Geochemical Analysis of CO_2 Storage in Lithuanian Deep Saline Aquifers: Implications for Long-Term Carbon Capture and Storage Feasibility

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Abstract

The Carbon Capture and Storage (CCS) technique has emerged as a pivotal strategy in the battle against climate change by mitigating CO2 emissions. This study delves into the intricate geochemical dynamics involved in storing captured CO2 in deep saline aquifers, specifically focusing on Lithuanian reservoirs, Syderiai and Vaskai, renowned for their substantial storage potential. The investigation seeks to comprehend the variations in petrophysical properties and mineral composition resulting from prolonged CO2 interactions over a 500-year injection period.

As CO2 is captured and injected into subsurface formations, it initiates both physical and chemical transformations that influence the porosity and permeability of these formations, consequently affecting their storage capacity. The study employs a reactive transport model to simulate this intricate process. The prevailing mineral in these saline aquifers is quartz, constituting more than 90%, with traces of clay minerals and carbonates. The stability of quartz is a key focus, as it undergoes minimal changes in concentration during continuous CO2 injection.

The research sheds light on the dynamic role of clay minerals in influencing pore fluid chemistry, potentially impacting the absorption or entrapment of CO2 molecules. Furthermore, carbonate minerals react with CO2, inducing dissolution and precipitation reactions. These geochemical reactions result in changes in the rock's porosity and permeability, directly affecting the storage capacity of injected CO2. The observed alterations in petrophysical properties, including porosity and permeability, are found to be concentrated around the injection site, gradually diminishing with distance from the point of injection.

A noteworthy finding is the stability and minimal reactivity of quartz, contributing significantly to the containment of injected CO2. The study provides critical insights into the feasibility and viability of long-term CO2 storage in Lithuanian deep saline aquifers. By comprehensively understanding the geochemical intricacies involved, this research contributes valuable knowledge for optimizing and ensuring the sustainability of CCS implementations in similar geological settings.