Multi-isotope monitoring of enhanced weathering of glauconitic sands under controlled high pCO_2 conditions

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Enhanced water-rock interaction in aquifers overlying CO_2 storage sites in deep saline formation can be expected in the case of CO_2 leakage, leading to a release of geogenic compounds into freshwater resources. Our study investigates the use of trace elements and several isotope systematics (B, Li, C, O, D, Sr) as monitoring tools to detect CO_2-leaks in aquifers. For this, we develop batch experiments under controlled pCO_2 conditions. The glauconitic Albian greensands of the Paris Basin were chosen as interacting solid phase because i) the Paris Basin contains aquifers identified as CCS targets and ii) the Albian aquifer is a deep freshwater resource of strategic national importance. The selected greensand sample consists mainly of quartz with presence of glauconitic minerals and traces of apatite, rutile, ilmenite. The water used for the experiments was pumped from the confined part of the Albian aquifer. PTFE reactors (liquid/solid ratio of 10, pCO_2= 2 bar; room temperature, continuous pH measurements) were run simultaneously, over 1 day, 1 week, 2 weeks and 1 month. A pH drop from 6.6 to 4.9 was noticeable immediately after the injection, due to CO_2 dissolution (ΔHCO_3 = 0.8 mmol/L). Cations and silica increased by a factor of 2 (Ca), 2 (SiO2), 1.5 (K), 1.3 (Mg), 1.5 (Sr), 3.7 (Li), 4.2 (B) for t=1 month. From 1 day to 1 month of contact with CO_2, the $\delta^{13}C_{DIC}$ decreased from -15.7 ‰ to -21 ‰ vs. PDB suggesting a proton-consuming process which entails supplementary CO_2 dissolution. Weathering reactions and surface complexation consume acidity and account for the observed chemical variations. Glauconitic minerals being the main B-bearing phase, the evolution of the aqueous B concentrations indicates their implication in the water-gas-mineral interactions. This is supported by a shift of $\delta^{11}B$ towards more negative values in the presence of CO_2. The $\delta^{11}B$ is different according to the origin of the B (surface or structural), which gives additional information of the actual processes at stake during the evolution.

We focus here on the complex weathering behavior of glauconitic minerals, as poorly defined phases with regards to its mineral structure, under pCO_2 and low-pH conditions, constraining e.g. dissolution rates and surface complexation models through isotope and geochemical data.

A comparative mineral magnetic study of the intrabasaltic palaeosols and modern soils from the Deccan volcanic province, India

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Total 65 samples representing a variety of red, green and brown bole beds (intrabasaltic palaeosols), the associated underlying and overlying Deccan trap basalts and the modern soils (developed upon the basalts during Holocene) are studied for their mineral magnetic characterization augmented with field examination. The red boles show highest Fe-oxide concentrations amongst the studied intrabasaltic palaeosols but lower than the modern soils formed over these basalts. The qualitative mineral magnetic parameters however indicate a polygenetic control of the mineral species for of these bole beds with a unimodal finer superparamagnetic (SP) fraction that may be of pedogenic origin or product of baking. Comparisons of mineral magnetism of with the unbaked modern soils however suggest that the finer faction is from baking effects. This depicts a complex recycled nature for the red boles with pigmentary hematite imparting the red colouration over a combination of detrital mixtures. The green boles with low ferrimagnetic concentration indicate less oxidative but humid conditions that may possibly occur during the short events of volcanic winters. Although the bole beds largely depict the recycled nature of the magnetic mineral concentrates disproportionate to the concentrations of magnetic minerals in the underlying (/parent) basalts (unlike the modern soils). This suggests in a profile indicate the independent controls like the intensity and duration of baking in the red boles in particular and the palaeoweathering and palaeoenvironments in general (in all the bole beds). The mineral magnetic results further do not support existence of systematic soil profiles amongst any of the studied sections and the genesis of bole beds is largely governed by the surface water interaction with the weathering products. A detailed knowledge on these bole beds can lead to understanding on the post-eruptive paleoweathering and palaeoenvironmental conditions and hence demand a during the formation of these intrabasaltic bole beds employing a multi-proxy approach is therefore warranted in further understanding and characterizing the genesis of large variety of intrabasaltic bole beds which abundantly occur in the Deccan volcanic province of India including mineral magnetism.