CO_2 Storage in Deltaic Environments of Deposition: Integration of 3-Dimensional Modeling, Outcrop Analysis, and Subsurface Application

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ABSTRACT

Carbon sequestration in geologic reservoirs is a proven method for reducing greenhouse gas emissions. Deltaic deposits are attractive candidates for CO_2 storage projects due to their prominent role as hydrocarbon reservoirs. This research informs subsurface deltaic reservoir characterization and performance for carbon sequestration through integration of geocellular modeling, outcrop analyses, and seismic mapping of prospective offshore CO_2 reservoirs. Results emphasize the importance of recognizing sequence stratigraphic architectures for predicting CO_2 migration.

Initially, a model of a deltaic system was generated from a prior flume deposit to better understand fundamental aspects of reservoir and seal performance. This model was scaled and assigned geologic properties, generating a novel and extremely high-resolution geologic model. Physical architectures represented in the geologic model are consistent with global examples of deltaic reservoirs as well as outcrops studied in this research. Twenty CO_2 injection simulations were run on the geologic model to understand the relationship between heterogeneity and fluid migration. Baffles affecting migration are identified as the shale layers between sand clinoforms and regressive surfaces in the highstand-lowstand systems tracts. Primary trapping surfaces influencing CO_2 migration are the regressive surfaces in the transgressive systems tract (TST), where migration pathways converge along common surfaces. The sequence stratigraphic observations are then applied to reservoir characterization in 3D seismic data from the Gulf of Mexico. The regional, sequence stratigraphic surfaces are well represented in sub-surface data. Hydrocarbon production data indicate fluid accumulation in TST stratigraphy, similar to the geologic modeling results, suggesting some predictability of fluid flow in deltaic settings. The novel integration of datatypes produces enhanced understanding of subsurface fluid flow in deltaic environments.

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