Screening Assessment of Prospective CO_2 Storage Resources Potential in Saline Carbonate Systems, Central North Dakota Region

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Abstract

As part of the U.S. Department of Energy-funded North Dakota CarbonSAFE Phase III effort, a screening-level assessment was conducted over central North Dakota, including McLean, Mercer, and Morton Counties, to determine if viable CO_2 storage resource potential exists within carbonate saline reservoirs. Published literature and data from 173 wells were used in the study which focused on identifying carbonate saline reservoirs and suitable confining zones for CO_2 storage, with emphasis on three key questions: 1) are the carbonate saline reservoirs viable for CO_2 storage? 2) what is their range of storage resource potential? and 3) what are the main elements driving uncertainty and risk of potential capacity and containment? Petrophysical analyses were carried out using SLB Techlog software and the available wireline and core calibration data for wells across the area of interest (AOI), with five recently drilled stratigraphic wells that included advanced wireline log data forming the basis of the petrophysical model. The analysis resulted in profiles of total and effective porosity, permeability, and lithological model for key wells across the study area. A systematic risk assessment of the Cambrian through Mississippian carbonate and clastic units was conducted using six screening criteria. The assessment focused on identifying favorable characteristics of carbonate saline reservoirs with overlying confining zones. For the reservoirs that exhibited significant storage resource potential, further work was conducted to characterize depositional setting, primary lithology, and facies allowing characterizations of zonal continuity and average thickness across a 100-square-kilometer circular region used for the storage resource potential estimates. The National Energy Technology Lab (2010) log odds CO_2 storage resource estimating tool was used to calculate storage resource potential estimates for each reservoir using 10th, 50th, and 90th percentile estimates to quantify uncertainty. Storage resource potential exists in numerous carbonate reservoirs within the AOI. Following application of geologic risk scores to the unrisked 50th percentile storage mass estimates, the best candidate storage zones are 1) Silurian Interlake Formation, 2) Mississippian Mission Canyon Formation Tilston interval, 3) Devonian Birdbear/Duperow Formations, 4) Mississippian Charles Formation Ratcliffe interval, and 5) Devonian Dawson Bay Formation. The five most prospective zones represent 750 million metric tonnes of CO_2 storage resource potential within a 100-square-mile region. Additional storage resource potential of 407 million metric tonnes CO_2 exists in the remaining 12 candidate zones, but the risk profile is elevated. The five most prospective CO_2 storage candidate zones are carbonates and 11 of the 17 evaluated zones are dominantly carbonates.