LOWER PALEOZOIC ROCKS IN THE EL PASO AREA

by

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ABSTRACT

The Lower Paleozoic of the Border Region near El Paso is represented by four basic rock units. The first unit (Late Cambrian (?)-Early Ordovician) consists of Bliss Sandstone and El Paso Group, which is time-transgressive and is older in the west and younger in the east. Detailed stratigraphic and paleontological studies reveal a complex series of transgressions and regressions rather than a simple west-to-east transgression.

The first unit is thickest on the south and thins to a feather edge in central New Mexico.

The second unit (Montoya Group-Upper Ordovician) is separated from the lower by a profound regional angular unconformity. The Montoya Group consists of four basic units that have been correlated by Flower from El Paso area to northern Greenland. These include an unnamed, sporadically occurring sandstone (Harding-Winnipeg erosion remnants); the Upham Formation, including the basal, locally developed Cable Canyon Sandstone (Red River); the Aleman Formation (Lower Richmond). All units except Aleman and Cutter Formations are separated by distinct regional disconformities.

The third unit (Fusselman Dolomite—Lower and Middle Silurian) disconformably underlies the Devonian Canutillo Formation.

The fourth unit consists of rocks of Devonian age and includes the Canutillo Formation (probably Middle Devonian in age) and the overlying Percha Shale (Upper Devonian). The fourth unit is disconformably overlain by the Mississippian Las Cruces Formation in the Franklin Mountains.

RESUMEN

El Paleozoico Inferior de la region frontcriza cerca de El Paso, está representado por cuatro unidales básicas de roca. La primera unidad (Cámbrico Tardio (?)—Ordovicico Temprano) consiste de la Arenisca Bliss y el Grupo El Paso y es transgresiva, en tiempo es más antigua hacia el occidente y más reciente hacia el oriente. Estudios estratigráficos y paleontolOgicos detallados, ban revelado series complejas de transgresiones y regresiones, más que una simple transgresión del occidente hacia el oriente.

La primera unidad es más gruesa en el sur y e adelgaza hasta desaparecer en la parte central de Nuevo Mexico.

La segunda unidad (Ordovicico Superior-Grupo Montoya) esá separada de la unidad inferior por una profunda discordancia angular regional. El Grupo Montoya consiste de cuatro unidades básicas que han sido correlacionadas por Flower dcsde el area de El Paso hasta el norte dc Groenlandia. Este incluye una arenisca sin nombre de ocurrencia (remanentes de erosion Harding-Winnipeg); la Formación Upham, localmente desarrollada (Red River), incluye la arenisca basal Cable Canyon y la Formación Alemán (Richmond Inferior). Todas la unidades excepto las Formaciones Aleman y Cutter están separadas por discordancias regionales notables.

La tercera unidad (Dolomita Fusselman-Silurico Inferior a Medio) infrayace discordante en la Formación Devónica Canutillo.

La cuarta unidad consiste de rocas de edad devónica e incluye la Formación Canutillo (probablemente de edad Devónica Media) y la lutita suprayacente Percha (Devónica Superior).

La cuarta unidad está discordantemente cubierta por la Formación Misisipica Las Cruces en las Montaflas Franklin.

ROCK SEQUENCES

BLISS SANDSTONE-EL PASO GROUP

The first unit is divided into eight Formations in the southern Franklin Mountains (from oldest to youngest) : Bliss Sandstone; El Paso Group (Sierrite Formation, Cooks Formation, Victorio Hills Formation, Jose Formation, McKelligon Canyon Formation, Scenic Drive Formation, and the Florida Mountains Formations) .

Bliss Sandstone

The Bliss Sandstone (Richardson, 1904, p. 27, 1909, p. 3) rests with apparent nonconformity on a Precambrian sur face of low to considerable relief. Richardson (1909, p. 3, 7) reports that the contact between the Bliss and the underlying granite is intrusive and post-Carboniferous in age. Further work by E. M. P. Lovejoy (1969, p. 104-109) and J. M. Hoffer (1969, p. 102-103) is in progress to determine the relationship between the Bliss and the underlying Precambrian (?), particularly the Red Bluff Granite, which has been designated by Nelson (1940, p. 160) as being Precambrian in age. Radioactive dates in the Franklin Mountains are summarized by Denison and Hetherington, Jr. (1969, p. 1-6) .

A low Precambrian mountain of rhyolite, which is lithologically similar to the type discussed by Harbour in the

GENERAL STRATIGRAPHY OF THE FRANKLIN MOUNTAINS

TIME UNITS	TIME ROCK UNITS				ROCK UNITS
NEOGENE	PLEISTOCENE				BOLSON DEPOSITS CAMP RICE FORT HANCOCK
CRETACEOUS		NEW CLASSIFICATION W.S. STRAIN	BÖSE 1910	UNIT	CENTRAL TEXAS EQUIVALENTS
	GULFIAN	BOQUILLAS		10	EAGLE FORD
	COMANCHEAN	BUDA	WASHITA GROUP	9	BUDA
		DEL RIO		8	DEL RIO
		*ANAPRA		7	MAIN STREET
		*MESILLA VALLEY		6	WENO-PAW-PAW
		*MULEROS		5	FORT-WORTH-DENTON
		*SMELTERTOWN		4	DUCK CREEK
		*DEL NORTE *COURCHESNE	FREDRICKS-BURG GROUP	1-3	EDWARDS
		*CRAZY CAT			TRINITY GROUP
PERMIAN	LEONARDIAN (?)		HUECO GROUP		ALACRAN MTN. FM. CERRO ALTO LS.
	WOLFCAMPIAN				HUECO CANYON FM.
PENNSYLVANIAN	VIRGILIAN MISSOURIAN		MAGDALENA GROUP		PANTHER SEEP EQUIVALENT (WITH GYPSUM)
	DES MOINESIAN ATOKAN MORROWAN				BISHOPS CAP FM. BERINO FM LA TUNA FM.
MISSISSIPPIAN	CHESTERIAN				HELMS FM.
	MERAMECIAN				RANCHERIA FM. LAS CRUCES FM.
DEVONIAN	UPPER				PERCHA SHALE
	MIDDLE (?)				CANUTILLO FM.
SILURIAN	NIAGARAN (MIDDLE) ALEXANDRIAN (LOWER)				FUSSELMAN FM.
ORDOVICIAN	CINCINNATIAN (UPPER)		MONTOYA GROUP		CUTTER FM. ALEMAN FM. UPHAM FM.
	CANADIAN (LOWER)		EL PASO GROUP		† FLORIDA MTS. FM. SCENIC DRIVE FM. McKELLIGON CANYON FM. JOSE FM. ‡ VICTORIO HILLS FM. COOKS FM. SIERRITE FM.
CAMBRO-ORDOVICIAN	CROIXAN AND/OR CANADIAN				BLISS SANDSTONE
YOUNGER PRECAMBRIAN	RED BLUFF GRANITE				RHYOLITE PORPHYRY LLANORIA QUARTZITE MUNDY BRECCIA CASTER LIMESTONE JoC

* NEW NAME
† = FLORIDA MTS. FM = FLORIDA FM.
‡ = VICTORIO HILLS FM. = VICTORIO FM.

LE MONE
1969

Fusselman Canyon area (1960, p. 1785-92) exposed on the western slope of South Mount Franklin, protruded above the sea floor and influenced sedimentation well into Canadian time (LeMone, Kottlowski and Foster, 1967, p. 129-130 and Kottlowski, LeMone and Foster, 1969, p. 134-142) . Lochman-Balk (1958, p. 46-52) reports burial of a Precambrian surface of relief varying from 50-100 feet (15-30 meters) in the Capitol Dome area in the Florida Mountains, New Mexico.

The Bliss Sandstone in the Franklin Mountains, 225-250 feet (69-77 meters) thick, has been divided into two members (LeMone, 1966a, p. 22) . In the Southern Franklin Mountains the lower member is quartzitic and contains a few shaly partings and is a coarse-to-fine-sand size quartzite which weathers dark red. It is overlain by the glauconitic member which is composed of glauconitic-hematitic, cross-bedded quartzite that weathers to a dark reddish green. Brachiopod fragments, observed along the planes of the cross-bedding in the member, are too poorly preserved to be recovered. The glauconite was probably formed from fecal pellets in much the same manner as suggested by Lewis (1962, p. 26-27) .

The age of the Bliss Sandstone in the Franklin Mountains is not clearly established. Lingulepis aff. walcotti Resser has been collected from strata approximately eighty feet (24 meters) below the top of the Bliss Sandstone by Cloud and Barnes (1958, p. 369) . Lingulepis aff. walcotti has been found in the Bliss Sandstone at Beach Mountain in Culberson County, Texas, in association with Ordovician cephalopods and gastropods (Cloud and Barnes, 1958, p. 360) . Richardson (1909, p. 3) recovered Lingulepis *acuminata* from the Bliss Sandstone, and, on the basis of this inarticulate brachiopod, assigned a Cambrian age to the Bliss Sandstone.

Inarticulate, lingulepisoid brachiopods are sporadically distributed in lenses in the Bliss Sandstone. Several zones of "Sinuopea-like" gastropods, which would normally be associated with strata of Canadian age, are present in the Southern Franklin Mountains Bliss Sandstone. Fucoids in the Bliss Sandstone are recorded in eleven beds in the McKelligon Canyon Park area in the Southern Franklin Mountains. These fucoids include vertical (Scolithus and Sabellariflex-like forms), straight, angular (45°), and horizontal tubes. Trilobites, which are sporadic in their distribution in the Bliss Sandstone of New Mexico and West Texas, have not been reported from the Franklin Mountains. Several spine-like fossils of uncertain affinity have been collected from a zone about 21 feet above the base of the Bliss Sandstone. Similar undesignated fossils occur in rocks of both Trempeleau and Gasconade age (Flower, personal communication, 1966) .

El Paso Group

The type El Paso Limestone as defined by Richardson (1904, p. 29) includes all the limestones of Ordovician age exposed in the Franklin Mountains. Richardson (1909, p. 3) divided the El Paso Limestone into two formations: the El Paso Formation which includes only rocks of Lower Ordovician age; the overlying Ordovician sediments were called the Montoya Formation.

Kelley and Silver (1952, p. 41) raised the El Paso Formation to group status and subdivided the El Paso Formation in New Mexico into two formations: the lower, Sierrite Limestone and the upper, Bat Cave Formation. These units cannot be recognized in the Southern Franklin Mountains for several paleontological and lithologic reasons (Flower, 1964,p. 148) .

Kelley and Silver (1952, p. 52) recognized the north-south regional angular unconformity between the El Paso and Montoya Groups. In general, it may be stated that in far west Texas and southern New Mexico there exists a general and progressive thinning of the El Paso Group from south to north as the result of erosion of the upper part. Howe (1959, p. 2292-2293) clearly illustrated this same relationship in a series of north-south sections from Scenic Drive in the southern Franklins to the Organ Mountains to the north in south-central New Mexico. Northward thinning has also been demonstrated in the San Andres Mountains (Kottlowski, et. al., 1956, p. 21). In central New Mexico the El Paso Group is absent because of erosion (Kottlowski, 1963, p. 15). Examination of the northern eroded edge of the El Paso Group indicated that the shoreline was farther to the north.

The El Paso Group is time-transgressive from west to east. Kelley and Silver (1952, p. 55) recognized this general west to east transgression of the Cordilleran geosynclinal sea during the deposition of the Cambrian and Lower Ordovician sedimentary units in Arizona and New Mexico. This transgression can be demonstrated as far east as the Van Horn area in west Texas (Cloud and Barnes, 1948, p. 352-360). Sabins (1957, p. 471) has presented a simplified diagram of the time-transgressive nature of the Cambrian and Ordovician units in Arizona, New Mexico, and West Texas. Subsequent detailed examination of the sequences by Flower and others indicate, however, that this relationship is a complex one of transgression and regression rather than simple, single transgression.

The type section of the El Paso Group in the southeastern Franklin Mountains represents probably the most complete Canadian section exposed in northern Chihuahua, New Mexico, and west Texas area.

Flower (1957, p. 17-19) proposed major divisions of the Canadian series into four stages utilizing, in part, New Mexico units with the Ozark standard stages (Twenhofel, 1954, Plate 1) (Table I, columns 1 and 2). These stage names are: (1) Gasconadian-Lower Canadian; (2) Demingian-Middle Canadian; (3) Jeffersonian-Early Upper Canadian; and (4) Cassinian-Late Upper Canadian.

Flower (1964, p. 148-149) designated ten formation names that are well-suited for substage designations, as they represent not only distinct rock stratigraphic units on a regional basis, but also distinct sequential biostratigraphic-paleontological units (Table I, column 3) . The El Paso Group in the southern Franklin Mountains includes seven of these formations (Table I, column 6) (LeMone, 1969).

CANADIAN	OZARK STANDARD G.S.A. (1954)	NEW MEXICO-WEST TEXAS STANDARD FLOWER (1957)	NEW MEXICO-WEST TEXAS SUBSTAGE FLOWER (1964)	NEW MEXICO-WEST TEXAS FAUNAL ZONES	COMPOSITE GARDEN CITY-IBEX AREAS UTAH WESTERN U.S. STANDARD HINTZE (1951, 1952), ROSS (1951) ZONE	FAUNA	EUROPEAN STANDARD
LATE UPPER	Odenville-Black Rock	Cassinian	Florida Mountains	Buttsoceras	K (?) J	Hespernomiella minor Pseudocybele nasuta	ARENIG
	Smithville Powell		Scenic	Curtoceras	I	Paranileus ibexensis	
	Cotter		Drive	Ceratopea buttsi-hami Ceratopea ankylosa	H	Trigonocerca typica	
EARLY UPPER	Jefferson	Jeffersonian	Mc Kelligon	Third Piloceroid	G-2	Protopliomerops contracta	
				Second Piloceroid			
	City		Canyon	Mc Queenoceras	G-1(?)	Protopliomerops celsaora	
MIDDLE	No Apparent Equivalent	Demingian	Snake Hills	Leiostegium-Paranileus	G-1(?)	P. celsaora	
			Mud Springs Mountain	Bridgeites	G-1(?) F (?)	P. celsaora P. superciliosa	
			José	Bridgeina-Aulacoparia	F E	P. superciliosa Tesselacauda	
	Roubidoux		Victorio Hills	First Piloceroid	E	Tesselacauda	?
			Cooks	First Endoceroid	D-2	Leiostegium-Kainella	TREMADOC
	No Apparent Equivalent		Big Hatchet	Leiostegium-Kainella	D-1	Leiostegium-Kainella	
LOWER	Gasconade	Gasconadian	Sierrite (restricted)	Lytospira-Symphysurina brevispicata	C (?) B	Paraplethopeltis Symphysurina	
	Van Buren		Bliss	Apheoorthis melita	A(?)	Nanorthis-Bellefontia	

	SOUTHERN FRANKLIN MOUNTAINS EL PASO COUNTY TEXAS	SOUTHERN FRANKLIN MOUNTAINS CLOUD AND BARNES (1948) BEDS	UNITS	APPROXIMATE CENTRAL TEXAS EQUV.
EL PASO GROUP	Florida Mountains Formation	1-6	C	Odenville-Black Rock
	Scenic Drive Formation: Nameless Canyon Member; Black Band Member	7-10	B_2b	Post-Honeycut-Pre-Black Rock
	Mc Kelligon Canyon Formation	11-14	B_2a	
		15	B_1	Honeycut
	Pistol Range Member	16 and upper 17		
		Missing		
	José Formation	lower 17 and 18	B_1	Honeycut (?)
	Victorio Hills Formation	19-22	A	Gorman
	Cooks Formation	23-24		
		Missing (?)		
	Sierrite Formation (restricted)	25-27	A	Gorman / Tanyard (?)
	Bliss Sandstone	Tanyard		

SIERRITE FORMATION, GASCONADE, EARLY CANADIAN, LYTOSPIRA-SYMPHYSURINA BRE-*VISPICATA* ZONE

The basal unit of the El Paso Group is the Sierrite Formation. Flower (1964, p. 146, 148) has restricted the Sierrite Formation to the lower thin-bedded limestone with wavy bedding of early Canadian age of the type Sierrite Formation as originally designated by Kelley and Silver (1952, p. 259). The type section is on the southwestern side of Cable Canyon in the Caballo Mountains, Sierra County, New Mexico (Sec. 10, T 16 S, R 4 W) .

The Sierrite Formation in the southern Franklin Mountains, 121 feet (37 meters) thick, has been divided into two members (LeMone, 1967a, p. 21). The Transition Zone Member, 20 feet (6 meters) thick, rests on the quartzite of the Bliss Sandstone and consists of a cross-bedded, dolomitic sandstone which weathers in bas-relief; three zones of granitic and quartzitic pebbles and cobbles up to 3 inches (8 centimeters) in diameter. The upper four feet (1.2 meters) of this member develops two distinct edgewise conglomerates, each overlain by a layer of granitic-like pebbles.

The overlying Wavy Bedded Member of the Sierrite, 101 feet (31 meters) thick, is composed largely of silt and fine sand, with calcarenitic to calcilutic dolomite. The peculiar wavy bedding observed is probably due to differential solution, compaction, or both. Two relatively pure dolomite units separated by a sandy dolomite, 93-98 feet above the Bliss Sandstone, contain flow cast structure.

Fossils include fucoids, gastropods (five zones, mostly of Ophileta or Ozarkospira persuasion), and a brachiopod fauna (Apheoorthis finkelburgia). The fauna of the El Paso Group is discussed in detail in Flower's recent manuscripts (1969a, 1969b). Fauna and lithology indicate an intertidal to supratidal environment. The Sierrite Formation is equivalent to Cloud and Barnes Unit A, beds 25-27 (1948, p. 368) .

BIG HATCHET FORMATION, DEMINGIAN, MIDDLE CANADIAN LEIOSTEGIUM-KAINELLA ZONE

The Big Hatchet Formation was named by Flower (1964, p. 148) for a massive dolomite and interbedded shale sequence in the Big Hatchet Mountains. This formation is not recognizable in the Franklin Mountains. Either it is represented by facies change or it may be absent because of nondeposition or erosion or both. The type section is on the northwestern side of Mescal Canyon in the northern Big Hatchet Mountains, Hidalgo County, New Mexico (SW/4, Sec. 29, T 30 S, R 15 W) . These strata have been described by Zeller (1965, Plate 1, 2; p. 17, 79).

The Big Hatchet Formation may be equivalent to the Apheoorthis finkelburgia Zone (Flower, 1969a, p. 6, 11; 1969b, p. 59, 60). The Big Hatchet Formation has been recognized only in the Big Hatchet Mountains and the Victorio Mountains in southwestern New Mexico.

COOKS FORMATION, DEMINGIAN, MIDDLE CANADIAN FIRST ENDOCEROID ZONE

The Cooks Formation was named by Flower (1964, p. 148) for the ghost town of Cooks, 12 miles (19 kilometers) north of Deming. The type section is on the northern end of the Cooks Range in Luna County, New Mexico (Sec. 11, T 20 S, R 9 W). Kuellmer's Hillsboro quadrangle map (1956) and Jicha's study of the Lake Valley Quadrangle (1954) give the general geologic setting of the type section area.

The Cooks Formation in the Franklin Mountains is 109 feet thick and thus thicker than the equivalent carbonate sections in New Mexico, which do not exceed 80 feet (24 meters) (Flower, 1969, p. 6) . In the southern Franklin Mountains the basal unit contains a pebble conglomerate of rock fragments and black pebbles in a dolomitic matrix. However, the formation consists largely of calcarenitic dolomites. A large fauna of nautiloids has been collected from this formation. Nautiloids, pelmatozoan fragments, brachiopods, and gastropods are the main faunal elements of the Cooks Formation.

Three supratidal to intertidal algal stromatolites are developed in this section. Paleoecological studies of the uppermost stromatolite have revealed 18 demonstrable disconformities in 20 feet (6 meters) of section (LeMone, 1967a, p. 21). The Cooks Formation represents an intertidal to very shallow subtidal environment. The Cooks Formation is equivalent to Unit A, beds 23 and 24 of Cloud and Barnes (1948, p. 367-368).

VICTORIO HILLS FORMATION, DEMINGIAN, MIDDLE CANADIAN FIRST PILOCEROID ZONE

The name Victorio Hills Formation replaces the Victorio Formation (Flower, 1964) because of preoccupation of the name Victorio (G. V. Cohee, personal communication, 1968). The Victorio Hills Formation was designaed by Flower (1964, p. 148) for a well exposed and thick section in the Victorio Mountains, approximately 3 miles (5 kilometers) south of Gage, New Mexico. The type section is in the East Hills of the Victorio Mountains, Luna County, New Mexico (SE 1/4, NE I/4, Sec. 28, T 24 S, R 12 W). A detailed geologic map of the Victorio Mountains was made by Kottlowski (Griswold, 1961, Plate 3) .

In the Franklin Mountains, the Victorio Hills Formation is approximately 290 feet thick which is considerably more than in the New Mexico sections where it is usually less than 100 feet thick (Flower, 1969, p. 6). The Victorio Hills Formation consists largely of fossiliferous, nearshore carbonate rocks. In the southern Franklin Mountains the base of the formation is the lowest limestone of the El Paso Group.

The main elements of the fauna of the Victorio Hills Formation are gastropods, pelmatozoan fragments, brachiopods, and nautiloids. The oldest piloceroid in the El Paso section has been recovered from the basal foot (30 centimeters) of the formation.

The Victorio Hills Formation is predominantly a shallow water marine section somewhat deeper than the underlying nearshore to supratidal Cooks Formation. This formation is the approximate equivalent of Unit A, beds 19-22 of Cloud and Barnes (1948, p. 366-367) .

JOSE FORMATION, DEMINGIAN, MIDDLE CANADIAN, BRIDGEINA-AULACOPARIA ZONE

The Jose Formation was named for the Jose mining district in the Cooks Range (Flower, 1964, p. 148). The type section is located in Sec. 11, T 20 S, R 9 W, Luna County, New Mexico (Kuellmer, 1956) . The Jose Formation forms a distinct dark band in the gray to light gray rocks of the El Paso Group.

In the southern Franklins, the Jose Formation is 72 feet (22 meters) thick and is divided into two members (LeMone, 1968, p. 15-16) . The lower Cyclic Member, which is 54 feet (16 meters) thick, disconformably overlies the Victorio Hills Formation. It reflects an intertidal environment (digitate algae) alternating with sand. Seventeen cycles are recognizable in this member with each cycle consisting of a basal sand, cross-bedded in part, and overlying digitate stromatolites with associated fossiliferous arenaceous surge-channel deposits. The digitate algae are similar to those reported by Howe from southeastern Missouri Ordovician (1966, p. 64-77). The upper Barren Member is 18 feet (5.5 meters) thick and consists of cross-bedded sand with lutitic stringers. Howe's interpretation (1966, p. 75-76) of the paleoecology of the digitate algae seems to be reasonably consistent with the evidence preserved in the Jose Formation in the Franklin Mountains. The Jose Formation indicates repeated shifting of shallow water environments across wide areas. The lateral largely oolitic character of the formation indicates slightly deeper, but still very shallow, water conditions. Rocks in this formation have a strong fetid odor.

Silicified gastropods, brachiopods, pelmatozoan fragments and slender nautiloid siphuncles occur in the arenaceous surge channels. The Jose Formation is approximately equivalent to Unit A, bed 18 and Subunit B_1, Lower Bed 17 of Cloud and Barnes (1948, p. 366).

MUD SPRINGS MOUNTAIN FORMATION, DEMINGIAN, MIDDLE CANADIAN, BRIDGEITES REEF ZONE

The Mud Springs Mountain Formation is not recognized in the southern Franklins, where it is believed to be absent because of either nondeposition or erosion. Flower (1964, p. 148) named the formation for its exceptional exposure and development on the southwestern flank of Mud Springs Mountain, Sierra County, New Mexico (Sec. 25, T 13 S, R 2 W). Kelley and Silver (1952, p. 251, Plate I) show the location and give the general lithology of the section which is located north and west of Truth or Consequences-Hot Springs, New Mexico. The formation consists of 20 to 30 feet of cherty, cliff-forming, stromatolitic limestone which generally weathers to a light color (Flower, 1969, p. 7). The only common fossil is a discoidal gastropod Bridgeites discoideus 2.5 to 4 centimeters across.

SNAKE HILLS FORMATION, DEMINGIAN, MIDDLE CANADIAN, LEIOSTEGIUM-PARANILEUS ZONE

The Snake Hills Formation is not recognized in the Franklin Mountains, where it is believed to be absent because of either nondeposition or erosion. The formation was named by Flower (1964, p. 148) for the largely thin bedded calcilutites, which overlie the cliff-forming Mud Springs Mountain Formation. Small gastropods, locally abundant, are not readily extracted in identifiable condition. Trilobites are rare. The type section is exposed in the Snake Hills, approximately 10 miles southwest of Deming and 4 miles south of Red Mountain in Luna County, New Mexico (Sec. 33, T 24 S, R 10 W). The observed maximum thickness of this formation is 60 feet in the Cooks Range (Flower, 1969, p. 7).

McKELLIGON CANYON FORMATION, JEFFERSON CITY, EARLY UPPER CANADIAN McQUEENOCERAS-SECOND PILOCEROID ZONE, THIRD PILOCEROID ZONE

The McKelligon Canyon Formation is approximately 675 feet (205 meters) thick and was named by Flower (1964, p. 148). It is exposed in dip slopes on the east side of McKelligon Canyon but the type locality of the formation is to the south and west of McKelligon Canyon above the Scenic Drive in El Paso. The base of the McKelligon Canyon Formation type section is one mile (1.6 kilometers) west and 1500 feet (460 meters) south of the intersection of longitude 106° 27' 30" (El Paso, Texas 7.5 minute quadrangle, 1955) . It is most easily reached by driving west on Scenic Drive and stopping at the first canyon south and west of the quarry in which the Police Academy is located.

The lower 70 to 80 feet (21-24 meters) are designated the Pistol Range Member. This member has a distinctive basal sand which ranges from 2 to 5 feet (0.6 to 1.5 meters) in thickness. It is principally intertidal to supratidal in origin and contains several stromatolitic units. A detailed paleoecological study of a part of the Pistol Range Member, approximately 70 feet (21 meters) above the base has revealed five depositional phases in a two-foot (0.6 meters) vertical exposure, including two periods of stromatolitic growth, and four phases of subaerial and/or subaqueous erosion (LeMone, 1967b) . The Pistol Range Member probably is equivalent to Subunit B_1, upper part of bed 17 and bed 16 of Cloud and Barnes (1948, p. 366) .

Above the Pistol Range Member of the McKelligon Canyon Formation there is exposed a carbonate sequence containing numerous *Pulchrilamina* mounds. The fauna and paleoecology of these stromatolitic-like mounds and similar mounds in southern Oklahoma have been described in considerable detail by Toomey and Ham (1967, p. 981-987) from exposures in the Franklin Mountains and the Wichita and Arbuckle Mountains. The mounds were wave resistant structures with surge channels submerged in very shallow water.

Nautiloids, sponges, especially Archaeosyphia and Calathium (Toomey, 1964, p. 98-111), gastropods, trilobite fragments, pelmatozoan fragments, and brachiopods are the most common faunal elements observed in association with the Pulchrilamina in the mounds. That part of the McKelligon Canyon Formation above the Pistol Range Member is equivalent to Subunit B_1, beds 15 and 16 and all of Subunit

Boa, beds 11 through 14 of Cloud and Barnes (1948, p. 365-366).

SCENIC DRIVE FORMATION, CASSINIAN, LATER UPPER CANADIAN, CERATOPEA ZONES-CURTOCERAS ZONE

The Scenic Drive Formation was named by Flower (1964, p. 149) for a sandy dolomite, dolomite, and limestone sequence that is equivalent to Subunit B_2b, beds 7 through 10 of Cloud and Barnes (1948, p. 365-366) . The type locality of this formation is directly above the type section of the McKelligon Canyon Formation. The base of the section can be seen in an arroyo north of Scenic Drive approximately 1000 feet (305 meters) northeast along the Drive from the bench mark at Scenic Point.

The Scenic Drive Formation which is 288 feet (88 meters) thick is divided into the Black Band Dolomite Member and the overlying Nameless Canyon Member. The Black Band Dolomite rests disconformably on the McKelligon Canyon Member.

The basal part of the Scenic Drive Formation is composed of very coarse grained, slightly dolomitic sandstone, which represents the first major sand unit above the base of the McKelligon Canyon Formation, more than 600 feet (180 meters) lower stratigraphically, in the El Paso Group. The Black Band Dolomite Member, approximately 60 feet (18 meters) thick, contains several dark bands within the dolomite. This member has two well-developed faunal zones: a lower Ceratopea aynklosa Zone, an upper Ceratopea buttsi and C. hami Zone .

The Nameless Canyon (Curtoceras Zone) Member is largely made up of calcilutitic limestones. Chert in the upper part of the member weathers orange and, on the dip slope, it is difficult to distinguish from overlying units of the Florida Mountains Formation.

Silicified brachiopods and gastropods including operculi (Ceratopea) have been recovered from the formation. Trilobites, nearly always fragmental, pelmatozoan fragments, gastropods, nautiloids, and sponges make up the remainder of the main faunal elements.

FLORIDA MOUNTAINS FORMATION, CASSINIAN, LATE UPPER CANADIAN, BUTTSOCERAS ZONE

The name Florida Mountains Formation replaces the Florida Formation because the name Florida had been preoccupied (G. V. Cohee, personal communication, 1968). The Florida Mountains Formation was named by Flower (1964, p. 149) for rocks exposed in the Florida Mountains. The type locality is in the east-central part of the Florida Mountains, Luna County, New Mexico (Sec. 6, T 26 S, R 7 W). The formation is approximately 36 feet (11 meters) thick, both in the southern Franklin Mountains (Scenic Point area and east entrance to McKelligon Canyon) and in the east-central Florida Mountains. In the Franklin Mountains the formation contains a 6.5 foot (2 meter) orange weathering, resistant key bed, 10 feet (3 meters) below the top of the formation.

The Florida Mountains Formation contains an abundant fauna, including: nautiloids, brachiopods, cystoid plates, pelmatozoan fragments, trilobites, gastropods, and sponges (LeMone, 1966, p. 121) . It is equivalent to Unit C, beds 1 through 6 of Cloud and Barnes (1948, p. 362-363).

In summary, the El Paso Group in the southern Franklin Mountains is divided into seven lithologic units utilizing the formational nomenclature of Flower (1964, p. 148, 149). A distinct sedimentological break is present at the base of each unit. The El Paso Group section represents one of the best examples of nearshore to supratidal shelf Canadian rocks.

The paleontological divisions of the El Paso Group are well established on the basis of nautiloids and other faunal groups.

The formations of the El Paso Group have been tentatively correlated with the deeper water, miogeosynclinal, western standard section (Table I, column 5), Hintze 1951, 1952; Ross, 1952; Flower, 1969a; and Hintze, et. al., 1969.

MONTOYA GROUP

The second unit is divided into four formations in the West Texas-New Mexico region (from oldest to youngest) : (Rio Mimbres Sandstone; Upham Dolomite, which includes the basal Cable Canyon Sandstone Member; Aleman Formation and the Cutter Formation).

The name Montoya was first used by Richardson in the El Paso area (1908, p. 475-479). Entwistle (1944, p. 16-19) subdivided the Montoya into three members: the Second Value, Par Value, and Raven. Kelley and Silver (1952, p. 57), in view of the difficulty of stratigraphic continuity, alteration, and accessibility presented by Entwistle's members, decided to propose new names in the Caballo Mountains, an area that offers continuous and accessible exposures. The type locality of the Montoya Group is in Cable Canyon opposite the Sierrite mine, Caballo Mountains, Sierra County, New Mexico (NW1/4, Sec. 10, T 16 S, R 4 W). The formations, named for stations along the Santa Fe Railroad are the Cable Canyon Sandstone, the Upham Dolomite, the Aleman Formation, and the Cutter Formation (Kelley and Silver, 1952, p. 58, 59, 60, 62). Flower (1957, p. 20) pointed out the presence of an unnamed sporadic basal sand which he refers to as the Harding-Winnepeg equivalent. Pray (1953, p. 1906-1911) named a light gray, thin-to medium bedded, sublithographic dolomite unit the Valmont Dolomite, which is apparently equivalent to the Raven Member and the Cutter Formation.

The stratigraphy of the Montoya Group has been studied in some detail by Richardson (1908, p. 475-479, 1909, p. 4), Nelson (1940, p. 162-163), Pray (1958, p. 31-40), Howe (1959, p. 2284-2332) and Flower (1969, p. 70-85). The most exhaustive work on the El Paso section was done by Howe, who measured ten sections in the Franklin Mountains of Texas and New Mexico.

Paleontological studies date back to Ulrich's identification of fossils collected by Richardson (1909, p. 4). Ulrich equated the faunas to the Galena and the Richmond; the Richmond fauna was interpreted to have a Fernvale aspect. Howe has written an excellent series of papers on the details

of the brachiopod fauna of the Montoya Group (1965a, p. 235-247; 1965b, p. 647-656; 1966, p. 241-247; and 1967, p. 845-860). Flower has written a series of papers discussing the Montoya Group nautiloids (see especially Flower, 1957). Flower (1961) described the coelenterate fauna and attached organisms. Hill (1959, p. 25) described some of the Montoya coral fauna. Flower (1965, p. 122-126) correlated the Middle and Late Ordovician fauna of west-central North America from the New Mexico-Texas region with that of Greenland and demonstrated that equivalents of the four units of the post-Canadian Ordovician occur in Colorado, the Big Horn Mountains of Wyoming, Winnepcg, and Hudson Bay.

Rio Mimbres Sandstone (previously an unnamed sandstone), Mohawk-Porterfield, Harding-Winnipeg equivalent

Flower (1957, p. 20-21) described a basal remnant of sandstone of extremely local nature which seldom exceeds a few feet in thickness. He reported (1965, p. 126) the presence of this sequence at the following southern New Mexico localities: Mimbres Valley, Grant County; Hembrillo Canyon in the San Andres Mountains, Dona Ana and Sierra Counties; Lone Mountain, Grant County; Big Hatchet Mountains, Hidalgo County; and the Cooks Range, Luna and Grant Counties, New Mexico. This unit was apparently deposited on an uneven El Paso Group surface and subsequently eroded to a remnant. The age of the beds is based solely on stratigraphic position. Howe (1959, p. 2291) reported the presence of a thin basal sandstone 6 to 12 inches (15-30 centimeters) thick between the Upham Dolomite and the El Paso Group in the Hueco Mountains and the southern Franklin Mountains.

It is proposed that, until such time as the age and relationship for the unnamed sandstone are resolved, the name Rio Mimbres Sandstone be adopted for this unit. Flower (1965, p. 126) described the Harding-Winnipeg equivalents at Mimbres Valley as being 2-3 feet (0.6-0.9 meters) of white sandstone that sharply contrasts with the overlying darker, coarser Cable Canyon Sandstone. Flower also indicated the facies relationships in the aforementioned localities that range from siltstone to dolomitic sandstone. The type section is located on the west side of the Mimbres Valley (Sec. 26, T 17 S, R 11 W, Grant County, New Mexico) not far from New Mexico Highway 180 which leads westward to Santa Rita (Flower, 1961, p. 10).

Cable Canyon Sandstone, Mohawkian-Cincinnatian, Coburg-Eden, Red River Equivalent

The Cable Canyon Sandstone was named by Kelley and Silver (1952, p. 58-59). It is a massive, ledge-forming sandstone 35 feet (11 meters) thick that occurs at the base of the Montoya Group. The type locality is near the Sierrite mine at the head of Cable Canyon, Caballo Mountains, Sierra County, New Mexico (Sec. 10, T 16 S, R 4 W).

Kottlowski (1963, p. 18-20) noted that the Cable Canyon Sandstone appears to thicken significantly towards a possible source area located in the vicinity of southeastern Catron County. The Cable Canyon shows great lateral variation and normally grades vertically into the overlying Upham Dolomite (Kottlowski, 1963, p. 18). It appears that this sandstone is a distinct unit at its type locality in the Caballo Mountains; however, it may be a basal arenaceous phase of the Upham Dolomite.

Kottlowski (1963, p. 20) suggested that the Cable Canyon Sandstone and the arenaceous beds of the Upham Dolomite are marine elastics deposited and reworked from a low positive area to the north in the Catron County region.

Upham Dolomite, Mohawkian-Cincinnatian, Coburg,-Eden, Red River Equivalent

The Upham Dolomite was named by Kelley and Silver (1962, p. 59-60) for the cliff-forming, massive, medium-gray to brown-gray dolomite, 78 feet (24 meters) thick, that conformably overlies the Cable Canyon Sandstone at the type locality in Cable Canyon, Caballo Mountains, Sierra County, New Mexico (Sec. 10, T 16 S, R 4 W). The Cable Canyon Sandstone and the Upham Dolomite are equivalent to Entwistle's Second Value Member (1944, p. 16-19). Flower (1957, p. 20-21) raised the Second Value to formational rank.

Howe (1959, p. 2301), on the basis of eight sections measured throughout the Franklin Mountains, stated that the thickness ranged from 98.5 to 102.8 feet (30-31 meters). Howe (1959, p. 2299) noted very abrupt changes in dolomitization in sections in the Franklin and Hueco Mountains, Texas. His key section at the north end of the Franklins clearly shows this relationship. Pray (1958, p. 32, 39) measured 104 feet (32 meters) of Upham Dolomite in the northern Franklin Mountains 1.1 miles (1.8 kilometers) south of the intersection of 32° 00' N and 106° 30' W, (Canutillo 7.5 minute Quadrangle). He subdivided the Upham into 3 major units of carbonate rocks with a basal foot (0.3 meter) bed of sandstone and limestone. Decreasing minor amounts of sand in the carbonates are observed up to 26 feet (8 meters) above the base of the unit.

The abundant Red River fauna includes: four genera of brachiopods (expanded by Howe), trilobites, gastropods particularly large *Maclurina* and Hormotorna, the questionable sponge Receptaculites oweni, eight genera of coelenterata (see Flower, 1961, p. 124), and at least fourteen genera of nautiloids. Fauna of this age are very similar from northern Greenland to west Texas.

Aleman Formation, Cincinnatian-Lower Richmond

The Aleman Formation was named by Kelley and Silver (1952, p. 60-62). It is a distinct handed chert and dolomite section 100 feet (39 meters thick). The type locality is in Cable Canyon, Caballo Mountains, Sierra County, New Mexico (Sec. 10, T 16 S, R 4 W). It is equivalent to the Par Value Member of Entwistle (1944, p. 16-69).

Howe (1959, p. 2310) listed five measured sections in the northern Franklin Mountains ranging from 166 to 177 feet (50-54 meters) in thickness and two sections in the southern Franklin Mountains, 151 and 152 feet (46 meters) thick. Pray (1958, p. 138) reports 163 feet (50 meters) of

Aleman, which he subdivided into ten units composed of limestone and dolomite with considerable chert. The Aleman rest disconformably on the Upham Dolomite.

The fauna of the Aleman Formation is abundant and varied. Howe (1959, p. 2314) lists six genera of corals, thirteen genera of brachiopods, bryozoans, and trilobites. Howe (1959, p. 2310-2311) defines five fauna zones; they are (oldest to youngest) : Zone A = Lepidocyclus-Thaerodonta Onniella Zone; Zone B = *Herbertella* Zone; Zone C = Lepidocyclus-Thaerodonta Zone; Zone D Paleophyllum Zone; and Zone E = *Hypiptycha* Zone. Flower lists four zones for the same intervals in the San Andres Mountains. They are (oldest to youngest) : Zygospira Zone; Rafinesquina Zone; Rhynchotrema *capax* Zone; and the "Megaripple" Zone (1957, p. 20).

Cutter Formation, Cincinnatian-Upper Richmond

The Cutter Formation was named by Kelley and Silver (1952, p. 62-64). It is a light to medium gray, thin- to medium-bedded dolomite sequence, 129 feet (39 meters) thick. The type section is in Cable Canyon in Caballo Mountains, Sierra County, New Mexico (Sec. 10, T 16 S, R 4 W). It is equivalent to the Valmont Dolomite of Pray (1953, p. 1906-1911) and to the Raven Member of Entwistle (1944, p. 16-19).

Flower (1947, p. 22) reports a minor disconformity separating the Aleman and Cutter Formations. Howe (1959, p. 2319) described five measured sections in the northern Franklin Mountains ranging in thickness from 148.5 to 166.5 feet (45 to 51 meters) and two sections in the southern Franklin Mountains of 145 to 149 feet (44-45 meters). In the northern Franklin Mountains, Pray (1958, p. 38) subdivided the Cutter Formation 162 feet (49 meters) thick into eleven units.

Howe, in his Trans-Pecos Montoya studies (1959, p. 2320), recognized two zones in the Franklin Mountains: Zone A = *Herbertella* Zone and Zone B = Diceromyonia Zone.

Flower (1961) states that the upper beds are largely barren, but may contain from one to three horizons of silicified corals, mainly Paleofavosites, with rarer stromatoporoids.

In the Franklin Mountains, the Montoya Group is overlain by the massive, very light gray to brownish orange Fusselman Dolomite.

In summary, the Montoya Group appears to conform to the model designated for it by Flower. Four sedimentary units are deposited with intervening erosional periods; the units are (oldest to youngest) : Harding-Winnipeg equivalents (Rio Mimbres Sandstone); the Cable Canyon Sandstone-Upham Dolomite; Aleman Formation; and the Cutter Formation. Flower (1965, p. 124) correlates the Montoya Group from Texas to Greenland across western North America.

ORDOVICIAN
TYPE LOCALITIES

*1. Bliss Sandstone:
Undesignated in the southern Franklin Mountains, El Paso County, Texas.

*2. Sierrite Formation:
Southwestern side of Cable Canyon, Caballo Mountains, Sierra County, New Mexico (Sec. 10, T 16 S, R 4 W).

*3. Big Hatchet Formation:
Northwestern side of Mescal Canyon, northern Big Hatchet Mountains, Hidalgo County, New Mexico (SW 1/4, Sec. 29, T 30 S, R 15 W).

*4, Cooks Formation:
Northern end of the Cooks Range, Luna County, New Mexico (Sec. 11, T 20 S, R 9 W).

*5. Victorio Hills Formation:
East Hills of the Victorio Mountains, Luna County, New Mexico (SE 1/4, NE1/4, Sec. 28, T 24 S, R 12W) .

*6. Jose Formation:
Cooks Range, Luna County, New Mexico (Sec. 11, T 20 S, R 9 W).

7. Mud Springs Mountain Formation:
Western flank of Mud Springs Mountain, Sierra County, New Mexico (Sec. 25, T 13S, R 2 W).

8. Snake Hills Formation:
Low hills approximately 10 miles southwest of Deming and four miles south of Red Mountain in Luna County, New Mexico (Sec. 33, T 24 S, R 10 W).

*9. McKelligon Canyon Formation:
Base of the formation is one mile west and 1500 feet south of the intersection of longitude 106° 27' 30" and latitude 31° 47' 30" (El Paso, Texas 7.5 minute quadrangle, 1955) in the southern Franklin Mountains, El Paso County, Texas. Section easily reached approximately 0.1 mile southwest of the Police Academy on Scenic Drive.

*10. Scenic Drive Formation:
Immediately above the McKelligon Canyon Formation in the southern Franklin Mountains, El Paso County, Texas.

*11. Florida Mountains Formation:
East-Central part of the Florida Mountains in Luna County, New Mexico (Sec. 6, T 26 S, R 7 W) .

12. Rio Mimbres Sandstone (Harding-Winnipeg Equivalent) :
Near New Mexico Highway 180 on the west side of the Mimbres Valley in Grant County, New Mexico (Sec. 26, T 17 S, R 11 W).

*13. Upham Dolomite:
Cable Canyon, Caballo Mountains, Sierra County, New Mexico (Sec. 10,T 16 S, R 4 W).

*14. Aleman Formation:
Cable Canyon, Caballo Mountains, Sierra County, New Mexico (Sec. 10, T 16 S, R 4 W).

*15. Cutter Formation:
Cable Canyon, Caballo Mountains, Sierra County, New Mexico (Sec. 10, T 16 S, R 4 W).

FUSSELMAN DOLOMITE

The third unit is the Fusselman Dolomite. It has been divided into three members (Kottlowski and Pray, 1967,

* Formations represented in the Southern Franklin Mountains.

p. 209-235), which are from oldest to youngest: Chamberino, Flag Hill, and Crazycat Members.

The Fusselman Limestone was originally designated by Richardson (1908, p. 476, 479, 480) for a massive, whitish, magnesium limestone approximately 1000 feet (305 meters) thick. Richardson states that the Fusselman overlies the Montoya Limestone (now Cutter Formation of the Montoya Group) and underlies the Hueco Limestone (included originally the Mississippian Helms, the Pennsylvanian Magdalena Group, and the Permian Hueco Group) . The Fusselman Limestone as originally defined in the Franklin and Hueco Mountains therefore included all of the now designated Fusselman Dolomite, the Devonian, and the Mississippian Las Cruces and Helms Formations.

Entwistle in his Silver City area studies (1944, p. 19-20) redefined the Fusselman to include the rocks between the Raven Member (Cutter Formation) of the Montoya Group and the disconformably overlying Devonian Percha Shale. Entwistle was the first to utilize the designation of Dolomite for the Fusselman.

L. C. Pray's Franklin Mountains suggested type section (1958, p. 36, 37) has been adopted by the U.S.G.S. (Keroher, et al., 1966, p. 1448). The type section is approximately six miles (9.7 kilometers) north of Fusselman Canyon, the site of the Intermountain Highway. The formation is named for the exposures in Fusselman Canyon.

The Fusselman Dolomite is usually a massive, medium to dark brownish gray dolomite with silicified fossils. The Fusselman as noted by Flower (1969a, p. 86) is generally so altered by dolomitization that the original lithologies and most of the fossils are not recognizable.

Flower (1969a, p. 36) indicated a Lower (Alexandrian) to Middle (Niagaran) Silurian age for the Fusselman Dolomite. Large pentameroid brachiopods are an abundant and distinct fauna in the Fusselman Dolomite.

The 608 foot (183 meters) type section is approximately 1.1 miles (1.8 kilometers) south of the intersection of 32° 00' N and 106° 30' W, (Canutillo, 7.5 minute Quadrangle).

Chamberino Member

The Chamberino Member is 261 feet (80 meters) thick and disconformably overlies the Montoya Group Cutter Dolomite. Pray (1958, p. 41) divided the Chamberino into nine members of dolomite (units 1-9). The basal unit (1) contains 1 to 2 inch (2.5-5 centimeters) phosphatic granules and pebbles. Units 4 through 8, 138-230 feet (42-69 meters) thick, contain silicified and poorly preserved brachiopods, corals and crinoid columnals (Pray, 1958, p. 40).

Flag Hill Member

The Flag Hill Member consists of very light to medium gray, medium to coarsely crystalline dolomite (98 feet-29 meters). Pray (1958, p. 40) divides the Flag Hill into three units (10-12). Unit 10 contains sporadic, obscure fossils.

Crazycat Member

The Crazycat Member consists of light gray dolomite 249 feet (76 meters) thick. Pray (1958, p. 40) divides the Crazycat into six units (13-18). Unit 14 is 362-418 feet (110-127 meters) thick and has calcitic fossils common in local zones 2-5 inches (5-13 centimeters) thick. Dolomitized and silicified colonial corals, bryozoans and crinoidal detritus are present. The zones have an erratic lateral distribution probably dependent on dolomitization. In unit 17, 537-582 feet (164-177 meters) thick, Pray noted stromatolitic and fossiliferous limestone.

The Fusselman Dolomite is disconformably overlain by the Devonian Canutillo Formation.

CANUTILLO FORMATION-PERCHA SHALE

The fourth unit of the Lower Paleozoic of the Franklin Mountains is the Devonian sequence, which consists of a cherty carbonate siltstone Canutillo Formation and the overlying Percha Shale. The Devonian is disconformably underlain by the Fusselman Dolomite and disconformably overlain by the Mississippian Helms Formation.

Canutillo Formation

The Canutillo Formation was named by L. A. Nelson (1937, p. 89; 1940, p. 163) for Middle Devonian strata in the Franklin Mountains. Nelson's original definition included the Upper Devonian Percha Shale, which is believed to be present in the Franklin Mountains. The type section is on the slopes of Vinton Canyon on the western side of the main crest in the north-central Franklin Mountains.

Laudon and Bowsher (1949) restricted the Canutillo to 15 feet (5 meters) of gray shale in the middle of the originally defined (Nelson, 1940) 175 feet (53 meters) section.

The Canutillo Formation, as suggested by McGlasson (1969, p. 32) has come to mean the light colored cherty carbonate siltstone and silty carbonate between the overlying Upper Devonian Percha Shale and the underlying Silurian Fusselman Dolomite. Flower (1969a, p. 88) suggests that the Canutillo Formation is probably, as is the Swisshelm Formation in Arizona, a representative of one of the eight distinct Devonian formations that may be observed in the west Texas-southern New Mexico-southeastern Arizona area. Brachiopods indicate a Middle or Late Devonian age for the Canutillo Formation; however, it is generally considered to be Middle Devonian.

Tentaculites has been recovered from the Franklin Mountains and the Bishop's Cap section. Conodonts of the Devonian sequence are currently being studied by Ellison and his students at the University of Texas.

Percha Shale

The Percha Shale consists of the upper 65 feet (20 meters) of the originally defined Canutillo Formation of Nelson (1940). Gordon (1907, p. 59) originally described the Percha from Percha Creek near Hillsboro, Sierra County, New Mexico. In the Franklin Mountains the Percha Shale is a distinct black shale.

Recent stratigraphic work by Robert Rosado (personal communication, 1969) displays the irregularity of the Devonian formations in his thickness measurements of the Franklin Mountains and Bishop Cap Devonian.

The total Devonian in four sections (south slope of Vin-

ton Canyon, north slope of Vinton Canyon, Anthony pass south of the O'Hara Highway Anthony Pass crest, and Bishop's Cap) ranges in thickness from 135 feet (41 meters) to 234 feet (70 meters). Total Canutillo Formation has been measured as being 135 feet (41 meters) on the south slope of Vinton Canyon; 115 feet (36 meters) north slope of Vinton Canyon; 102 feet (30 meters) Anthony Pass; and 49 feet (15 meters) at Bishop's Cap. The thicknesses of the Percha Shale are 67 feet (21 meters) south slope of Vinton Canyon; 65 feet (20 meters) north slope of Vinton Canyon; 33 feet (10 meters) Anthony Pass and 185 feet (56 meters) at Bishop's Cap.

In the Franklin Mountains the Upper Devonian Percha Shale is disconformably overlain by the Mississippian Las Cruces Limestone.

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