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3-D Stratigraphic Inversion of Carbonate Reservoirs: A New Technology for Reservoir Assessment

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We have completed the industry's first 3-D stratigraphic inversion of a carbonate field data set. We selected an 80X80km area in the Williston Basin, USA, that contains numerous oil fields. The approximately 35m-thick stratigraphic interval extends from the Glenburn into the Sherwood Members of the Mission Canyon (Mississippian) Formation. The interval contains 13 stratigraphic cycles, of which 9 were used in the modeling. Facies range from deep-water mudstones, to shallow-water packstones and grainstones, to sabhka evaporites, although most of the section simulated comprised deeper water facies. Reservoir facies are mudstones and skeletal wackestones with pinpoint vuggy and intercrystalline porosity. Reservoir facies are cyclically interlayered with nonporous mudstones. Progradational units were deposited on a low-angle ramp with differential topography and subsidence induced by movement along deep-seated faults. Besides simulating a broad range of water-depth facies, a major challenge of this study was the simulation of this differential topography and subsidence.

Five cored wells in the study area, each separated by 20-35 km, were used for inversion. An additional six cored wells were reserved for blind tests. The stratigraphic inverse model accurately simulated the successions and thickness of facies and the thickness of the stratigraphic cycles. Differences between observed and simulated facies intervals were <5 cm in 24% of the simulations, 5-10 cm in 16%, 10-20 cm in 20, and 20-30 cm in 12% of the simulations. These differences are well within the range of ambiguity of facies thickness measured in core and well log and, consequently, the simulations are just as accurate as if 6400 wells of 1km spacing were used to create a 3-D stratigraphic model. Successions and thickness of facies intervals and cycle thickness in the six wells used for the blind tests were comparable to those wells used in the inversion. Stratigraphic inversion is additional technology for reservoir characterization and for creating accurate stratigraphic models for fluid-flow simulation.