CO_2 degassing and groundwater mixing in the Navajo aquifer, Green River, Utah

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Natural subsurface CO_2 accumulations provide a unique opportunity to understand the long-term fate of anthropogenic CO_2 injected into geological reservoirs. Key parameters include the impact of CO_2 dissolution on reservoir pH and subsequent mineral dissolution / recrystallization processes. Cold-water geysers driven by the degassing of CO_2-saturated fluids in Crystal Geyser, Green River, Utah, allow direct sampling of the underlying CO_2-rich Navajo aquifer. Liquid and gaseous phases have been synchronously sampled during and between geysers eruptions; both water and gas samples have been analyzed for carbon isotopic composition. Water samples have also been analyzed for major and trace elements. The fluid composition changes systematically through the course of an eruption. This reflects mixing of fluid from a deep CO_2-charged aquifer into the shallow Navajo aquifer on the time-scale of eruptions, driven by the pressure perturbation induced by geysering. The evolution of CO_2 degassing has been reconstructed using thermodynamic modelling of the solubility of CO_2 and aqueous phase speciation coupled with a Rayleigh distillation model to reproduce the observed trends in $\delta^{13}C$ of gases and dissolved inorganic content of the waters. Results suggest that the Navajo aquifer at depth is under-saturated in CO_2. Degassing is estimated to initiate about 120 meters below the surface, when the fluid rises in the pipe. The pH at depth is calculated to be ~5.35, which is 1.35 pH unit lower than its surface value.

Ce-rich layers in manganese micronodules of the Brasil Basin

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Manganese micronodules (MN) were selected from miopelagic clays of Brasil basin (Atlantic Ocean) to investigate the evolution of their chemical composition depending on the size fraction. We studied bulk MN composition in size fraction: 1000-500, 500-250, 250-100 и 100-50 μm at site 1536 (24º01.1' W, 22°17.6' S, depth 5500 m (depth in core 420-430 cm).

Mn and Fe contents are changed from 23.6 to 31% and from 4.0 to 12.2% respectively. The ratio of Mn/Fe is initially increased from 3.5 to 5.8 and then it is decreased to 2.5 with the increase of MN size fraction.

Changes in iron content resulted in the similar variation in contents of phosphorus, Co, Li, Be, V, Tl, Y, Th, U and rare earth elements.The value of cerium anomaly is decreased from 5.1 to 4 and then it is increased to 14 with the increase of the MN size fraction.

To understand the variations of trace element composition between separate size fractions we analyzed the polished sections of MN by X-ray microanalysis on a scanning electron microscope JEOL JSM-6480LV.

Phase 1 with high manganese and nickel contents and the ratio of Mn/Fe = 9.6 is most widely represented. It is not-layered, enriched in clay material, captured during its formation from the associated sediment. It was formed during early diagenesis and grew at relatively high rate.

Phase 2 is thin-layered, Mn/Fe = 3.2. Phase 1 overlaps unconformably phase 2. It represents the first generation of MN.

Phase 3 is layered, Mn/Fe = 2.1, discontinuous layers of Ce enriched oxyhydroxide phase are contained between their layers.

Enriched in cerium phase 4 is found as the island chains of the substance between the layers of phase 3 and contains an average of about 8% of cerium. It has the lowest Mn/Fe = 1.6 and high Ti and P contents.

Variations in micronodule composition can be explained by influence of two processes – hydrogenous-diagenetic (phases 2-4) and diagenetic (phase 1).