Modeling the Transmissibility of Faults in Carbonate Reservoirs

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ABSTRACT

Methods for calculating and predicting fault-sealing potential, including transmissibility multipliers for cellular models, are well established for faulted siliciclastic reservoirs. Algorithms currently in place are based on the percentage of shale within a faulted sequence, which can act to generate a clay smear or gouge, reducing the permeability of a fault to create a baffle / seal. However, faulting within carbonates has received significantly less attention despite their importance in global hydrocarbon reserves, and currently no algorithms exist to predict the sealing potential of faulted carbonates without shaley interbeds. The hydraulic properties of carbonate fault zones are significantly more complicated than faulted siliciclastics, due to the heterogeneity of intact carbonates and their respective fault rock textures, and the tendency for carbonates to respond to fluids and diagenetic processes. We have examined the distribution and petrophysical properties of fault rocks in a variety of carbonate lithofacies and a range of tectonic settings, in order to assess the across fault flow potential, with the ultimate aim of developing a methodology to predict the transmissibility of faulted carbonates. The collated database of carbonate fault rock permeability, from outcrop and core, has been used to find patterns that are likely to be controlling the sealing potential. We have found that the types of fault rock produced are a function of porosity, permeability and strength, which in turn is controlled by the host rock texture, specifically grain size, sorting, porosity and pore types. These factors contribute to the creation of a large variety of fault rocks produced, with varying porosity and permeability. Trends to the variable fault rock poroperm are observed, dependent on host lithofacies, juxtaposition and displacement. These trends are used to predict the transmissibility multipliers that could exist under certain conditions within a geocelluar model. Further to this, the fault rock permeability and transmissibility can also be calculated from triangular juxtaposition diagrams, allowing for a quick 2D analysis of carbonate fault seal. Understanding the controls on the deformation style during faulting of a carbonate sequence aids prediction of the types of fault rocks formed, their hydraulic properties and influence during reservoir simulation.