cherts in the upper part of the Cutter may be useful if they are preserved. In addition, the dolomitic beds of the upper Cutter rarely contain fossils, whereas basal strata of the overlying Fusselman commonly display silicified solitary and *Halysites* chain corals on weathered surfaces.

The Montoya formation is assigned a late Middle Ordovician (Red River) to Late Ordovician (late Richmond) age (Flower, 1965; Hayes, 1975). It lies disconformably on a widespread, Middle Ordovician erosion surface representing a hiatus that resulted from gentle uplift and erosion of pre-Montoya strata. In the Florida Mountains, the Montoya is disconformably overlain by Fusselman Dolomite.

FUSSELMAN DOLOMITE (*Sf*) — The Fusselman Dolomite was named by Richardson (1908) for the type locality in the southern Franklin Mountains. Darton (1916, 1917b) extended usage of the name to Silurian rocks in Luna County. Darton misinterpreted Fusselman Dolomite in the Florida Mountains and included it within his Gym Limestone which was named for exposures at Gym Peak. Later stratigraphic study (Keyes, 1940; Kelley and Bogart, 1952; Bogart, 1953); reassigned most of the Gym Limestone as Fusselman Dolomite. The age of Fusselman Dolomite is Silurian, but further refinement is hindered due to poor fossil preservation after extensive dolomitization.

Fusselman Dolomite is best exposed on the east and southeast slopes of Gym Peak. The Fusselman is extensively exposed in a band across the mountains to Mahoney Park, but faulting complicates stratigraphic relationships, and it is completely brecciated along the crest of the range.

The Fusselman Dolomite is composed of medium- to massive-bedded, alternating light- and dark-gray, fine to coarsely crystalline dolomite. Although variations occur within each unit, the Fusselman in the Florida Mountains consists of: 1) a lower, dark-gray dolomite (160 ft), 2) a lower, light-gray dolomite (305 ft), 3) a middle, dark-gray dolomite (160 ft), 4) a middle, light-gray dolomite (610 ft), 5) an upper, dark-gray dolomite (165 ft), and an upper, light-gray dolomite (80 ft). One dolomitic sandstone bed occurs 80 ft below the top of the Fusselman southeast of Gym Peak. Chert is generally lacking except for minor beds and nodules near the base and top of the formation. No limestones are preserved within the Fusselman Dolomite, but silicified corals and fossil ghosts are common in several beds. In many parts of the map area, the entire formation has undergone extensive tectonic brecciation, which has obliterated bedding.

The Fusselman Dolomite is 1,480 ft thick on the southeast slopes of Gym Peak. Kelley and Bogart (1952) measured 1,387 ft of Fusselman in Mahoney Park, 1.5 mi west of the Gym Peak quadrangle. Kottlowski (1963) questioned this great thickness and suspected thrust repetition in the section. The Fusselman is overlain disconformably by Percha Shale (Devonian) in the southeastern Florida Mountains.

PERCHA SHALE (*Dp*) — The name "Percha Shale" was first assigned to rocks of Devonian age by Gordon and Graton (1906). Stevenson (1945) designated the type section near Percha Creek, 2.5 mi southeast of Hillsboro, New Mexico. Darton (1916, 1917b) used the term for Devonian strata in mapping the Deming Folio but did not recognize Percha in the Florida Mountains; Darton included Percha as part of his Gym Limestone. Bogart (1953) redefined Darton's Gym Limestone and assigned the shale that crops out in the canyon southeast of Gym Peak to the Percha. Percha Shale also crops out northwestward over the crest of the range along the northeast side of the south Florida Mountains reverse fault. The Percha Shale in southern New Mexico is generally assigned a Late Devonian (Late Famennian) age (Lochman-Balk, 1965). The age is not well documented in the Florida Mountains due to lack of identifiable, diagnostic megafossils.

The Percha Shale is composed of olive-gray to black shale with a one-foot-thick, dark-gray, packed biomicrite bed 10 ft above the base. Because the Percha is poorly exposed, it was mapped generally by relying upon stratigraphic position, characteristic weathered slope, exposures in a few scattered prospect pits, and presence of shale fragments in colluvial deposits. Brown (1982) indicated that the Percha Shale is 249 ft thick southeast of Gym Peak. This measurement is in close agreement with the 236 ft reported by Bogart (1953) at the same locale.

The Percha Shale is recognized as a gentle slope-former above medium- to massive-bedded, light- to dark-gray, cliff-forming Fusselman Dolomite. The Percha is overlain disconformably by thin-bedded, light- to medium-gray, cherty limestone of the Rancheria Formation (Mississippian) which typically forms steep, brown slopes or ledges.

RANCHERIA FORMATION (*Mr*) — Laudon and Bowsher (1949) proposed the name "Rancheria Formation" from Rancheria Peak in the Hueco Mountains of west Texas and designated a type section in the Franklin Mountains, east of Vinton, Texas. Darton (1916), 1917b) used the name "Lake Valley" for Mississippian strata in mapping the Deming Folio but did not recognize their occurrence in the Florida Mountains; Darton instead included the Mississippian beds as part of his Gym Limestone. Later stratigraphic study by Bogart (1953) recognized the occurrence of Mississippian rocks that he assigned, based on Mississippian-age fossils and lithologic similarity, to the Andrecito Member of the Lake Valley Formation. Kottlowski (1958, 1963) noted that the Mississippian in the Florida Mountains is similar lithologically to the Rancheria Formation. Some later workers in the Florida Mountains accepted the usage of the Lake Valley Formation (Griswold, 1961; Corbitt, 1971). Armstrong (1962) indicated that the Florida Mountains section was part of the Hachita Formation (a shelf equivalent of the basinal Rancheria). Yurewicz (1977) located the Florida Mountains section on the Hachita–Rancheria (shelf-basin) boundary, and Armstrong and Mamet (1978) placed the shelf-basin margin just west of the Florida Mountains. We recommend assignment of the Florida Mountains section to the Rancheria Formation based on its lithology and the late Osage–Meramecian age reported by Armstrong and Mamet (1978).

The Rancheria Formation exposed in the NE¼ sec. 18, T. 26 S., R. 7 W. is composed of thin-bedded, interstratified, spiculitic biomicrite, silty micrite, pelneosparite, bioneosparite, and chert. The pelneosparite is silty near its base and develops a pseudo-crossbedded appearance on weathered surfaces. The limestones and cherts are all medium to dark gray but typically weather light gray to brown. Shale breaks are abundant low in the section, and chert content increases upsection to nearly 50% at the top. A thickness of about 220 ft of Rancheria was measured on the south slope of the canyon, 1 mi southeast of Gym Peak. This is comparable to Bogart's (1953) measured value of 196 ft.

HUECO LIMESTONE (*Ph*) — The Hueco Formation was named by Richardson (1904) for the type section in the Hueco Mountains in west Texas. Darton (1916, 1917b) also included the Permian rocks south of Gym Peak in his Gym Limestone. Bogart assigned the name Hueco to these rocks based on lithologic similarity and a study of gastropod fauna interpreted to be nearly identical to the Permian (Wolfcampian) Hueco fauna (Bogart, 1953). The Hueco disconformably overlies the Rancheria Formation in the Gym Peak quadrangle and is angularly overlain by Lobo Formation (Upper Cretaceous–lower Tertiary?).

The Hueco Limestone consists of medium- to massive-bedded, dark-gray, light- to medium-gray-weathering biomicrites, bioneosparites, and biosparites. Chert development is restricted to a few scattered, brown nodules. The Hueco is fossiliferous and abundant, large bellerophon gastropods are characteristic of this unit. Scattered, silicified, high-spired gastropods, solitary corals, brachiopods, and echinoid fragments are common. Reddish-brown siltstone (Abo?) near the top of the section interfingers with limestone, and 30 ft of red shales form the top of the Paleozoic section.

Total thickness of the Hueco is difficult to determine due to fault complications. Bogart (1953) measured 548 ft but apparently failed to note thrusting within the Hueco. The thickness of 433 ft measured during this study is considered a minimum.

Mesozoic(?)–Cenozoic rocks

LOBO FORMATION (*TKl*)—The Lobo Formation was named by Darton (1916) for the type locality at Lobo Draw in the northwest Gym Peak quadrangle. Darton (1917b) also mapped the Lobo Formation in the Cooke's Range, Fluorite Ridge, and later in the Victorio Mountains (Darton, 1928). Jicha (1954) and Kottlowski (1958, 1963) recognized that the Lobo of the Cooke's Range was Abo Formation (Permian). The Fluorite Ridge section also was reassigned by Clemons (1982e) as Abo Formation because of proximity and similarity to the outcrops in the Cooke's Range. Lemley (1982) concluded that the Victorio Mountains section is not correlative with the Lobo Formation in the Florida Mountains and thus, the Lobo is restricted in known occurrence to the Florida Mountains area. It probably is present in the subsurface of adjacent areas.

The type section on the north side of Lobo Draw in the SW¼ sec. 19, T. 25 S., R. 7 W. has a measured thickness of 512 ft (Lemley, 1982). The Lobo rests on Precambrian quartz syenite and is overlain by Rubio Peak Formation volcaniclastic rocks of late Eocene age. Basal, channel-shaped conglomerates contain abundant clasts of limestone, chert, sandstone, and syenite. Above the basal unit, the Lobo is thin- to medium-bedded, light-gray, calcareous siltstone and sandstone interbedded with yellowish-brown mudstone and sandstone, red mudstone, and pebble conglomerate. Lower beds are very coarse grained and arkosic, reflecting derivation from the underlying quartz syenite. The section shows a general fining-upward sequence, with siltstones and interbedded fine sandstones increasing in abundance towards the top of the section, with a cap of massive, silty micrite. No fossils were found in the section, but a few, small, vertical burrows (1 cm in diameter) are present. The uppermost siltstones and mudstones of the Lobo also crop out along the southwest base of Three Little Hills, 1.5 mi southeast of Lobo Draw. Approximately 2.6 mi south of Three Little Hills, the Lobo Formation consists of 490 ft of cobble to boulder conglomerate. Rounded clasts of limestone, dolomite, siltstone, sandstone, chert, syenite, and granite are in a reddish-brown, sandy mud matrix.

Darton (1916) tentatively assigned the Lobo a Triassic age. Kottlowski (1958) and Kottlowski and Foster (1962) believed that the type Lobo was probably of Early Cretaceous age. Griswold (1961) concurred with the Early Cretaceous age and Hayes (1975) referred to the Lobo as Cretaceous in age. Dane and Bachman (1965) considered the Lobo to be Early Cretaceous(?) or Tertiary(?) as did Corbitt (1971, 1974), although he favored a Tertiary designation. Clemons (in press) considered the Lobo Formation in the Florida Mountains to be of Late Cretaceous–early Tertiary age. Lemley (1982) interpreted the Lobo Formation to be a non-marine, syntectonic, clastic wedge that was deposited in response to Laramide deformation in the Florida Mountains. This interpretation is supported by the following field observations: 1) Lobo Formation in the southeast Florida Mountains rests in angular unconformity on Permian Hueco strata that were homoclinally tilted during or possibly before Laramide deformation; 2) clast-composition trends in the Lobo reflect unroofing of uplifted Precambrian and Paleozoic rocks; 3) basal Lobo contains clasts of sparry calcite veins that probably formed during Laramide deformation; 4) Lobo Formation conglomerates are displaced by the south Florida Mountains reverse fault, and 5) thin-bedded shales and siltstones of Lobo Formation near Capitol Dome are undeformed whereas underlying Paleozoic beds are intensely deformed, presumably by Laramide stresses. Lemley (1982) reported an early Tertiary paleomagnetic assignment for a few samples collected from the Lobo at Capitol Dome.

Evidence obtained while mapping the Florida Mountains and current study of the Lobo Formation by Greg Mack (personal communication, 1983) indicate that the Starvation Draw member in the Massacre Peak quadrangle and the Lobo Formation in the Florida Mountains probably are correlative. Both units were deposited in response to, and adjacent to, Laramide uplifts. Clast lithology in both units reflects unroofing of fault blocks and sediment-size distributions indicate fining-upward and basinward sequences. Volcanic detritus, absent in the basal beds, are present in upper parts of both the Lobo Formation and Starvation Draw member. Therefore, use of the name "Starvation Draw member" should be discontinued.

RUBIO PEAK FORMATION (*Trs*) — Volcanic arenites assigned to the Starvation Draw member (Clemons, 1982e) of the Rubio Peak Formation form the high, rugged Florida Peak, the area to the east in the northwest corner of the Gym Peak quadrangle, and most of the Three Little Hills. Approximately 1,600 ft of conglomerate, sandstone, and tuffaceous breccia rest with slight angular unconformity on the Lobo Formation. This angular unconformity is represented in the Gym Peak quadrangle by a poorly indurated, basal Rubio Peak boulder conglomerate lying on slightly channeled Lobo red mudstone. Rubio Peak rocks consist predominantly of material derived from andesitic to dacitic tuffs and lavas, with lesser amounts of basalt clasts. Beds are chiefly fluvial deposits, but laharic and and talus(?) deposits are common in the lower part.

The basal conglomerate is composed of subangular to well-rounded clasts, up to boulder size, of limestone, cherty limestone, Bliss Sandstone, Precambrian granite and syenite, and volcanic rocks in a tuffaceous, sandy matrix. The conglomerate is overlain by a thick sequence of interbedded sandstone, and polylithic breccia with volcanic clasts up to several feet in size. Bedding is commonly thick to massive and in many places obscure. Clast size generally decreases upward through the sequence so that the upper beds are fine- to medium-grained sandstones with a few interbedded pebble conglomerates. The sandstones are intensely propylitized, very poorly sorted, plagioclase-rich, volcanic arenites with microcrystalline quartz cement. Epidote alteration is common throughout the Rubio Peak sequence.

Darton (1916, 1917b) Lochman-Balk (1958, 1974), and Corbitt (1971) mapped these rocks as Tertiary volcanic agglomerate. Clemons (1982c) tentatively correlated them with the informally named Starvation Draw member of the Rubio Peak Formation (middle to late Eocene) in the Massacre Peak quadrangle, approximately 20 mi to the north.

DIKES (*Ta, Tb, Tr*) — Basaltic andesite, fine-grained diorite (andesite), and very light gray rhyolite dikes intrude Rubio Peak and older rocks in the western third of the quadrangle. All of the dikes and small plug-like rocks have been altered. Plagioclase is sericitized and saussuritized; hornblende(?) is replaced by chlorite, carbonate, epidote, and quartz. The rhyolite is aphanitic holocrystalline and composed of orthoclase and quartz, with minor muscovite, magnetite, and pyrite. Manganese-oxide coatings are pervasive on fracture surfaces.

The basaltic-andesite and rhyolite dikes have predominant east and northeasterly trends. They are typically 4–8 ft thick but pinch and swell from zero to as much as 20 ft. These dikes apparently intruded en echelon fractures and faults. Several small, plug-like intrusions of fine-grained diorite cut Fusselman Dolomite between Gym and Baldy Peaks and one transects Precambrian syenite, northeast of Baldy Peak.

The basaltic-andesite dikes have not been dated but are thought to be correlative with youngest Rubio Peak Formation rocks (approximately 37 m.y.). A feldspar concentrate from rhyolite of the White Hills, 4 mi west of Florida Peak, yielded a K-Ar age of 29.1 ± 1.3 m.y. This rhyolite is identical to that forming the long, conspicuous dikes crossing the mountains. The diorite intrusives are post-Laramide in age (Brown, 1982) and may be contemporaneous with Miocene volcanism in the Little Florida Mountains (Clemons, 1982c).

FORMATION OF MIMBRES BASIN (*QTm* and *Qm*) — An informal name is used for this formation until current mapping projects in the basin are completed (Clemons, 1982c). The formation is part of a unit that has been previously mapped as Gila Group. The piedmont-slope facies of the formation of Mimbres Basin is composed of mostly alluvial-fan and coalescent-fan deposits and includes thin, colluvial veneers on pediment surfaces. *Qm* is correlative with the Camp Rice Formation piedmont facies (Seager and Hawley, 1973) in south-central New Mexico and *Qlp* in part of southwest New Mexico (Seager and others, 1982). *QTm* is correlative in part with the basal Camp Rice Formation (Seager and Hawley, 1973) but includes some Pliocene-age strata. Remnants of colluvial veneers and well-developed alluvial fans cemented with caliche are present in the southwest and central parts of the quadrangle.

QUATERNARY ALLUVIUM — The geology for the eastern half of the Gym Peak quadrangle was in large part interpreted from aerial photographs and maps with soil descriptions in the Soil Survey of Luna County, New Mexico (Neher and Buchanan, 1980).

Older piedmont-slope alluvium (*Qpo*) is similar in composition to the formation of Mimbres Basin piedmont-slope facies in that it invariably reflects the lithology of local source areas. *Qpo* includes arroyo-terrace and fan deposits and thin (less than 10 ft) veneers on erosion surfaces, generally of late Pleistocene age. Thin soil horizons and weak soil-carbonate accumulations are present in most sections. Arroyo channel, terrace, and fan deposits associated with modern arroyos (*Qpy*) range in age from late Wisconsinan to the present (less than 25,000 yrs B.P.). These and the late Pleistocene deposits are products of repeated episodes of arroyo-valley and partial back-filling (Seager and others, 1975). Zones of soil-carbonate accumulation are weak or absent in the Holocene (less than 10,000 yrs) deposits. An undifferentiated piedmont unit (*Qpa*) is used in areas where *Qpo* and *Qpy* deposits did not warrant mapping separately.

Colluvial and alluvial deposits (*Qca*) have been mapped on slopes where they form a nearly continuous cover on older units. These deposits are generally less than 10 ft thick. As expected, the deposits reflect the lithology of nearby higher slopes and ledges. Most of the mapping unit is of an age equivalent to older and younger piedmont-slope alluvium (*Qpo* and *Qpy*). Locally, *Qca* may correlate with the younger piedmont-slope facies of the Mimbres Formation (*Qm*).

Basin-floor sediments (*Qbfy*) cover an extensive area to the east of the Gym Peak quadrangle and extend into the eastern part of the quadrangle. They include loamy to clayey alluvium deposited by distributaries of the Mimbres River and the Florida Mountains arroyos in an area essentially unaffected by arroyo incision. The deposits are typically void of gravel, but sporadic, intertonguing gravelly lenses were deposited by flooded arroyos from the Florida Mountains and ancient Mimbres River floods. This unit is approximately correlative to *Qpy*.

Eolian sand (*Qs*) covers a long narrow area along the margin of the piedmont slope and basin floor, east and southeast of the mountains. The dunes are generally less than 10 ft high and most are somewhat stabilized by desert vegetation. Nearby exposures generally warrant using a double map symbol to indicate the underlying unit, such as *Qs/Qpa*.

STRUCTURAL GEOLOGY

The following sections describe major structural features within the Mahoney Park–Gym Peak area. These include the south Florida Mountains reverse fault, and the Victorio, Gym Peak, and Mahoney thrust faults. The thrust faults are described following the south Florida Mountains reverse fault. Movement on the south Florida Mountains reverse fault is interpreted to have generated three levels of imbricate thrusting within the Paleozoic rocks (figs. 2–4); the Victorio, Gym Peak, and Mahoney thrusts are named for the lower, middle, and upper levels, respectively. The Victorio thrust fault is the most difficult to document as a thrust fault; demonstration of actual thrusting is inferred through the Victorio thrust fault's attitude and similarity to the well-documented Gym Peak and Mahoney thrust faults (Brown, 1982). Mapping the complex structure required more detail than can be shown at the 1:24,000 scale of the quadrangle map. Note, for example, the truncated, overturned anticline of Montoya Formation in fig. 3, mapped at a scale of 1:6,200.

South Florida Mountains fault

The most prominent structural feature in the quadrangle is the south Florida Mountains reverse fault. Darton (1917b) described this fault as a thrust fault dipping 40°–70° S. and displacing granite upon the upper beds of his Gym Limestone. Corbitt (1971, 1974) noted that this northwest-trending, steeply-dipping, reverse fault is steep at deep structural levels but flattens abruptly upward; in Mahoney Park, 1.5 mi west of the Gym Peak quadrangle, this flattening appears to be real. In the Gym Peak quadrangle, the average fault attitude strikes N. 50° W. and dips 60° SW. After removal of basin-and-range tilting of about 25°, the original fault attitude strikes N. 50° W. and dips 85° SW.

The fault displaces Precambrian alkali-feldspar granite against various Paleozoic formations and Precambrian quartz alkali-feldspar syenite. Several other secondary reverse (?) faults, probably related to imbrication, are located southwest of the main fault within Precambrian alkali-feldspar granite. Amount of displacement on these faults is unknown.

Southeast of Silver Cave mine, an extensive breccia zone has developed beneath the reverse fault and was mapped separately as a tectonic melange. This melange is a chaotic mixture of variable-sized blocks of Paleozoic rocks as old as Upham Dolomite and as young as Lobo Formation. Also, the middle El Paso Formation beds are locally thrust over the Fusselman Dolomite near the Priser and Silver Cave mines. These relations justify assigning the thickness of the Paleozoic section (4,108 ft) as a minimum stratigraphic separation on the Florida Mountains reverse fault. W. R. Seager (personal communication) pointed out that the early Paleozoic beds east and south of Gym Peak show a continuous change in strike from nearly north, 2 mi northeast of the fault, to due east adjacent to the fault, suggesting significant right-lateral movement. Similar relations in bedding attitudes in Mahoney Park to the west may have been caused by drag as the north block moved eastward relative to the south block. The syenites north (down) of the fault and granite south (up) of the fault are believed to be consanguineous. Their present positions are more easily explained by lateral movement on the fault than by only vertical uplifting that placed the granite in juxtaposition with syenite of the same pluton. The wide zones of brecciation that parallel the fault are also suggestive of strike-slip movements. Drewes and Thorman (1980a, 1980b) and Thorman and Drewes (1979, 1980, 1981) indicated lateral movements on several faults with similar trends that they mapped to the west. However, they indicated possible left-lateral movements on some of the faults.

Southwest of the reverse fault (in SE¼ sec. 2, T. 26 S., R. 8 W.) a small outcrop of Rubio Peak Formation (Eocene) rests on the upthrown Precambrian granite block. This relationship proves that by Rubio Peak time (latest Eocene to earliest Oligocene) uplift along the south Florida Mountains reverse fault had resulted in erosion of the upthrown block deep into the Precambrian.

Victorio thrust fault

The Victorio thrust fault (fig. 4) is the lower surface of multiple allochthonous sheets that form Victorio Ridge and Baldy Peak. The Victorio thrust fault overlies the Mahoney Park autochthon and Precambrian basement. The thrust sheet is overlain by both the Gym Peak thrust fault to the south and three klippen remnants of the Mahoney thrust sheet. Three klippen remnants of the Victorio sheet are also preserved northeast of the main sheet (in SW¼ sec. 31, T. 25 S., R. 7 W.) where they rest on Precambrian basement.

The Victorio thrust sheet is an intensely deformed, locally brecciated, complex sheet that places younger strata over older strata (Mahoney Park autochthon) along a highly variable fault surface. The complexities include folding, at the northern end, of the middle and upper units of the El Paso Formation which is surrounded by complicated faulting.

Tectonic elimination of strata is pervasive along the Victorio thrust surface. A notable example is well exposed at the southwest end of the fault (in SE¼ sec. 36, T. 25 S., R. 8 W.) where the Victorio thrust fault merges with the Gym Peak thrust fault. There, the upper El Paso unit rests upon a tectonically truncated section of middle El Paso only 250 ft thick. Comparison with the measured thickness of 905 ft indicates that 655 ft of section is missing. The direct result of this tectonic elimination is an apparent normal fault 0.25 mi to the north. Here, the southward-dipping Victorio thrust fault brought the Montoya Formation upon middle El Paso strata and approximately 200 ft of upper El Paso beds are cut out. Other examples of tectonic elimination are present along the trace of the thrust, where strata ranging from middle El Paso to Fusselman Dolomite rest on Precambrian basement.

The location of the Victorio thrust sheet north of and below the Gym Peak thrust fault suggests that at one time this sheet may have been in the present location of the Gym Peak thrust and was pushed northeast in front of the Gym peak thrust (fig. 4).

Gym Peak thrust

The Gym Peak thrust is here named for the well-exposed, low-angle fault that underlies the upper 1,000 ft of Gym Peak (fig. 3). In the vicinity of Gym Peak, the fault displaces strata ranging from middle El Paso beds to Fusselman Dolomite over Bliss Sandstone to lower Fusselman beds. These younger over older relations are well exposed in a window on the south side of Gym Peak where Fusselman Dolomite rests on El Paso Group and Montoya Formation.

Documentation of thrust fault relations is demonstrated by a large drag fold that is well exposed in the steep cliffs north of Gym Peak. The fold is recumbent with both upper and lower limbs cut by thrust faults (fig. 3). The Upham and Aleman Members are locally repeated three times, with the central Montoya sequence overturned and separated by the thrust faults. Displacement on the upper thrust fault decreases northwestward, and the structure becomes a recumbent anticline with an axial plane slightly inclined to the southwest. Displacement on the complementary lower thrust decreases to the southeast and the structure evolves into a recumbent syncline. The fold attitudes indicate probable generation by a northeast-yielding Gym Peak thrust fault.

The amount of horizontal displacement on the Gym Peak thrust fault may be estimated by analysis of the fold shown in cross section (fig. 3). To restore the rocks of the fold to their original position requires a minimum of approximately 2,000 ft of horizontal movement.

The Gym Peak thrust fault continues northwestward as the lower of two thrust levels below the north side of Mahoney Ridge. East of Mahoney Park, the Gym Peak thrust can be traced southwestward back beneath the south Florida Mountains reverse fault.

Darton (1917b) and Corbitt (1971) described and mapped a large normal fault west of Gym Peak. We interpret this fault as syntectonic with Laramide deformation and not basin and range in origin, because the fault is truncated to the north and south by the Gym Peak thrust fault. The key to understanding development of extensional features within a dominantly compressive stress field comes from consideration of the following relations: 1) trend of the fault is roughly parallel to the direction of maximum compression; and 2) extreme relief changes in the Precambrian basement can localize tensional stress in an overriding allochthonous sheet, analogous to extension across the crest of domes or folds. This relationship of the major normal fault and other similar, minor normal faults is shown in fig. 2. Some of the high-angle faults may be tear faults, but no evidence was found of horizontal movements on these faults.

Mahoney thrust fault

The Mahoney thrust fault is the highest thrust on Mahoney Ridge (in SW¼ sec. 1, T. 26 S., R. 8 W.). East of Mahoney Park, the thrust parallels the south Florida Mountains reverse fault locally as a steep reverse fault (after removal of basin-and-range tilting, the fault is nearly vertical), and it flattens eastward under Mahoney Ridge. The fault trace underlies the higher levels of Mahoney Ridge and marks the lower limit of an allochthonous sheet as much as 500 ft thick. In addition to its occurrence on Mahoney Ridge, the thrust occurs in three isolated klippen to the north. The Mahoney thrust places younger over older strata (figs. 2 and 4).

The Mahoney thrust fault is distinguished from other thrust faults by its lithology, which consists of tectonically brecciated Fusselman Dolomite except for the restricted occurrence of Percha Shale in the immediate vicinity of the south Florida Mountains reverse fault. The Mahoney thrust fault truncates underlying structures, suggesting latest movement postdated movements on lower thrust faults. The second relation may best be explained by imbrication related to movement on the south Florida Mountains reverse fault. Sanford (1959) showed through experimental study that vertical uplift caused successive imbricate thrust slices to develop with higher levels having the latest movements. The analog here is that formation of the south Florida Mountains reverse fault initiated movement on the Gym Peak thrust (which contemporaneously influenced movement on the Victorio thrust), followed by contemporaneous and later movement on the Mahoney thrust.

Mahoney Park autochthon

The partial lower Paleozoic section beneath the Victorio thrust fault south and southwest of Baldy Peak is herein referred to as the Mahoney Park autochthon. Mahoney Park extends from Baldy Peak westward into the South Peak quadrangle. Bliss Sandstone and, locally, El Paso Formation were deposited in this area on Precambrian syenitic rocks as evidenced by nonconformable contacts. Deformation is restricted to four, east-northeast-trending, normal faults, down to the south, that displace Precambrian as well as Paleozoic rocks. The development of these faults explains why these rocks remained autochthonous; thrust faults encountering massive Precambrian basement transferred displacements to higher, more easily deformed levels in the Paleozoic section.

ECONOMIC GEOLOGY

Several significant mineral deposits have been exploited in the Gym Peak quadrangle. The area has proven occurrences of zinc, copper, lead, silver, barite, fluorspar, and manganese. Active mining began in the late 1800's and continued through the early part of this century. Since production ceased, intermittent exploration has failed to locate significant new deposits; this is in part attributable to structural complexities and remoteness that hampered exploration efforts. Large volumes of receptive carbonate rocks combined with known occurrences of mineralization indicate that this area is a favorable target for further exploration. The following descriptions are taken in part from Darton (1916, 1917b), Griswold (1961), Corbitt (1971), and Brown (1982).

Mahoney mines

The Mahoney mines are located on Mahoney Ridge (sec. 1, T. 26 S., R. 8 W.) and are accessible by a four-wheel drive road from Mahoney Park. The mineral claims are the property of Gene Cook of Deming, and permission is required for access and use of the road.

The mine was noted by Darton (1917b) as active in 1914, but date of discovery and earlier work are unknown. Several ore shipments are believed to have been made in 1915–1917 and 1926 (Griswold, 1961, 1974). According to Gene Cook, the ore was hand sorted and assayed at the mines, carried by pack mule to Mahoney Park and then by wagon to Deming for rail shipment. The mines were apparently dormant until the late 1960's when 15 claims were staked by Gene Cook. Recent work included mining of higher grade mine dumps and development of exploratory adits.

The deposit is within the Mahoney thrust sheet. Mineralization is in northeast-trending, near-vertical veins in brecciated Fusselman Dolomite. Locally, the veins are 5 ft wide, but they typically pinch and swell. Past development of the mines included: 1) trenches on veins, 2) several vertical shafts, 3) a long adit that follows a vein southwestward from the base of the Mahoney thrust on the northeast side of Mahoney Ridge, and 4) a short adit developed during the 1970s on the crest of Mahoney Ridge.

Darton (1917b) referred to the Mahoney mines as a zinc deposit and Griswold (1961, 1974) described them as lead-zinc-copper producers. According to Gene Cook, the predominantly zinc-rich ore occurs in localized, high-grade pockets of dry-bone smithsonite with minor associated silver, lead, and copper values. Due to extensive mining, little ore remains for examination. The vein material is highly oxidized and contains smithsonite, cerussite (?), malachite, and azurite as potential ore minerals in a gangue of limonite, quartz, and calcite (Griswold, 1961, 1974). Minor amounts of galena, sphalerite, barite, fluorite, and psilomelane were also noted.

The mineralization is not offset by Laramide deformation and therefore is of Tertiary age. Veins are approximately parallel to normal faults in the Gym Peak thrust sheet below; thus, the faults probably served as conduits for ascending ore fluids and deposition occurred in the chemically and texturally receptive Fusselman Dolomite.

Silver Cave mine

The Silver Cave mine is located at the head of the canyon on the south slopes of Gym Peak (SW¼ sec. 7, T. 26 S., R. 7 W.).

Lindgren and others (1910) mentioned mineral development at the Silver Cave mine but did not visit the area. Darton (1917b) referred to the mine as a silver-lead deposit. The mine was active during the period 1881–1885 and produced 1,800 tons of oxidized silver ore valued at $60,000 (Jones, 1904). Apparently, there has been no production since that time. The mines are covered by two patented claims: the Silver Cave lode (M.S. 644) and the Pocohonta lode (M.S. 632) (Griswold, 1961, 1974).

Mineralization occurs in Fusselman Dolomite on part of the homocline that forms most of Gym Peak. The south Florida Mountains reverse fault, approximately 250 ft to the south, locally brecciated the Fusselman host rock.

A north-trending, inclined adit was used for extraction of ore and access to stopes. Mineralization is in a north-trending, vertical vein. Only small amounts of galena and cerrusite remain in the adit and on nearby dumps. Griswold (1961, 1974) noted a small shaft 150 ft northeast of the incline where some stoping was done on a N. 80° W. fracture zone that contained replacement pods of oxidized lead-zinc ore (cerrusite and smithsonite (?) in a gangue of limonite, calcite, and quartz). This shaft is now inaccessible, but the small mine dumps do not indicate much underground development. Prospect pits are ubiquitous in the hillsides surrounding the mine but no significant mineral occurrences were noted. Mineralization is similar to that on Mahoney Ridge.

Anniversary prospect

The Anniversary prospect is located approximately 1,300 ft southwest of the Mahoney mines (SW¼ sec. 1, T. 26 S., R. 8 W.). The claims are the property of Gene Cook, who filed the six claims in 1970 (Anniversary 1–6). Access is by a four-wheel-drive road that connects with the Mahoney mines road.

A small deposit of fluorite (200 tons, 60% effective grade) was leased and mined by Baily Fluorspar Company of Marfa, Texas which operated a fluorspar shipping terminal in Deming (McAnulty, 1978). The fluorite occurs as open-space filling and replacement of limestone in and near a fault-breccia zone. The deposit was localized near a change in strike of a major high-angle fault that forms the northern boundary of an intricately step-faulted zone continuing southeast for approximately 0.5 mi.

Priser mine

The Priser mine is located on the southwest slopes of Gym Peak near the head of Copper Kettle Canyon (NW¼ SE¼ sec. 12, T. 26 S., R. 8 W.). Access is by four-wheel-drive road through Copper Kettle Canyon.

This mine has not been previously described and examination was restricted to surface exposures because the underground workings were considered unsafe. Manganese and fluorite mineralization were observed on the dumps with manganese predominating. Mineralization occurs in Precambrian plutonic rock that is brecciated and sheared by movement on the south Florida Mountains reverse fault. The size of the mine dumps indicates minor underground development.

Atir mine

The Atir mine is located near the head of Lobo Draw (SE¼ sec. 24, T. 25 S., R. 8 W.). Griswold (1961) referred to this mine as the Waddel prospect. It was renamed and explored by Consolidated Minerals Corp. in 1959.

The Atir mine exploited mineralization in the Lobo Formation along a west-trending, south-dipping, normal fault zone that dropped Lobo down against Precambrian syenite. Development consists of an adit and several winzes on the vein that dips 60° S. The adit is about 170 ft long, with good fluorite-barite-galena mineralization for the first 50 ft and spotty mineralization for another 50 ft; the last 70 ft is mostly syenite gouge. Ore was transported by bucket-cable line down to a crusher located 800 ft below and 2,100 ft east of the mine.

During 1979 and 1980, Barite of America Co. drove a large adit from a point 2,100 ft southeast of the Atir mine through syenite cut by rhyolite and basaltic-andesite dikes in an attempt to intersect the Atir vein at a lower level. The adit trends N. 30° W. for 775 ft. At 600 ft, a branch adit extends 220 ft to the N. 55° E. A 900-ft horizontal drill core was taken in a N. 60° W. direction from the end of the 775-ft adit (Clemons, 1982d). The adits and core transected many small fissure veins, but exploration ceased in 1980, and the prospect is inactive.

Other mines and prospects

Pacheco mine, a manganese deposit located in the NW¼ sec. 24, T. 26 S., R. 8 W., was previously called the Wet King mine. Griswold (1961, p. 128) has this mine mislocated in sec. 13.

San-Tex mine, a manganese deposit located in the SE¼ sec. 31, T. 25 S., R. 7 W., was previously named the White King mine. Griswold (1961, p. 128) has this mine mislocated in T. 26 S.

Birchfield mines are manganese prospects located in the NE¼ sec. 6, T. 26 S., R. 7 W. and SE¼ sec. 31, T. 25 S., R. 7 W.

Birchfield zinc prospect is located in the SW¼ sec. 32, T. 25 S., R. 7 W. A carload of ore was reported to have been shipped from the deposit in 1949.

The manganese mines are reported to have shipped small tonnages during World War II and again in the middle 1950's (Griswold, 1961, 1974).

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