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The Huego (GYM) Limestone, Luna County, New Mexico

Lowell E. Bogart

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BOGART

THE HUECO
[GYM]
LIMESTONE

THE HUECO (GYM) LIMESTONE,
LUNA COUNTY, NEW MEXICO

By

Lowell E. Bogart

A Thesis

In partial fulfillment of the
Requirements for the Degree of
Master of Science in Geology

The University of New Mexico

1953

This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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DATE

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MASTER OF [illegible]

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ABSTRACT

Southwestern New Mexico is characterized by Basin and Range physiography. Nearly level bolson plains are interrupted irregularly by linear mountain ranges. Sedimentary rocks ranging in age from Cambrian to Recent crop out in the mountain areas.

Darton (1916) mapped and described a limestone formation, about 1,000 feet thick, which he named the Gym limestone. He thought the Gym was restricted in outcrop to Luna County and was distinct from previously described upper Paleozoic formations. The Gym was originally thought to be Pennsylvanian in age but later on was regarded as Permian. In the restudy of the Gym limestone which was the basis of this thesis it was found that Darton's Gym included Silurian, Devonian, Mississippian, Pennsylvanian, and Cretaceous (?) rocks in addition to some strata of Permian age.

Outcrops at Gym Peak in the Florida Mountains, the type locality, are Fusselman dolomite (Silurian) and Montoya formation (Upper Ordovician) instead of Gym limestone. On Gym Peak and down the southeastern side into Mine Canyon a thickness of 1,377 feet of Fusselman was measured. This is the greatest thickness of Fusselman yet described. Overlying the Fusselman, 236 feet of Percha formation, 196 feet of slabby Mississippian limestone and shale, and 548 feet of

ABSTRACT

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massive, dark-gray Heuco limestone crop out. These rocks are cut off to the southeastward by high-angle faulting which uplifts Precambrian granite. All of this sedimentary sequence except the lower 50-200 feet of Fusselman was originally included in the Gym limestone. Stratigraphic and paleontologic evidence was sufficient to eliminate from the Gym and reassign all but the massive, gray limestone. This remaining restricted "Gym" is the Hueco limestone of Texas. The fauna of the two formations are identical.

In the Tres Hermanas Mountains all the sedimentary rocks were originally mapped as Gym limestone. The present investigation has revealed the presence of 343 feet of lower Paleozoic limestone and dolomite, 359 feet of probable Mississippian marble, 637 feet of Pennsylvanian (Naco) formation and 190 feet of Hueco limestone.

In the Victorio Mountains the rocks overlying the Montoya formation and underlying the Tertiary agglomerate were originally mapped as Gym. No sections were measured here but lithologic and paleontologic evidence indicates that the "Gym" included a sequence of rocks of probable early Cretaceous age. Although Darton cites Manzano fossils from the Victorio Mountains, the writer was unable to find any fossils or to otherwise find any indication that the Hueco limestone is present.

In Cooks Range 25-30 feet of Gym limestone was previously mapped, locally overlying Pennsylvanian shale and

elsewhere overlying Mississippian limestone. This 30-foot interval contains Pennsylvanian (Des Moines) fusulinids and is in turn overlain by the Lobo formation (Yeso equivalent?). Therefore, no Hueco limestone occurs in Cooks Range.

In the Robledo Mountains a marine limestone, very similar to the Hueco of the Florida Mountains, intertongues with red beds of the Abo or Yeso formation.

The limestone herein called Hueco which crops out in the Florida, Tres Hermanas, and Robledo Mountains, contains a rich fauna that is identical with that of the Hueco of southeastern New Mexico and Texas. The age of the Hueco is lower Permian, Wolfcamp. Correlation of the restricted "Gym" (Hueco) of Luna County, New Mexico with the Hueco of Texas and adjacent areas is, therefore, substantiated.

It is suggested that the name Gym, applied to rocks now shown to be greatly restricted in the stratigraphic column and also in outcrop, be abandoned in favor of the term Hueco.

INTRODUCTION

Geography

The area included in this report is in general the southern half of Luna County, New Mexico and adjacent areas (Fig. 1). Physiographically, it lies in the Mexican Highland section of the Basin and Range Province. The area consists largely of desert bolsons which average about 4,500 feet above sea level. Rising from the bolsons at intervals are several fault-block mountains that range from 2 to 20 miles in length and from a few hundred feet to about 2,500 feet in height. Only those ranges of pertinent interest will be considered here.

Mountains

Cooks Range is the most prominent, with an altitude on Cooks Peak of 8,409 feet. The Florida Mountains, about 10 miles southeast of Deming, form a rugged range that rises 2,500 feet above the surrounding bolsons and has an altitude of 7,400 feet in the northern part. Gym Peak, in the southeastern part of the mountains rises to about 7,200 feet. The Tres Hermanas Mountains are located about 15 miles south of Deming and a few miles southwest of the Florida Mountains. As their name suggests, they are dominated by three prominent peaks. These peaks have an elevation of about 6,200 feet and are surrounded by low rolling hills. The Victorio Mountains are located about 20 miles west of Deming, along U. S. Highways

INTRODUCTION

Geography

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Mountains

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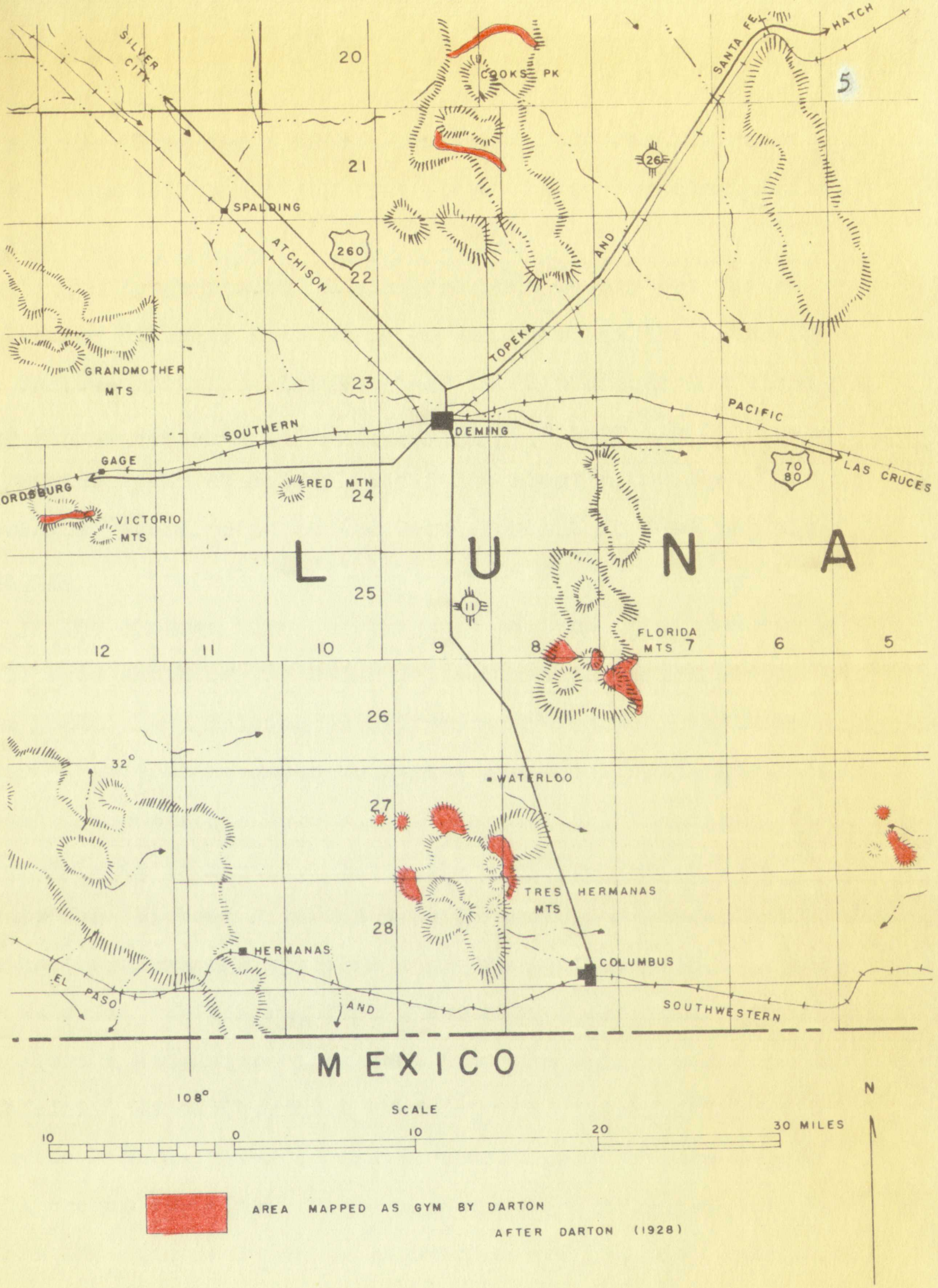

FIGURE 1 Index Map of Luna County

70 and 80. They are a short, southeastward-trending range which rises only about 500 feet above the surrounding plains.

Bolsons

The large plains of southern Luna County are formed by coalescing alluvial fans which spread out from the bases of the various mountain ranges. Near the Rio Grande the elevation of the plain is about 4,000 feet and near the Continental Divide south of Silver City it is about 6,000 feet, showing a general rise to the west of about 20 feet per mile.

Drainage

The Mimbres River drains most of Luna County except a small area south of the Cedar Grove Mountains which slopes into Mexico, and Palomas Arroyo which drains southeastward between the Tres Hermanas Mountains and the Florida Mountains where it turns south across the international boundary into Palomas Lakes in Mexico. Along the northern part of the county the Mimbres River is usually a flowing stream but in its southern reaches it flows only during flash-flood periods. Any water in the Mimbres that flows around the north end of the Florida Mountains disappears into the bolson east of the mountains. Several arroyos draining the Silver City area join the Mimbres River in the northwest part of Luna County. Small creeks from the various mountains are tributary to either the Mimbres River or Palomas Arroyo but they rarely flow water except during periods of excessive rainfall.

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Vegetation

The vegetation of southwestern New Mexico is typical of the kind found in most arid regions. In the Florida Mountains, Cooks Range, and some of the other higher mountains scattered junipers and some small pines are found but the slopes are essentially rocky, supporting mostly sotol, creosote, and various species of cacti. The lower slopes of the mountains support yucca and cacti. Farther down on the alluvial fans scrubby growths of mesquite occur which give way to grasses and shrubs in the center of the bolsons. The mesquite appears as distinct patches of green and the line between these patches and the grass is usually abrupt. There is enough grass to make grazing possible on a limited scale. Near springs and irrigation wells small clumps of cottonwoods grow. With the development of ground water in the bolson south of Deming, farming has become rather extensive. Cotton is grown most widely but small amounts of corn, alfalfa, cane, and beans are also grown.

Climate

The climate in southwestern New Mexico is included in the climatic belt extending from western Texas into southwestern California. The winters are generally mild and the summers are hot but the excessive aridity makes the heat much more tolerable than in a moist climate. Inasmuch as the bolson area averages about 4,500 feet above sea level, the heat is less intense than in the lower parts of the Southwest.

The rainy season is in July, August, and September. The rainfall, however, is moderate, averaging about 10 inches a year in the lowlands and considerably more in the mountain ranges. For nearly 300 days of a year the sun shines for a greater part of the day. The mean annual temperature is about 60°.

Nature of the Problem

The problem in this report was brought to the attention of the writer by Dr. V. C. Kelley of the University of New Mexico. The question arose as to what the Gym limestone was, what it correlated with, and why Darton had originally assigned to it a new name. When Darton described the Gym he thought it was Pennsylvanian in age but, apparently to him, the limestone did not resemble the Magdalena formation, a widely used name for Pennsylvanian rocks of New Mexico. Since Darton's original work the Gym limestone has been placed in the Permian. The nature of the problem was to determine the age of the Gym limestone and with what formation it correlates.

The field work consisted of a detailed examination of all the areas Darton mapped as Gym limestone (Fig. 1). Stratigraphic sections were measured in an attempt to establish the sequence of formations. Faunal collections were also made in order to determine the age of the rocks.

The Gym fauna was well preserved by silicification of

The rainy season of July, August, and September [illegible] the rainfall, however, is [illegible] year in the lowlands and [illegible] rapidly than in the mountain ranges. [illegible] nearly 200 days of the year. [illegible] greater part of the [illegible] about 60°.

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the fossils in the limestone so that etching with hydrochloric acid produced free and fairly complete specimens for identification. The etching was done by immersing blocks of limestone in a solution of 20 parts of water to one part of concentrated hydrochloric acid until effervescence stopped. The solution was then changed and the process repeated until the silicified fossils were completely free of limestone. The more delicate forms were protected during the etching process by adding collodion to the surface of the fossil. About a week of continuous etching was needed to obtain a fairly complete collection of the fauna.

During the course of the field work, it became evident that errors had been made by Darton in mapping the formations. Consequently, some changes in the geologic mapping have been included on a generalized map of the principle areas of outcrop (Fig. 2, in pocket). The Tres Hermanas Mountains were purposely not shown on this map because Dr. Robert Balk, of the New Mexico Bureau of Mines and Mineral Resources, is now engaged in mapping and describing in detail this mountain range.

Finally, correlation of the Gym limestone and contiguous formations was attempted. This correlation is shown by graphic sections in the Florida and Tres Hermanas Mountains (Fig. 3, in pocket).

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[illegible] general [illegible] and [illegible] graphic sections [illegible] (Fig. 3, [illegible]).

Previous Work

In 1916 Darton named the Gym limestone from exposures at Gym Peak in the Florida Mountains and summarized (p. 35) the occurrence in southern New Mexico as follows:

> "In the central and southeastern portions of the Florida Mountains and the central portion of the Victorio Mountains and extending part way around the north end of the Tres Hermanas Mountains there is a thick series of limestones to which it is proposed to apply the name Gym limestone, from Gym Peak, where the formation is extensively exhibited. The formation constitutes the summits of the high ridges at and northwest of Gym Peak and the two ridges west of The Park, and it extends down and along the east slope of the mountain east of Gym Peak."

Also in this report on the Gym Darton (p. 38) has this to say about the fauna:

> "Fossils were found in various parts of the Gym limestone, and while most of them are stated by G. H. Girty to be distinctive of the Manzano group of the Pennsylvanian series they do not afford a sufficiently definite basis for correlation with any formation of that group in central New Mexico, nor do they indicate how much of the group is represented. Some of the gastropods strongly suggest the Hueco fauna."

The original definition and description of the Gym were essentially repeated in the Deming Folio (Darton, 1917a, p. 5). In this report Darton (p. 1) suggests a correlation of the Gym with the Hueco.

In a later paper Darton (1917b, p. 31) lists the names and thicknesses of 'Carboniferous' formations from several localities in southern New Mexico. These formations are given in the table below.

Locality	Formation	Thickness (feet)
Franklin Mountains	Hueco	1,200
Florida Mountains	Gym	1,000-1,200
Cooks Range	Gym Magdalena	30 40
Silver City	Magdalena Fierro	200 800
Caballo Mountains	Magdalena	600
Lake Valley	Magdalena	200-300

Concerning the Gym, he (1917b, p. 54) goes on to say that

> "The formation has not been recognized outside of Luna County, although doubtless it is represented in the Manzano and Hueco sections in other areas...In the San Andres and Sacramento Mountains and farther north in New Mexico the supposed equivalent of the Gym limestone is separated from the Magdalena group by a thick series of red beds (Abo sandstone) but these beds are lacking in the southwest corner of the State and also in the region near and east of El Paso."

Darton further states (p. 55) that

> "The Hueco and Gym are contemporaneous, at least in part, with the Manzano group, which includes 500 to 1,000 feet of red beds (Abo sandstone) that thin to the north."

In 1922 Darton (p. 182) concluded that

> "The Gym limestone of the Luna County region represents a part of the Chupadera formation."

At this time he introduced the name Chupadera formation for

the upper part of the Manzano group and to include Lee's (1909, p. 12) Yeso and San Andres formations. This correlation represented a change in the age assignment of the Gym from Pennsylvanian to Permian. Since that time the Gym has been considered to be Permian in age. Again, in 1928, in his "Red Beds" bulletin Darton (1928, p. 26) correlated the Gym with the Chupadera formation. The term Chupadera has since been abandoned by P. B. King, 1942, p. 687.

P. B. King and R. E. King (1929, p. 922-924) extended the term Gym into the Hueco Mountains of Texas, correlated it with the Abo and Yeso in the San Andres Mountains, the Hess formation and upper Wolfcamp in the Sierra Diablo, and the uppermost part of the Naco in southern Arizona. Concerning the Gym fossils the authors stated (p. 923) that

> "The fauna of the Gym formation has a remarkable resemblance to the 'upper Carboniferous' fauna of the Andes."

Some time elapsed before the Gym was again mentioned in the literature. However, in 1940 Keyes endeavored to solve the problem by acrimoniously attacking earlier conclusions. He (1940, p. 369) has this to say about the Gym:

> "Now in the Florida Mountains the heavy Gym limestone, a thousand feet thick, rests in marked erosional unconformity upon inclined and beveled Ordovicic and Devonic strata...To the westward a similar limestone, carrying the identical fauna occurs around Silver City... Further on, in the Mimbres Range, and neighboring mountains, the same limestone, apparently, and the same fauna occur, but here they are termed the Magdalena limestone, which is essentially the Aubrey limestone of Arizona. Thus, to all intents and purposes the Gym limestone is really the typical Magdalena limestone, in thickness, in

> lithology, in stratigraphic relations, in faunal identity, in the peneplanal unconformity at the base, and in being surmounted by Red-beds."

Keyes goes on to conclude:

> "So Darton's Gym limestone is not a Red-beds component at all; but merely an isolated outlier of the Magdalena, or Aubrey limestone...The limestone crest of Gym peak, high-point of the Floridas, is Aubreyan. Arbitrarily placing it a thousand feet out of stratigraphic alignment does not make of it a new formation, nor does it warrant the giving it a new name."

If Keyes had climbed Gym Peak it is inconceivable that he could have reached those conclusions. He compared the Gym with the Pennsylvanian Magdalena formation but said also it was Aubreyan, a term that embraced Permian rocks before it was abandoned.

Preliminary work on the Gym limestone by V. C. Kelley and the author resulted in the publication of a short note (Kelley and Bogart, 1952) outlining some revision in the stratigraphic column. The authors found that the Gym limestone at the type locality on Gym Peak in the Florida Mountains consisted chiefly of Fusselman dolomite of Silurian age. Examination of the other areas of "Gym" outcrop revealed similar misidentification or considerable dissimilarity. Only a small area of "Gym" was found to outcrop in the entire Florida Mountains (<u>op</u>. <u>cit</u>., p. 1647).

In summary, the Gym limestone, containing the so-called Manzano fauna was originally described by Darton in 1916 and the age determined as Pennsylvanian by G. H. Girty. In 1922 the U. S. Geological Survey changed the age assignment

to Permian. Following that change the Gym has been correlated with Permian rocks of other areas. It appears, however, that these later correlations were made on the basis of Darton's original fossil lists which seem controversial at best. Keyes' paper in 1940 stated definitely that the Gym was the same as the Magdalena. Kelley and Bogart (1952) pointed out that the Gym, as originally described, was mostly Fusselman dolomite, and that only a small area of restricted "Gym" outcrops in the Florida Mountains.

Inasmuch as the present paper concludes that the "Gym" limestone is identical with the Hueco limestone and that the term Gym should be abandoned in favor of the name Hueco, the latter name will be used throughout the remainder of this paper except where reference is made to the original description.

Acknowledgments

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Knight, for the identification of the gastropod fauna. Thanks are also due Kenneth Sharp and A. K. Armstrong, who assisted the writer in collecting fossils. All fusulinid identifications in this report were made by R. V. Hollingsworth, Midland, Texas.

REGIONAL GEOLOGIC SETTING

The Paleozoic Era in southwestern New Mexico was one of quiet sedimentation in shallow seas. During early Paleozoic time the adjacent land area must have been one of low relief because of the predominance of carbonate rocks and the relative absence of clastics. The general succession of formations with similar attitudes indicates the absence of any sharp disturbances. However, fossil evidence and sometimes lithology indicate that systemic boundaries are present, but because of continuous deposition from one period to another they are difficult to establish. Wide gaps in the fossil record could be explained either by partial regression of the sea and non-deposition or by epeirogenic uplift and erosion. During the later part of Paleozoic time, however, earth movements became more active as indicated by the presence of clastics throughout the section, and the complete absence of certain formations. The sedimentary rocks of southwestern New Mexico undoubtedly occur in widespread sheets below the present bolson deposits but are now exposed only where they have been ruptured and brought up in faulted mountains or flexures that rise out of the flat plains.

The basement complex in southwestern New Mexico consists of Precambrian crystalline rocks which in most places are buried at unknown depths but are locally brought to the surface by mountain uplifts. Unconformably overlying the

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The [illegible] in southwestern New Mexico [illegible] of Precambrian [illegible] and [illegible] during [illegible] to the surface by mountain uplifts, [illegible]

basement complex is a thick succession of sedimentary strata ranging in age from Cambrian to Recent. The wide, uniform bolsons between the mountain ranges are filled with Quaternary sand, clay, and gravel of unknown thickness. Also included in the area are various kinds of igneous rocks, mostly Tertiary in age, that are chiefly extrusive although some are intruded into the sedimentary rocks. These rocks include porphyry, latite, andesite, basalt, rhyolite, and various kinds of pyroclastics.

Cooks Peak consists of a large laccolithic mass of granodiorite porphyry that has been intruded principally into the Lake Valley (Mississippian) formation and younger strata. To the north of Cooks Peak, granite is exposed and overlying it are outcrops of Bliss formation, El Paso formation, Montoya formation, Fusselman dolomite, Percha formation, and Lake Valley formation. Also the Lobo formation, Sarten sandstone and Colorado shale of Mesozoic age are present here. Along the north and east side of the range occurs a great mass of Tertiary agglomerate. To the south the outcropping Paleozoic formations include the Lake Valley formation, part of the Magdalena formation, Lobo formation, Sarten sandstone, and a small area of Colorado shale. In general, the sedimentary rocks dip away from the high point of Cooks Peak. Intruding and overlapping these sedimentary rocks to the south and east are quartz latite, andesite, rhyolite, and a large area of agglomerate, all of Tertiary age.

basement complex is a thick succession of sedimentary strata ranging in age from Cambrian to Recent. The wide, uniform bolsons between the mountain ranges are filled with Quaternary sand, clay, and gravel of unknown thickness. Also included in the area are various kinds of igneous rocks, mostly Tertiary in age, that are chiefly extrusive although some are intruded into the sedimentary rocks. These rocks include porphyry, latite, andesite, basalt, rhyolite, and various kinds of pyroclastics.

Cooke Peak consists of a large laccolithic mass of granodiorite porphyry that has been intruded principally into the Lake Valley (Mississippian) formation and adjacent strata. To the north of Cooke Peak, granite is exposed and overlying it are outcrops of Bliss formation, El Paso formation, Montoya formation, Fusselman dolomite, Percha formation and Lake Valley formation. Also the Lobo formation, Sarten sandstone and Colorado shale of Mesozoic age are present here. Along the north and east side of the range occurs a great mass of Tertiary agglomerate. To the south, the outcropping Paleozoic formations include the Lake Valley formation, part of the Magdalena formation, Lobo formation, Sarten sandstone, and a small area of Colorado shale. In general, the sedimentary rocks dip away from the high point of Cooke Peak. Intruding and overlapping these sedimentary rocks to the south and east are quartz latite, andesite, rhyolite, and a large area of agglomerate, all of Tertiary age.

The Florida Mountains consists chiefly of Precambrian granite and Tertiary agglomerate, the latter forming the high part of the northern end of the range and also most of the Little Florida Mountains. Near Capitol Dome in the north end of the Florida Mountains (pl. 1) underlying the Tertiary are outcrops of Bliss formation lying on granite, El Paso formation, and probably some Montoya formation. The latter is overlain unconformably by the Lobo formation (Darton, 1916, p. 19). In the southern part of the mountains in The Park, on the ridge east of The Park, and also on Gym Peak and down its eastern slope the following formations occur: Bliss formation, El Paso formation, Montoya formation, Fusselman dolomite, Percha formation, some Mississippian (Lake Valley formation?), a small interval of Hueco, and overlying this a red conglomeratic sequence of probable Cretaceous age. This section is faulted into three blocks. The most complete sequence of strate crops out on the Gym Peak block. The dips of the sedimentary rocks as well as the agglomerate are generally eastward. The structure, however, is more complex than Darton (1916, plate 1) indicates on his Luna County map.

The Tres Hermanas Mountains consist of a great mass of granite porphyry (the three peaks) and are flanked in part by andesite, rhyolite, agglomerate, and some Paleozoic sedimentary rock. The sedimentary rocks include some probable Montoya and Fusselman dolomite, a questionable Mississippian

The Florida Mountains [illegible] [illegible] of [illegible] granite and Tertiary [illegible], the latter [illegible] the high part of the northern [illegible] of the [illegible] [illegible] the Little Florida Mountains [illegible] [illegible] in the north end of the Florida Mountains (Fig. 1) [illegible] the Tertiary are outcrops of [illegible] [illegible] [illegible] El Paso formation and [illegible] [illegible] formation. The latter is overlain [illegible] by the [illegible] formation (Darton, 1916, p. 17). [illegible] the [illegible] of the [illegible] in The Park, [illegible] [illegible] of [illegible] Peak, [illegible] on [illegible] Peak and down the eastern slope [illegible] following formations occur: Bliss formation, El Paso formation, Montoya [illegible], Fusselman dolomite, [illegible] formation, [illegible] (Lake Valley formation?) [illegible] and overlying [illegible] [illegible] of Cretaceous age. [illegible] The most complete sequence of [illegible] [illegible] Gym Peak block. The [illegible] the agglomerates are [illegible] [illegible]. The [illegible], however, is more [illegible] than Darton (1916, plate 29) indicates on his Luna County map.

The three [illegible] [illegible] consist [illegible] of granite porphyry (the [illegible]) and [illegible] in part by andesite, [illegible] [illegible] and [illegible] sedimentary rock [illegible] [illegible] include [illegible] Montoya and Fusselman dolomite, a questionable [illegible]

interval, a thick section of Pennsylvanian, and, overlying this, a thin sequence of Hueco limestone. Much of the rock next to the porphyry contact has been metamorphosed to marble (probable Mississippian) and tactite. The dips are generally southeastward.

The main ridge of the Victorio Mountains consists of a tilted block of andesite. The three hills to the south are composed of El Paso formation in part, Montoya formation, Fusselman dolomite, and, overlying the Fusselman, an interval of clastic limestone that is probably Mesozoic in age. Between this section and the andesite is a sequence of purplish sandstone, shale, and conglomerate that may be Cretaceous or Tertiary in age.

It can be seen from the above that outcrops are in most cases widely separated by bolson areas whose stratigraphic and structural character at depth are almost wholly unknown. Correlation from one area to another is commonly uncertain. The tracing of lithology over any distance as well as the determination of facies changes is entirely impossible because of the isolated nature of the outcrops.

interval, a thick section of [illegible] this, a thin [illegible] next to the porphyry contact has [illegible] marble (probably Martinsburg) [illegible] generally [illegible] eastward.

The [illegible] of the Virginia [illegible] consists of a tilted block of [illegible] are composed of [illegible] Fusselman dolomite, [illegible] of clastic limestone [illegible] Between this [illegible] [illegible] Cretaceous [illegible] in [illegible]

It can [illegible] most [illegible] granite [illegible] unknown [illegible] underlie [illegible] well as the [illegible] possible [illegible]

STRATIGRAPHY

Pre-Hueco Rocks

General statement

The pre-Hueco rocks of Luna County consist of sandstone, limestone, dolomite, shale, and varying amounts of argillaceous limestone and arenaceous shale. Their age, names, and general character are given in the following table:

Pre-Hueco Rocks of Luna County
(modified after Darton 1916)

Age	Name	Thickness (feet)	Character
Pennsylvanian	Magdalena formation	0-800	shale, slabby limestone
Mississippian	Lake Valley formation	0-700	light-gray limestone with shale members, chert at top
Devonian	Percha formation	0-225	olive-gray to black shale, thin limestone beds
Silurian	Fusselman dolomite	0-1385	massive gray dolomite
Ordovician	Montoya formation	0-300	gray dolomite with chert, dark at base, shaly members
	El Paso formation	500-800	light-gray limestone, slabby, shaly
Cambrian	Bliss formation	30-200	sandstone and sandy shale, glauconitic, hematitic
Precambrian			granite

The Bliss formation consists of about 150-200 feet of gray to brown sandstone, partly quartzitic, in members 30-40 feet thick and separated by sandy shale layers. Some of the beds are calcareous and others contain a large amount of glauconite in disseminated grains. The El Paso formation is composed of gray, slabby limestone and dolomitic limestone 500-800 feet thick. Some chert occurs in the limestone and several beds contain a few fossils. The Montoya formation consists of light-gray dolomite and calcitic dolomite interbedded with lenses and beds of chert. Some thin beds of argillaceous limestone occur, locally quite fossiliferous. The over-all thickness of the formation is about 300 feet. The Fusselman dolomite is a gray, massive dolomite almost devoid of chert. The thickness recognized in this report is nearly 1,400 feet in the Florida Mountains. Except for a few corals, it is barren of fossils. The Percha formation, where it occurs, consists of olive-gray to black fissile shale that is generally unfossiliferous. Its thickness is 0-225 feet. The Lake Valley formation consists chiefly of slabby to massive limestone, some coarsely crystalline and crinoidal, but some dark, calcareous shales occur in places. The upper part is a white, coarse limestone containing abundant nodules and beds of chert. The Magdalena formation is represented in only a few places in Luna County. Darton (1916, pl. 1) mapped the Magdalena together with the Gym in Luna County, 1916. Where it occurs it is mostly made up of slabby

limestone, argillaceous limestone and shale. The limestones contain abundant lenticular and nodular chert.

Florida Mountains

In the Florida Mountains the pre-Hueco sedimentary rocks include representatives of Cambrian, Ordovician, Silurian, Devonian, and Mississippian series.

The Bliss formation of Cambrian age crops out on the slope west of Capitol Dome, in the cliffs east of The Park, and in the long slope north of Gym Peak. The basal beds, where exposed, lie on an eroded surface of the underlying pink granite. These beds are pebbly and arkosic, indicating their derivation from the underlying granite. Considerable glauconite is present in disseminated grains which is fairly characteristic of Cambrian rocks in other areas. The thickness of the Bliss is about 150 feet.

The El Paso formation crops out west of Capitol Dome, on the ridge east of The Park, and on the slope north and east of Gym Peak. It rests on the Bliss formation with an apparent disconformity separating the two formations. The section west of Capitol Dome is probably the most complete, containing about 800 feet of slabby, thin-bedded, light-gray limestone and dolomitic limestone. On the ridge east of The Park about 700 feet of El Paso rests on the Bliss and is overlain by the Montoya formation and Fusselman dolomite. On the long slope north of Gym Peak is found another nearly complete section containing about 800 feet of slabby limestone.

limestone, argillaceous limestone [illegible] the limestones contain abundant [illegible]

Florida Mountains

In the Florida Mountains the [illegible] rocks include [illegible] Ordovician, Silurian, Devonian, and [illegible]

The Bliss Formation of Cambrian age crops out on the slope west of Capitol Dome [illegible] and in the long escarpment of [illegible] where exposed [illegible] on the eroded surface of the underlying pink granite. The beds are [illegible] their weathered [illegible] glauconitic [illegible] characteristic [illegible] base of [illegible] about 90 feet.

The El Paso [illegible] on the east part of the [illegible] east of [illegible] apparent [illegible] section west of Capitol Dome [illegible] containing about 900 feet of [illegible] limestone [illegible] dolomitic limestone [illegible] Peak about 700 feet of [illegible] overlain by the Montoya [illegible] the long slope north of [illegible] complete section containing about 600 feet of [illegible] limestone

Some beds of the formation are slightly cherty. On the whole fossils are scarce in the El Paso but previous work by Ulrich and Kirk (Darton, 1916, p. 27) has determined the age to be Lower Ordovician (Beekmantown).

The Montoya dolomite crops out in the lower part of the section in The Park, in the ridge east of The Park, and north and west of Gym Peak. A thin sequence overlies the El Paso in the slope west of Capitol Dome where it is overlain unconformably by red beds which Darton (1916, p. 28) named the Lobo formation. Perhaps the most complete interval is exposed north and west of the summit of Gym Peak. Here the formation rests disconformably on the El Paso and is overlain by the Fusselman. The contact between the Montoya and Fusselman has long been an elusive surface to establish and the writer experienced the usual difficulty in separating the two formations. However, the abundance of chert beds and fossils in the Montoya helps to establish its upper limits. In general, the Montoya is a dolomite but it contains some dolomitic limestone and a few limestone beds. Bedded, lenticular chert is common in the more thin-bedded part of the strata. The color is medium to dark gray and the bedding ranges from thin to thick. At least one of the thin limestone beds is biostromal in character and very rich in fossils. Elsewhere in the sequence fossils are less abundant. The age of the Montoya has been determined as Upper Ordovician (Richmond).

Some beds of the formation are [illegible]. In the whole fossils are scarce in the El Paso but [illegible] Ulrich and Kirk (Darton, 1916, p. 27) are [illegible] to be Lower Ordovician (Beekmantown).

The [illegible] dolomite crops out in the [illegible] the section in the [illegible] north and west [illegible] El Paso. In the [illegible] lain unconformably by [illegible] named the [illegible] is exposed north and west of [illegible] the formation [illegible] disconformably on the [illegible] overlain by the Fusselman [illegible] and [illegible] the two formations [illegible] and fossils [illegible] In general, [illegible] dolomitic limestone [illegible] color [illegible] strata. [illegible] ranges from thin [illegible] stone [illegible] fossils [illegible] The age of the Montoya [illegible] cian (Richmond).

Before undertaking a discussion of the Fusselman a brief review of past work is advisable. Darton (1917a, p. 5) described the Gym limestone at the type locality in the Florida Mountains as follows:

> "The formation consists chiefly of limestone, in great part massively bedded, of light-gray color and showing a brecciated structure in many beds. On the west of Gym Peak the lower part is dark and the upper part much lighter colored, the change from one to the other being abrupt...In the canyon a mile southeast of Gym Peak, where the beds dip steeply southward, the limestone apparently in the middle of the formation is overlain by 80 feet of dark-gray fissile shale,...This shale may be the Percha, lifted by a branch fault and elsewhere overlapped by Gym limestone. This shale is overlain on the east by cherty beds of Gym limestone containing abundant Manzano fossils..."

In describing the fossils and age of the Gym, Darton (*op. cit.*, p. 5) stated:

> "On the east side of the Florida Mountains the lower beds have yielded only a few fossils, which are all classed by G. H. Girty as probably of Manzano (late Carboniferous) age. The fauna is well represented, however, in the limestone above the dark-gray shale member southeast of the peak..."

Darton (1916, p. 35) estimated the thickness of the Gym limestone to be about 1,000 feet.

The present investigation in the Florida Mountains indicates that most of the terrain shown as Gym limestone on Darton's (1917a) areal geologic map is Fusselman dolomite. The twin points of Gym Peak, which Darton described as massive beds of Gym limestone consist largely of Montoya formation, mostly dolomite, and Fusselman dolomite (pl. 2). Furthermore, all the rocks mapped by Darton as Gym in The

Park are also of lower Paleozoic age; here, about 1,377 feet of Fusselman overlies nearly 280 feet of Montoya (pl. 3). The top of the Fusselman is cut off by a thrust fault which brings up the Precambrian granite (pl. 1). As previously stated, the Montoya-Fusselman contact is difficult to determine over most of southern New Mexico. Because of these two conditions it is impossible to determine exactly how much Fusselman dolomite once existed in the Florida Mountains. However, the present thickness measured in The Park is the greatest yet described. At the type locality in the Franklin Mountains, Texas, 65 miles to the east, the Fusselman, as measured by Richardson (1909, p. 4), is 1,000 feet thick.

The Fusselman in the Florida Mountains is almost entirely medium to massive bedded dolomite and contains six alternating light and dark gray units. Chert is generally lacking except for some beds and nodules near the base and a little near the top of the section. A distinctive coral bed (unit 1 of Mine Canyon graphic section, Fig. 3 in pocket) was found in The Park near the top of the sequence and also on the southeast slope of Gym Peak, so that the two sections could be correlated with little difficulty. Although Darton briefly mentions Manzano fossils below the "dark-gray shale member" (Percha formation), no late Paleozoic fossils were found by the writer. However, several species of Halysites (chain corals) were found which are Silurian in age and typical of the Fusselman. In this connection it should be

noted that in Darton's description of the Fusselman in the Florida Mountains he (1916, pp. 30-31) states that

> "Near Gym Peak and The Park the dark slabby limestone above the Montoya yielded a few fragments of corals believed to be of Silurian age, but the rocks do not closely resemble the Fusselman limestone of other areas. Moreover, the Percha shale is absent, so there is great difficulty in separating the Fusselman from the Gym limestone..."

Darton (1917a, p. 3) concluded that the Fusselman had been largely removed in the Florida Mountains by pre-Gym erosion and that only 50-200 feet of strata remained. All the light-gray limestone and at least part of the dark-gray limestone described by Darton as part of the Gym belong instead to the Fusselman (Fig. 3, in pocket).

The dark-gray shale which crops out in the bottom of the canyon southeast of Gym Peak is the Percha formation, as Darton suspected. Here it lies on the eroded top of the Fusselman. Unfortunately the section is mostly covered but by projection a thickness of 236 feet was measured. Where exposed, the Percha consists of a dark gray to olive gray fissile shale. Except for a 1-foot limestone bed containing numerous fossils, the section is barren. The general lithologic character and stratigraphic position is sufficient to establish this shale as part of the Percha formation. Elsewhere in New Mexico the upper part of the Percha is fossiliferous and the lower part barren. It would appear, then, that the upper part either had not been deposited or was planed off in the Florida Mountains and that only the lower part remains.

Disconformably overlying the Percha is a 196-foot interval of thin bedded, argillaceous limestone, thin shale and chert beds of Mississippian age. The limestone beds are light gray, fine grained, thin, and interbedded with closely spaced lenticular beds and nodules of chert. The chert is light gray to white and weathers rusty so that the section forms a brown slope easily separated from the overlying Hueco. The Mississippian beds strike N 38° E and dip 39° SE; the overlying Hueco beds strike N 24° E and dip 32° SE. A slight change in attitude is shown between the two formations but not enough to indicate much post-Mississippian, pre-Permian diastrophism except epeirogenic uplift and erosion. This undoubtedly accounts for the absence of Pennsylvanian beds in the Florida Mountains.

At the Mississippian-Permian contact some blocks of presumably Mississippian rock are incorporated in the lowermost Permian (Hueco) beds. These blocks are 3-4 inches in diameter and generally subround. They have a lithology similar to the underlying thin-bedded Mississippian beds and are surrounded by rock of Hueco lithology and fauna. The line of unconformity is slightly wavy but any angularity between the two formations or relief on the Mississippian are practically negligible.

In general, fossils are scarce and poorly preserved in the Mississippian strata. The following fossils were collected from the thin-bedded limestone below the Hueco in

Mine Canyon: Eumetria? sp., Cyrtina? sp., Linoproductus sp., Torynifer sp., a small costellate brachiopod, probably Spiriferina, and abundant fenestelloid bryozoans in the chert lenses. Torynifer was formerly called "Reticularia" and is definitely Mississippian in age, according to Northrop (oral communication). Laudon and Bowsher (1949, p. 24) report Reticularia cooperensis from the Caballero (Kinderhook) of the Sacramento Mountains and Reticularia sp. (op. cit., p. 38) from the Rancheria (Meramec) in the Franklin Mountains. Because fossil evidence is so scarce it is impossible at this time to determine exactly the age of this Mississippian sequence. On the basis of lithology it is quite similar to the Rancheria as described by Laudon and Bowsher (op. cit., p. 24). However, it could equally well belong to part of the Lake Valley formation. Inasmuch as some probable Lake Valley occurs in the Tres Hermanas Mountains, the Mississippian rocks in the Florida Mountains are herein placed in the Andrecito member of the Lake Valley formation of Laudon and Bowsher (op. cit., pp. 12-13). The above authors found that the limestone beds in their Andrecito member were "...commonly covered with fenestelloid bryozoans." Abundant bryozoans of the same type were found in the upper part of the Mississippian strata in the Florida Mountains. The lithologic character of these rocks appears to verify placing them in the Andrecito member as described by Laudon and Bowsher. The section overlying the

Mississippian in the Florida Mountains is discussed later under Hueco Rocks (p. 55).

The section measured in The Park, Florida Mountains (Sections 34 and 35, T 25 S, R 8 W) is as follows:

Unit	Description	Thickness (feet)
	Top (thrust fault, Precambrian on Fusselman, Pl. 1)	
FUSSELMAN DOLOMITE		
Upper Light-Gray Member		
49	Dolomite: medium- to massive-bedded; medium-gray, weathered buff; fine-grained; greatly fractured	33
48	Dolomite: thin- to medium-bedded; medium-gray; fine- to medium-grained	22
47	Chert and limestone: about 60 per cent chert and 40 per cent limestone; chert white, limestone medium-gray; fine-grained	6
46	Dolomite: medium-bedded; medium-gray; medium-grained	9
45	Dolomite: massive; yellowish-gray, weathered buff; coarse-grained; porous	33
44	Dolomite: thin- to massive-bedded (lower part thin, upper part massive); medium-gray, weathered grayish-white; fine-grained; upper part weathered with laminated, evenly-bedded appearance	68
43	Dolomite: thin-bedded; medium-gray; fine- to medium-grained; alternating bands of light-gray chert in beds 6-18 inches thick	16
42	Dolomite: massive; light pinkish-gray, weathered buff; coarse-grained	23

Unit	Description	Thickness (feet)
41	Dolomite: medium-bedded; light-gray, weathered white- to light-gray; very fine grained	23
40	Covered mostly: probably thin-bedded limestone	18
39	Dolomite: thin-bedded; medium-gray; fine- to medium-grained	3
38	Covered: probably thin limestone beds	8
Upper Dark-Gray Member		
37	Dolomite: thin-bedded; color of beds alternating light- and medium-gray, some beds dark-gray, weathered medium-gray; fine-grained	72
36	Dolomite: thin-bedded; medium-gray; fine-grained; slightly darker in color than lower beds; 21 feet above the base is a *Syringopora*-like coral bed	79
Middle Light-Gray Member		
35	Dolomite: thick-bedded; medium-gray, weathered light-gray; fine- to medium-grained; forms ledge	15
34	Dolomite: thin-bedded; medium-gray, weathered light-gray; fine- to medium-grained	64
33	Dolomite: massive; light- to medium-gray, weathered light-gray; medium- to coarse-grained	112
32	Dolomite: massive; light-gray, weathered light-gray, fine- to coarse-grained	11
31	Dolomite: massive, few thin beds; medium-gray, weathered with laminated appearance; fine-grained	44

Unit	Description	Thickness (feet)
30	Dolomite: massive; light-gray, weathered light-gray; fine- to coarse-grained; surface weathered saccharoidal in appearance	175
Middle Dark-Gray Member		
29	Dolomite: thinly laminated; dark-gray; fine-grained; looks deformed	14
28	Dolomite: thin- to thick-bedded; medium-gray, weathered medium-gray, fine-grained	13
27	Dolomite: thin, wavy, laminated beds; dark-gray; fine-grained	15
26	Dolomite: thin-bedded; medium-gray; fine-grained; scattered chert grains and nodules	5
25	Dolomite: thin- to thick-bedded; medium-gray, weathered medium-gray; fine-grained; some beds fairly dark	158
Lower Light-Gray Member		
24	Dolomite: massive; light-gray, weathered buff and sandy looking; coarse-grained; fresh surface saccharoidal; forms ledge between two darker gray units	68
Lower Dark-Gray Member		
23	Dolomite: thin- to medium-bedded; medium-gray, weathered light-gray; very fine grained; contains some darker and coarser grained dolomite ...	44
22	Dolomite: thin-bedded; dark-gray; medium-grained; has nodular or banded chert lenses	18
21	Dolomite: thin-bedded; dark-gray; medium-grained	49

Unit	Description	Thickness (feet)
20	Dolomite: thin-bedded; dark-gray, weathered dark-gray; medium-grained; bands of chert 1-2 inches thick, weathered rusty	8
19	Dolomite: medium-bedded; dark-gray, weathered dark-gray; medium-grained; scattered nodular lenses of light-gray and rusty weathered chert; has peculiar light-gray dendritic seams of calcite	23
18	Dolomite: laminated; gray and dark-gray; medium- to coarse-grained; scattered chert lenses	35
17	Dolomite: thick- to massive-bedded; light-gray in bottom half, medium- to dark-gray in upper half; medium- to coarse-grained; scattered, granular chert	40
16	Dolomite: thin- to massive-bedded; medium- to dark-gray; medium-grained; upper part lighter gray and coarser	25
15	Dolomite: thin- to medium-bedded; medium- to dark-gray; fine-grained; lenticular, patchy lenses of chert up to 3 inches thick and thickly scattered nodules of chert; chert light-gray to white, weathered rusty	28
	Total Fusselman:	1,377
MONTOYA FORMATION (top?)		
14	Dolomite: medium- to thick-bedded; medium-gray, weathered light-gray; fine- to medium-grained, coarser-grained near top	33
13	Dolomite: thin-bedded; medium- to dark-gray, weathered dark-gray; fine- to medium-grained	22

Unit	Description	Thickness (feet)
12	Calcitic dolomite: massive; light- to medium-gray, mottled in thin laminations; fine-grained; the lighter-gray looks banded and coarser, may be a reworked bed	18
11	Dolomitic limestone: medium- to thick-bedded; dark-gray; very fine grained; contains fossil fragments; wavy lenses, and patches of dolomite ..	16
10	Limestone biostrome: light-gray; fine-grained; very fossiliferous (same as bed found east of Gym Peak)	5
9	Limestone; thin-bedded; medium- to dark-gray; very fine grained; many wavy nodules and scattered grains of chert	21
8	Dolomitic limestone: thin-bedded; medium-gray; coarse-grained; has wavy seams along which are dense buff dolomite lenses and scattered fragments; looks detrital, may be a calcirudite	13
7	Limestone: thin-bedded; medium-gray; fine-grained; abundant chert lenses and wavy bands; very fossiliferous, large brachiopods	11
6	Dolomite: medium-bedded; medium-gray; coarse-grained; scattered chert nodules	6
5	Dolomitic limestone: thin-bedded; medium- to dark-gray; fine- to medium-grained; alternating wavy bands and lenses of chert every 3-5 inches; chert dark-gray, weathered black and rusty; fossiliferous in zones	100
4	Dolomite: thin-bedded; light-gray, weathered light-gray; medium-grained; much chert breccia	5

Unit	Description	Thickness (feet)
3	Dolomite: thin-bedded; medium-gray; medium-grained; scattered chert nodules	11
2	Covered interval	14
1	Dolomite: thin-bedded; medium-gray; fine-grained; thin bands and concretions of chert; fossiliferous	11
Base		
	Total:	1,663

The base of unit 25 appears to be the base of Darton's Gym limestone but the occurrence of Halysites definitely places the interval above this bed within the Fusselman.

The section of pre-Hueco rocks measured in Mine Canyon southeast of Gym Peak, Florida Mountains (N 1/2 Sec 18 and NW 1/4 Sec 17, T 26 S, R 7 W) is as follows:

Unit	Description	Thickness (feet)
	Top (Hueco above)	
LAKE VALLEY FORMATION(?)		
Andrecito Member(?)		
26	Limestone: thin-bedded; light-gray, weathered light-gray; fine-grained; contains about 30-35 per cent chert in wavy lenses and beds 2-5 inches thick; chert is light-gray and weathered rusty-brown	30
25	Covered interval	16
24	Limestone: thin-bedded; dark-gray; contains some chert; fossiliferous	5
23	Covered interval	6

Unit	Description	Thickness (feet)
22	Limestone: medium-bedded; medium-gray, weathered medium-gray; fine-grained; contains chert lenses 3-6 inches thick	6
21	Covered interval	6
20	Limestone: thin-bedded; medium-gray, weathered medium-gray, fine-grained; contains chert lenses 3-6 inches thick	3
19	Covered interval	16
18	Limestone: thin-bedded; medium-gray; very fine grained; contains thin laminations and nodules of chert	4
17	Covered interval	4
16	Limestone: thin-bedded; medium-gray; very fine grained; contains thin laminations and nodules of chert (similar to unit 18)	2
15	Covered interval	3
14	Limestone: laminated- to thin-bedded; medium gray, weathered medium-gray; fine-grained; interbedded with medium-gray laminated chert; chert comprises 30-40 per cent and is in nodular lenses and stringers, some black and weathered rusty (shale units in covered intervals)	69
13	Limestone: massive; light- to medium-gray, weathered medium-gray; coarse-grained; nodular stringers and lenses up to 1 inch thick of gray, rusty-weathered chert	8
12	Limestone: thin-bedded; medium- to dark-gray; medium- to coarse-grained; contains granular spongy chert laminations and a few lenses of black chert	11

Unit	Description	Thickness (feet)
11	Chert and limestone: about 50 per cent chert and 50 per cent limestone; medium-bedded; chert light-gray, in nodules and nodular lenses up to 1 foot thick	7
	Total Lake Valley:	196
PERCHA FORMATION (Top?)		
10	Covered interval: scattered outcrops of olive-green fissile shale, probably Percha; upper 30 feet may be a covered interval of overlying Mississippian	226
9	Limestone: thin-bedded; dark-gray; very fine grained; abundant tiny, but poorly preserved fossils..........	1
8	Covered interval: probably Percha shale and limestone	9
	Total Percha:	236
FUSSELMAN DOLOMITE (Top eroded)		
Upper Light-Gray Member		
7	Dolomite: thin-bedded; light medium-gray, weathered medium-gray; fine-grained; interbedded with chert bands up to 2 feet thick	25
6	Dolomite: massive; medium- to dark-gray, weathered medium-gray; fine- to medium-grained; abundant lacy chert; surface weathered to laminated appearance; corals near top	8
5	Dolomite: massive; medium- to light-gray with brownish tinge, weathered very light-gray; surface vuggy and dolocastic; looks cross-bedded and may be a calcarenite	13

Unit	Description	Thickness (feet)
4	Dolomite: medium-bedded; medium- to dark-gray, weathered light-gray; very fine-grained; abundant lacy chert that weathers rusty; contains stromatoporoid-like growths, 8-10 inches in diameter, near top	57
3	Dolomite: medium-bedded; medium- to dark-gray, weathered white; very fine-grained; contains scattered, well-rounded quartz grains at base; abundant rusty, lacy chert; lavendar spots on fresh surface	12
2	Dolomite: medium-bedded; medium- to dark-gray, weathered light-gray; fine-grained; contains granular chert in scattered bands; some of dolomite beds weather with finely laminated surface; some lacy chert near top	104
1	Dolomite: medium-bedded; light-gray, weathered light-gray; medium-grained; contains Syringopora-like corals replaced by light-gray chert which weathers rusty brown	3
Base		
	Total:	654

Unit 1 of the above section is the distinctive coral bed that was found 21 feet above the base of unit 36 in The Park section and it was by means of this bed that the two sections were correlated. In The Park 392 feet of Fusselman lies between this coral bed and the thrust fault; in Mine Canyon only 222 feet of Fusselman occurs above the coral bed and beneath the overlying Percha. This shows that the Fusselman in Mine Canyon was planed off by pre-Percha erosion more than the section in The Park. In order to clarify this

relationship, summarized sections are given below for The Park and Mine Canyon.

Park Section

Unit	Description	Thickness (feet)
	Top (?) Fusselman dolomite, thrust fault	
6	Upper light-gray member	262
5	Upper dark-gray member	151
4	Middle light-gray member	421
3	Middle dark-gray member	205
2	Lower light-gray member	68
1	Lower dark-gray member	270
	Base (?) Fusselman dolomite	
	Total	1,377

Mine Canyon Section

Unit	Description	Thickness (feet)
	Top of Lake Valley formation	
3	Cherty limestone and shale	196
	Top (?) of Percha formation	
2	Percha formation, mostly covered ...	236
	Top of Fusselman dolomite (eroded)	
1	Fusselman dolomite	222
	(Fusselman below)	
	Total	654

Unit 1 in the above Mine Canyon section is the eroded equivalent of unit 6 in the Park section.

Tres Hermanas Mountains

Pre-Hueco rocks in the Tres Hermanas Mountains include some probable lower Paleozoic, some probable Mississippian (Lake Valley), and a fairly thick sequence of Pennsylvanian strata (Fig. 3 in pocket). The lower part of the section crops out on the westernmost ridge that extends northward from the north peak of the mountains (Pl. 4). This ridge is made up of probable Fusselman dolomite, the base of which is covered by alluvium and bolson deposits. The rocks all dip southeastward at about 12°. The strata consist of thin- to thick-bedded, fine-grained, light-gray dolomitic limestone interbedded with thin beds of chert. The intrusion of sills between limestone strata with resulting silicification of the limestone is common throughout. This interval is barren of fossils and no determination of age was possible. However, it appears to be in the correct stratigraphic position to be placed within the Fusselman although it is lithologically unlike the Fusselman in the Florida Mountains. The dissimilarity is due in great part to alteration during the intrusion of the granite porphyry that constitutes the main body of the mountains. In any event, it appears to be of lower Paleozoic age.

The rocks next above are mostly covered in the valley which separates the two sedimentary ridges extending

Unit 8 in the [illegible] section [illegible] equivalent of unit 6 in the [illegible] section.

Tres Hermanas Mountains

Pre-Hueco rocks in the Tres Hermanas Mountains include some probable Lower Paleozoic rocks [illegible] (Lake Valley), and a fairly thick sequence of Pennsylvanian strata (Fig. [illegible]). The lower part of the section crops out in the [illegible] from the north end of the mountains (Pl. [illegible]). [illegible] made up of probable Pennsylvanian [illegible] covered by alluvium and Hueco [illegible] southeastward [illegible] thick-bedded, fine-grained, [illegible] interbedded with thin beds of chert. The [illegible] between [illegible] the limestone is [illegible] of fossils and no determination of [illegible] every [illegible] to be [illegible] cally unlike the [illegible] distinctive [illegible] intrusion [illegible] body [illegible] lower Paleozoic age.

The [illegible] which separates the two [illegible]

northward from the igneous peaks of the mountains. This covered interval may contain some Percha formation. Some metamorphosed shale was found but evidence is inconclusive to establish it as Percha.

On the east side of this valley there occurs a thick marble sequence that may be Mississippian in age. It rests in normal position upon the covered interval that may contain the Percha. This coarse-grained, white marble section, about 360 feet thick, is massively bedded and contains spectacular nodules of novaculite-like chert. Some of the nodules approach several feet in length; others are smaller, and all are in wavy, irregular shapes. They all have a 1/2-inch rim around the exterior that is bleached completely white; otherwise the chert is darker in color. This effect was probably caused during the metamorphism of the original limestone to marble by the Tertiary intrusion. Although metamorphosed, this interval resembles the Lake Valley in Cooks Range. Consequently, it is tentatively placed in the Alamogordo member of the Lake Valley formation, the member it most closely resembles.

Disconformably overlying the marble is a sequence of Pennsylvanian strata that is about 636 feet thick. The lower half of the interval is made up of thick beds of siliceous limestone, in part dolomitic, some metamorphosed to marble, thick quartzite beds, and abundant bedded and nodular chert. The limestone beds are light to medium gray

and fine grained, and the quartzite beds are light greenish gray. The silicified beds and also the chert weather rusty brown. The upper part of the section consists of thin limestone beds interbedded with thin chert layers. The limestones are medium to dark gray, fine grained and weather medium gray. The chert is dark gray to black and weathers rusty brown. Most of the chert is primary, being parallel to the bedding but much of it is secondary and occurs as nodules or vein fillings in joints and cracks. In fact the configuration of the chert in the upper part of the section is curiously suggestive of letters written on the limestone beds. Shale partings in the limestone beds occur throughout the section.

This Pennsylvanian sequence was measured on three isolated outcrops in the Tres Hermanas Mountains (Fig. 3 in pocket). These three sections are separated by covered intervals and float from the igneous rock of the main peaks. They were correlated, however, as shown in Figure 3. Subsequent to the measuring of these sections, a continuous sequence was found on the north end of the ridges that extend north from the north peak (Pl. 4), which is unbroken by covered intervals. Here, the strata indicate a gradation from Pennsylvanian up into the Hueco which supports the correlation of the three sections measured on the north and east sides of the mountains. In both places the top of the Hueco is concealed beneath bolson deposits.

Fossils are scarce and poorly preserved in the Pennsylvanian strata of the Tres Hermanas Mountains. The mode of preservation was probably affected by the metamorphism that took place during Tertiary time. Near the base of the interval the following fossils were identified by Northrop: Neospirifer alatus, Linoproductus sp., and several large fenestelloid bryozoans. In the Mid-Continent area Neospirifer alatus is restricted to rocks of Missouri age. Near the top of the section a Linoproductus sp. and several other brachiopods too poor to identify were collected.

On the basis of lithology, stratigraphic position, and limited faunal evidence, this Pennsylvanian sequence is placed in the Magdalena formation and correlated with the Naco formation of Arizona. In discussing the Naco of Arizona Bryant (1952, p. 39) states:

> "Nowhere in southern Arizona has evidence of an unconformity between the Naco formation and overlying deposits of Permian age yet been recognized."

In the Tres Hermanas Mountains the Pennsylvanian-Permian contact is likewise a gradational one.

The three sections of pre-Hueco rocks in the Tres Hermanas Mountains are given below.

Section 1 in Tres Hermanas Mountains

Measured in canyon between two ridges extending north of northern-most peak and over the eastern of these two ridges. Sections 24 and 25, T 27 S, R 9 W.

Unit	Description	Thickness (feet)
	Top (Rhyolite dike contact)	
MAGDALENA FORMATION		
62	Limestone: massive; gray-buff, weathered gray-buff; coarse-grained; friable	10
61	Limestone: thin-bedded; mottled light- to dark-gray, weathered light-gray to white; fine-grained; abundant lacy chert bands; chert white, weathered brown; slight ledge	6
60	Covered: probably thin limestone beds ...	10
59	Limestone: thin-bedded; mottled light and dark-gray; fine-grained; contains closely spaced lacy bands of rusty chert	3
58	Limestone: thin- to medium-bedded; dark-gray, weathered medium-gray; medium-grained; contains regular bands and irregular nodules of chert, bands rusty, nodules black	5
57	Porphyritic rhyolite (?) sill	5
56	Covered slope: probably thin limestone beds	11
55	Limestone: medium-bedded; dark-gray, weathered dark-gray; fine-grained; contains nodules of black chert	6
54	Limestone: thin-bedded; dark-gray, weathered muddy-gray; medium-grained	1
53	Limestone: medium-bedded; dark-gray, weathered medium-gray; medium-grained; contains fossil fragments and crinoid stems; irregular nodules of black chert .	11
52	Covered slope: probably shaly limestone .	16
51	Limestone: thin- to medium-bedded; medium- to dark-gray; fine-grained; 10-15 per cent chert in wavy, lacy bands and	

Unit	Description	Thickness (feet)
	some nodules; fossiliferous with large crinoid stems, cup corals, and shell fragments	21
50	Limestone: medium-bedded; dark-gray, weathered dark muddy-gray; friable; fine-grained; fossil fragments	2
49	Limestone and chert: alternating thin beds, about 15 per cent chert; limestone light- to dark-gray; fine- to medium-grained; chert rusty-brown; a few siliceous limestone beds associated with the chert; fossiliferous, one bed containing numerous brachiopods	20
48	Limestone: thin-bedded; light-gray, weathered rusty-buff; fine- to medium-grained; contains lacy chert	2
47	Limestone: thin-bedded; dark-gray, weathered light-gray; fine- to medium-grained; chert bands about every 6 inches; chert weathered rusty-brown; contains "bursts" of white, radiating mineral, probably tremolite	12
46	Limestone: thin-bedded; dark-gray, weathered buff to brown; fine-grained; fossil fragments	4
45	Limestone: thin- to medium-bedded; dark-gray, weathered medium-gray; fine- to medium-grained; abundant bands and nodules of rusty chert 6-12 inches apart; tremolite "bursts"; crinoid and other fossil detritus near base	11
44	Limestone: medium-bedded; dark-gray to black, weathered medium-gray; fine- to medium-grained; contains rounded chert nodules; abundant tremolite aggregates ..	6
43	Limestone: thin-bedded; black, weathered medium-gray; medium-grained; shaly partings and wavy thin bands of rusty-brown chert	5

Unit	Description	Thickness (feet)
42	Covered interval: probably shaly	1
41	Limestone: thin- to medium-bedded; medium- to dark-gray, weathered medium-gray; medium-grained; fossiliferous with cup corals, large crinoid stems and small shell fragments of black calcite	5
40	Covered interval: probably thin limestone beds	5
39	Chert: thin-bedded; white, weathered brownish-gray; very fine-grained and dense; garnetized	2
38	Limestone and siliceous limestone: alternating thin beds of dark-gray, medium-grained limestone with white siliceous limestone containing chert; the chert is white and weathered brown; the dark-gray limestone is fossiliferous	10
37	Siliceous limestone and chert: thin-bedded; white, weathered white; very fine-grained; chert weathered brown	2
36	Limestone: thin-bedded; light-gray, weathered light-gray; medium-grained; has lacy, thin beds of brown chert	2
35	Covered: probably thin limestone beds and chert	2
34	Chert: thin-bedded; light-gray, weathered rusty; cryptocrystalline	2
33	Covered interval	2
32	Siliceous limestone: medium-bedded; gray, weathered white; fine-grained; very hard; contains fine bands of rusty-brown chert and aggregates of tremolite; forms ledge near top of ridge	5
31	Siliceous limestone and chert: alternating thin beds; limestone gray, weathered light-gray to white; fine-grained; chert gray, weathered rusty; some limestone beds fossiliferous	56

Unit	Description	Thickness (feet)
30	Limestone: medium-bedded; gray, weathered gray; corase-grained; friable .	2
29	Siliceous limestone and chert: gray, weathered white; thin-bedded; fine-grained	1
28	Mostly covered: a few limestone beds exposed	15
27	Siliceous dolomite: thin-bedded; light greenish-gray, weathered pinkish-gray; joints garnetized; very hard; fine-grained	5
26	Siliceous dolomite: thin-bedded; dolomite light-gray, weathered white; chert white, weathered rusty-brown; fine-grained	3
25	Covered slope	4
24	Siliceous dolomite: thin-bedded; light greenish-gray, weathered pinkish-gray; joints garnetized (green); very hard; fine-grained	15
23	Covered slope: probably shaly	20
22	Quartzose sandstone: medium- to thick-bedded; buff to gray, weathered red-brown; very fine grained; contains stromatoporoid-like growth at bottom and also some *Lepidodendron*? imprints; forms cap on crest of eastern ridge	26
21	Limestone: thick-bedded; mottled buff-gray, weathered buff-gray; very coarse grained; porous	20
20	Covered: probably thin limestone beds ...	5
19	Chert: thin-bedded; white, weathered rusty-brown; fine-grained; some limestone	1
18	Dolomitic limestone: medium- to thick-bedded; black, weathered light-gray; very fine grained; has abundant chert lenses up to 3 inches thick	46

Unit	Description	Thickness (feet)
17	*Mostly covered slope*: a few outcrops of thin-bedded, dense, fine-grained quartzite which is garnetized	21
16	*Siliceous limestone*: medium-bedded; buff, weathered rusty-brown; medium-grained; cherty in lenses; a few shale beds	39
15	*Limestone and chert*: alternating thin beds; medium-gray limestone; dark-gray chert; limestone weathered medium-gray; chert weathered rusty-brown; medium-grained; fossils at top	12
14	*Siliceous limestone*: thin-bedded; light-gray, weathered buff to pink; very fine grained	1
13	*Covered slope*	10
12	*Marble*: massive; buff, weathered buff-gray; coarse-grained; loose and friable	16
11	*Siliceous dolomite and dolomitic limestone*: alternating thin beds; mottled gray, weathered rusty-brown; very fine grained	7
10	*Marble*: massive; buff; coarse-grained; friable; porous	15
9	*Siliceous dolomite*: thin-bedded; mottled gray, weathered rusty-brown; extremely fine grained; alternating with 1-3 inch beds of dark-gray, fine-grained dolomitic limestone near top	20
8	*Quartzite*: thin-bedded; light-gray, weathered rusty-brown; extremely fine grained	29
7	*Quartzite and chert*: laminated- to thin-bedded; white, weathered white; chert in lenses, weathered rusty; hard and dense; a few thin beds of dolomitic limestone near top	14

Unit	Description	Thickness (feet)
6	Marble: medium- to massive-bedded; buff, weathered buff; coarse-grained; vuggy porosity	11
5	Quartzite: laminated- to thin-bedded; white, weathered white; alternating rusty chert lenses; fine-grained; hard	5
4	Dolomitic limestone: thin-bedded; white- to light-gray, weathered light-gray; coarse-grained	2
3	Quartzite: thin-bedded; light-gray, weathered white; extremely hard; fine-grained; alternating with beds of rusty chert; some resembles replaced limestone, grains have radiating structure	10
	Total Magdalena:	636

LAKE VALLEY FORMATION(?)

Alamogordo Member (?)

Unit	Description	Thickness (feet)
2	Marble: massive; white; very coarse-grained; contains long irregular chert nodules parallel to bedding; nodules surrounded by white rim; bottom more cherty than rest	308
1	Marble: massive; white; coarse-grained; greatly fractured with epigenetic calcite filling fractures	51

Base

Total: 995

Section 2 in Tres Hermanas Mountains

Measured in canyon that extends eastward from the base of the north peak. Sec 30, T 27 S, R 8 W; Sec 25, T 27 S, R 9 W

Top (granite porphyry contact?)

MAGDALENA FORMATION

Unit	Description	Thickness (feet)
19	Mostly covered: a few outcrops of dark-gray limestone and lacy banded chert; upper part is injected with igneous sills	51
18	Igneous sill (unit 57 in Section 1)	4
17	Limestone: medium-bedded; dark-gray, weathered dark-gray; dense- to fine-grained; fossiliferous; fissile shale intervals	8
16	Covered interval	15
15	Limestone: medium-bedded; dark-gray, weathered medium-gray; medium-grained; fossiliferous; contains brown lacy chert bands and black chert nodules near top	10
14	Covered interval	6
13	Limestone: medium-bedded; dark-gray, weathered medium-gray; fine-grained; lacy chert; fossiliferous, Productids	15
12	Covered slope	3
11	Limestone: medium- to thick-bedded; dark-gray, weathered medium- to dark-gray; fine-grained; has regular layers of rusty chert bands and some nodules; fossiliferous with cup corals, large crinoid stems; one bed contains many brachiopods (unit 49 of Section 1)	35
10	Siliceous limestone: thin-bedded; light greenish-gray, weathered rusty-buff; dense	1
9	Limestone: medium-bedded; dark-gray, weathered light-gray; fine-grained	3

Unit	Description	Thickness (feet)
8	Siliceous limestone: thin-bedded; white, weathered white; fine-grained	1
7	Covered: mostly thin-bedded limestone and chert (similar to unit 6)	5
6	Chert and limestone: thin- to medium-bedded; chert white, weathered white; limestone dark-gray, weathered medium-gray	5
5	Siliceous limestone: dolomitic; thin-bedded; greenish-gray, weathered pinkish-buff; quartzitic in appearance ..	4
4	Limestone: thick-bedded; light-gray, speckled darker gray; coarse-grained; friable in part	4
3	Chert and limestone: massive; 90 per cent chert, 10 per cent limestone; chert white, weathered medium-gray; limestone in bands 2-6 inches thick; some of the limestone is fossiliferous; grades upward into unit 4	10
2	Slate: thin-bedded; brown, weathered red-brown	0.5
1	Chert: thin-bedded; white; fine-grained; dense	2
Base		
	Total:	182.5

Section 3 in Tres Hermanas Mountains

Measured on two knobs farther east than Section 2, in the canyon that extends eastward from the base of the north peak. Sec 30, T 27 S, R 8 W.

Unit	Description	Thickness (feet)
	Top (Hueco beds above)	
MAGDALENA FORMATION		
14	Porphyritic igneous sill: olive drab	21

Unit	Description	Thickness (feet)
13	Limestone: thin-bedded; dark-gray, weathered mottled light and medium-gray; very fine grained; contains chert	5
12	Limestone: alternating buff-weathered and light-gray weathered limestone; some chert bands and nodules of rusty chert	10
11	Covered: probably shaly limestone	12.5
10	Limestone: thin-bedded; light-gray, weathered light-gray to buff; very fine grained; dense	2
9	Mostly covered: some brown siliceous limestone and thin-bedded shaly limestone exposed	22
8	Siliceous limestone: thin- to medium-bedded; greenish-gray, weathered reddish brown to brown; medium- to corase-grained; some banded chert near the top	24
7	Covered interval	5
6	Siliceous limestone: thin-bedded; greenish-gray, weathered pinkish-buff to brown; very fine grained; dense	7
5	Covered interval: probably like beds above	10
4	Calcareous sandstone: thick-bedded; greenish-gray, weathered pinkish-brown; fine-grained	5
3	Siliceous limestone: massive; greenish-gray, weathered green-gray; very dense and fine grained; cherty	7
2	Siliceous limestone: thick-bedded; greenish; coarse-grained; hard	3

Unit	Description	Thickness (feet)
1	*Siliceous limestone*: massive; greenish-gray with green spots; weathered green-gray; cherty; very dense; hard	4
Base		
	Total:	137.5

Cooks Range

Inasmuch as no sections were measured in Cooks Range, the stratigraphy will be considered only briefly. The succession of sedimentary strata that flank the high part of the range follows: a thin sequence of Bliss formation, 600 feet of El Paso formation, about 250 feet of Montoya formation, about 200 feet of Fusselman dolomite, 175 feet of Percha formation, 700 feet of Lake Valley formation and locally above this a thin section of Magdalena shale. The top beds of the Lake Valley consist of a coarse-grained, white, crinoidal limestone with large nodules of white chert. The upper part of the Lake Valley in Cooks Range resembles the white marble of the Tres Hermanas Mountains, as previously pointed out. About 40 feet of dark-gray shale containing Magdalena fossils locally overlies the Lake Valley in Cooks Range. Above this Darton mapped a thin interval of Gym (Hueco) beds and (1916, p. 37) described them as follows:

> "...it [the *Gym*] lies between the cherty limestone supposed to mark the top of the Lake Valley limestone and locally the black shale of the Magdalena formation and a 10-foot bed of conglomerate underlying red shale of the Lobo formation. Its total thickness here is

> only 25 to 30 feet, comprising 5 feet of nodular limestone at the top, 20 feet of blue limestone, and a 5-foot bed of conglomerate with some red jasper, which probably marks the base of the formation."

These units were easily found in the sequence of sedimentary rocks that dip southward from Cooks Peak. From the light-gray limestone (Darton's "blue" Gym limestone) above the jasper-containing conglomerate, the writer collected several specimens of Cherokee-type _Fusulina_ of lower Des Moines age. This proves conclusively that the "Gym" in Cooks Range is Pennsylvanian in age and readily correlated with the Magdalena formation elsewhere. The black shale containing Magdalena fossils locally underlying Darton's "Gym" is early Pennsylvanian in age. The fact that Des Moines rocks, with a conglomerate at the base, overlap older Pennsylvanian beds and Mississippian beds indicates considerable movement during Pennsylvanian time in Cooks Range. The resulting erosion was sufficient to plane off early Pennsylvanian beds except for local areas and to cut down into the Mississippian rocks prior to Des Moines deposition.

Overlying the Magdalena formation in Cooks Range is the Lobo formation. Succeeding formations include the Sarten sandstone and Colorado shale of Cretaceous age and various igneous rocks of Tertiary age. Thus, no Hueco (Gym) limestone occurs in Cooks Range.

Victorio Mountains

The pre-Hueco sedimentary rocks in the Victorio

only 25 to 30 feet [illegible] stone at the top, 20 [illegible] 5-foot bed of conglomerate [illegible] probably marks the base of the formation.

These units [illegible] sedimentary rocks [illegible] the light-grey limestone [illegible] above the jasper-containing [illegible] several specimens of [illegible] Moines age. This proves [illegible] Range is Pennsylvanian [illegible] the Magdalena formation [illegible] ing Magdalena fossils [illegible] early Pennsylvanian [illegible] with a conglomerate [illegible] beds and Mississippian [illegible] during Pennsylvanian time [illegible] erosion was [illegible] except for local [illegible] rocks prior to [illegible]

Overlying the Magdalena formation [illegible] the Abo formation [illegible] sandstone and [illegible] igneous rocks in [illegible] stone occurs in [illegible]

Volcanic Mountains

The [illegible]

Mountains include El Paso formation, Montoya formation, and Fusselman dolomite. The El Paso crops out on a small knob just north of Mine Hill. About 300 feet of Montoya is exposed on the north slope of Mine Hill and on the lower slopes of the three limestone peaks south of Victorio Peak. This section is abundantly fossiliferous and contains layers of chert. The beds on Mine Hill dip southward and those on the lower slopes of the main range dip northward under succeeding formations. Next above the Montoya formation is the Fusselman dolomite but the contact is apparently gradational. The Fusselman makes up the greater part of the three limestone peaks south of Victorio Peak and the southeastern part of Mine Hill. With regard to this Darton (1916, p. 85) states that

> "In this area the cherty beds of the Montoya are overlain by the Gym limestone, and while some Fusselman limestone may intervene, no direct evidence of its existence was obtained, and it appears to be cut out either by faulting or unconformable overlap."

The writer believes that there is a considerable thickness of Fusselman strata above the Montoya in the three limestone peaks south of Victorio Peak. The lithology matches that of Fusselman rocks elsewhere. Darton (1916, p. 37) describes the overlying Gym in this manner:

> "...the Gym limestone constitutes the higher parts of the three limestone peaks south of Victorio Peak and extending for about a mile along a northwesterly course. It appears to lie on the Montoya limestone, but some Fusselman limestone may intervene."

In addition Darton (1928, p. 341) points out that

> "The Gym limestone is overlain unconformably by about 700 feet of shale and sandstone, largely reddish, which suggests the Lobo formation (Triassic?) but may be Cretaceous or Tertiary."

Although Darton (op. cit., p. 340) gives a list of Manzano fossils from the Gym limestone in the Victorio Mountains, the writer was unable to find them. Instead, an abundant pelecypod fauna (Pl. 5) was found that Northrop places definitely in the Mesozoic and probably in the Lower Cretaceous. These fossils came from near the middle of the rocks Darton (1916, Fig. 9, p. 84) mapped as Gym. These rocks are strikingly different lithologically from the Florida Mountains section in that they contain many clastic beds. It seems, therefore, that the "Gym" sequence of the Victorio Mountains is in part Silurian (Fusselman) and in part Mesozoic in age, resting on the Montoya formation and overlain by a volcanic interval that may be either Cretaceous or early Tertiary. Thus, no Hueco (Gym) limestone occurs in the Victorio Mountains.

Hueco Rocks

General Statement

Upon examination of the principal outcrops of Darton's Gym limestone, it becomes immediately evident that the lithology from one outcrop to another is very dissimilar. The reason for this dissimilarity, as pointed out under Pre-Hueco

Rocks, is that most of the original "Gym" was misidentified and included Silurian and Cretaceous rocks. Upon reassignment of much of the stratigraphic sequence, it was found that only a minor part of the original rocks mapped as Gym were Permian in age. Therefore, the "Gym" or Hueco is greatly restricted in the stratigraphic column and also in areal distribution.

Distribution

In the Florida Mountains Hueco rocks occur only in Mine Canyon southeast of Gym Peak, N 1/2 Sec 18 and NW 1/4 Sec 17, T 26 S, R 7 W. Here they crop out in the low ridge on the south side of Mine Canyon (Pl. 6) where the ridge disappears under the bolson. The beds are underlain by Mississippian (Andrecito member of the Lake Valley formation?) rocks and overlain by a red arkosic sequence that is probably Lobo (Yeso?). Overlying the red beds is a limestone conglomerate that is probably early Cretaceous in age. The beds dip southeastward and occur as a narrow strip between valley alluvium on the east and upthrown Precambrian rocks on the west. This is the only outcrop of Hueco limestone in the Florida Mountains (Fig. 2).

In the Tres Hermanas Mountains Hueco rocks crop out on two isolated knobs (Sec 30, T 27 S, R 8 W) that are the tops of ridges extending eastward from the north and middle peaks of the mountains. These isolated outcrops appear to be faulted blocks of a once continuous section. On the north

side of the mountains there are several northward-trending ridges. These ridges consist chiefly of eastward-dipping pre-Hueco rocks but Hueco rocks crop out in two small areas, one a faulted block yielding many Permian fusulinids, and the other in normal position overlying Pennsylvanian strata. On the northwest side of the mountains where the old zinc mines are the limestone is so metamorphosed that an age determination was not made. On the west side of the range Darton mapped Gym rocks, but the writer believes that these beds are of Lower Paleozoic age. Two small outliers, one about 3 miles west of the Tres Hermanas Mountains on the road to Tomerlin and the other about 20 miles due east of the mountains near Birchfields, were also mapped as Gym by Darton. These outcrops were not visited, however, largely because of their inaccessibility.

A brief reconnaissance was made by the writer in the Robledo Mountains, northwest of Las Cruces, to determine whether rocks similar to the Hueco in the Florida Mountains and Tres Hermanas Mountains are present. The reconnaissance was made in the southeastern part of the mountains on ridges west of an old drag-line quarry. The quarry is excavated at the head of a canyon and can be reached by an old road. The north side of the quarry is a hill capped by basalt. On a ridge about one-half mile southwest of this basalt-capped hill there occurs a limestone sequence that is lithologically very similar to the Hueco elsewhere. It consists of

side of the mountains there was [illegible] the [illegible]
ridges. These ridges [illegible]
pre-Hueco [illegible]
one a faulted block [illegible]
the other in normal [illegible]
On the northwest side of [illegible]
mines are the limestones [illegible]
termination [illegible]
Darton mapped [illegible]
beds are of lower [illegible]
about 3 miles west of the [illegible]
to [illegible]
mounta[illegible]
Darton. [illegible]
be [illegible]

A brief reconnaissance was made by the writer [illegible]
Robledo [illegible]
whether rocks similar [illegible]
and [illegible]
was made in the [illegible]
west of [illegible]
the [illegible]
north side of the [illegible]
rifle [illegible]
hill [illegible]
very similar to [illegible] Hueco [illegible]

medium-bedded, dark-gray to black limestone that weathers medium-gray and contains a fauna very similar to the Hueco fauna. Both above and below this limestone are red clastic strata interbedded with limestone. The writer believes that this complete sequence is equivalent to the Hueco that crops out in the Florida Mountains, although considerably thicker, and is a Permian section which indicates intertonguing of limestone wedges on the south with Abo or Yeso red beds on the north. Such a relationship is shown in Fig. 4.

Lithology

The Hueco limestone consists chiefly of thin-bedded, dark-gray limestone. In Mine Canyon the lower beds are thick to massive, dark- to medium-gray, weathered medium-gray, and finely crystalline. The lower part of the sequence is very fossiliferous. Chert is generally lacking except for scattered grains and as replacement of the fossils. The thin beds of limestone are partly covered in slopes. About 200 feet above the base the limestone becomes thinner bedded, contains shaly beds and is noticeably lighter in color. Near the top of the section the strata contain some bedded chert, become buff, olive drab, and pinkish and grade upward into the red arkosic, conglomeratic rocks overlying the Hueco. The top of the Hueco was placed at the top of the uppermost limestone bed, but it is possible that the red sequence overlying the Hueco and underlying the limestone conglomerate of probably Cretaceous age is also the same age as the Hueco.

medium-bedded, [illegible]

medium-gray and [illegible] fauna [illegible]

fauna. Both [illegible]

strata interbedded with limestone [illegible]

this complete [illegible] equivalent [illegible]

out in the [illegible]

and is a [illegible] formation [illegible]

limestone was [illegible]

the north. [illegible]

Lithology

The Ruedo limestone consists [illegible]

dark-gray limestone [illegible]

thick to massive, [illegible]

gray, and finely [illegible]

is very fossiliferous. [illegible]

for scattered [illegible]

thin beds of [illegible]

200 feet above the [illegible]

contains [illegible]

the top of the [illegible]

become buff, olive, [illegible]

the red [illegible]

The top of the Ruedo [illegible]

limestone bed, [illegible] it is possible [illegible]

lying the Ruedo and [illegible]

probably Cretaceous [illegible]

A detailed measured section of the Hueco in the Florida Mountains is given below.

Mine Canyon Section

Measured on the southeast side of the canyon. N 1/2 Sec 18 and NW 1/4 Sec 17, T 26 S, R 7 W.

Unit	Description	Thickness (feet)
	Top (limestone conglomerate above)	
Red Clastic Interval		
68	Arkosic conglomerate: dark-red; coarse-grained	2
67	Limestone conglomerate: matrix medium-gray; fine-grained; contains limestone granules and cobbles	1
66	Claystone: thin-bedded; brick-red; calcareous	7
65	Arkosic conglomerate: dark-red; coarse-grained	9
64	Limestone conglomerate: medium-bedded; matrix medium-gray; contains pebbles and cobbles of limestone	4
63	Calcareous claystone: thin-bedded; brick-red	3
	Total:	26
HUECO LIMESTONE		
62	Limestone: thin-bedded; greenish-brown to gray, weathered buff; medium-grained	15
61	Covered interval	52
60	Limestone: thin- to medium-bedded; buff- to medium-gray, weathered light-gray to pinkish; fine-grained; brecciated in part	9

Unit	Description	Thickness (feet)
59	Covered interval	39
58	Limestone: thin-bedded; mottled light pinkish-gray; breccia structure; some chert fragments	1
57	Shale: thin-bedded; purple	3
56	Limestone: massive; mottled light pinkish-gray; brecciated in part; black chert lenses near top	6
55	Partly covered: gully; pinkish-red limestone and shale	20
54	Limestone: thin-bedded; dark-gray to black, weathered light-gray; very fine grained; surface weathered very hackly	12
53	Covered: probably shaly limestone, buff, gray, and red	16
52	Dolomite: calcareous; thin-bedded; red- to mauve, weathered pink	4
51	Shaly limestone: thin-bedded; buff, gray, and red; partly covered	12
50	Limestone: thin-bedded; dark-gray, weathered gray- to olive drab with hackly surface; fine-grained	16
49	Limestone: thin-bedded; dark-gray, weathered olive drab; very fine-grained; dense	1
48	Covered interval	2
47	Limestone: medium-bedded; dark-gray, weathered medium-gray; very fine-grained	2
46	Covered: probably limestone; weathered buff	4
45	Limestone: thin- to medium-bedded; dark-gray, weathered medium-gray; very fine grained	4

Unit	Description	Thickness (feet)
44	Covered in part: probably thin-bedded limestone	14
43	Limestone: medium-bedded; dark-gray to black; fine-grained; contains irregular chert-incrusted dolomite nodules	5
42	Limestone: thin-bedded; dark-gray; medium-grained	16
41	Limestone: medium- to thick-bedded; dark-gray, weathered medium-gray; fine-grained; contains nodules of chert-incrusted dolomite that weather brown; has beds or bands of black chert 2-3 inches thick	21
40	Covered slope	14
39	Limestone: thin-bedded; medium-gray; fine-grained	2
38	Limestone: thin-bedded; dark-gray; fine- to medium-grained; some fossils	4
37	Covered interval	6
36	Limestone: thin-bedded; dark-gray; fine- to medium-grained; fossiliferous	3
35	Covered: probably thin beds of limestone and gray clay shale	22
34	Limestone: medium-bedded; medium-gray, weathered medium-gray; fine-grained; very fossiliferous; contains some chert lenses at top	12
33	Covered: probably gray shale and thin-bedded limestone	9
32	Limestone: medium-bedded; medium-gray, weathered gray; fine-grained ...	4
31	Covered: probably gray shale and laminated limestone	6

Unit	Description	Thickness (feet)
30	Limestone: medium- to thick-bedded; medium-gray, weathered medium-gray; fine-grained; very fossiliferous, contains large gastropods	74
29	Limestone: thick- to massive-bedded; medium-gray, weathered medium-gray; fine-grained; fossiliferous; contains *Composita* sp., corals and many gastropods	81
28	Covered interval	22
27	Limestone: thick-bedded; lower part massive; dark-gray, weathered medium-gray; fine-grained; fossiliferous with many echinoid spines at the base, occurring in the matrix surrounding incorporated blocks of underlying beds	15

Base (Lake Valley? below)

Total Hueco: 548

The section of Hueco exposed in the Tres Hermanas Mountains is a small one but there is little question as to its correlation with the Hueco in the Florida Mountains. Lithologically and faunally they are almost identical. The most noticeable difference is the degree of silicification of the Hueco in the Tres Hermanas Mountains. The limestone is thin to medium bedded, dark gray, weathered dark gray, and fine to medium crystalline in texture. This sequence corresponds to the lower part of the section in the Florida Mountains; the upper, lighter limestone beds exposed in the Florida Mountains are apparently covered by bolson deposits

in the Tres Hermanas Mountains. The same rich fauna that occurs in the lower beds in the Florida Mountains also occurs in the Tres Hermanas Mountains.

The measured lithologic sequence of the Hueco limestone in the Tres Hermanas Mountains is given below. The section was measured on ridges that extend eastward from the north peak, Sec 30, T 27 S, R 8 W.

Unit	Description	Thickness (feet)
	Top (covered)	
23	*Limestone*: thin-bedded; dark-gray, weathered dark-gray; medium-grained; abundant lacy granular and bedded chert; shaly; fossiliferous	14
22	*Limestone*: thin- to medium-bedded; dark-gray, weathered dark-gray; fine-grained; fossiliferous, many gastropods; some bedding planes covered with *Composita* sp.	51
21	*Siliceous limestone*: thin-bedded; white, weathered rusty-brown; medium-grained; has wavy, white lines of epigenetic calcite on bedding surfaces	2
20	*Covered interval*	4
19	*Limestone*: thin- to medium-bedded; dark-gray, weathered medium- to dark-gray; fine-grained; contains rusty chert grains; fossiliferous; shale stringers separating beds 1-3 feet thick	93
18	*Porphyritic igneous sill*	9.5
17	*Covered interval*	4.5

Unit	Description	Thickness (feet)
16	Limestone: thin-bedded; dark-gray, weathered dark-gray; medium-grained; fossiliferous, bellerophon-type gastropods	2
15	Limestone: medium-bedded; medium-gray weathered medium-gray; medium-grained; some lacy chert nodules that weather rusty, some resembling fossils	10

Base (Magdalena below)

Total Hueco: 180.5

Paleontology

The lower beds of the Hueco limestone in the Florida Mountains and also those in the Tres Hermanas Mountains have yielded a rich fauna, predominantly gastropods, but also containing pelecypods, brachiopods, corals, bryozoans, echinoid spines and plates, and fusulinids. A collection of the gastropods was sent to J. Brookes Knight at the National Museum for identification. Ellis L. Yochelson of the Paleontology & Stratigraphy Branch of the U. S. Geological Survey, under the supervision of Knight, identified the specimens. Yochelson's (written communication, October 14, 1952) report and identifications follow:

> "The following is a report on six collections of silicified gastropods from the Gym formation. Preservation is fairly good, but coarseness of silicification has obscured details on many of the smaller specimens.
>
> Five collections are from the Florida Mountains. The gastropod fauna is so similar to that of the Hueco formation that there is no doubt that they are of the same age. An attempt was made to correlate the various Gym collections with different divisions of the Hueco.

However, the evidence is inconclusive; possible correlations can be made when more is known of the Hueco gastropods. The divisions used for the Hueco are taken from King and Knight (1945), USGS OGI Map 36.

The sixth collection, from the Tres Hermanas mountains, also seems to be equivalent to the Hueco formation. It should be noted that this is the smallest collection of the six, and only one species is present.

The Hueco gastropod fauna is completely undescribed. For this reason, no specific and often no generic names can be given. The fauna is under study by J. B. Knight and associates and may be published within a few years. Dr. Knight has worked with me in this report and has checked my identifications.

The age of the Hueco and the Gym cannot be determined from the collections submitted. The placement of the Pennsylvanian-Permian boundary in West Texas area, is in dispute. Many geologists and paleontologists favor placing it at the base of the Wolfcamp formation. This formation is officially classified as Permian (?) by the U. S. Geological Survey. Studies in progress by members of the U. S. National Museum staff will, when completed, be of considerable value as evidence bearing on this question.

Florida Mts. Unit 27

1 *Platyzona* sp.	Similar to an undescribed species from the middle Hueco, but somewhat larger.
1 *Paragoniazona* sp.	Probably a new species; this genus is not reported from the Hueco.
1 *Glyptospira* sp.	Undescribed species restricted to Hueco and its equivalents. Specimen seems closest to a subspecies from the middle Hueco.
2 *Trachydomia* sp.	1 specimen quite similar to an undescribed species from the Hueco. The other specimen may be an individual variant; it is somewhat higher spired.
2 *Straparolus* (*Euomphalus*) sp.	Very similar to an undescribed species from the middle Hueco and Talpa limestone of North Central Texas.

However, the evidence from [illegible] [illegible] cions [illegible] more [illegible] of [illegible] gastropods [illegible] the [illegible] from [illegible] (1[illegible]), 1906, [illegible].

The sixth collection, from [illegible] also seems to [illegible] should be [illegible] the six, [illegible].

The Hueco [illegible] For this reason, [illegible] can be given. The [illegible] and [illegible] Dr. Knight [illegible] checked by [illegible].

The age of the [illegible] from the collections [illegible] Pennsylvanian-Permian [illegible] in [illegible] placing [illegible] formation [illegible] the U. S. Geological Survey [illegible] members of the [illegible] complete [illegible] on this question.

[illegible]

1 Platyceras sp. [illegible]

1 Paraconularia [illegible]

1 [illegible] sp. [illegible]

2 [illegible] sp. [illegible]

2 Straparollus [illegible]

[illegible]

1 pseudozygopleurid.	Poorly preserved sinistral specimen. A sinistral species is known from the middle Hueco.
2 unidentified.	1 fragment of a murchisonid 1 fragment of a pleurotomarid
1 *Meekospira* sp.	Specimen similar to a species in the lower and middle Hueco.

Florida Mts. Unit 29

12 *Glyptospira* sp.	An undescribed Hueco species. Higher spired than specimens of Unit 27.
8 New genus near *Peruvispira*.	Conspecific with species in lower and middle Hueco.
3 *Glabrocingulum* sp.	Ornamentation poorly preserved, but general shape is that of Hueco species.
2 *Worthenia* sp.	Very close to an undescribed species from the lower Hueco, Wolfcamp, and Talpa limestone.
6 *Yunnania* sp.	Conspecific with an undescribed species from lower and middle Hueco.
4 New genus related to *Donaldina*.	Found in Hueco limestone.
4 *Soleniscus* sp.	May be referable to a variable species in the Hueco.
2 *Stegocoelia* (New subgenus) sp.	Specimens appear to be conspecific with an undescribed species in the lower and middle Hueco.
7 *Pseudozygopleura* sp.	Three different species. Two species are conspecific with middle Hueco species; the other is somewhat similar to Hueco species.
3 New genus related to *Pseudozygopleura*.	Genus is known only from lower and middle Hueco, but this is a new species.

5 Orthonema sp.	Two species conspecific with lower and middle Hueco undescribed species.
2 New genus related to Anomphalus.	Conspecific with an undescribed Hueco species.
5 Meekospira sp.	Conspecific with an undescribed lower and middle Hueco species.

The following are present, but are not specifically identifiable:

3 Bellerophon sp.
1 Straparolus (Euomphalus) sp.
2 Goniasma sp.
1 Naticopsis sp.
1 Meekospira sp.
1 Donaldina sp.
25 Not identified

Florida Mts. Unit 30

2 New genus related to Peruvispira.	Conspecific with lower and middle Hueco species. Same as in Unit 29.
6 Glabrocingulum sp.	Conspecific with an undescribed species from the lower Hueco.
4 Worthenia sp.	Two species present. One close to an undescribed species from lower Hueco, Wolfcamp, and Talpa limestone; the other related to a Hueco species.
4 Yunnania sp.	Conspecific with an undescribed species from lower and middle Hueco. Same as Unit 29.
6 Glyptospira sp.	Conspecific with a Hueco species.
1 New genus.	Not previously known as far as I can determine.
1 Stegocoelia (Stegocoelia) sp.	Similar to a Hueco species. Preservation is too poor to be absolutely sure.

3 *Stegocoelia* (New subgenus). A new subgenus occurring in the Hueco; species not identifiable.

2 *Straparolus* (*Euomphalus*) sp. Conspecific with an undescribed Hueco species.

4 *Straparolus* (*Amphiscapha*) sp. Conspecific with an undescribed Hueco species.

1 *Omphalotrochus obtusispira* (Shumard). Similar to species in the Wolfcamp. (This form redescribed by Girty in 1937, Jour. Paleo. vol. 11, p. 202, plate 33).

3 New genus related to *Omphalotrochus*. Closest to specimens in the middle Hueco. This genus has not been studied in detail as yet.

5 *Orthonema* sp. Conspecific with an undescribed species from lower and middle Hueco.

8 New genus related to *Orthonema*. Genus occurs in lower and middle Hueco, but this is a different species.

The following are present but are not specifically identifiable:

4 *Soleniscus* sp.
1 *Pseudozygopleura* sp.
3 *Meekospira* sp.
4 *Bellerophon* sp.
1 *Naticopsis* sp.
1 *Cylindritopsis* sp.
26 unidentified

Florida Mts. Unit 32

27 New genus related to *Peruvispira*. Conspecific with an undescribed species in the lower and middle Hueco. Same species as in Unit 29.

6 New genus related to *Anomphalus*. Conspecific with an undescribed species in the lower and middle Hueco. Same species as in Unit 30.

4 Worthenia sp.	3 specimens not specifically identifiable; the fourth, a species ranging through the Hueco.
6 Yunnania sp.	Conspecific with a lower and middle Hueco species. Same as in Unit 29.
3 New genus related to Omphalotrochus.	Previously known only from the Leonard of the Glass Mountains.
1 Omphalotrochus sp.	Definitely a Hueco species. Closest to specimens from 3 Mile Mountain area near Van Horn, Texas.
5 Glyptospira sp.	Definitely a Hueco species.
6 Soleniscus sp.	Quite similar to an undescribed lower Hueco species.
1 Donaldina sp.	Poorly preserved but appears similar to a middle Hueco species.
7 Meekospira sp.	Conspecific with an undescribed lower and middle Hueco species. Same as in Unit 29.
9 Orthonema.	Two species, both very close if not identical, with lower and middle Hueco species.
4 New genus near Orthonema.	Genus at present known only from lower Hueco; species not identifiable.
2 Cylindritopsis sp.	Conspecific with an undescribed middle Hueco species.
2 Goniasma sp.	Some similarity to a middle Hueco species. Fine detail is eroded, making identification uncertain.

Following are present but are not specifically identifiable:

1 Knightites (Retispira) sp.
5 Bellerophon sp.
2 Glabrocingulum sp.
1 Naticopsis sp.
6 Pseudozygopleurids. At least three genera, all poorly preserved.

Florida Mts. Unit 34

1 *Knightites* (*Retispira*) sp.	Seems to be conspecific with an undescribed Hueco species, but a more mature specimen is needed to be certain.
1 *Glabrocingulum* sp.	Conspecific with an undescribed Hueco species.
2 New genus related to *Peruvispira*.	Conspecific with an undescribed species in lower and middle Hueco. Same as in Unit 29.
2 *Goniasma* sp.	Some similarity to a middle Hueco species. Same as in Unit 32.
8 *Orthonema* sp.	Conspecific with lower and middle Hueco species. Same as in Unit 29.
2 *Yunnania* sp.	Both are fragments. What little there is present resembles a Hueco species.
3 *Meekospira* sp.	Conspecific with an undescribed lower and middle Hueco species. Same as in Unit 29.
1 *Omphalotrochus* sp.	Specimen seems closer to specimens from lower Hueco, than from higher in the formation.

The following are present, but are not specifically identifiable:

1 *Worthenia* sp.
1 *Cylindritopsis* sp.
1 ?*Baylea* sp.

Tres Hermanas Mts. Unit 22

9 *Knightites* (*Retispira*) sp.	Identical or at least very closely related to an undescribed species in the Hueco formation. Same as in Unit 34 of Florida Mountains."

In addition to the gastropods of Yochelson's report above, the following forms were identified by the writer from the Hueco limestone:

Florida Mountains

Foraminifera:	*Staffella* sp. a small globose, primitive and long-ranging fusulinid of insignificant value. It ranges from Atokan through Guadalupian in age.
Echinoidea:	*Echinocrinus* sp., spines and plates common.
Bryozoa:	Branching and fenestelloid types.
Brachiopoda:	Productids, probably *Marginifera* sp. *Composita mexicana*? *Composita subtilata*?
Pelecypoda:	*Nucula* sp. *Astartella* sp. *Pleurophorus*? sp. *Parallelodon* sp.
Scaphopoda:	*Dentalium* sp. *Plagioglypta* sp.

Tres Hermanas Mountains

Algae:	An encrusting type over large gastropod shells.
Foraminifera:	*Staffella* sp. *Schwagerina* sp. Silicified specimens of Wolfcamp age.
Echinoidea:	*Echinocrinus* sp., spines and plates.
Bryozoa:	Branching and fenestelloid types.
Brachiopoda:	*Meekella striatocostata* *Spirifer* sp. *Wellerella* sp. *Composita mexicana*? *Marginifera* sp.

Pelecypoda: *Astartella* sp.
  Nucula sp.
  Parallelodon? sp.

Gastropoda: The gastropod collection sent to the National Museum from the Tres Hermanas Mountains contained only one genus. However, several other genera do occur and are as follows:
  Cymatospira? sp.
  Pharkidonotus sp.
  Meekospira sp.
  Omphalotrochus sp., probably *O. obtusispira*
  Orthonema sp.
  Straparolus (*Amphiscapha*) sp.
  Bellerophon sp.
  Baylea? sp.
  Yunnania? sp.
  Soleniscus sp.
  Pseudozygopleura? sp.

Scaphopoda: *Dentalium* sp.
  Plagioglypta sp.

Robledo Mountains

Foraminifera: *Staffella* sp.
  Pseudoschwagerina sp. Wolfcamp age
  Triticites sp. Wolfcamp age

Anthozoa: numerous cup corals

Echinoidea: *Echinocrinus* sp., spines and plates

Brachiopoda: *Composita* sp.
  Phricodothyris sp.
  Wellerella sp.

Gastropoda: *Euomphalus*? sp.
  Numerous other small forms not specifically identifiable.

The above forms in the Robledo Mountains came from a dark-gray limestone that is lithologically similar to the Hueco farther south. It appears, therefore, that the Hueco

definitely crops out in the Robledo Mountains, and is equivalent in age to some part of the Abo and possibly the Yeso formations.

It is worthy of note that the fauna occurring in the Florida Mountains and also in the Tres Hermanas Mountains is preserved very well by silica. The silicification takes the form of beekite rings on the surface of each fossil, forming small concentric doughnut-like circlets of bluish-white, translucent to opaque chalcedony. Howell (1931, p. 1104) states that beekite rings form under conditions of subaerial erosion and weathering and cites examples of well cuttings containing these rings as coming from a zone immediately below an erosional unconformity. Krumbein (1942, p. 56) also lists beekite rings as a criterion for the recognition of subaerial weathering. This form of silicification in the above fauna could be formed either during a period of erosion in the Permian or at the present time. It is believed, however, that the phenomenon is a result of present surface weathering because there seems to be less silicification of the fossils and fewer beekite rings formed a small distance beneath the surface of the limestone.

Post-Hueco Rocks

General Statement

The post-Hueco rocks of Luna County include sandstone, shale, limestone, conglomerate, and volcanic rocks of

Mesozoic and Cenozoic age. Their ages, names, thicknesses, and general character are given in the table below.

Post-Hueco Rocks of Luna County

(modified after Darton, 1916)

Age	Name	Thickness (feet)	Character
Quaternary	bolson deposits	1,665 ±	sand, clay, gravel
Tertiary	Agglomerate	2,000 +	red sand, shale, volcanic fragments, and igneous sheets
Cretaceous	Colorado shale	300 +	gray shale with limestone and sandstone
	Sarten sandstone	300	massive gray sandstone, in part quartzitic
	limestone of Comanchean age	0-400	limestone conglomerate, gray slabby limestone, and sandy shale
Permian(?)	Lobo formation	25-500	reddish shale, impure limestone, and conglomerate

The post-Hueco rocks in Luna County were not studied in great detail and will not be considered at length here. However, these rocks were carefully examined in order to establish the upper limits of the Hueco in each outcrop area.

Florida Mountains

Overlying the Hueco in the Florida Mountains is a sequence of red shale, red siltstone, and limestone conglomerate. Some of the beds are arkosic. These strata may

be the same age as the Hueco, or may represent part of Darton's Lobo formation. Kelley (1949, p. 23) stated that the Lobo formation represents continental deposition during the Permian period (Harrison Schmitt expressed to Kelley the belief that the Lobo was most likely equivalent to the Abo). More recently, however, Kelley (oral communication) believes that the Lobo may be Yeso or possibly Jurassic in age. No attempt was made to definitely establish the age of the red beds overlying the Hueco in the Florida Mountains, but it is believed that the sequence probably represents some part of the Yeso.

Overlying the red beds is a thick interval of gray limestone conglomerate that contains fragments of Hueco limestone as well as fragments of lower Paleozoic limestone (Pls. 7 and 8). Lithologically, this limestone conglomerate (and possibly the underlying red beds) resembles Lasky's (1947, pp. 16-18) Broken Jug limestone of Lower Cretaceous age. The limestone conglomerate is concealed eastward by alluvium and bolson deposits and cut off by a fault toward the southwest. This fault brings Precambrian granite in contact with all the sedimentary beds that crop out in Mine Canyon (Pl. 6).

Tres Hermanas Mountains

Post-Hueco rocks in the Tres Hermanas Mountains consists wholly of Quaternary bolson deposits and scattered Tertiary fragmental volcanic rocks.

Cooks Range

Inasmuch as no Hueco occurs in Cooks Range, "post-Hueco rocks" necessarily rest on Pennsylvanian, Mississippian and older rocks. These younger strata include: the Lobo formation; limestone of Comanche age and the Sarten sandstone, both of Lower Cretaceous age; the Colorado shale of Upper Cretaceous age; a great thickness of Tertiary pyroclastics and agglomerate; and Quaternary bolson deposits.

Victorio Mountains

No Hueco limestone crops out in the Victorio Mountains; instead, there are clastic limestone beds that contain probable Lower Cretaceous fossils (Pl. 5). Overlying the limestone is a section of red shale and sandstone that may be either Cretaceous or Tertiary in age. Overlapping the sedimentary rock is a volcanic sequence of Cretaceous or early Tertiary age.

Elsewhere in Luna County considerable thicknesses of Tertiary volcanic rocks border the mountain ranges and form isolated hills. In the basins between the mountain ranges Quaternary bolson deposits have accumulated in unknown thicknesses.

CONCLUSIONS

Early Paleozoic History

In order to visualize better the surface upon which deposition of the Hueco took place, it perhaps is best to examine the sequence of events in the deposition and erosion of pre-Hueco rocks.

The deposition of lower Paleozoic rocks in southern New Mexico took place on a slowly subsiding shelf covered by shallow seas. This shelf was transitional between the relatively stable land area to the north in central New Mexico and the deeper part of the basin in Mexico. Deposition was continuous throughout lower Paleozoic time except for epeirogenic uplift with resulting erosion or nondeposition.

Previous work by Imlay (1939, p. 1741) and Kellum (1944, p. 305) has shown that Paleozoic rocks (all but Silurian which have not been recognized anywhere in Mexico) occur in northern Mexico in considerable thickness and that they thin toward the north. In parts of central New Mexico Pennsylvanian beds lie directly on Precambrian granite. Therefore, a wedge of lower Paleozoic rocks underlies Pennsylvanian strata; this wedge is the result, in large part, of pre-Pennsylvanian erosion which truncated succeedingly older beds farther north (Kelley and Silver, 1952, p. 224, Fig. 24). There is some evidence that pre-Mississippian rocks extended much farther north than their present

wedge-edges; that they did extend northward into the northern part of the State is indicated by the lack of near-shore depositional character of the rocks and by their apparently slight northward thinning (op. cit., p. 78-79). The fact that Mississippian outcrops are scattered over the central and northern parts of the State indicates that that system was once much more extensive. The above described relations are shown diagrammatically by means of a cross section from the Caballos Mountains southward to the Tres Hermanas Mountains (Fig. 4). Post-Pennsylvanian erosion accounts for the absence of Pennsylvanian rocks in the Florida Mountains. In discussing the Pennsylvanian-Permian contact in southern New Mexico, Thompson (1942, p. 20) states that

> "...in an area from Cooks Range on the north to the Florida Mountains on the south and apparently extending southeastward, considerable post-Pennsylvanian deformation and subsequent pre-Permian erosion took place. Along this area the Pennsylvanian-Permian contact bevels the entire Pennsylvanian system and cuts down through a large portion of the lower Paleozoic section."

Origin and Environment

The early Permian sea existed in southern New Mexico as a regressive phase of the Pennsylvanian sea. This is indicated by the change from marine to terrestrial facies toward the north in central New Mexico. The sea was shallow and the adjacent land low, as indicated by the paucity of clastic sediments. The lithologic character and faunal content of the Hueco suggests deposition in an infraneritic

wedge-edges that [illegible] [illegible] into the northern
part of the State is influenced by the lack of, or
depositional character of, the [illegible] by their [illegible]
slight northward thinning (op. cit., p. [illegible]). [illegible]
that Mississippian outcrops are scattered over the central
and northern parts of the State indicates that the [illegible]
was once much more extensive. The [illegible] [illegible] relations
are shown diagrammatically by graph of a [illegible] section from
the Caballo Mountains southward to the Franklin Moun-
tains (Fig. 4). Post-Pennsylvanian erosion accounts for the
absence of Pennsylvanian rocks in [illegible] areas. In
discussing the Pennsylvanian-Permian contact in south-central
New Mexico, Thompson (1942, p. 20) states that:

> "...in an area of great extent [illegible] [illegible]
> [illegible] Mountains on the south [illegible] [illegible] [illegible]
> Pennsylvanian [illegible] conformable [illegible] [illegible] ero-
> sion and overlap [illegible] [illegible] [illegible] [illegible].
> Along this area of Pennsylvanian-Permian contact the
> entire Pennsylvanian system [illegible] [illegible] through
> large portions of the lower Paleozoic rocks."

[illegible] and Early Permian

The early Permian seas extended northward [illegible] as a
regressive phase of the Pennsylvanian sea. This is
indicated by the change [illegible] [illegible] [illegible]
toward the north in central New Mexico [illegible] [illegible]
and [illegible] [illegible] [illegible] [illegible] [illegible] of
clastic sediments. The [illegible] [illegible] [illegible] [illegible] ex-
tent of the Hueco [illegible] [illegible] in [illegible]

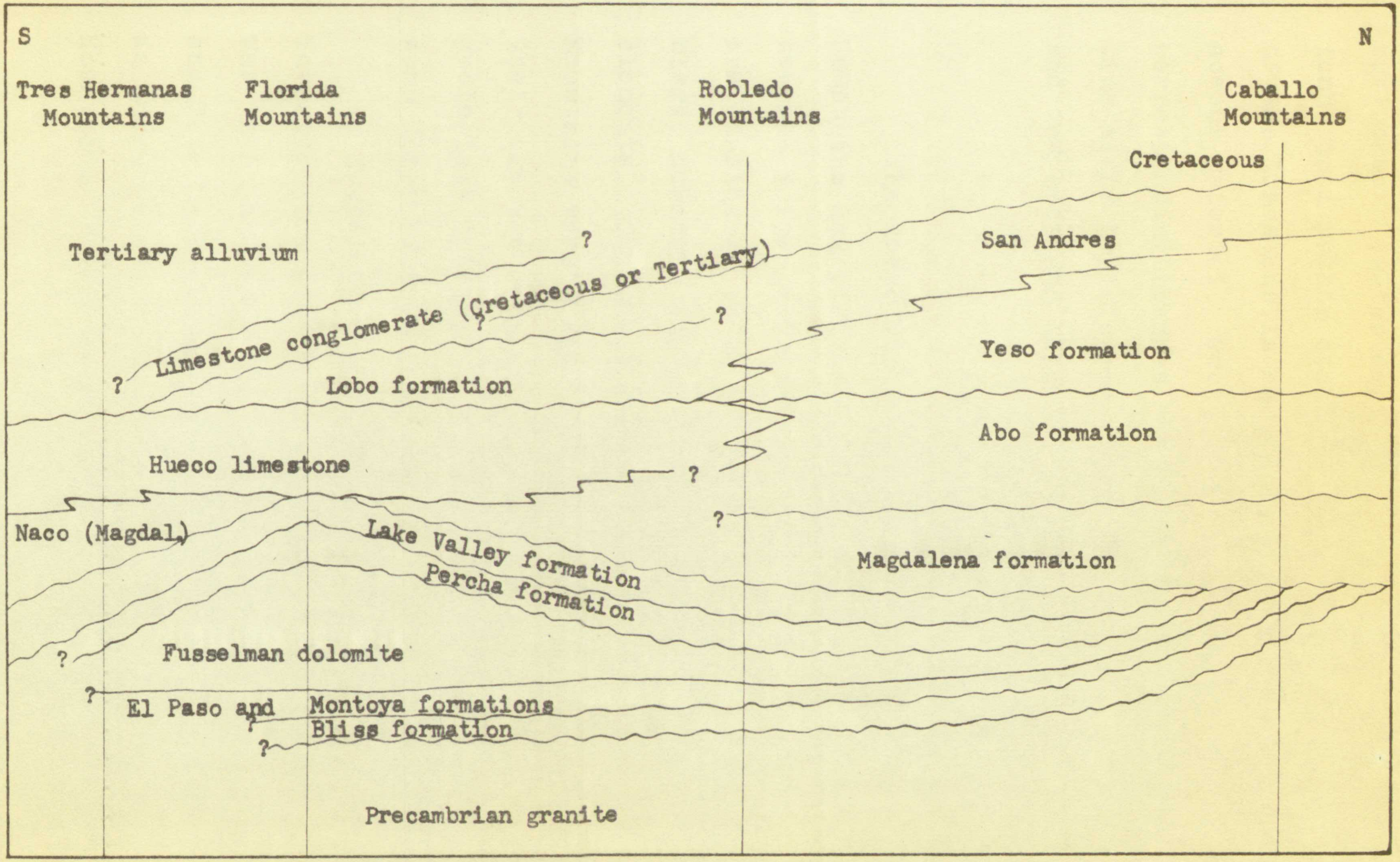

Figure 4. Diagrammatic Cross Section of Southern New Mexico

environment (water depth 120-600 feet), relatively far from land, on a rather stable shelf. The predominantly dark color of the limestone is caused by the inclusion of much carbonaceous material. Oscillatory movements of sea level and corresponding changes in the shoreline throughout Permian time might be inferred from the interdigitation of marine and red beds and also by the distribution of the deposits.

Age and Correlation

The Hueco limestone in the Florida and Tres Hermanas Mountains has yielded a prolific fauna of small gastropods, several large gastropods, fusulinids and other forms which are considered to be Permian (Wolfcamp) in age. The assemblage, however, includes Pennsylvanian as well as Permian elements. The fusulinids from the Hueco in the Tres Hermanas Mountains were a deciding factor in the age determination; their age was determined as Wolfcamp (cf. Hueco). Many geologists consider Wolfcamp Permian but it may also include some Upper Pennsylvanian as well.

Yochelson's report on the fauna collected for this investigation has been previously discussed. His conclusion was that the fauna from the "Gym" limestone of the Florida and Tres Hermanas Mountains is identical with the Hueco fauna as known in the Hueco Mountains and the southern Sacramento Mountains. Therefore, this limestone sequence is correlated

environment (w [illegible]) [illegible] from

land, on a rather stable shelf. [illegible]

of the limestone is [illegible]-

aceous material. [illegible]

corresponding changes in the [illegible]

time might be inferred from the [illegible]

and red beds and [illegible] distribution of [illegible].

Age and Correlation

The Hueco limestone in the [illegible]

Mountains has yielded a [illegible]

several large gastropods [illegible]

are considered to be Permian [illegible]. The assem-

blage, however, includes Pennsylvanian as well as Permian

elements. The fusulinids from the [illegible]

Mountains were a [illegible]

their age was determined as Wolfcamp [illegible]

geologists consider Wolfcamp [illegible]

some Upper Pennsylvanian as [illegible].

Yochelson's report [illegible]

investigation [illegible]

was that the fauna from the "Hueco" limestone of the [illegible]

and Tres Hermanas Mountains is [illegible]

as known in the Hueco Mountains and the [illegible]

Mountains. Therefore the [illegible]

with the Hueco limestone of southeastern New Mexico and western Texas.

Nomenclature

The Gym limestone was named by Darton in 1916 (p. 35) for exposures on Gym Peak in the Florida Mountains. The name Hueco was first introduced by Richardson in 1904 (pp. 32-38) for outcrops in the Hueco Mountains, El Paso County, Texas. The Hueco originally included Mississippian, Pennsylvanian, and Permian rocks but the name has been restricted to the upper part which the U. S. Geological Survey classes as Permian (?) in age (Wilmarth, 1938, p. 991). Many geologists regard the Hueco as Permian. Therefore, it is suggested that the name Gym be abandoned in favor of the term Hueco for the following reasons:

1. The Gym limestone, as originally described, and the Hueco limestone are identical, at least with respect to faunal content.
2. The rocks on Gym Peak, the type locality of the Gym, are Fusselman (Silurian) and Montoya (Ordovician) instead of Permian.
3. The name Hueco has priority over the name Gym.
4. The Gym, as originally mapped, was restricted to several isolated outcrops, all in Luna County, New Mexico, and included rocks of very different lithology and age.

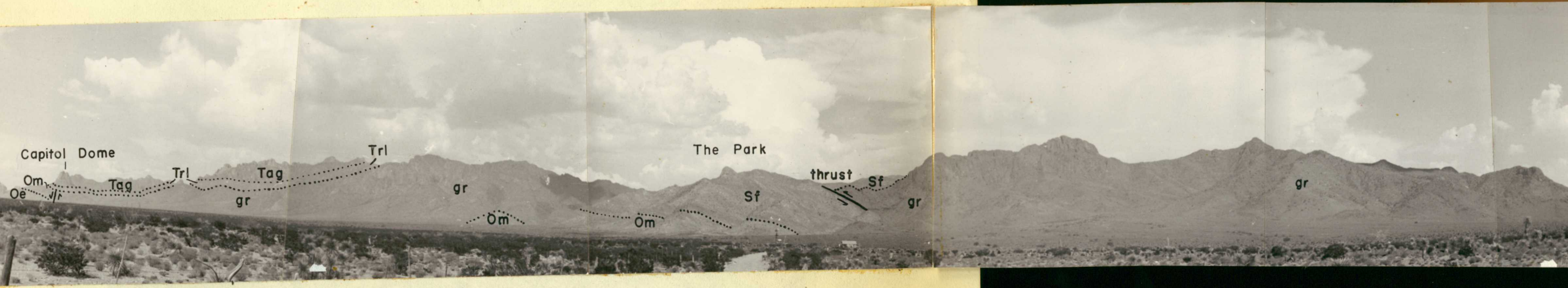

Plate 1. Panorama of west side of Florida Mountains. View toward the east; Precambrian granite (gr); El Paso formation (Oe); Montoya formation (Om); Fusselman dolomite (Sf); Lobo formation (TRl); Volcanic agglomerate (Tag).

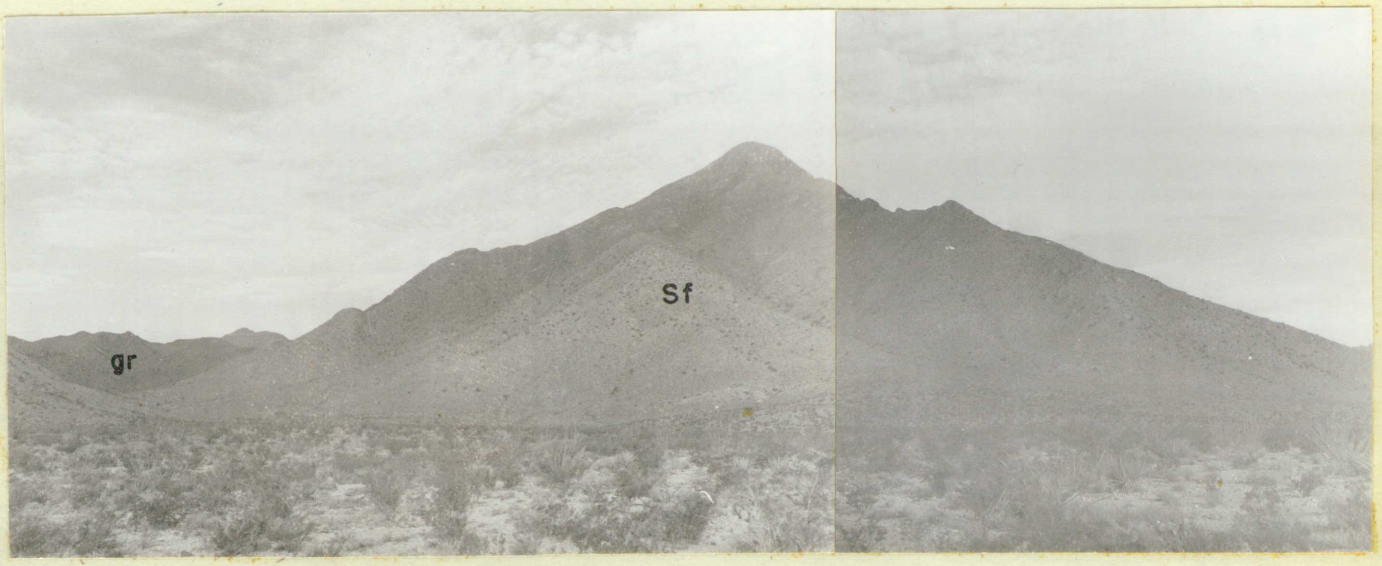

Plate 2. Gym Peak, southeastern Florida Mountains.
View northwest from Mine Canyon;
Fusselman dolomite (Sf);
Precambrian granite (gr).

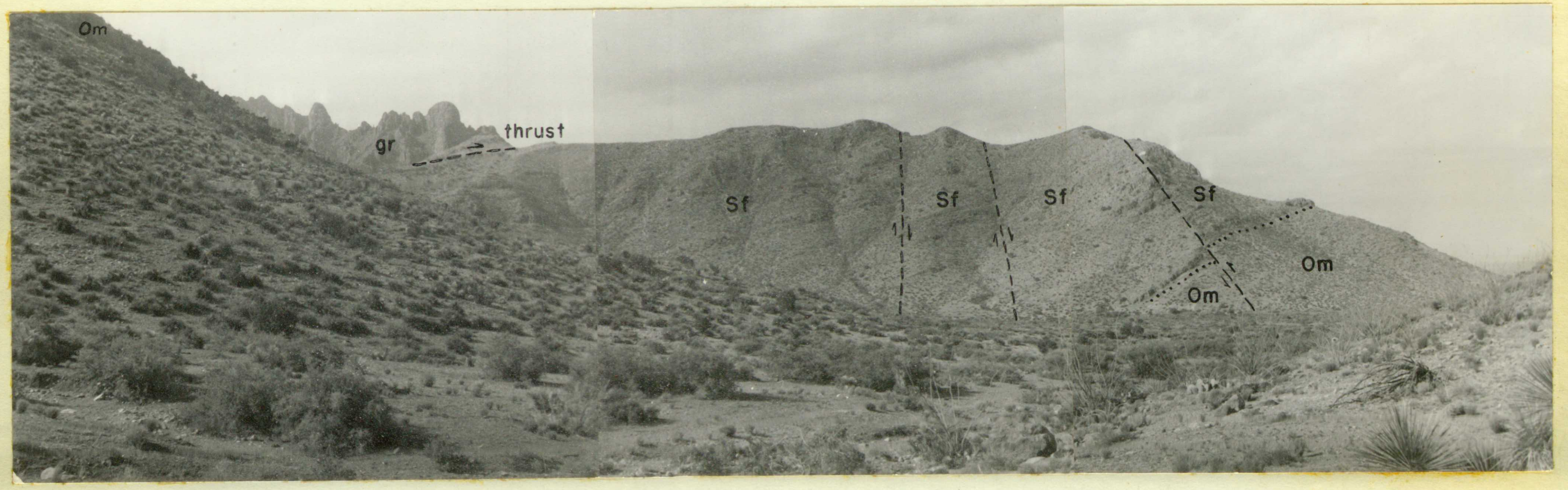

Plate 3. View southwest of lower Paleozoic rocks in The Park. Precambrian granite (gr); Montoya formation (Om); Fusselman dolomite (Sf).

Plate 4. North Peak of Tres Hermanas Mountains. View southeast. Ridges extending northeast of peak are Paleozoic rocks; light band in eastern ridge to left is Lake Valley ? marble.

Plate 5. Darton's Gym limestone of Victorio Mountains. Large pelecypods are apparently of Cretaceous age.

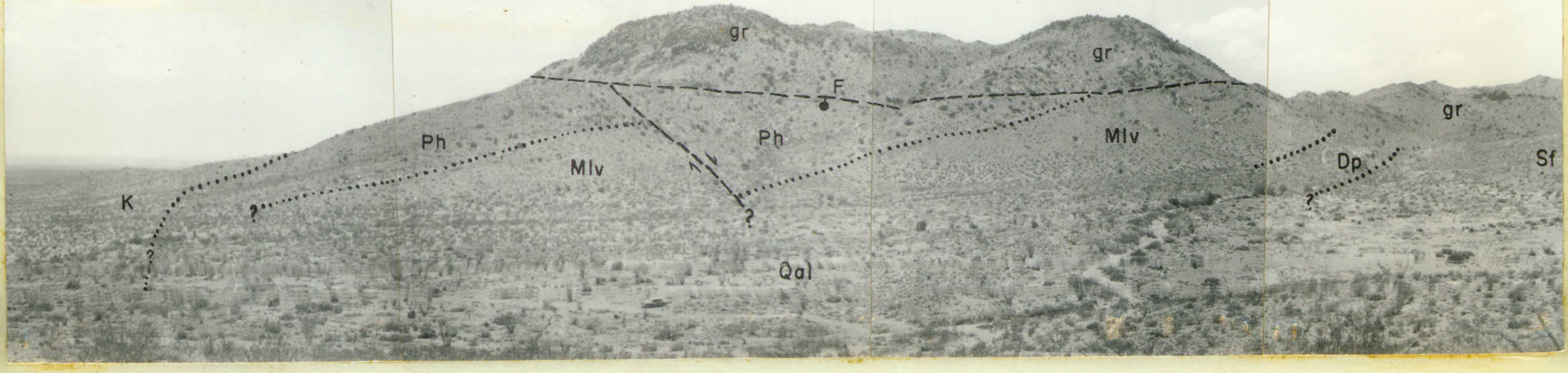

Plate 6. View of southwest side of Mine Canyon southeast of Gym Peak. View toward southwest; Precambrian granite (gr); Fusselman dolomite (Sf); Percha formation (Dp); Lake Valley formation? (Mlv); Hueco limestone (Ph); Cretaceous? limestone conglomerate (K); fault (F) is high-angle.

Plate 7. Limestone conglomerate overlying Hueco in Mine Canyon; Ph indicates fragment of Hueco. Other fragments are probably lower Paleozoic limestone.

Plate 8. Limestone conglomerate overlying Hueco in Mine Canyon; Ph indicates fragment of Hueco. Other fragments are probably lower Paleozoic limestone.

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