Fracture Aperture and its Variation along Fracture Height in a Heterogeneous and Anisotropic Shale Oil Reservoir, Turonian Second White Specks Formation, West-Central Alberta

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Abstract

Detailed characterization of natural fracture geometry in unconventional reservoirs is critical as these fractures can provide essential permeability for hydrocarbons and influence hydraulically induced fracture propagation. Geometric elements used to describe fracture networks typically include size (height, length, aperture), orientation, and abundance (intensity, spacing). Since fracture height and length are challenging to characterize in subsurface datasets, scaling relationships are often applied that relate height and length to aperture, which is more easily measured in core and image logs. Several relationships between fracture length and aperture have been proposed, with previous workers arguing for linear, sublinear and superlinear scaling. These relationships have been based on both theoretical models and field observations. However, they have primarily been derived from thickly bedded conventional reservoirs. To evaluate the applicability of these relationships to thin bedded unconventional reservoirs, we characterized fracture aperture in the organic-rich marine mudstones and enveloping thin bedded strata of the Turonian Second White Specks Formation in west-central Alberta. In this study, kinematic apertures were measured at small increments (5 mm) along the stratigraphic height of natural calcite-filled, opening-mode fractures exposed in a vertical core through the Second White Specks Formation. The objectives of this work are to quantify the variation in aperture observed along fractures developed in

a complex reservoir unit and to investigate the relationship between fracture height and aperture. Along individual fractures, aperture was observed to vary substantially from 0.1 to 1.5 mm. Additionally, fractures regularly do not display centrally located maxima as some theoretical models suggest. Our findings show no clear scaling relationship between fracture height and aperture, but rather a lithologic control on aperture. Regardless of fracture height, the largest apertures were consistently observed in coarser lithologies (sandstone), while silt and mud dominated lithologies displayed very narrow apertures. These findings suggest that previously established scaling relationships between fracture size and aperture may not be valid for highly heterolithic and anisotropic reservoir targets. Furthermore, the results from this study have direct consequences for predicting and modelling the variation in fracture porosity and permeability that arise from stratigraphic variations in fracture aperture in heterogeneous reservoirs targets.

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