Enhanced Fluid Flow in Critically Stressed Fractures-Implications for Reservoir Permeability and Fault Seal Evaluation

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ABSTRACT

Understanding fracture distribution and orientations can be an important aspect in reservoir optimization. Pre-existing fractures in the earth's crust generally evolve over geologic time as the result of multiple episodes of deformation. Although "conventional wisdom" says that fractures have a preferred orientation in a given reservoir, they usually are found to be at a wide range of orientations. Understanding which set of fractures is permeable is the key optimizing reservoir productivity. A commonly held view that "open" fractures (mode1) provide pathways for fluid migration is generally not applicable. Rather, episodes of shear displacement create increased permeability, which is maintained with continued deformation, thereby sustaining open conduits for fluid migration. Therefore, fractures optimally oriented for shear failure (critically stressed fractures, where (τ/σ_{neff}~0.6) in the present day stress field are more likely to be the producing fractures in a reservoir.

Wellbore images provide fundamental data for assessing fracture permeability and reservoir optimization. Fracture orientation and distribution can be directly determined from image logs. Using the knowledge of the stress field, the resolved shear stress on the fault can be determined and evaluated for proximity to slip. A correlation between high fluid flow and critically stressed fractures has been documented in a variety of reservoirs worldwide. Similar principles have been applied to the investigation of large-scale faults in an effort to determine seal capacity. This method has been successful in the North Sea and the Timor Sea off NW Australia.