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MISSISSIPPIAN DEPOSITIONAL HISTORY OF THE TEXAS PANHANDLE: A REAPPRAISAL

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ABSTRACT

Recent lithostratigraphic and biostratigraphic study of subsurface Mississippian rocks of the Texas Panhandle indicates that previous interpretations of the sequence and timing of depositional events in the area need revision.

Early Mississippian (Kinderhookian to Osagean) deposition in the area was restricted to the northeastern Panhandle (Anadarko Basin). The Texas Arch, a Devonian structure, remained positive and effectively limited sediment accumulation throughout the remainder of the area at this time. Major inundation of the southern Panhandle did not occur until the Meramecian. At that time shallow platform conditions developed in the area of the submerged Texas Arch; carbonate buildups formed locally on the outer ramp along the previous margin of the Arch. This marine transgression correlates with drowning of platform margins throughout the midcontinent region. The Texas Arch continued intermittently to control deposition until the end of the Mississippian Period.

INTRODUCTION

Mississippian rocks are present throughout most of the subsurface of the Texas Panhandle (Fig. 1). Although the lithostratigraphy of these rocks is reasonably well known, biostratigraphic data are scarce. Because of this, no detailed depositional history has been presented. Lane and De Keyser (1980), for example, omitted Texas from their reconstruction of Osagean depositional environments in the midcontinent region (New Mexico to Illinois), recognizing the lack of data. A few generalized reconstructions have been published (Mapel and others, 1979; Gutschick and Sandberg, 1983); these, however, have been based on extrapolation from outcrop and subsurface sections hundreds of miles distant without benefit of biostratigraphic control.

Recently, conodont faunas have been recovered from several cores taken in the southern Texas Panhandle. These data have made it possible, for the first time, to develop a biostratigraphic framework for the Mississippian sequence in the area. Reconsideration of lithofacies relationships in light of this new biostratigraphic control reveals a depositional history that is quite different from that previously indicated. These new data suggest that (1) Mississippian rocks in the southern Panhandle differ substantially in age and mode of deposition from those in the north and (2) Mississippian deposition in the area was controlled by the Texas Arch (Adams, 1954), a northwest-southeast trending structural positive that developed during the Devonian and was previously thought to have been inactive during the Mississippian.

In this paper, I present a history of Mississippian deposition in the Texas Panhandle based on recent lithostratigraphic (Ruppel, 1985) and biostratigraphic (Ruppel and Lemmer, 1986) study. Although by no means unequivocal, the sequence of events depicted here is most consistent with available data; it differs significantly from previous interpretations.

SETTING

The Texas Panhandle area includes four structural basins (Fig. 1). With the exception of the Anadarko Basin, however, these basins and intervening uplifts did not form until the Pennsylvanian, and thus exerted no control on Mississippian deposition. There is no evidence to support the contention (Lane and De Keyser, 1980, Figs. 1 and 8) that the Amarillo-Wichita Uplift had significant expression during Mississippian time. The Anadarko Basin began to subside along the axis of the early Paleozoic Southern Oklahoma Aulacogen in the Late Devonian following Middle Devonian regional uplift (Amsden and others, 1967). Topographic basins did not develop in the Palo Duro and Hardeman Basins, however, until the Middle Pennsylvanian.

The present distribution of Mississippian rocks in the Texas Panhandle (Fig. 1) is primarily a result of removal of these deposits along the Amarillo-Wichita Uplift during the Pennsylvanian. This discontinuity of the Mississippian subcrop has played a significant role in previous misconceptions of the area. The Mississippian sequence in the northern Panhandle, which is relatively well known due to the abundance of drill holes, is similar to and can be correlated relatively easily with the subsurface section in Kansas for which extensive lithostratigraphic and biostratigraphic data are available (Lee, 1940; Goebel, 1968). A superficially similar section in the southern Panhandle has led many to assume that Mississippian rocks there represent a continuation of the Kansas trend. The relative scarcity of drill-hole data and the lack of detailed study in the southern Panhandle area has made it difficult to confirm or deny this interpretation. I feel, however, that there are now sufficient data to challenge previous interpretations.

KINDERHOOKIAN

Basal Mississippian quartz sandstones conventionally assigned to the Kinderhookian are found only in the northern Texas Panhandle. The Kinderhookian age of these rocks, which everywhere overlie Lower Devonian or older strata, is supported by biostratigraphic studies of lithologically correlative deposits in southwestern Kansas (Goebel, 1968). It has been concluded by several workers that these sandstones were deposited during a major early Mississippian transgression that followed a period of extensive regional erosion at the end of the Devonian (Lee, 1940; Geobel, 1968; Mapel and others, 1979). The evidence for this hiatus, however, is equivocal at best. Biostratigraphic studies of the Woodford Formation, which in the Oklahoma part of the Anadarko Basin occupies the same stratigraphic position as the Kinderhookian sandstones in Texas, suggest continuous deposition across the Devonian-Mississippian boundary. Although most of the Woodford is thought to be Late Devonian in age, the upper parts of this black shale sequence are at least locally of Kinderhookian age (Goebel, 1968). This suggests that the basal Mississippian sandstones and the Woodford shales are, at least in part, contemporaneous facies. I conclude that the Kinderhookian sandstones of the northern Panhandle area formed as the regional transgression of the southern midcontinent, which began in the Late Devonian in the Anadarko Basin of Oklahoma, and spread westward into Texas (Fig. 2A). Precambrian granitic rocks exposed along the Texas Arch provided a local source of coarse clastic sediment (Kinderhook sandstones) that was not present to the east.

There is no indication that Kinderhookian deposition extended into the southern Texas Panhandle. Instead it appears that the Texas Arch remained emergent during this time and prevented widespread inundation of the area (Fig. 2A).

OSAGEAN

Recent studies indicate that an environmentally diverse platform to basin depositional system developed throughout much of the southern midcontinent region during the Osagean (Lane and De Keyser, 1980). Gutschick and Sandberg (1983) suggested that this system extended into Texas and that by Middle Osagean time the entire state was submergent. Although this conclusion agrees with previous interpretations of the area (Mapel and others, 1979), it is not consistent with recent data. Instead it appears that most of the southern Panhandle area remained emergent or received only very minor amounts of sediment during the Osagean (Fig. 2B). Thin (usually less than 8 meters thick), basal shales and carbonates are present in the southwestern and eastern parts of the Panhandle but are absent over the Texas Arch (Fig. 2B; Ruppel, 1985). This indicates that the Arch continued to influence deposition in this area at the beginning of Mississippian sedimentation. The exact age of these basal Mississippian deposits is not known; however, conodont faunas of middle Meramecian age have been recovered from within 15 meters of the base of the Mississippian section (core 2, Fig. 1). This suggests that these basal sediments may be as young as Meramecian. However, even if they are Osagean, their absence over the Texas Arch supports the argument that much of the area remained emergent at this time.

The regional Osagean platform to basin system (Lane and De Keyser, 1980) probably did extend into parts of the Texas Panhandle (Fig. 2B). Analysis of well cuttings in the Anadarko Basin of Texas and Oklahoma (Selk, 1948; Maher and Collins, 1949) indicates the presence of rocks similar to those interpreted as basinal deposits in Kansas (Lee, 1940; Goebel, 1968). Rocks studied in the northeastern part of the southern Panhandle (core 1, Fig. 1), however, represent shallower water, subtidal to supratidal, deposition. These deposits, the oldest (late Osagean - early Meramecian) dated rocks in the southern Panhandle, are found along the northeastern edge of the Texas Arch. The age and depositional setting of the deposits also support the contention that the Texas Arch was emergent during the Osagean; these rocks probably record the maximum landward extent of the Osagean sea.

Lane and De Keyser (1980) indicated that Osagean platform rocks are also present in the Hardeman Basin. Although this may be true locally, conodont studies imply a Meramecian age for platform and deep ramp facies in much of this area (Ruppel and Lemmer, 1986). These biostratigraphic data suggest that much of the Hardeman Basin area was starved during the Osagean (Fig. 2B).

MERAMECIAN

During Meramecian time, all previously emergent areas in the Texas Panhandle were inundated. In the early to middle Meramecian, dolomites and dolomitic limestones were deposited along the trend of the Texas Arch in an inner platform setting (Fig. 2C), while argillaceous limestones were deposited in the eastern Panhandle on the outer platform. In the western Hardeman Basin area equivalent deposits comprise interbedded, spiculitic, lime mudstones and allochthonous skeletal silts and sands that accumulated below wave base on the outer ramp (Ruppel, 1984; 1985). Carbonate buildups (Allison, 1979; Ross, 1981) developed locally further eastward on the ramp.

Regional shallowing during the latter half of the Meramecian led to the development of skeletal/ooid sand shoals across the entire Panhandle region (Ruppel, 1984; 1985). It is not clear whether the Texas Arch had any control on deposition at this time.

CHESTERIAN

Shallowing begun in the late Meramecian culminated at the end of the Meramecian or beginning of the Chesterian by uplift along the axis of the old Texas

Arch (Fig. 2D). Basal Chesterian deposits in this area are characterized by limestone pebble conglomerates, sandstones, and shales. Northeast and southwest of this trend deposition appears to have been continuous.

Deposition throughout the remainder of the Chesterian contrasted sharply with prior Mississippian depositional patterns. Terrigenous clastics were episodically transported into the Panhandle from areas to the north, resulting in a sequence of interbedded shales and oolitic limestones. Although biostratigraphic control is lacking, it appears that coarse clastics prograded into the central southern Texas Panhandle in the late Chesterian; whereas the Hardeman Basin area received no significant influx of clastics until the Pennsylvanian.

DISCUSSION

It is clear from the foregoing that the Texas Panhandle area was characterized by considerable paleoenvironmental diversity during the Mississippian Period. It is also apparent that, contrary to previous interpretations, the Texas Arch played a major role in the development of this diversity. Previous studies recognized that the Arch remained emergent during the Kinderhookian (Craig and Connor, 1979). During this time sediments accumulated only in the Anadarko Basin, which was subsiding in a region of previous crustal instability. Most workers have concluded, however, that the Texas Arch was submergent by Osagean time (Mapel and others, 1979; Gutschick and Sandberg, 1983). Whether the Arch actually remained emergent at this time is uncertain; it is possible that thin sequences of Osagean sediments accumulated locally. Significant sediment accumulation, however, was restricted to peripheral areas northeast and southwest of the Arch.

The major inundation of the southern Texas Panhandle occurred during the Meramecian, not the Osagean. Thick sequences of shallow-water carbonate sediments accumulated throughout the area, including the Texas Arch, during the Meramecian. Indeed it appears that as much as two-thirds of the Mississippian section in the southern Panhandle is Meramecian in age; the remainder is younger. The marine transgression that resulted in the drowning of the area has been recognized elsewhere in the midcontinent. Osagean platform margin deposits in New Mexico (Lane, 1974) and the central United States (Lane, 1978) were also drowned at this time; Maher (1953) has documented Meramecian onlap of Ordovician and Precambrian rocks along the northeastern margin of the Texas Arch in southeastern Colorado.

Carbonate buildups, common in the eastern part of the Hardeman Basin, are widely assumed to be depositional and temporal equivalents of those that formed along the platform margin in New Mexico (Lake Valley Formation) during the Osagean (Gutschick and Sandberg, 1983). Recent data (Ruppel, 1985; Ruppel and Lemmer, 1986), however, suggest that the Hardeman Basin buildups are at least in part Meramecian. Although some buildups may have formed earlier in more basinward positions (for example, those in the Fort Worth Basin; see Turner, 1957; Henry, 1982), many in the Hardeman Basin developed on the outer ramp during the Meramecian transgression.

Regardless of their ages, the occurrence of carbonate buildups in the Hardeman Basin area seems structurally controlled. Buildups occur only where the platform margin runs along the northeastern edge of the Texas Arch. Buildups apparently did not form further northwest along the margin in the northern Panhandle (Anadarko Basin) or along the southwestern margin of the Texas Arch. Although at present data are sparse, it seems likely that platform margin geometry may be the controlling factor. Further lithostratigraphic and biostratigraphic studies are underway to address this question.

In summary: (1) the history of Mississippian deposition in the Texas Panhandle is considerably different from that which has been suspected previously, (2) early Mississippian deposition was confined to areas peripheral to the Texas Arch (Anadarko Basin), (3) major transgression of the southern Panhandle did not begin until the Meramecian, (4) Mississippian carbonate buildup growth was limited to the Hardeman Basin on the northeast flank of the Texas Arch, and (5) the Texas Arch, a northwest-southeast trending extension of the Transcontinental Arch, exerted at least episodic control over sedimentation until the end of the Mississippian Period.

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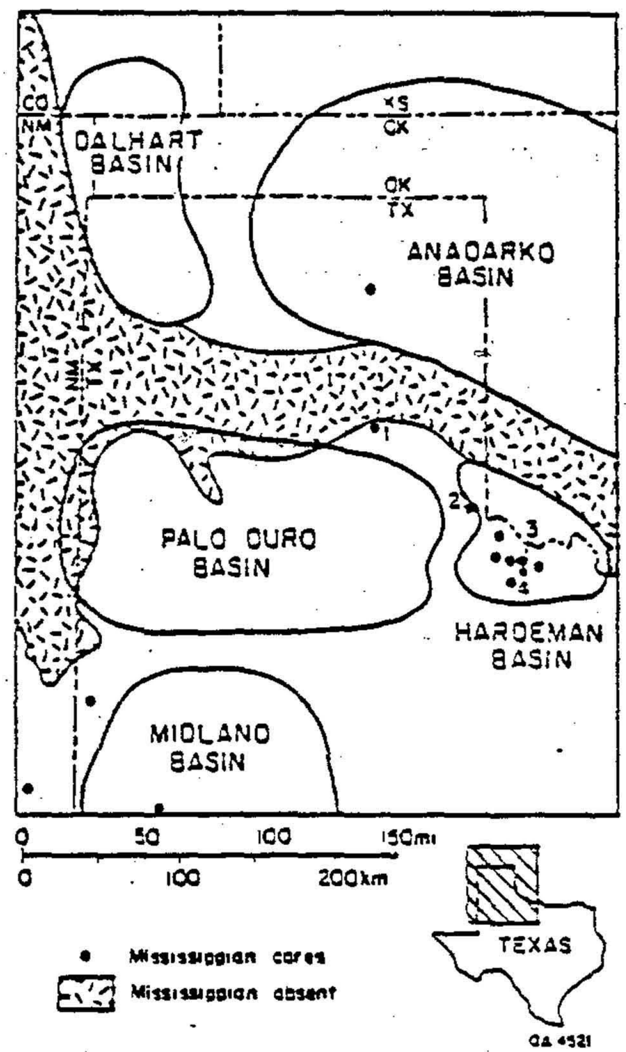
Figure Captions

Figure 1. Map of Texas Panhandle area showing major structural features, the extent of Mississippian rocks, and the location of core wells.

Figure 2. Mississippian paleogeography. A. Kinderhookian. Deposition at this time was limited to areas northeast (Anadarko Basin) and southwest (Midland Basin) of the Texas Arch. Precambrian crystalline rocks were emergent along the axis of the Texas Arch; Ordovician carbonates were exposed along the margins. B. Osagean. The core of the Texas Arch remained emergent or nearly so at this time. Thin deposits of argillaceous carbonate accumulated along margins of the Arch. C. Early Meramecian. The remainder of the Panhandle area was probably submergent by this time. Dolomitic carbonates accumulated over the axis of the Texas Arch; carbonate buildups developed along the eastern margin. By the Late Meramecian the entire area was characterized by shallow-water skeletal and ooid sand shoals. D. Latest Meramecian-Early Chesterian. Local upwarp resulted in erosion (emergence?) along the axis of the Texas Arch; continuous deposition characterized the rest of the area.



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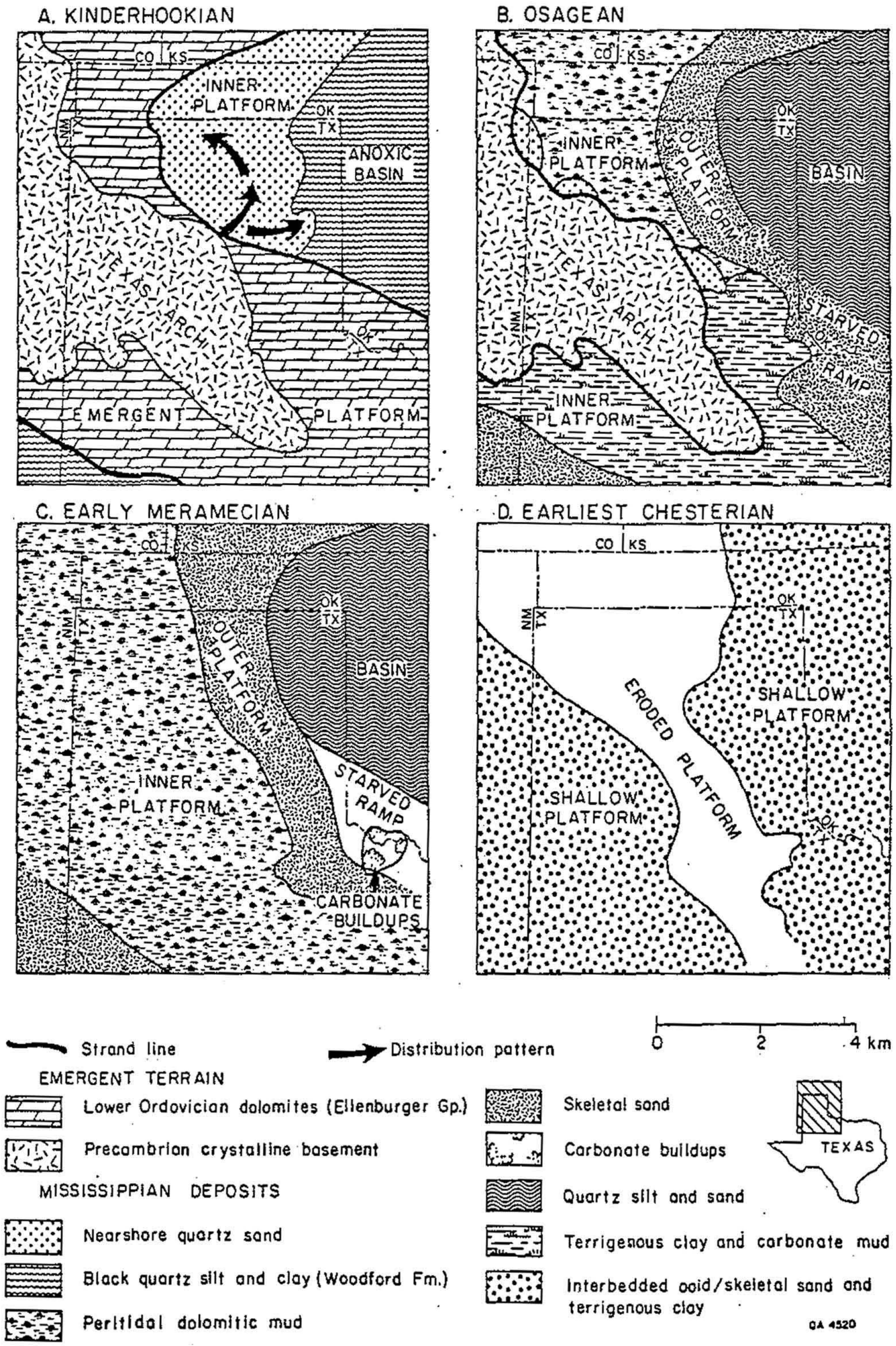

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