ABSTRACT: The Lower Permian (Wolfcamp-Leonard) section on the North Platform of the Midland Basin is a mosaic of lithofacies composing vertically stacked, progradational, and erosional backstepping platform-to-basin sequences. Shelf facies include carbonates, evaporites, and siliciclastics, and contiguous basinal deposits are reworked carbonate detritus and siliciclastics. Wolfcamp strata were deposited in a humid climatic setting and are dominantly carbonate-shale ramp and distally deepened ramp systems that pass seaward to shallow- to moderately deep-basin facies. Progradational as well as lowstand erosional phases of platform development are recognized in the section. Maximum progradation of platform facies occurred in middle early Wolfcamp time, when relatively high rates of basin subsidence were coincident with the rapid deposition of shales in the basin. The resulting shale wedge provided a foundation over which younger Wolfcamp platform depositional systems rapidly prograded. A major period of shelf deepening separates the late Wolfcamp and overlying lower Leonard sections.

The Wichita and Lower Clear Fork are rimmed-shelf systems that stacked vertically at a location basinward of the late Wolfcamp platform margin. Sedimentation and subsidence rates and shelf-to-basin depositional relief during early Leonard time represent the maxima for the Early Permian on the North Platform. Four regionally correlative megacycles are readily identifiable within shelf deposits in each of these formations, and the tops of these represent periods of sea-level lowstand and partial shelf emergence. The megacycles pass into thick, but vertically discontinuous, shelf margin reefs. The megacycles are themselves composed of innumerable subcycles that shoal upward to peritidal carbonate and/or sabkha evaporite deposits. The shelf Tubb and equivalent basinal Dean sections record a major episode of gradual, highstand-terminated sea-level fall that terminated in complete shelf emergence. Thus began a period of alternating carbonate-evaporite and sandstone deposition on the North Platform that persisted into the late Leonardian. The subdued rimmed-shelf systems of the Middle and Upper Clear Fork prograded rapidly into the northern Midland Basin during highstands, across the sandstone wedges that were deposited during lowstands; sedimentation rates exceeded subsidence rates during this time.

The evolution of depositional systems recognized in the Lower Permian on the North Platform was affected by complex changes in several parameters, including: (1) contrasting rates of basin subsidence and sedimentation; (2) probable glacio-eustatic sea-level fluctuations; (3) the shift from dominantly carbonate to mixed carbonate-siliciclastic deposition; and (4) the evolution of reef biotic communities and extent of synsedimentary marine cementation of shelf margin deposits.

INTRODUCTION

During Early Permian time, the Permian Basin of west Texas and southeastern New Mexico (Fig. 1) was an actively subsiding depocenter in which platform deposits (carbonates, evaporites, shales) surrounded deep, dominantly siliciclastic basins. Platform-to-basin depositional sequences in subsurface Lower Permian (Wolfcamp and Leonard) strata are particularly well developed on the stable North Platform province of the northern Midland Basin (as well as on the Eastern Shelf), where cumulative sediment thicknesses exceed 1,980 m (6,500 ft). The Lower Permian section here is readily amenable to detailed subsurface geologic and seismic stratigraphic studies because of the general lack of structural complexity and the high density of well control. This stability is in marked contrast to such areas as the subsurface Central Basin Platform and outcrops on the Southern Shelf (Fig. 1), where the Lower Permian section was disturbed by syn- and post-depositional tectonism and, accordingly, is stratigraphically incomplete (i.e., Ross, 1986; Mazzullo and Reid, in prep.).

Despite the long history of geologic studies and petroleum exploration in the northern Midland Basin, details of the evolution through time of Wolfcamp and Leonard depositional systems remain poorly understood. Previously published studies on the North Platform and peripheral areas have been concerned mainly with the stratigraphy and depositional facies of the Wolfcampian and Leonardian series, and have only briefly described the sedimentology and diagenesis of hydrocarbon reservoir facies in shelf and basin carbonates in these units (Silver and Todd, 1969; Jeary, 1978; Mazzullo, 1982, 1984; Mazzullo and Reid, 1987a, b; Mazzullo and others, 1986, 1987). The depositional framework of this area is grossly similar to coeval sequences elsewhere in the Permian Basin, for example, in the northern Delaware and southern Midland basins and the Eastern Shelf (Cook, 1983; Hobson and others, 1985; Loucks and others, 1985; Wiggins and Harris, 1985; Ross, 1986; Gawloski, 1987; L. J. Mazzullo and Reid, 1987). Thus, a more thorough understanding of the stratigraphy, sedimentology, and facies evolution through time on the North Platform will provide a valuable analog for interpreting similar parameters in the Lower Permian section throughout the Permian Basin.

During the last several years, we have been involved in regional studies of the Pennsylvanian to Lower Permian section in the Permian Basin, with the specific objective of describing in detail the stratigraphic and depositional framework of the Wolfcamp and lower Leonard systems throughout the Midland Basin. This paper describes the results of these ongoing studies as they apply to our current knowledge of the stratigraphic and depositional-systems evolution of platform and basin sequences in the Lower Permian in the western portion of the North Platform of the Midland Basin (Fig. 1). The principal objective of this study is to relate the evolutionary development of depositional systems within the Lower Permian platform and basin sequence on the North Platform to such parameters as relative sea-level fluctuations, history of basin subsidence, variations in sedimentation rates, and the effects on sequence development of contrasting patterns of carbonate and siliciclastic sedimentation. Although we focus specifically on the Wolfcamp to lower Leonard (Wichita-Lower Clear Fork-Tubb-Dean) section in this paper, we also include a brief...