Stratigraphic Framework of the Wolfcamp – Spraberry, Midland Basin

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ABSTRACT

The Midland Basin of west Texas contains numerous large conventional oil and gas fields, including the giant Kelly -Snyder field (Penn. reef, Horseshoe Atoll) and Spraberry Trend (early Permian deep-water clastics). Recently, the Wolfcamp shale and Spraberry Formation have emerged as two of the nation's leading unconventional plays. Bounded by the Lower Strawn Limestone below and by middle Permian units above, this thick (~4,000 ft.) package of strata record the history of basin-fill during Late Pennsylvanian - early Permian time. To facilitate the development of these massive unconventional resources, the Wolfcamp – Spraberry interval is now informally subdivided into a number of lithostratigraphic-based operational units and sub-units. Major units include, from oldest to youngest, the Wolfcamp D, Wolfcamp C, Wolfcamp B, Wolfcamp A, Dean, Lower Leonard Shale, Jo Mill, and the Lower, Middle, and Upper Spraberry.

The Wolfcamp D consists of a series of semi-starved, basinal cyclothems deposited during the Late Pennsylvanian icehouse. The Wolfcamp C is a predominantly clay-rich shale representing the distal portions of large delta systems that rapid prograded across the Eastern Shelf. During the upper portion of Wolfcamp C time, the Glasscock Nose was constructed by a series of mounded/progradational deep water carbonate flows (carbonate drift deltas?). Concurrently, regional structural movements within the Central Basin Uplift resulted in formation of the mid-Wolfcamp unconformity along the western flank of the Midland Basin. The Wolfcamp B and Wolfcamp A constitute a thick series of organic-rich, silt- and calcareous-rich mud rocks currently residing in the peak oil generative window. Deposition of the Wolfcamp shale was terminated by the first major incursion of deep-water clastics, represented by the Dean sandstone. This was followed by deposition of the Lower Leonard shale, Jo Mill, Lower Spraberry, Middle Spraberry, and Upper Spraberry, a series of silty mudstones and clay-rich siltstones punctuated by numerous deep-water submarine fan complexes containing massive to laminated, fine-grained sandstones. The Dean through Upper Spraberry units are stratigraphically-equivalent to the Bone Spring of the Delaware Basin.

Each Wolfcamp – Spraberry operational unit is geologically unique, the product of a dynamic set of tectonic, climatic, sedimentologic, oceanographic, and biological factors that characterize the Late Pennsylvanian – early Permian setting of western Pangea. Analysis of regional sea-level curves tie specific operational units to particular periods of long-term lowstands and highstands encapsulating the Late Pennsylvanian icehouse and transition to an early Permian greenhouse. Understanding of the regional geologic setting and sea-level history of these rocks helps unravel the complex lithologies and stratigraphy observed on seismic, logs, and in cores. Recognition of the geologic uniqueness of each operational unit also assists geologists and engineers during the drilling, targeting, completion, and development phases of these important unconventional resources.