3-D Geological Modeling and 'Reservoir' Flow Simulation of a Leveed-Channel Outcrop with Application to Deepwater Leveed-Channel Reservoirs

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This paper presents a 3D geological model of part of the Cretaceous Dad Sandstone (Lewis Shale) leveed-channel outcrop that was built from outcrop and ground-penetrating radar (GPR) data. Because this outcrop is an analog to deepwater leveed-channel systems, the goal was to evaluate possible hydrocarbon production problems related with sub-seismic scale stratigraphic heterogeneities. To accomplish this, the geological model was imported into EclipseTM for well performance simulation under a number of drilling and geologic scenarios. For example, slumps which often line the bottoms of channel-fill are common in subsurface leveed-channel reservoirs, but they are likely to be deleted during the upscaling process for reservoir simulation. The objective of this paper was to demonstrate that deleting such small-scale features in an upscaled model may lead to erroneous simulation of reservoir performance.

The geological model was built by the integration of Ground Penetrating Radar (GPR), photomosaics and measured stratigraphic sections, and focused on sub-seismic scale continuity and connectivity of sandstones and mudstones. Petrophysical data such as porosity and permeability for the model were obtained from a 1700ft. well drilled and cored through the same strata 4.3 Km away. The shallow GPR data was scaled for input into PetrelTM and seismic attributes were applied to enhance GPR signal quality. Focus of the simulations was on channel-lining slumps and their effect as potential barriers or baffles to fluid flow into a wellbore. Five depletion simulations and fifteen waterflood simulations were generated, each with different permeability (1-40md) of the slumps and injector well locations. Low slump permeability was found to better maintain the water in the reservoir by reducing water coning in the depletion simulations. However, an increase in slump permeability improved oil production for the waterflood simulations.

Using flow simulation it was possible to conclude that the continuity, thickness, distribution and petrophysical properties of the base-channel slumps in reservoirs may result in different well performance than predicted by simulation in leveed-channel deposits.