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3-D Geomechanical Modeling Technique for Constraint of Subseismic Fault Simulation in Reservoirs

Within any faulted reservoir there are large numbers of faults that are below the resolution of seismic surveys. Some of these faults are encountered in wells, but vast majority of them remain undetected. Such subseismic faults can significantly influence the flow of hydrocarbons during production. The size distribution of subseismic faults can be predicted by extrapolating the size distribution measured at the seismic scale down to the subseismic scale. However, the positions and orientations of the subseismic faults are more difficult to determine. A method based on mechanical modeling is described here to constrain the positions and orientations of subseismic faults. The seismically-resolvable faults are brought into a 3-D numerical mechanical model in order to determine the stress conditions near these faults at the time of faulting. The stress field is then combined with failure criterion in order to predict the orientations and densities of the subseismic faults. This information is represented on a pair of grids (i.e. a density and strike). The grids are then used to condition 2-D or 3-D stochastic models of faulting, which use a power-law distribution and/or stochastic growth processes to simulate subseismic faults. Two contrasting stochastic methods are used: i) a method in which the subseismic faults are placed in the volume as fully-grown structures and ii) a method in which the faults are allowed to grow and interact. The Oseberg Sør field, Northern North Sea is used as an example of the application of these methods.