Strategic Integration of Geology and Geophysics in Support of Recent Niobrara Drilling and Engineered Completions, Western Powder River Basin, Wyoming, USA

Rex D. Stout[1] and Tanya Inks[2]

[1]Sage Butte Energy, LLC
[2]IS Interpretation Services, LLC

Abstract

Sage Butte's acreage position on the western limb of the highly asymmetric Powder River Basin poses some unique complexities not seen in less structurally complex portions of the basin. The geoscience team had to address the essential issues required to support successful drilling and completion activity for Sage Butte's Niobrara drilling program. Maturity is a crucial metric to predict productivity in this basin, as a normal depth-maturity relationship is interrupted by widely recognized maturity "hot-spot" developments. Utilizing API gravity as a maturity proxy indicated a relationship to productivity. Early in this process, we observed a relationship between basement variations and maturity. Using 3D seismic to review the basement showed a large reflective body within the upper basement, which correlated with the Niobrara API map, mimicking API contour placement and imaging regional lineaments, including a significant lineament mapped by Sims (2001.) West of the basin axis, steeper dips are more common and small-scale normal faulting is commonly observed in sparse vertical well control. Structural interpretation, as with most unconventional horizontal drilling in other basins, was crucial to the success of the Sage Butte Aspen 29W32 wells. Seismic mapping showed a much steeper incline, especially at the toe of the Aspen 29W32-1NH well. Because of completion risks associated with an area with an interpreted dip greater than 3 degrees laterals were drilled until we encountered steeper dips rather than drilling to the southern edge of the DSU. Interpreting small faults at or near seismic resolution improves the predictability of results and parent-child relationships between wells within the DSU and is essential. The geophysically mapped regional basement lineament trends commonly underly clusters of more pervasive small, primarily wrench faults in the Niobrara. Faults interconnect the Aspen 29W32-1NH and the Aspen 29W32-3NH. Considering these faults during completion planning is a step toward avoiding pressure collisions and communication between the wells in this area. Completion stages were strategically gapped to avoid interpreted faults that showed changes in GR or gas units while drilling. Significant gas kicks in the Aspen wells correlate to the major basement lineament at the boundary between gneiss and granitic basement (Figure 1). The geoscience team's focus on maturity and detailed structural analyses allowed the team to impact the drilling program immediately. We evaluated fracture trends over regional lineaments, predicted areas of increased gas, and helped the drilling and completion engineers to limit well control issues, pressure hits and other issues resulting from well-to-well communication. As adjacent wells are drilled in the future, we can minimize drainage issues and pressure sinks and also isolate faults and fractures that could affect completions and production by optimizing the placement of stages.