Geostatistical modeling and upscaling permeability for reservoir scale modeling in bioturbated, heterogeneous tight reservoir rock: Viking Fm, Provost Field, Alberta

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While burrow-affected permeability must be considered for characterizing reservoir flow, the marked variability generated at the bed/bedset scale makes bioturbated media difficult to model. Study of 28 cored wells of the Lower Cretaceous Viking Formation in the Provost Field, Alberta, Canada integrated sedimentologic and ichnologic features to define recurring hydrofacies possessing distinct permeability grades. Transition probability analysis was employed to model spatial variations in biogenically enhanced permeability at the bed/bedset scale. Results suggest that variations in permeability are strongly related to variations in hydrofacies rather than grain size. The variability in permeability at the bed/bedset scale was simplified by calculating an equivalent permeability that represents the thickness-weighted sum of permeability at the bed/bedset scale using expressions for layered media. Numerical block models were then generated for both the bed/bedset hydrofacies and the upscaled hydrofacies. Vertical and horizontal flows were simulated at both scales, and the volumetric flows in each direction were compared to verify the representativeness of the equivalent permeability. Vertical and horizontal flows simulated for bed/bedset scale and composite hydrofacies differ by less than ±5%, suggesting that permeabilities at the bed/bedset scale can be simplified through upscaling. Reservoir-scale groundwater flow was simulated along a hydrogeological cross section comprised of the composite hydrofacies. The resulting flow regime was consistent with those simulated using permeability estimates from tight reservoir units of the Viking Formation. This approach may lead to improved reserve calculations, estimates of resource deliverability, and understanding of reservoir responses during recovery.