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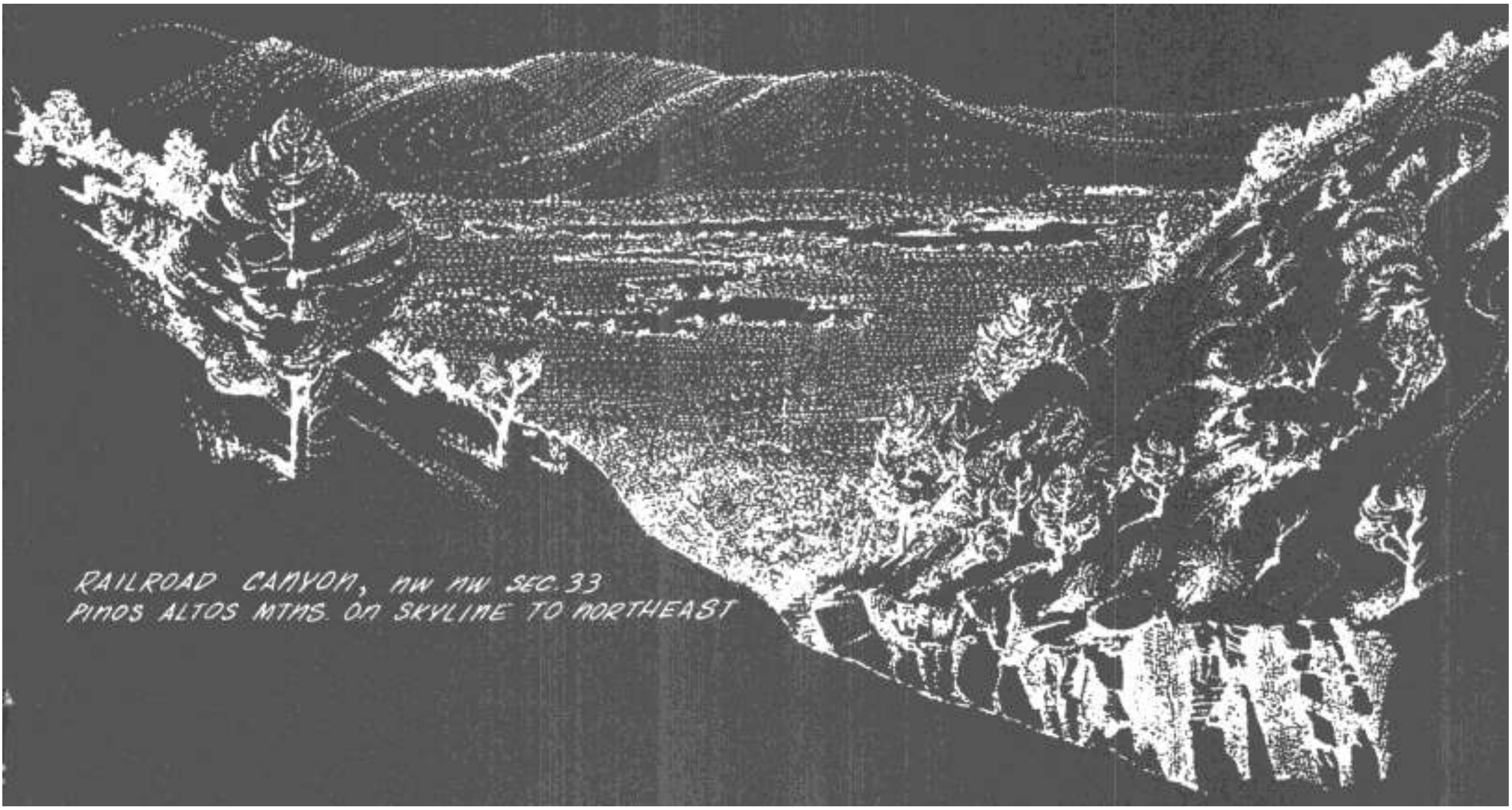
Pennsylvanian System of Chloride Flat Grant County, New Mexico

by D.V. LeMone, W.E.King, J.E.Cunningham



New Mexico Bureau of Mines & Mineral Resources

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Pennsylvanian System of Chloride Flat, Grant County, New Mexico

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SOCORRO 1974

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ABSTRACT

The Oswaldo Formation (Pennsylvanian) is exposed in faulted, eroded remnants immediately north of Silver City, Grant County, New Mexico. The Oswaldo unconformably overlies the Lake Valley Formation (Mississippian). The Beartooth Quartzite (Upper Cretaceous) unconformably overlies the Oswaldo Formation. The fauna of the Oswaldo consists primarily of foraminifera, rugosan and tabulate corals, crinoids, brachiopods, bryozoa, gastropods, ostracods, some sponge spicules, and trilobite fragments. The fusulinids are represented in three reasonably well-defined zones (in ascending order): *MillerellaEostaffella* zone (Morrow), *Profusulinella* zone (lower Atoka), and *Fusulinella* zone (upper Atoka). Three biohermal to biostromal zones of *Chaetetes milleporaceous* were observed. The algal flora is represented by dasycladacean and phylloid algae. Petrographic analysis of the Oswaldo carbonate sequence indicates a shallow water, normal marine, low to moderate energy, open shelf environment. Silicification, apparently confined to the surface, is recorded. The upper surface of the Oswaldo Formation has a zone of limonite weathering. Patchy recrystallization is noted throughout the sequence. The presence of this Morrow-Atoka sequence of carbonates prompts two interesting paleogeographic speculations. The Oswaldo Formation at Silver City could represent a sag in the positive Florida Islands-Zuni arch axis. The Silver City sag could be an interconnecting link between the marine sediments of the Florida shelf of the Pedrogosa basin and the Robledo shelf of the Orogrande basin. The Silver City sag could also represent the westernmost known Robledo shelf (Lower Pennsylvanian sequence).

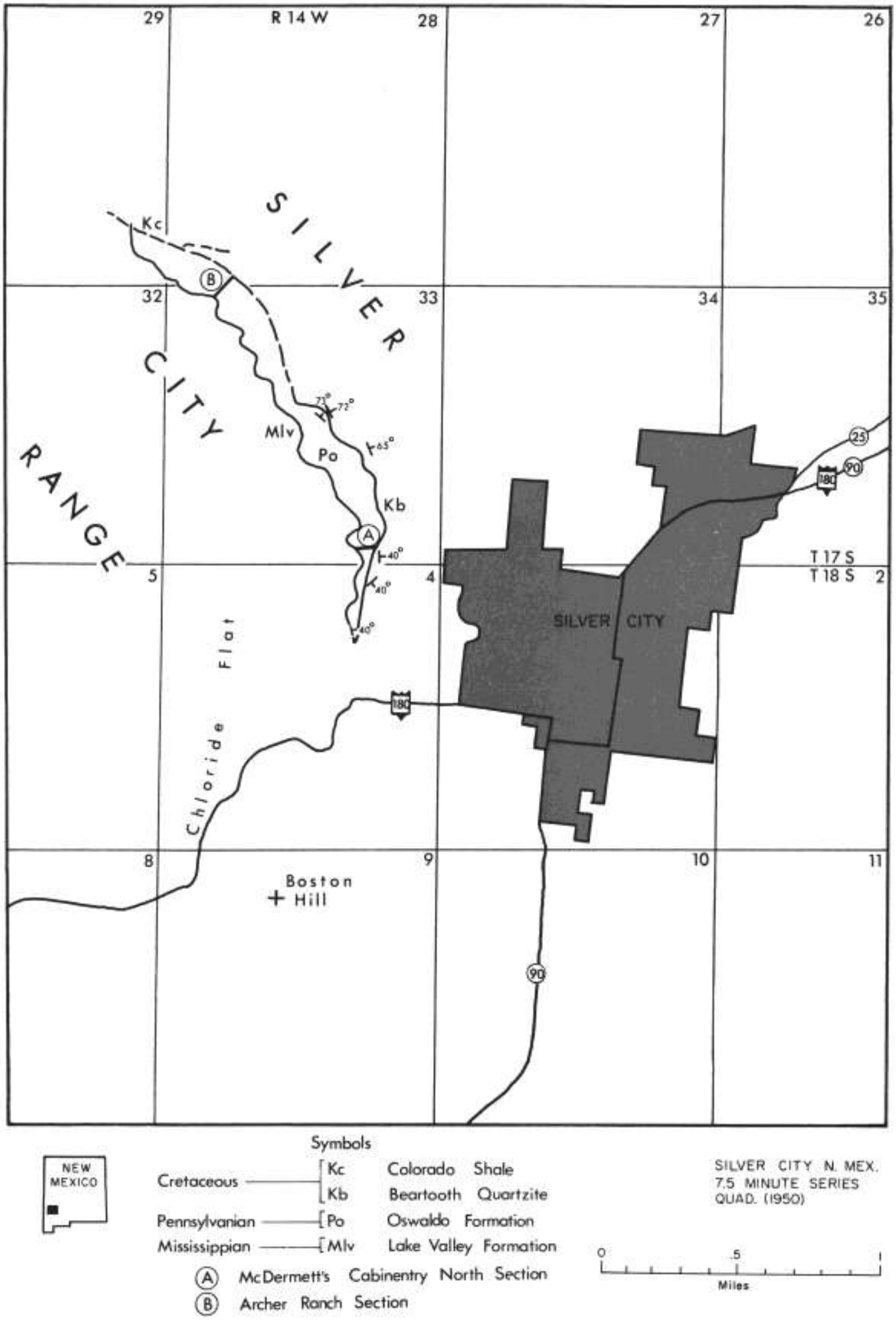


FIGURE 1–*Location of the Oswaldo Formation outcrop in the Chloride Flat fault block, Grant County, New Mexico.*

INTRODUCTION

Stratigraphic studies completed in 1970 revealed the presence of structurally uncomplicated sequence of the Oswaldo Formation in the Chloride Flat fault block of the southern part of the Silver City Range (fig. 1). Chloride Flat is a valley formed on the easily-eroded Percha Shale at the south end of the Silver City Range, just north of the town of Silver City. The Silver City Range is an eroded east-dipping monocline which exposes a sequence of rocks from Precambrain to Mesozoic age.

Entwistle (1944, p. 23) observed 89 ft of Pennsylvanian beds beneath the Beartooth Quartzite in the Bear Mountain area 6 miles northwest of Silver City. The earlier map of Paige (1916) does not separate the Pennsylvanian. Four known areas of occurrence of Pennsylvanian rocks are now recorded in the Silver City quadrangle.

The 80 Mountain Area has Pennsylvanian strata in the SW/4 of section 19 and the SE/4 of section 8, T. 15 S., R. 14 W. The base of the Pennsylvanian is not exposed in the 80 Mountain Area. The Cretaceous-Pennsylvanian unconformity and a partial section are reasonably well exposed in this area. Pennsylvanian is also recorded in the Cleveland mine area.

The Cleveland mine area is too structurally complex to construct a section. Pennsylvanian rocks underlying the Cretaceous are present in center sec. 2, T. 17 S., R. 14 W.

Structurally, the Bear Mountain fault block is somewhat complex, having been involved with local intrusive activity. The stratigraphic sequence of the Pennsylvanian is not well exposed. Exposures are noted in the Little Walnut Creek area (center S/2 sec. 2, T. 17 S., R. 15 W.) and the South Fork of the Little Walnut Creek (SE sec. 12 and the NE sec. 13, T. 17 S., R. 15 W). These two exposures exceed the previously reported 89 ft. Possibly the Syrena Formation (Pennsylvanian) and the Abo Formation (Permian) both may be represented in the Little Walnut Creek area.

The most accessible and best Pennsylvanian exposures are observed in the Chloride Flat block (fig. 1). Here the Oswaldo Formation (Morrow-Atoka) is an eroded remnant unconformably underlain by the Lake Valley Formation (Osage) and unconformably overlain by the Beartooth Quartzite or the Colorado Shale (both Gulf). The two sections listed in the Appendix were measured in this block. The southern section is designated the McDermett's Cabinentry North (SE/4, sec. 33, T. 17 S., R. 14 W.) and consists of 186 ft. of Oswaldo Formation. The Archer Ranch section was measured on the south side of Railroad Canyon (NW/4, sec. 33, T. 17 S., R. 14 W.) and consists of 145.5 ft of Oswaldo Formation. The Dunham carbonate classification was used in megascopic descriptions of lithology. Thickness of rock units were measured in a standard manner with a Jacob's staff. Sediment color is in accordance with the Rock-Color Chart published in 1951 by the Geological Society of America. Thin-section analyses of floral and faunal content were made (tables 1-6). Carbonates were cross-classified in accordance with Dunham and Folk nomenclature (tables 7-9). *(Tables in appendix.)*

Paige (1916) is the best prior reference for a general geology map of the Silver City quadrangle. Spencer and Paige (1935), Jones and others (1967), Entwistle (1944), and Thompson (1942) are among the major contributors to the Pennsylvanian stratigraphy in the area. The studies of Kottlowski (1960, 1963, 1970), Wengerd (1969, 19'70), Meyer (1966), and Wilson and others (1969) are important regional references on the Pennsylvanian of southwestern New Mexico. The Silver City quadrangle has recently been remapped by one of the co-authors, John E. Cunningham (to be published by The New Mexico Bureau of Mines and Mineral Resources).

The present study has been supported by the New Mexico Bureau of Mines and Mineral Resources and the University Research Institute of the University of Texas at El Paso.

STRATIGRAPHY

The late Paleozoic rocks of the Silver City area are underlain unconformably by the Lake Valley Formation (Osage) which is a coarsely crystalline, gray, crinoidal limestone (Lochman-Balk, 1965, p. 98). The late Paleozoic rocks are subdivided into 3 distinct formations (fig. 2), in ascending order: the Oswaldo Formation (Morrow-Missouri), the

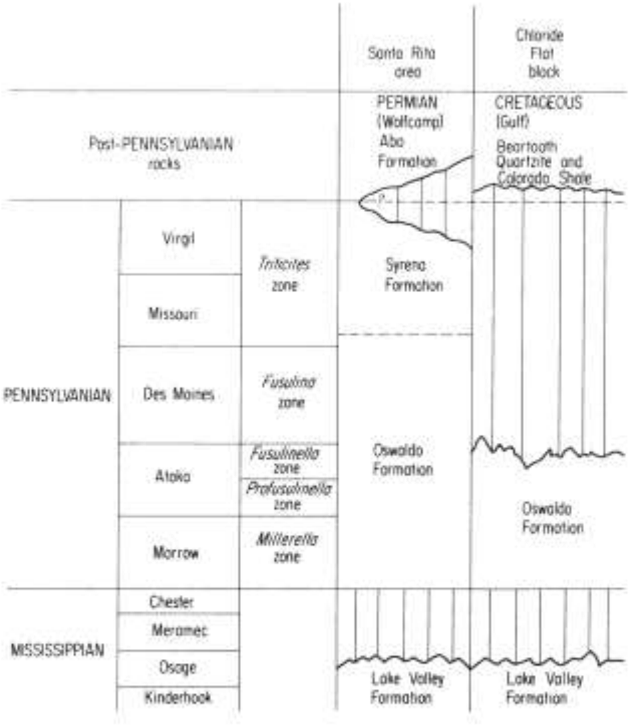


FIGURE 2—*Nomenclature chart for the Pennsylvanian rocks of Grant County, New Mexico.*

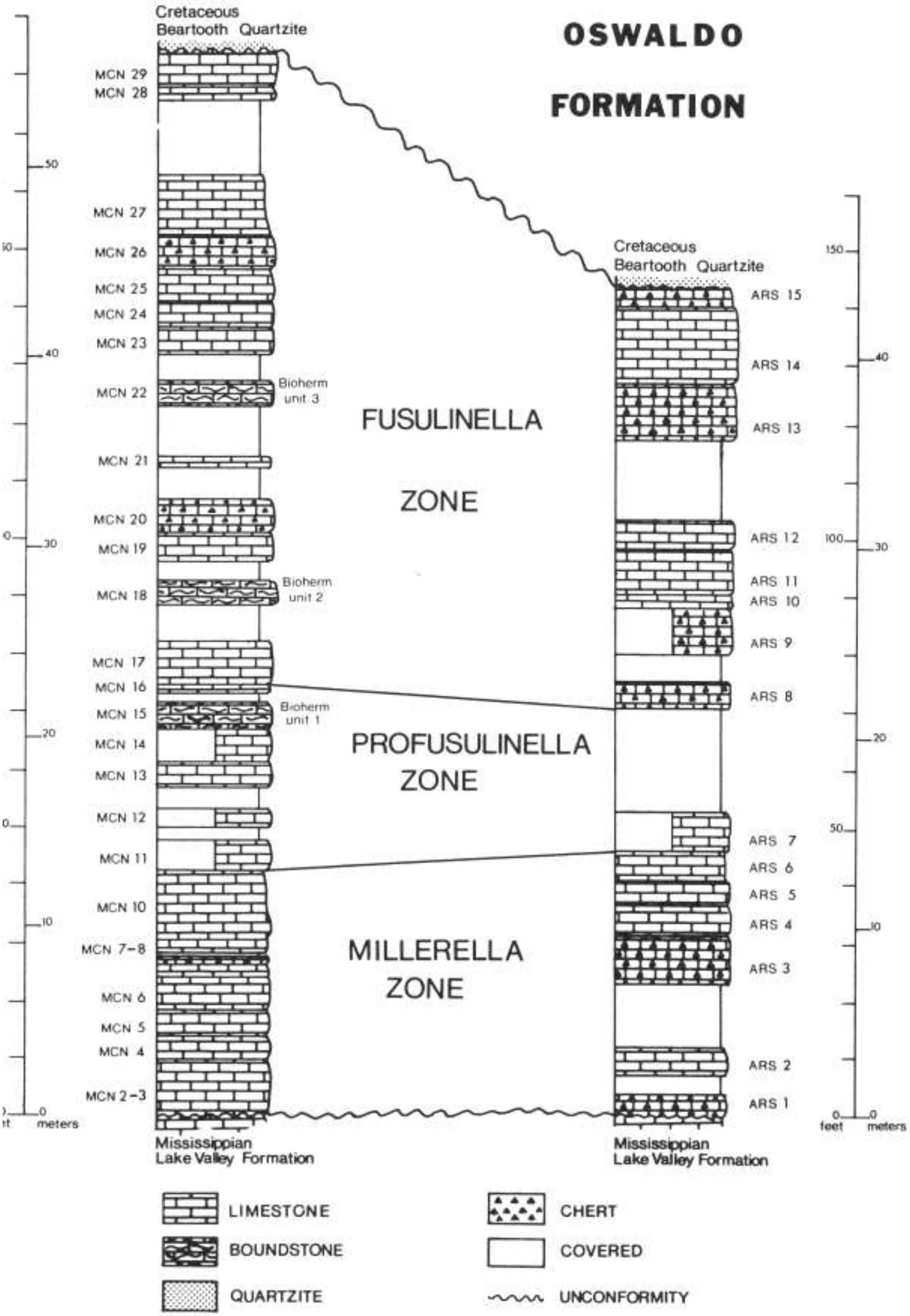


FIGURE 3—*Stratigraphic sections of the Oswaldo Formation in the Chloride Flat fault block, Grant County, New Mexico.*

Syrena Formation (Missouri-Virgil), and the Abo Formation (probably Wolfcamp). The late Paleozoic rocks are unconformably overlain by either the Beartooth Quartzite (Cretaceous) or Colorado Shale. The Beartooth Quartzite (Probably Gulf) is a fine- to medium-grained quartzite. The Colorado Shale (Gulf) consists largely of limy shales in the lower part of the section.

The Chloride Flat fault block, unconformably overlain by the Colorado Shale and the Beartooth Quartzite, preserves only the lower part of the Oswaldo Formation. The overlying upper Oswaldo, Syrena, and Abo Formations were probably deposited in the Chloride Flat area and were removed by post-Wolfcamp to pre-Gulf erosion. The upper surface of the Oswaldo is iron stained. The lithology of the Oswaldo consists of a sequence of fine- to medium-grained limestone; the upper surface in contact with the overlying Beartooth Quartzite is highly altered by weathering.

The carbonate petrography of the Oswaldo reveals a sequence composed primarily of biomicrites and biomicrudites with sporadic occurrences of intraclastic material (wackestone to packstone in the Dunham classification; see tables 7-9 for petrography). Recrystallization to micro-spar and pseudospar is slight to moderate. Virtually no dolomitization is observed in the sequence. Extensive fracturing of one or more generations is noted in many samples. The fractures are normally filled with secondary sparitic calcite. Pressure solution is demonstrated between grains (photo 1), and by the development of stylolites (photo 2). Sporadic corrosion of individual grains is noted, probably due to coating by a blue-green algae such as *Girvanella.* Silicification, which is slight to moderate, is probably developed as a weathering phenomena.

Spicular biomicrites (photo 3) are recorded in the sequence. Boundstones (biostromal to biohermal in shape and averaging 5 ft in thickness) of *Chaetetes milleporaceous* are recorded in 3 intervals in the Atoka portion of the Oswaldo in the McDermett's Cabinentry North section (photo 4). *Chaetetes* was observed in the talus on the north slope of Railroad Canyon. The *Chaetetes* boundstone units were not located on the south slope of Railroad Canyon, in the Archer Ranch section.

PALEONTOLOGY

The megafauna of the Oswaldo Formation was not studied in detail. The rich fauna includes crinoid ossicles, corals (tabulate and rugosan), echinoid spines, brachiopods (largely productoid and spiriferoid, photo. 5), bryozoans (fistuloporid and fenestrate), gastropods, trilobite exuviae, fusulinids, and pelecypods. The megaflora consists of poorly preserved phylloid algae recorded in up to 7 zones in the Morrow and the Atoka sequences. Stromatolitic layers may also be present. Thin-section analysis reveals an equally varied microscopic fauna and flora (tables 4-6).

The microscopic identifications of the carbonates reveal an extensive foraminifera fauna that includes *Millerella* (photo. 2), *Eostaffella* (formerly *Paramillerella)* (photo. 6), *Saccamminopsis*, endothyrids, ophthalmid foraminifera (?), *Bradyina*, *Profusulinella* (photo. 7), *Fusulinella* (photo. 8), *Tetrataxis* (photo. 9), *Climacammina* (photo. 10), and *Eoschubertella* (see tables 1-3).

The fusulinid sequence enables precise zonation of the Oswaldo Formation (fig. 3). Random orientation of fusulinid specimens in thin section makes specific identification impossible and generic identification difficult. In poorly oriented random sections, advanced *Profusulinella is* difficult to distinguish from *Fusulinella.* In each case where *Fusulinella is* designated, a clear and distinct diphanotheca was observed.

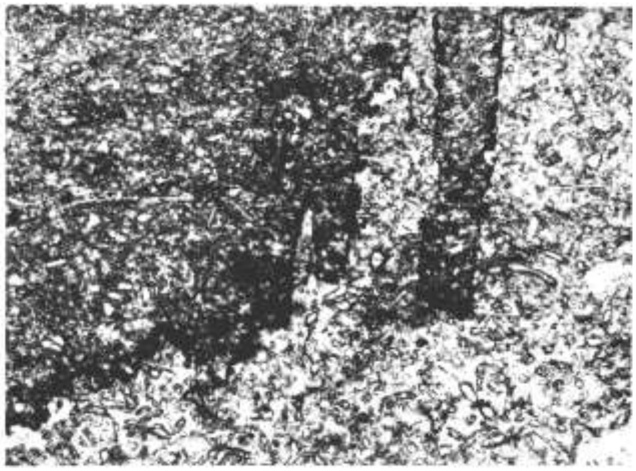
The subdivisions revealed by thin section are, in ascending order: the *Millerella-Eostaffella* zone (Morrow), *Profusulinella* zone (lower Atoka), and the *Fusulinella* zone (Atoka). The McDermett's Cabinentry North section develops a 42-ft *Millerella* zone (MCN 2-10), a 31 1/2-ft *Profusulinella* zone (MCN 11-16), and a 112 1/2-ft eroded *Fusulinella* zone (MCN 17-29). The Archer Ranch section to the north closely approximates these thicknesses which are a 46-ft *Millerella* zone (ARS 1-6), a 25-ft *Profusulinella* zone (ARS-7), and a 74 1/2-ft eroded *Fusulinella* zone (ARS 8-15). Variations in thickness can be attributed to position of a sample in the unit used for thin section and the normal variations in sedimentology that would be recorded on an open shelf environment. All of the megafauna discussed are represented in thin section examples. The flora represented in thin section includes recrystallized phylloid algal blades (photo. 11), *"Girvanella"* corrosion, and dasycladacean algae. The presence of Morrow and Atoka phylloid algal blades is noteworthy, being the second recorded occurrence of Morrow phylloid algae in the region. The other occurrence is in the Franklin Mountains north of El Paso, Texas in the La Tuna Formation (Mims, 1971). The overlying Berino Formation (Atoka) in the Franklin Mountains also contains phylloid algae. The traditional exploration for phylloid algae has been limited to rocks ranging in age from Des Moines to Wolfcamp. The possibility of developing phylloid banks in Morrow and Atoka rocks now needs to be seriously reexamined in current exploration programs throughout the Southwest and elsewhere.

PALEOGEOGRAPHY AND PALEOECOLOGY

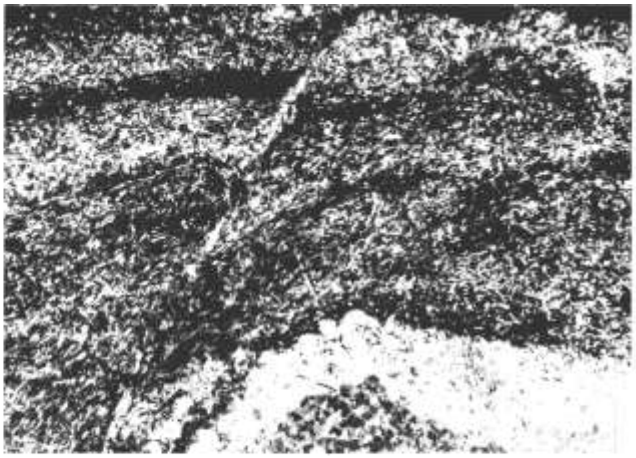
The paleoecology of the Oswaldo Formation of the Chloride Flat fault block reveals an environment that would be normal marine, warm shallow water with low to moderate energy on an open shelf.

The paleogeographic implications of this interpretation indicate that by position this section would be very close to the crest of a Defiance-Zuni arch-Florida axis positive element if they formed a continuous NNW-SSE axis (fig. 4). Two conclusions are possible with this interpretation. The

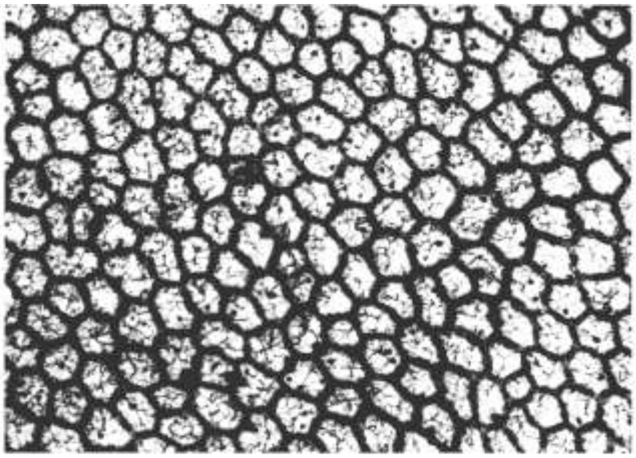
PHOTOMICROGRAPH ***1—Crinoidal*** *biomicrudite demonstrating recrystallization of crinoidal ossicles and em bayed grain formation by pressure solution (MCN-3). x 11*



PHOTOMICROGRAPH *2—Styolite formation and sections of* Millerella *capped by limonite (MCN-5). x 11*

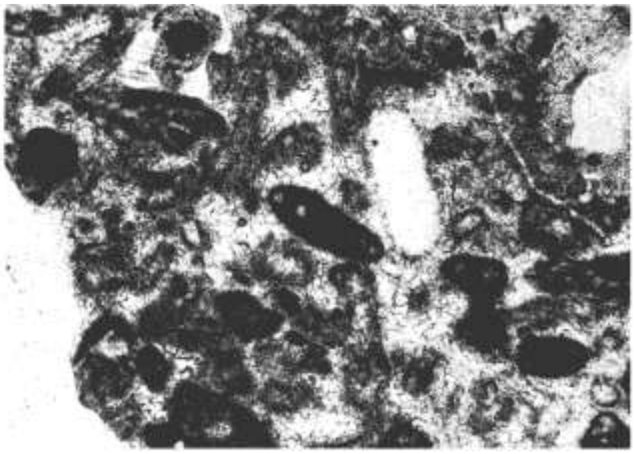


PHOTOMICROGRAPH *3—Spiculitic biomicrite (MCN-5). x 11*

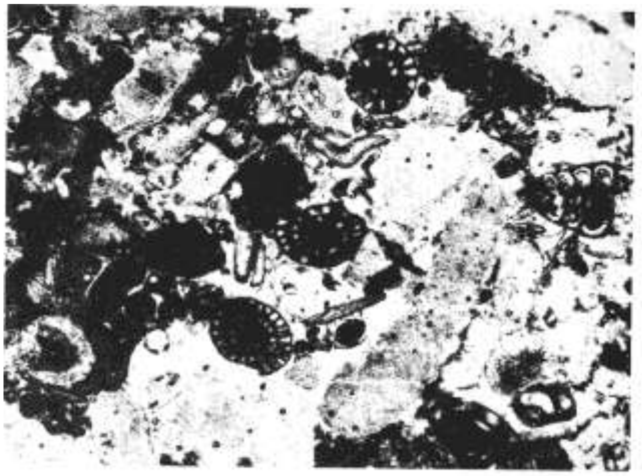


PHOTOMICROGRAPH 4 —Chaetetes milleporaceous *boundstone (MCN-22). x 11*

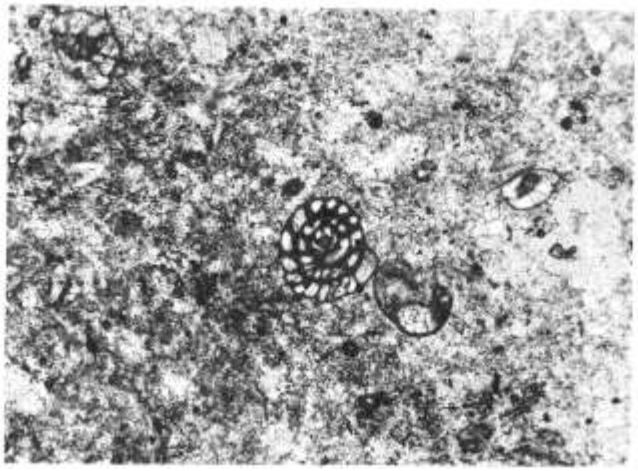
PHOTOMICROGRAPH *5—Biomicrudite with productid brachiopod demonstrating geopetal structure (ARS-10). x*



PHOTOMICROGRAPH 6 —Eostaffella *sp. in a recrystallized biomicrite 33X (MCN-4). x 11*



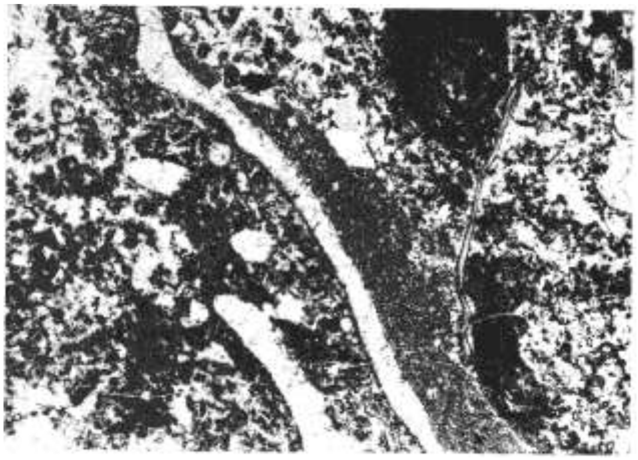
PHOTOMICROGRAPH 7 —Profusulinella *sp. with a textularid foraminifera (MCN-13). x 11*



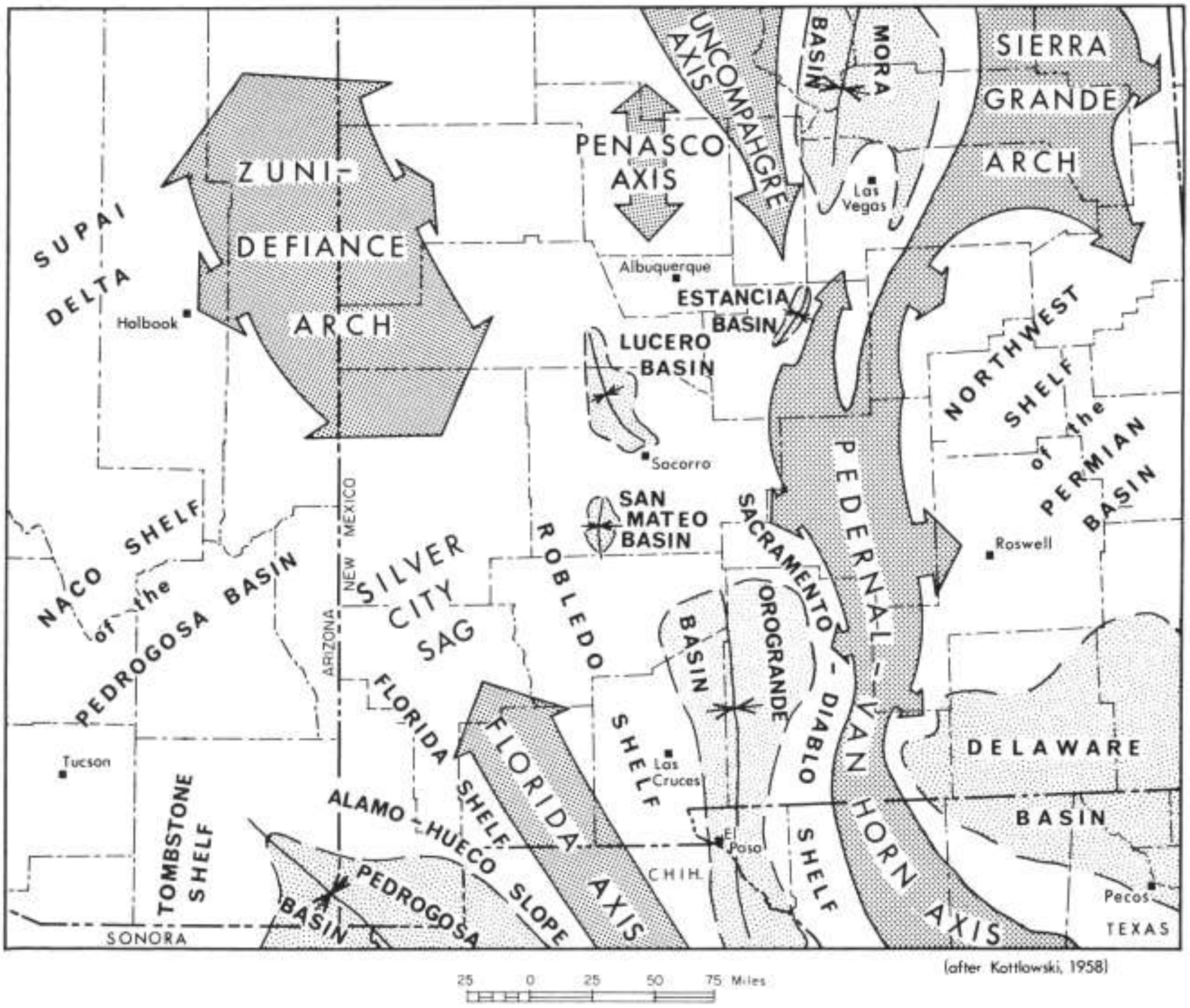
PHOTOMICROGRAPH 8 —Fusulinella *sp. in a recrystallized biomicrite (MCN-132). x 11*

PHOTOMICROGRAPH 9 —Textraxis *sp. in a recrystallized biomicrite (MCN-152). x 11*

PHOTOMICROGRAPH 10—Climacammina *sp. in a recrystallized biomicrite (MCN-21). x 11*



PHOTOMICROGRAPH 11 —*Recrystallized phylloid algal blade (MCN-9). x 11*



(after Kottlowski, 1958)

FIGURE 4—*Pennsylvanian paleotectonic and paleogeographic map of the southwestern New Mexico region.*

Oswaldo Formation (of the Chloride Flat fault block) represents the far western extension of the Robledo shelf open-shelf marine sequence or the far eastern extension of the Florida shelf open-shelf marine sequence. The term Robledo shelf (Meyer 1966) is equivalent to the term Potrillo shelf of Wengerd (1969, 1970).

The second interpretation is that the Defiance-Zuni arch and Florida axis do not represent one continuous positive element but instead are separated by a sag. The name Silver City sag is proposed for this paleogeographic feature. Probably this area remained a shallow water open-marine region connecting the western Florida shelf sequences with the eastern Robledo shelf sequence.

CONCLUSIONS

The results of this study are particularly interesting because we have observed *"Ivanovia* "-like phylloid algae in rocks bearing Morrow and Atoka fusulinids. The fusulinids assigned for dating are referred to Morrow-Atoka age and the term Derryan is disregarded. The eroded Oswaldo sequence contains a fauna and flora that indicates an open-shelf sequence of low to moderate energy in a normal marine environment.

The occurrences of phylloid algae in Morrow and Atoka sediments should be reexamined regionally to determine whether or not phylloid algae and their biohermal bank structures, which are so commercially feasible, are present and acting as stratigraphic reservoirs for petroleum. This data will require a reevaluation of the petroleum possibilities of the Pennsylvanian system in southwestern New Mexico.

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APPENDIX

TABLE 1 – Archer Ranch series (ARS) foraminiferal distribution

	FUSULINELLA	PROFUSULINELLA	MILLERELLA	EOSTAFFELLA	STAFFELLA	EOSCHUBERTELLA	PROFUSULINA	OPHTHALMIDS	ENDOTHYRIDS	ENCRUSTING FORAMS	SACCAMMINOPSIS	CLIMACAMMINA	TETRAXIS	BRADYINA	OTHER FORAMS
ARS-15											X	X			
ARS-14										X	X		X		
ARS-13	X				X										
ARS-12	X														
ARS-11															
ARS-10											X				X
ARS- 9	X										X				
ARS- 8	X														
ARS- 7		X	X	X											
ARS- 6				X											
ARS- 5			X	X					X			X			
ARS- 4			X	X					X						
ARS- 3			X	X						X			X		
ARS- 2			X						X						
ARS- 1															X

TABLE 2 – MCN series foraminiferal distribution

	FUSULINELLA	PROFUSULINELLA	MILLERELLA	EOSTAFFELLA	STAFFELLA	EOSCHUBERTELLA	PROFUSULINA	OPHTHALMIDS	ENDOTHYRIDS	ENCRUSTING FORAMS	SACCAMMINOPSIS	CLIMACAMMINA	TETRAXIS	BRADYINA	OTHER FORAMS
X MCN-29-186															
MCN-29-183	X-								X						
MCN-29-181															
X MCN-28-173															
MCN-27-160															
MCN-27-158	X-			X-							X-				
X MCN-27-153															
X MCN-26															
X MCN-25															
X MCN-24															
MCN-23-135	X														
MCN-23-132				X											
MCN-22															
MCN-21	X		X	X				X-	X			X-			X
MCN-20	X			X					X						
MCN-19	X			X											
MCN-18			X-	X										X	X
MCN-17	X		X	X							X-	X			

TABLE 3 – MCN series foraminiferal distribution

	FUSULINELLA	PROFUSULINELLA	MILLERELLA	EOSTAFFELLA	STAFFELLA	EOSCHUBERTELLA	PROFUSULINA	OPHTHALMIDS	ENDOTHYRIDS	ENCRUSTING FORAMS	SACCAMMINOPSIS	CLIMACAMMINA	TETRAXIS	BRADYINA	OTHER FORAMS
MCN-16		X		X											
X MCN-15															
MCN-14															
MCN-13		X	X	X	X							X			
MCN-12			X-	X-											
MCN-11			X	X		X-	X-		X						
MCN-10			X	X								X			
MCN- 9				X				X		X					
MCN- 8				X								X			
X MCN- 7															
MCN- 6			X	X										X-	
MCN- 5															
MCN- 4			X	X					X		X-				X
MCN- 3			X-												
MCN- 2			X	X					X			X			X
MCN- 1															X

TABLE 4 – Archer Ranch series (ARS) faunal distribution

	SPONGE SPICULES		CORALS	CHAETETES		FENESTRATE BRYOZOA	FISTULOPORID BRYOZOA	BRYOZOA (INDET.)		BRACHIOPOD SPINES	BRACHIOPOD VALVES		GASTROPODS		OSTRACODS	TRILOBITE FRAGMENTS	CRINOIDAL DEBRIS	ECHINODERMATA (OTHER)		DASYCLADACEANS	PHYLLOID ALGAE	ALGAL CORROSION
ARS-15											X				X		X					
ARS-14													X					X		X	X	
ARS-13										X								X		X		
ARS-12											X		X		X							
ARS-11																	X			X		
ARS-10								X			X		X				X			X	X	
ARS- 9							X										X					
ARS- 8																						
ARS- 7								X			X		X		X		X	X		X		
ARS- 6	X									X					X		X					
ARS- 5								X		X	X						X	X				
ARS- 4											X						X					
ARS- 3						X				X	X		X		X		X				X	
ARS- 2											X						X	X				
ARS- 1	X																					

TABLE 5 – MCN series faunal distribution

	SPONGE SPICULES		CORALS	CHAETETES		FENESTRATE, BRYOZOA	FISTULOPORID BRYOZOA	BRYOZOA (INDET.)		BRACHIOPOD SPINES	BRACHIOPOD VALVES		GASTROPODS		OSTRACODS	TRILOBITE FRAGMENTS	CRINOIDAL DEBRIS	ECHINODERMATA (OTHER)		DASYCLADACEANS	PHYLLOID ALGAE	ALGAL CORROSION	
X MCN-29-186																							
MCN-29-183										X	X						X	X		X			
MCN-29-181						X				X			X		X		X						
X MCN-28-173																							
MCN-27-160	X														X								
MCN-27-158								X		X	X				X		X						
X MCN-27-153																							
X MCN-26																							
X MCN-25																							
X MCN-24																							
MCN-23-135							X										X	X		X			
MCN-23-132						X					X												
MCN-22				X																			
MCN-21										X	X						X						
MCN-20											X						X						
MCN-19											X				X								
MCN-18			X	X									X				X						
MCN-17											X		X				X						

TABLE 6 – MCN series faunal distribution

	SPONGE SPICULES		CORALS	CHAETETES		FENESTRATE BRYOZOA	FISTULOPORID BRYOZOA	BRYOZOA (INDET.)		BRACHIOPOD SPINES	BRACHIOPOD VALVES		GASTROPODS		OSTRACODS	TRILOBITE FRAGMENTS	CRINOIDAL DEBRIS	ECHINODERMATA (OTHER)		DASYCLADACEANS	PHYLLOID ALGAE	ALGAL CORROSION	
MCN-16								X		X					X		X	X					
X MCN-15																							
MCN-14																							
MCN-13							X				X		X					X		X			
MCN-12								X		X			X		X		X			X	X	X	
MCN-11								X		X	X				X		X				X		
MCN-10								X		X	X						X	X					
MCN- 9																	X				X		
MCN- 8															X		X	X					
X MCN- 7																							
MCN- 6							X				X				X								
MCN- 5	X																						
MCN- 4								X			X						X						
MCN- 3								X		X	X				X		X			X			
MCN- 2											X						X						
MCN- 1							X	X					X			X	X	X					

TABLE 7 – *Archer Ranch series (ARS) petrography*

	ORTHOQUARTZITE		MUDSTONE	WACKESTONE	PACKSTONE		BIOMICRITE	BIOMICRUDITE	INTRACLASTIC BIOMICRITE	INTRACLASTIC BIOMICRUDITE		INTRACLASTS	PELLETS (MINOR)		RECRYSTALLIZED	IRON OXIDE REPLACEMENT	FRACTURED (RESEALED WITH CALCITE)	FRACTURED (LIMONITIC FILLED)	LIMONITIC STAINING	SILICIFIED FAUNA			
ARS-16	X																						
ARS-15				X				X															
ARS-14				X			X	X							X								
ARS-13					X		X								X								
ARS-12					X					X		X			X		X						
ARS-11				X	X		X								X								
ARS-10				X				X											X	X			
ARS- 9				X	X		X								X			X					
ARS- 8				X			X								X		X						
ARS- 7					X			X					X				X						
ARS- 6			X	X			X										X						
ARS- 5					X		X								X								
ARS- 4				X	X		X								X		X	X					
ARS- 3				X	X				X			X					X						
ARS- 2				X	X		X	X								X	X						
ARS- 1				X			X									X	X	X					

TABLE 8 – *MCN series petrography*

	ORTHOQUARTZITE		BOUNDSTONE	MUDSTONE	WACKESTONE	PACKSTONE	GRAINSTONE	BIOLITHITE	BIOMICRITE	BIOMICRUDITE	BIOSPARITE	INTRACLASTIC OOLITIC BIOSPARITE	MICRITE	INTRACLASTIC BIOSPARITE		INTRACLASTS	OOLITES		RECRYSTALLIZED	FRACTURED (RESEALED WITH SPARITE)	ALGAL CORROSION	STYOLITES	LIMONITE STAINING
BO - 1	X																						X
X MCN-29-186																							
MCN-29-183					X				X														X
MCN-29-181					X				X										X				
X MCN-28-173																							
MCN-27-160				X	X				X											X			
MCN-27-158					X															X			
X MCN-27-153																							
MCN-27-152					X				X										X				
X MCN-26-150																							
X MCN-25-145																							
X MCN-24-139																							
MCN-23-135						X								X		X			X				
MCN-23-132						X			X										X				X
MCN-22			X					X															
MCN-21					X	X			X														
MCN-20					X	X			X										X				
MCN-19					X				X											X		X	X
MCN-18					X				X										X				
MCN-17					X	X			X										X	X			
MCN-16					X				X														
X MCN-15			X					X															
MCN-14				X									X							X			

TABLE 9 – MCN series petrography

	ORTHOQUARTZITE	BOUNDSTONE	MUDSTONE	WACKESTONE	PACKSTONE	GRAINSTONE	BIOLITHITE	BIOMICRITE	BIOMICRUDITE	BIOSPARITE	INTRACLASTIC OOLITIC BIOSPARITE	MICRITE	INTRACLASTIC BIOSPARITE	INTRACLASTS	OOLITES		RECRYSTALLIZED	FRACTURE (RESEALED WITH SPARITE)		PRESSURE SOLUTION	ALGAL CORROSION	STYOLITES	LIMONITE STAINING
MCN-13					X				X														
MCN-12				X	X			X			X			X	X						X		
MCN-11					X			X									X						
MCN-10					X			X									X	X					
MCN- 9					X				X								X	X					
MCN- 8			X	X	X			X						X									
X MCN- 7																							
MCN- 6					X			X		X			X				X	X				X	X
MCN- 5				X				X									X	X					
MCN- 4					X	X		X		X			X	X				X					X
MCN- 3					X				X								X	X		X			
MCN- 2				X	X			X						X			X	X					X
MCN- 1				X	X			X	X								X			X			

Archer Ranch Section (ARS series)

Located in NW/4, sec. 33, T. 17 S., R. 14W., Silver City Range. In Railroad Canyon the Oswaldo Formation has been recognized above the Tierra Blanca member of Lake Valley Formation (Mississippian). Fusulinids and *Chaetetes milleporaceous* were collected on the north slope of the canyon. Measurements in the arroyo of the canyon indicate a minimum of 62 feet of Oswaldo. The Colorado Shale (Cretaceous) is observed beyond the overlying 38 feet. A fault zone is strongly indicated. Section (ARS series) was taken on the better exposures on the south canyon wall.

Mudstone, wackestone, packstone, grainstone, and boundstone refer to Dunham's carbonate classification scheme which is adequate for megascopid identification. All carbonates are limestones.

Sample No.	Description	Thickness (ft)
	Beartooth Quartzite (Cretaceous):	
ARS-16	Float of questionable fault gouge and Beartooth Quartzite. Iron staining extensive Fresh–grayish orange 10YR7/4, grayish red 10R4/2	
	Oswaldo Formation (Pennsylvanian):	145½
	Fusulinella zone	
ARS-15	Recrystallized limestone with crinoid columnals and solitary corals. Mottled. Chert make-up 30 to 55% of the total volume Weathered–medium gray N5 Fresh–brownish gray 5YR4/1, grayish red 10R4/2, moderate yellowish brown 10R5/4	4½
ARS-14	Wackestone containing large rugosoid corals, fusulinids, brachiopods, and questionable fragmental phylloid algae. At 135 ft wackestone has a banded look on the weathered surface Weathered–light brownish gray 5YR6/1 Fresh–medium dark gray N4	13
ARS13	Dark-gray wackestone containing fusulinids, crinoid ossicles, and other fine faunal debris, with banded dark-brown chert. This unit grades up into a recrystallized, mottled purple and gray, medium-grained limestone, which has features of soft sedimint deformation Weathered–medium light gray N6 Fresh–medium dark gray N4	10
ARS-12	Wackestone and packstone containing fusulinids, crinoids, and irregularly bedded (graded) phylloid algae. Upper ft contains a chert and limestone unit. White chert has distinct fusulinids. Intraclasts of one inch. Iron stained Weathered–medium light gray N6 Fresh–medium dark gray N4	5
	Covered with rubble	14
ARS-11	Medium-bedded wackestone with forams (?), crinoidal debris, and fragments of unidentified fusulinids Weathered–medium light gray N6 Fresh–medium dark gray N4	8
ARS-10	Limestone. Medium to coarse grained in a mottled unit. Silicified fauna (crinoidal). Wackestone in part with good graded faunal fragments in micrite. Weathered–medium light gray N6 Fresh–medium dark gray N4	2
ARS-9	Mudstone to wackestone weathers distinct light gray, fresh surface dark gray to black. Contains forams (?) and gastropods. White chert with fusulinids. Fair to poor exposure Weathered–medium gray N5 Fresh–medium dark gray N4	8
	Covered	5
ARS-8	Wackestone with a silicified fauna contains fusulinids. Minor chert light gray in color, with a purplish tinge on the fresh surface Weathered–medium light gray N6 Fresh–brownish gray 5YR4/1	5
	Profusulinella zone	
	Covered with rubble	18
ARS-7	Encrinal wackestone and packstone. Poor exposures as in the entire section. Red siliceous zone at the top followed by covered interval. Thinner bedded than ARS-6 Weathered–medium gray N5 Fresh–medium dark gray N4	7
	Millerella zone	
ARS-6	Largely mudstone with some encrinal grainstone. Mudstone contains irregular beds of graded crinoidal debris and phylloid algae. Cross sections of brachiopods. Thin-bedded but weathers massive. Forms a rubble slope Weathered–light gray N7 Fresh–olive gray 5Y4/1	5
ARS-5	Largely mudstone with some fine-grained calcarenitic stringers. Contains large crinoid columnals. No slabby surfaces Weathered–light gray N7 Fresh–medium dark gray N4	5
ARS-4	Gray mudstone with encrinal packstone and grainstone stringers. Considerable hematite. Poor exposure. Contains large crinoid çolumnals Weathered–light gray N7 Fresh–medium gray N5, grayish red 10R4/2	5
ARS-3	Silicified, excellently preserved brachiopod in a mudstone matrix, gastropods, phylloid algal debris. Poor exposure. Some encrinal debris with brachiopod fragments that indicates reworking. Contains red brown flattened lenticular chert Weathered–medium light gray N6 Fresh–medium gray N5	8
	Covered	11
ARS-2	Alternating mudstone and encrinal packstone with gastropods and solitary corals (7-8.5). 8.5-11 ft covered. Floculent hematite in medium grained limestone (11-12). Questionable microfauna. Phyl-	

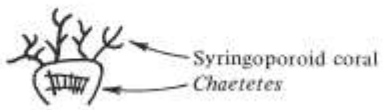
	loid algal debris Weathered–moderate yellowish brown 10YR5/4 Fresh–brownish gray 5YR4/1 medium gray N5	5
	Covered	3
ARS-1	Fine-grained limestone, laminated red and brown chert, with about half limestone and half chert. Some soft sediment deformation. This zone is selectively covered with a lichen (exposures on north side of the canyon, typically shaded). This unit is probably equivalent to the "Parting Shale" Weathered–moderate brown 5YR4/4 Fresh–medium light gray N6 moderate yellowish brown 10YR5/4 moderate reddish brown 10YR4/6	4
	Lake Valley Formation (Mississippian)	

McDermett's Cabinentry North

Base of section approximately 100 yards north of McDermett's home in arroyo at foot of slope. SE/4, sec. 33, T. 17 S., R. 14W., Silver City, Grant County, New Mexico.

Mudstone, wackestone, packstone, grainstone, and boundstone refer to Dunham's carbonate classification scheme which is adequate for megascopic identification. All carbonates are limestone.

Sample No.	Description	Thickness (ft)
	Beartooth Quartzite (Cretaceous):	
BQ-1	Orthoquartzite. Some limonitic and other iron staining. Base is disconformable surface of high relief	
	Oswaldo Formation (Pennsylvanian):	186
	Fusulinella zone	
MCN-29	Lower footage mostly covered. Three intervals described at 181 ft, 183 ft, and 186 ft above the base of the section are: 1) 186 ft Micritic mudstone, with banded chert and considerable quantities of limonite, no recognizable fauna Weathered–light gray N7, grayish orange 10YR7/4 Fresh–olive gray 5Y4/1 2) 183 ft Alternating mudstone and packstone, fauna, present, but not recognizable megascopically, micritic Weathered–light olive gray 5Y6/1, moderate yellowish brown 10YR5/4 3) 181 ft Micritic mudstone, fine size crinoids, brachiopods, surface silicification, nodular chert Weathered–light olive gray 5Y6/1 Fresh–dark yellowish orange 10YR6/6	10
MCN-28-173	Somewhat purplish mottled mudstone, large brachiopods. Possible rounded clasts, no chert, micritic, crinoids and fusulinids. Mudstone Weathered–medium light gray N6, yellowish gray 5Y8/1 Fresh–medium dark gray N4, light olive gray 5Y5/2	3
	Covered	13
MCN-27	Samples taken at 152, 153½, 158, and 160 ft. For the most part gray limestone, fresh surface dark gray. Slope-former, some chert. Fusulinid zone in sugary calcarenite (bioclastic) at about 155 ft. The units are: 1) 160 ft Micritic mudstone, brachiopods, fusulinids and gastropods Weathered–light gray N7 Fresh–olive gray 5Y4/1 2) 158 ft Micritic mudstone with phylloid algae Weathered–light gray N7 Fresh–olive gray 5YR4/1 3) 153½ ft Micritic packstone, fusulinids (some surface silicification), large variety of small fauna Weathered–medium light gray N6 Fresh–olive gray 5Y4/1 4) 152 ft Micritic wackestone with crinoids Weathered–light gray N7 Fresh–medium dark gray N4	10
MCN-26-150	Like underlying material. Poor exposure considerable tan chert. Wackestone with fusulinids, crinoids and trilobite cross section (phillipsid ?) Weathered–very pale orange 10YR8/2 Fresh–medium dark gray N4	5
MCN-25-145	Fusulinid wackestone with crinoids, and questionable phylloid algae, micritic Weathered–light olive gray 5Y5/2 Fresh–light olive gray 5Y5/2, light gray N7	5
MCN-24-139	Dark-gray wackestone, micritic, ? fusulinids, crinoids Weathered–light brownish gray 5YR6/1 Fresh–brownish gray 5YR4/1	5
MCN-23-135	Cloudy medium crystalline limestone, fauna not recognized Weathered–light gray N7 Fresh–dark yellowish orange 10YR6/6	
MCN-23-132	Wackestone, micritic, brachiopods Weathered–light olive gray 5Y6/1 Fresh–dark gray N3	5
	Hill top, covered	4
MCN-22	Biohermal unit 3. *Chaetetes milleporaceous* and syringoporoid corals. Weathers gray with dark-brown silicified brachiopods, corals, and fusulinids. Chert at top, bands about 6 inches in thickness Weathered–light olive gray 5Y6/1 Fresh–olive gray 5Y4/1 *Chaetetes milleporaceous* Boundstone	5
	Covered	8
MCN-21	Wackestone, micritic. Gray-weathering reddish-gray fresh surface with fusulinids and other fragmental material, micritic Weathered–light olive gray 5Y6/1	

	Fresh–medium dark gray N4	2
	Covered	5
MCN-20	Gray wackestone, micritic. Some lens-like irregular chert, tan in color at 103 ft. Lower 3 ft black on fresh surface and with fusulinids very abundant. Upper 3 ft more gray red with fusulinids very abundant Weathered–light gray N7 Fresh–medium dark gray N4	6
MCN-19	Wackestone with visible fossils, micritic. With fusulinids, mostly fine faunal hash. Distinct 1 to 3 inch limonite-stained zone at 100 ft Weathered–medium light gray N6 Fresh–olive gray 5Y4/1	5
	Covered	3½
MCN-18	Biohermal unit number 2. Massive bench of boundstone–*Chaetetes milleporaceous* with syringoporoid corals. Exposure good, as in the first exposures the hair corals and syringopora are silicified (weathers tan). High-spired gastropods Weathered–light olive gray 5Y6/1 Fresh–light olive gray 5Y5/2	3½
	Covered rubble	6½
MCN-17	Wackestone, micritic (top 6 inches very cherty). At 80 ft syringoporoid coral colony–(6 inches by 3 to 4 inches). Brachiopods, crinoids. Fusulinids. Unit is more or less massive covered with rubble Weathered–light gray N7 Fresh–olive gray 5Y4/1	8
	Covered (Shifted section laterally)	
	Profusulinella zone	
MCN-16	Wackestone. Replete with small fauna across surface (crinoid, etc.) large brachiopods Weathered–light brownish gray 5YR6/1 Fresh–brownish gray 5YR4/1	1
	Covered	1½
MCN-15	Biohermal unit number 1. Boundstone, lower unit micritic with abundant brachiopods. Light tan in color. *Chaetetes milleporaceous.* Colonites 12 inches by 12 inches. Syringoporoid colonies also, some in association with *Chaetetes.* 8 inch gray units alternating with ¾ inch tan units, fetid odor, micritic. Small fusulinids at 70-71  Weathered–light olive gray 6/1 Fresh–dark yellowish brown 10YR4/2	5
MCN-14	Packstone to mudstone. Covered for the most part. Small unit of purplish micrite with rounded fragments. Good microfauna, brachiopods, corals Weathered–olive gray 5Y4/1 Fresh–medium dark gray N4	5
MCN-13	Massive packstone to mudstone (?) fusulinids. Micrite alternating with crinoidal calcarenites with crinoids and dasycladacean algae Weathered–medium gray N5 Fresh–medium gray N5	5
	Covered	4
MCN-12	Lower 2 ft covered. Upper 3 ft limestone. Abundant microfauna, gastropods, brachiopods, fusulinids, corals, crinoids, dasycladacean algae, fine fauna Weathered–light gray N7 Fresh–light olive gray 5Y5/2	5
MCN-11	Limestone. Poorly exposed. Fusulinids, forams crinoids, appears to be fine-grained packstone. Unidentifiable fragments Weathered–medium light gray N6 Fresh–pale yellowish orange 10YR8/6	5
	Millerella zone	
MCN-10	Limestone as in MCN-9, micritic, much purer looking. More tan on fresh surface, break in slope on this unit. Fusulinids, crinoids, dasycladacean algae? Weathered–grayish orange 10YR7/4, dark yellowish brown 10YR4/2 Fresh–medium light gray N6	5
MCN-9	Limestone. Forms massive cliff, considerable limonite replacement after crinoids, questionable phylloid algae, brachiopods, first fusulinids (observed megascopically). Micritic Weathered–light gray N7 Fresh–medium gray N5, dark yellowish orange 10YR6/6	7
MCN-8	Limestone. Basal 2½ ft massive with 6 x 3 inch chert nodules at 2 ft, dark gray. Top 1½ ft nodular limestone with crinoidal debris and brachiopods, gastropods with 4 x 47 mm echinoid spines. Dark gray at 30 ft Weathered–light brownish gray 5YR6/1 Fresh–medium dark gray N4	5
MCN-7	Limestone, with 2- to 3-inch bands of gray-brown chert, at base of massive, limestone gray brown on fresh surface, unit micritic like the underlying MCN-6	1½
MCN-6	Limestone. Micritic, weathered and fresh surface gray, questionable microfauna Weathered–medium light gray N6, moderate yellowish brown 10YR5/4	5
MCN-5	Chert and limestone. Chert is laminated cream, red and brown and make in excess of 50% of unit; unit would make an excellent keybed. Limestone micritic or recrystallized micrite. No fauna observed. Limestone weathered and fresh surface gray. Weathered–grayish orange 10YR7/4, light olive gray 5Y5/2 Fresh–grayish orange 10YR7/4, olive gray 5Y5/2	4½
MCN-4	Limestone. Darker than the underlying unit contains brown chert (minor in extent), darker in color than MCN-3, crinoid debris. Jasperoid material in great abundance, does not affect the fossil material, noticeable in the micritic matrix. Rich zone at the very top of section Weathered–medium gray N5 Fresh–dark gray N3	4
MCN-3	Limestone. Crinoidal coquina, apparently cemented with sparite, reflects probably high energy environment. Crinoids and (?) foraminifera (not fusulinids) Weathered–moderate brown 5YR3/4 Fresh–medium gray N5	5
MCN-2	Limestone. Large crinoid columnals 8 x 12 mm, some brachiopods, small crinoidal debris in fine-grained matrix. Much less in fossils than MCN-1, weathers with pinpoint porosity Weathered–pale yellowish brown 10YR6/2 Fresh–light olive gray 5Y6/1	5
	Lake Valley Limestone (Mississippian):	

MCN-1	Base of section in resistant dip slope-former (approximately 6 inches at base) limestone. Surface silicification of crinoid columnals (weathers out tan, encrinal coquina with trilobites, crinoids, ostracods, and brachiopods. Encrinal bioclastic with sparite cement Weathered–light gray N7 Fresh–yellowish gray 5Y7/2

Type Faces: Camera-ready copy composed on IBM MT
Text 10 pt. Press Roman leaded two points
Display heads 18 pt. Times Roman and 18 pt. Garamond
Subheads 11 pt. Press Roman
Appendix 8 pt. Press Roman leaded two points

Presswork: Text printed on 38" single color Miehle
Cover printed on 20" single color Harris

Paper: Cover on 65# antique white
Body on 70# Mountie Matte