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Outcrop-Based Modeling of Shallow-Marine and Marginal-Marine Reservoirs: Examples from the Book Cliffs, Utah

The near-continuous exposures of the Book Cliffs, Utah provide ideal datasets to construct geologically accurate, static and dynamic flow simulation models of reservoir analogues. We present three such models: (1) stacked shoreface parasequences and incised valley fill, field-scale model, (2) detailed fluvio-estuarine incised valley fill model, (3) detailed shoreface parasequence model. The high quality of the outcrop results in a near-deterministic appreciation of stratigraphy and facies architecture in three dimensions. The resulting models serve as robust templates for the subsurface.

Models have been constructed using a range of industry-standard and experimental techniques in order to develop efficient, fit-for-purpose modelling tools. Novel techniques include adaptive gridding, which has allowed complex rock geometries such as clinoform surfaces to be incorporated efficiently within the model. A combination of careful grid design and upscaling procedures that retain depositional geometries has minimised data loss during transfer from the static geologic model to the dynamic flow model.

Flow simulation has also been undertaken using various techniques, from the standard use of finite-difference codes to solve pressure fields between the model grid-blocks (which is computationally intense) to a streamline-based approach (a quick 'first-pass' technique). In addition, experimental design techniques have been used to assess the relative impact of different geological and field-development factors on fluid flow and reservoir performance.

Key results include the importance of using geologically based models; the need to model fluid-rock interactions in three dimensions; the importance of intelligent grid design and upscaling; and the varying effectiveness of different modelling techniques to address specific reservoir-performance issues.