Characterizing Reservoir Quality for Geologic Storage of CO2—A Case Study from the Lower Miocene Shore Zone at Matagorda Bay, Texas

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ABSTRACT

The geologic storage of anthropogenic CO_2 through Carbon Capture, Utilization, and Storage (CCUS) is necessary to reduce the emissions produced as a biproduct of energy consumption. This process of injecting CO_2 into the subsurface is known as carbon sequestration and requires the assessment of geologic reservoirs. Stratigraphy and depositional processes have great influence over reservoir performance. The objective of this study is to demonstrate the depositional controls on storage capacity.

A subsurface Lower Miocene 2 strandplain/barrier bar complex of the Texas Gulf Coast at Matagorda bay is interpreted and modeled using well data and 3D seismic. This reveals the presence of a major shore zone that experienced initial progradation through the late highstand and into the lowstand before later retrogradation. A stratigraphic framework is built that captures these changes in shoreline position at both the systems tract and parasequences level. Sediments were strike fed and wave-dominated processes are apparent. Petrophysical properties of this region including porosity are modeled from with machine learning from log data. Machine learning to predict porosity is carried out using a random forest regression in which porosity is a function of lithology and depth. Finally, a 3D geocellular reservoir model is built integrating the stratigraphic, facies, and petrophysical properties. Static storage capacity estimates and storage capacity maps are created from the 3D model. Storage capacity occurs at a strike parallel geometry. This "axis" of highest storage capacity tracts with the position of the shore zone in vertical succession highlighting a sea level dependency on the position of storage capacity. At a finer resolution, storage capacity is observed highest within the foreshore where beach ridges are interpreted from seismic stratal slices. Storage capacity is then a direct function of the high wave energy paleo-depositional processes occurring at the shoreline.

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