Effect of grid resolution and permeability anisotropy on mineral trapping for CO_2 disposal in the saline aquifer of Subei Basin, China

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A vertical 2-D numerical model is built to study the interactions between water and minerals after supercritical CO_2 is injected into the saline aquifer of Yancheng Formation in Subei Basin, China using the parallel reactive transport modelling code TOUGHREACT-MP. The result shows that the carbonate minerals (e.g., calcite, siderite and dawsonite) significantly precipitated due to the dissolution of epidote, chlorite and albite. The total amount of CO_2 mineral trapping was as high as 34.0% after 5000a. The results of sensitivity analysis show that the volume of epidote significantly affects the CO_2 storage capacity. Three scenarios for the same conceptual model with different grid resolution are carried on to analysis the effects of numerical resolution. The results show that grid resolution has little impact on the reaction path of minerals dissolution and precipitation, however, the total amount of CO_2 mineral trapping using coarser grid is overestimated comparing to that with finer grid. The influence of the ratio of permeability anisotropy is also compared using another three scenarios corresponding to large, moderate and small vertical permeability, respectively. The results indicate that reduction of the vertical permeability results in more solubility and mineral trapping for a short period of time (e.g., 1000 a). However, more CO_2 is stored in minerals for the model with a moderate vertical permeability after 1000a, which implies that convective mixing process may significantly enhance mineral trapping.

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Reconstructing past organic matter fluxes from $\delta^{15}N$ records

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Organic matter fluxes from mixed layer to sea floor are hard to quantify from sediment records. Remineralization in the water column and in the sediment extinguishes the primarily produced signal to different degrees. As the reliability of biogenic barium as a proxy for primary production turned out questionable during the past decade, the quantification of organic matter fluxes is open again. In a recent study, we demonstrate that in certain settings stable isotopes of nitrogen (δ15N) may provide a tool to reconstruct past organic matter fluxes.

Stable isotope ratios of nitrogen are indicative for N sources, availability and cycling in the water column. The δ15N signal can be transferred to the sea floor by sinking particulate organic matter and further archived in the sediments. Interpretation of sedimentary δ15N records is usually complicated by an early diagenetic isotopic enrichment that mainly occurs during particle sinking and at the sediment water interface. However, we discovered that isotopic enrichment proceeds systematically due to organic matter remineralization and follows Rayleigh type fractionation logics. Accordingly, if isotopic enrichment is known, we can recalculate the amount of organic N that has been remineralized.

Our study has been carried out on Eastern Mediterranean Sea sediments from Holocene to Pleistocene sapropels and their remnants after post-depositional remineralization. The data set further comprises recent to subrecent sediments as well as sediment trap samples. Reconstructed N fluxes from recent and past sediment samples match fluxes reported in sediment traps and seem to validate our approach. Similar coincidence has been obtained for Arabian Sea core record and sediment traps. Hence, the new application of δ15N possibly is appropriable in a wider range of marine settings.

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