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A Three-Dimensional Stochastic Model of Fluid Flow Through Fault Damage Zones

Major fault zones are surrounded by damage zones composed of minor faults that, in siliclastic rocks, often form significant barriers to fluid flow. Information on fault damage zone architecture is usually available only as 2-D maps, or as 1D line samples or well logs. The accurate determination of the 3-D fault population characteristics is crucial for flow prediction.

We review a stochastic model for modelling fault damage zones by incorporating the statistical properties of fault populations and different spatial distributions. Techniques for modelling spatial clustering, as found from core, outcrop and seismic-scale data, have now been developed which lead to realistic 'sub-clusters' of faults within the damage zone.

These damage zone models have been used to investigate the characteristics of 2-D and 1D samples. The hierarchical clustering model, which most closely resembles nature, suggests that deviations from simple predictive rules for describing subsample populations can be significant.

Geometric techniques have also been developed to simulate flow through these systems. We have introduced a new methodology which both derives the minimum value of the fault rock thickness along flow paths traversing the fault zone and predicts areas of reduced fault zone connectivity for matrix host rock and fault rock of varying permeabilities. This is an advance on other techniques used to model the impact of faults on cross fault flow since it maintains both the true complexity and spatial distribution of the fault damage zone.