Contribution of the reactive mineral surface area on CO_2 mineralization under natural conditions

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A natural hydrothermal field is considered to be a useful analogue of carbon dioxide mineralization because it integrates the long-term interaction signal. The hydrothermal field of Galicia is characterized fluids resulting from a granit reservoir with pCO_2 from 103 to 105 Pa and pH from 10 to 6. Fluids are characterized by an increase of major elements correlated to pCO_2. We evaluated the effect of deep CO_2 perturbation We evaluated the effects of deep CO_2 perturbation on the fluid-rock interaction system. Mineral reactivity which produces changes in the fluid mineral composition is mainly dependent on the 'real' reactive surface area.

The mineral surface area participating in reactions resulting from this pCO_2 gradient was estimated by an inverse model approach. Input data was based on the chemical composition of the fluids we sampled. The rate of mineral dissolution was estimated by the observed pH and equilibrium conditions.

Moreover, the major elemental concentrations allowed us to quantify the variation of the reactive surface area of minerals involved with the overall water-rock interaction.

The irreversible mass transfer process, ruled by the continuum equilibrium condition, was defined by the overall degree of reaction advancement, using a set of polynomial equations solved independently of time scale.We found that reactive surface area of calcite, albite and K-feldspar increases by 2 orders of magnitude over the entire CO_2 fluid-rock interaction process, while the reactive surface area of biotite increases by 4 orders of magnitude. This shows that fluid neutralisation and consequent CO_2 mineralization under the form of carbonate species is greatly dependent on the behaviour of the reactive surface area of the mineral association in this geological context. We propose that biotite plays a basic role on the pH stabilisation and redox control of environmental perturbation and CO_2 mineralization.

Origin and evolution of ferromanganese crusts from South Altantic

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Ferromanganese crusts are important tools in palaeooceanography for seawater microelement composition reconstruction and palaeocurrents identification. In this study the trace element content of crusts collected in South Atlantic at Mid Atlantic Ridge (st.2176), Angola Basin (st.2179) and Cape Basin (st.2188 and seamount st.2193) was determined.

We perform the layer-specific chemical analysis to estimate hydrogenous and hydrothermal contribution into crust formation. All crusts surfaces are dominantly hydrogenous that is proved with their chemical composition, namely trace elements enrichment and high positive Ce anomaly. Sample 2176 enriched with iron (up to 27%) and Mn/Fe ratio across the whole crust is about 0.4. We found high Co (up to 0.24%), Cu (0.1%) and As (0.04%) concentrations. Content of typical hydrogenous elements decreases from surface into deep crust layers reflecting changes in origin of matter.

The surface of sample 2179 (Angola Basin) abnormally enriched with Co (0.92%), Th (89 ppm) and Ce (0.29%). The REE composition of the crust upper layers exhibit high Ce anomaly (3.8-5.4) manifesting their hydrogenous signature, in contrast to lower layers with Ce anomaly value about 1.3. The lower layers are also depleted with other trivalent REEs and Y, and enriched with chalcophile elements like Zn and Cu, that indicates the hydrothermal origin of Fe oxyhydroxides.

The crust sample 2193 comes up to 20 kg in weight and characterized with dense texture without visible layers. Preliminary results show the sample enrichment with trace elements (Co – 0.82%, Ni – 0.33%, Pb – 0.22%, Ce – 0.20%, W – up to 170 ppm, Bi – 52 ppm, Th – 47 ppm) and Mn in contrast to other samples. The surface of crust probably undergo the dissolution due to strong near bottom currents flow.

The obtained data reveal a complex history of crusts formation, which origin often associated with submarine weathering (halmyrolysis), hydrothermal transportation reflected in chalcophile elements Cu and Zn concentrations. Subsequent crusts growth supplied with hydrogenous accumulation of matter from seawater.