THE STRUCTURAL EVOLUTION OF THE VAL VERDE BASIN, WEST TEXAS

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Abstract—The Val Verde Basin is a northwest-southeast trending foreland basin within the southern portion of the Permian Basin. The Val Verde Basin has several large gas fields, e. g. Brown Bassett and JM, which have a combined ultimate recovery of over one trillion cubic feet of gas. Structurally, the major fields are complexly faulted features related to differential uplift of basement blocks. Vertical and horizontal displacement resulted from a wrench system dominated by northwest and northerly trending faults. Reverse faults associated with the wrench system appear to exhibit characteristics of both high-angle and low-angle faults, as is typical of foreland structures. Tectonism was initiated during late Mississippian time, consequent to Ouachita plate convergence, and continued into Permian time.

Some of the present structural features in the Val Verde Basin were inherited from tectonic processes which evolved from the sagging of Precambrian basement (aulacogen) prior to Mississippian deposition. The sagging stage resulted in the creation of the early Paleozoic Tobosa Basin, located on a retreating continental plate margin.

During late Mississippian time, the Tobosa Basin began to separate into several foreland basins and uplifts by displacements along older zones of weakness and along new orientations. The Val Verde Basin area records these early structural modifications primarily by an erosion surface which pre-dates Pennsylvanian sediment deposition. Thus, Atoka-Strawn sediments unconformably overlie the Barnett shale in the southern and western portion of the basin and overlie Devonian, Simpson, and Ellenburger rocks to the northeast and east. The Devils River Uplift, the Val Verde Basin's southern boundary, became emergent during this time.

The Val Verde Basin began to subside rapidly as a foredeep basin and existed as a distinct depositional trough following Strawn deposition. Terrigenous clastics derived from the emergent Ouachita orogen to the south depositionally prograded to the north during Middle Pennsylvanian through Permian time. Middle and Upper Permian strata are not present in the central and southern Val Verde Basin. Appreciable amounts of Permian sediment were eroded prior to deposition of Cretaceous strata, as inferred from well control, regional seismic, and vitrinite reflectance studies. Thus, Cretaceous rocks unconformably overlie Wolfcamp sediments. Restored estimates for vitrinite reflectance data indicate a minimum of 8,000 to 10,000 feet of Permian rocks have been eroded. Therefore, in the central and southern portions of the basin, Ellenburger rocks are inferred to have occupied depths several miles deeper than present. Vitrinite reflectance values for Ellenburger rocks at Brown Bassett are approximately 1.8 to 2.0% Ro. Ellenburger reflectance values increase to the south and southeast to values greater than 4.5% Ro. The most southerly wells also have reflectance depth trends which show a break in gradient within Wolfcamp sediments (9,000-10,000'). The change in gradient suggests a thermal event contemporaneous with the basin's rapid downwarping and Wolfcamp deposition.

Sequence geometries within the post-Strawn pre-Cretaceous rocks suggest the present structural attitude of the pre-Pennsylvanian rocks may not represent relative structural position during Permo-Penn time (i.e. migration timing). Any exploration in the basin, therefore, must recognize the unique relationships between structural timing, structural position, depth of burial, thermal pulses, and hydrocarbon mobility for a large portion of the Val Verde Basin.

The Dewey-Pittman model for late-Paleozoic basin geometries and thermal histories appears to fit present data for the Val Verde Basin.

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