Integrated Application of Petrophysical and Seismic Inversion Techniques for Reservoir Quality Prediction Based on Sediment Provenance in the Cretaceous Nanushuk and Torok Formations, North Slope, Alaska

Jennafer Foreman[1], Shuvajit Bhattacharya[2]
[1]University of Alaska, Anchorage; [2]University of Alaska

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Abstract

Recent large discoveries targeting the Cretaceous Nanushuk and Torok Formations on Alaska's North Slope have focused exploration in the region to these shallower, younger targets. The Nanushuk topsets and Torok foresets and bottomsets were deposited as a series of west to east prograding clinoforms across the Colville Foreland Basin. The reservoir quality of these prolific formations varies greatly across the study area. Generally, reservoir quality within the study area has both a regional and localized control. The regional control across the Alaska North Slope is related to the maximum burial depth of the formation. As the maximum burial depth increases, reservoir quality is greatly diminished primarily due to compaction related porosity loss. The local control on reservoir quality is related to both depositional environment and the provenance of the reservoir sediments. The western portion of the Colville Foreland basin received a proportionally higher input of sediments derived from the Chukotkan orogeny as compared to southeastern portion of the Colville Foreland basin, which received a proportionally higher input of sediments derived from the Brooks Range orogeny. Fields and discoveries such as Smith Bay and Pikka/Horseshoe contain Brookian sediments derived primarily from the Chukotkan orogeny in the northwestern portion of the study area. These

northwestern fields have more favorable reservoir quality as compared to fields in the southeastern portion of the study area, such as Umiat, containing more sediments derived from the Brooks Range orogeny. This study will focus on the interpretation and application of the results of petrophysical-log-guided seismic inversion of three 3D seismic surveys across the study area, with each survey in an area of distinct sediment provenance with coverage over a field with targets in either the Nanushuk or Torok Formation. Two surveys in the northwestern region of the study area (Aklaq 3D and Nanuq South 3D) represent regions with a higher Chukotkan derived sediment influx and one survey in the southeastern portion of the study area (Umiat 3D) represent a region with a higher Brooks Range derived sediment influx. Each survey slated for analysis has a well or wells, which penetrate or target the Nanushuk and/or Torok Formations within or near the survey boundary. These wells will help constrain the inversion result. The results of the inversion workflow should indicate a discernable and quantifiable difference between the reservoir quality, specifically porosity, fluid type, and clay content, of the surveys in the northwestern portion of the study area as compared to the results from surveys in southeastern portion of the study area. Preliminary results from petrophysical inversion, petrophysical cross plot analysis and seismic attribute analysis indicate a quantitative link between reservoir parameters and rock physics properties.