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CO_2/clay interactions and the significance for geological storage of carbon dioxide

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For the characterization of CO_2 storage reservoirs a number of critical parameters need to be assessed, like storage capacity or injection rate, where a straight-forward work flow based on existing experience in the oil and gas industry is available. Added complexity is in the identification of (potential) leakage pathways along wellbores, faults/fractures or even capillary seal networks. The critical aspects are mechanisms and rates of potential leakage. Over the past few years an improved understanding of the interaction of CO_2 with clay minerals was generated, with a major focus on swelling clays, such as montmorillonite. Especially in relatively young and / or low maturity sedimentary basins, smectite contents of the seal lithologies can be high (e.g. North Sea). It was found that for CO_2 storage and storage containment non-negligible physical effects result from clays in contact with CO_2 and water under pressure, temperature and stress conditions representative for geological reservoirs. It was shown that all clay minerals are able to adsorb significant amounts of CO_2, while only smectite swells in the presence of CO_2, thereby creating a swelling force that is potentially large and may affect local stress fields. Several cases where this interaction might become important are discussed in this contribution: (1) clay swelling between wellbore cement and host rock, (2) CO_2 adsorption of clays in the storage reservoir, (3) clay swelling and the impact on fractures and faults, potentially acting as pathways, for fluid leakage and (4) shrinkage of swelling clays due to dehydration by CO_2 and the possible creation of dehydration cracks. This contribution aims at summarizing these effects, increasing awareness and discussing its significance for the geological storage of CO_2.