Diagenesis of mudstone in ancient CO_2 reservoir: Implications for CO_2 geological storage

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Ancient CO_2 reservoir is a natural analogue for CO_2 geological storage, where the passage of the CO_2-bearing fluids is preserved as mineralogical and geochemical changes in the rock. The ancient CO_2 reservoir is characterized by the dawsonite-bearing sandstone in Southern Songliao basin, China. Cored interval (1478.5-1484.0 m) from well HX in the Southern Songliao basin Provides ideal material for revealing the influence of CO_2-bearing fluids on mudstone. Mudstone interlayer interval (1480.5-1481.5 m) and mudstone caprock interval (1472.5-1478.5m) have been examined with respect to petrology, mineralogy, and geochemistry, based on a total of 23 core samples.

The mudstone interlayer consists mainly of clay mineral and quartz plus feldspar, with subsidiary non-clay authigeneic mineral. Clay minerals were identified as illite/smectite and illite. The non-clay authigeneic mineral is characterized by the occurrence of dawsonite (1.8-5.9%), with varying amounts of dolomite, siderite, and pyrite. The $\delta^{13}C$ composition of dawsonite and dolomite has a very narrow ranges from -0.9 to -1.5‰ (PDB) and -0.3 to -1.2‰ (PDB), respectively; $\delta^{18}O$ composition ranges from -14.8 to-15.2‰ (PDB) and -15.2 to-16.0‰ (PDB), respectively.

The content of clay mineral and most of non-clay fraction in the mudstone caprock are similar to that of the mudstone interlayer, except for dawsonite. Being different from the mudstone interlayer which all contain dawsonite□dawsonite is detected only in one sample in mudstone caprock interval, where is located above the interface between sandstone and mudstone, and the vertical distance is about 1m. The $\delta^{13}C$ composition of dolomite also has a very narrow range from -1.0 to -2.4‰ (PDB), $\delta^{18}O$ composition ranges from -16.2 to-17.3‰ (PDB).

Based on carbon isotope data, CO_2 used for dawsonite and dolomite formation in mudstone interlayer and caprock is inferred to have derived from magmatic source, the carbonate minerals may thus be the result of mass transfer from the underling sandstone (ancient CO_2 reservoir) and CO_2 immobilization through carbonate precipitation. This research is funded by the National Natural Science Foundation of China (No. 41172091 and No. 41572082).