

Tracing particulate scavenging fluxes using ^{210}Po and ^{210}Pb during North Atlantic GEOTRACES

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Quantifying the flux of oceanic particles is central to understanding the coupling of carbon and nutrient cycles that control the functioning of the ocean ecosystems and ultimately the global climate. The natural ^{210}Po and ^{210}Pb nuclide pair affords a radiometric means to model scavenging particle fluxes in the ocean on seasonal to annual time periods.

Data on the dissolved ($<0.2\ \mu\text{m}$), particulate ($>0.2\ \mu\text{m}$, $>53\ \mu\text{m}$) and/or the total phases of ^{210}Po and ^{210}Pb has been gathered during two GEOTRACES cruises at the western (GA02, spring 2010) and eastern (GA03, fall 2010) basins of North Atlantic, that include entire (GA03) and upper (GA02) water profiles.

Excess of ^{210}Pb relative to its parent nuclide ^{226}Ra is observed in surface water indicating atmospheric inputs. These inputs are more significant in the subtropics, in association with Saharian dust deposition. In the sub-surface, ^{210}Pb activities decrease and generally attain either equilibrium or deficit with respect to ^{226}Ra , indicating ^{210}Pb removal by scavenging. The surface ^{210}Pb maximum generally corresponds to a minimum in ^{210}Po . Such surface ^{210}Po depletion reflects beside atmospheric input, large particle formation and export to deeper water, where ^{210}Po is regenerated in excess with respect to ^{210}Pb . The highest surface ^{210}Po depletion and deeper regeneration is encountered at the eastern boundary of North Atlantic. Evident here is the expression of enhanced surface production induced from nearby continental sources and upwelling off Africa, and benthic boundary processes.

Based on the ^{210}Po - ^{210}Pb and ^{210}Pb - ^{226}Ra disequilibria, the upper water profiles of ^{210}Po and ^{210}Pb will be modeled using a steady-state box model for the assessment of particle scavenging fluxes. These can then be compared to the shorter term rates using ^{234}Th nuclide from the same cruises over weeks to months. Thus scavenging rates of several important components such as particulate organic carbon can be assessed over different time scales. Based on the different biogeochemical properties of these nuclides, a distinction can be made between biogenic and lithogenic scavenging associated with particle fluxes in both basins of North Atlantic. As important, these scavenging rates can be compared to the legacy of modeling these nuclides over the past decades to assess transient changes in basin biodynamics.

Estimation of the mineral reactive surface area during CO_2 mineralization in natural hydrothermal fields.

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19b Linking experimental and field observations of mineral carbonation for in-situ long-term carbon storage

The quantitative description of fluid-rock reactivity in natural geothermal field is a useful tool in predicting become and fate of CO_2 artificially injected in natural geological reservoirs. The complex process of CO_2 mineralization involving a set of mineral dissolution and precipitation reactions is probably the best way to permanently storage CO_2 . However the overall process strongly depends on the real amount of mineral able to react in the CO_2 mineralization process. In this work we report results of an original methodology able to estimate the Reactive Surface Area (RSA) of the minerals in the high CO_2 fluid geothermal system of Galicia (Spain). This field is characterized by fluids having pH ranging from 6 to 10 with corresponding pCO_2 partial pressure varying from 10^5 to 1 Pa and CO_2 content linearly correlated to the variation of the major dissolved cations.

The methodology to estimate the variation of RSA during the CO_2 neutralization is based on an inverse model approach using the composition of springs and borehole fluids as input data. Assuming the continuum equilibrium condition, the irreversible mass transfer process has been described by the overall degree of reaction advancement using a set of polynomial equations solved independently of time scale. The apparent rate of mineral dissolution was estimated by the observed pH and equilibrium conditions. Calculations were carried out for albite, K-feldspar, biotite and calcite, assuming dissolved aluminum and silica activities controlled by quartz and kaolinite equilibria.

We found that RSA of calcite, albite and K-feldspar increases by 2 orders of magnitude over the entire CO_2 -fluid-rock interaction process, while RSA of biotite increases by 4 orders of magnitude. This shows that reactive surface area of minerals is not constant and changes by several orders of magnitude along the entire CO_2 -water-rock process. Our work quantifying the evolution of this key kinetic parameter allows new constrains in modelling reactive transport of fluid-rock interaction processes and the safe mineralization of artificially injected CO_2 in natural reservoirs.