GUIDEBOOK

Geology of the Florida Mountains
Luna County, New Mexico

EDITOR
LeRoy L. Corbitt

Field Trip Leaders
LeRoy L. Corbitt
Fred L. Nials
Ronnie J. Varnell

EL PASO GEOLOGICAL SOCIETY

Eighth Annual Field Trip, May 4 and 5, 1974.
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>President's Message</td>
<td>ii</td>
</tr>
<tr>
<td>El Paso Geological Society Officers</td>
<td>iii</td>
</tr>
<tr>
<td>Introduction</td>
<td>iv</td>
</tr>
<tr>
<td>Index map'</td>
<td>v</td>
</tr>
<tr>
<td>Stratigraphic Nomenclature chart</td>
<td>vi</td>
</tr>
</tbody>
</table>

## ROAD LOGS

<table>
<thead>
<tr>
<th>Road Log</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deming to Capital Dome</td>
<td>1</td>
</tr>
<tr>
<td>Capital Dome to Mahoney Park</td>
<td>3</td>
</tr>
</tbody>
</table>

## ARTICLES

<table>
<thead>
<tr>
<th>Article</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Capital Dome Section, Florida Mountains</td>
<td>7</td>
</tr>
<tr>
<td>Christina Lockman-Balk</td>
<td></td>
</tr>
<tr>
<td>Structure and Stratigraphy, Florida Mountains</td>
<td>16</td>
</tr>
<tr>
<td>LeRoy L. Corbit</td>
<td></td>
</tr>
<tr>
<td>Mineral Deposits, Florida Mountains</td>
<td>30</td>
</tr>
<tr>
<td>George B. Griswold</td>
<td></td>
</tr>
<tr>
<td>The Lower Ordovician Florida Mountains Formation Stratotype, Luna County, New Mexico</td>
<td>36</td>
</tr>
<tr>
<td>Dave V. LeMone</td>
<td></td>
</tr>
<tr>
<td>Preliminary Radiometric Age Determination from the Florida Mountains, New Mexico</td>
<td>47</td>
</tr>
<tr>
<td>Douglas G. Brookins and Roger E. Denison</td>
<td></td>
</tr>
</tbody>
</table>
THE PRESIDENT'S MESSAGE

It is my pleasure to welcome you to the eighth annual field trip of the El Paso Geological Society. This year's excursion will view the structure and stratigraphy of the Florida Mountains.

Special thanks are extended to Dr. Leroy Corbitt and his colleagues and students of the Department of Geology, Eastern New Mexico University who organized the trip and prepared the guidebook.
The El Paso Geological Society
DEPARTMENT OF GEOLOGICAL SCIENCES
UNIVERSITY OF TEXAS AT EL PASO
El Paso, Texas 79968 — Telephone 747-5501

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INTRODUCTION

by

LeRoy L. Corbitt

The eighth annual El Paso Geological Society field trip is through the northern and western portions of the Florida Mountains where structures similar to those present in the Sierra De Juarez can be observed. The Florida Mountains are located in the Cordilleran foldbelt of southwestern New Mexico near the contact with the cratonic foreland. Block faulting during the Tertiary created the present mountains by uplift along range-marginal faults; however the internal structures within the mountains are principally thrust faults of Laramide age.

At stop one (Capitol Dome) a lower Paleozoic section overlies Precambrian metamorphic and igneous rocks and sedimentary diamictite of possible glacial origin. The postorogenic Lobo Formation and overlying andesite agglomerate will also be seen.

At stop two and three (Mahoney Park) a lower Paleozoic section with complex imbricate thrust slices is seen. Also contacts that have been interpreted to be both fault and intrusive can be observed.

I would like to express my gratitude to all who have contributed so generously of their time and knowledge. Your president Dr. Jerry M. Hoffer first suggested the trip. Ronnie Varnell and Fred Nials aided greatly in preparing the road log. The authors of all articles gave freely of their time and knowledge. Mrs. Pete Ann Braught, secretary for the Geology Department at Eastern New Mexico University typed the manuscript. Marlene Bachicha drafted the cover design.

We hope you enjoy the trip and contribute some good healthy arguments at the outcrops for the benefit of all interested in this area.
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>AGE</th>
<th>GROUP</th>
<th>FORMATION</th>
<th>THICKNESS</th>
<th>LITHOLOGY</th>
<th>DESCRIPTION</th>
</tr>
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<tr>
<td>QUATERNARY</td>
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<td></td>
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<td>0-7</td>
<td>Gravels and Alluvium</td>
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<td></td>
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<td>Andesite-latite agglomerate and tuff, with interbedded gravels</td>
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<td></td>
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<td>Lobo</td>
<td>250-500</td>
<td>Interbedded red and buff calcareous siltstones, chert pebble</td>
<td>Lenses and limestone conglomerate</td>
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<td>50-75</td>
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<td></td>
<td></td>
<td></td>
<td>Syenite</td>
<td></td>
<td>Syenite, gabbro, diabase, dolite, anorthosite, granite</td>
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<td></td>
<td>Gabbro</td>
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<tr>
<td>PERMIAN</td>
<td>Lower</td>
<td></td>
<td>Hueco</td>
<td>548</td>
<td>Thick to massive, light to dark gray, fine to medium crystalline</td>
<td>Limestone, thin bedded, light gray, fine crystalline with miliolocids beds and nodule of gray to white chert, forms oolite shoal</td>
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<td></td>
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<td>dolomite, four (?) alternating units of light and dark gray</td>
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<tr>
<td>MISSISSIPPIAN</td>
<td>Lower</td>
<td></td>
<td>Lake Valley</td>
<td>196</td>
<td>Laminated to thin-bedded chert in limestone or dolomite matrix</td>
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<tr>
<td>DEVONIAN</td>
<td>Upper</td>
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<td>Percha Shale</td>
<td>236*</td>
<td>Olive green fossil shale with a one foot thick fossiliferous</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>limestone bed at base</td>
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<tr>
<td>SILURIAN</td>
<td>Middle</td>
<td></td>
<td>Fusseman</td>
<td>800-1000</td>
<td>Massive light tan weathering dolomite, four (?) alternating</td>
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<td></td>
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<td></td>
<td>Dolomite</td>
<td>1000 (?)</td>
<td>units of light and dark gray dolomite</td>
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<td></td>
<td>Upper</td>
<td>Montoya</td>
<td>Cuter</td>
<td>200</td>
<td>Light to dark gray, medium-to-thick-bedded dolomite, minor chert,</td>
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<td>lower 60 feet limy and fossiliferous</td>
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<td></td>
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<td>Upham</td>
<td>50-75</td>
<td>Dark brown, course crystalline, cherty, block weathering</td>
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<td></td>
<td>dolomite, sandy or base</td>
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<td></td>
<td></td>
<td></td>
<td>White to blue-gray limestone 20-30% chert</td>
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<tr>
<td>ORDOVICIAN</td>
<td>Lower</td>
<td>El Paso</td>
<td>Unnamed</td>
<td>1050</td>
<td>White-gray to blue-gray limestone with interbedded stromatolite</td>
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<td></td>
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<td>and sponge reefs, fossiliferous calciretes with many lime-pellet and pebble beds, nodules and</td>
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<td>crinkled limonite of buff silt</td>
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<td></td>
<td>Dark gray black weathering, medium grained dolomite</td>
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<tr>
<td>CAMBRIAN</td>
<td></td>
<td>Blies</td>
<td>0-200</td>
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<td>Ar-honed to quartzite sandstone with conglomerate and limestone</td>
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<td>PRECAMBRIAN</td>
<td></td>
<td>Unnamed</td>
<td>35-45</td>
<td></td>
<td>Diatomite, boulders igneous, meta, and sed in red-green shale</td>
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FIGURE 15 Summary of stratigraphy of the Florida Mountains, thickness in feet. (modified from literature)
ROAD LOG FROM DEMING TO CAPITOL DOME AND MAHONEY PARK IN THE FLORIDA MOUNTAINS

by

LeRoy L. Corbitt

ASSEMBLY POINT: Ramada Inn, Deming.

0.0 Log begins at Ramada Inn. Face west.

0.6 Turn left (south) from U.S. 70-80 on to Columbus Road, N.M. 11.

1.3 Join N.M. 11 to Columbus.

4.3 9:30 Little Florida Mountains, Tertiary volcanics.

10:00-11:00 Florida Mountains (7448'), Precambrian, Paleozoic, Mesozoic, and Tertiary.

12:00 Tres Hermanas Mountains (5802'), Tertiary quartz monzonite intrusive.

1:00 Sierra de las Palomas, Mexico (7552') Paleozoic and Cretaceous.

2:00 Cedar Mountains (6215') Tertiary volcanics and Paleozoic strata.

2:30 Snake Hills, low outcrops of tectonically mixed lower Paleozoics.

3:00 Red Mountain (5422'), Tertiary rhyolite dome.

6.3 Turn left (east) on to farm to market road. Sign says Rockhound State Park.

12.3 Make jog to right then left on road to the Florida Mountains.

14.8 STOP # 1 - See guidebook article by Lockman Balk for detail description of Capitol Dome Section.

Climb to top of Precambrian granite hill at 10:00 to contact with the Bliss Formation.

Panoramic View (from top of hill):

12:00 (north) Cooks Peak, 8404'; 28 miles away. Tertiary granodiorite.

1:00 Little Florida Mountains composed of Tertiary rhyolitic volcanics.

7:00 Tres Hermanas Mountains, Tertiary quartz monzonite intrusive.

8:00 Big Hatchet Peak, 8441; 56 miles away. Permian Horquilla Limestones.

9:00 Snake Hills and Victoria Mountains in background.

10:00 Red Mountain, a rhyolite dome, 5422; 'Burro Peak in distance, 7965; 56 miles away.

11:00 Black Mountain. Tertiary rhyolitic rocks capped by basalt.
Stop # 1. Capitol Dome. Precambrian metamorphics (Pem), Precambrian granite (Pegn), Precambrian diamictite (Pesed), Bliss (Cbl), El Paso (Oep), Montoya (Om), Mesozoic (?) Syenite (msn), Mesozoic gabbro (mgb), Lobo Formation (tl), Andesite Agglomerate (Tag).
DISCUSSION STOP #1

The Precambrian rocks beneath Capitol Dome are granite and syenite that are intrusive into older metamorphic rocks. The metamorphic rocks consist of interbedded granite gneiss, porphyroblastic granite, biotite schist, hornblende gneiss and amphibolite and regional evidence suggest the rocks are 1.4 to 1.8 b.y. old. The granite beneath the Bliss at Capitol Dome is dated at 1.45 to 1.6 b.y. old. Most of the igneous body between Capitol Dome and Mahoney Park to the south (STOPS # 2 & # 3) is syenite yielding similar dates.

Approximately 1/2 mile to the north Upper Precambrian (?) diamicite is preserved beneath the Bliss Formation. Diamicrites of similar stratigraphic position and lithology occurring from Alaska to California have been interpreted to be essentially synchronous units on the basis of their unique lithology and possibly represent a time of glaciation.

Here the sandy Bliss formation ranges from 5-110 feet thick. The overlying El Paso Group is about 1150 feet thick and is divided into a lower dark-gray to black dolomite, a middle white to blue limestone and a upper cherty limestone. The El Paso is overlain by the Montoya Group and portions of the dark Upham Dolomite and cherty Aleman Formation are preserved at Capitol Dome.

Tertiary (?) Lobo red beds and conglomerates unconformably overlie the Precambrian, the Paleozoic strata and the syenitic rocks. Interbedded with and overlying the Lobo Formation are about 1600 feet to Lower Tertiary (Eocene-Oligocene?) andesitic rocks which make up Capitol Dome.

Turn around and head back to N.M. 11.

4.5
19.3 Turn left from Ventura Boulevard to County road.
4.0
23.3 Turn left (south) on N.M. 11.
3.0
26.3 Dip in highway, 12:00 Tres Hermanas Mountains.
1.0
27.3 Sunshine school on right.
2.0
29.3 Turn left (east) on county road, cross cattleguard. Sign on left--Koenig's Hereford Ranch.
1.1
30.4 Cattleguard. Farm buildings on right.
1.0
31.4 Cattleguard. Road intersection. Continue straight ahead.
10:00 Tertiary andesite agglomerate.
11:00 Capitol Dome with reddish Precambrian at base of mountains.
11:00-12:30 Mesozoic (?) syenite--darker weathering, cut by white rhyolite dikes.
12:30 Baldy Peak composed of El Paso limestone intruded (?) by syenite.
1:00 Low hill foreground shows repeated Fusselman-Montoya sections.
1:00-2:00 Precambrian (?) granite and syenite.
3:00 Tres Hermanas Mountains.
32.9 Road on left leads to White Hills composed of Tertiary felsite. Continue ahead.

33.5 Road bears to right, fence on left.

35.1 Gate. 2:00-3:30, hill shows repeated Fusselman-Montoya sections.

35.4 3:00 Hill on immediate right—faulted Fusselman Montoya. 2:00 Hill east of gap has El Paso at base overlain by the Montoya Group and Fusselman Dolomite. Northeast side of hill has syenitic rocks in fault or intrusive contact with Paleozoics.

12:00 Baldy Peak with syenite intrusive (?) into El Paso Group.

9:00-12:00 Syenite cut by white rhyolite dikes.

35.6 3:00 Hill to south through gap has repeated Fusselman-Montoya section.

35.8 STOP # 2 - Jeep trail on right leads through gap. Follow jeep trail to south on foot. The following roadlog pertains to the walk along the jeep trail.

0.1 Bottom of arroyo.

0.2 El Paso Limestone on left overlain by Montoya Group and Fusselman Dolomite.

0.3 Outcrops on right are Montoya and Fusselman. El Paso, Montoya, and Fusselman are exposed on hill to left.

0.6 Deep arroyo. End of trail. Repeated Fusselman and Montoya on hill ahead (south).

36.0 Abandoned ranch house on left.

36.1 Corral and windmill—road bears to right. In 0.05 mile a jeep trail leads to left, continue straight ahead.

36.4 Abandoned buildings on right. Mesozoic (?) syenite exposed on both sides of road.

36.5 Sharp bend in road to right,

36.6 Top of hill composed of Mesozoic (?) syenite.

12:00 Low hills ahead are Fusselman Dolomite.

10:00-1:00 Rugged hills in background are Precambrian (?) granite and syenite. Continue ahead down hill, road bears sharply to left.

36.8 Bottom of arroyo. Hills on right are Fusselman Dolomite.

37.0 Top of hill.

9:00 Low hill capped by white El Paso limestone shows intrusive nature of syenite.

1:00 Black outcrop of Devonian Percha Shale.
Stops # 2,3. Mahoney Park. Second ridge south shows complex imbricate thrust slices of Fusselman (Sf), Montoya (Om) and El Paso (Oep) beneath Precambrian (?) granite (PEgn). Determine if wavey contacts are intrusive, fault or both. Devonian (Dp), Mississippian (Mlv), Mesozoic (?), syenite (msn), Tertiary rhyolite (Tr).
37.1 Outcrops on right are Fusselman Dolomite.

37.2 Bottom of arroyo.

37.3 STOP # 3-

3:30 The low dip to the syenite thrust over Paleozoic rocks can be seen to the west.

9:00 Climb low hill to east which is capped by El Paso limestone to see intrusive nature of syenite.

Turn around and return to Deming.
THE CAPITOL DOME SECTION, FLORIDA MOUNTAINS

Christina Lockman-Balk
New Mexico Institute of Mining and Technology

Capitol Dome is a prominent cliff with rounded top on the northwest side of the Florida Mountains. It is composed of a mass of Tertiary tuffs and agglomerates surmounting a section of Precambrian rocks, Cambrian sandstones, Ordovician sandstone and carbonates, and the Lobo Formation.

The Precambrian rocks, Cambrian and Ordovician sediments occur in a relatively small fault block which has been downdropped several thousand feet between the surrounding Precambrian blocks. In the southern part of the Florida Mountains, similar down-faulted blocks show a more complete Paleozoic section, with the Upper Ordovician Cutter Formation, the Silurian Fusselman Dolomite, Upper Devonian Percha Shale, some Mississippian Lake Valley Limestone and some Permian Hueco Limestone. Stratigraphic evidence suggests that the major faults bounding these blocks developed near the end of the Mesozoic in this region. The fault on the north side of the block strikes approximately N. 50° W., while that on the south averages S. 60° W. Both faults may be seen on the outcrop and are overlapped and concealed by the Lobo Formation and the overlying Tertiary volcanics. The Paleozoic section of this block was deeply eroded before the deposition of the Lobo Formation. Consequently the section here must be regarded as a very fragmentary example of the Paleozoic sequence which once covered the region of the Florida Mountains.

The section we will see, section A-A, is marked on text figures 1, 2 and 3. No complete, unfaulted section exists within this block. The formations are cut by some steep normal faults which may be of the same age as the major bounding faults, or may be later, and also by a number of low angle thrusts, more or less paralleling the strike, which appear to have been associated with Laramide deformation. The normal fault near the top of the El Paso Group in section A-A has shortened this section. It was not possible to determine accurately the amount of vertical displacement on the fault as reliable key beds were not located.

At the base of the section, resting upon different kinds of Precambrian rocks, there occurs a transgressive sandstone, presumably the initial Paleozoic marine deposit in this region. This sandstone shows at least three contrasting lithofacies which developed in response to local conditions. 1) At section A usually 5 to 10 feet, and at one position not more than one foot of greenish white quartzose sandstone lies between the Precambrian and the lowest occurrence of beds or lenses of fine-grained gray limestone and limestone pebble conglomerates. The greenish cast of the white sands in this section is attributed to chlorite and rock fragments derived from gabbros and metadiorites which were exposed in the area about one-fourth of a mile farther northeast. In section A about 84 feet of beds are assigned to a basal lithic unit called the Bliss Formation, in which the pure quartzose sandstones are limited to the base, and most of the unit consists of interbedded calcareous sandstones, sandy limestones with some beds of pebble conglomerate limestones or dense gray limestone. The amount of carbonate increases upward; the unit appears to be related to the overlying limestone

7
Figure 1
AREAL GEOLOGY OF THE CAPITOL DOME AREA,
NORTHWESTERN FLORIDA MOUNTAINS,
LUNA COUNTY, NEW MEXICO

By
Dr. C. L. Balk, New Mexico Institute Mining & Technology

- Quaternary alluvium
- Tertiary agglomerate and dikes
- Lobo formation
- Montoya group [Aleman formation, Upham dolomite]
- El Paso group
- Bliss formation
- Precambrian granite and rhyolite
and is here regarded as belonging to the Ordovician cycle of sedimentation. 2) Beginning one-fourth of a mile to the southwest in section B-B (see figure 2) the basal unit presents a very different aspect. Here a relief of 50 to 100 feet has been preserved on the Precambrian surface and the cross-section of a valley is now exposed.

Within this valley there occurs about 110 feet of arkosic, cross-bedded, dark yellow-brown to red-brown sandstones. Hematite as a cement or matrix forms a conspicuous element of these sands and is responsible for the dark coloration. Locally the sand may be nearly white. In the lower portion, quartz pebble beds are conspicuous and the sands are coarse-grained. Toward the top of the valley fill, the amount of feldspar steadily decreases and then disappears, the hematite cement disappears and the color becomes yellow brown. It is overlain fairly abruptly by 70 feet of 3) white quartzose sandstones, medium-grained, even-bedded, with no iron impurities. There is only a short transition zone between the two types (which could be attributed to reworking of the top of the brown sandstones), and the upper sandstones extend beyond the valley fill. Near the top of the white sandstones a few buff-weathering, fine-grained limestone lenses appear in the sands. In this section the transition to the overlying dark-gray dolomite unit of the El Paso is quite abrupt, but in places a bedding plane fault can be seen at this position, which may be responsible for the apparent abruptness of the lithic change. The entire basal sandstone unit, consisting abruptly of 110 feet of brown arkosic sandstones overlain by 70 feet of white quartzose sandstones is termed the Bliss Formation. The upper white sandstones with the carbonate lenses are believed most probably to be early Ordovician in age.

No Cambrian fossils have been found in this region and it is possible that the entire Bliss unit could be early Ordovician in age. However, Late Cambrian faunas have been recovered from the basal sandstone unit in several localities to the north, Lone Mountain, Caballo Mountains, Mud Spring Mountain and San Diego Mountains (Tonuco locality of Flower, 1958; Lochman-Balk, 1972). It is believed that if any Late Cambrian sedimentation did occur in the Florida Mountains area, it is represented by the arkosic, coarse-grained, hematitic valley fill sands in section B. This assumption has been strengthened by the recent late discovery (Woodward, 1970; L.L. Corbit and L.A. Woodward, 1973) of an exposure of diamicite one-half mile north of Capitol Dome. The occurrence is described by Woodward (1970, p. 29).

"A small downfaulted block containing nonmetamorphosed diamicite is unconformably overlain by the Bliss Formation. The diamicite consists mostly of granitic clasts up to 5 feet long and pellets of shale up to 2 cm in diameter enclosed in a fissile shale matrix. A few sandy layers are also present. The diamicite is unconformably on a deeply weathered Precambrian mafic gneiss and is also in fault contact with Precambrian granite. Thus, the diamicite is younger than the granite and older than the Bliss; it seems likely that the diamicite is younger Precambrian, but it may be as young as Cambrian as the Bliss appears to be no older than Late Cambrian."

In 1973 Corbit and Woodward, p. 171, separated the diamicite into two units.

"The lower 9 m probably formed from ice-rafted pebbles, cobbles, and boulders that were dropped into marine mud. The clasts were not locally derived, as they consist of rock types not present in the older Precambrian rocks of the Florida Mountains. The upper 3 m appears to be a conglomeratic arkose derived locally after faulting of the lower part of the diamicite."

9
<table>
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<th>Precamb.</th>
<th>Ordovician</th>
<th>Tertiary</th>
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<tr>
<td>Bliss</td>
<td>El Paso</td>
<td>Albin</td>
</tr>
<tr>
<td>50'-100'</td>
<td>155'</td>
<td>750's</td>
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**Figure 4**

Northwestern Florida Mountains, Luna Co., New Mexico

Columnar section, Capitol dome locality.

Layer 1: Triassic-Jurassic. Some limestones, dolomites, and shales.

Layer 2: Cretaceous. Marl and dolomite with some limestone.

Layer 3: Cenozoic. Volcanic rocks and sedimentary rocks.

Note: The diagram shows a cross-section of the geological layers with various rock types and their properties.
Figure 2. Looking east at the Capitol Dome area, stop No. 1, Northwestern Florida Mountains.
Figure 3. Close up view of the Capitol Dome area, Stop No. 1, Northwestern Florida Mountains
The environment of deposition of the upper 9 feet of conglomeratic arkose appears also to have been a surface of moderate relief. At present it cannot be determined whether the conglomerate accumulated at the base of a low sea cliff or as valley fill in a fault valley. The preservation of the conglomerate suggests that the region had begun to downwarp and the arkose may well represent a coarse beach deposit. It is highly probable that this conglomeratic arkose belongs to the same cycle of sedimentation as the arkosic, coarse-grained, hematitic lower sandstone of the Bliss Formation in section B. In this northern exposure Woodward (1970, p. 29) reported that the Bliss Formation unconformably overlies the conglomeratic arkose. Clearly, the Bliss Formation referred to by Woodward (1970) and Corbitt and Woodward (1973) is the white to greenish white quartzose sandstone (lithofacies 1 and 3) which occurs widely at the base of the Paleozoic section in the Florida Mountains. The report of an unconformable (i.e., disconformable) relation between the conglomeratic arkose and the widespread white quartzose sandstone which belongs to the early Ordovician cycle of sedimentation favors the assignment of a Late Cambrian age to the conglomeratic arkose and the valley-fill hematitic sandstones of section B. It is probable that the marine transgressions into this region occurred at the same times during the Franconian, as they did in the regions to the north where the lower portion of the Bliss Formation is dated by the presence of marine faunules.

Three lithic units may be recognized within the El Paso Group. At the base is 155 to 200 feet of dark-gray, thin-bedded, medium-grained crystalline dolomite. The base of the unit is drawn arbitrarily in section A-A at the lowest beds of this lithology. The change from the Bliss unit is fairly sharp, but one to two feet of buff sandy limestone can be found above these lowest dolomites. In section A-A no fossils were found, but many of the beds contain small (1/4 inch) concretionary nodules, probably of algal origin, which are characteristic of the unit. At this position in the section and in this type of matrix, brachiopods and trilobites correlative with Ross' Zone C of the Gasconade have been obtained at other localities. The unit is easily recognized in exposures (text figures 2, 3) by its darker color and a series of low cliffs. In section A-A there is a long dip slope at the top of the unit. In contrast to the transgressive marine conditions of deposition of the underlying sandy limestone and limy sandstones of the early Ordovician Bliss Formation, this dolomite unit records the onset and persistence of regressive conditions. Downwarping was extremely slow and the algal build-up was able to maintain the surface of the carbonate banks constantly in an intertidal to supratidal position. The resultant diagenetic dolomitization destroyed the sedimentary structures of the carbonate bank lithotopes as well as most of the organic remains.

The middle unit records the return of transgressive conditions over the carbonate banks, when increased downwarping of the area resulted in the carbonate sedimentation accumulating predominately in the infralittoral to intertidal zones. The middle unit consists of 740 to probably 775 feet of thin-, medium- and thick-bedded, white-gray to blue-gray limestones showing a variety of sedimentary structures. Five or six lithic subunits, representing five or six different lithotopes, are repeated over and over again in the sections, and indicate the long continued shifting of the different lithotopes of the carbonate bank back and forth across the region as the bank built up.
At the base of the middle unit there is a narrow transition zone in which the dark crystalline dolomites are interbedded with limestone pebble conglomerate lenses and light-gray, fine-grained limestones with crinkled silt laminae (algal mats). Blue-gray and white-gray limestone with crinkled silty laminae or patches is a very characteristic subunit of the middle lithic unit, and at some horizons the silty component may comprise nearly 60% of a bed. Traces of fossils appear almost immediately in the section.

At 65 feet above the base of the middle unit, twig-like algal structures may be seen on the surface of the beds. This algal type is considered characteristic of sublittoral bottoms, 50 feet or so in depth, and these unbedded masses of blue-gray limestone are believed to be small sublittoral reef structures. In the overlying 40 feet they are interbedded with pink and buff pellet beds of dolomitic limestone which are moderately fossiliferous (the sedimentation of the interreef basins and pools). At 100 feet lenses of calcirudite occur, indicating portions of the bank had been in the intertidal zone. At 180 feet specimens of *Girvanella* are found, and the overlying 20 feet form a conspicuous cliff of the dense silty laminated limestone interbedded with numerous thin pellet and pebble beds, the second lithic subtype. The clasts average around 5 mm. in long dimension, the smaller ones becoming more spherical while the larger specimens are roller or blade shape, and they lie at angles to the bedding. Each long thin lense or bed had an uneven lower and upper surface, and appears to have originated as a coating of fine clastic debris over the surface of deposition. These pellet beds are a conspicuous lithic subtype at intervals throughout the El Paso Group.

A good exposure of a stromatolite and sponge reef occurs between 220 and 240 feet above the base of the middle unit. Specimens of sponges, gastropods and long thin cephalopod siphuncles are noticeable. The stromatolites form short pillars (8 inches by 3 to 4 inches) of fine, contorted lime laminae. At this exposure the irregular top of one of the reefs may be seen, and appears as if it had actually been exposed subaerially before being covered by the overlying coarsely crystalline limestone. In the ensuing 200 foot interval this fossiliferous reef subtype intercalated with numerous thin pellet beds is well exposed.

At 450 feet above the base of the middle unit, a fourth lithic subtype is noticeably developed: pink and buff pebbly dolomitic limestone beds occurring in bands 1 to 1 1/2 feet in thickness. This subtype appears sporadically in the interval 75 to 100 feet above the base, but is more conspicuously developed at this higher position. It alternates with bands of blue-gray, fine-grained limestone in which sponges and gastropods are common. In the highest beds placed in the middle unit, the fine-grained silty laminated limestones, the unbedded blue-gray reef limestones, and the numerous pellet beds alternate up to the fault.

Above the fault an upper unit of 115 feet was measured to the base of the Upham Dolomite of the Montoya Group. This unit is composed of the same three alternating lithic subtypes which occur in the beds immediately below the fault, but the upper unit is readily distinguished from the beds of the middle unit by an abundance of fresh chert which may make up as much as 20 to 30 percent of a bed. The unit forms a reddish-brown-weathering cliff or steep slope below the Upham.
In section A-A very little of the Montoya Group has escaped erosion. The Upham Dolomite forms a low cliff no more noticeable than the upper unit of the El Paso Group, but farther to the south the entire Upham Dolomite and some of the Aleman Formation are present. The Cable Canyon sandy dolomite may be distinguished at the base of the Upham, overlain by dark-brown crystalline dolomite, succeeded at the top by light-gray brecciated dolomite or limestone conglomerates. In section A-A later erosion has removed all but 30 feet of the Upham. To the south the level of this eroded surface rises stratigraphically so that immediately below the nose of Capitol Dome the Upham totals 50 to 60 feet in thickness and is overlain by 70 to 80 feet of thin-bedded, buff-gray, very cherty limestones of the Aleman Formation.

The Lobo Formation overlies this Paleozoic section and forms long slopes up to the base of the Tertiary agglomerate cliff. The age of this formation is not known. Fossils have not been found. The formation is known only in the northern and southeastern parts of the Florida Mountains where the exposures start on the northwest side of the range, then cross the range in a southeasterly direction south of Arco del Diablo (Florida Peak) to Lobo Draw, the type locality. The Lobo Formation overlaps the bounding faults of the Paleozoic fault block and rests upon both Ordovician and the Precambrian rocks with noticeable angular unconformity. Its areal distribution in the range is the same as the overlying Tertiary volcanics. At the base of the formation in section A-A there occurs a coarse conglomerate of variable thickness (3 to over 10 feet) composed of Paleozoic limestone and chert boulders in a buff silty limestone matrix. At his locality a 40-foot lens of striking gray-purple, dense nodular limestone intimately mixed with a maroon-red silt matrix is well exposed. The lens is overlain by 2- to 4-foot coarse buff conglomerate. The basal unit is succeeded rather abruptly by medium-to thin-bedded buff calcareous siltstones and thin-bedded gray shales. Higher in the section, units of maroon-red shales and calcareous siltstones appear and alternate with the buff and gray beds. The Lobo Formation ranges in thickness from 250 to 350 feet. Throughout the section lenses of coarse sand and granules of angular to subangular chert appear sporadically in the siltstones. About 40 feet from the top, a coarse conglomerate occurs. The matrix is a buff calcareous siltstone like the overlying and underlying beds; the boulders are predominately subangular to subrounded limestones and cherts, but pink granite boulders appear for the first time. This conglomerate is overlain by red and buff calcareous siltstones typical of the Lobo. At Capitol Dome where red siltstone is the top unit, the contact with the basal conglomerate assigned to the Tertiary sequence is disconformable. But at several localities to the north where the buff siltstones and conglomerates are the top beds, the contact appears gradational.

At Capitol Dome, the basal conglomerate associated with the Tertiary volcanics is composed predominately of well-rounded boulders of limestone, cherty limestone, and pink granite, with rare angular pieces of andesite, in a gray-green tuffaceous matrix. Within this conglomerate for as high as 8 feet above the base there occur lenses and thin beds of buff and maroon-red calcareous siltstones apparently identical with the Lobo lithofacies. By analogy with similar andesites in the region which have been dated, these volcanics are probably of Eocene-Oligocene age.
Acknowledgements

Dr. Frank Kottlowski, New Mexico Bureau of Mines and Mineral Resources, very kindly reviewed this revised version of my 1958 article and up-dated the regional tectonic and volcanic data.

References


STRUCTURE AND STRATIGRAPHY OF THE FLORIDA MOUNTAINS

BY

LEROY L. CORBITT

INTRODUCTION

The Florida Mountains are in the Basin and Range Province in south central Luna County, New Mexico (Fig. 1) about 8 miles southeast of Deming. Block faulting during the Tertiary created the present mountains by uplift along range-marginal faults; however, the internal structures within the mountains, are principally thrust faults of Laramide age. At least 3,000 feet of Cambrian through Permian strata are preserved above Precambrian rocks. Higher peaks in the range exceed 7,000 feet in elevation, rising about 2,800 feet above the adjacent bolsons.

Some of the major structures and stratigraphic relations within the range were recognized by Darton (1917) during reconnaissance mapping for the Deming Folio. Kelley and Bogart (1952) recognized that the Gym Limestone as described by Darton was mostly Fusselman Dolomite and Bogart (1953) concluded the term Gym should be abandoned in favor of the name Hueco. Complex thrusts within the Montoya-Fusselman stratigraphic interval were noted by Kottlowski (1957) Lockman-Balk (1958) mapped and described the area near Capitol Dome in the northern part of the Florida Mountains. The paleotectonic setting of the region during Pennsylvanian time was discussed by Kottlowski (1958). Griswold (1961) described the mineral deposits of the Florida Mountains.

This report is based mainly on a Ph. D. dissertation at the University of New Mexico by Corbitt under the supervision of Woodward. Financial support and air photographs were provided by Forest Oil Corporation. Mobile Research and Development Corporation provided nine Rb/Sr-K/Ar dates through the courtesy of R.E. Denison. Eastern New Mexico University Institutional Research Funds helped defray expenses for radiometric dates provided by Douglas G. Brookins.

STRATIGRAPHY

The igneous rocks in the Florida Mountains (Fig. 2) consist of at least three masses of granite and syenite that are intrusive into older metamorphic rocks. Regional evidence suggest the metamorphic rocks are probably 1.4 to 1.8 b.y. old (Woodward, 1970). The rocks consist of interlayered granite gneiss, porphyroblastic granite, biotite gneiss, biotite schist, hornblende gneiss and amphibolite.

The northernmost intrusive mass is the granite beneath the Bliss Formation near Capitol Dome. This granite is dated at .45 to .60 b.y. (Murphy et. al., 1970).
Fig. 1 Tectonic map of southwestern New Mexico and part of adjacent Mexico showing structures of Cordilleran foldbelt (modified from Corbitt and Woodward, 1973). Numbers refer to localities mentioned in 1973 text.
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>AGE GROUP</th>
<th>FORMATION</th>
<th>CHRONOLOGY</th>
<th>LITHOLOGY</th>
<th>DESCRIPTION</th>
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<td></td>
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<td>TERTIARY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Andesite-latite agglomerate and tuff, with interbedded gravels</td>
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<td></td>
<td>Unnamed</td>
<td></td>
<td>1600</td>
<td></td>
<td>Interbedded red and buff calcareous siltstones, chert pebbles</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and limestone conglomerate</td>
</tr>
<tr>
<td></td>
<td>Lobob</td>
<td></td>
<td>250-500</td>
<td></td>
<td>Siltstone with occasional pebbles</td>
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<tr>
<td>CRETACEOUS</td>
<td>Lower</td>
<td>Syenite</td>
<td>50-75</td>
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<td>Syenite, gabbro, diabase, dolore, monzonite, granite</td>
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<td></td>
<td></td>
<td>Gabbro</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERMIAN</td>
<td>Lower</td>
<td>Hueco</td>
<td>548</td>
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<td>Thick to massive, light to dark gray, fine to medium crystalline limestone,</td>
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<td></td>
<td>shale beds in middle unit, lower part very fossiliferous, base is a fault</td>
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<td>MISSISSIPPIAN</td>
<td>Lower</td>
<td>Lake Valley</td>
<td>196</td>
<td></td>
<td>Limestone, thin bedded, light gray, fine crystalline with micaeous beds and</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>pebbles of gray to white shale, termo brown shale</td>
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<tr>
<td>DEVONIAN</td>
<td>Upper</td>
<td>Parahu Shale</td>
<td>236</td>
<td></td>
<td>Olive green fissile shale with one foot thick fossiliferous limestone bed of</td>
</tr>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>bone</td>
</tr>
<tr>
<td>SILURIAN</td>
<td>Middle</td>
<td>Fusselman 800-1000</td>
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<td></td>
<td>Massive light tan weathering dolomite, four (? alternating units</td>
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<td></td>
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<td>Dolomite 1000 (?)</td>
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<td>of light and dark gray dolomite</td>
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</tr>
<tr>
<td>ORDOVICIAN</td>
<td>Upper</td>
<td>Montoya</td>
<td>200</td>
<td></td>
<td>Light to dark gray, medium to thick bedded dolomite, minor chert, lower</td>
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<td></td>
<td></td>
<td></td>
<td>60 feet lenses and fossiliferous</td>
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<tr>
<td></td>
<td></td>
<td>Alman</td>
<td>150-200</td>
<td></td>
<td>Laminoed to thin bedded chert in limestone or dolomite matrix</td>
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<td></td>
<td></td>
<td>Uphorn</td>
<td>50-75</td>
<td></td>
<td>Dark brown, coarse crystalline, crystalline, black weathering dolomite,</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>pebbles of gray to white shales</td>
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<td></td>
</tr>
<tr>
<td>CAMBRIAN</td>
<td>Lower</td>
<td>El Paso 1050</td>
<td></td>
<td></td>
<td>White-gray to blue-gray limestone with interbedded chert and sponge</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>reefs, fossilerous calcitufites with many lime-pellet and pebble beds,</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>nodules and crinoid laminae of buff silt</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dark gray black-weathering, medium grained dolomite</td>
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<tr>
<td></td>
<td>Bliss</td>
<td></td>
<td>0-200</td>
<td></td>
<td>A-keistic to quartzose sandstone with conglomerate and limestone</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRECAMBRIAN</td>
<td></td>
<td>Unnamed   35-45</td>
<td></td>
<td></td>
<td>Schist, gneiss, amphibolite intruded by granite</td>
</tr>
</tbody>
</table>

**FIGURE 2.** Summary of stratigraphy of the Florida Mountains, thickness in feet. (modified from literature)
A central body lying between Capitol Dome and the large thrust fault south of Mahoney Park consists predominantly of syenite. Its age of formation/emplacement is uncertain as fault, sedimentary and apparent intrusive contacts with Paleozoic sediments are noted (Brookins and Corbitt 1974, in press). Age of formation/emplacement based on geologic inference range from Precambrian to Mesozoic. Rb/Sr dates range from 0.40 to 0.75 b.y. even when weathering contamination is not suspected. As no evidence for Paleozoic intrusive activity is known for this area we propose that this body represents contaminated Precambrian material possibly emplaced in the Mesozoic. This problem is critical due to the mineralization associated with Mesozoic intrusives elsewhere in the Southwest.

Most of the southern part of the range appears to be a mass of quartz syenite to granite thrust northward over the other rocks. This igneous body yields Rb/Sr whole rock isochron of 1.13 ± 0.20 b.y. with initial Sr (87/86) = 0.704 consistant with a Precambrian origin (Brookins and Corbitt, 1974 in press). However, one Cretaceous date is reported to have been obtained from a sample collected near Copper Canyon (Kottlowski, personal communication, 1972).

Approximately 1/2 mile north of Capitol Dome an Upper Precambrian (?) diamictite overlies Precambrian mafic gneiss (Corbitt and Woodward 1973).

The diamictite sequence is 12 m thick and consists of clasts 3.0 cm to 1.2 m in diameter in a shale matrix. The diamictite rests unconformably on mafic gneiss and is unconformably overlain by the Bliss Formation.

Of 127 clasts that were examined, 45 percent were composed of lithic sandstone with thin cherty limestone interbeds; 17 percent were silty hematite breccia; 17 percent were siliceous ironstone; 12 percent were diabase or basalt; and 10 percent were granite. The lithic sandstone is composed of grains of quartzite with silica and calcite cement; limestone intercalated with the sandstone occurs in beds as thick as 15 cm. The silty hematite breccia consists of angular fragments of hematite in a siltstone matrix. Rarely, pebbles and cobbles are striated and some have poorly faceted faces. In addition to the clasts described above, pellets of clay reaching a maximum of 2 cm in diameter are present enclosed by shale matrix.

The basal 1.8 m of the diamictite consists of reddish, fissile shale with clasts of all the lithic types noted above. The next 7.5 m is composed of greenish gray, fissile shale containing all the varieties of clasts. Some of the boulders have deformed the bedding within the underlying shale as though the boulders were dropped into unconsolidated mud. The upper 3 m consists of granitic boulders reaching a maximum of 30 cm in diameter in an arkose matrix.

At least 80 percent of the clast are not similar to any known Precambrian rocks in New Mexico or Texas. We propose that the lower part of the diamictite was formed by ice rafting of clasts, and the upper part by deposition of locally derived granite debris that filled a downfaulted depression.
Approximately 3,000 feet of Paleozoic strata are preserved above the Precambrian rocks (Fig. 2). Because of complex thrusting in the middle and upper Paleozoic part of the section precise stratigraphic thicknesses cannot be determined. The stratigraphic relationships in the Florida Mountains are summarized in Fig. 2. The Paleozoic strata are mostly shelf carbonates; the Bliss Formation of Late Cambrian and Early Ordovician age and the Upper Devonian Percha Shale are the only Paleozoic clastic units present.

The stratigraphic section at Capitol Dome is described in detail by Lockman-Balk (1958, see guidebook article).

The Bliss Formation in the Florida Mountains is from 0-200 feet thick and consist of arkosic to quartzose sandstone with conglomerate and limestone. Where the Bliss is absent, the El Paso contacts with the underlying igneous rocks appear to be either intrusive or fault in origin.

The Lower Ordovician El Paso Group at Capitol Dome is approximately 1,050 feet thick and is divided into a lower, dark-gray to black dolomite, a middle, white to blue limestone and a upper, cherty limestone. The lower, dark dolomite is not recognized elsewhere in the Florida Mountains. The Upper Ordovician Montoya Group is approximately 450 feet thick and consists of a lower dark Upham Dolomite with a basal sandy Cable Canyon unit, a middle cherty Aleman Formation and the upper Cutter Dolomite.

The Cutter Dolomite is overlain unconformably by the Middle Silurian Fusselman Dolomite which is approximately 1000 (?) feet thick. The Fusselman appears to consist of four alternating units of light and dark-grey dolomite. The least deformed Montoya-Fusselman section is on the first hill south of Mahoney Park at stop two.

The Fusselman Dolomite is unconformably overlain by the olive-green Upper Devonian Percha Shale which appears to be approximately 250 feet thick. The Lower Mississippian Lake Valley Formation conformably overlies the Percha Shale and is about 200 feet thick. Approximately 500 feet of massive Lower Permian Hueco Limestone overlies the cherty Lake Valley limestones. The Hueco-Lake Valley contact appears to be both a thrust fault and a sedimentary unconformable contact. Pennsylvanian rocks are absent in the Florida Mountains.

The syenite body between Capitol Dome and the large thrust fault which crosses the range south of Mahoney Park appears to intrude rocks stratigraphically as high as the Fusselman Dolomite and may represent Precambrian material emplaced in the Mesozoic.

A small outcrop consisting of 50 to 75 feet of highly deformed silicified conglomerate, overlying El Paso limestone in the southeastern portion of the range is interpreted to be Early Cretaceous in age.
The post-orogenic Lobo Formation lies unconformably on the Precambrian, the Paleozoic, the syenitic intrusive rocks and the thrusts, (see guidebook article by Lockman Balk for description of the Lobo Formation at Capitol Dome). The upper portion of the Lobo Formation is interbedded with and overlain by 1600 feet of andesitic deposits.

At the base of the mountains and extending up the valleys are deposits of gravel and alluvium. The flanks of the range are composed of thick alluvial deposits which at depth, probably grades into the Tertiary Santa Fe-Gila Formation. Well data indicates the alluvium and interbedded volcanics surrounding the mountains are at least 4,000 feet thick.

PALEOTECTONIC SETTING

From Cambrian through Mississippian time the Florida Mountains area was part of a stable shelf to the south of the Transcontinental arch. At least three episodes of epeirogenic uplift during the Middle Ordovician, Early Silurian, and Late Silurian-Middle Devonian are recorded by stratigraphic breaks. In Pennsylvanian time this shelf was deformed epeirogenically and the Pedregosa basin developed in the far southwestern corner of New Mexico (Kottlowski, 1958). A mildly positive area, the "Florida Islands", bordered the basin on the northeast, near the present Florida Mountains (Kottlowski, 1958).

Pennsylvanian strata are absent in the Florida Mountains. However, in all surrounding ranges Pennsylvanian shelf carbonates with minor clastic units overlie Mississippian carbonates. The Permian Hueco Formation overlies the Mississippian Lake Valley Formation in the Florida Mountains indicating shelf conditions prevailed again during Wolfcamp time. Immediately to the north in the Cooks Range, red beds and conglomerates, up to 50 feet thick, containing angular fragments of igneous and metamorphic rock are considered to be Permian Abo (Greenwood et al., 1970) and indicate nearby uplift and erosion to the Precambrian. These conglomerates overlie Pennsylvanian limestone and underlie the Lower Cretaceous Sarten Sandstone.

Kottlowski (1958) suggested that the "Florida Islands" were emergent in Late Pennsylvanian time. Sam Thompson III (1972, personal communication) concluded that the Florida Mountain area was not emergent until possibly Wolfcamp time, during which Pennsylvanian rocks were eroded. Corbitt (1970, 1971) indicated that Pennsylvanian strata were absent in the Florida Mountains because of tectonic elimination along Laramide thrust faults rather than pre-Hueco erosion.

The only outcrop of Hueco in the Florida Mountains is in the canyon south of Gym Peak. Here a major reverse fault has brought Precambrian (?) granitic rocks over a thrust slice of Permian Hueco and Devonian Percha Shale which overlies the Mississippian Lake Valley Formation. The Hueco-Lake Valley contact appears to be both a thrust fault and a sedimentary unconformable contact. The western
portion of the contact is a fault breccia zone, silicified in most exposures. Thin-beded limestones and cherts beneath the breccia zone are drag-folded and overturned to the north. To the east the contact appears to be sedimentary with angular to subrounded fragments of Lake Valley limestone surrounded by rock of Hueco lithology and fauna. The basal Hueco limestone in the Florida Mountains is not indicative of nearby uplift and erosion to the Precambrian as the "Lobo-Abo (?)" conglomerates are immediately to the north in Cooks Range.

The location of the Wolfcampian Abo-Hueco "Florida Islands" that provided the angular clasts of Precambrian rock in the Cooks Range is not apparent. It is doubtful that it was in the Florida Mountain area. Also the Wolfcampian isopach and facies map prepared by Kottlowski (1963, p. 52) indicates a distant northern source area rather than the "Florida Islands" to the south in central and northwestern Luna County. The map gives no indication of an uplift in Luna County during Wolfcampian time. Corbitt (1971) suggested that both Lower Cretaceous and Permian Abo had been mapped as Lobo Formation in the Cooks Range and that the conglomerates which disconformably (?) underlie the Cretaceous Sarten Sandstone and contain clasts of Precambrian rock were Lower Cretaceous in age. This problem needs more study.

During the Mesozoic the Florida Mountains area was a southeastern extension of the Burro uplift described by Elston (1958). These positive elements comprised part of the more extensive Deming axis (Turner, 1962). Elston (1958) suggested that the Burro uplift was formed during the Early Cretaceous; Turner (1962), however, indicated that the Deming axis was probably positive throughout much of Mesozoic time. The syenite between Capitol Dome and the large fault crossing the range south of Mahoney Park appears to be contaminated Precambrian material emplaced in the Mesozoic.

A Cretaceous trough that was present in southwestern New Mexico (Kottlowski, 1963) probably was bordered on the north by the Deming axis. Northward-yielding thrust faults and overturned folds developed during Laramide time within and along the northern margin of this trough creating the internal structure of the Florida Mountains. Block faulting during the Tertiary created the present mountains by uplift along range-marginal faults.

LARAMIDE STRUCTURES

In the southern Florida Mountains thrust and steeply dipping reverse faults cut or deform rocks as young as Early Cretaceous (?) and syenitic rocks probably emplaced in the Mesozoic and are in turn unconformably overlain by the Tertiary Lobo Formation. Thus these faults appear to have formed during the Laramide orogeny.

The most conspicuous fault is a northwest-trending, steeply dipping reverse fault that has brought Precambrian (?) granitic rocks over the Paleozoic in the southern part of the mountains south of Mahoney Park. This fault is steep at deep structural levels; but flattens upward. There is at least 2,000 feet of stratigraphic separation on this fault.
In the Paleozoic strata beneath this fault, on the northeast side, complex imbricate thrust slices are particularly well exposed in the second ridge south of Mahoney Park in Secs. 34 and 35, T 25 S, R 8 W. At this location undulating to gently dipping thrusts have repeated parts of the Ordovician-Silurian section three times. There is tectonic elimination of strata, as well as repetition along some of the faults. The thrusts and the strata dip southeast at an average of about 15°. The fault surfaces commonly are marked by brecciated zones up to 60 feet thick that locally are silicified. A precise calculation of slip on these faults cannot be made, but there must be at least 4,000 feet of horizontal yielding in a northerly direction. Presumably these imbricate slices are related genetically to the steeper fault described above, where granite has been brought over the Paleozoic rocks; possibly the imbricate thrusts are slightly older than the steep fault and have been offset by the latter. However, the absence of Paleozoic rocks on the south side of the steep fault precludes proving this possibility. At any rate, all the thrusts and steep reverse faults probably formed during the same general orogenic episode.

Complex thrusting of the Paleozoic rocks beneath the major steep reverse fault also is seen at Gym Peak. Here the thrusts mainly involve tectonic elimination of strata although locally there is repetition. In the canyon south of Gym Peak, below the major reverse fault, a thrust plate composed of Permian Hueco Limestone and Devonian Percha Shale overlies the Mississippian Lake Valley Formation. These faults have been tilted by Basin-Range deformation and their present attitudes do not indicate their original orientations. Mostly, the faults are subparallel with bedding. Exact amounts of movement cannot be determined, but the movement probably was several thousand feet or more.

On the hill north of Victorio Canyon on the East side of the Florida Mountains, the Ordovician El Paso Formation has been thrust onto strata ranging from the El Paso to the Silurian Fusselman Dolomite, with a maximum stratigraphic separation of 1,300 feet. The horizontal component of movement is at least a few thousand feet. Some of the stratigraphic units have been tectonically thinned at this locality.

BASIN - RANGE STRUCTURE

North-South block faulting during the Tertiary created the present uplift along range-marginal faults. This uplift is commonly assumed to be Miocene in age. Elston (et al., 1973) dated the beginning of Basin and Range faulting in the Mogollon-Datil Province at 20 m.y. B.P. However, west of the Franklin Mountains, andesites dated at 47.1 ± 2.3 m.y. are younger than, and guided by some north striking Basin and Range faults (Lovejoy, 1972) indicating uplift probably began in mid-Eocene.

If the data reported in the Angelus # 2 drilled in the NE ¼ SE ¼ of sec. 8, T. 26 S., R. 8 W. (Kottlowski and others, 1969) is correct, more than 3,000 feet of displacement occurred on the west side of the range. This test drilled about one mile from the lowest outcrop at the foot of the mountain, immediately west of South Peak, reported Quaternary and Tertiary sediments to a total depth of 3,365 feet. At least
Figure 3. Tectonic map showing interpretation of Basin and Range faults of Florida Mountains.
this much valley fill is present five miles east of the range. Two test wells drilled in sec. 4 and 8, T. 25 S., R. 6 W., reported Tertiary volcanics in the lowest samples at 3,815 feet (Kottlowski and others, 1969). Thus the block forming the Florida Mountains appears to have been uplifted at least 4,000 feet along range-marginal faults (Fig. 3).

DISCUSSION

North of the Florida Mountains (Fig. 1) a few small structurally isolated thrusts have been observed (Corbitt and Woodward, 1973). These thrusts are local and have no consistent direction of yielding; their geometry indicates that they are either upthrusts that become nearly vertical at depth or gravity-slide masses derived from uplifted blocks. Thus, these structures are very similar to many other Rocky Mountain foreland features and are dominated by vertical movements whereas the foldbelt structures indicate a strong component of horizontal movement.

The major Laramide thrust faults exposed in southwestern New Mexico (Fig. 1) have yielded northeastward toward the foreland.

Uncertainty concerning the extent of basement involvement impedes analysis of the mechanics of thrusting. If the basement is involved in thrusting, as it appears to be in the Florida Mountains, gravitational gliding probably was not the driving mechanism. Also, no evidence has been presented to indicate the presence of extensional structures within the thrust plates. Possibly, however, a gravitational model similar to that proposed by Price and Mountjoy (1970) may have been operative, with upward and outward pushing from an uplifted central core in the foldbelt. Southwestern New Mexico was marginal to any hypothetical central foldbelt uplift, and the thrusts in this region appear to have moved upslope.

The amount of displacement on the thrusts cannot be determined accurately, but movement probably was at most several miles and in many areas was no more than a few thousand feet.

By analogy with areas in the foldbelt in Nevada and Utah (Mackin, 1960), anomalous minor structures may be superimposed on the foldbelt. These structures include doming by intrusions and gravity-slide plates derived from intrusive doming or from block uplift during Basin-Range deformation. Obviously, however, the thrust faults and compressional folds are not related to Basin-Range deformation because the range-marginal faults of the Basin-Range uplifts truncate the thrusts and folds.

Thrust faults along tectonic strike of the New Mexico thrust belt are reported in the Chiricahua and Dos Cabezas Mountains of eastern Arizona (Sabins, 1957). Northward-yielding thrust faults also are present in central Cochise County, Arizona (Gilluly, 1956). Drewes (1968) dated northeast-directed thrust faults in southeastern Arizona as beginning about 90 m.y. ago and ending about 52 m.y. ago, with a time of quiescence between 62 and 57 m.y. ago. Hayes (1970) dated initial phases of the Laramide orogeny in southwestern New Mexico as late Turonian.
Lovejoy (1974) indicated Laramide thrusting and folding in the Juarez Mountains had ended prior to the emplacement of andesites believed to be 50-45 m.y. old. The postorogenic andesites interbedded with and overlying the Lobo Formation in the Florida Mountains may be of similar age. However, andesites of the Upper Cretaceous-Lower Tertiary (?) Hidalgo Formation are involved in Laramide thrusting in the Little Hatchet Mountains and Brockman Hills (Fig. 1).

The zone of frontal breakthrough marked by overthrusts along the northern margin of the New Mexico segment of the foldbelt appears to continue southeast into southwestern Texas (King, 1969) and into the eastern Chihuahua tectonic belt (Gries and Haenggi, 1960). Thus the northern margin of the Laramide thrust zone coincides with the Texas lineament. Consequently, in southwestern New Mexico, the Texas lineament (Albritton and Smith, 1957) appears to be a zone separating the foldbelt from the foreland on the north.
REFERENCES CITED


Bogart, J.E., 1953, The Hueco (Gym) Limestone, Luna County, New Mexico: M.S. thesis, University of New Mexico, 91 p.


MINERAL DEPOSITS FLORIDA MOUNTAINS

by

George B. Griswold

This condensation is from the New Mexico Bureau of Mines and Mineral Resources Bulletin 72, Mineral Deposits of Luna County, New Mexico by George B. Griswold, 1961.

Lead, zinc, copper, silver, and gold have been mined from the district in the past, mostly in the period 1880 - 1920. Manganese deposits were exploited on the southeast slopes during the 1950's, when the manganese purchasing program of the U.S. Government was in effect. Mining activity is now at a standstill.

Description of Mines and Prospects:

Silver Cave Mine

This deposit is located on the south slope of Gym Peak in the SW ¼ sec. 7, T-25-S, R. 7 W. The deposit is said to have been worked in the period 1881 - 85. During this time 1,800 tons of oxidized lead-silver ore, valued at $60,000, was shipped. There is no known production since 1885.

The mine is located on the north slope of an arroyo that drains to the east. Near the mine, the arroyo follows a large northwest-trending fault that has displaced Paleozoic sediments (on the northeast) against Precambrian granite (on the southwest). Farther east, the fault trace climbs the south slope of the canyon and then abruptly swings to the south.

The block of Paleozoic rocks northeast of the fault is a homocline dipping to the east and forms the bulk of Gym Peak. The beds range from Ordovician to Permian in age. Darton (1917) placed the Silver Cave mine in an area underlain by what he called Gym (Permian) limestone. Actually, the mine is within a massive, gray dolomite that the writer believes to be Fusselman dolomite. Complicated structure and intense silicification make accurate age definition difficult.

In the vicinity of the mine, the Fusselman (?) dolomite strikes N. 45° E. and dips 40° SE. A basic dike about 5 feet wide, trending N. 5° E. and dipping 70° W., has cut the dolomite. A steep incline was driven along the hanging wall of this dike. Little mineralization occurs at this location, but the incline apparently served as an extraction opening for ore stoped farther up into the hillside.
A shallow shaft was sunk about 150 feet northeast of the portal of the incline, and some stoping was done on a N. 80° W. fracture zone containing replacement pods of oxidized lead-zinc ore. Little ore is left. The ore mineral was cerussite, accompanied by smithsonite (?), limonite, calcite, and quartz. The stope openings are not accessible without the aid of ladders, but they are believed to extend downward to the level of the incline. The mine dumps do not indicate a large amount of underground development.

Lucky John (Mahoney) Mine

A lead-zinc-copper deposit is located on a high ridge about one mile north of Gym Peak in the central part of sec. 1, T. 26 S., R. 8 W. The date of discovery is not known, but Darton indicated that the mine was worked in 1914. Several ore shipments are believed to have been made in 1915-17 and 1926.

The deposit is located in a block of Paleozoic sediments almost completely surrounded by Precambrian granite. The block dips gently to the east for the most part, but locally the attitude varies greatly.

The lead-zinc-copper mineralization is limited to a series of east-trending vertical veins in a gray dolomite believed to be Fusselman. In the vicinity of the mine, the beds strike almost due north and dip 10° - 50° E. Five distinct east-trending veins, as well as several other weakly mineralized zones, crop out on the crest of the ridge. Development consists of trenching on the veins, several vertical shafts, and one long adit driven into the ridge from the east side about 200 feet below the crest.

Several stopes have broken through to the surface; in these openings the vein widths range from 0.5 foot to 4 feet. The vein material is much oxidized at the surface, containing smithsonite, cerussite, malachite, and azurite as the ore minerals, in a gangue of limonite, quartz, barite, and calcite. A few specimens of galena were noted; apparently some sulfide ore was mined at depth. The strength of the vein outcrops tempts one to recommend this property for further development, but its remoteness would make the cost of such a program extremely high.

San Antonio Mine

A lead-zinc deposit is located about a quarter of a mile west of Capitol Dome near the base of the mountains in the SE 1/4 sec. 10, T. 25 S., R. 8 W.

The local geologic setting is a block of east-dipping Ordovician sediments bounded on the north and south by east-trending faults, on the west by Precambrian granite underlying the sediments, and on the east by the Tertiary Lobo Formation and andesitic agglomerate that overlie the Ordovician sequence.
The lead-zinc deposits are restricted to the lower dolomite member of the El Paso group. The principal veins occur in and near a west-draining arroyo, where the sediments strike N. 10° - 25° E. and dip 30° - 40° E. On the north side of the arroyo, two shallow shafts have been sunk on two east-striking veins that dip steeply to the north. The veins are very narrow at the surface, the maximum width being about 2 feet. Several hundred feet south of the arroyo, two other narrow veins have been prospected, one striking N. 30° W., the other N. 85° E. The exposed parts of the veins contain minor amounts of cerussite and smithsonite(?) in a gangue of limonite, calcite, and quartz.

Still farther south, a short adit was driven on a vertical vein striking due east just above the base of the El Paso group. The dip of the sediments increases to 60° E. here, but otherwise the mineralization is similar to that described above.

The amount of dump material present on the property indicates only a minor amount of underground work; likewise, the amount of ore shipped must have been small.

Stenson Mine

A small copper mine, called the Stenson, is located about 1 mile south of the San Antonio mine, near the center of sec. 14, T. 25 S., R. 8 W.

The deposit is described by Lindgren et al. (1910) as having had about 1,000 feet of underground development by 1910. Since that time, another adit has been driven an additional 650 feet. An examination of the workings indicated that little stoping had been done; therefore, the amount of ore shipped must have been small.

The deposit is located within the large exposure of Precambrian rocks on the western slope of the range. The Precambrian consists of red and gray, coarse-grained granite, gabbro, and diorite.

A small vein-fault zone trending N. 70° E., with dips ranging from 65° to 85° S., traverses the Sunny Slope and Georgia claims. Development consists of three adits and one shaft. The upper adit is caved at the portal, but is reported to be 150 feet long (Lindgren et al., 1910). A shaft from the surface extends through this level about 70 feet in from the portal. The middle adit is accessible for 390 feet, at which point it is badly caved. A raise, located 320 feet inside the portal, is reported to connect with a sublevel 60 feet above; the shaft from the surface also connects with the sublevel. The lower adit contains a total of 650 feet of workings, but of this distance only 500 feet was driven along the vein structure.

The exposures in the middle adit show a weak vein containing chalcopyrite, pyrite, magnetite, and quartz. The vein is partially oxidized, yielding malachite and limonite. The vein width varies widely, but the mean width is 3 feet. Much postore fault movement is evident along the vein.
In the lower adit, a definite vein is not visible. Instead, a zone 40 feet or more wide contains numerous randomly oriented veinlets and disseminations of pyrite and chalcopyrite. On the surface, in the vicinity of the portal, the diorite (?) is altered by bleaching and contains much limonite. The average grade of the zone explored by the lower adit is low, probably only a fraction of 1 percent copper.

Bradley Mine

A lead-zinc-silver prospect is located in sec. 18, T. 25 S., R. 7 W.

This mine is believed to be one of the oldest in the district, having been worked in the early 1900's or earlier. The writer was not able to obtain a complete record of production, but one shipment was recorded in 1927.

The deposit is located in the Tertiary agglomerate sequence. In the vicinity of the mine, the agglomerate is composed of light brownish-gray tuffs and conglomerate beds that strike northwest and dip 10° - 30° NE. An east-striking vein with vertical dip cuts the agglomerate. The vein has been developed by trenching and stoping for about 200 feet along the strike. The material on the dump indicates that the vein contains galena, sphalerite (?), and minor chalcopyrite, in a gangue of pyrite, limonite, calcite, and quartz. The vein width is variable, but the average is estimated to be 2 feet. Two large cuts were made in a tuff bed a few hundred feet west of the vein outcrop. These cuts do not show a distinct vein structure; copper stains, however, are present as streaks in the tuff.

The Park (Hilltop) Mine

An old zinc mine is located in what is known as The Park, a large amphitheater on the west side of the Florida Mountains. The precise location is the center of the S 1/4 sec. 35, T. 25 S., R. 8 W.

The date of discovery and past ore shipments are not known.

The deposit is located near a northwest-trending fault that has displaced Precambrian granite on the northeast against Lower Paleozoic sediments on the southwest. The general attitude of the sediments is one of northeast strike and southeast dip. In the immediate area of the mine, however, the beds are contorted, presumably caused by movement on the aforementioned fault, which lies immediately to the northeast. The sediments at the mine are gray, crystalline, calcic dolomite beds, which weather to tan and grayish black. The beds are probably members of either the Montoya or Fusselman dolomite.

Several trenches, shafts' and pits expose indistinct veins that trend northwest and dip steeply to the southwest. The most promising vein strikes N. 55° W. and dips 65° S. The vein material is thoroughly oxidized, and the ore mineral
is "dry bone" smithsonite accompanied by a minor amount of cerussite. Limonite is abundant. A grab sample from a small pile of handsorted ore near one of the pits assayed 26.4 percent zinc and a trace of lead. The sample is not to be considered as representative of the ore in place.

An adit was noted a quarter of a mile south of The Park mine, but it was not examined. It is in Precambrian rock.

There are numerous manganese deposits in the Florida Mountains. Prominent among these are:

Birchfield mines, secs. 5 and 6, T. 26 S., R. 7 W., and secs. 31 and 32, T. 25 S., R. 7 W.
White King mine, SE $\frac{1}{4}$ sec. 31, T. 26 S., R. 7 W.
Wet King mine, NW $\frac{1}{4}$ sec. 13, T. 26 S., R. 8 W.

These mines are reported to have shipped small tonnages during World War II, and again in the middle of 1950's.

The Florida mining district has remained dormant, except for manganese mining, for a number of years. During the field investigation of the district, the writer did not have the advantages of an experienced guide to show him where the various mines and prospects are located. Hence, it is certain that a number of deposits were completely missed. After the termination of field work, the writer learned of the existence of several additional prospects, but time would not allow a reexamination of the area. These deposits are:

Birchfield zinc prospect, a zinc prospect located in the SW $\frac{1}{4}$ sec. 32, T. 25 S., R. 7 W. A carload of ore was reported to have been shipped from the deposit in 1949.
Shaw prospect, a copper prospect located in sec. 35, T. 25. 25 S., R. 8 W. This prospect may be the adit noted south of The Park mine.
Waddel prospect a galena, barite, and fluor spar deposit located in the S $\frac{1}{2}$ sec. 24, T. 25 S., R. 8 W. This deposit may have been renamed the Atir mine, in which case it was briefly explored by the Consolidated Minerals Corp. in 1959.
Edna Belle prospect, a lead prospect located in the W $\frac{1}{2}$ sec. 18, T. 25 S., R. 7 W. This deposit may be the same as the Bradley mine described above.
Window Mountain mine. Darton (1917) mentions a prospect of this name but fails to describe it.

Uranium occurrence. Purple fluorite containing a radioactive mineral is reported from the district, but the location of the occurrence is now known.
REFERENCES CITED


The derivation of the name Florida Mountains is from that mountain range of the same name in Luna County, New Mexico. The word is Spanish in origin and means "flowery" and refers to the many flowers that grow on the slopes of the range particularly after the summer (July-August) rainy season (see Pearce, 1965, p. 57). The local pronunciation is Spanish, not English. The general type locality is in the east-central part of the range.

The formation was defined by Flower (1964, p. 149) who indicated the general type locality. Flower originally designated the formation as Florida which had been pre-empted (G.V. Cohee, personal communication, 1968). LeMone (1969, p. 22) subsequently designated the formation as Florida Mountains and located the precise type locality.

The Florida Mountains Formation represents the youngest Canadian (Lower Ordovician) rocks exposed in the Texas-New Mexico area of the southwestern United States. The Florida Mountains Formation is the uppermost of the ten formations comprising the Canadian Series El Paso Group. It is equivalent to Unit C which is an informal designation made by Cloud and Barnes (1948) in West Texas. Ordovician age rocks have been recognized in boreholes in the United States and Mexico. The Florida Mountains Formation, if present, in these petroleum tests is not separable at this time. The Canadian El Paso Group forms a regional angular unconformity that dips to the south and confines the Florida Mountains to a narrow belt that is recognized only from the Florida Mountains, New Mexico in the west to the Van Horn area (Beach Mountain) in the east. The El Paso Group is recognized as a time-transgressive unit from west to east originating in the Cordilleran Geosyncline. The nearest surface outcrops of the Lower Ordovician to the south is the Placer de Guadalupe area south and east of Chihuahua City, Chihuahua, Mexico some 250 miles south-southeast of the Florida Mountains stratotype area. The Placer de Guadalupe section lacks the precision to indicate correlation relationships at this time.

The Florida Mountains Formation stratotype is located in the NE/4, sec. 6, T. 26s., R.7W., Luna County, New Mexico (see Figure 1). Examination of the Gym Peak 7.5 minute quadangle will indicate that the holostratotype can be reached by means of an unimproved dirt road that parallels the east slope of the Florida
Stratotype Florida
Mountains Formation

Calcereous Sandstone
Limestone
Limestone with Interbedded Silstone
Chert

Figure 1
Mountains. Local conditions should be checked at time of entry. A secondary reference hypostratotype of the easily accessible, intensively studied Southern Franklin Mountain Scenic Drive section will be subsequently published elsewhere.

The thickness of the stratotype is 14.295 meters (46.9 feet). The unit is typically a slope-former below the overlying, massive Upper Ordovician Upham Formation of the Montoya Group. The stratotype is a medium to poorly exposed unit which is partially covered (see Figure 1). It consists of very fossiliferous, calcareous carbonate with interbedded siltstones and silty limestone with several zones of light brown to pale yellow brown chert. A lithologic description of the stratotype is included in Appendix I.

Carbonate petrography (see Appendix II) of the stratotype indicates considerable recrystallization throughout the section. Stylolitization and pressure solution of allochemical grains are also noted. Pyrite is common. Carbonate grain sorting is typically poor and usually angular. Slides which were stained with Alizarin Red-S over 50% of the surface revealed some minor dolomitization.

The Florida Mountains Formation is very fossiliferous as described in Appendix I and II. The flora contains megascopically and microscopically recognizable stromatolitic units. Thin-section analysis reveals algal corrosion of grains which can probably be assignable to *Girvanella*. *Nuia siberica* (Maslov) is recognized at the stratotype as well as the hypostratotype at El Paso.

The fauna is varied and rich. Abundant pelmatozoan ossicles are recognized in thin-section and outcrop. Ostracods are fairly abundant but have been recognized only in thin-section. Conodons are undoubtedly present but have not been processed at the stratotype. Trilobites are abundant and represented by species of the genera of *Pseudocybele*, *Pseudomaria*, *Gonioteiulus*, and *Isoteloides* (?). Nautiloids are represented by *Buttsoceras*, *Cyptendoceras*, *Protocycloceras*, and unidentified taphyceroid fragment. Brachiopods include species of *Diaparalasma*, *Triteuchia*, and *Syntrophopsis*. Riberoid bivalves and monoplacophorans (high and low-conical forms) have also been recovered. Porifera has been recognized in thin-section and as questionable fragments in the outcrop. Gastropods are common. Calaurops has been recognized by Flower. Flower is in the process of preparing a detailed paleontological study of the formation.

The fauna is typical of the foreland (West Texas-New Mexico) *Buttsoceras* Chronozone. It is correlative to the Hintz (1951, 1952) and Ross (1951) composite Garden City-Ibex, Utah miogeosynclinal western North America standard series (see Figure 2). It would include Chronozone J-*Pseudocybele nasuta* and Chronozone K-*Hesperonemiella minor*. It is Upper Cassinian Stage or West Granville Substage. It is probable chronostratigraphic equivalent of the following formations: Wahwah (Utah); Upper West Spring Creek (Oklahoma); Smithville-Black Rock (Ozarks); Odenville (Southern Appalachians); Pinesburg Station (Northern Appalachians); Upper
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**STRATOTYPE FLORIDA MOUNTAINS FORMATION**
Copake (?) (Southern Hudson Valley); Providence Island (Fort Ann, New York); Bridport-Beldens (Vermont); Corey and Basswood Creek (Phillipsburg, Quebec); and the Uppermost St. George Group (Western Newfoundland). There is not apparent equivalents to this formation in either the Spitzbergen or the Baltic sequences. The Florida Mountains Formation is Uppermost Canadian Series or the equivalent to a portion of the Upper Arenig Series of Great Britain.

The Florida Mountains Formation can be recognized from the underlying Lower Cassinian Stage Scenic Drive Formation by an increasing silt content, yellowish-brown weathering character, thin beds, and chert development. The lower contact is covered. Where the surface is well exposed elsewhere, it does not form a particularly distinct disconformity and may present some identification problems to the uninitiated.

The Upper Ordovician Cable Canyon Member of the Upham Formation of the Montoya Group overlies the Florida Mountains Formation at the stratotype. The mottled (bioturbated), cliff-forming massive carbonate is everywhere distinct and unmistakable. It is Eden-Gobourg Stage of the Cincinnatian Series. It is equivalent to the Caradoc in the Great Britain Series. The sporadically occurring Champlainian (Middle Ordovician) Rio Membres Sandstone (LeMone, 1969, p. 22-23) is not recognized at the stratotype.

The Florida Mountains Formation, where present, is regionally overlain by the profound unconformity that separated the uppermost Sauk from the Lowermost Tippecanoe Sequences or Supersystems of Sloss. The overlying chronostratigraphic unit (Chronzone L- Orthoambonites subalatus) is represented only in the deeper basins or miogeosynclinal areas such as the Garden City-Ibex region of Utah. The basal Champlainian Series-Whiterock Stage Juab Substage is recognized in the Juab Limestone. The Juab Substage is the partial equivalent of the lower part of the Spitzbergen Valhallfonna Formation and is equivalent to the Baltic Volkhov Formation. The Juab Substage is equivalent to the uppermost Arenig and lowermost Llavn of the Great Britain Series.

The Florida Formation is interpreted to be a foreland, tidal to subtidal probably initial regressive facies of the Candian in West Texas and New Mexico.
REFERENCES


Pearce, T.M., (1965), New Mexico Place Names, The Univ. of New Mexico Press, Albuquerque, New Mexico, p. 57.

TYPE FLORIDA FORMATION

AREA: Southeastern Flank of the Florida Mountains, Lena County, New Mexico. Total Thickness = 14.295 meters or 46.9 feet.

UPPER ORDOVICIAN
MONTOYA GROUP
UPHAM FORMATION

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<td>TF-10CC</td>
<td>Calcareous sand; color weathered-not observed; color fresh-pale red, 10R 6/2; sedimentary features: Cable Canyon of the Upham Formation of the Montoya Group. Specimen taken laterally along the outcrop. Distinct color change fine to medium sandstone: fauna and flora: not observed: sandy mudstone: sandy micrite.</td>
<td>14.295 meters or 46.9 feet</td>
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LOWER ORDOVICIAN
EL PASO GROUP
FLORIDA MOUNTAINS FORMATION

Sedimentary features: covered. No positive outcrop. Probable top of the Florida Mountains section estimated at 46.9. Sample of Cable Canyon taken laterally at this point. In the line of section no outcrops can be found in place.

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<tr>
<td>TF-9</td>
<td>Limestone-coarsely crystalline; color (weathered)-medium grey (N5); color (fresh)-medium light grey (N6); sedimentary features: slightly softer at 2-3 feet coquina like. Very friable; choppable material replete with good fauna of trilobites, gastropods, brachiopods, pelmatozoan fragments; packstone-coarse grained limestone; biosparrudite.</td>
<td>1.829</td>
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<tr>
<td>TF-8</td>
<td>Limestone: color (weathered)-some light brown (5YR 6/4) chert and silt, medium grey (N5): color (fresh)-medium grey (N5); sedimentary features: calcarenitic, some chert (nodular) intraclastic, soft sediment structure, flame structure; excellent fauna, pelmatozoan fragments, questionable algae, brachiopods; packstone: intramicrite and biomicrudite.</td>
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Covered, no certain outcrops. 1.494
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<td>TF-7</td>
<td>Limestone and minor siltstone; color (weathered)-silt light brown as scattered lenses, medium grey (N5); color (fresh)-medium light grey (N6); sedimentary features: intraclastic (fine orange silt) alternating in part with fossiliferous calcarenites; fauna and flora: replaced forms, pematozoan fragments; wackestone to packstone; intramicrite and intramicrudite.</td>
<td>.457</td>
</tr>
<tr>
<td>TF-6</td>
<td>Limestone and silt; color (weathered)-siltstone, light brown (5YR 5/6), limestone, light grey (N7); color (fresh)-siltstone, moderate brown (5YR 4/4), limestone, medium light grey (N6); sedimentary features: like TF-5. Very tough to sample. Contains reddish zones which take on the aspect of a paper shale. Alternates with coquina-like dark zones. Coarse grained alternating with fine micritic laminated beds; fauna and flora: trilobites, brachiopods, pematozoans; wackestone with siltstone; biomicrudite with siltstone.</td>
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<tr>
<td>TF-5</td>
<td>Limestone and silts (minor light brown chert); color (weathered)-medium grey (N5); color (fresh)-medium light grey (N6); sedimentary features: This is the lowest unit with extensive limonite. Silty interbeds. Forms a massive slope forming unit. Coarse grained. Surface silicification. Styloitic. Mineralized in part; fauna and flora: contains chopable trilobites, algal structure?, brachiopods, pematozoans: packstone to grainstone; biomicrudite to biopassrudite.</td>
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<td>TF-4</td>
<td>Limestone and chert; color (weathered)-chert grey orange pink (5YR 7/2), medium light grey (N6); color (fresh)-chert light brown (5YR 5/6), medium grey (N5); sedimentary features: silty, differential compaction, chert and limestone intermixed. Chert more bedded; fauna and flora: none observed. Questionable algal material. Possible bioturbation; mudstone; micrite.</td>
<td>.914</td>
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<td>TF-3</td>
<td>Limestone; color (weathered)-moderate brown (chert and silicified fauna) (5YR 4/4), medium grey (N5); color (fresh)-medium dark grey (N4); fauna and flora: Indistinct, replaced pematozoans (moderate brown), questionable gastropods, brachiopods; wackestone to packstone; biomicrudite.</td>
<td>.213</td>
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</tbody>
</table>

Covered.
Sample No. | Description                                                                                                                                                                                                                                                                                                                                                               | Thickness |
---|---|---|
TF-2 | Limestone: color (weathered)-medium grey (N5); color (fresh)-medium grey (N5); sedimentary features: alternating minor lutitic carbonates and calcarenites fossiliferous material. Some orangish silicified material; fauna and flora: bivalves, trilobites, brachiopods pelmatozoans (slightly silicified), trochoid gastropods; packstone to wackestone; biomicrite to biomicrudite. | .122      |
| | Covered.                                                                                                                               | .975      |
TF-1 | Limestone and chert; color (weathered)-pale red brown (10R 5/4) (chert), pale yellow brown (10YR 6/2), color (fresh)-medium grey (N5); sedimentary features: well developed chert; fauna and flora: possibly some small debris; mudstone; micrite. | .305      |
| | Covered.                                                                                                                               | .122      |
TOTAL THICKNESS |                                                                                                                                     | 14.295    |

LOWER ORDOVICIAN  
EL PASO GROUP  
SCENIC DRIVE FORMATION

TF-BASE | Limestone and chert; color (weathered)-moderate orange pink (5YR R/4) (chert), medium grey (N5); color (fresh)-moderate brown (5YR 4/4) (chert), medium light grey (N6); sedimentary features: Scenic Drive Formation. Base of section is an orange chert unit. Sample taken 1 foot below lithologic change. Grey muddy calcarenites and calcilutites. Soft sediment deformation (compaction). Laminated in part with orangish silty laminae; fauna and flora: Tubular material vertically situated in section (3.6 inches high with a cross-section diameter .37 inches). Material interpreted to be digitate algae. Trilobites, gastropods, unidentifiable fragments; mudstone and wackestone; sparse biomicrite. |
### TF-Series (Type Section - Florida Mountains, Luna County, New Mexico)

**Florida Mountains Formation**

<table>
<thead>
<tr>
<th>No.</th>
<th>FOLK'S CLASS</th>
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<th>TRILOBITES</th>
<th>OSTRACODS</th>
<th>GASTROPODS</th>
<th>BIVALVES</th>
<th>NAUTILIDS</th>
<th>CRICOCARIDS</th>
<th>BRACHIOPODS</th>
<th>PORIFERA</th>
<th>CONCHIDOIDS</th>
<th>GRAPTOIDES</th>
<th>ANELIDS</th>
<th>NUDA</th>
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<td>Algal biomicrite</td>
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</table>

G = Good, F = Fair, P = Poor; A, SA; SR, R.
Preliminary Radiometric Age Determinations from the Florida Mountains, New Mexico

Douglas G. Brookins
University of New Mexico

Roger E. Denison
Mobil Research and Development Corporation

Introduction

The bulk of the igneous rocks of the Florida Mountains can be divided into three groups: Old (~1.35 b.y.?) granitic rocks in the northernmost part of the area, granite to (quartz) syenite of uncertain age which occurs south of the major high angle reverse fault which roughly divides the Floridas into northern and southern parts (Corbitt, 1971; Corbitt and Woodward, 1973), and enigmatic syenitic rocks, also of uncertain age, which occur north of the major high angle reverse fault. This last group of rocks is of extreme importance in that Corbitt (1971) has proposed a Mesozoic age of emplacement for them although Griswold (1961) has placed them in the Precambrian; mineralization, albeit somewhat minor, is more or less confined to occurrences within or near the northern body.

It is the purpose of this report to summarize preliminary geochronologic data for the major occurrences of igneous rocks from the Florida Mountains (i.e. those with syenitic or quartz syenitic to granitic affinities) and to attempt to interpret their history. K-Ar and Rb-Sr mineral and Rb-Sr whole rock age data have been obtained; further, geochemical and normative data are included for assistance in interpretation.

Previous work

The most comprehensive field study of the Florida Mountains has been that of Corbitt (1971). He mapped or re-mapped the entire range and was able to precisely tie down the high angle reverse fault separating the northern and southern parts of the Floridas; the tectonic map resulting from his study has been reported by Corbitt and Woodward (1971; 1973). The most difficult part of Corbitt's work to evaluate, however, is the age of the igneous rocks with syenitic affinities which occur north of the reverse fault. In brief, Corbitt (1971) argues for intrusion of the syenite (Note: Corbitt's terminology will be used for the remainder of this section except where noted) into the Paleozoic sedimentary sequence in the Mesozoic; he notes probable intrusive contacts of syenite-sedimentary rocks in several places (p. 61-67). Further, as the syenite is overlain by the sedimentary rocks of the Lobo Formation (Cretaceous-?-Tertiary-?) he places the age of intrusion as Mesozoic. Because of similarities between the major igneous rocks to the north and south of the reverse fault those south of the thrust fault are also mapped as Mesozoic syenites (or quartz syenites).
There are three basic problems involved: (1) The age(s) of the syenitic rocks. (2) The nature of the contacts of the syenitic rocks with the Paleozoic sedimentary rocks. (3) The proper rock classification of the major igneous rocks north and south of the thrust fault (hereafter simply referred to as the northern and southern bodies). As stated in the Introduction, the rocks of the southern body are in fault contact with the Paleozoic and older rocks and are of uncertain age; hence comments concerning age based on geologic evidence pertain to the northern body only.

The contact of the northern body with the Paleozoic rocks is not clear; Coebitt (1971) cites the following evidence for low grade, contact alteration: (a) recrystallization and/or dolomitization of carbonates at the contact, (b) replacement of arenaceous contact material by chlorite, clinozoisite, cordierite and epidote, (c) fine-crystalline syenite exhibiting flow structure within the marginal parts of the northern body, (d) zones of mineralization possibly related to syenite emplacement, (e) zones of induration and/recrystallization near the syenite contact, (f) baking and alteration in contact zones.

The contact relationships of the northern body are by no means clear. F.E. Kottlowski (written communication to R.E. Denison, 1972) mentions fault, sedimentary, and possible cold intrusive-type contacts of the syenite with the Paleozoic rocks. It is impossible to comment further on the nature of these contacts without further field work; it is sufficient to simply state here that the problem is not unequivocally resolved and the basic problem of age of the syenite remains uncertain. Previous workers (See Griswold, 1962; for example) have placed all of the major igneous rocks of the Florida Mountains in the Precambrian; little detail has been paid to the "intrusive" types of contacts noted, however.

Of further importance, if for no other reason than for comparative petrographic classification, is the chemistry of the rocks involved. Coebitt (1971) refers to both the northern and southern bodies as syenites to quartz syenites; others have called the rocks granites, alkali granites, granites with syenitic affinities, etc. This will be commented on later in this report.

The sample locations are shown in Figure One; only the last two digits of each number have been plotted.

Results for The Southern Body

a. Rb-Sr whole rock age determinations

The results of Rb-Sr age determinations for eleven whole rocks are shown in Table One; these include four samples which, based on thin section examination, are unsuitable for age work (i.e. presence of carbonates indicating open system conditions). The remaining seven samples yield a mean age of $1.13 \pm 0.2$ b.y. assuming initial Sr (87/86) = 0.705. The four altered samples yield apparent ages ranging from 0.4 to 0.6 b.y. to which no significance can be drawn at this time.
Table 1

<table>
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<th>Sample No.</th>
<th>K/Rb</th>
<th>K/(Rb/Sr)</th>
<th>SiO₂(%)</th>
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<td>-</td>
<td>Quartz Syenite</td>
</tr>
<tr>
<td>1189</td>
<td>532</td>
<td>1.45</td>
<td>66.7</td>
<td>.64</td>
<td>-</td>
<td>Quartz Syenite</td>
</tr>
<tr>
<td>1191</td>
<td>870</td>
<td>19.3</td>
<td>64.3</td>
<td>.51</td>
<td>-</td>
<td>Quartz Syenite</td>
</tr>
<tr>
<td>1197</td>
<td>241</td>
<td>.58</td>
<td>78.1</td>
<td>.70</td>
<td>-</td>
<td>Granite</td>
</tr>
<tr>
<td>1200</td>
<td>605</td>
<td>11.6</td>
<td>63.7</td>
<td>-</td>
<td>+</td>
<td>Quartz Syenite</td>
</tr>
<tr>
<td>1186</td>
<td>600</td>
<td>5.1</td>
<td>63.5</td>
<td>.57</td>
<td>+</td>
<td>Quartz Syenite</td>
</tr>
</tbody>
</table>

I. Samples from North of High Angle Reverse Fault

II. Samples from South of High Angle Reverse Fault

IIa. South and west of South Peak

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>K/Rb</th>
<th>K/(Rb/Sr)</th>
<th>SiO₂(%)</th>
<th>Apparent Rb-Sr Age</th>
<th>Carbonate Alteration</th>
<th>Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>1190</td>
<td>503</td>
<td>1.45</td>
<td>72.9</td>
<td>.28</td>
<td>+</td>
<td>Granite</td>
</tr>
<tr>
<td>1192</td>
<td>282</td>
<td>1.84</td>
<td>75.5</td>
<td>-</td>
<td>+</td>
<td>Granite</td>
</tr>
<tr>
<td>1193</td>
<td>257</td>
<td>0.50</td>
<td>76.8</td>
<td>.87</td>
<td>-</td>
<td>Granite</td>
</tr>
<tr>
<td>1194</td>
<td>255</td>
<td>.73</td>
<td>80.1</td>
<td>.70</td>
<td>-</td>
<td>Granite</td>
</tr>
<tr>
<td>1195</td>
<td>423</td>
<td>2.7</td>
<td>77.9</td>
<td>.46</td>
<td>+</td>
<td>Granite</td>
</tr>
<tr>
<td>1196</td>
<td>198</td>
<td>.59</td>
<td>77.1</td>
<td>.51</td>
<td>-</td>
<td>Granite</td>
</tr>
<tr>
<td>1199</td>
<td>611</td>
<td>2.7</td>
<td>74.4</td>
<td>.39</td>
<td>+</td>
<td>Granite</td>
</tr>
</tbody>
</table>

IIb. South and east of South Peak

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>K/Rb</th>
<th>SiO₂(%)</th>
<th>Rb-Sr Age</th>
<th>Carbonate Alteration</th>
<th>Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>1184</td>
<td>400</td>
<td>74.4</td>
<td>1.06</td>
<td>-</td>
<td>Granite</td>
</tr>
<tr>
<td>1185</td>
<td>242</td>
<td>79.1</td>
<td>1.24</td>
<td>-</td>
<td>Granite</td>
</tr>
<tr>
<td>1187</td>
<td>197</td>
<td>79.3</td>
<td>1.32</td>
<td>-</td>
<td>Granite</td>
</tr>
<tr>
<td>1188</td>
<td>202</td>
<td>71.3</td>
<td>1.47</td>
<td>-</td>
<td>Granite</td>
</tr>
</tbody>
</table>

Notes to Table 1.

1. Age calculated from $t = \frac{(Sr^{87}/Sr^{86})_{measured} - (Sr^{87}/Sr^{86})_{initial}}{(\lambda)(Rb^{87}/Sr^{86})_{measured}}$

where $(Sr^{87}/Sr^{86}) = 0.705$ and $\lambda = 1.39 \times 10^{-11}/y$
Table 2

Mineral Ages

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Rock Type</th>
<th>Rb-Sr(m.y.)</th>
<th>K-Ar(m.y.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1650-1F</td>
<td>Quartz Syenite</td>
<td>474 ± 32</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Quartz Syenite</td>
<td>473 ± 32</td>
<td>-</td>
</tr>
<tr>
<td>1650-2F</td>
<td>Quartz Syenite</td>
<td>456 ± 56</td>
<td>-</td>
</tr>
<tr>
<td>1652F</td>
<td>Quartz Syenite</td>
<td>515 ± 26</td>
<td>-</td>
</tr>
<tr>
<td>1652H</td>
<td>Quartz Syenite</td>
<td>-</td>
<td>418 ± 8</td>
</tr>
<tr>
<td></td>
<td>Quartz Syenite</td>
<td>-</td>
<td>419 ± 8</td>
</tr>
<tr>
<td>1654H</td>
<td>Hornblende gabbro</td>
<td>-</td>
<td>555 ± 11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>545 ± 11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>530 ± 20</td>
</tr>
</tbody>
</table>

Notes: (1) F = Feldspar, H = hornblende.
(2) Rb-Sr ages calculated using $\lambda = 1.39 \times 10^{-11} \text{/y}$.
b. Whole rock chemistry

The chemistry of rocks from the southern and northern bodies will be reported on in detail elsewhere; roughly they vary in SiO₂ content from 71 percent to 80 percent. The compositions of rocks from the southern body are plotted on a normative quartz-albite-K-feldspar diagram in Figure 2. All samples plot within limits of error for normal alkali granites.

c. Discussion

The age of the rocks of the southern body is Precambrian (1.13 ± 0.2 b.y.) but it is not clear as to whether it belongs to the 1.4 b.y. old province or 1.0 b.y. old province as discussed by Denison and Hetherington (1969) and Wasserburg and others (1965); as more samples are contemplated for analysis further statements concerning age of formation would be premature here.

The rocks southeast of South Peak are granites and not syenites; although those south and west of South Peak are alkalic. They contain abundant modal and normative quartz (in quantities such that even the use of the term "quartz syenite" is to be discouraged).

The samples from the southern body have been further subdivided into a south and western group and a southeastern group from South Peak for convenience; the former (Group IIa) yield apparent ages ranging from 0.5 to 0.87 b.y. for three unaltered samples and low ages for altered samples. K/Rb ratios for unaltered samples range from 198 to 257 for the three unaltered samples with K/(Rb/Sr) ranging from 0.50 to 0.73. For altered samples, K/Rb ranges from 282 to 611, a range more characteristic of syenitic rocks (Erlank, 1968) and K/(Rb/Sr) from 1.45 to 2.7.

For samples from Group IIb (all unaltered) K/Rb varies from 197 to 400 and K/(Rb/Sr) from 0.38 to 0.95. The former ratios are characteristic of acidic, non-syenitic rocks (Erlank, 1968) and the low K/(Rb/Sr) ratios coupled with the high (i.e. > 1 b.y.) ages support their classification as Precambrian granites.

Of interest, though, are the altered samples of Group IIa; the high (relative to unaltered samples) K/(Rb/Sr) ratios as well as low ages are readily explained by addition of Sr in the form of Sr in carbonates added during alteration. Not readily explained are the higher K/Rb ratios for three of the four altered samples. Preferential addition of K relative to Rb (or, alternately, removal of Rb preferential to K) is implied but the mechanism to account for this unknown.

Results for The Northern Body

a. K-Ar and Rb-Sr mineral and Rb-Sr whole rock age determinations

From Rb-Sr age determinations for feldspars from the quartz syenite range from 456 ± 56 m.y. to 515 ± 26 m.y. while two hornblendes from quartz syenite and three hornblendes from penecontemporaneous (See Corbitt, 1971) hornblende gabbro range from 418 ± 8 m.y. to 555 ± 11 m.y. Four whole rock Rb-Sr age determinations range from 500 m.y. to 750 m.y. for quartz syenites which show no signs
Figure Two: Plot of normative Qz-Ab-Or for northern and southern bodies, Florida Mts.

○ Southern body
+ Northern body