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The effect of mica group minerals on CO_2 storage in the sandstone reservoir of Kazakhstan

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Geochemical CO_2 sequestration (GCS) alter the water and mineral contents, therefore, consequences of the formation reactions at the local environmental conditions are crucial. This study aims to verify the mineral trapping of CO_2 in the subsurface and check the reactivity and effectiveness of mica minerals on storage performance. Prorva sandstone reservoir from the Pre-Caspian basin (Kazakhstan) was chosen for GCS modelling since it contains dark grey aleurolites with mica based on lithological analysis. TOUGHREACT (2-D radial model) was used to investigate the effect of mica minerals on reservoir potential to secure the CO_2 for a long-term safely. Constant rates of 1 kg/s for 10 and 10000 years over a distance of 1000 m radial were set for a simulation.

According to results of reactive transport modelling, injection of CO_2 lowered the pH value of the storage over a radial distance and resulted in prominent changes of primary minerals to secondary minerals. Essential minerals influencing carbonate storage, such as glauconite, muscovite and biotite, showed fast and complete dissolution. Dissolution of mica group minerals provided Fe^{2+}, Mg^{2+} and Al^{3+} to the brine leading to the precipitation of other minerals. Moreover, carbonates (siderite, ankerite, magnesite) and clay minerals (illite, kaolinite) were saturated in the model. The porosity of the reservoir decreased by the formation of secondary minerals leading to the shortage of CO_2 storage capacity. Precipitation of clay minerals can adversely affect pore availability. However, at the end of the simulation, poro-permo changes in the reservoir were minor, and carbon fixation results showed a safe and successful long-term storage at the selected site. Consequently, the mica group could be good candidates for the disposal of CO_2 through the synergetic formation of three thermodynamically stable carbonates, e.g., siderite, ankerite, and magnesite.