Characterization of natural CO2 systems of the Lower Ordovician through Lower Permian strata in the Delaware, Val Verde, and Marfa Basin areas and the Marathon-Ouachita Fold Belt area of the southern Permian Basin of Texas

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ABSTRACT

The U.S. Geological Survey has constructed a model for the generation and migration of natural CO2 that occurs in Lower Ordovician through Lower Permian strata in the southern Permian Basin of Texas. In order to construct the model, interpretations of 2D seismic reflectance surveys in the Delaware and Val Verde sub-basins have been correlated to build a subsurface structural framework to identify potential CO2 migration pathways. Water chemistry analyses from 43 producing gas wells and geothermal springs in the Delaware, Val Verde, and Marfa sub-basins, and the Marathon-Ouachita Fold Belt are interpreted in conjunction with this structural framework to create a source-to-sink migration model for natural CO2.

The majority of CO2 production in the southern Permian Basin has been from the Ellenburger Dolomite and the Caballos Novaculite. Natural gas and formation water samples were collected from the Ellenburger, Fusselman, Devonian, Caballos, Atoka, and Wolfcamp units. Gas compositional data and both stable and noble gas isotopic analyses indicate a complex mix of CO2 that is derived from crustal sources and magmatic sources associated with intrusion, uplift and high heat flow in the central part of the Permian Basin. CO2 is thought to have migrated vertically along high angle faults within the sub-basins and along north-verging thrust plates from the Marathon-Ouachita Fold Belt. Understanding the generation, migration, and fate of this CO2 is important since many of the gas fields in the Delaware and Val Verde foreland sub-basins have been significant natural sources of CO2 for use in CO2-enhanced oil recovery floods for nearly 50 years. The presented migration pathway model for CO2 can be used as a prospective tool for future studies focused on natural CO2 resource potential and economic potential of natural gas discoveries within the southern Permian Basin of Texas.