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STRATIGRAPHY, FACIES AND PALEOTECTONIC HISTORY OF MISSISSIPPIAN ROCKS IN THE SAN JUAN BASIN OF NORTHWESTERN NEW MEXICO AND ADJACENT AREAS

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Abstract—Lowermost Mississippian rocks in the San Juan Basin of northwestern New Mexico are Kinderhookian(?) and earliest Osagean in age and are restricted to the western margins of the basin. They overlie rocks of Late Devonian age and were laid down as carbonate sediments during a regional transgression. The Osagean marine transgression moved east and south from the Four Corners region and north from south-central New Mexico, flooding a terrane of Precambrian igneous and metamorphic rocks. The Precambrian surface on which the transgression occurred was irregular, and islands above the late Osagean sea included the Zuni-Defiance highlands, the Uncompahgre highlands and the Pedernal highlands. The Osagean rocks that formed adjacent to the highlands include supratidal and intertidal lime mudstone, anhydrite, gypsum, dolomite, quartz sandstone and shale. In more open marine environments, calcareous sand shoals were composed of pellets, bioclasts of crinoids, brachiopods and bryozoans and ooids and oolites. The end of Osagean time was marked by regional marine regression and erosion of the carbonate platform.

A regional marine transgression during Meramecian time is documented in the upper part of the Redwall Limestone in the subsurface of the Black Mesa basin in northeastern Arizona, in the upper part of the Leadville Limestone in the subsurface of New Mexico in the western part of the San Juan Basin and equivalent rocks in southeastern Utah and in outcrops of the Tererro Formation of the Arroyo Peñasco Group in the Nacimiento and San Pedro mountains on the eastern side of the San Juan Basin in New Mexico. These marine bioclastic carbonate rocks are composed of dolomite, lime mudstone, oolites, crinoids, Foraminifera, algae, brachiopods and pellets.

In Late Mississippian time, the region was differentially uplifted, and Mississippian rocks were removed from large areas. The remaining carbonate rocks were subjected to solution, and a thick regolith developed. On the east flank of the San Juan Basin, in the San Pedro and Nacimiento mountains, Mississippian carbonate rocks of the Arroyo Peñasco Group are unconformably overlain by continental red beds of the uppermost Mississippian (Chesterian) Log Springs Formation. Reworking of this continental regolith by the advancing Pennsylvanian sea to form the Molas Formation is documented in the San Juan Mountains and in the subsurface. Throughout the region, Mississippian sedimentary rocks are truncated by Pennsylvanian sedimentary rocks.

INTRODUCTION

The present-day San Juan Basin is a strongly asymmetrical, rhombic-shaped depression, and thick accumulations of Cretaceous and Tertiary rocks have buried many Paleozoic structures. Paleozoic structures in the basin include northwest-trending faults of the San Luis uplift (Fig. 1), the Four Corners lineament, the Tocito horst and the Zuni uplift. The Four Corners platform, bounded by the House Creek fault and the Hogback monocline, is a prominent northeast-trending feature that separates the Paradox basin to the north from the San Juan Basin to the south. The basin is bounded on its west and east sides by the north-trending Defiance and Nacimiento uplifts, respectively (Stevenson, 1983a).

Reconstruction of the biostratigraphy and paleogeography of the Mississippian System in the San Juan Basin is difficult because of scant subsurface data. Over the years, many cores and cuttings have been lost or scattered and are not available for study. Outcrop sections adjacent to the San Juan Basin are in widely separated mountain ranges and consist of very thin, condensed carbonate sections that contain numerous hiatuses and have been subjected to postdepositional solution and brecciation (Fig. 2).

Lithologic correlations for Mississippian carbonate rocks are not reliable unless a good biostratigraphic framework is established, and paleogeographic and paleotectonic reconstructions cannot be made without accurate correlations. For outcrop sections in the region, we used the microfossil zonation established by B. L. Mamet (in Sando et al., 1969), Mamet and Skipp (1970), Armstrong and Mamet (1974, 1976, 1977a, b) and Armstrong et al. (1979). For the subsurface, we used unpublished Shell Oil Company microfossil reports compiled by L. D. Holcomb (1960 to 1972). Studies of outcrops from adjacent mountain ranges by Armstrong (1958, 1967), Armstrong and Mamet (1974, 1977a, b) and Armstrong et al. (1979) were used to determine both regional correlations and the sedimentological and tectonic history of areas adjacent

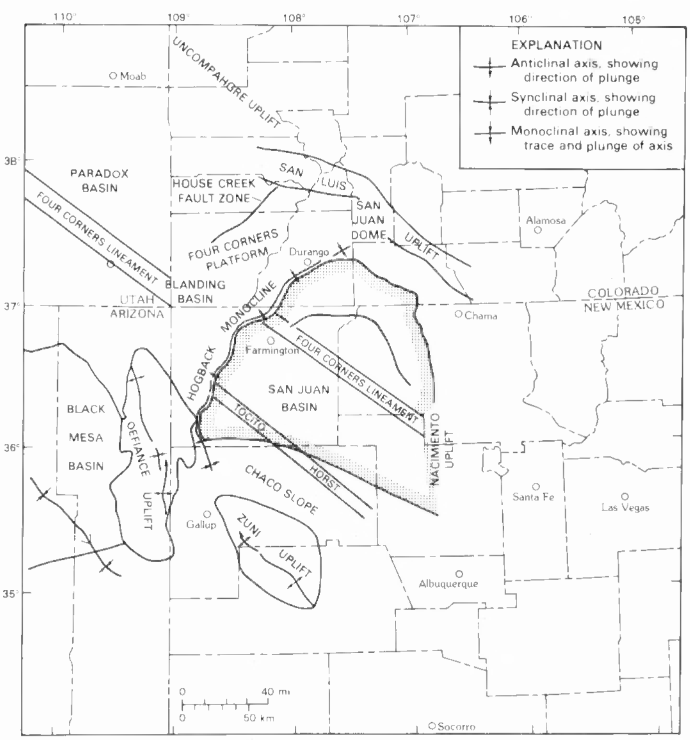


FIGURE 1. Structural features in the San Juan Basin of northwestern New Mexico and adjacent areas. Names of structural features from Kelley and Clinton (1960) and Stevenson (1983a). San Juan Basin margin is stippled.

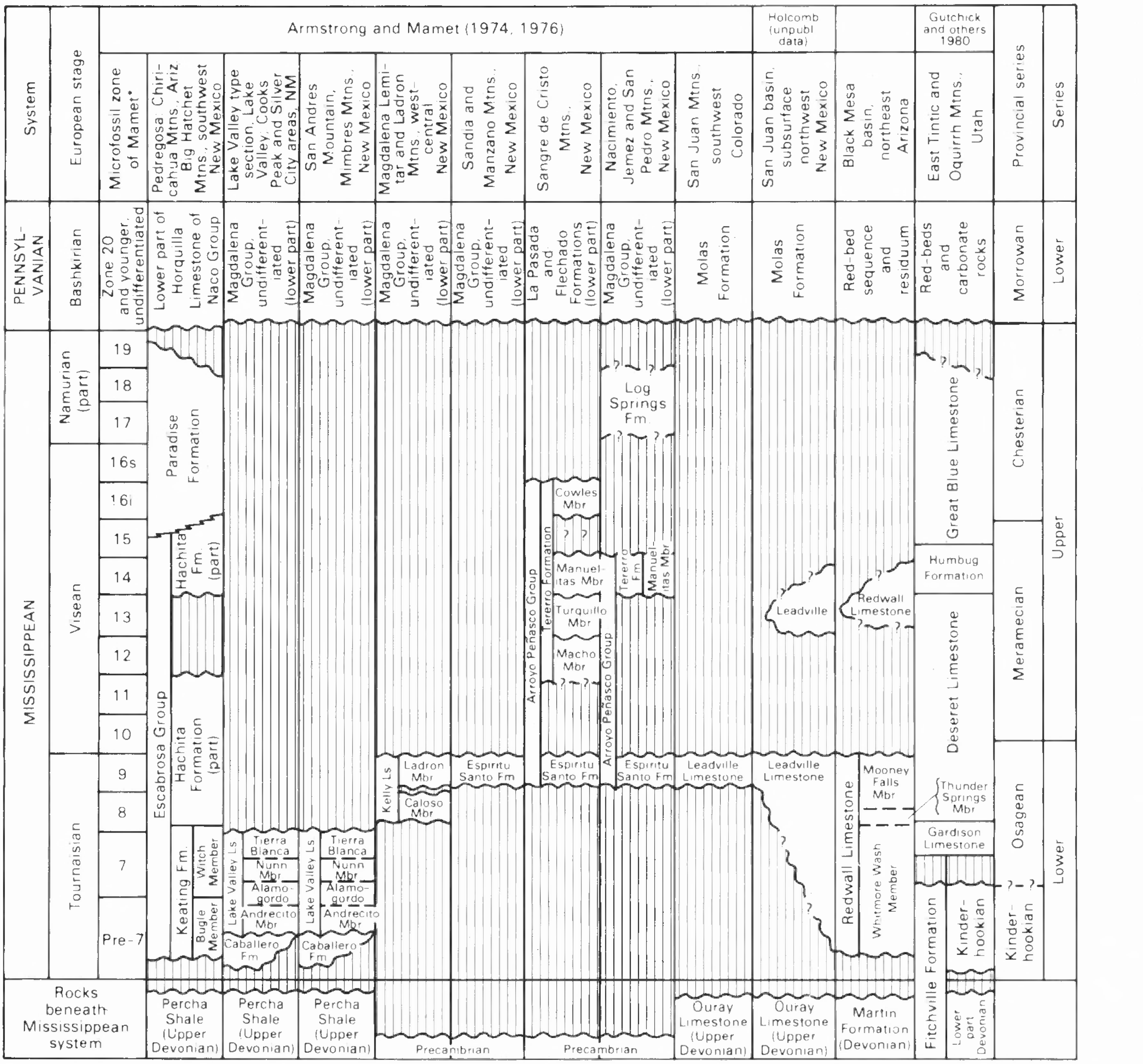


FIGURE 2. Regional correlation chart for the Mississippian System, San Juan Basin of northwestern New Mexico and adjacent areas. Krukowski's (1988) conodont studies indicate one base of the Caloso Member of the Kelly Formation is Kinderhookian and the top of the Ladron Member is possibly Meramecian.

to the San Juan Basin. The carbonate rock classification scheme of Dunham (1962) was used in this study.

REGIONAL STRATIGRAPHY AND CORRELATIONS

In the San Juan Basin and adjacent areas, rocks of Mississippian age are mapped as the Leadville Limestone and equivalent rocks, the Redwall Limestone, the Arroyo Peñasco Group and the Log Springs Formation (Fig. 2). In the northern and western parts of the San Juan Basin, Mississippian rocks unconformably overlie the Upper Devonian Ouray Limestone or Elbert Formation, which underlies the Ouray. On the eastern side of the San Juan Basin and in the Nacimiento and San Pedro mountains, Mississippian strata rest unconformably on Precambrian igneous and metamorphic rocks.

The Leadville Limestone typically is a complex suite of cratonic carbonate rocks that are generally devoid of terrigenous clastic material. Pellet-echinoderm-ooid foraminifer packstone and wackestone and minor amounts of lime mudstone are the most common rock types; no organic reefs or waulsortian mounds are known within the Leadville Limestone. Dolomite in the Leadville Limestone formed by replacement of lime mudstone and coarse-grained encrinite. Nodular light-gray to dark-brown-gray chert is also common.

McKee (1951) published isopach maps for the Devonian and Mississippian systems of northwestern New Mexico. Parker and Roberts (1963) correlated the Leadville Limestone of the San Juan Mountains and the subsurface of the San Juan and Paradox basins with the Redwall Limestone of the Grand Canyon region of Arizona. They considered the lower part of the Leadville Limestone at Rockwood Quarry, Colorado, to be equivalent to the Thunder Springs Member (McKee, 1963) of the Redwall Limestone and the upper part of the Leadville to be equivalent to the Mooney Falls Member. Their correlations are based on analysis of subsurface electric logs from eastern Arizona.

Studies of the lithology and paleontology of the Redwall Limestone by McKee and Gutschick (1969) and McKee (1972, 1979) indicate that the Mooney Falls Member represents the maximum preserved eastward transgression of the Redwall Limestone. A limestone unit recognized in the subsurface of the Black Mesa basin, Arizona is assigned to the

Meramecian part of the Redwall Limestone (Fig. 2). The unit may be part of or equivalent to part of the Mooney Falls Member to the west or to the overlying Horseshoe Mesa Member of the Redwall. Microfossil studies of surface sections of the Leadville Limestone of the San Juan Mountains by B. L. Mamet (in Sando et al., 1969) show the Leadville Limestone to be equivalent to the middle part of the Mooney Falls Member of the Redwall Limestone. Numerous oil tests drilled in the Black Mesa basin of northern Arizona and the Paradox basin of Utah show continuous Mississippian carbonate beds in the subsurface from the west side of the Wasatch Mountains of north-central Utah and the east side of the Grand Canyon to the eastern edge of the San Juan Basin (Fig. 2).

Mississippian strata in the subsurface of the San Juan Basin have been assigned to the Redwall Limestone in various studies, including many of the American Stratigraphic Company's stratigraphic logs, particularly those in the western part of the basin. Stevenson (1983b) assigned Mississippian rocks in the Four Corners region to the Leadville Limestone and those in the southeastern part of the San Juan Basin to the Arroyo Peñasco Group. It is generally agreed that Mississippian rocks in the Black Mesa basin are the Redwall Limestone, Mississippian rocks in the Paradox basin of southeast Utah are the Leadville Limestone, and those to the west of the Paradox basin are the Redwall Limestone (Stevenson, 1983b).

The Mississippian Arroyo Peñasco Group crops out on the eastern flank of the San Juan Basin in the San Pedro and the Nacimiento mountains and comprises two formations, the Osagean Espiritu Santo Formation (Baltz and Reed, 1960) and the overlying Meramecian and Chesterian Tererro Formation. The base of the Espiritu Santo Formation, the Del Padre Sandstone Member (Sutherland, 1963) is 0.3–6.1 m thick and is composed of quartz conglomerate, sandstone, siltstone and thin shale. It interfingers with overlying carbonate rocks of the Espiritu Santo Formation and rests unconformably on Precambrian igneous and metamorphic rocks (Fig. 2).

Carbonate rocks of the Espiritu Santo Formation include dolomite and dedolomite; coarse-grained poikilotopic calcite commonly has corroded dolomite rhombs. Stromatolitic algal mats, spongiostromata mats, echinoderm wackestone, kamaenid birdseye-rich lime mudstone and oncholitic-bothrolitic mats have been recognized in areas where the rock is not dolomitized.

The Espiritu Santo Formation is disconformably overlain by the Upper Mississippian Tererro Formation of the Arroyo Peñasco Group. The *Eoendothyranopsis macra* (Zeller) fauna is typical of the upper part of this formation. The Tererro Formation is composed of thickly bedded, oolitic-bothrolitic grainstone and a silty, pelletal, fine-grained grainstone-packstone containing minor amounts of calcareous silt. The Tererro Formation is younger than the Leadville Limestone of the San Juan Mountains, Colorado, and the absence of Meramecian beds in the San Juan Mountains is believed to be the result of late Chesterian and Early Pennsylvanian erosion. Meramecian carbonate rocks are, however, in the subsurface of the Paradox basin of southeastern Utah, the Black Mesa basin of northeastern Arizona and the San Juan Basin of northwestern New Mexico (Fig. 1).

The Upper Mississippian Log Springs Formation (Armstrong, 1955) crops out on the eastern flank of the San Juan Basin in the San Pedro, Nacimiento and Jemez mountains and is 0.3–24 m thick. Extensive solution of the underlying limestones of the Tererro Formation has resulted in brecciation and solution cavities filled with basal ferruginous shales of the Log Springs Formation. The Log Springs Formation was deposited in a continental-fluvial environment. The beds have well-developed cut-and-fill channel structures. The Log Springs Formation is a sequence of maroon to gray shale, sandstone and conglomerate. The lower part of the formation contains beds of pisolitic hematite and ferruginous shale. The lower sandy conglomerates of the formation contain a few sporadically distributed rounded pebbles of Mississippian chert; clasts in conglomerates higher in the formation are angular to subrounded pebbles to boulders of Precambrian granite and schist and Mississippian chert and carbonate rocks. The Log Springs Formation rests with angular unconformity on the karst surface of the Arroyo Peñasco Group and in turn is overlain with angular unconformity by fossiliferous Morrowan limestones. Because the Log Springs Formation is younger than Mamet's zone 16i and is overlain by Morrowan fossiliferous limestones of zone 20 (Fig. 2), it must be Chesterian age equivalent (Armstrong and Mamet, 1974, 1976).

The Lower Pennsylvanian Molas Formation typically is a clastic red-bed sequence of silty variegated shale containing chert or limestone nodules, red to brown siltstone and limestone. The lower part of the Molas Formation is believed to be a residual soil that covers a karst surface on the Leadville Limestone (Szabo and Wengerd, 1975). Merrill and Winar (1958) stated "The lower Coalbank Hill Member of the Molas Formation can be defined only by its stratigraphic position, post-Leadville, pre-Middle Molas. The Mississippian-Pennsylvanian boundary is probably contained within it or the overlying member." The Molas Formation is a time-transgressive unit. Fusulinids of late Chesterian to early Desmoinesian age were identified by M. L. Thompson for Merrill and Winar (1958) who stated that fossils of Leadville age were found in residual chert pebbles in the Molas, and fossils of Early and Middle Pennsylvanian age were found in the upper 3 m of the Molas. We believe the Molas is in part an old regolith formed in late Chesterian time and re-worked by Morrowan waters.

Mississippian carbonate facies and diagenesis

Conceptual facies models for the Leadville Limestone and the Arroyo Peñasco Group are shown in Figures 3 and 4 and were derived in part from the carbonate-facies models of Wilson (1975), James (1984) and Harris et al. (1985). The Leadville Limestone, as indicated by outcrop studies of Armstrong and Mamet (1976), is a series of incomplete, upward-shoaling carbonate cycles (Figs. 3, 4). Studies of the Leadville Limestone and the Espiritu Santo Formation by Armstrong (1967) and Ulmer and Laury (1984) indicate lagoonal to supratidal environments of deposition for parts of these formations, similar to those in the present-day Persian Gulf (Evans et al., 1973; Purser and Evans, 1973; Shinn, 1973; Hardie and Garrett, 1977). The extensive areas of crinoidal-bryozoan-brachiopod wackestone and grainstone in the Leadville Limestone have no known modern analog. These carbonate rocks are believed to be of shallow-marine origin, having formed in less than 21 m of water, and to have been primarily bioclastic sands in which the fauna lived on areas of hard ground (Ramsbottom, 1978).

Crinoidal-bryozoan-brachiopod wackestone and packstone are abundant in the Leadville Limestone and are very common in Mississippian carbonate rocks throughout North America (Mamet, 1976; Armstrong and Mamet, 1977a). In the subsurface, Osagean carbonate rocks equivalent to part of the Leadville Limestone have a persistent 31–76-m-thick zone of replacement of secondary dolomite. The replacement dolomite has a relic texture of crinoids, Foraminifera and brachiopods that indicates the rock was a crinoid packstone or wackestone. Fine-grained dolomite containing anhydrite crystals or pseudomorphs of anhydrite and gypsum is interbedded with the replacement dolomite (Arm-

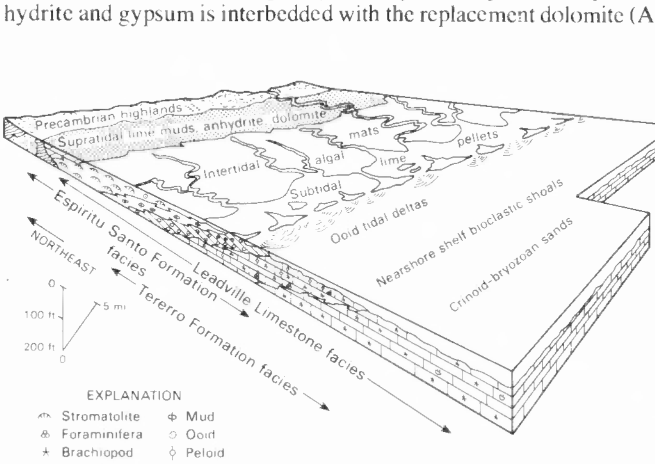
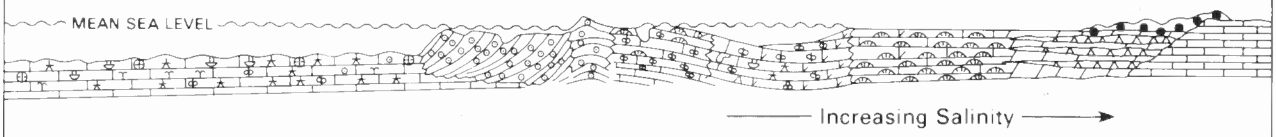


FIGURE 3. Carbonate facies relationships of the Mississippian Leadville Limestone and Espiritu Santo Formation of the Arroyo Peñasco Group. Environments of deposition were shallow marine to supratidal, under conditions similar to those in the modern Persian Gulf.



FACIES	Tidal shelf	Crinoid bioclastic sands	Nearshore shelf	Tidal delta and tidal channel	Frontal beaches and oolitic dunes; back-beach algal mats and lime mudstone	Restricted platform, subtidal lagoon, and channel zone	Intertidal	Supratidal	Vadose weathering of sabkha surface; carbonate dune sands, calcrete, and caliche
LITHOLOGY	Interbedded, thin- to medium-bedded lime mudstone dolomite and chert	Crinoid bryozoan brachiopod packstone wackestone lenticular to nodular chert	Bioclastic wackestone packstone to pelletoid lime mudstone abundant foraminifera	Bioclastic oolitic packstone and grainstone	Inclined oolitic packstone and grainstone, lime mudstone with algal mats, tidalite deposits backside	Pelletoid lime mudstone, crinoid wackestone, packstone dolomite, brachiopods, ostracodes	Algal mat stromatolites with skeletal pelletal carbonate sand and mud, dolomite and gypsum	Seams and nodules of anhydrite, micrite, and dolomite, displaced microfauna, fine quartz sand	Coated particles, peloids, and pisolites, alternating microlaminae, limpid dolomite
COLOR	Gray to brown	Gray to light gray	Gray to light gray	Light gray	Gray to light gray	Light gray to gray	Gray yellow to brownish red	Gray, yellow, orange brownish red	Gray, light gray, yellowish red
BEDDING AND SEDIMENTARY STRUCTURES	Thoroughly bedded thin to medium wavy to modular bedded Surfaces show dia stems of dark gray to black chert	Crossbedded, massive beds common Nodular gray chert	Stratified, abundant ripple marks bioturbated. Nodular gray chert	Cross stratified abundant ripple marks	Steeply inclined cross stratified Scattered carbonate lithoclasts	Bioturbation, tidal channel lags and fill of coarse material	Stromatolites, pseudomorphs after gypsum, tidal channel lag and fill of coarse material, birds eye structures, lime mud chips	Anhydrite and gypsum rhombs, bedded anhydrite, lime mud chips, algal mats, tepee structures	Large chips and chunks of carbonates, thick zone of caliche

EXPLANATION

⊕ Solitary coral | Brachiopod | Foraminifera | ○ Ooid, coated
Echinoderm | Stromatolite | Mud, silt-sized | ● Pisoid, coated
Bryozoan | Ostracode | Crossbedding

FIGURE 4. Carbonate rock types and environments of deposition for the Mississippian Leadville Limestone and Arroyo Peñasco Group, San Juan Basin and adjacent areas.

strong and Mamet, 1976, pl. 2). In the San Juan Basin, most of the Mississippian oil and gas is in this replacement dolomite. The Lisbon oil field of southeastern Utah, northwest of the basin, has estimated reserves of 43 million barrels of oil in the dolomite.

DEPOSITIONAL AND TECTONIC HISTORY

Kelley and Clinton (1960, fig. 9) illustrated and described a series of northwest-oriented lineaments and the northeast-oriented Hogback trend in the Four Corners region (Fig. 5). Their structural ideas were further developed by Baars (1966, 1976), Gorham (1975), Stevenson (1983a, b) and Stevenson and Baars (1977), all of whom argued that a large northwest-trending graben consisting of upper Precambrian through Mississippian rocks is exposed in the core of the San Juan Mountains. The latter workers believed tectonism was rejuvenated periodically throughout the Paleozoic, and that movement on these structural lineaments actively controlled sedimentation through Mississippian time. Baars (1966, 1976), Stevenson and Baars (1977) and Baars and Stevenson (1982) projected the structural trends observed in the San Juan Mountains into the subsurface of the San Juan Basin, where they showed these lineaments to be aligned at almost right angles to the Jemez lineament (Fig. 5). The northwest-trending pattern or configuration of Mississippian rocks in the San Juan Basin is parallel with the Paleozoic fault system of Kelley and Clinton (1960) and Baars (1966, 1976) (Fig. 5).

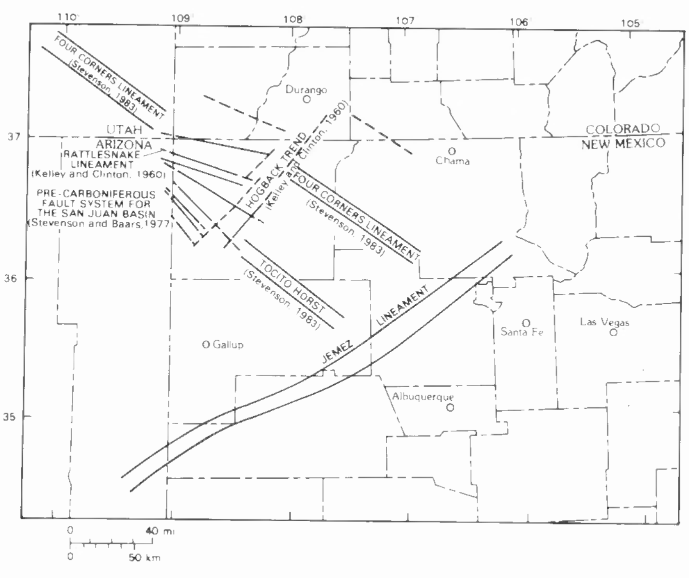


FIGURE 5. Precambrian and early Paleozoic structural features, San Juan Basin and adjacent areas.

A simplified Late Devonian paleogeographic and paleotectonic map for the area of the San Juan Basin is shown in Figure 6. Unpublished subsurface studies of Devonian rocks made by Armstrong in 1965–1966 suggest that the Defiance highlands stood as Precambrian monadnocks that shed detrital quartz into adjacent marine environments. Preserved Devonian rocks are restricted to the western part of the San Juan Basin, between the Uncompahgre and Zuni-Defiance highlands. A small outlier of Upper Devonian Elbert Formation is preserved in the center of the basin. The hiatus between the Devonian and the Mississippian systems represents latest Famennian and much, if not all, of Kinderhookian time. Extensive erosion of Devonian sediments must have occurred during this time, and the contact between the two systems is a paraconformity.

Marine transgressions and regressions in the Late Devonian and Mississippian of New Mexico are probably related to events of the Antler orogeny to the northwest in Nevada. Orogenic pulses are reflected in the Upper Devonian sediments and in the regional hiatus between Upper Devonian and Mississippian rocks in Nevada, Arizona and New Mexico (Poole and Sandberg, 1977; Schumacher, 1978).

Mississippian strata disconformably overlie the Upper Devonian (Famennian) Ouray Limestone in the western part of the San Juan Basin and the older, Upper Devonian Elbert Formation and Precambrian igneous and metamorphic rocks in the central part of the basin. Wherever the Devonian rocks are carbonates, the basal Mississippian rocks generally are limestone, and, wherever Mississippian rocks rest on Precambrian rocks, the basal Mississippian rocks commonly comprise a 0.15–1-m-thick bed of white quartz conglomerate and sandstone.

Basal beds of the Mississippian are diachronous. The marine transgression came from the northwest and west between the Uncompahgre and Zuni-Defiance highlands. The oldest Mississippian beds are in the subsurface of southeastern Utah and in northwestern New Mexico and are carbonate rocks of possible Kinderhookian(?) age to early Osagean (pre-zone 7?, zone 7) age. By late Osagean time (zone 9), a regional inundation had occurred that extended as far as southern New Mexico and Arizona and northeastern Arizona and southeastern Utah into northern and central New Mexico. Figure 7 shows a theoretical

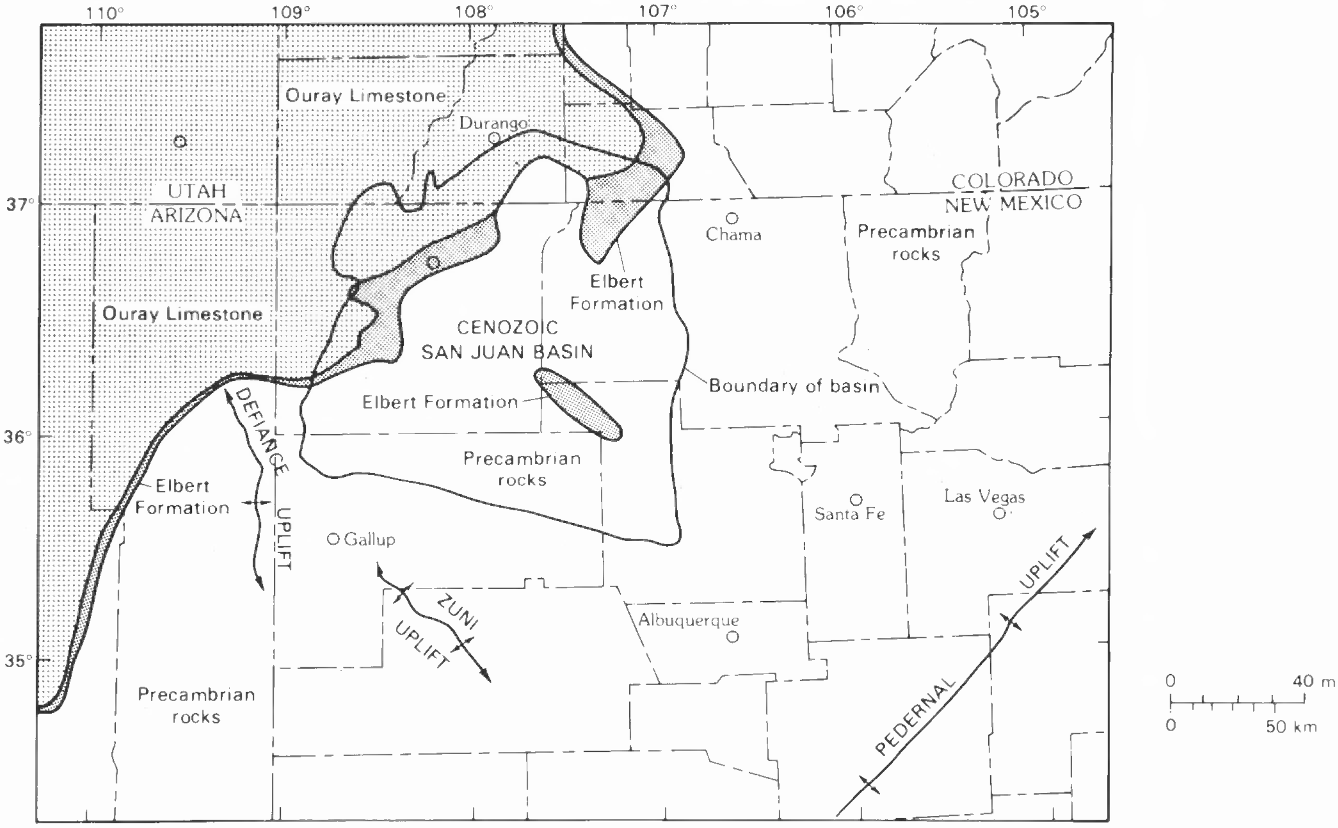


FIGURE 6. Late Devonian paleogeography and paleotectonics, San Juan Basin and adjacent areas.

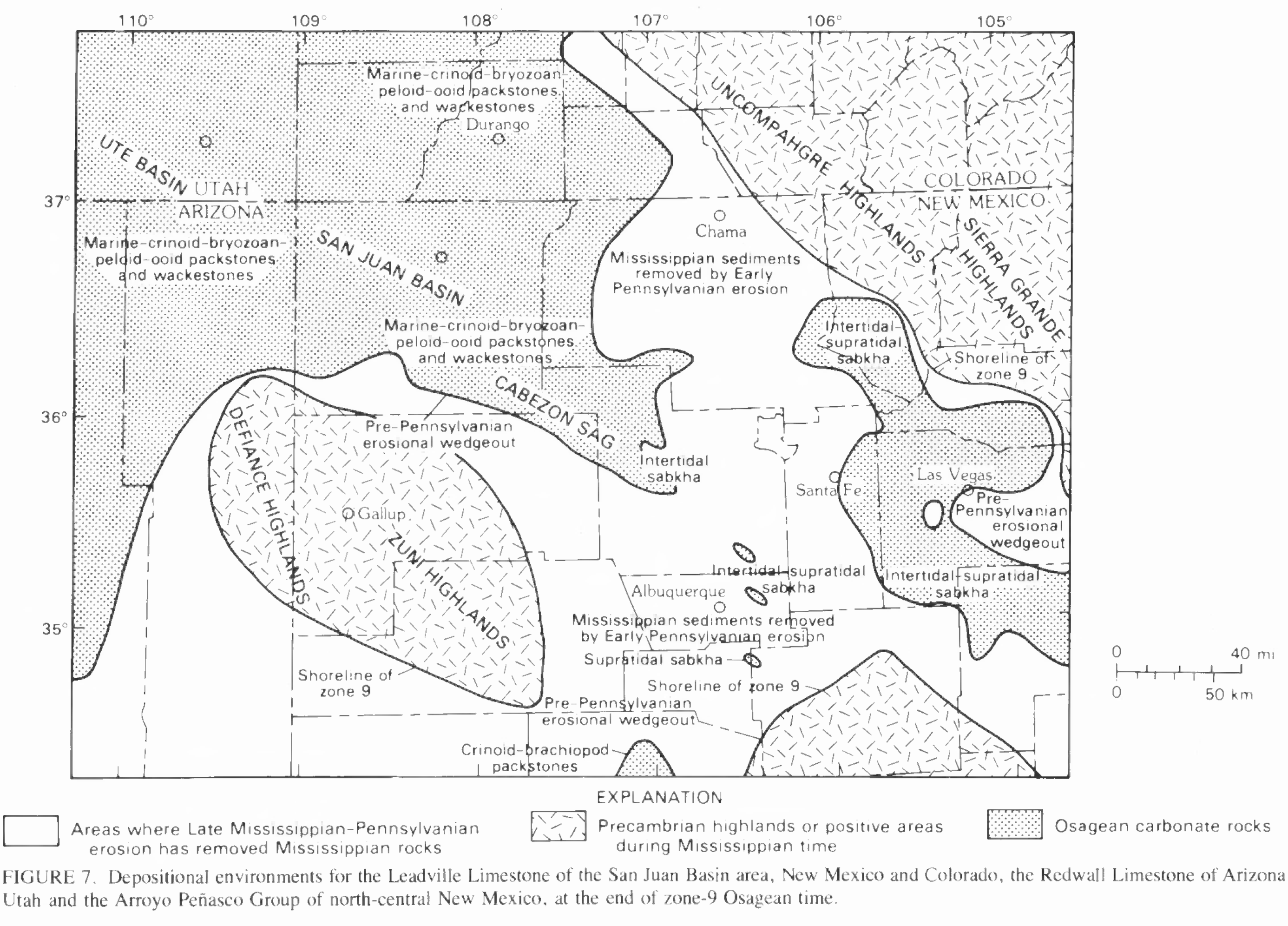


FIGURE 7. Depositional environments for the Leadville Limestone of the San Juan Basin area, New Mexico and Colorado, the Redwall Limestone of Arizona and Utah and the Arroyo Peñasco Group of north-central New Mexico, at the end of zone-9 Osagean time.

reconstruction of depositional environments for the Leadville Limestone of the San Juan Basin and the Arroyo Peñasco Group of north-central New Mexico. In the area of the San Juan Basin, Osagean and Meramecian carbonate rocks typically are bioclastic sandstones composed of crinoids, brachiopods, bryozoans, pellets, ooids, oolites, lime mudstone and dolomite. They were deposited in shallow-water to supratidal-sabka environments. A schematic reconstruction of Mississippian carbonate-facies relationships and Precambrian highlands in northern New Mexico and adjacent parts of Colorado, Utah and Arizona is shown on Figure 7.

The end of Osagean time was marked by a regional hiatus that has been recognized over a large area (Gutschick et al., 1980). B. L. Mamet (written commun., 1987) believes that the Osagean-Meramecian (Tournaisian-Visean) boundary is worldwide and profound in North America and the Russian platform. Detailed studies of outcrop sections in the San Pedro and Nacimiento mountains on the eastern side of the San Juan Basin show that the hiatus spans zones 10 to 13 (Fig. 3) and that the overlying Meramecian carbonates are pelloid-ooid-crinoid-Foraminifera wackestone to packstone (Armstrong and Mamet, 1974, 1976). Meramecian carbonate rocks can be traced in the subsurface into the Blanding basin of southeastern Utah.

The isopach maps of Mississippian strata shown in Figures 8 and 9 are based on the pre-Pennsylvanian erosional remnants of Mississippian rocks. During Late Mississippian (Chesterian) and Early Pennsylvanian (Morrowan) time, Mississippian strata were elevated, eroded and dissected, and, during Pennsylvanian and part of Permian time, large areas of Mississippian strata were eroded from structurally active features such as the Zuni, Defiance, Uncompahgre and Pedernal uplifts.

The Chesterian Log Springs Formation in the Nacimiento and San Pedro mountains on the eastern flank of the San Juan Basin is a continental-fluvial clastic red-bed sequence that unconformably overlies Mississippian carbonate rocks. Sediments comprising the Log Springs Formation range from mud and silt facies to bouldery facies and were derived from erosion of Precambrian igneous and metamorphic and Mississippian carbonate terranes. Stratigraphic and paleontologic evidence indicates that the tectonic events that heralded the Pennsylvanian began in the eastern part of the San Juan Basin by Chesterian time. The Molas Formation in the subsurface of the San Juan Basin and in outcrops in the San Juan Mountains is a paleosol that developed on the Leadville Limestone and was reworked during the Pennsylvanian transgression.

During Late Mississippian and Early Pennsylvanian time, major tectonic events occurred that probably are related to the Carboniferous Ouachita orogeny, an arc-continent or continent-continent collision (Kluth and Coney, 1981; Dickinson, 1981). Major structural elements rejuvenated by this event include the Uncompahgre uplift, a northwest-trending fault block that forms the northern boundary of the San Juan Basin, the Peñasco uplift at the eastern boundary of the San Juan Basin, and the ancestral Zuni uplift that consists of the Zuni uplift, an east-west structural alignment, and the Defiance salient or uplift, a north-plunging structural nose on the northern flank of the Zuni uplift (Fig. 8; Wengerd, 1962; Szabo and Wengerd, 1975).

SUMMARY

During Mississippian time, the area of the San Juan Basin was part of a northwest-trending, broad, shallow sag between the San Juan

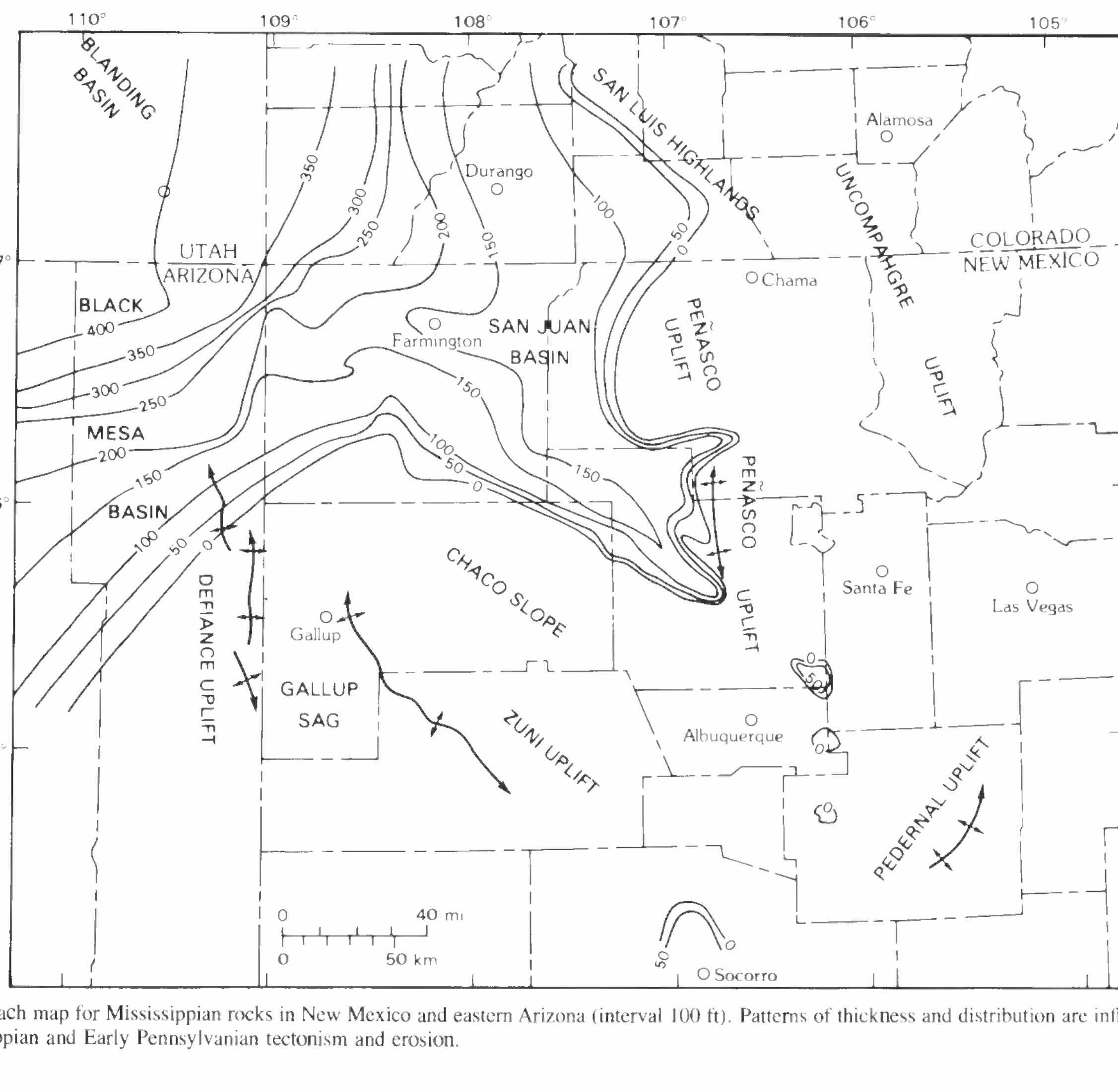


FIGURE 8. Isopach map for Mississippian rocks in New Mexico and eastern Arizona (interval 100 ft). Patterns of thickness and distribution are influenced, in part, by Late Mississippian and Early Pennsylvanian tectonism and erosion.

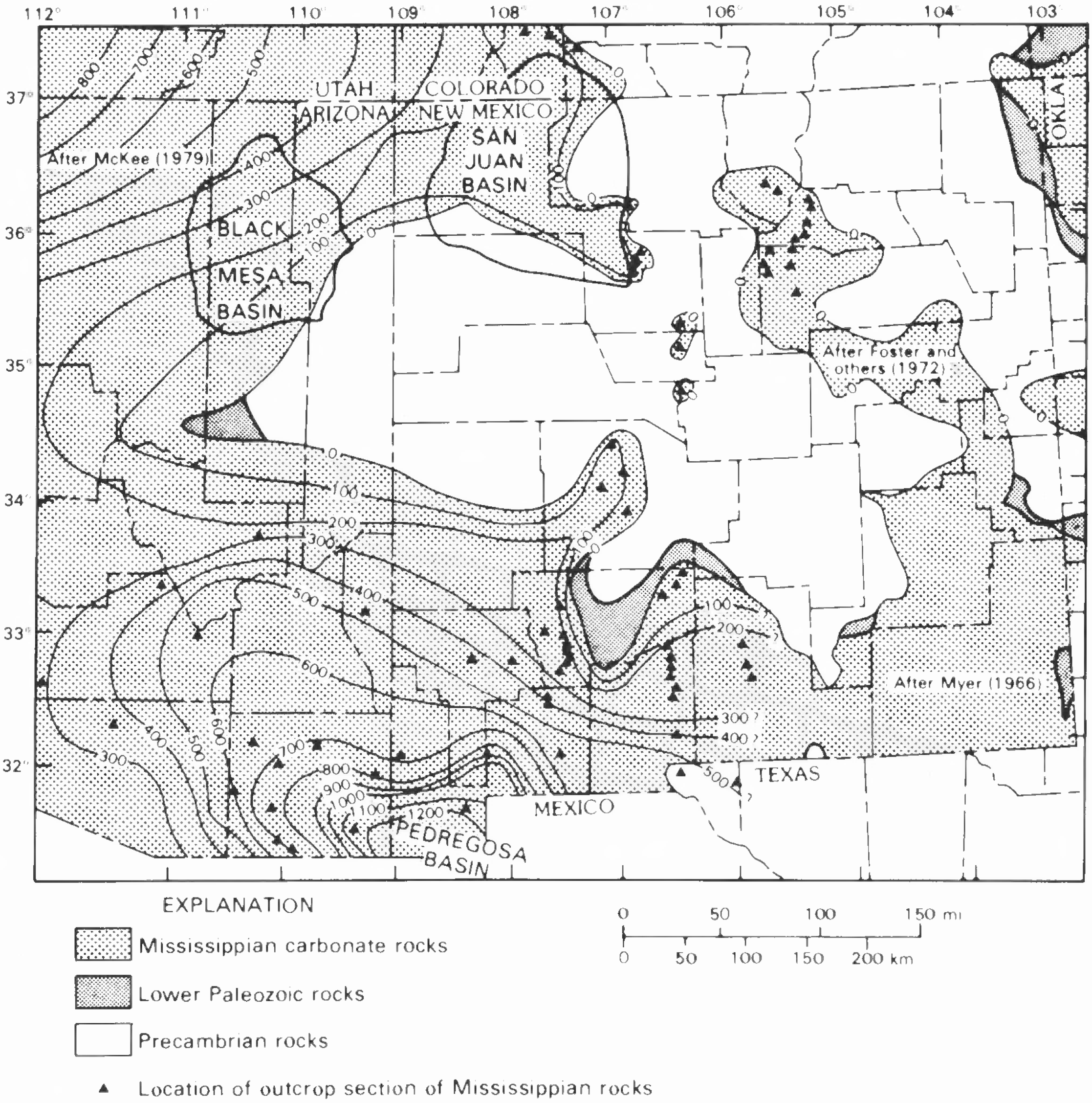


FIGURE 9. Isopach map of Mississippian rocks in the San Juan Basin and adjacent areas at the end of the Carboniferous (interval 50 ft). Regional late Paleozoic structural features are shown; the names of the structural features are, in part, after Kelley and Clinton (1960) and Wengerd (1962).

highlands (Uncompahgre uplift) to the north and the Zuni-Defiance uplift to the south. By latest Kinderhookian or early Osagean time, marine waters from the northwest had flooded the area of the San Juan Basin, and, near the end of Osagean time, marine waters covered much of northern New Mexico. At the end of Osagean time, regional uplift and erosion of the Lower Mississippian carbonate rocks had occurred, and a thin sequence of Meramecian carbonate rocks was deposited on the Osagean erosion surface. Mississippian strata of the San Juan Basin region include dolomite, lime mudstone, bioclastic limestone and encrinite. During Late Mississippian and Early Pennsylvanian time, Mississippian carbonate strata were subjected to extensive erosion and karsting.

Shows and noncommercial oil and gas pools are known from the Leadville Limestone in the San Juan Basin of New Mexico. The principal reservoir beds are fractured limestone and vuggy dolomite in the western and deeper part of the basin. Most likely, any future oil and gas found in the Mississippian of the San Juan Basin will be associated with basement structures, although the trap probably will be stratigraphic (Stevenson, 1983b).

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