Fault Seal Analysis: Integration of Empirical and Deterministic Approaches

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Over the years, a large number of methodologies have been proposed to estimate the sealing capacity of faults. These methodologies can be divided into those that are empirical (evidence-based methods) and those that are deterministic (i.e. forward models). Forward models of fault sealing are based on measurements of fault flow properties (e.g. permeabilities)) and structures (e.g. fault population statistics). Evidence-based approaches are those in which empirical relationships are established between sealing capacity and factors such as fault offset, clay content etc. A problem with the deterministic approach is that fault zones are complex and it is uncertain that we fully understand all of the physical processes that affect flow within and around fault zones. For example, uncertainties exist regarding the lateral continuity of fault rocks, their relative permeability etc. A problem with an evidence-based approach is that interpretation of subsurface data is often non-unique and therefore it is often not possible to determine the sealing capacity of faults based on static and dynamic data. Consequently, empirical databases of fault sealing capacity are often populated with misleading data. The most successful fault seal analyses combine deterministic and empirical approaches. Interpretations of static and dynamic data are often improved by having a constrained fault zone model. On the other hand, forward models of fault-related fluid flow are improved if they are calibrated using static and dynamic data. Examples will be given showing the benefit of integrating empirical and deterministic fault seal methodologies.