Permeability Anisotropy and Meandering Fluvial Facies Architecture of the Bartlesville Sandstone, Nowata County, Oklahoma

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Abstract

Permeability anisotropy is characterized using permeametry, petrographic, and image-based rock analyses, and is related to the fluvial facies architecture of a Bartlesville sandstone. Permeability anisotropy is often upscaled in reservoir models such that finer scale heterogeneities are rendered irrelevant; however, studies have demonstrated that finer scale heterogeneities pose significant consequences for hydrocarbon recovery. The Bartlesville sandstone (Boggy Formation, Desmoinesian) is represented in core from Nowata County, Oklahoma from depths 803 to 847.5 feet. The core exhibits minimal residual hydrocarbon presence, minimal drilling fluid invasion, and lacks telogenesis alteration. A meandering fluvial hierarchical facies architecture is constructed from a detailed core description. Three stacked meandering fluvial storeys consisting of channel floor, lateral accretion bar, crevasse splay, and floodplain elements are identified. Probe permeametry is sampled as a grid along the outer surface of the core and core plugs are extracted parallel to strike, parallel to dip, and perpendicular to stratal elements within individual lithofacies for use in core plug permeametry. Probe permeametry reveals the geometric mean of permeability of lithofacies elements varies from 0.27 mD in rippled sandstone of the lateral accretion elements up to 98 mD in structureless sandstone of the channel floor element. Horizontal anisotropy is best observed in cross bedded sandstone of the channel floor whereby the stratal strike and dip directions exhibit the maximum

and minimum horizontal permeability respectively (dip:strike = 0.68). Additional methods include petrographic analyses and image-based rock analyses which are utilized to investigate permeability anisotropy at the microscale relative to facies architectural elements. Petrographic analysis of thin sections is employed to qualitatively characterize pore systems and grain fabrics. Three-dimensional quantitative analyses of micro-pore size, pore shape, pore distribution, and pore interconnectivity are evaluated utilizing micro-computed tomography (micro-CT) to image core plugs. Three-dimensional pore networks extracted from micro-CT images are used to model transport properties such as single and multiphase fluid flow.

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