Caprock's nanoporus structure modification by supercritical CO_2/water interaction:A contribution of adsorption techniques

D. RHENALS[1,2] ,S.LAFORTUNE[1] , H. SOULI[2] AND P. DUBUJET[2]

[1]French National Institut for Industrial Environment and Risks, Parc Technologique Alata, BP 2, Verneuil-en-Halatte, 60550,France-david-rhenals@ineris.fr
[2]National School Engeeniers of Saint Etienne, 58 rue Jean Parot, Saint-Etienne, France

CO_2 storage is envisioned as a technique which reduces large quantities of CO_2 rejected in the atmosphere because of many human activities.

The effectiveness of this technique is mainly related to the storage capacity as well as its safety. The safety of this operation is primarily based on the conservation of petro-physical properties of the caprock, which prevents the transport of CO_2 through it. However when CO_2 reaches the reservoir/caprock interface due to buoyancy effects, the interaction between interstitial fluid and injected fluid creates a series of dissolution/precipitation reactions affecting the properties of containment of the caprock, which is generally characterized by low transport properties.

This study aims to assess the impact caused by CO_2/interstitial fluid interaction on the nanostructure of the caprock under geological storage conditions. In order to do this, degradation experiments in a well characterized shale have been conducted using batch reactors for two months.

Adsorption-desorption isotherms showed an increase in the sorption capacity as well as a variation on pore size distribution. BJH and Dubinin Stoeckli distributions showed an increase in porous density lower than 10 nm, which is mainly attributed to dissolution of carbonates and some aluminosilicates detected initially with XRD techniques. Chemical water analysis showed an increase in Ca,Mg,Na,K,Si concentration, which is consistent with porous structure variation determined by physical adsorption.

Composition of the shallow aqueous fluids released beneath the SE Mariana Forearc Rift

JULIA RIBEIRO[1], ROBERT J. STERN[1], KATHERINE A. KELLEY[2], ALISON SHAW[3], FERNANDO MARTINEZ[4] AND YASUHIKO OHARA[5]

[1]Geosciences, University of Texas at Dallas, USA.
[2]GSO, University of Rhode Island, USA.
[3]Depart. of Geology and Geophysics, WHOI, USA.
[4]SOEST, University of Hawai'i at Manoa, USA.
[5]Hydrographic and Oceanographic Depart. of Japan, Japan.

Fluids released from subducted slabs are thought to be more aqueous beneath forearcs than are the fluids released beneath arc volcanoes; however, investigating their composition is challenging as the cold forearc mantle generally does not melt. Basaltic lavas of the Southeast Mariana forearc rift (SEMFR) provide an unusual opportunity to examine basalts affected by such fluids. SEMFR extends from arc volcanoes nearly to the Mariana trench and was generated by forearc seafloor spreading ~2.7–3.7 Ma ago. SEMFR basalt compositions are similar to backarc basin basalts and contain olivines with unusually depleted basaltic melt inclusions. These OL-MI were captured by unusually refractory olivines ($Fo_{90\text{-}93}$), and we interpret them to have formed as hydrous melts trapped in the forearc mantle. Fragments of this mantle (OL xenocrysts and Cr-spinel) were entrained with SEMFR basalt magmas during their ascent. SEMFR glassy rinds and Ol-MI have variable volatile contents (mean H_2O=1.85±0.26 wt%, S=757±109 ppm, Cl=334±169 ppm, F=94±31 ppm, CO_2=144±137 ppm). SEMFR Ol-MI and their host basaltic glassy rinds have unusually high ratios of volatiles and fluid-mobile elements (FMEs; mean H_2O/Ce=10096±3901, Cl/Nb=1238±516, Cs/Th=6±5, Ba/Th=523±203, Rb/Th=79±38 for the Ol-MI; and mean H_2O/Ce=4953, Cl/Nb=838, Cs/Th=0.84±0.66, Ba/Th=265±97, Rb/Th=27±14 for the glassy rinds) ever recorded in the Mariana intraoceanic arc (mean H_2O/Ce=1705±1125, Cl/Nb=429±414, Cs/Th=0.39±0.16, Ba/Th=264±150, Rb/Th=15±3), indicating that the shallow fluids have distinctive FMEs/Th and volatile/incompatible ratios. SE-NW gradient in these ratios demonstrate that the aqueous fluids and the volatile fluxes are the highest at ~50–100 km slab depth, suggesting that hydrous minerals in the subducted slab mostly break down beneath the arc.

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