

Vertical and lateral geological and geochemical characterization of the upper and lower benches of the 3rd Bone Spring Sand, a case study in Lea County, New Mexico, USA

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Abstract

Recently, the 3rd Bone Spring Sands have been targeted for drilling laterals in the northern Delaware Basin. It is important to understand the reservoir quality to select appropriate landing points considering the lateral heterogeneities in specific benches. This study focuses on multiple 3rd Bone Spring sands through a variety of surface logging geological and geochemical data to understand the reservoir characteristics, assist in defining the lithological and reservoir fluid facies, identify fluid barriers, lateral heterogeneity, hydrocarbon saturations, production potential between benches, and evaluate whether the reservoir fluids are similarly sourced by assessing light hydrocarbons and fingerprinting produced fluid properties from the various benches.

Drill-cuttings were sampled in high resolution through the various benches from the top of the 3rd Bone Spring upper sand to the landing point of the lower sand and across 4 laterals, to build a lithofacies scheme, better understand reservoir architecture and model the spatial distribution of the reservoir. These samples were analyzed using a combination of high-resolution image analysis algorithms, XRF-XRD and selected SEM data and were further integrated with the quantitative mud gas characterization for reservoir fluid saturations, fluid type, reservoir compartmentalization and source. Produced oil samples were analyzed through GC fingerprinting and analytical techniques to compare with produced oils from shallower formations in the location to assess source and maturity.

Multiple lithofacies are defined utilizing the extracted image analysis data to optimize and select landing points for laterals and study potential targets for future drilling. The upper sand shows significant vertical and lateral heterogeneity in both rock properties and hydrocarbon fluid saturations, while the lower bench has a more homogenous character. The upper sands show a much higher initial hydrocarbon production trend compared to a stable trend from the lower sand. Mud gas isotopes show potential reservoir connectivity between both the benches, but there are minor differences that could infer heterogeneity along lateral. The fluids however are from a different source compared to shallower 2nd and 3rd Bone spring sands and carbonates. Produced oils analyzed through GC-fingerprinting techniques agreed with mud gas isotopes and light hydrocarbon fluid compositions.

Low-cost advanced surface logging geological and geochemical techniques offer operators a robust near-real-time comprehensive description of the reservoir to assist in making quick decisions for determining appropriate landing points, evaluate secondary targets, optimize, and improve well planning and well placement across their acreage. The lithofacies derived from the image analysis and inorganic measurements combined with the quantitative hydrocarbon evaluation from a variety of geochemical analytical and statistical models, provides a powerful near-real-time tool to predict production potential and provide valuable inputs for well completions, well planning and well placement and understanding the regional hydrocarbon source, maturity, reservoir connectivity and compartmentalization.