Novel Work Flow to Model Complex Deltaic Settings: A Case Study From Zubair Reservoir Modeling in North Kuwait

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ABSTRACT

The Albian-Aptian clastic sediments of North Kuwait were deposited in a dominantly deltaic environment with lateral extensions to distal and proximal settings. The complexity of deltaic sedimentation and the marine or fluvial influence on it were better understood with more core descriptions and higher density well data with special logs. The work flow for modeling of these environments have been modified accordingly. Integrated Sedimentological study of Zubair and Ratawi Formations have brought out more fluvial dominance over deltaic environment than marine. Bio stratigraphic data, reservoir continuity from field history and fossil assemblages supported this observation. New well data showed more minor channels in stratigraphic intervals than predicted earlier. Current depositional model was broadly divided into Delta front and Delta top Gross Depositional Environments (GDE) having varying distribution of channels, levees and mouth bars. An innovative workflow for facies modeling combining deterministic and stochastic methods simulated the modified depositional setting. The depositional units captured in well logs from core-log calibration were extended to uncored wells. The pi diagrams of all wells displaying channel, mouthbar, shoreface, abandoned channel and offshore facies were overlain by log signatures and isochore maps. Dominant flow trends were drawn in these composite plots along regional paleo transport directions. Determining Delta top or Delta front GDEs were based on the dominance of arenaceous facies, channel thickness and fossil assemblages. Each GDE was further subdivided into litho-dominant facies belts and were modelled separately using sequential indicator simulation (SIS) and paleoflow vectors. Different variogram ranges were used to match observed reservoir connectivity while preserving the depositional trends. The merged simulated depositional environment was in agreement with sedimentological model. The trends used in SIS to depict degree of uncertainties include lateral well based facies fractions, facies fraction trend maps, depositional environment maps and vertical combined facies fraction trends. The vector maps of depositional dip guided facies distribution and porosity. The novel facies workflow combined deterministic understanding of sedimentation with stochastic variations of facies seen within and between drilled wells. The resulting static model would be used for flow simulation for better prediction of reservoir behavior.