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Integration of 3-D Structural Modeling and Fault Seal Analysis to Reduce Reservoir Uncertainty

Reservoir modeling encompasses a wide array of specialties, from visualization and seismic interpretation to reservoir characterization and fault transmissibility analysis. This workflow can be divided into two segments: 1) structural modeling and 2) facies and property modeling. Structural modeling, the subject of this talk, integrates visualization, seismic interpretation, and fault-horizon modeling to construct a fault-horizon model of 3-D structured grids. This 3-D structural model is subsequently populated with facies models and reservoir properties prior to up-scaling and reservoir simulation. Fault transmissibility analysis requires both fault grids and facies (i.e. sand-shale) models and typically occurs later in the reservoir modeling workflow. During structural modeling, 3-D models of fault networks, reservoir surfaces and reservoir-fault intersections (fault polygons) are generated during seismic interpretation. The structural validity and consistency inherent in these 3-D models greatly facilitates and streamlines the construction of reservoir models, eliminating seismic reinterpretation and grid editing by geologic modelers and reservoir engineers. Fault grids are created and assembled into a fault network, within which stratigraphic horizons are modeled. Fault polygons (or horizon cutoffs) are generated at the fault-horizon intersections, in effect producing field-wide networks of 3-D fault-plane profiles. Structural complexity incorporated into the models is only constrained by the quality of the seismic data. The combination of 3-D fault-plane profiles, internally consistent horizons, and rigorously defined fault networks provides the geologic modeler and reservoir engineer with a structural "shell" that can subsequently be populated with facies models and reservoir properties. This high quality 3-D structural framework reduces the uncertainty in subsequent analyses. Derivative analyses can then be done to evaluate fault zone properties. These fault zone properties are then used to calculate fault-seal capacity and constrain the cross-fault flow during production. The business impact of this approach is significant in assessing in-place volumes and maximizing hydrocarbon recovery.