lower Permian and Pennsylvania stratigraphy and shale gas potential of the Palo Duro Basin

Brendan Talbert, Xiayang Xie
School of Geological Sciences, Texas Christian University, Fort Worth, TX

Abstract

The Palo Duro Basin (Fig. 1) is a northwest-southeast trending cratonic basin in the Texas Panhandle that formed from uplift of the Amarillo-Wichita Mountains during the Pennsylvanian, and subsequent subsidence during the Permian. Sediments were deposited in a number of environments, the most prominent being fan-delta, carbonate shelf, and deep basin settings. Major lithofacies in the basin are: sandstone, shale, and carbonates, and their controls are important for determining the basin’s subsurface stratigraphy.

Stratigraphy

Stratigraphic correlations of the subsurface have been made to identify the lower Permian and Pennsylvania systems, as well as determine the dominant lithofacies that make up these systems, which give insight to depositional environments. Type logs from Dutton (1980) and Hardford (1981) were used to identify time stratigraphic boundaries to put constraints on the Pennsylvania and Lower Permian.

Lithofacies are separated by gamma ray responses:
- 20-25% Carbonate (Blue/Purple)
- 25-40% Sandstone (Yellow)
- 40-60% Siltstone (Orange)
- 60-200% Shale (Gray/Black)

Methods

More detailed petrophysical analysis and/or geocellular analysis is required to determine hydrocarbon potential. One method to determine organic content is the Δ log R method (Paszay’s Method), by crossplotting sonic logs and the natural logarithm of resistivity data (Paszay et al. 1990; Bowling 2010).

Results

Results from stratigraphic correlations show a general thickening of net shale in the Pennsylvania system moving from the north to south and west to east (Fig. 7 and 8). Net shale thickness generally increases from Bailey to Moloney county where it thins onto a structural high between Friona and Eastland counties. These trends are apparent in structural maps of the Pennsylvania system (Fig. 8 and 10). Figures 9 and 10 show the trend of the top of the Pennsylvania, showing a shallowing in the southeast, while the isopach in Figure 10 shows the same thinning and thickening sequences, following a NW-SE axis.

Discussion

Correlating Lower Permian and Pennsylvania sections of the subsurface show laterally extensive shale units throughout much of the southeastern and western portions of the Palo Duro Basin. Defining accurate depositional environments of these shale units will require more a more detailed look into the geologic trends of each stratigraphic unit as well as their rock properties, though the lateral extensiveness of these shales are apparent and do come in thick sequences throughout the basin.

Initial petrophysical analysis studies of the Lower Permian and Pennsylvania components of the Palo Duro Basin show source rock potential through Δ log R crossties, indicated by areas of high resistivity and a speed up in sonic transit time. Further examination of source rock potential will be done to place constraints on potential hydrocarbon sourcing areas. Though source potential appears to be present, there is still a question regarding thermal maturity of the basin. Once there is further study into the source potential of the basin as a whole, maturational of the basin will be addressed.

Conclusion


References


Notes:

• Primary depositional environments and lithologies: 1) deltaic sandstones, 2) carbonate shelf, and 3) slope system limestone and shale.

• Intervals of interest in the study:
  - 1) 20-25% Carbonate (Blue/Purple)
  - 2) 25-40% Sandstone (Yellow)
  - 3) 40-60% Siltstone (Orange)
  - 4) 60-200% Shale (Gray/Black)

• Stratigraphy
  - 1) Lower Permian and Pennsylvania systems
  - 2) Crossplotting sonic logs and resistivity data

• Discussion
  - Net shale thickness generally increases from Bailey to Moloney county
  - Structural maps show thinning to southeast

• Conclusion
  - Further study needed to determine source potential
  - Maturational of the basin addressed