# PBS-SEPM JANUARY LUNCHEON

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# Basinwide subsurface stratigraphic architecture and wireline facies distribution within Leonardian strata, Midland Basin, West Texas

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**ABSTRACT**

Wolfcamp A, Dean, and Sprayberry strata of the Lower Permian Leonardian series contain major unconventional landing targets in the Midland Basin. It is vital to have detailed knowledge of the three-dimensional reservoir architecture and internal lithofacies in order to economically extract oil and gas from these units. Although cores provide the best way to assess lithofacies, cores are rare compared to the vast, historical archive of wireline logs available from Midland Basin vertical wells. As such, we core-calibrated wireline-log suites and applied the calibrations from widely-distributed wells to facilitate the identification and mapping of major Leonardian reservoir units and their respective facies throughout the entirety of the Midland Basin.

Core data was incorporated from 4 vertical wells, including a continuous core of nearly the entire Leonardian interval from a Martin County well. Wireline log data from 4,805 (mostly) vertical wells were used for stratigraphic correlation of Leonardian strata, and wireline lithofacies were estimated for 1,952 of these wells. Core-to-log calibration began by combining detailed core observations/descriptions with x-ray diffraction data to define core facies. Integer numerical codes for the various core facies were assigned at 0.5-foot (15 cm) intervals for each core. The core facies codes were imported into PetraTM and depth shifted to match their respective wireline depths.

The facies codes were viewed in cross plots of shale volume (normalized gamma ray, VSHGR) versus deep resistivity (Rd) by color coding each core facies. Polygons were then drawn to visually identify particular facies clusters on the cross plots. Several iterations of adjustments to the polygon domains were required to attain a reasonable match between the wireline log-generated facies and actual core facies. The cross-plot model was then applied to 1,931 wells for which VSHGR-Rd suites were available, resulting in a 'wireline facies curve' for each well. Wireline log cross sections that are color-filled to match the cross plot-calculated facies codes were constructed to facilitate correlations and observe lateral and vertical facies patterns. Each log-based facies curve was summed within each Leonardian reservoir unit and isopached.

Orogenic activity related to Marathon-Ouachita thrusting had largely ceased by Leonardian time, and glacio-eustatic sea-level fluctuations enabled preservation of siliciclastic-dominated strata during lowstands (LST) and carbonate-bearing units during highstands (HST). The Dean, Lower Spraberry, and Upper Spraberry represent lowstands, whereas the Wolfcamp A (also designated as Lower Leonard), Middle Leonard (or Spraberry Shale), and Middle Spraberry represent highstands.

Wireline facies maps show Leonardian HST units to be volumetrically dominated by siliciclastic shales and siltstones that are most abundant on the basin floor. Sandstone is rare in HSTs; siltstone is the predominant grain-supported siliciclastic. Carbonate-bearing and organic-rich mudrock facies are less voluminous than siliciclastic facies, and are most abundant along the north-south trending deep structural axis of the western Midland Basin, adjacent to the Central Basin Platform. Coarse carbonate grainstones-packstones and argillaceous bioclast-lithoclast floatstones (debrites) occur as line-sourced deposits that fringe the basin margins. Leonardian LST units are volumetrically dominated by very-fine grained quartz sandstones that are most common north of the Horseshoe Atoll, and siltstones that are abundant throughout the basin, especially in the south. Carbonates and carbonate-bearing facies are much less abundant in LSTs than in the HST units. Only minor volumes of organic-rich mudrocks are present in LSTs. The wireline facies maps show that where the geographic coincidence of high organic content and low siliciclastic content plus relatively deep burial (structure map), which serves as a proxy for thermal maturity, collectively illustrate that geologic factors contribute to favorable unconventional oil productivity.

**BIOGRAPHY:**

David has worked for 4 decades in a variety of geologic roles in oil & gas exploration and production, gas storage, carbon sequestration, and regional stratigraphic projects. He has been at the BEG since 2007, where his he has focused on subsurface stratigraphy and reservoir characterization in Texas and U.S. basins. David holds Geology degrees from Colorado State University (B.S.) and the University of Texas at Austin (M.A.). When off duty, he enjoys family, exercise, gardening, and generating bone-crushing guitar riffs.