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Impact of CO2 Permeation on Inter-layers and Reservoir Cap-rock Sealing Efficiency

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The need to find sufficient capacity for geological storage of carbon dioxide (CO_2) to meet demand means less-than ideal, heterogeneous reservoirs need to be considered. Many such reservoirs are apparently compartmentalised by inter-layers, which may help, or hinder, CO_2migration and storage capacity, depending upon their nature. The impact of shale inter-layers of thicknesses below seismic resolutions are generally neglected in plume migration simulations, but have been shown here to be important. Only simulations of plume migration that include the full coupling of all three of mass transport, geo-chemical and geo-mechanical processes together provide proper prediction of the barrier efficiency of relatively thin shale inter-layers. A series of feedback interactions, between these three process types, has been studied in detail, and, for example, leads to the unexpectedly higher barrier efficiency of relatively thin inter-layers compared to slightly thicker inter-layers. The results showed that changes to the capillary breakthrough pressure, together with diffusion processes, played the vital roles in enhancing the migration of the CO_2 plume via the thicker shale inter-layers towards the overburden. This presentation identifies significant research gaps regarding the effects of complicated, intricate processes affecting shale inter-layer (or seal) integrity under realistic reservoir conditions.