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Multi-Scale Facies Classification for Prediction of Textural Rock Properties from Post-Stack Seismic Data: BV Nose Discovery, Upper Miocene Deepwater Stevens Play, San Joaquin Basin, California

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ABSTRACT

This paper exhibits a data-driven, multi-scale, and assimilated facies classification for deepwater Stevens sandstones in BV Nose Oilfield, Kern Co., California. Pore-scale measurements of pore throat radii, permeability, porosity, and volume of clay are linked to core and logs, which are upscaled to the seismic detection threshold. The end result is a multi-scale interpretation of facies associations, which links to the inverted seismic response for prediction of porosity-height.

Buena Vista Nose (BV Nose) oilfield was discovered in April 2012 by well 313–15H– RD1. Subsequent enhanced completions have resulted in initial production rates in high net-to-gross sandstone in excess of 1000 barrels of oil per day. Five wells are currently producing from an average depth of 10,000 ft true vertical depth subsea. Production is from the deepwater upper Stevens N–O sandstone member of the Monterey Formation (Gordon and Gerke, 2006). The discovery well was drilled based upon a seismic isochron thick, as detailed by Paz and Meyerholtz (2016).

74 ft of whole core was obtained to support lithologic characterization of the field. Sandstone facies are described based on deepwater bedforms and particle size. Facies associations are defined based on inferred depositional processes. Facies associations for Traction, Suspension, Transitional (Slurry), and Cohesive processes are identified within a complex of high-density turbidite flows. Mercury injection capillary pressure (MICP) pore throat diameter data and XRD clay volume corroborate the descriptive facies associations. We adapt the Flow Zone Indicator model of Amaefule et al. (1993) to define facies-dependent permeability trends in terms of $\phi*(1+V_{cl}\alpha)$. The petrophysical model is constrained to core-derived grain density and clay volume enabling computation of log-derived facies association flags and a facies-dependent permeability curve.

Seismic isochron trends demonstrate multiple confined turbidite complexes trending northwest across the east-west trending structural nose of the BV Hills Anticline.

Production currently is established within the unconfined, flow expansion (inner and middle fan) portions of the system. Upper Stevens N–O sandstone is encased by high-velocity biosiliceous mudstones. On seismic, sand-bodes generally reside above the detection threshold and are tuned, resulting in a post-stack seismic inversion response predictive of sandstone porosity-height. The predictive relationship is improved by

excluding Traction and Cohesive (non-reservoir) facies-associations from the porosity-height summation, resulting in a seismically-derived estimation of net pay.

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