AAPG/SEG/SPE HEDBERG CONFERENCE
"GEOLOGICAL CARBON SEQUESTRATION: PREDICTION AND VERIFICATION"
AUGUST 16-19, 2009 – VANCOUVER, BC, CANADA

A Regional Site Selection Methodology for Large-Scale Prospect Models in Data-Poor Regions

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Regional prospecting for saline aquifer storage sites present a number of technical challenges for carbon sequestration models. Firstly, simulations need to include realistic boundary conditions for multi-phase flow, pressure and formation water displacement. Secondly, simulations need to include common geological heterogeneity such as faults and facies variation. Thirdly, the model needs to be designed at high resolution to usefully resolve the impact of heterogeneity on potential storage acreage. Fourthly, the simulation run time needs to be fast enough to allow for multiple stochastic realisations in order to risk across uncertainty in geological data; prospective saline aquifer storage regions are likely to be data-poor when remote from petroleum exploration and production activity.

We review the underlying assumptions and critique the boundary conditions of large-scale flow simulations, and present a model for identifying and appraising storage potential at the regional scale, that incoporates geological heterogeneity and data uncertainty. The observed injection rates and distribution patterns of large operational storage sites (In Salah, Sleipner) favour capillary-dominated flow as the probable migration mechanism. We review the governing equations for both multi-phase flow and single-phase flow, and quantify the flow regime for existing saline aquifer storage using capillary number calculations. We critique current strategies for modeling faulted geological environments, and summarise the theoretical and empirical relationships between sandstones and faults with respect to permeability and threshold pressure. This understanding allows us to construct a large-scale model with a novel approach to a large-scale regional case study.

The case study (Fig. 1) uses a new technology for identifying and assigning faults to a model. The case study also demonstrates a widely applicable approach to high-resolution large-scale flow models. The model risks across reasonable input ranges for a region (80x140 km) with poor data coverage and related high uncertainty. The outcome of the stochastic simulation is the identification of 4 stable prospects from a potential 21 closures identified within the area, and an understanding of the simulated system response to variation in critical parameters (seal integrity, fault location and transmissibility) that help to target site-specific data acquisition.

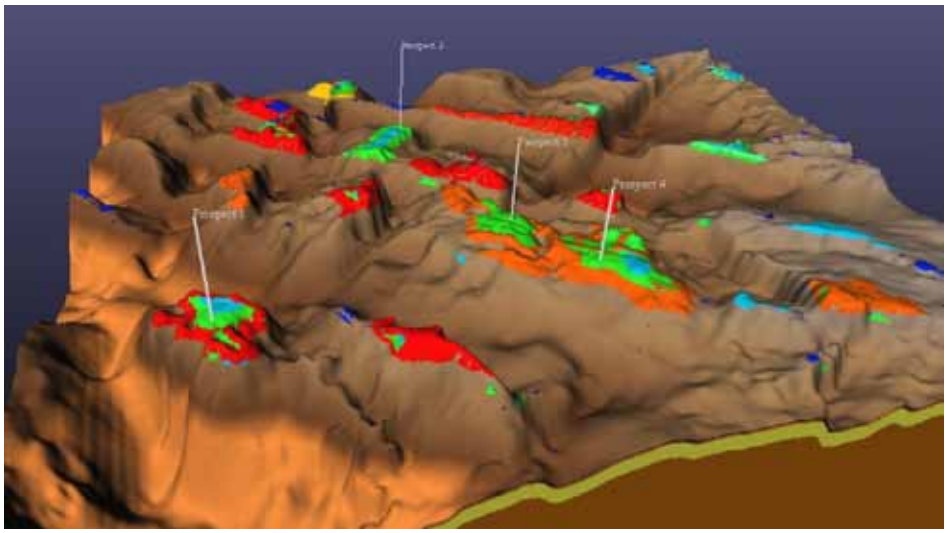

Fig. 1. A high-resolution large-scale flow simulation for identifying prospects in a data-poor region.